Environmental Assessment

Issuance of an Endangered Species Act Section 10(a)(1)(A) Enhancement Permit to the National Marine Fisheries Service Southwest Fisheries Science Center Fisheries Ecology Division for the Operation of the Southern Coho Salmon Captive Broodstock Program

Photo: Morgan Bond, SWFSC

Prepared By:
NOAA's National Marine Fisheries Service
West Coast Region
May 20, 2025

COVER SHEET

Title of Environmental Review:	Environmental Assessment for the Southern Coho Salmon Captive Broodstock Program
Evolutionary Significant Unit:	California Central Coast coho salmon
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Location of Proposed Activities:	Coastal streams of the Santa Cruz Mountains in San Mateo and Santa Cruz counties, California
Activity Considered:	National Marine Fisheries Service proposes to issue an Endangered Species Act section 10(a)(1)(A) enhancement permit for the operation of the Southern Coho Salmon Captive Broodstock Program according to the hatchery genetic management plan submitted by the National Marine Fisheries Service Southwest Fisheries Science Center.

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LIST OF ACRONYMS AND ABBREVIATIONS

CCC	Central California Coast
CCRWQCB	Central Coast Regional Water Quality Control Board
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
DCFH	Don Clausen Fish Hatchery
DPS	Distinct Population Segment
EA	Environmental Assessment
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FED	Fisheries Ecology Division (NOAA SWFSC)
FRGP	Fisheries Restoration Grants Program
HGMP	Hatchery Genetic Management Plan
HOR	Hatchery-Origin
KFH	Kingfisher Flat (Genetic Conservation) Hatchery
L/sec	Liters per second
MBSTP	Monterey Bay Salmon Trout Project
MMPA	Marine Mammal Protection Act
NAHC	Native American Heritage Commission
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOR	Natural-Origin Fish
NPDES	National Pollutant Discharge Elimination System
PHOS	Proportion of natural spawning population consisting of Hatchery fish
PNI	Proportionate Natural Influence
PNOB	Proportion of Broodstock Consisting of NOR fish
RRCSCBP	Russian River Coho Salmon Captive Broodstock Program
SCMDS	Santa Cruz Mountains Diversity Stratum
SCSCBP	Southern Coho Salmon Captive Broodstock Program
SWFSC	Southwest Fisheries Science Center
SWRCB	State Water Resources Control Board
UCSC	University of California at Santa Cruz
USACE	United States Army Corps of Engineers

1 INTRODUCTION

The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) is the lead agency responsible for administering the Federal Endangered Species Act (ESA) (16 U.S.C. 1531 *et seq.*) as it relates to listed salmon and steelhead. Actions that may affect listed species are reviewed by NMFS under section 7 and section 10 of the ESA, or under section 4(d), which is used to limit the application of take prohibitions described in section 9.

In September 2018, NOAA's Southwest Fisheries Science Center (SWFSC) Fisheries Ecology Division (FED) shared with NMFS a preliminary draft of the hatchery genetic management plan for the Southern Coho Salmon Captive Broodstock Program (program). At this time, NMFS anticipated the HGMP would be finalized and submitted with an ESA section 10(a)(1)(A) enhancement permit application for the program. NMFS proceeded with its review of the program. However, completion of the HGMP and section 10(a)(1)(A) enhancement permit application was delayed due to several factors, including funding/staffing availability, exceptional drought conditions, and the aftermath of the 2020 CZU Lightning Complex Fire in the Santa Cruz Mountains (coupled with continued drought in 2021-2022).

On February 16, 2023, FED submitted a section 10(a)(1)(A) enhancement permit application and HGMP to NMFS for the program. The HGMP provides a framework for the breeding, rearing, releasing, and associated monitoring and evaluation activities that will occur in coastal streams of Santa Cruz and San Mateo counties known to support populations of the federally endangered Central California Coast (CCC) coho salmon (*Oncorhynchus kisutch*) Evolutionary Significant Unit (ESU) and the federally threatened CCC steelhead (*O. mykiss*) Distinct Population Segment (DPS).

NMFS seeks to consider, through a National Environmental Policy Act (NEPA) analysis, how its pending action may affect the natural and physical environment and the relationship of people with that environment. The NEPA analysis provides an opportunity to consider, for example, how the action may affect the conservation of other listed species, non-listed species, and the socioeconomic objectives that seek to balance conservation with the use of affected resources and other legal and policy mandates. If NMFS determines that the application meets all applicable criteria, NMFS will issue the ESA section 10(a)(1)(A) enhancement permit to FED for operation of the program as described in the HGMP (Appendix A).

1.1 Description of the Proposed Action

FED proposes to operate a genetically managed hatchery program for the restoration of depleted or lost populations of CCC coho salmon in the Santa Cruz Mountain Diversity Stratum (SCMDS). The program will operate as an integrated recovery type hatchery as defined by the California (CAHSRG 2012) and Columbia River Hatchery Scientific Review Group (CRHSRG 2014)[1]. The intent of an integrated program is to create conditions wherein the natural

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[1] The HSRGs provide a definition for an integrated program, but not recovery. The HGMP templates states: An artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular

environment drives the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild (i.e., naturally).

The program currently uses both natural-origin (NOR) and captive broodstock as well as the release of juvenile and adult fish to prevent regional extirpation, conserve population genetics, and to maintain a breeding population of CCC coho salmon south of San Francisco. Broodstock for the program are usually collected in SCMDS streams. A small number of outbreeders are used annually to increase genetic diversity. The outbreeders are sourced from the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) operated at Don Clausen Fish Hatchery (DCFH) in Sonoma County and include NOR fish from the Russian River (Sonoma County) and Lagunitas-Olema Creek (Marin County).

The program releases CCC coho salmon annually into SCMDS streams. Hatchery programs contribute to the recovery of listed salmonid populations by maintaining or increasing the abundance and genetic diversity of the naturally spawning population until it is self-sustaining. The HGMP outlines a four-phased approach for the Program that details a hatchery management strategy from a population preservation phase (Phase 1) to full recovery in SCMDS (Phase 4). Established regional monitoring will provide data to evaluate the program's status and effects to ESA-listed species, and inform the decision making-body, a technical oversight committee (TOC), on program progress.

NMFS is reviewing the ESA section 10(a)(1)(A) permit application submitted by FED to evaluate whether the application meets applicable criteria specified in section 10(a)(1)(A) of the ESA and NMFS' implementing regulations. Under the proposed action, NMFS will determine if the HGMP meets the criteria of the ESA, and if it meets these requirements, NMFS will issue an ESA section 10(a)(1)(A) enhancement permit. Additionally, NMFS is reviewing the effects of the program under section 7 of the ESA to determine whether issuance of the enhancement permit is likely to jeopardize the continued existence of CCC coho salmon or CCC steelhead, or result in destruction or adverse modification of any critical habitat.

The following enhancement activities, as described in the HGMP, have the potential to affect CCC coho salmon and/or CCC steelhead:

- Transport of collected broodstock including NOR and hatchery-origin (HOR) adults and NOR juveniles,
- Mating/spawning of adult fish,
- Egg incubation and juvenile captive rearing,
- Marking of HOR juveniles,
- Egg, fry, parr, advanced parr, yearling (smolt) and adult broodstock releases to streams

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natural population(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Sometimes referred to as "supplementation."

1.2 Purpose and Need for Action

Issuance of an ESA section 10(a)(1)(A) enhancement permit is a Federal action subject to analysis for potential environmental impacts under NEPA. NMFS proposes to issue the ESA section 10(a)(1)(A) enhancement permit to FED, in order to operate the broodstock program. The purpose of the proposed action/preferred alternative is to carry out section 10(a)(1)(A), which allows for the authorization of actions to enhance the propagation or survival of listed species, here the CCC coho salmon ESU.

Coho salmon have been in decline in California for decades (Brown et al. 1994; Weitkamp et al. 1995; CDFG 2004; Spence et al. 2011; Williams et al. 2016), and populations are especially imperiled in the SCMDS at the southern end of their range (NMFS 2012; Williams et al. 2016; Spence 2022). Therefore, the proposed action is needed to conserve CCC coho salmon, which are in danger of extinction, pursuant to Congress' directive to conserve listed species.

1.3 Project Area

The project, or program, area includes the location of activities described in the HGMP including the three facilities and nine streams where CCC coho salmon are to be: (1) collected; (2) spawned, incubated, and reared; and (3) acclimated or released (Figure 1).

The three facilities used for the program are the Monterey Bay Salmon and Trout Project's (MBSTP) Kingfisher Flat Genetic Conservation Fish Hatchery (KFH), the FED laboratory facility (FED Lab), and U.S. Army Corps of Engineers' (Corps) DCFH facility (Figure 1).

KFH is located along Big Creek, a tributary to Scott Creek in northern Santa Cruz County, California. KFH is the primary facility for coho salmon spawning, egg incubation, and juvenile/adult rearing. All three facilities are expected to be utilized for rearing captive broodstock. In the case of a catastrophic event, the three facilities serve as a redundancy for the captive broodstock population, while also increasing total program rearing capacity.

The HGMP proposes to collect, rear and release CCC coho salmon in up to nine regional streams within Santa Cruz and San Mateo counties (Figure 2). The HGMP and current operations prioritize fish collections and releases on Scott, Waddell, San Vicente, and Pescadero creeks due to the presence of naturally produced coho salmon and fish trapping and monitoring infrastructure. Pescadero Creek is one of two independent populations within the SCMDS, with the other being the San Lorenzo River (Spence et al. 2008). Fish collection and releases in San Gregorio Creek, Gazos Creek, the San Lorenzo River, Soquel Creek, and Aptos Creek will be opportunistic during the first 10 years of the program and are limited until adult coho salmon abundance increases in the priority streams.

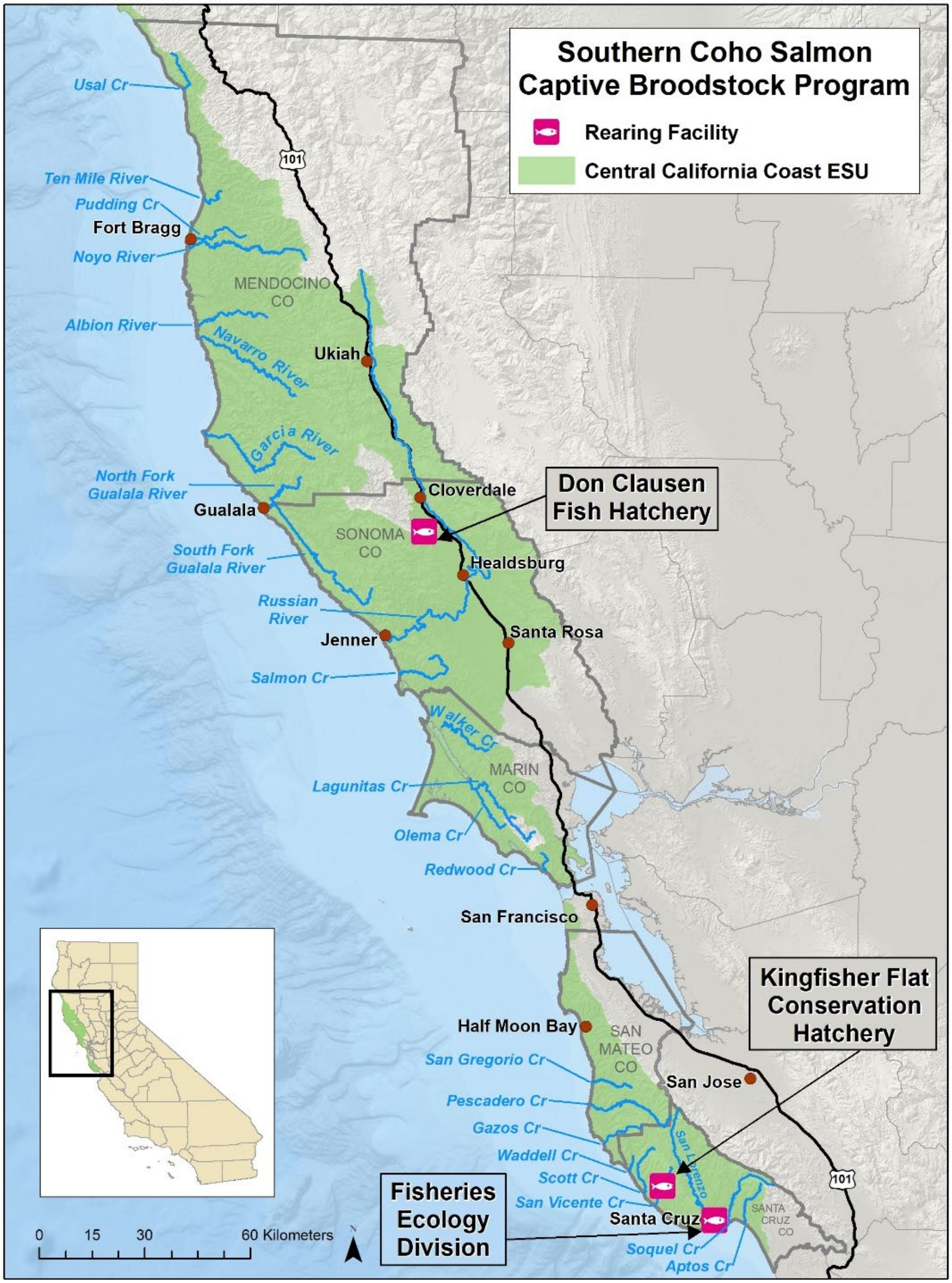

Figure 1. Boundary map of the Central California Coast coho salmon evolutionarily significant unit (ESU) and the locations of three rearing facilities of the Southern Coho Salmon Captive Broodstock Program. Map modified from CDFW and Corps (2017).

Figure 2. Location map of coho salmon recovery watersheds within the Santa Cruz Mountains Diversity Stratum. Except for Laguna Creek (recognized as a supplemental watershed rather than a recovery watershed), the program targets all watersheds in the diversity stratum.

1.4 Public Involvement

On March 18, 2024, a Notice of Availability for a draft EA was published in the Federal Register (89 FR 19297), which included a request for public comment. The 30-day public comment period closed on April 17, and no comments were received.

2 ALTERNATIVES

2.1 Alternatives Analyzed in Detail

Two alternatives were analyzed in detail: No Action Alternative (Alternative 1) and the Proposed Alternative (Alternative 2).

2.2 Alternative 1 (No Action Alternative): Do Not Issue the Section 10(a)(1)(A) Permit, do not Approve the HGMP

Under this alternative, NMFS would determine that the submitted application fails to meet the criteria necessary to issue an ESA section 10(a)(1)(A) enhancement permit to FED, and NMFS would not approve the HGMP as submitted. Because the HGMP would not be approved, the hatchery actions proposed by FED would not have ESA authorization or exemptions and would therefore be liable for take under Section 9 of the ESA. NMFS treats Alternative 1 as resulting in the termination of the ongoing SCSCBP, where coho salmon production would cease until a new permit application and HGMP are submitted and the applicants obtain an ESA section 10(a)(1)(A) enhancement permit.

2.3 Alternative 2 (Proposed Action): Issue the Section 10(a)(1)(A) Permit with Conditions and Approve the HGMP

Under this alternative, NMFS would issue a permit under section 10(a)(1)(A) of the ESA to FED for a period of ten years that authorizes hatchery production and release of up to 380 captive broodstock coho salmon adults and up to 170,000 combined eggs, fry, parr, advanced parr, and yearling coho salmon annually as described in the HGMP (Table 1). The number of coho salmon released by life stage is designed to achieve the adult downlisting criteria for SCMDS streams (NMFS 2012). The streams are prioritized into three groups for receiving adult and juvenile releases of hatchery production (Table 1). Group 1 streams are the highest priority locations for coho salmon releases.

2.4 Alternatives Considered but Not Analyzed in Detail

The HGMP considered the following alternative for implementation:

- Elimination of Captive Broodstock Element; Increase Juvenile Rearing Space and Juvenile Production

This alternative was rejected because the termination of the captive broodstock element eliminates a safety net for protecting the remaining genetic resources of CCC coho salmon in the SCMDS. Having a source of genetic material (fish) in the hatchery protects the population from adverse environmental effects (e.g., drought, flooding, fire and poor ocean survival), which, in addition to anthropogenic factors, have driven coho salmon to near extinction. Therefore, NMFS expects the elimination of the captive broodstock element would greatly impair the persistence and recovery of CCC coho salmon populations within the Santa Cruz Mountains, and the recovery of the ESU. Because this alternative was analyzed and rejected in the HGMP, it was not further analyzed in this EA.

Table 1. Annual maximum number of program egg, fry, parr, advanced parr, smolt and captive brood adults released by stream and group. Priority of egg and fish releases is to Group 1 streams. Total number of coho salmon released in a year (all life stages and locations) will not exceed 170,380*.

Stream Priority Group	Stream	Population Status	Naturally Produced Coho Salmon Present	Adult Abundance Downlisting Criteria	Maximum Release Number by Life Stage					Captive Brood
					Early Life Stages		Juveniles			
					Eggs	Fry	Parr	Advanced Parr	Smolts	
1	Scott Creek	Dependent	Yes	255	100,000	100,000	70,000	35,000	35,000 to 70,000	240
	Waddell Creek	Dependent	Yes	157	100,000	100,000	70,000	29,600	11,822	157
	San Vicente Creek	Dependent	Yes	53	100,000	79,819	53,213	9,977	3,991	53
	Pescadero Creek	Independent	No	1,150	100,000	100,000	70,000	35,000	35,000	240
2	Gazos Creek	Dependent	No	140	100,000	100,000	70,000	26,355	10,542	140
	San Lorenzo River	Independent	No	1,900	100,000	100,000	70,000	35,000	35,000	240
	San Gregorio Creek	Dependent	No	682	100,000	100,000	70,000	35,000	35,000	240
3	Soquel Creek	Dependent	No	561	100,000	100,000	70,000	35,000	35,000	240
	Aptos Creek	Dependent	No	466	100,000	100,000	70,000	35,000	35,000	240

**Note*: These release assumptions are based on achieving the in-hatchery survival performance metrics by life stage. If survival is lower than the metrics, then the release of more adults may be necessary. The juvenile numbers would not change, but the number of captive broodstock adults that would be available for release would be higher, or up to a maximum of 380.

3 AFFECTED ENVIRONMENT

3.1 Introduction

The affected environment in this analysis is defined as that portion of the physical and biological environment that may be affected by implementation of the alternatives described in Section 2. This chapter describes the existing baseline conditions for the following resources that may be affected by the two alternatives considered in this EA:

- Water Resources
- Salmon and Steelhead
- Other Fish Species
- Wildlife
- Cultural Resources

The proposed action is expected to have no, or extremely minor, effects on other resources such as geologic resources, air quality, noise and visual resources, vegetation, and species of wildlife other than those addressed. Therefore, those resources are not specifically addressed in this analysis.

3.2 Water Resources

The water resources potentially affected by the operations at KFH are those within Big Creek and Berry Creek (Scott Creek Watershed). The hatchery sits along Big Creek at approximately 1.5 river kilometers (rkm) upstream from the confluence with Scott Creek. Big Creek provides most of the water utilized by KFH. Berry Creek is a non-fish bearing tributary of Big Creek and serves as a primary source of water for egg incubation at KFH. KFH water diversion infrastructure is already in operation and no new permanent facilities will be built under the proposed action. Substantial changes or effects to water resources associated with the KFH facility are not anticipated.

The water resources potentially affected by the operations at the FED Lab are those from the Pacific Ocean, as seawater is drawn into the FED Lab. The FED Lab is already in operation and no new permanent facilities will be built under the proposed action.

At DCFH, the water resources potentially affected by the operations that occur at this facility are those within Dry Creek (Lake Sonoma), a tributary to the Russian River. DCFH is located immediately downstream of Warm Springs Dam/Lake Sonoma and is fed water directly from Lake Sonoma. This facility is the home of the Russian River Coho Salmon Captive Broodstock Program. No new permanent facilities will be built under this Proposed Action.

3.2.1 Water Quantity

The water supply for the SCSCBP is obtained from water sources that are associated with its specific facility.

3.2.2 Kingfisher Flat Hatchery

Surface water for the hatchery is obtained from two nearby sources - Big Creek and Berry Creek.

Big Creek - Water is diverted from Big Creek via a small retention dam built by California Department of Fish and Wildlife (CDFW) in 1927 and renovated by MBSTP in 1982. Diverted water is routed through a 20.3-centimeter (cm) PVC underground mainline to the hatchery. Maximum water flow rate is 92 liters per second (L/sec) and average late summer (base) flows are approximately 35 L/sec. However, low flows can approach 13 L/sec during drought conditions. An emergency backup line is used during critical low flows and provides water from Big Creek at a rate of approximately 8 L/sec. Additional emergency backup water is provided by a 9.5 L/sec sump pump placed in the stream. The intake on Big Creek is screened to prevent entrainment/impingement of fish and other wildlife. During periods of low stream flow, hatchery water is managed (via a designated spillway at the retention dam) to ensure freshwater habitats downstream of the dam receive adequate water and remain suitable for salmonid rearing.

Berry Creek - Surface water (19 L/sec) is diverted from Berry Creek through a screened inlet structure where water is passed through a sediment removal canister and then continues underground via a 10.2-centimeter (cm) PVC mainline to a 757 L storage tank on the hatchery grounds. Water is then gravity fed via a plastic pipeline to the hatchery.

Water from both sources is used for egg incubation and fish rearing and is returned back to Big Creek through multiple points adjacent to the hatchery. Outfall structures are elevated above the creek to prevent aquatic organisms from accessing and entering effluent conveyance systems and hatchery rearing tanks. Each hatchery rearing container is screened prior to its outfall to prevent fish from escaping, and likewise to prevent the entry of exogenous animals into the rearing container.

3.2.3 Fisheries Ecology Division

At the FED Lab, yearling and adult broodstock are reared in seawater. Seawater is pumped (59-95 L/sec) from the Pacific Ocean seaward of the Long Marine Laboratory at the University of California at Santa Cruz (UCSC) from the subtidal zone at rates depending on usage needs. The FED Lab and the Long Marine Laboratory share a common seawater intake and primary filtration system. Water is discharged back to the Pacific Ocean through several screened discharge pipes in the rocky subtidal zone. No listed or sensitive species are known to occur in the areas of intake or discharge.

3.2.4 Don Clausen Fish Hatchery

Surface water (up to 60 cfs, 1,699 L/sec) to operate DCFH is obtained from the stilling basin of Warm Springs Dam (Lake Sonoma). Water used for fish production at the hatchery is returned immediately to Dry Creek below the dam, where it eventually flows into the Russian River (NMFS 2020).

3.2.5 Water Quality

3.2.6 Kingfisher Flat Hatchery:

This facility is exempt from the National Pollutant Discharge Elimination System (NPDES) permit by the Central Coast Regional Water Quality Control Board due to the size of the facility (i.e., density and number of animals maintained), and the fact that no chemical effluent is released. Under the exemption, the only materials that may be discharged to the creek are fish food and feces as the potential adverse ecological effects from these products are considered negligible.

3.2.7 Fisheries Ecology Division Laboratory:

The FED Lab operates under NPDES general permit No. CAG993003, Order No. R3–2008–0059 issued to the University of California at Santa Cruz (UCSC), Long Marine Laboratory. Seawater used for rearing is pumped back to the ocean.

3.2.8 Don Clausen Fish Hatchery:

Discharged water from the DCFH is regulated by a NPDES Permit No. CA0024350, I.D. No. 1B84034050N issued by the North Coast Regional Water Quality Control Board (NCRWQCB). Discharge standards were established for the DCFH by the NCRWQCB based on designated beneficial uses for the subject waters, and include standards for turbidity, suspended sediment concentrations, temperature, and dissolved oxygen (NMFS 2008). Apart from infrequent periods of low dissolved oxygen in some years, DCFH has been in continuous compliance with its NPDES permit requirements.

3.3 Salmon and Steelhead

3.3.1 Central California Coast (CCC) Coho Salmon

The CCC coho salmon ESU, currently listed as endangered, was initially listed as threatened on October 31, 1996 (61 FR 56138). On June 28, 2005 (70 FR 37160), the species was reclassified as an endangered species in response to severe population declines (Brown et al. 1994; Adams et al. 1999). The ESU includes genetically managed coho salmon produced at KFH as part of the SCSCBP. Critical Habitat for CCC coho salmon was designated on May 5, 1999 (64 FR 24049). The action area is in the southern portion of the species range and their designated critical habitat.

The CCC coho salmon ESU ranges from Punta Gorda in southern coastal Humboldt County, California, south to Aptos Creek in Santa Cruz County, California. In addition, the ESU includes coho salmon from the following artificial propagation programs: the RRCSCBP[2], and the Southern Coho Salmon Captive Broodstock Program[3]. A total of 75 watersheds (populations) in the CCC ESU historically supported coho salmon and these populations have been grouped into

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[2] Formerly referred to as the Don Clausen Fish Hatchery Captive Broodstock Program.

[3] Formerly referred to as the Scott Creek/King Fisher Flats Conservation Program and the Scott Creek Captive Broodstock Program.

five diversity strata (i.e., geographically distinct areas with similar environmental conditions) for recovery planning (Bjorkstedt et al. 2005; NMFS 2012). The action area for this program is located within the Santa Cruz Mountains Diversity Stratum (SCMDS), the southern-most stratum for the species.

All populations in the CCC coho salmon ESU are currently doing poorly due to range constriction, fragmentation, and loss of genetic diversity (Williams et al. 2016; NMFS 2016a, 2016b). Coho salmon are especially imperiled within the SCMDS as populations have been functionally extirpated from nearly all historical watersheds. Within the SCMDS, coho salmon have rarely been observed in watersheds in any appreciable numbers other than Scott Creek. Nevertheless, the Scott Creek population has experienced substantial declines and few NOR adults have returned to the basin since 2006.

With a predominant three-year life cycle, coho salmon typically exhibit three distinct brood lineages. At the inception of the SCSCBP in 2002, the Scott Creek source population had already been reduced to a single dominant broodline with very small numbers of breeding individuals, while the two adjacent broodlines were severely depressed. Although NMFS, CDFW, and other program partners had originally anticipated terminating the SCSCBP in 2009, continued operation was deemed necessary to prevent extirpation of coho salmon south of San Francisco. Field surveys indicated that returns of natural-origin adult coho salmon to Scott Creek, once the regional stronghold that supported all three broodlines, had declined to critical levels (Figure 3).

Consequently, the population is presently at high risk of extirpation through demographic and genetic processes. The small effective population size (number of breeders) combined with low encounter rates between potential mates in the natural environment has resulted in a substantial loss of genetic variation in the population and the SCMDS. Moreover, the near elimination of brood lineages, coupled with the relatively inflexible three-year life history of coho salmon in California, increases the likelihood of extirpation since there is minimal gene flow among brood lineages and little chance of demographic rescue. Extirpation, or even the reduction of native populations to an unsustainably small number of family groups necessitates continued production of coho salmon through captive breeding as a means of preserving the remaining genetic lineage and reducing the likelihood of regional extirpation. The CCC Coho Salmon Recovery Plan explicitly recognizes that domain-scale recovery will not be possible without sustained, high-volume broodstock production coupled with strategic reintroductions and effectiveness monitoring (NMFS 2012).

Natural-origin CCC coho salmon production in SCMDS streams is concentrated in Scott Creek, Waddell Creek, San Vincente Creek and Pescadero Creek (Appendix A). However, except for Scott Creek, little information is available on CCC coho salmon abundance and productivity of other SCMDS streams.

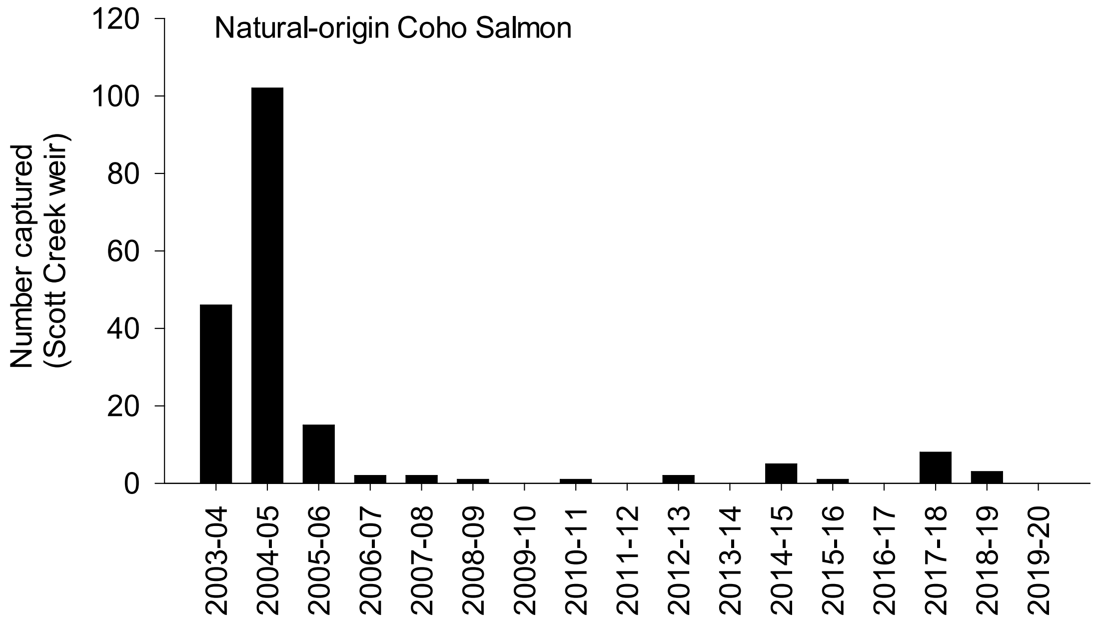

Figure 3. Time series of adult natural-origin coho salmon intercepted at the Scott Creek weir (Santa Cruz County, California) for return winters 2003–2004 through 2019–2020. Data are weir captures only and thus represent minimum estimates. Source: Kiernan et al. 2022.

Under current conditions, the SCSCBP releases fewer than 40,000 juveniles (fry, parr, smolt) annually into SCMDS streams, and in most years, releases do not exceed 25,000 total juveniles. Also, variable numbers of sexually mature adults (N = <200) have been released in two of the Program streams—Scott Creek and neighboring San Vicente Creek (Appendix A).

3.3.2 Central California Coast (CCC) Steelhead

The CCC steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS) was listed as a federally threatened species on August 18, 1997 (62 FR 43937). Following a status review on January 6, 2005, NMFS issued a final determination that CCC steelhead remain a threatened species as previously listed (71 FR 834). The CCC steelhead DPS includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian River to Aptos Creek, and the drainages of San Francisco and San Pablo Bays. CCC steelhead are present in all watersheds targeted for coho salmon reintroduction in the SCMDS. Since there is substantial life-history overlap between CCC coho salmon and CCC steelhead, there is potential for direct and indirect ecological interactions to occur between the species. The action area occurs within critical habitat for CCC steelhead, which was designated on September 2, 2005 (70 FR 52488).

Scarce abundance data makes it extraordinarily difficult to definitively ascertain the status of the DPS. However, within the action area steelhead still appear to occur in most watersheds. While data availability for this DPS remains poor (Williams et al. 2016), there is little new evidence to suggest that the extinction risk for this DPS has changed appreciably in either direction since the last status review (NMFS 2016c).

As was the case for CCC coho salmon, data on adult CCC steelhead abundance in the SCMDS comes primarily from Scott Creek (Figure 4). Juvenile CCC steelhead abundance for Gazos Creek, Waddell Creek and Scott Creek indicate that the number of fish per 100 feet of stream ranges from about 10 to 64 fish (Figure 5).

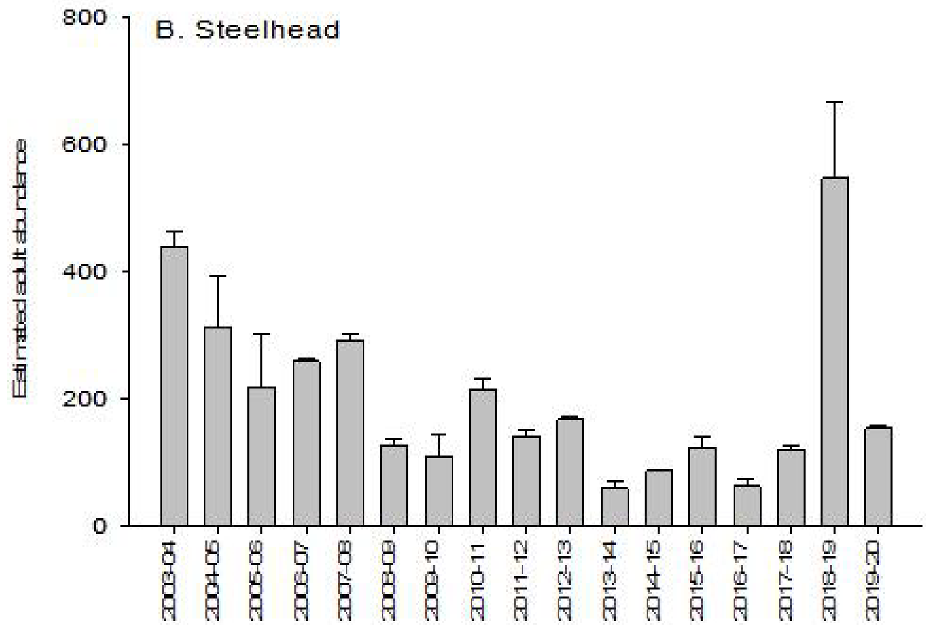

Figure 4. Time series of adult steelhead escapement to Scott Creek, spawn winters 2003–2004 through 2019–2020. Point estimates are derived from mark-recapture sampling and error bars represent +1 standard error. Source: Kiernan et al. 2022.

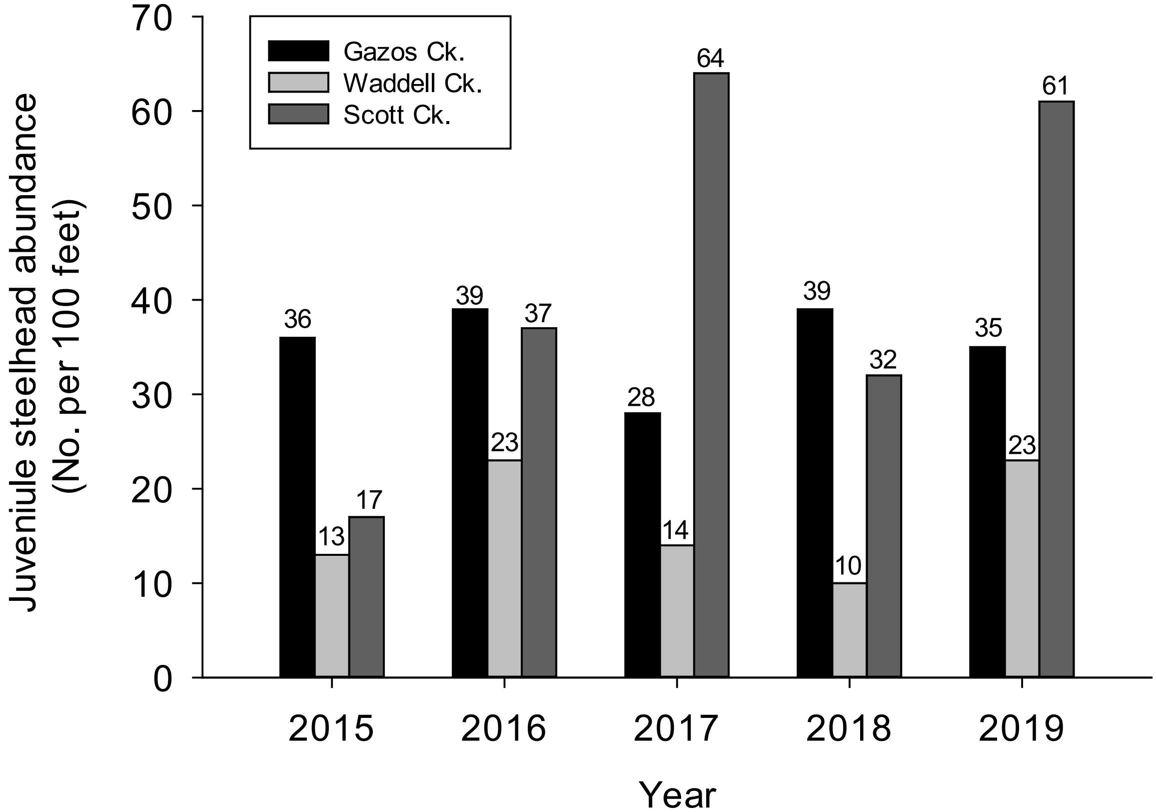

Figure 5. Steelhead juvenile abundance (individuals per 100 linear feet of stream) derived from summer-fall electrofishing surveys of Gazos Creek, Waddell Creek, and Scott Creek (2015–2019). Source: J. Smith, SJSU.

3.4 Other Fish Species

Various fish species in the action area have a relationship with salmon as competitors, prey, or predators (Table 2). Many fish species in the action area compete for food and space with salmon; as juveniles they may act as prey for salmon and as adults they may act as predators. Fish species known to occur in the action area that may prey on or compete with coho salmon include: brown bullhead (*Ictalurus nebulosus*), bluegill (*Lepomis macrochirus*), Monterey roach (*Hesperoleucus venustus subditus*), coastrange sculpin (*Cottus aleuticus*), green sunfish (*Lepomis cyanellus*), golden shiner (*Notemigonus crysoleucas*), Pacific lamprey (*Entosphenus tridentatus*), prickly sculpin (*Cottus asper*), Sacramento sucker (*Catostomus occidentalis*), speckled dace (*Rhinichthys osculus*), and striped bass (*Morone saxatilis*).

While specific habitat preferences vary greatly across species, the geographic range, or distribution, of many of the native species overlaps with coho salmon in the action area, thus many of these species may be affected by current and future program operations. Several of the fish species have been introduced to regional streams (Table 2); their distributions are limited to a few basins with most only occurring in the San Lorenzo River watershed.

The tidewater goby (*Eucyclogobius newberryi*) is a small native species that resides in estuarine environments and is listed as endangered under the ESA (59 FR 5494, February 4, 1994) with Critical Habitat designated on February 6, 2013 (78 FR 8745). Tidewater Goby are administered under the ESA by the United States Fish and Wildlife Service (USFWS).

3.5 Wildlife

The action area supports a variety of birds, mammals, amphibians, and invertebrates that may eat coho salmon, compete with coho salmon for food and space, and/or scavenge on coho salmon (throughout their different life stages) (Table 3). Predators of salmon include many bird species, amphibians, and marine and terrestrial mammals. Examples of avian predators of coho salmon in the action area include blue heron *(Ardea herodias),* double-chested cormorant *(Phalacrocorax auritus)*, and the western gull *(Larus occidentalis).*

Avian predation is a concern in the region. A recent empirical study by Frechette et al. (2012) demonstrated that avian predators can take up to 4.6% of out-migrating coho salmon and steelhead from the Scott, Waddell, and San Vicente Creek watersheds, annually. In addition to avian predators, marine mammals such as harbor seals *(Phoca vitulina),* northern elephant seals (*Mirounga angustirostris),* and California sea lions (*Zalophus californanus*) are present in the region and may represent substantial natural sources of predation on multiple coho salmon life stages.

Other wildlife species compete with salmon and steelhead for food and/or habitat. Adult coho salmon currently produced by the program are a food source for various wildlife species, which transport nutrients from the ocean (marine derived nutrients) into the terrestrial ecosystem through nutrient cycling. Another species that might provide benefits to the Program is the American beaver *(Castor canadensis)*, which can create slow-moving, and complex freshwater habitat utilized by juvenile coho salmon. However, the distribution of American beaver within the action area appears limited to the Pescadero Creek watershed (and its presence in this watershed remains unclear).

Table 2. Fish species, status, habitats utilized, and anticipated interactions with coho salmon in the action area

Species (N=Native; I=Introduced)	Listing Status (Federal and State)	Habitat Type	Type of Interaction with Salmon
Monterey Roach (N)	Species of Moderate concern (State)	Found in lower gradient riverine habitats. Can occupy large pools as well as shallow water areas.	● Potential prey item for juvenile salmon ● May compete with salmon for food
Pacific Lamprey (N)	Species of Moderate Concern (State)	Associated with migratory and rearing habitat in the various coastal streams of the Santa Cruz Mountain Diversity Stratum. Young use backwater and other low velocity habitats.	● Predator of salmon eggs and fry ● Potential prey item for juvenile salmon ● May compete with salmon for food and space. ● May benefit from carcasses of hatchery-origin fish
Sacramento Sucker (N)	None	Utilize lower gradient rivers and warm water	● Potential predator of salmon eggs and fry ● Potential prey item for salmon ● May compete with salmon for food and space
Sculpins Coastrange Sculpin (N) Prickly Sculpin (N) Staghorn Sculpin (N)	None	Coastrange Sculpin and Prickly Sculpin are associated freshwater habitats in coastal streams. Staghorn Sculpin are found in estuarine and marine habitats.	● Predator of salmon eggs and fry ● May compete with salmon for food and space. ● May benefit from carcasses of hatchery-origin fish
Speckled Dace (N)	None	Utilize well oxygenated streams with deep cover or overhead vegetation and woody debris.	● Potential predator of salmon eggs, fry, and juveniles ● May compete with juvenile salmon for space and food

Species (N=Native; I=Introduced)	Listing Status (Federal and State)	Habitat Type	Type of Interaction with Salmon
Threespine Stickleback (N)	None	Utilize slow moving waters with emerging vegetation	• May compete with juvenile salmon for food and space. • Potential prey item for salmon • May benefit from carcasses of hatchery- origin fish
Tidewater Goby (N)	Endangered (Federal)	Utilize shallow, slow moving, estuarine habitats	• Potential prey item for salmon • May compete with juvenile salmon for food and space
Bluegill (I)	None	Utilize lower gradient rivers and warmer water habitats	• Potential predator of juvenile salmon
Brown Bullhead (I)	None	Utilize lower gradient rivers	• Predator of salmon eggs and fry
Golden Shiner (I)	None	Utilize slow moving streams with dense aquatic vegetation.	• May compete with salmon for food and space
Green Sunfish (I)	None	Utilize lower gradient rivers and warmer water habitats	• Potential predator of salmon eggs, fry, and juveniles
Striped Bass (I)	None	Utilize lower gradient rivers and warmer water habitats	• Potential predator of juvenile salmon

Sources: NOAA's species webpage. Available at https://www.fisheries.noaa.gov/find-species; California Department of Fish and Wildlife Fish Species of Special Concern. Available at https://www.wildlife.ca.gov/Conservation/SSC/Fishes; University of California, Division of Agriculture and Natural Resources California Fish Website. Available at https;//calfishapp.wfcb.ucdavis.edu

Table 3. Status and habitat of native wildlife in the action area with indirect or direct relationships with hatchery-origin salmon.

Species	Listing Status (Federal and State)	Habitat Type	Type of Interaction with Salmon
California red-legged frog	Threatened (Federal) Species of special concern (State)	Freshwater	● Potential predator of salmon eggs and fry ● Potential prey item for juvenile salmon
Pacific giant salamander	Species of special concern (State)	Freshwater	● Potential prey item for juvenile salmon
western pond turtle	Species of special concern (State)	Freshwater	● Potential predator of salmon eggs and fry ● May compete with salmon for food and space
ducks, geese, and swans	None	Freshwater, Marine, Estuary	● Potential predator of salmon eggs and fry
gulls and terns	None	Freshwater, Marine, Estuary	● Potential predator of juvenile salmon ● Potential scavenger of adult salmon carcasses
great egret	Special animal (State)	Freshwater, Estuary	● Potential predator of juvenile salmon
great blue heron	Special animal (State)	Estuary	● Potential predator of juvenile salmon
double-crested cormorant	Special animal (State)	Freshwater, Marine, Estuary	● Potential predator of juvenile salmon ● Potential scavenger of adult salmon carcasses

Species	Listing Status (Federal and State)	Habitat Type	Type of Interaction with Salmon
osprey	Special animal (State)	Freshwater, Estuary	● Potential predator of juvenile salmon ● Potential scavenger of adult salmon carcasses
raccoon	None	Freshwater, Estuary	● Potential predator of salmon eggs, fry, and juveniles ● Potential scavenger of adult salmon carcasses
harbor seal northern elephant seal	MMPA (Federal)	Marine, Estuary	● Potential predator of salmon eggs, fry, and juvenile and adult salmon
California sea lion Stellar sea lion	MMPA (Federal)	Marine, Estuary	● Potential predator of salmon eggs, fry and juvenile and adult Potential predator of salmon eggs, fry, and juveniles

Endangered Species Act (ESA), California Endangered Species Act (CESA), California Department of Fish and Wildlife (CDFW), and Marine Mammal Protection Act (MMPA).

Sources: https://www.fisheries.noaa.gov/find-species; California Department of Fish and Wildlife, California Natural Diversity Database, Special Animal List, April 2018. Available at https://www.wildlife.ca.gov/Data/CNDDB

3.6 Cultural Resources

Effects on cultural resources typically occur when a proposed action disrupts or destroys cultural artifacts, disrupts cultural use of natural resources, or when it would disrupt cultural practices. Hatchery programs have the potential to affect cultural resources if there is construction, expansion or transportation at the hatchery facilities that disrupts or destroys cultural artifacts, or if the hatchery programs affect the ability of indigenous people to use salmon and steelhead in their cultural practices.

Salmon represent an important cultural resource to many indigenous people or tribes. It is a core symbol of tribal identity, individual identity, and the ability of many indigenous cultures to endure. The survival and well-being of salmon is seen as inextricably linked to the survival and well-being of indigenous people and the cultures of many tribes.

In addition, tribal assets are legal interests in property held in trust by the United States for tribes or individuals. The U.S. Secretary of the Interior, acting as the trustee, holds tribal assets, which may either be on or off tribal reservations. The United States, and thus Federal agencies, have a trust responsibility to protect and maintain these rights reserved by or granted to tribes or individuals by treaties, statutes, and executive orders. (NMFS 2005)[4]. The natural or physical environment of a tribe may include resources reserved by treaty or lands held in trust; native species (e.g., salmon and steelhead); sites of special cultural, religious, or archaeological importance, such as sites protected under the National Historic Preservation Act or the Native American Graves Protection and Repatriation Act; and other areas reserved for hunting, fishing, and gathering. Fishing is considered a tribal trust asset because treaties with the United States government on the West Coast guaranteed tribes party to those treaties the right to fish.

No new construction is planned, and transportation routes use existing roadways which avoids sites of special cultural, religious, or archaeological importance. The endangered status of CCC coho salmon, and the take prohibitions[5] associated with this listing, supersede any permissions that may exist otherwise allowing take of this species as a cultural resource. SCSCBP activities involve the collection of adult and juvenile coho salmon, and the spawning, rearing and release of fish into SCMDS streams. Therefore, program activities are reasonably likely to potentially affect cultural use and practices that utilize this natural resource. NMFS contacted the Bureau of Indian Affairs on September 17, 2018, in reference to tribal interest in the action area. The Bureau of Indian Affairs informed NMFS that there are no federally recognized tribes within the action area of the SCMDS. However, there is one federally recognized tribe that has land adjacent to DCFH where some of the program fish are reared. The Dry Creek Rancheria Band of Pomo has federally recognized land that is located adjacent to the DCFH facility (NMFS 2020). This tribe was contacted for the development of an EA for the issuance of an enhancement permit for the Russian River Coho Salmon Captive Broodstock Program, which described and evaluated the environmental impacts of rearing coho salmon at the DCFH.

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[4] For more information on Sovereign Relations, please visit the NMFS, West Coast Region website at: https://www.fisheries.noaa.gov/west-coast/partners/sovereign-relations-west-coast.

[5] Take of coho salmon is prohibited pursuant to section 4(d) and section 9 of the ESA (61 FR 56138).

In May 2023, NMFS obtained a list from the Native American Heritage Commission (NAHC) of tribes culturally affiliated with the program area, and who may have knowledge of cultural resources within the program area. Pursuant to 36 CFR § 800.4(a)(4), on June 21, 2023, NMFS sent letters offering consultation to the Association of Ramaytush Ohlone, Amah Mutsun Tribal Band, Amah Mutsun Tribal Band of San Juan Bautista, Costanoan Ohlone Rumsen-Mutsen Tribe, Indian Canyon Mutsun Band of Costanoan, Muwekma Ohlone Indian Tribe of the San Francisco Bay Area, Wuksache Indian Tribe/Eshom Valley Band, and the Costanoan Rumsen Carmel Tribe and requested their assistance to identify sites of religious or cultural significance in the program area that may be affected by the program. No responses were received. This outreach is also intended to ensure compliance with the American Indian Religious Freedom Act (1978) and Consultation and Coordination with Indian Tribal Governments (Executive Order 13175 [2000]).

4 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

The goal of this EA is to determine if any of the alternatives' effects are likely to be significant (NOAA 2009). The significance of the effect is determined by the degree to which the actions adversely or beneficially effect the affected environment's resources. To evaluate each alternative's potential environmental consequences on the affected environment, actions and effects must be placed in context of the Affected Environment, and an estimation of the probability of occurrence, magnitude or intensity and duration of the effect or intensity must be made. The relative degree of effects is described using the following terms:

- No Effect: No beneficial or adverse effect
- Undetectable: The effects would not be detectable
- Negligible: Beneficial or adverse effects would be at the lower levels of detection
- Low: Beneficial or adverse effects would be slight, but detectable
- Moderate: Beneficial or adverse effects would be measurable with low statistical power[6]
- High: Beneficial or adverse effects would be measurable with high statistical power[7]

This chapter provides the scientific and analytic basis for comparing the two alternatives. Each alternative is compared, where appropriate, to the effects the hatchery program had on environmental resources prior to 2020 (Appendix A). It includes a discussion of the probable consequences of the two proposed alternatives on environmental resources. The proposed action potentially can affect the physical or biological resources within the action area. The following is an analysis of the potential environmental consequences on the major components of the environment based on the current affected environment conditions described in Section 3

[6] Low statistical power means that a monitoring program designed to measure the effect would have a small chance of detecting a true effect as the results can be heavily influence by random or systematic error.

[7] High statistical power means that results from a monitoring program designed to measure the effect are likely valid.

(Affected Environment), above, organized by the alternatives considered in Section 2 (Alternatives Including the Proposed Action). Differences between the No-Action and Proposed Action alternatives are primarily related to incremental biological improvements due to full implementation of the HGMP over the next ten years.

A summary of effects by resource area is provided in Table 4. The rationale for each effect classification is provided in subsequent sections of this EA.

Table 4. Summary of effects on resources under each Alternative

Resource	Metric	Alternative 1 (No Action)	Alternative 2 (Proposed Action)
Water Resources	Quantity	No Effect	Negligible Adverse
	Quality	No Effect	Negligible Adverse
CCC Coho Salmon	Overall	High Adverse	High Beneficial
	Population	High Adverse	High Beneficial
	Ecological	Negligible Beneficial	Low Adverse
CCC Steelhead	Overall	Negligible Adverse	Low Beneficial
	Population	Negligible Adverse	Low Beneficial
	Ecological	Negligible Beneficial	Low Beneficial
Other Fish Species	Competing with Salmon	Negligible Beneficial	Negligible Adverse
	Predators of Salmon	Negligible Adverse	Negligible Beneficial
Wildlife	Predators of Salmon	Negligible Adverse	Negligible Beneficial
	Potential Prey Item	Negligible Beneficial	Negligible Adverse
Cultural Resources	All Aspects	No Effect	Negligible Beneficial

4.2 Alternative 1 (No Action)

Under the No Action Alternative, NMFS would not approve the application and HGMP as submitted after determining the submitted permit application and HGMP fail to meet the criteria necessary to issue an ESA section 10(a)(1)(A) enhancement permit. For the purposes of this analysis, this alternative would not allow for continued operation of the Program.

4.2.1 Water Resources

4.2.1.1 Water Quantity

Under Alternative 1 (No Action), the use of water for hatchery operations at KFH would not occur and therefore there would be no effect to water resources of Big Creek or Berry Creek.

Similarly, effects to waters diverted from the Pacific Ocean to operate facilities at the FED Lab would not occur, nor would any additional waters used from Lake Sonoma in the Russian River drainage be used to maintain Program fish at DCFH.

4.2.1.2 Water Quality

Under Alternative 1 (No Action), there would be no discharge from hatchery operations at KFH and therefore any effects from discharges to receiving waters, as occurs in Alternative 2 (Proposed Action) in Big Creek would be avoided. Similarly, there would be no discharge of waters to the Pacific Ocean from the FED Lab, or any added discharge related to the rearing of Program fish to Dry Creek in the Russian River basin.

4.2.2 Salmon and Steelhead

As described in Section 2.1 under Alternative 1 (No Action), if NMFS determines to not issue an ESA section 10(a)(1)(A) permit to FED to maintain the SCSCBP, Program operations would cease until a new permit application and HGMP are submitted, and the applicants are granted an ESA section 10(a)(1)(A) enhancement permit. Without the SCSCBP, all potential beneficial or adverse effects of the Program on biological resources would be eliminated.

4.2.2.1 Central California Coast Coho Salmon

If FED is not issued an ESA section 10(a)(1)(A) enhancement permit as described under Alternative 1 (No Action), it is anticipated high adverse effects to the CCC coho salmon ESU are reasonably likely to occur because of the discontinuation of hatchery production by the Program.

Population Effects

Hatchery production currently contributes to the overall abundance, population growth rate (productivity), population spatial structure and diversity of SCMDS CCC coho salmon. These four metrics form the viable salmon population (VSP) parameters used to define population status (McElhaney et al. 2000). The elimination of the program is expected to result in a decrease in all four VSP parameters resulting in a large decrease in population viability. Thus, this alternative is expected to have a high adverse effect on population viability.

Ecological Effects

Ecological effects of the Program on CCC coho salmon occur through the mechanisms of competition, predation, and disease. Competition between hatchery-origin and natural-origin coho salmon for limited resources may occur when large numbers of hatchery fish are released into the natural environment. The released fish may also prey on natural-origin fish resulting in a decrease in natural production. Both hatchery operations and fish releases may increase disease risk to naturally produced CCC coho salmon that can also reduce natural fish abundance.

Without the Program, as stated under Alternative 1 (No Action), hatchery-origin adult and juvenile CCC coho salmon will no longer be released to SCMDS streams. This in turn will reduce competition and predation risk to natural-origin CCC coho salmon, which is likely to result in a negligible beneficial effect as supported by the PCD-Risk modeling analysis provided in the HGMP (Appendix A). This modeling analysis showed that ecological effects to naturally produced CCC coho salmon from hatchery production was quite low (values of <3 out of possible maximum score of 100) over a range of hatchery release numbers, stream temperatures and the amount of time hatchery fish spend in the stream (Table 5).

In summary, while the elimination of the Program results in negligible beneficial effects on coho salmon, this benefit is diminished by the high adverse effect to population viability. Therefore, NMFS expects the adoption of Alternative 1 (No Action) would result in high adverse effects to the CCC coho salmon ESU including jeopardizing species recovery (NMFS 2012).

Table 5. PCD Risk results for natural-origin (NOR) coho salmon fry and smolts by hatchery-origin (HOR) residence time in the stream and stream temperature. The maximum PCD Risk value possible is 100.0 which results in complete loss of NOR fish.

7-Day Residence Time									
	Fry Release (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0.1	0.2	0.4	0.2	0.5	0.7	0.6	1.0	1.3
12	0.1	0.2	0.4	0.2	0.5	0.8	0.6	1.0	1.4
14	0.1	0.3	0.5	0.2	0.5	0.7	0.6	1.0	1.4
16	0.1	0.2	0.4	0.3	0.5	0.8	0.7	1.0	1.4
	Smolt (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3
12	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.3
14	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4
16	0.1	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.5
14-Day Residence Time									
	N = 4,000 (HOR Coho Salmon)								
Temperature (°C)	Fry Release			Smolt Release					
	Min	Ave	Max	Min	Ave	Max			
16	1.3	1.9	2.6	0.8	0.9	0.9			

4.2.2.2 Central California Coast Steelhead

If FED is not issued an ESA section 10(a)(1)(A) enhancement permit as described under Alternative 1 (No Action), it is anticipated that CCC steelhead will face negligible adverse effects. These negligible adverse effects will stem from the localized loss of coho salmon as prey (eggs and fry), as well as the minor impacts on the food chain from the reduced marine derived nutrient loads provided by more abundant adult coho salmon carcasses in the stream channel.

Population

These negligible adverse effects will be realized through decreased abundance of CCC coho salmon eggs, fry, and juveniles in program streams, which steelhead may use as a food source. If operations cease under Alternative 1 (No Action), these life stages of coho salmon will no longer be raised, or released, as part of the program and therefore CCC steelhead are expected to face negligible adverse effects to their salmon-based food sources, which constitute only a minor portion of the overall CCC steelhead diet. In addition, there would be a reduction of marine derived nutrients from adult coho salmon carcasses (returns or artificially placed from the hatchery), which would have some minor effect on the food chain.

Ecological

Similar to natural-origin CCC coho salmon, under Alternative 1 (No Action), it is likely juvenile CCC steelhead would experience negligible beneficial effects from the decreased abundance of juvenile coho salmon due to decreased competition for resources (i.e., food and habitat), and reduced predation. This would only occur in watersheds within the SCMDS where coho salmon are present because of releases by the program, otherwise there would be no effect for SCMDS watersheds where coho salmon are extirpated. There would also be negligible adverse effects related to the loss of marine-derived nutrients from adult salmon carcasses and eggs produced from these adult coho salmon during spawning.

4.2.3 Other Fish Species

If CCC coho salmon hatchery production were to cease, as described under Alternative 1 (No Action), those species identified in 2 as a "predator of salmon eggs, fry, juveniles and adults", and/or those identified as benefiting from "fish carcasses from hatchery-released fish" are reasonably expected to experience negligible adverse effects under Alternative 1 (No Action).

Conversely, it is also possible that fish identified in Table 2 as "competing with salmonids for food and space" may experience negligible beneficial effects due to increased availability of resources (i.e., food and habitat) from decreased competition with salmon and steelhead.

The effects to these other species are considered negligible based on the size of the hatchery program that is eliminated and the geographic scale it operates over (multiple basins).

4.2.4 Wildlife

Like the description above concerning "other fish species" wildlife species that are potential predators of coho salmon eggs, fry, juveniles, and adults in the action area have likely benefited to some degree from the ongoing efforts of the Program and may experience negligible adverse effects with Program termination under Alternative 1 (No Action).

Under this alternative it is possible that species identified in Table 3 that may be a "potential prey item of salmon" may experience negligible beneficial effects from the elimination of predation by hatchery-origin coho salmon. This includes the California red-legged frog (*Rana draytonii*), a species listed as threatened under the Federal ESA.

4.2.5 Cultural Resources

The Program utilizes existing facilities and roadways for transportation which already avoid culturally important artifacts. Under Alternative 1 (No Action), FED would not be issued a permit for the SCSCBP as proposed, resulting in adverse effects to salmonid populations, and would reasonably be expected to increase the extinction risk of the CCC coho salmon ESU (as described in section 3.3.1). Though salmon represent an important cultural resource to many tribes, the take prohibitions currently supersede any permissions that allow take of this species as a cultural resource at this time; thus, there is no effect to tribal assets under Alternative 1 (No Action).

4.3 Alternative 2 (Proposed Action)

Under this alternative (Proposed Action), NMFS would approve the submitted application and HGMP and issue the section 10(a)(1)(A) enhancement permit to FED for a period of ten years after determining that the application sufficiently meets the issuance criteria. The issued ESA section 10(a)(1)(A) enhancement permit would grant FED and other entities operating under the permit permission for the take of the ESA-listed species associated with the proposed hatchery program, including the production of CCC coho salmon (Appendix A). Operation of the program would include implementation of risk aversion measures to minimize the likelihood for adverse genetic and ecological effects, effects to water resources, listed species, and other wildlife as described in the HGMP.

4.3.1 Water Resources

4.3.1.1 Water Quantity

Under Alternative 2 (Proposed Action), the potential effects to water quantity is not expected to have a significant effect on hydrologic conditions and resources at the three program facilities.

At KFH, water for hatchery operations is managed with a designated spillway at a retention dam to ensure freshwater habitats downstream of the dam receive adequate water and always remain viable for salmonids. Because the water utilized to operate the KFH is continuously discharged back into the stream, and no appreciable consumption of water occurs. Therefore, any adverse effects on water quantity in the stream environment from operating these systems will be negligible.

At the FED Lab, seawater is pumped directly from the Pacific Ocean. The limited amount of water used to fill and maintain holding tanks at the FED Lab is negligible and would have no effects on supply.

Water used to rear Program fish at DCFH is obtained from the stilling basin of Warm Springs Dam (Russian River basin). Water used for fish production at the DCFH is returned to Dry Creek, where it eventually flows into the Russian River. The amount of water used for continued rearing of Program fish would be negligible (adverse), particularly when compared to the amount water available in Lake Sonoma (used to store and release water into Dry Creek for downstream uses), and the amount used to maintain ongoing DCFH program CCC coho salmon and steelhead hatchery programs.

4.3.1.2 Water Quality

No significant effects on water quality are expected under Alternative 2 (Proposed Action). Under this alternative water discharged from KFH is released into Big Creek and would contribute minor amounts of nutrient and organic matter (food and feces) to the creek due to KFH operations. However, this is not expected to result in significant effects to nutrients or algal growth in Big Creek or Scott Creek, which is consistent with past observations since 2002.

Because of its small size and the lack of chemical discharge to streams, the Central Coast Regional Water Quality Control Board (CCRWQCB) has exempted KFH from obtaining an NPDES permit. At both the FED Lab and DCFH facilities, water quality is closely monitored and treated to comply with existing NPDES permits issued by the CCRWQCB and NCRWQCB, respectively.

Therefore, Alternative 2 (Proposed Action) is expected to result in negligible adverse effects to water quality within the action area.

4.3.2 Salmon and Steelhead

4.3.2.1 CCC Coho Salmon

If NMFS issues an ESA section 10(a)(1)(A) permit for the SCSCBP as submitted under Alternative 2 (Proposed Action), high beneficial effects to CCC coho salmon are likely to occur.

Population Effects

Program releases of various life stages of hatchery-origin CCC coho salmon are expected to result in improvements in each of the four VSP parameters, abundance, population growth rate (productivity), spatial structure and diversity. The expected increase in adult CCC coho salmon abundance from Program fish releases is shown by life stage and stream in Table 7.

Over the 10-year term of the HGMP, benefits to CCC coho salmon will occur primarily in Stream Priority Group 1 that consists of Scott Creek, Waddell Creek, San Vicente Creek and Pescadero Creek. This occurs because the Program has insufficient production capacity to release fish into all nine streams of the SCMDS simultaneously.

The streams selected for inclusion in Stream Priority Group 1 were selected because they either currently have some natural CCC coho salmon production, and/or have existing infrastructure that supports collection of adults for program broodstock and/or population monitoring (e.g., Scott Creek). Additionally, Pescadero Creek is included in Group 1 because it is classified by NMFS as an independent population, and therefore has sufficient juvenile carrying capacity to support large releases of program fish without resulting in significant density-dependent effects to naturally produced CCC coho salmon because few are present in this basin. Therefore, the effects to CCC coho salmon from Alternative 2 (Proposed Action) is classified as highly beneficial.

Program produced adult CCC coho salmon will assist in the attainment of the NMFS adult downlisting criteria for Stream Priority Group 1 (Table 6). The attainment of this criterion in a stream will increase population viability and therefore reduce extinction risk for CCC coho salmon (McElhaney et al., 2000).

Hatchery broodstock practices may result in an increase in inbreeding and genetic drift (random loss of alleles). Inbreeding occurs when related individuals are mated. This results in the lowering of the population’s ability to survive and reproduce over time, a phenomenon called inbreeding depression. To reduce inbreeding depression, the program uses a genetically based spawning matrix for selecting mates. This approach reduces relatedness among spawn pairs compared to random mating (Figure 6). However, because of low adult abundance at the population scale, an insufficient number of broodstock are available to eliminate inbreeding completely. This can be seen by the number of pairs (yellow bars) in Figure 6 that exceed the do-not-mate threshold value established by geneticists for the program. When this occurs, the related fish are not released to the natural environment.

Additionally, to reduce inbreeding and improve population genetic variability the program may import CCC coho salmon from other basins (e.g., Lagunitas Creek) for use as program broodstock (i.e., outbreeders). The Lagunitas-Olema Creek population is in Marin County immediately north of San Francisco, and is the nearest, persistent population to the north within the ESU. The collection of NOR juvenile coho salmon from Lagunitas-Olema Creek, or from the next northern population (Russian River) is conducted by staff from the Corps or CDFW under ESA section 10(a)(1)(A) enhancement permit 21501 issued for the RRCSCBP. The purpose of these collections is to improve genetic diversity within the Russian River population. Surplus captive broodstock fish from these two populations are then made available to the SCSCBP for outbreeding and genetic diversity enrichment.

The use of the spawning matrix and importation of broodstock from other basins is expected to improve (high beneficial) the genetic variability of CCC coho salmon above that which would be obtained naturally given current adult abundance levels. The extremely low abundance of natural-origin CCC coho salmon in SCMDS streams makes it highly likely that genetic variability will continue to decline without the program.

HOR adult and NOR juvenile and adult coho salmon needed for broodstock may be collected by the program or other parties working at SCMDS streams. For example, coho salmon from Scott Creek used as broodstock will be collected by FED under ESA section 10(a)(1)(A) research permit 17292-3R. The FED uses a weir to monitor CCC coho salmon and CCC steelhead adult and juvenile production in Scott Creek as part of long-running Life Cycle Monitoring Station. In addition, FED conducts other monitoring activities in adjacent watersheds, including San Vicente Creek and has an established network of PIT-tag antennas in various program streams. The effects of weir operations (i.e., fish capture and handling) or other fisheries collections by FED are covered under their research permit. The enhancement permit for the program would authorize the transport of coho salmon captured during these monitoring activities for use as broodstock to program facilities, and for their subsequent captive rearing and spawning. Because mortality associated with fish transport is expected to be less than 2%, the effect to CCC coho salmon is considered low adverse (Appendix A).

The program may also collect HOR or NOR adult coho salmon for use as broodstock from other SCMDS using seines on an ad hoc basis. This is considered ad hoc due to the low abundance and unpredictable nature of where adult coho salmon may occur and be detected prior to spawning in the wild.

The removal of NOR adult and juvenile CCC coho salmon from SCMDS streams has the potential to reduce natural production in the streams where they are collected. However, the overall effect to the CCC coho salmon population will be highly beneficial as the program increases total population size through the production of hatchery-origin fish. For Phase 1 and

Table 6. Expected adult production from the maximum release of eggs, fry, parr, advanced parr, yearlings and captive brood adults by stream and Stream Priority Group.

Stream Priority Group	Stream	Population Status	Naturally Produced Coho Salmon Present	Adult Abundance Downlisting Criteria	Expected Adult Production by Life Stage					
					Early Life Stages		Juveniles			Captive Brood
					Eggs	Fry	Parr	Advanced Parr	Smolts	
1	Scott Creek	Dependent	Yes	255	33	66	70	186	465–930	240
	Waddell Creek	Dependent	Yes	157	33	66	70	157	157	157
	San Vicente Creek	Dependent	Yes	53	33	53	53	53	53	53
	Pescadero Creek	Independent	No	1,150	33	66	70	186	465	240
2	Gazos Creek	Dependent	No	140	33	66	70	140	140	140
	San Lorenzo River	Independent	No	1,900	33	66	70	186	465	240
	San Gregorio Creek	Dependent	No	682	33	66	70	186	465	240
3	Soquel Creek	Dependent	No	561	33	66	70	186	465	240
	Aptos Creek	Dependent	No	466	33	66	70	186	465	240

* Independent populations historically are believed to have had a high probability of persistence over a 100-year period, with or without immigrants from adjacent populations, while dependent populations require such immigrants.
**Adult downlisting criterion for each stream is based on the total kilometers of intrinsic potential habitat (IPkm) present.

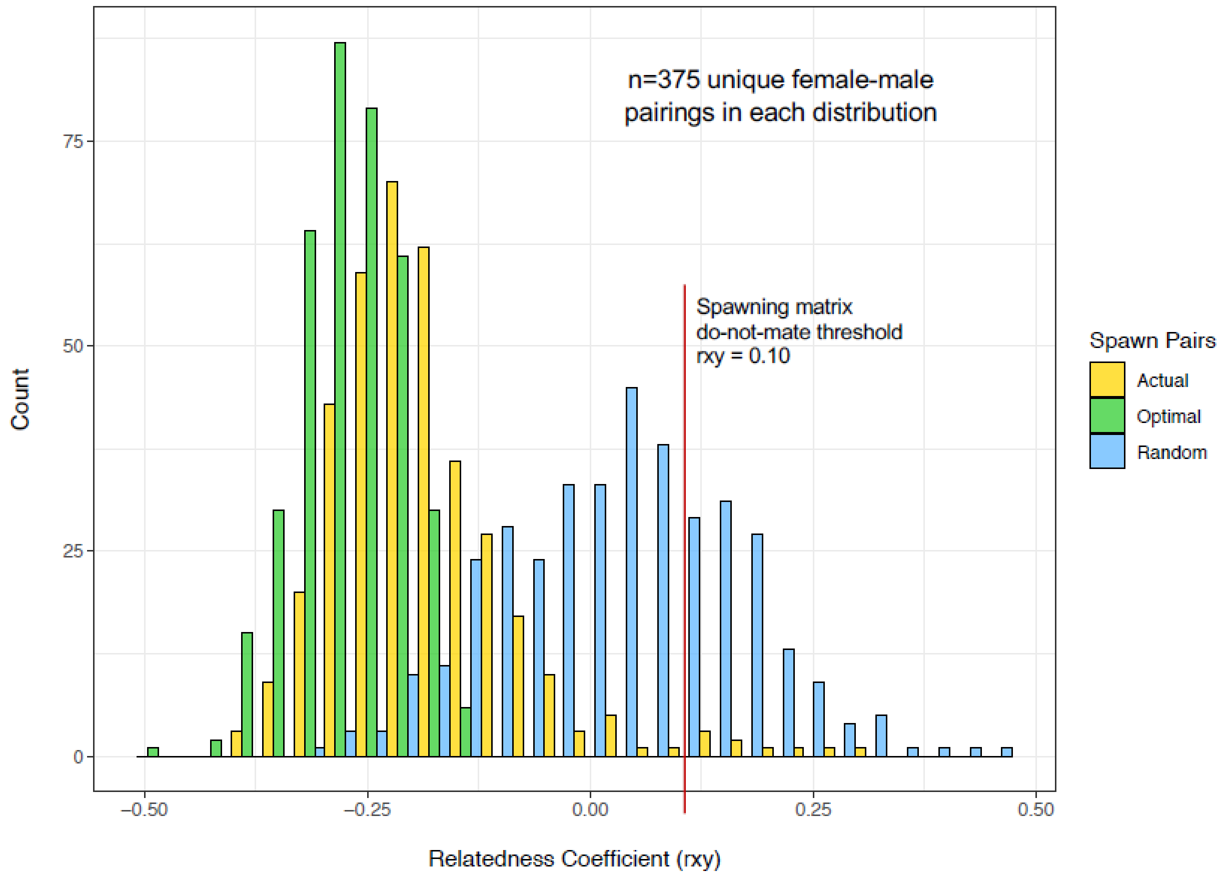

Figure 6. Distributions of the relatedness coefficient for three categories of spawn pairs: actual (fish spawned at KFH); optimal (top mate choices in the spawning matrix); and random (mates chosen using a random number generator), for the 2019–2020 spawn season. Vertical orange bar denotes the do-not-mate (r_{xy} > 0.1, currently 0.125) threshold in the spawning matrix.

Phase 2, the program will take a maximum of 75 NOR adults to produce approximately 465 HOR adults (Appendix A). Up to 600 natural-origin juveniles may be collected each year by the program (or by others under permit 17292-3R) and used to create the captive broodstock for the program. Fish may be captured using traps, seines and or backpack electroshocking gear. The effects of this monitoring on other species such as CCC steelhead (also a focus of the research monitoring) has been evaluated for the issuance of the section 10(a)(1)(A) research permit.

Ecological Effects

The ecological effects the program has on CCC coho salmon occur through the mechanisms of competition, predation, and disease. Competition between hatchery-origin and natural-origin coho salmon for limiting resources may occur when large numbers of hatchery fish are released into the natural environment. The released fish may also prey on natural-origin fish resulting in a decrease in natural production. Both hatchery operations and fish releases may increase disease risk to naturally produced coho salmon that can also reduce natural fish abundance. The effect on CCC coho salmon is considered to be low, adverse.

If NMFS issues an ESA section 10(a)(1)(A) permit for the SCSCBP, as stated under Alternative 2 (Proposed Action), there will be a potential increase in the abundance of hatchery-origin coho salmon that are found in program streams. However, the program intends to primarily release yearling smolts near the mouths of these streams. Fry, parr and advanced parr releases will be prioritized to streams where CCC coho salmon abundance is extremely low, or extirpated. Combined, these actions will minimize the competition and predation risks program fish pose to natural CCC coho salmon populations in each stream.

Hatchery fish production may increase disease risk in streams where fish are reared (via hatchery effluent) or released. Program rearing activities follow disease and prevention guidelines developed by the CDFW Fish Health Laboratory (Appendix A). Prior to fish being released, or transferred between facilities, a sample of 60 fish are sacrificed and sampled for disease screening by CDFW pathologists. Fish are not released until they receive health certification from the pathologists.

NMFS concludes that the ecological effects of the program pose a low adverse effect to CCC coho salmon of the SCMDS. This conclusion is supported by the PCD-Risk modeling analysis provided in the HGMP (Appendix A). This modeling analysis showed that ecological effects to naturally produced coho salmon from releases of HOR fish was quite low (values of <3 out of possible maximum score of 100) over a range of hatchery release numbers, stream temperatures and the amount of time hatchery fish are likely to spend in each release stream (Table 5 and Table 7).

In summary, due to the extremely precarious condition of coho salmon populations in the SCMDS, NMFS has determined (NMFS 2012) that the restoration of extirpated populations and the enhancement of few extant populations of CCC coho salmon in the SCMDS will require continued implementation of a genetically managed hatchery program. Any minor species-specific benefits from eliminating the release of hatchery-origin fish, are far outweighed by the larger benefits of implementing the program. As such, NMFS considers adoption of Alternative 2 (Proposed Action) to result in high beneficial effects to the CCC coho salmon ESU.

4.3.2.2 CCC Steelhead

It is reasonably likely that the CCC steelhead population will face a mixture of beneficial and adverse effects if FED is issued an ESA section 10(a)(1)(A) enhancement permit and the SCSCBP is implemented as described under Alternative 2 (Proposed Action). Low beneficial effects to CCC steelhead will be realized by progressively increasing the abundance of CCC coho salmon fry and juveniles to program streams, and through the addition of marine-derived nutrients to the freshwater environment. In time, it is expected that the program will lead to increased natural-origin production in the SCMDS, which in turn will result in more eggs, fry and marine-derived nutrients. Under current program operations, the SCSCBP releases less than 50,000 juveniles (fry to smolt) into program streams. As proposed, the number of juvenile releases would increase to a maximum of 170,000, and up to 380 adult carcasses would be available for release as nutrient enrichment.

If the SCSCBP is permitted as proposed, CCC steelhead throughout the action area are reasonably likely to experience low beneficial effects to their salmon-based food sources because coho salmon (eggs and juveniles) make up some portion of the CCC steelhead diet (NMFS 2016b). In addition, the nutrient loading from an increase in adult CCC coho salmon carcasses in Program streams would also benefit CCC steelhead because they serve as a source of marine-derived nutrients for the riverine food web (Joy et al. 2021).

However, under Alternative 2 (Proposed Action) it is also possible that juvenile CCC steelhead may experience low adverse effects from the increased abundance of hatchery-origin CCC coho salmon because of increased competition for resources (i.e., food and habitat), and increased predation. PCD-Risk modeling analysis conducted in the HGMP showed that ecological effects to naturally produced CCC steelhead from hatchery production was quite low (values of <3 out of possible maximum score of 100) over a range of hatchery release numbers, stream temperatures and the amount of time hatchery fish are likely to spend in each release stream (Table 7).

Table 7. PCD-Risk results for natural-origin CCC steelhead fry and parr/yearlings by HOR residence time in the stream and stream temperature. The maximum PCD-Risk value possible is 100 which results in complete loss of natural-origin fish.

7-Day Residence Time									
	Fry Release (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0.1	0.2	0.4	0.2	0.5	0.8	0.6	1.0	1.4
12	0.1	0.2	0.4	0.2	0.5	0.8	0.6	1.0	1.4
14	0.1	0.2	0.5	0.3	0.5	0.8	0.6	1.0	1.4
16	0.1	0.2	0.4	0.3	0.5	0.8	0.5	1.0	1.4
	Parr/Smolt Release (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0	<0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
12	0	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
14	0	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
16	0	<0.1	0.2	0.1	0.1	0.2	0.3	0.3	0.3
14-Day Residence Time									
	N = 4,000 (HOR Coho Salmon)								
Temperature (°C)	Fry Release			Smolt Release					
	Min	Ave	Max	Min	Ave	Max			
16	1.2	1.9	2.8	0.5	0.5	0.6			

4.3.3 Other Fish Species

If FED is issued an ESA section 10(a)(1)(A) enhancement permit as described under Alternative 2 (Proposed Action), those species identified in Table 2 as a "predator of salmon eggs, fry, juveniles and adults", and/or those identified as benefiting from "fish carcasses from hatchery-released fish" are reasonably expected to experience negligible beneficial effects. These beneficial effects will be realized through an increased abundance of CCC coho salmon (all life stages) in program streams, as described above in (Section 3.3).

Conversely, it is also possible that fish identified in Table 2 as "competing with salmonids for food and space" may experience negligible adverse effects due to increased competition with salmon and steelhead for resources.

Under Alternative 2 (Proposed Action), those species identified in Table 3 as a "predator of salmon eggs, fry, or juveniles" and/or those identified as benefiting from "carcasses of hatchery-origin fish" are reasonably expected to be negligibly beneficial under Alternative 2 (Proposed Action).

Under Alternative 2 (Proposed Action) it is also possible that fish identified in Table 3 as "competing with salmon for food and space" may experience negligible adverse effects due to decreased availability of resources (i.e., food and habitat) from increased competition with hatchery-origin juvenile coho salmon. However, these effects would be insignificant because the number of juvenile coho salmon released to streams as part of the program is still far below the natural abundance that would have naturally occurred and is low relative to the more abundant native fishes with which they may potentially compete. Furthermore, other native fish species (e.g., coastrange sculpin, threespine stickleback) remain abundant despite nearly two decades of hatchery releases. As with CCC steelhead, native fishes in these streams co-evolved with coho salmon and have developed dietary and habitat preferences within the aquatic community to minimize competition.

4.3.4 Wildlife

The species identified in Table 3 as "potential predator of salmon eggs, fry, and juveniles" or as a "potential scavenger of adult salmon carcasses" are expected to be negligibly benefited by the Program.

Under Alternative 2 (Proposed Action) it is possible that species identified in Table 3 that may be a "potential prey item of salmon" may experience low adverse effects from predation by hatchery-origin coho salmon. These include California red-legged frog (*Rana draytonii*), a species listed as threatened under the Federal ESA (USFWS 2002). While there is some habitat overlap between the two species, the level of anticipated effects on the California red-legged frog from predation is expected to be negligible adverse because the number of juvenile coho salmon planned for release is still far below the natural historic abundance, and because California red-legged frog tadpoles are not considered a common prey item of juvenile coho salmon.

4.3.5 Cultural Resources

As described above, effects to cultural resources typically occur when an action disrupts or destroys cultural artifacts, disrupts cultural use of natural resources, or would disrupt cultural practices. Under Alternative 2 (Proposed Action), a permit for the SCSCBP would be issued, resulting in utilization of existing facilities for rearing and breeding of coho salmon, and transportation of fish between the program facilities and streams of the SCMDS. Because existing facilities and roadways would be utilized for associated SCSCBP operations, which already avoid culturally important artifacts, there will be no significant effects to these cultural resources under Alternative 2 (Proposed Action).

Current and future SCSCBP activities involve the collection and rearing of juvenile fish and the rearing, spawning and release of adult fish throughout the action area. These activities are reasonably likely to increase both the numbers of coho salmon and populations throughout the action area. If the SCSCBP is successful, and the coho salmon populations recover, tribal trust assets and use for cultural purposes may be reinstated resulting in negligible beneficial effects to tribal cultural practices. However, because we are unable to determine the magnitude of these beneficial effects at this time, for analysis purposes we assume they would be negligible beneficial.

5 CUMULATIVE EFFECTS

5.1 Geographic and Temporal Scales

The cumulative effects analysis area is the portion of the CCC coho salmon ESU that spans the SCMDS (Section 1.3, Figure 2). The scope of the action considered here includes the broodstock rearing, and fish release activities into Program streams across the SCMDS. Adult collection and transport, egg incubation, juvenile rearing, and release activities would occur in localized areas only; associated effects of these activities are analyzed in Section 4, Environmental Consequences. The HGMP would be in effect after the associated ESA section 10(a)(1)(A) permit is issued and would remain in effect for up to ten years, or until NMFS determines that the HGMP is no longer effective. During the ten-year life of the permit, NMFS will review the HGMP every five years, and the plan could be modified as warranted by NMFS.

NMFS considered whether the Pacific Ocean should be included in the cumulative effects analysis area. Available knowledge and research abilities are insufficient to discern the role and contribution of the Proposed Action to density dependent interactions affecting salmon and steelhead growth and survival in the Pacific Ocean. NMFS' general conclusion is that the influence of density dependent interactions on growth and survival are likely small compared to the effects of large scale and regional environmental conditions. While there is evidence that hatchery production, on scales much larger than the Proposed Action, can affect salmon survival at sea, the extent of the effect or level of influence is not yet understood or predictable, nor is there any evidence that programs of this size have any discernible effects in the ocean. Thus, direct, indirect, and cumulative effects of the SCSCBP on the Pacific Ocean are not expected.

5.2 Effects on Climate Change from Alternatives

Neither of the alternatives are expected to result in significant effects to climate change. No activities would occur under Alternatives 1 and 2 that would result in significant changes to greenhouse gas emissions or other pollutants that are likely to contribute to environmental conditions associated with climate change.

Under Alternative 1 (No Action), the amount of carbon emitted due to the SCSCBP would be reduced to zero. Under Alternative 2 (Proposed Action), carbon emissions would increase to approximately 0.01 tons of carbon emitted each year from transporting fish between the three broodstock rearing facilities and Program streams for release. Carbon emissions were calculated using the Environmental Protection Agencies (EPA) calculator website[8]. While there will be an increase in carbon emissions under Alternative 2 (Proposed Action), the quantity of emissions is exceptionally low[9] and not expected to result in significant cumulative effects to climate change.

5.3 Reasonably Foreseeable Future Actions

These actions have occurred in the past, are currently occurring, and are expected to continue into the foreseeable future throughout the ten-year life of the permit.

5.3.1 Timber Harvest

Timber harvest can result in increases in sediment to waterways, reductions in stream shading from loss of vegetation, and reductions in the amount of woody debris that enters into streams (NMFS 2012; NMFS 2016b). Based on recent trends, NMFS reasonably expects that, on average, at least one timber harvest project might occur every year during the life of the ten-year permit in the action area. While management of timber harvest has improved in recent decades with the onset of the California Forest Practice Rules implemented by the California Department of Forestry, legacy effects are likely still affecting environments in the action area. These effects include increased sediment loads into streams, and reduced stream complexity by removal of woody debris (NMFS 2012; NMFS 2016b). It is reasonably expected that present and future timber harvest in the action area will have much lower adverse environmental effects now that timber harvest projects from the Big Creek Lumber Company are subject to California Forest Practice Rules. Furthermore, both San Mateo and Santa Cruz County have developed and implemented more stringent timber harvest rules that provide protections beyond those required in the California Forest Practice Rules. For example, both counties only allow for selective harvest and not clear-cut, even-age management harvest practices. Considering the above rules and measures regarding timber harvest, coupled with the Program's measures to protect water quality, the cumulative effects of the Proposed Action are not expected to result in any discernable change to the quality of waterways or the aquatic habitats they provide.

5.3.2 Water Diversions

Increased water diversions can reduce stream flow which provides habitat for fish rearing and spawning. Aside from Loch Lomond Reservoir in the San Lorenzo River watershed, there are no water storage reservoirs to maintain dry season base flows in streams within the action area. Stream flow in other streams throughout the action area is affected by water diversions including residential and agricultural wells and small diversions. The state water resources control board (SWRCB) regulates direct diversions and storage of flow, and issues and monitors water rights for compliance with permits. Recently, the California Department of Water Resources developed the Sustainable Groundwater Management Act, which requires local regulators to achieve sustainable groundwater management by 2042, including avoiding significant and unreasonable

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[8] https://www3.epa.gov/carbon-footprint-calculator/

[9] Emissions occur primarily from the transport of fish to and from hatchery facilities and release sites which is expected to be less than 1,000 miles per year.

streamflow depletion[10]. With either of the proposed alternatives, there will be no change to water diversions.

5.3.3 Habitat Restoration

Habitat restoration can counteract negative consequences of land uses, including those listed above by restoring stream processes and increasing habitat quantity and quality. Funding for habitat restoration projects is provided by federal, state or privately sourced grants. California's Fisheries Restoration Grant Program (FRGP)[11] is a program that uses Federal and State species recovery plans as well as watershed management plans to guide restoration of salmon habitat with the goal of ensuring species survival and protection. Over the past 30 years, the FRGP and other grants have funded projects throughout coastal California, with multiple projects within the action area. While it is expected that the FRGP and other grants will continue to support habitat-based recovery actions similar to past efforts, this restoration is dependent on continued funding that is difficult to predict over time. Habitat restoration is reasonably expected to occur under either alternative and will incrementally benefit salmon and steelhead within the action area. These restoration efforts are likely to moderately benefit habitat, which will increase over time, considering the incremental nature of restoration projects. Benefits from habitat restoration are expected to affect salmon and steelhead survival similarly under all alternatives. Therefore, these efforts, along with the Proposed Action, will cumulatively increase survival and abundance of salmon and steelhead.

5.3.4 Steelhead Program at KFH

The MBSTP is currently developing an ESA section 10(a)(1)(A) enhancement permit application and HGMP for the reoperation of an integrated steelhead hatchery program for the San Lorenzo River. If approved, the steelhead program may share space at KFH for spawning, egg incubation and potentially juvenile rearing, in addition to rearing facilities in the San Lorenzo River basin. For the basis of this analysis, MBSTP's steelhead program is reasonably expected to resume operations in the near future. This future action may occur under either alternative within the cumulative analysis area. The steelhead program would utilize KFH and therefore would also be exempt from the NPDES permit. Juvenile steelhead would be released only into the San Lorenzo River and therefore would avoid effects to the remainder of the action area (i.e., program streams). In addition, adverse effects to CCC coho salmon at KFH due to competition for space and resources within the hatchery environment would be further minimized by priorities established by the resource agencies based on the Federal and State listing status of each species.

5.3.5 California Recreational Steelhead Fishery

CDFW maintains a regulated, recreational sport fishery for steelhead that overlaps with all program streams within the action area. Current fishing regulations restrict the steelhead fishery to on Saturdays, Sundays, Wednesdays, legal holidays and opening and closing days from December 1 through March 7, and only select portions of each stream are open to fishing.

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[10] https://water.ca.gov/programs/groundwater-management/sgma-groundwater-management

[11] https://wildlife.ca.gov/Grants/FRGP#:~:text=FRGP%20administers%20a%20competitive%20grant,nonprofit%20organizations%2C%20and%20private%20landowners.

Anglers may only use barbless hooks. In program streams of the Santa Cruz Mountains, current regulations allow two hatchery steelhead adults to be kept per day, which are marked with an adipose fin clip, and all natural-origin steelhead adults must be released. Although regulated, due to the temporal overlap between the two species adult run-times (e.g., December to March) there remains some potential for adverse effects to natural- or hatchery-origin CCC coho salmon that are incidentally captured during the state's recreational fishery. Incidental injury to or mortality of coho salmon adults may occur from hooks, as well as landing and handling the fish. Due to listing status of both CCC coho salmon (endangered) and CCC steelhead (threatened) it is unlikely that harvest rates of CCC steelhead will increase over baseline.

6 CUMULATIVE EFFECTS BY RESOURCE

6.1 Introduction

The following provides an assessment of the cumulative effects of Alternative 1 (No Action), Alternative 2 (Proposed Action) in combination with the past, present, and foreseeable future actions on each resource analyzed in this EA (i.e., water quantity and quality, salmon and steelhead, other fish species, wildlife, and cultural resources). If there are no anticipated effects from reasonably foreseeable future actions then there will be no mention of that action in the analysis below.

6.2 Water Quantity and Quality

Water quality within the SCMDS is expected to remain unchanged under all alternatives. Discharge standards for KFH are exempt from NPDES by the CCRWQCB. Within the reasonably foreseeable future, the discharge standards for KFH and other actions are not expected to change with the implementation of either Alternative 1 (No Action) and Alternative 2 (Proposed Action). Discharge standards were established for the DCFH by the NCRWQCB through an NPDES permit to ensure water quality concerns. Within the reasonably foreseeable future, the discharge standards established NPDES permits for DCFH and other actions are not expected to change. Therefore, there would be negligible cumulative adverse effects from effluent on receiving waters with implementation of the alternatives. While climate change is expected to continue increasing air and water temperatures, leading to changes in precipitation patterns and streamside vegetation, these changes are expected to have a low adverse effect on water quantity and water quality in the SCMDS, combined with either alternative. When considered cumulatively, neither alternative is expected to change current conditions as there is little to no consumptive use of water, and the discharge from the hatchery is regulated.

Habitat restoration actions will likely help to incrementally improve water quality and quantity by reducing erosion and sediment delivery to streams, improving large wood loading and increasing riparian habitat. These activities are expected to have high beneficial effects.

In summary, there is a high likelihood that there will be low to moderate cumulative adverse effects on water quantity and quality from the various activities within the action area in combination with either of the alternatives. Although, the Proposed Action is likely to restore salmon populations that were lost due to past degradation of water resources, and habitat restoration will likely offset some potential adverse effects.

6.3 Salmon and Steelhead

The climate influences freshwater stream temperature and flow, and because salmon and steelhead depend upon these streams during distinct stages of their life history cycle, their populations are likely to be affected by climate change. Changes in temperature, rainfall, snowpack, and vegetation are likely to have serious adverse effects on salmon and steelhead populations (NMFS 2008; NMFS 2012). Physical characteristics of river and stream environments found along the West Coast, which include the action area, are expected to be altered from climate change. In the recent past "California has experienced below average precipitation, record high surface air temperatures, and record low snowpack" (NMFS 2016a). These environmental changes that are expected to occur from climate change are reasonably expected to disrupt the natural distribution, behavior, growth, and survival of salmon and steelhead throughout the action area.

Salmon and steelhead population abundance naturally alternates between higher and lower levels on temporal and spatial patterns that may last decades or centuries and on more complex ecological scales than can be easily observed (Rogers et al. 2013). The effects of climate change on salmon and steelhead are described in general in ISAB (2007) and are variable among species and life history stages (Table 8). Changes in streamflow and water temperature resulting from climate change would likely affect both natural-origin and hatchery-origin salmon and steelhead. Under Alternative 1 (No Action) and Alternative 2 (Proposed Action) the moderate level of adverse effects on salmon and steelhead from climate change are expected to be similar because climate change would affect fish habitat under each alternative in the same manner. However, while climate change is reasonably likely to place additional stress on the conservation and recovery of the CCC coho salmon ESU, NMFS does not expect that long-term climate change effects will be significant enough to have an appreciable effect on the CCC coho salmon ESU during the 10-year life of the permit.

Table 8. Examples of potential effects of climate change on salmon life stages and life history periods.

Life Stage	Potential Effects
Egg	● Increased water temperatures and decreased flows during spawning migrations would increase pre-spawn mortality and reduce egg deposition for some species. ● Increased water temperatures would increase maintenance metabolism, leading to smaller fry. ● Increased water temperatures would result in faster embryonic development, leading to earlier hatching. ● Increased mortality for some species because of more frequent winter flood flows. ● Lower flow would decrease access to or availability of spawning areas.
Juvenile (Spring and Summer Rearing)	● Faster yolk utilization from increased water temperatures may lead to early emergence. ● Smaller fry are expected to have lower survival rates. ● Growth rates would be slower if food is limited.

Life Stage	Potential Effects
	● Lower flows would decrease habitat capacity. ● Sea level rise would eliminate or diminish the tidal wetland capacity.
Juvenile (Overwinter Rearing)	● Smaller size at start of winter is expected to result in lower winter survival. ● Mortality would increase because more frequent floods. ● Warmer winter temperatures would lead to higher metabolic demands, which may decrease winter survival if food is limited, or increase winter survival if growth and size are enhanced. ● Warmer winter temperatures may increase predator activity/hunger, which can decrease winter survival.
Juvenile and Adult (Out-Migration)	● Earlier snowmelt and warmer temperatures may cause earlier emigration to the estuary and ocean either during favorable upwelling conditions, or prior to the period of favorable ocean upwelling. ● Increased predation risk in the mainstem because of higher consumption rates by predators at the elevated spring water temperatures. ● Earlier sandbar formation due to low flows could impede juvenile migration.
Adult	● Increased water temperatures may delay fish migration. ● Increased water temperatures may also lead to more frequent disease outbreaks as fish become stressed and crowded. ● Longer sandbar persistence due to low flows could delay adult migration.

Sources: Glick et al. 2007; ISAB 2007; Beamish et al. 2009; Beechie et al. 2013

6.4 Other Fish Species

Like salmon and steelhead, other fish species (Table 2) may also be negatively affected by climate change, water diversions, and resource extractions such as logging from timber harvest due to the potential loss and degradation of their aquatic habitat and/or their inability to adapt to the changing conditions. However, these effects may be counterbalanced by current and future habitat restoration efforts. Under Alternative 2 (Proposed Action), there will be no expected change in adverse effects compared to current conditions when added to the other cumulative effects in the action area. It is reasonably expected that beneficial effects will occur to other fish species when compared cumulatively with other reasonably foreseeable future actions in the effects area. Under Alternative 1 (No Action), these benefits would not occur, therefore, there would be no offset of the cumulative negative effects discussed above.

6.5 Wildlife

Adverse cumulative effects from climate change, and resource extraction are expected to negatively affect wildlife (Table 3) in ways like those described above for salmon and steelhead. These adverse effects are reasonably likely to be somewhat mitigated by current and future habitat restoration efforts in the action area together with the Proposed Action.

Under Alternative 1 (No Action), the contribution of eggs, fry, juveniles, and adults that the Program currently produces that benefit wildlife that prey on these various salmon life stages will not occur. Alternative 2 (Proposed Action) would not only maintain the current contributions made by the Program but would increase the abundance of salmon life history stages available throughout the action area from production at the hatchery. When added to other past, present, and reasonably foreseeable future actions described above in Section 5, the KFH's contribution of eggs, fry, juvenile, and adult salmon will result in beneficial cumulative effects for wildlife that prey on these life history stages.

6.6 Cultural Resources

Adverse cumulative effects from climate change, resource extraction, and habitat restoration are not expected to have a negative effect on cultural resources listed above in Section 3.8.

As described in Sections 6, 4.2.5, and 4.3.5, current operations associated with the Program avoid culturally important sites in the action area. Alternative 1 (No Action) would result in no change from current conditions, and furthermore would not result in any cumulative effects to cultural resources. Under Alternative 2 (Proposed Action), negligible beneficial effects may occur to cultural uses and tribal trust assets throughout the action area from increased abundance of CCC coho salmon and other species, which are reasonably expected to increase throughout the life of the ten-year permit.

7 AGENCIES AND PERSONS CONSULTED

7.1 Tribes

Per the Bureau of Indian Affairs, there are no federally recognized tribes in the action area of the Santa Cruz Mountains. The Dry Creek Rancheria Band of Pomo, California was consulted on by NMFS' on May 4, 2018, during the HGMP/EA review period for the RRCSCBP at DCFH on Dry Creek. This included all fish being reared at DCFH including coho salmon that are part of the SCSCBP.

As described in Section 3.6 Cultural Resources, NMFS sent letters to tribes identified by the NAHC as being culturally affiliated with the program area and who may have knowledge of cultural resources within the program area to offer consultation and to seek their assistance with the potential identification of sites of religious or cultural significance in the program area that may be affected by program activities. These tribes included:

- Association of Ramaytush Ohlone
- Amah Mutsun Tribal Band,
- Amah Mutsun Tribal Band of Mission San Juan Bautista,
- Costanoan Ohlone Rumsen-Mutsen Tribe,
- Indian Canyon Mutsun Band of Costanoan,
- Muwekma Ohlone Indian Tribe of the San Francisco Bay Area,
- Wuksache Indian Tribe/Eshom Valley Band, and
- Costanoan Rumsen Carmel Tribe

7.2 National Marine Fisheries Service

NMFS staff and contractors that developed this EA are:

- Kevin Malone (NMFS contractor)
- Ryan Bernstein (NMFS contractor)
- Joel Casagrande (NMFS)

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9 APPENDIX A

Southern Coho Salmon Captive Broodstock Program Hatchery and Genetic Management Plan

HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Hatchery Program:	Southern Coho Salmon Captive Broodstock Program
Species or Hatchery Stock:	Coho Salmon (*Oncorhynchus kisutch*) Central California Coast Evolutionarily Significant Unit
Agency/Operator:	NMFS Southwest Fisheries Science Center Fisheries Ecology Division
Watershed and Region:	Coastal Streams of the Santa Cruz Mountains in San Mateo and Santa Cruz Counties, California
Date Submitted:	14 February 2023
Date Last Updated:	9 February 2023

EXECUTIVE SUMMARY

The operators of the Southern Coho Salmon Captive Broodstock Program (program) have developed this Hatchery Genetic Management Plan (HGMP) for submittal to, and approval by National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS). The information provided in the HGMP is intended be used by NMFS to evaluate the impacts of this hatchery program on Coho Salmon and steelhead populations listed under the U.S. Endangered Species Act (ESA). The primary goal of an HGMP is to develop biologically based hatchery management strategies that ensure the conservation and recovery of Coho Salmon and steelhead populations in the region where the hatchery program is operated. In this case, the fish populations most likely to be affected by program operations are Central California Coast (CCC) Coho Salmon and CCC steelhead within the Santa Cruz Mountains Diversity Stratum (SCMDS). The CCC Coho Salmon Evolutionary Significant Unit (ESU) and CCC steelhead Distinct Population Segment (DPS) are listed under the ESA as endangered and threatened, respectively.

The purpose of the program is to help conserve and recover CCC Coho Salmon in the SCMDS using captive rearing and hatchery propagation. The conservation focus is deemed necessary to protect the remaining genetic resources of SCMDS Coho Salmon. The program will operate as an integrated recovery type hatchery as defined by the California and Columbia River Hatchery Scientific Review Groups (HSRG) and NMFS. A hatchery program is defined as an "integrated type" if the intent is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild (i.e., naturally).

The program will be implemented following the four-phase approach developed by the Columbia River HSRG. The four phases and their objectives are as follows:

Phase 1 – Preservation

- Prevent the extirpation of populations
- Maintain/increase genetic diversity and identity of the existing Coho Salmon populations
- Increase the adult abundance of Coho Salmon (i.e., provide demographic benefit)
- Create a sustainable hatchery population

Phase 2 – Recolonization

- Re-populate Coho Salmon to populations with suitable (often restored) spawning and rearing habitat
- Increase Coho Salmon abundance, spatial structure, and diversity (spawning and rearing) of the population
- Conserve the genetic identity and diversity of the population

Phase 3 – Local Adaptation

- Meet and exceed minimum viable Coho Salmon spawner abundance targets for natural-origin spawners
- Increase fitness, adult Coho Salmon reproductive success, and life history diversity through local adaptation (e.g., by reducing hatchery influence by maximizing the

proportionate natural influence [PNI])

Phase 4 – Full Restoration

- Maintain a viable salmon population using long-term adaptive management

The objectives for the four phases will help to achieve key delisting imperatives identified in the federal Recovery Plan for CCC Coho Salmon (NMFS 2012):

- Conserve existing genetic diversity and provide opportunities for the exchange of genetic material between and within metapopulations (Phase 1)
- Maintain current distribution of Coho Salmon and restore their distribution to historically occupied areas (Phase 1 to Phase 3)
- Increase Coho Salmon to viable population levels, including the expression of all life history forms and strategies (Phase 2 and Phase 3)
- Develop and maintain a monitoring, research and evaluation program that advances understanding of the factors associated with Coho Salmon survival and recovery, and that allows adaptive management of recovery strategies and actions over time (Phase 1 through Phase 4)

The program will move from phase to phase based on the achievement of quantitative biological triggers that include total adult (hatchery and natural-origin) Coho Salmon production by population, low risk spawner escapement targets, adult abundance downlisting criterion for each population, proportion of natural spawning population consisting of hatchery-origin adults (pHOS), proportion of broodstock consisting of natural-origin adults (pNOB) and proportionate natural influence (PNI) (Table 1). PNI is a metric used to assess the dominance of natural-origin individuals in the population over time. PNI is calculated using the formula:

$$PNI = pNOB / (pHOS + pNOB)$$

PNI values range from 0 to 1.0 and values > 0.5 indicate that local adaptation is being driven by the natural, rather than hatchery environment. The higher the PNI value, the greater the influence the natural environment is having on local adaptation. Fish better adapted to the natural environment are more productive, and likely to express a range of life histories that make them more resilient to environmental variability and change (HSRG 2014). A description of each phase of the program follows.

Phase 1 – Preservation

The program is currently in Phase 1 where the primary goal is to prevent the extirpation of Coho Salmon from the SCMDS. The program is likely to stay in this phase for the duration of the HGMP (10 years) due to the extremely low abundance of Coho Salmon in SCMDS streams. The production goal of the program is to release 170,000 eggs/juveniles/smolts each year. The goal is established based on the rearing capacity of the three rearing facilities available to the program and the funding available for their operation. Currently, program rearing facilities only have sufficient capacity to release 35,000 smolts annually. Long-term, the program has the goal of releasing 70,000 smolts and will actively seek funds to increase hatchery capacity. Thus, to achieve the 170,000 fish release target, some Coho Salmon must be released at earlier life stages.

Figure 1 provides a flow chart for Phase 1 operations from broodstock to juvenile release location.

Table 1. Program objective and performance metrics for Phase 1, Phase 2 and Phase 3.

Objective and Performance Metrics	Phase 1 (Preservation)	Phase 2 (Recolonization)	Phase 3 (Local Adaptation)
Objective	Prevent the extinction/extirpation of populations	Re-populate Coho Salmon to restored and/or depleted habitat	Meet and exceed minimum viable spawner abundance for natural-origin spawners
	Retain/Increase genetic diversity and identity of the existing Coho Salmon populations	Increase Coho Salmon abundance and temporal and spatial diversity (spawning and rearing) of the population	Increase fitness, adult reproductive success, and life history diversity through local adaptation (e.g., by reducing hatchery influence by maximizing the proportionate natural influence [PNI])
	Increase adult abundance (i.e., provide demographic benefit)	Maintain population genetic identity and diversity	
	Create a self-sustaining hatchery population		
Adult Abundance	465 HOR	465 HOR 235 NOR	465 HOR 465 NOR
Broodstock Source	Captive Broodstock (NOR Juveniles), HOR and NOR Adults, Imported out-of-basin	75% HOR and 25% NOR Adults	50% HOR and 50% NOR
Percent of the Hatchery Broodstock Consisting of NOR Fish (pNOB)	10%	25%	50%
Hatchery Production	70,000 juveniles, 100,000 eggs / fry	70,000 juveniles, 100,000 eggs / fry	70,000 juveniles, 100,000 eggs / fry
Life-Stage Release Priority	Smolts – (Group 1 Streams) Advanced Parr – (Group 1 Streams) Eggs/Fry/Parr (Pescadero Creek) Surplus Captive Broodstock (Pescadero Creek, Group 1 or 2 Streams)	Smolts – (Group 1 Streams) Advanced Parr – (Group 1 Streams) Eggs/Fry/Parr (Pescadero Creek, Group 2 Streams)	Eggs/Fry/Juveniles (Group 2 and Group 3 Streams) Smolts – Scott Creek
Proportion of the Natural Spawning Population Consisting of HOR Fish (pHOS)	No Limit	< 0.50	< 0.25

Objective and Performance Metrics	Phase 1 (Preservation)	Phase 2 (Recolonization)	Phase 3 (Local Adaptation)
Proportionate Natural Influence (PNI)	No Criterion	> 0.33	> 0.67
Stream Spawner Density	No Criterion	14 Adults per IPkm	> 14 Adults per IPkm
HOR Smolt to Adult Survival Rate (SAR) Required to Achieve Program Goals	0.22% to 1.3%	> 1.3%	> 1.3%

The program has prioritized SCMDS recovery streams into three groups, with Group 1 streams having the highest priority for hatchery supplementation (Table 2). Scott Creek, Waddell Creek, and San Vicente Creek were selected as Group 1 streams because they still contain small populations of naturally produced fish or, in the case of Scott Creek, also have existing facilities that can be used to collect adult fish for broodstock and monitor Coho Salmon abundance over time. Pescadero Creek is included in Group 1 because it is classified by NMFS as an independent population and therefore has sufficient juvenile carrying capacity to support large hatchery fish releases without resulting in significant density-dependent effects on naturally produced fish. However, until facilities are available to rear more hatchery smolts, Coho Salmon releases to Pescadero Creek will consist primarily of eggs, fry, parr and/or captive brood adults.

Broodstock for the program will come from captive brood and NOR and HOR adult returns to SCMDS streams. Fish from Scott Creek, Waddell Creek and San Vicente Creek are the preferred source for broodstock, as natural Coho Salmon production, although limited, is still present in each watershed. However, adult or juvenile Coho Salmon from other SCMDS streams may also be used as broodstock if monitoring indicates the presence of naturally produced fish. To increase the genetic diversity of the broodstock, adult Coho Salmon may be imported from the Russian River Coho Salmon Captive Broodstock Program at Don Clausen Fish Hatchery (Russian River) and incorporated into the program. A genetic spawning matrix will be used to reduce inbreeding in the hatchery population.

The number of fish released by life stage to each recovery stream is based on two considerations:

1. Ability to produce and capture adult Coho Salmon for broodstock, and
2. Achieving the adult Coho Salmon downlisting criteria for Scott Creek (255), Waddell Creek (157), and San Vicente Creek (53) (Table 3).

The adult downlisting criterion for each stream is based on the total kilometers (km) of intrinsic potential habitat (IPkm) present. The total IPkm in Scott Creek, Waddell Creek and San Vicente Creek is 15.0, 9.1, and 3.1, respectively. Thus, there is a total of 27.2 IPkm in three streams combined, which is close to the minimum required (32 IPkm) to form a potentially Independent Coho Salmon population (Spence et al. 2008) (Table 3). Independent populations are historically believed to have had a high probability of persistence over a 100-year period, with or without immigrants from adjacent populations.

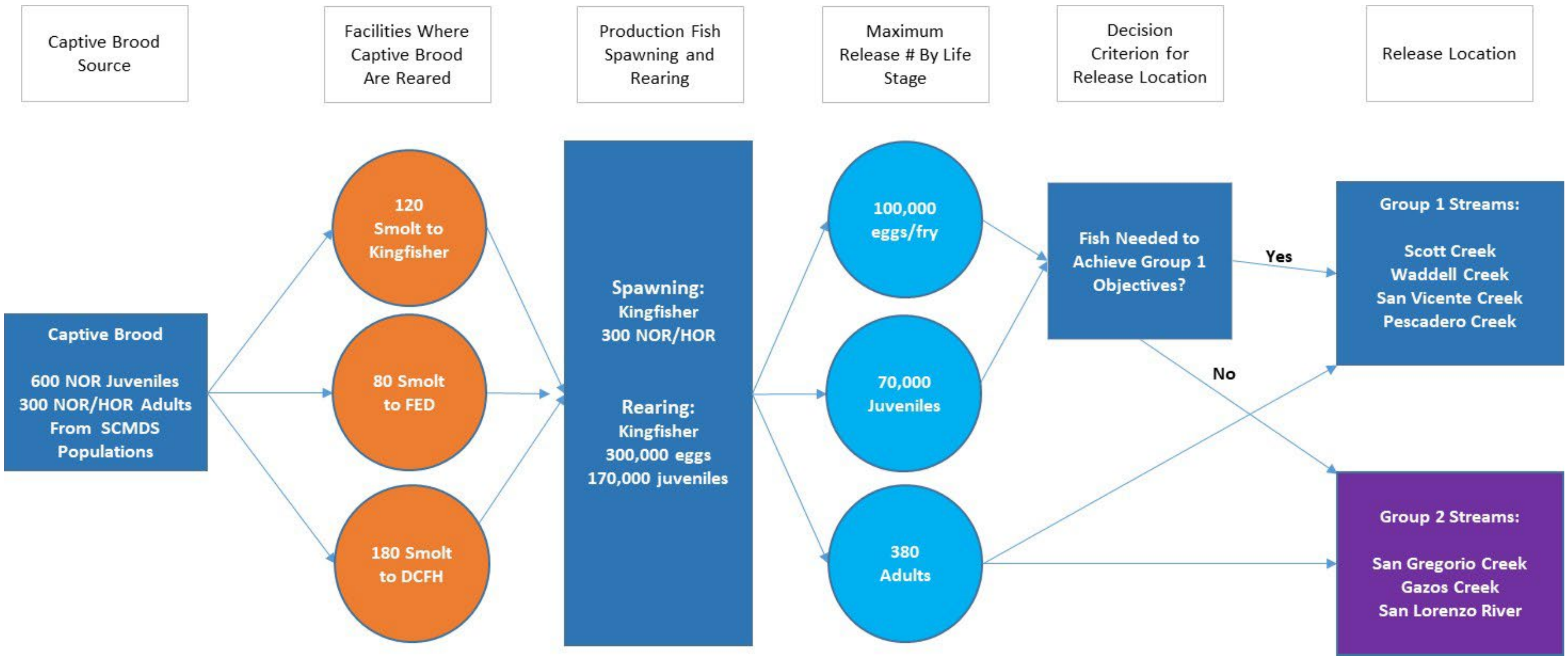

Figure 1. Flow chart illustrating Phase 1 pathway from broodstock source to stream release location for hatchery produced eggs, fry, juvenile and captive brood and imported adult Coho Salmon. Kingfisher refers to the Kingfisher Flat Hatchery facility, FED refers to the Fisheries Ecology Division laboratory, and DCFH refers to Don Clausen Fish Hatchery. This flow chart represents the flow of fish and eggs produced based on current realized survival rates in the hatchery. As in-hatchery survival rates increase under this HGMP, the number of adults required decreases from 380 adults to 240 adults.

Table 2. Program stream priority groupings and priorities for broodstock source and the release of juveniles for each population in the SCMDS. Data on population status, presence of naturally produced Coho Salmon and adult abundance downlisting criteria are also presented for SCMDS streams.

Stream Priority Grouping	Stream	Population Status	Naturally Produced Coho Salmon Present	Adult Abundance Downlisting Criteria
1	Scott Creek	Dependent	Yes	255
	Waddell Creek	Dependent	Yes	157
	San Vicente Creek	Dependent	Yes	53
	Pescadero Creek	Independent	No	1,150
2	Gazos Creek	Dependent	No	140
	San Lorenzo River	Independent	No	1,900
	San Gregorio Creek	Dependent	No	682
3	Soquel Creek	Dependent	No	561
	Aptos Creek	Dependent	No	466

The working hypothesis for the program is that habitat in the three streams can produce enough NOR Coho Salmon to reduce the risk of extirpation and increase the probability of population persistence in these watersheds over time.

In Phase 1, the release of smolts is prioritized over other life stages as they are expected to exhibit the highest rate of adult returns and subsequent egg production for continued propagation Table 4). In addition, releasing smolts that migrate rapidly from the stream reduces potential density dependence effects to naturally produced fish compared to the release of earlier life stages (Hayes et al. 2004). This is especially important for Scott Creek as monitoring data indicate that total juvenile production capacity may be less than 5,000 juveniles (Figure 2).

This level of juvenile production was not exceeded from adult escapement estimates ranging from 13 to 408 fish. A focus of the monitoring program in Phase 1 is to learn more about the carrying capacity of Group 1 streams and adjust hatchery release number by life stage to not exceed carrying capacity. Monitoring and evaluation (M&E) needed for this effort will be carried out by NMFS and other entities that work in these areas.

Surplus captive broodstock will be released into streams to minimize genetic relatedness, and the number and location of released fish will be based on estimated natural production. This action is designed to reduce inbreeding and increase the number of adult spawning in each receiving stream.

Table 3. Source of broodstock and priority for juvenile releases by stream. Data are provided on Intrinsic Potential Kilometers (IPkm) and Adult Abundance Downlisting Criteria for Scott Creek, Waddell Creek and San Vincente Creek.

Broodstock Source and Juvenile Release Priority	Stream/Population	Intrinsic Potential Kilometers (IPkm)	Adult Abundance Downlisting Criteria
1	Scott Creek	15	255
2	Waddell Creek	9.1	157
3	San Vicente Creek	3.1	53
Total		27.2	465

Table 4. Expected adult and inherent egg returns from the release of eyed-eggs, fry, parr, advanced parr and smolts based on release number, freshwater and marine survival rate assumptions for the HGMP.

Release Life Stage	Release #	Relative Freshwater Survival Rate vs. Smolts	Marine Survival Rate	Total Adult Production	Total Eggs from Returning Adults*
Eyed-Eggs	100,000	5%	1.33%	66	79,514
Fry	100,000	10%	1.33%	133	159,028
Parr	35,000	15%	1.33%	70	83,490
Advanced Parr (fall release)	35,000	80%	1.33%	372	445,470
Smolts	35,000	100%	1.33%	465	556,598

*1/1 male-to-female ratio, fecundity of 2,395 per female – expected to vary by year and broodstock source.

The number of eyed-eggs or fry released each year (if any) by stream will be determined by the Technical Oversight Committee (TOC) based on factors such as natural fish abundance, stream access, number of hatchery juveniles released to each stream, expected environmental conditions (drought, etc.), and the ability to collect resulting adult Coho Salmon production.

To achieve target release numbers, in-hatchery survival rate by life stage will need to be improved from historical rates. The needed survival increase will be accomplished by refining and improving culture practices and replacing captive broodstock with HOR and NOR Coho Salmon adults returning to the SCMDS as run sizes increase.

In Phase 1, the priority for returning HOR and NOR adult Coho Salmon is to use them as program broodstock. The program will collect up to 75 NOR adults (30 female, 45 male) from SCMDS streams. There are no restrictions on the number of HOR adults that may potentially be used as broodstock. HOR adults that are surplus to broodstock needs will be genetically sampled and released to Group 1 streams to spawn naturally. To maintain genetic continuity between the hatchery and natural components of the population, the program will incorporate enough NOR adult Coho Salmon into the broodstock population to achieve a minimum pNOB of 10%, as recommended by the HSRG. Furthermore, no restrictions will be placed on the number of HOR adults allowed to spawn naturally in any stream (i.e., pHOS) during this phase.

Captive broodstock (*N* = 380) will primarily be used to produce the eggs, fry and juveniles for annual release into Group 1 streams. Captive broodstock adults not needed for broodstock will be released to either Pescadero Creek (Group 1) or Group 2 streams to reduce inbreeding risk (Figure 1).

Phase 1 will end when NOR and HOR adult returns are large enough to maintain a self-sustaining hatchery population. At that point, it is expected that the captive broodstock component of the program will be terminated.

Phase 2 – Recolonization

In Phase 2, the program moves from an emphasis on protecting the genetic resources of the population to recolonization of habitat using hatchery supplementation with both HOR juveniles and HOR adults. Figure 2 provides a flow chart for Phase 2 operations from broodstock to juvenile release location.

Achieving a target smolt-to-adult survival rate (SAR) of 1.33% for a release of 35,000 smolts will result in the annual production of 465 adult HOR Coho Salmon. Up to 63 of these HOR adults may be required to meet broodstock needs if in-hatchery life stage survival targets are met (Figure 3)[1]. This will allow HOR Coho Salmon to spawn naturally, thus increasing natural juvenile production and eventually adult NOR's. To maintain genetic continuity between the hatchery and natural components of the population, the program will incorporate enough NOR adult Coho Salmon into broodstock to achieve a minimum pNOB of 25%.

A major goal of Phase 2 is to achieve a natural spawning adult escapement of 465 fish (i.e., the adult downlisting criterion for Group 1 streams in Table 3. The goal will be achieved with a combination of surplus hatchery adults (*N* = 225) and NOR adults, the number of which is expected to increase over time. However, the pace of this increase is unknown.

Phase 2 will end when escapement of NOR adult Coho Salmon to Group 1 streams identified in Table 3 exceeds a three-year running average of 163 fish. Based on 27.2 IPkm of stream habitat, this would result in approximately six NOR spawners per IPkm, and when combined with HOR spawners, 14.3 per IPkm. These numbers fall within the moderate risk spawner density criterion for Coho Salmon developed by Spence et al. (2008). Total adult NOR and HOR escapement would be about 465 fish, thereby achieving the adult abundance downlisting criterion.

[1] 125 HOR adults are needed for broodstock when yearling production is increased to 70,000.

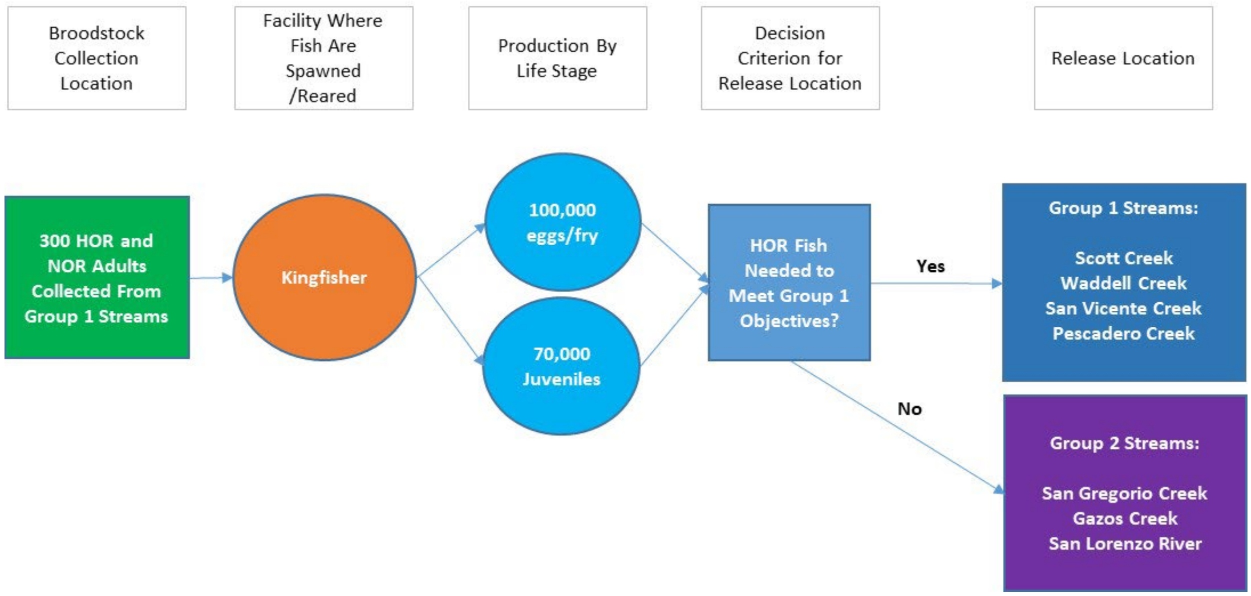

Figure 2. Flow chart illustrating Phase 2 and Phase 3 pathways from broodstock source to stream release location for hatchery-produced eggs, fry, and juveniles.

The program may revert to Phase 1 if HOR and NOR adult returns are insufficient to maintain the program.

Phase 3 – Local Adaptation

In Phase 1 the downlisting criterion (465) is met with HOR adults, while in Phase 2 it is met with a combination of HOR and NOR adults. In Phase 3, the goal is to meet the downlisting criterion with NOR adults only. Achieving this goal will require reducing the number of HOR juveniles released to the streams and controlling the number of HOR adults entering the streams. These actions reduce hatchery influence on the natural component of the population, allowing the natural environment to drive local adaptation, and resulting in an increase in the abundance of adult NOR Coho Salmon.

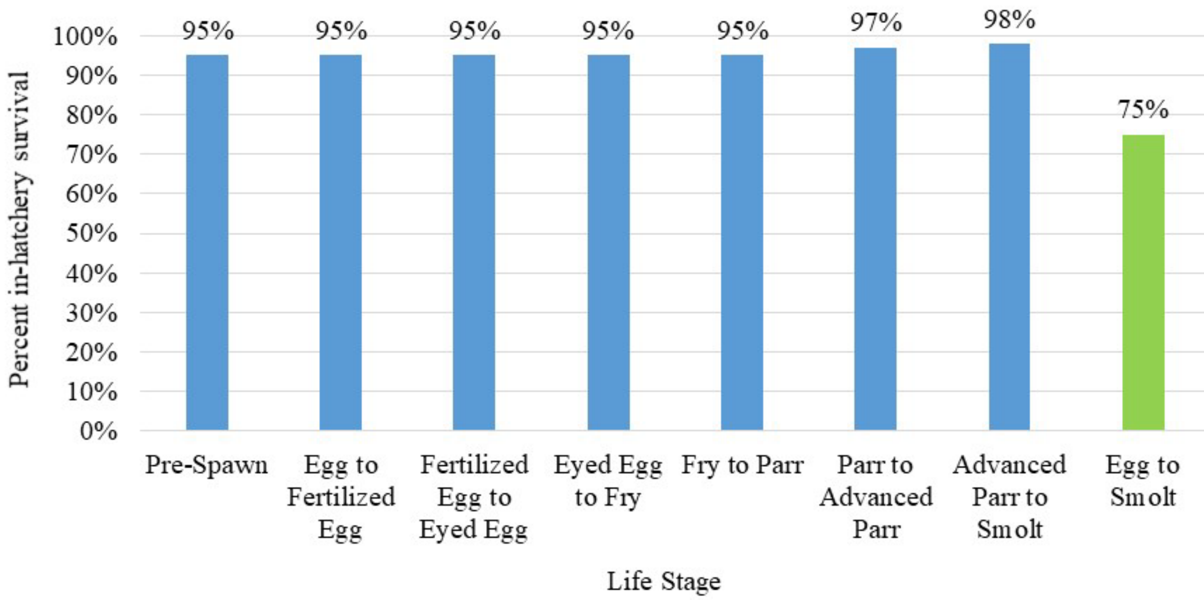

Figure 3. In-hatchery life stage survival rate performance metrics.

The program will be managed to achieve a pHOS of < 0.25 and a pNOB of > 0.50. Attainment of these two metrics results in a PNI of > 0.67 which satisfies the HSRG recommendation that pNOB be at least twice as large as pHOS.

Program managers will use three methods to achieve the PNI performance metric:

1. The number of HOR Coho Salmon allowed to spawn naturally (pHOS) will be controlled using weirs or other methods to capture HOR adults.
2. The number of NOR Coho Salmon used as broodstock (pNOB) will be varied based on adult run size.
3. The number of juveniles released in future years to Group 1 streams will be adjusted downward based on expected adult returns. Surplus juvenile production will be released to Group 2 streams.

Juvenile hatchery-origin fish no longer needed for supplementing three Group 1 streams (Scott Creek, Waddell Creek, San Vincente Creek) will be released in the next priority stream to begin restoring additional Coho Salmon populations.

Phase 3 will end when the 3-year running average of NOR adult returns to the three Group 1 streams of Scott Creek, Waddell Creek and San Vicente Creek is 465 or higher.
The program may revert to Phase 2 if NOR abundance is insufficient to achieve adult performance metrics for Phase 3.

Phase 4 – Full Restoration

The goal of Phase 4 is to increase the abundance of adult NOR coho salmon and achieve the delisting criteria for Scott Creek (510), Waddell Creek (313) and San Vicente Creek (105). Achieving this goal will require significant improvement in habitat conditions in each watershed, which is outside program control.

In this phase, the program will continue to operate by providing needed hatchery-origin fish to supplement Coho Salmon populations in Group 2 and Group 3 streams, if those populations remain below downlisting targets.

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LIST OF ACRONYMS AND ABBREVIATIONS

BY	Brood Year
BKD	Bacterial Kidney Disease
Cal Poly	California Polytechnic State University
CCC	Central California Coast
CCRWQCB	Central Coast Regional Water Quality Control Board
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
CWT	Coded-Wire Tag
DARR	Darroch Analysis with Rank Reduction
DCFH	Don Clausen Fish Hatchery
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
DPS	Distinct Population Segment
DTU	Daily Thermal Unit
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EWS	Emergency Water Supply
FED	Fisheries Ecology Division (NOAA SWFSC)
FL	Fork Length
FRGP	Fisheries Restoration Grant Program
GRTS	Generalized Random Tessellation Stratified (survey design)
g	Gram
HGMP	Hatchery and Genetic Management Plan
HOR	Hatchery-origin
HSRG	Hatchery Scientific Review Group
IP	Intrinsic Potential
IUPAC	International Union of Pure and Applied Chemistry
kg	Kilogram
km	Kilometer
KFH	Kingfisher Flat (Genetic Conservation) Hatchery
L	Liter
LAA	Landowner Access Agreement
LML	Long Marine Laboratory
m	Meter
mg	Milligram
mm	Millimeter
MAI	Moist-air Incubator
MBSTP	Monterey Bay Salmon and Trout Project
MOU	Memorandum of Understanding
MS-222	Tricaine Methanesulfonate
NCRWQCB	North Coast Regional Water Quality Control Board
NMFS	National Marine Fisheries Service
NOR	Natural-origin

NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PACT	Priority Action Coho Salmon Team
PIT	Passive Integrated Transponder
pHOS	Proportion of Natural Spawners Consisting of Hatchery-origin Fish
PNI	Proportionate Natural Influence
pNOB	Proportion Natural-origin Broodstock
ppm	Parts per Million
PSMFC	Pacific States Marine Fisheries Commission
PVC	Polyvinyl Chloride
RAS	Recirculated Aquaculture System
RRCSCBP	Russian River Coho Salmon Captive Broodstock Program
Rkm	River Kilometer
RSI	Remote Site Incubator
r_{xy}	Coefficient of Relatedness
RY	Release Year
SAR	Smolt-to-Adult Return
SCMDS	Santa Cruz Mountains Diversity Stratum
SCSCBP	Southern Coho Salmon Captive Broodstock Program
sec	Second
SJSU	San Jose State University
SNP	Single Nucleotide Polymorphism
SPR	Swanton Pacific Ranch
SWFSC	Southwest Fisheries Science Center
TAC	Technical Advisory Committee
TOC	Technical Oversight Committee
UCD	University of California at Davis
UCSC	University of California at Santa Cruz
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
UV	Ultraviolet
W	Winter (i.e., Spawn Winter)
WCR	West Coast Region (NMFS)
YOY	Young-of-the-Year

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of program

Southern Coho Salmon Captive Broodstock Program (program).

Initially, the conservation program consisted of two separate but jointly related efforts, which included the *Scott Creek/Kingfisher Flat Conservation Program* administered by the Monterey Salmon and Trout Project and the *Scott Creek Captive Broodstock Program* administered by NOAA's Southwest Fisheries Science Center (70 Fed. Reg. 37159). However, because the goals of these two efforts are interrelated regarding the conservation and recovery of extant and functionally extirpated populations throughout the Santa Cruz Mountains Diversity Stratum, the two separate efforts have been consolidated and are now referred to as the Southern Coho Salmon Captive Broodstock Program (SCSCBP).

1.2) Species and population under propagation and ESA status

Central California Coast (CCC) Evolutionarily Significant Unit (ESU), Coho Salmon (*Oncorhynchus kisutch*), State Endangered and Federally Endangered

1.3) Responsible organization and individuals

Operation of the program is a joint effort between NOAA's Southwest Fisheries Science Center Fisheries Ecology Division (FED) and the Monterey Bay Salmon and Trout Project (MBSTP), with technical assistance provided by National Marine Fisheries Service West Coast Region (NMFS WCR), the California Department of Fish and Wildlife (CDFW), and the University of California at Santa Cruz (UCSC). FED and MBSTP personnel work collaboratively to implement all the major elements of the program; however, there is a division of annual tasks between the two entities. Principally, MBSTP is responsible for (1) spawning and propagation of adult Coho Salmon; (2) rearing of Coho Salmon during their first year of life to the yearling stage; and (3) daily husbandry duties associated with the subset of age-1^+ and age-2^+ broodstock fish housed at Kingfisher Flat Genetic Conservation Hatchery (KFH). In contrast, FED is responsible for (1) quarterly health assessments of broodstock fish at all rearing facilities (excluding juvenile production fish at KFH); (2) coordinating the tagging and marking of program fish prior to release; (3) genetic screening of all program fish; (4) production of the annual spawning matrix, and (5) rearing a portion of the captive broodstock. Research and monitoring in support of the program is primarily conducted by UCSC and FED. Table 5 summarizes the division of routine annual activities between FED, MBSTP, Don Clausen Fish Hatchery (DCFH), and UCSC.

A Technical Oversight Committee (TOC) composed of representatives from CDFW, NMFS WCR, MBSTP, FED, as well as stakeholder groups and technical experts, will provide management recommendations based on scientifically justifiable needs, funding, available infrastructure, staffing levels, and compliance with all applicable federal, state, and local laws and statutes. The program will also establish a Technical Advisory Team (TAC) consisting of points of contact (POCs) for NMFS WCR and CDFW and key scientific personnel from FED. The TAC will make all final decisions regarding program operations.

In addition to input from the TOC and TAC, management of the program is based on rigorous monitoring and reporting of the performance metrics and targets established for the program. In the event that a metric or target is not met or unforeseen problems arise during operation, the program POCs identified below will be notified by phone and or email within 24 hours of detection. The POCs will notify other members of the TOC as is appropriate depending on the severity of the issue at hand.

Ideally, discussion of any problem and the formulation of adaptive solutions to ameliorate the issue will be taken up by the TOC, or a subset of members as determined by the POC. Any adaptive changes to the program's activities, whether at the hatchery or in the field, are based on principles and parameters laid out in this HGMP, and the best available scientific knowledge and professional judgement of program staff and scientists. Contact information for program operators is provided below.

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Monterey Bay Salmon and Trout Project

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Email: ed.mbstp@gmail.com

Name and Title: Mathers Rowley, Board Chairperson
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United States Army Corps of Engineers (Don Clausen Fish Hatchery)

Name and Title: Benjamin White, Coho Salmon Hatchery Supervisor
Telephone: (707) 431-4520
Email: Benjamin.C.White@usace.army.mil

Other agencies, tribes, cooperators, or organizations involved

Kingfisher Flat Hatchery is located on land owned and managed by the Big Creek Lumber Company. The Scott Creek weir used for the collection of broodstock and for monitoring the effectiveness of the program is located on land owned and managed by California Polytechnic State University (Cal Poly) San Luis Obispo's Swanton Pacific Ranch (SPR). Staff from UCSC contribute to program implementation and associated fisheries monitoring and research.

Table 5. Summary of the main activities conducted by each affiliated organization in support of the program.

Organization(s)	Program activity	Date(s) activity performed
NMFS WCR, SWFSC FED, MBSTP, CDFW, UCSC	Spring TOC meeting to discuss program performance and develop release strategies.	Mar–Apr
	Fall TOC meeting to examine program performance and progress towards all metrics and targets.	Oct–Nov
SWFSC FED	Daily husbandry of captive broodstock at FED	All year
	Measure captive broodstock fish at all 3 rearing locations	Quarterly
	Production of the annual genetic spawning matrix	Dec–Mar
	Tissue sampling of broodstock individuals	Feb–Apr
	DNA extraction from tissue samples, collection of genetic data, and analysis and interpretation of data	All year
	Research and monitoring in support of the program	All year
MBSTP	Daily husbandry of all captive broodstock at KFH	All year
	Daily husbandry of production fish at KFH	All year
	Care and monitoring of adult spawners	Nov–Mar
	Transport of adult spawners from FED and DCFH to KFH, as well as captive broodstock from KFH to DCFH and FED	Dec–Mar
	Fish propagation/spawning	Dec–Mar
	Outplanting of adult spawners to regional creeks	Dec–Mar
	Outplanting of juveniles and/or yearlings from captive broodstock production	Variable
	Vaccination of production fish	Variable
	Coded-wire tagging of all production fish	Variable
USACE	Daily husbandry of captive broodstock at DCFH	All year
UCSC	PIT tagging of production fish prior to release[†]	Variable
	Research and monitoring in support of the program	All year

[†] Passive Integrated Transponder (PIT) tagging and marking of juvenile fish is conducted by UCSC and FED to assess and inform specific performance standards and indicators.

1.4) Funding source, staffing level, and annual program operational costs
Funding for the operation of the program is acquired by MBSTP and UCSC through external grants from the CDFW's Fisheries Restoration Grant Program (FRGP) or other state sources. Funding for federal staff that assist with administration and execution of the program is provided via base funds from SWFSC FED and NMFS WCR. Annual operating expenses for hatchery operations (all rearing facilities) are estimated to be approximately $980,000. The annual costs associated with the monitoring and evaluation components of the program, which includes genetic analyses and the marking/tagging of all program fish prior to release, are approximately $465,000.

1.4.1) Kingfisher Flat Hatchery (KFH)
Funding Sources. – External grants (65%); other funds (e.g., memberships, donations, volunteer labor; 35%)

Staffing Level. – One executive director and two full-time employees (Hatchery Manager and Assistant Fish Culturist)

1.4.2) NMFS, Southwest Fisheries Science Center, Fisheries Ecology Division (FED)
Funding Sources. – FED base funds (40%); external grants (60%)

Staffing Level. – One full-time hatchery technician. Six part-time employees (Principal investigator, administrative coordinator, two geneticists, and two field/lab technicians).

1.4.3) Don Clausen Fish Hatchery (DCFH)
Funding Sources. – FED

Staffing Level. – One part-time employee (on-site daily husbandry), all additional staffing is provided by FED as detailed above.

1.4.4) University of California at Santa Cruz (UCSC)
Funding Sources. – External grants (100%)

Staffing Level. – Three full-time staff (Project scientist, fisheries specialist, fisheries technician). Four part-time employees (Principal investigator, administrative coordinator, two fisheries technicians).

1.5) Location of hatcheries and associated facilities
The three facilities used to house and rear fish in support of the program are described below and their locations are shown in Figure 4.

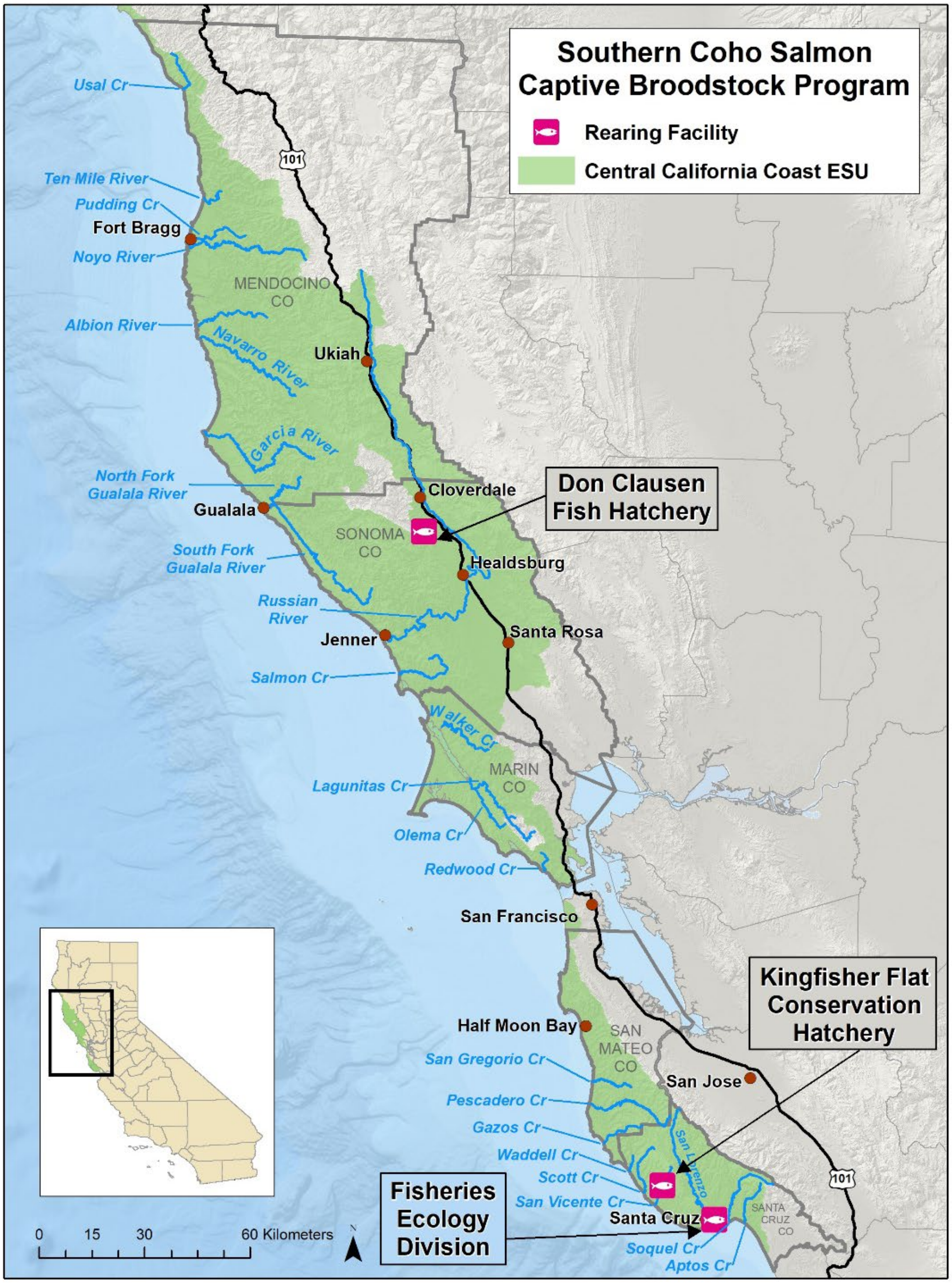

Figure 4. Boundary map of the Central California Coast Coho Salmon evolutionarily significant unit (ESU) and the locations of three rearing facilities of the Southern Coho Salmon Captive Broodstock Program. Map modified from CDFW and Corps (2017).

1.5.1) Kingfisher Flat Hatchery

Kingfisher Flat Hatchery (KFH) is located on Big Creek, a tributary to Scott Creek in Santa Cruz County, California. The hatchery facility is approximately 1.5 river kilometers (rkm) upstream of the confluence of Big Creek and the mainstem of Scott Creek and 4.8 rkm from the Pacific Ocean.

Latitude:	37.089722°
Longitude:	−122.230556°
Elevation:	102 m

1.5.2) Fisheries Ecology Division

The Southwest Fisheries Science Center (SWFSC), Fisheries Ecology Division (FED) laboratory is located on the Coastal Science Campus at the University of California at Santa Cruz.

Latitude:	36.951667°
Longitude:	−122.065000°
Elevation:	23.5 m

1.5.3) Don Clausen Fish Hatchery

Don Clausen Fish Hatchery (DCFH) is located on Dry Creek at the base of Warm Springs Dam (Lake Sonoma), within the Russian River watershed in Sonoma County of Northern California. The hatchery is located approximately 23.2 rkm upstream of the confluence of Dry Creek and the mainstem Russian River and 53 rkm from the Pacific Ocean.

Latitude:	38.718333°
Longitude:	−123.001111°
Elevation:	62.8 m

1.6) Program type

The program is operated as an 'integrated type' program as defined by the HSRG. The purpose of an integrated program is to have the natural environment drive the adaptation and fitness of a composite population of fish that spawn both in the hatchery and in the wild (i.e., naturally). Integration is achieved by incorporating natural-origin fish into the broodstock and controlling the proportion of returning hatchery fish that spawn naturally.

1.7) Purpose of program

The purpose of the program is to aid in the conservation and recovery of CCC Coho Salmon populations in the SCMDS.

1.8) Justification for program

Coho Salmon have been in decline in California for decades (Brown et al. 1994; Weitkamp et al. 1995; CDFW 2004; Spence and Williams 2011), and populations are especially imperiled at the southern end of their range (NMFS 2012). Recognition of these declines triggered a federal Endangered Species Act (ESA) listing for the CCC ESU as threatened in 1996 and a subsequent upgrade to endangered status in 2005 (70 Fed. Reg. 37159). The ESU is also listed as endangered under the California Endangered Species Act (CESA) (CDFG 2004). With a predominant three-year life cycle, Coho Salmon typically exhibit three distinct brood lineages.

At the inception of the program, the Scott Creek source population had already been reduced to a dominant broodline with very modest numbers of breeding individuals, while the two adjacent broodlines were severely depressed. Recognizing the high potential for extirpation due to a single stochastic event, fisheries managers began collecting Coho Salmon from Scott Creek and adjacent watersheds for captive rearing. The program was created with three primary objectives:

(1) Maintain a breeding population of Coho Salmon in captivity to prevent regional (Santa Cruz Mountains Diversity Stratum) extirpation,
(2) Collect fish from the wild to provide the source broodstock necessary to rebuild all three broodlines, and
(3) Use captive broodstock to reestablish Coho Salmon into regional streams where populations had been functionally or completely extirpated.

During the initial years of operation, the program faced myriad challenges in establishing both optimal husbandry practices and robust spawning protocols for captive brood (discussed in Sturm et al. 2009). Nevertheless, the program made strong progress toward all three primary objectives above. Between 2001 and 2006 the program successfully assembled three captive Coho Salmon broodlines, rebuilding the two nearly vacant broodlines in the Scott Creek watershed, and began outplanting Coho Salmon smolts to Scott Creek and three additional Santa Cruz Mountain watersheds where they had been functionally extirpated: Pescadero Creek, Waddell Creek, and Aptos Creek.

Unfortunately, adverse ocean conditions that began in the spring of 2006 (Lindley et al. 2009) temporarily disrupted the positive momentum of the program. Facing poor marine survival and the likelihood of critically low adult escapement, the program strategically refocused on preserving and enhancing the demographic and genetic health of the three broodlines in captivity. In 2010, major changes were initiated to substantially increase the number of adult captive broodstock and to improve the size and fecundity of mature fish. Specifically, new and larger volume rearing tanks were installed at KFH and additional tank space was leased at DCFH in Sonoma County, California. To increase the physical size and vigor of mature adults, several husbandry techniques employed by the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) were adopted. These husbandry techniques led to immediate improvements in mean female size at maturity and fecundity, and ultimately enhanced program production levels.

Although NMFS and program partners had originally anticipated terminating the program in 2009, continued operation was deemed necessary to prevent extirpation of Coho Salmon south of San Francisco Bay. Field surveys at the time indicated that returns of natural-origin (NOR) adult Coho Salmon to Scott Creek, once the regional stronghold that supported all three broodlines, had declined to critical levels. Sustained adult abundance monitoring has demonstrated that few NOR Coho Salmon have returned to Scott Creek since the winter of 2004−2005 (Figure 5).

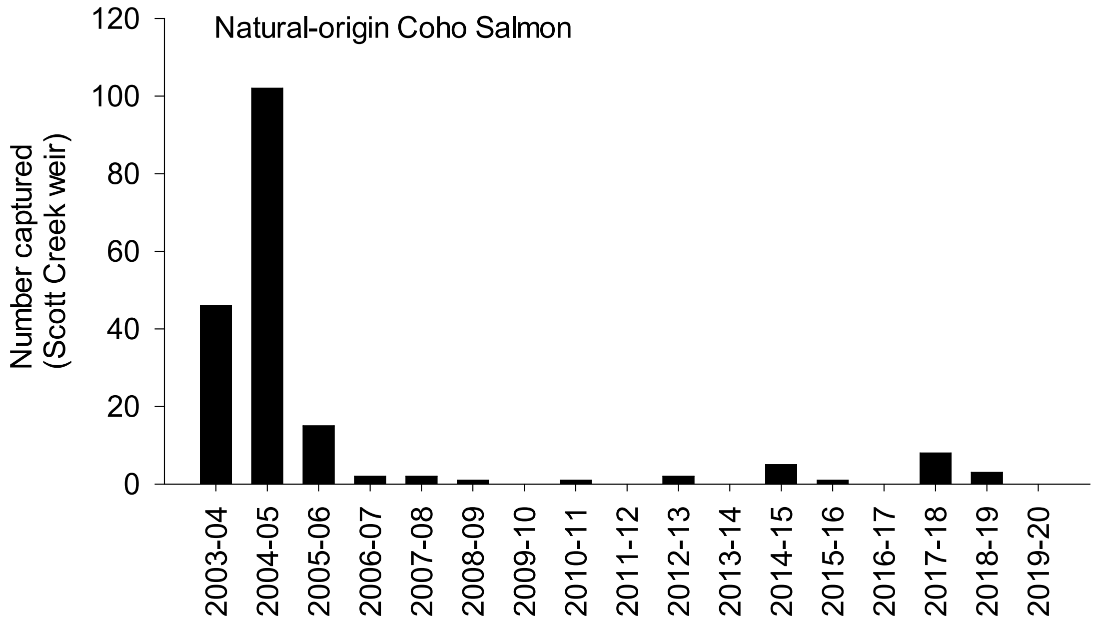

Figure 5. Time series of adult natural-origin Coho Salmon intercepted at the Scott Creek weir (Santa Cruz County, California) for return winters 2003–2004 through 2019–2020. Data are weir captures only and thus represent minimum estimates. Sources: Hayes et al. 2013, Kiernan et al. 2022

Consequently, the Scott Creek population is currently at high risk of extirpation through demographic and genetic processes. In addition, the near elimination of brood lineages, coupled with the three-year life history of Coho Salmon in California, increases the likelihood of extirpation since there is minimal gene flow between the brood lineages and little chance of demographic rescue without intervention. The reduction of the native population to an unsustainably small number of family groups requires continued artificial production of Coho Salmon, through captive breeding, as a means of preserving the remaining genetic lineage and reducing the likelihood of regional extirpation. The NMFS CCC Coho Salmon Recovery Plan explicitly recognizes that domain-scale recovery will not be possible without sustained, hatchery broodstock production coupled with strategic reintroductions and effectiveness monitoring (NMFS 2012).

1.9) List of program performance standards

The following program performance standards are based on those developed by the Columbia River HSRG (2004) and California HSRG (2012) as a means of assessing the benefits and risks of artificial production programs (Table 6). The program will also strive to achieve the specific in-hatchery and life stage performance metrics developed by the California HSRG (2012) (Attachment A).

Table 6. Program performance standards.

Performance Standard	Definition
Achieve Hatchery Best Management Practices	Culture practices developed by the CDFW and California HSRG (2012) to increase life stage-specific survival rates, protect the genetic resources of the cultured population, and provide a high-quality rearing environment.
Implement Appropriate Fish Marking Strategy	All program fish are either externally or internally marked (or genetically known) to distinguish them from naturally produced fish.
Produce High-quality Juveniles and Smolts	A high-quality juvenile/smolt is defined as having similar genetic, physical, behavioral traits and survival rates to naturally produced fish.
Achieve Production Target(s)	Collect, culture, and release the number of adults, eggs, and juveniles required to achieve annual production targets.
Achieve Conservation Objective(s)	1) Maintain a breeding population of Coho Salmon in captivity to prevent regional (Santa Cruz Mountains Diversity Stratum) extirpation. 2) Increase Coho Salmon abundance, productivity, spatial distribution, and diversity (genetic and life history) in SCMDS streams.

1.10) Program performance indicators

A list of performance indicators for the program are presented in Table 7. The table includes information on the benefits and risk associated with each indicator as well as the monitoring proposed to track these indicators over time.

1.11) Expected size of program

The goal of the program is to produce and release up to 170,240 Coho Salmon (all life stages combined) annually to streams within the SCDMS. Currently, juvenile rearing space is limited, and the program is unable to release more than 35,000 smolts in most years. When new rearing facilities become available, the program may release up to 70,000 smolts in SCMDS streams.

Table 7. Performance indicators that address the benefits and (or) risks of the program and accompanying monitoring and evaluation methods.

Performance Indicator	Metric/Action	Benefits and Risks
Broodstock Composition, Timing, and Age Structure Similar to Natural Fish	Broodstock Age Structure Male/Female Ratio Run-timing	**Benefit:** Achievement ensures that the hatchery population reflects the characteristics of the natural population to the extent possible by using only Coho Salmon from SCMDS streams as broodstock and collecting fish randomly over the entire adult run timing. **Risk:** To the extent that these indicators do not represent the natural population, the more divergent the two components (HOR and NOR) populations become. This results in a hatchery population that is not integrated with the natural population, thereby increasing domestication of the hatchery stock and potential genetic harm from hatchery fish when they spawn with natural fish in the wild. **Monitoring:** Life history characteristics of hatchery-origin and natural-origin adult Coho Salmon will be monitored through analysis of hatchery and natural adult returns to hatcheries, weirs, and spawning grounds.
Proportion of Broodstock Consisting of Natural-origin Fish (pNOB).	Phase 1 pNOB ≥ 0.10 Phase 2 pNOB ≥ 0.25 Phase 3 pNOB ≥ 0.50	**Benefit:** Maximizing pNOB increases the representation of alleles from Coho Salmon that have been subjected to natural selection, resulting in the natural environment driving local adaptation. **Risk:** While higher pNOB is likely to increase overall fitness, collection of natural-origin broodstock may have adverse demographic effects on the low-abundance populations from which they are removed. **Monitoring:** Staff will calculate the proportion of broodstock consisting of natural-origin Coho Salmon (pNOB) for the production component of the program using the following equation: $pNOB = NOB/(HOB+NOB)$ Where NOB = Number of natural-origin Coho Salmon used as broodstock and HOB = Number of hatchery-origin Coho Salmon used as broodstock. Results will be provided in annual reports.

Performance Indicator	Metric/Action	Benefits and Risks
High Proportionate Natural Influence (PNI)	Phase 1: No criteria Phase 2 PNI ≥ 0.33 Phase 3 PNI ≥ 0.67	**Benefit:** As PNI exceeds 0.5, the natural, rather than the hatchery environment, is having a greater influence on local adaptation (with maximum influence occurring at 1.0). Fish better adapted to the natural environment are more productive and more resilient to environmental change. **Risk:** Low PNI (< 0.5) is an indicator that the hatchery environment is the dominant force of adaptation. Fish adapted to this environment are less likely to perform well in the wild and therefore reduce the abundance, productivity, and genetic diversity of the natural component of the combined population. **Monitoring:** Staff will review data on Coho Salmon spawning escapement in Scott Creek, Waddell Creek, San Vicente Creek, and Pescadero Creek to calculate PNI using the formula: PNI = pNOB/(pHOS+pNOB) Where pNOB = proportion of broodstock consisting of natural-origin Coho Salmon and pHOS = proportion of natural spawning population consisting of hatchery origin Coho Salmon.
Inbreeding and Outbreeding Depression	Spawning Matrix: Achieve relatedness (r_{xy}) levels less than r_{xy} = 0.125 (first cousin level) Incorporate adult Coho Salmon from outside the SCMDS into broodstock	**Benefit:** Use of a genetic-based spawning matrix and incorporation of Coho Salmon from outside of the SCMDS into the broodstock population reduces the risk of inbreeding depression. **Risk:** The incorporation of fish into the broodstock population from outside of the SCMDS poses a risk of outbreeding depression, which may reduce the fitness of the population. **Monitoring:** The program will conduct genetic analysis to determine the relatedness of the broodstock. Staff will record and report the number of broodstock from *outside* the SCMDS that are used during spawning. An evaluation of the effectiveness of outbreeding will be conducted by NOAA FED staff and presented annually to the TOC (Attachment B). Data presented will allow for controlled comparisons between crosses of fish from within and outside the SCMDS.

Performance Indicator	Metric/Action	Benefits and Risks
Life Stage-specific Survival in Hatchery	Pre-spawn loss: < 5% Green egg to eye-up rate: ≥ 90% Eye-up to hatch (ponding) rate: ≥ 90% Fry to age-1 (smolt) survival: ≥ 95% Egg to age-1 (smolt) survival: ≥ 75% Age-1 (smolt) to adult broodstock survival: ≥ 75%	**Benefit:** High survival in the hatchery indicates good husbandry and genetic health. Monitoring life stage-specific survival allows early detection of problems including detection of pathogens. **Risk**: Low survival rates indicate the hatchery may be artificially selecting for genes/traits that are more conducive for survival in the hatchery rather than the natural environment reducing the ability of the program to increase the abundance of natural populations. **Monitoring:** Program staff will monitor, record, and report mortality in standard monthly reports for each facility. Significant mortality events (defined herein as > 0.2% of fish in any rearing tank in any 24-hour period for juveniles and < 2 individuals per tank for subadult or adult broodstock fish) will be immediately reported to the representatives of NMFS and CDFW identified in Section 1.3. Fish that exhibit deformities are logged, culled upon detection, photographed, and preserved whole or subsampled (depending on life stage) for genetics.
Achieve Annual Production Targets	Number of spawners: up to 300 adults (m/f) Fecundity: ≥ 1,750 green eggs per female Total egg-take: ≥ 125,000 and ≤ 300,000 ≤ 100,000 NOR eggs used as broodstock Progeny produced for release: Maximum of 100,000 eyed-eggs, 100,000 fry and 70,000 (parr, advanced parr or smolts)	**Benefit:** Production of Coho Salmon at or near program capacity will promote recovery of SCMDS Coho Salmon. **Risk:** The release of large numbers of program Coho Salmon to SCMDS streams could lead to adverse ecological and genetic effects on natural Coho Salmon populations, but the likelihood of such effects is low if the abundance of natural populations is below critical depensation levels. The release of large numbers of Coho Salmon juveniles may also result in predation and competition effects on steelhead. **Monitoring:** Staff will record and report relevant data on spawner number, fecundity, egg take, and progeny per life stage produced for release in monthly and annual hatchery operations reports to NMFS and CDFW. Any problems or anomalies detected or experienced are to be reported within 24 hours to NMFS and CDFW representatives.

Performance Indicator	Metric/Action	Benefits and Risks
Number and Severity of Disease Outbreaks is Low	Follow Best Culture Practices	**Benefit:** Having fewer and less severe disease outbreaks reduces the disease risks that hatchery populations and operations pose to natural populations. This results in better natural population productivity, diversity and spatial structure. Minimizing disease losses also allows an accurate evaluation of the number of contributing parents and family size variation, which are important components of effective population size estimates. **Risk:** Frequent and severe disease outbreaks reduce population productivity and require higher numbers of natural and hatchery-origin broodstock to produce a similar number of fish. The use of more natural-origin fish in the hatchery reduces natural spawning escapement, which can reduce population productivity, spatial structure, and diversity. **Monitoring:** Staff will follow the health care standards as outlined in the Fish Health Management Plan (Attachment C).
Hatchery Effluent Quality is High	Obtain specific effluent values: within NPDES permit limits. FED operates under permit No.CAG993003, Order No. R3-2008-0059 DCFH operates under permit No.CA0024350/I.D. No. 1B84034050N KFH has been granted an NPDES exemption by the Central Coast Regional Water Quality Control	**Benefit:** Sustaining releases of high-quality water protects the surrounding ecosystems. **Risk:** The release of pathogens or chemical contaminants through hatchery effluent could pose a threat to natural populations. **Monitoring:** Staff will monitor, record and report all parameters as defined in their permits.

Performance Indicator	Metric/Action	Benefits and Risks
Fish Deformities	100% of all deformities detected, culled, and reported.	**Benefit:** Fish deformities can be caused by inbreeding, environmental, or genetic × environmental effects. Tracking the incidence of deformities is critical to exploring and ameliorating potential causes. **Risk:** The lack of tracking of deformities and culling of deformed individuals can result in low fitness and poor long-term survival of cultured fish. Low fitness within a population can contribute to an increased extinction risk. **Monitoring:** Hatchery staff will monitor rearing vessels for the presence of deformed fish. Deformed fish will be culled upon detection, logged, photographed, and tissue samples will be collected (or specimens preserved) for potential genetic analysis. Logging of deformities will include a detailed description of the specific deformities that each culled individual exhibit and as much detail as possible regarding the rearing conditions the fish was exposed to.
Tagging Accuracy of Fish in Hatchery.	Fry May be marked with a coded-wire tag (CWT) Parr, Advanced Parr and Smolts: CWT: 100% CWT retention: ≥ 99% PIT tags: ≥ 25%, as resources permit Captive Brood Adults: PIT tags: 100% Disc tags for adult spawners: 100% Disc or Floy tags for adult release: 100% Jaw tags/Hole punch for Carcasses: 100%	**Benefit:** Marking with CWTs allows for accurate identification of all juvenile Coho Salmon released from the program. Fractional marking with PIT tags facilitates effective post-release monitoring of juveniles and adults. Both internal (PIT tag) and external (uniquely numbered Petersen Disc or Floy T-bar) tagging of captive adults facilitates identification of individual fish for implementation of a genetic spawning matrix during artificial spawning. Floy tagging of released adults allows for identification of HOR fish during instream spawner surveys. **Risk:** Marking can result in fish mortality, increased susceptibility to disease, and possible decreased survival once released from the hatchery. **Monitoring:** Program staff will mark all fish using best practices. Tagging information will be sent to NMFS and CDFW in monthly tagging reports. The report will describe the number of fish tagged by tag type, tagging mortality, and results of quality control efforts to determine tag retention rates.

Performance Indicator	Metric/Action	Benefits and Risks
Release Timing and Size	<u>Release Timing:</u> Eyed-eggs: January - February Fry: April–May Parr: June–August Advanced parr: September–December Smolts: February–May Adults: December–March <u>Juvenile Release Size (vary by year):</u> Fry: < 60 mm FL Parr: 60–79 mm FL Advanced Parr: 80–89 mm FL Smolts: 90–133 mm FL	**Benefit:** Releasing healthy fish at the target size and time increases overall survival and reduces the number of releases needed to achieve conservation and harvest goals. **Risk**: Releasing fish that are too large may result in increased predation on natural fish. A mismatch between release timing and environmental conditions required for good survival may reduce overall hatchery performance or result in fish being trapped in freshwater due to seasonal sandbar formation. Additionally, the release of large fish may result in the production of large numbers of jacks that reduce population productivity as they produce no eggs. **Monitoring:** Hatchery staff will record the release date, release location and size of fish released by the program each year. Fish lost during loading, transport, and release will be recorded and reported.
High Smolt-to-Adult Return Rate (SAR)	SAR for a 35,000 Smolt Release > 1.3%. SAR for a 70,000 Smolt Release > 0.66%	**Benefit:** High SAR is an indicator that the hatchery is producing a high-quality smolt that can survive in the natural environment from release to adulthood. The higher the survival rates, the fewer hatchery fish required to achieve conservation and harvest objectives. Decreased hatchery production reduces interaction with the natural population, which can result in increased abundance of natural fish. **Risk:** Low survival rates indicate that rearing practices are producing a fish of low quality. This means that larger fish releases are required to achieve program objectives. The larger the release of hatchery the greater the competition and predation risk these hatchery fish pose to natural populations. **Monitoring:** The program will estimate SAR for all juvenile fish released from the program. The data needed for this effort will be collected and recorded primarily by others and submitted to appropriate databases. Tagged fish returning to weirs, captured for broodstock or encountered in carcass surveys will be recorded by monitoring entities and reported to these databases. SARs for each life stage released will be reported in annual reports.

1.11.1) Proposed annual broodstock collection level (max. number of adult fish)
A maximum of 380 adult Coho Salmon will be used as broodstock in any given year. The source of the broodstock will consist of adult HOR and NOR returns, and NOR juveniles collected in SCMDS streams and subsequently reared to the adult life stage in the hatchery, as well as the offspring of these fish (i.e., captive broodstock).

The program proposes to collect, transport and spawn up to 30 NOR females and 45 NOR males from SCMDS streams for broodstock. Fish from Scott Creek used as broodstock will be collected by FED under NMFS Section 10(a)(1)(A) Research Permit 17292-3R (and future renewals).

To increase population genetic diversity, the program may incorporate up to 50 (13 female, 37 male) Coho Salmon adults from DCFH to meet outbreeding objectives for the program. DCFH currently uses Coho Salmon from Lagunitas Creek, Olema Creek, and the Russian River as broodstock. The program may use any source population of CCC Coho Salmon available from DCFH for outbreeding purposes if approved by NMFS and CDFW.

1.11.2) Proposed annual fish release levels (max. number) by life stage and location
Release locations (streams) have been prioritized into three groups (Table 8). The highest-ranked streams (Group 1) have the priority of stocking with program fish releases. Scott Creek, Waddell Creek, and San Vicente Creek were classified as Group 1 streams because they still contain small populations of naturally produced fish or, as in the case of Scott Creek, have existing facilities that can be used to collect fish for broodstock and monitor Coho Salmon abundance over time. Pescadero Creek is included in Group 1 because it is classified by NMFS as an independent population, and therefore has sufficient juvenile carrying capacity to support large releases of program fish without resulting in significant density dependence effects to naturally produced fish as few are present in this stream. However, until facilities are available to rear more hatchery smolts, Coho Salmon releases to Pescadero Creek will likely consist primarily of eggs, fry, parr, advanced parr, and/or captive brood adults.

Proposed annual maximum Coho Salmon release levels by stream are shown in Table 8. For all streams combined, the program will release no more than 170,000 total progeny (≤ 100,000 early life stages (eggs and fry) and ≤ 70,000 juveniles[2]) and up to 380 Captive Brood adult Coho Salmon into SCMDS streams.

Release numbers by life stage for each stream were developed based on hatchery rearing capacity, adult downlisting criterion, and the expected number of adults the release strategy is estimated to produce (Table 9). The total number of each released life stage was set such that the adult downlisting criterion for a stream was not exceeded. The exception to this rule is Scott Creek, where no limitations are placed on the possible number of fish released, so that returning adults can be collected at the Scott Creek weir and used for broodstock.

[2] Juveniles include parr, advanced parr, and smolts.

Table 8. Annual maximum number of program egg, fry, parr, advanced parr, smolt and captive brood adults released by stream and group. Priority of egg and fish releases is to Group 1 streams. The total number of Coho Salmon released in a year (all life stages and locations) will not exceed 170,000*.

Stream Priority Group	Stream	Population Status	Naturally Produced Coho Salmon Present	Adult Abundance Downlisting Criteria	Maximum Release Number by Life Stage					Captive Brood
					Early Life Stages		Juveniles			
					Eggs	Fry	Parr	Advanced Parr	Smolts	
1	Scott Creek	Dependent	Yes	255	100,000	100,000	70,000	35,000	35,000 to 70,000	240
1	Waddell Creek	Dependent	Yes	157	100,000	100,000	70,000	29,600	11,822	157
1	San Vicente Creek	Dependent	Yes	53	100,000	79,819	53,213	9,977	3,991	53
1	Pescadero Creek	Independent	No	1,150	100,000	100,000	70,000	35,000	35,000	240
2	Gazos Creek	Dependent	No	140	100,000	100,000	70,000	26,355	10,542	140
2	San Lorenzo River	Independent	No	1,900	100,000	100,000	70,000	35,000	35,000	240
2	San Gregorio Creek	Dependent	No	682	100,000	100,000	70,000	35,000	35,000	240
3	Soquel Creek	Dependent	No	561	100,000	100,000	70,000	35,000	35,000	240
3	Aptos Creek	Dependent	No	466	100,000	100,000	70,000	35,000	35,000	240

**Note*: These release assumptions are based on achieving the in-hatchery survival performance metrics by life stage. If survival is lower than the metrics, then the release of more adults may be necessary. The juvenile numbers would not change, but the number of captive broodstock adults that would be available for release would be higher, or up to a maximum of 380.

Table 9. Expected adult production from the maximum release of eggs, fry, parr, advanced parr, smolts and captive brood adults by stream and group.

Stream Priority Group	Stream	Population Status	Naturally Produced Coho Salmon Present	Adult Abundance Downlisting Criteria	Expected Adult Production by Life Stage					
					Early Life Stages		Juveniles			
					Eggs	Fry	Parr	Advanced Parr	Smolts	Captive Brood
1	Scott Creek	Dependent	Yes	255	33	66	70	186	465–930	240
	Waddell Creek	Dependent	Yes	157	33	66	70	157	157	157
	San Vicente Creek	Dependent	Yes	53	33	53	53	53	53	53
	Pescadero Creek	Independent	No	1,150	33	66	70	186	465	240
2	Gazos Creek	Dependent	No	140	33	66	70	140	140	140
	San Lorenzo River	Independent	No	1,900	33	66	70	186	465	240
	San Gregorio Creek	Dependent	No	682	33	66	70	186	465	240
3	Soquel Creek	Dependent	No	561	33	66	70	186	465	240
	Aptos Creek	Dependent	No	466	33	66	70	186	465	240

The number of eggs, fry, parr, and advanced parr released to each stream will also be dependent on the carrying capacity of the stream and potential density dependent (e.g., competition or predation) effects on natural populations. For example, Scott Creek monitoring data indicate that the total juvenile production capacity may be less than 5,000 juveniles in most years (see Section 2.7).

This level of juvenile production was not exceeded with adult spawner escapements ranging from 13 to 408 fish. The program will use this type of information to inform release numbers for fish life stages (fry, parr, advanced parr) that spend considerable time rearing and competing with NOR Coho Salmon.

1.12) Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels

Smolt-to-adult survival (SAR) for Coho Salmon released from the program to Scott Creek is summarized in Table 10. Since 2006, an average of 12,937 smolts have been released annually in the Scott Creek basin, and SAR has averaged 0.18%, with a low of 0% for release year (RY) 2009 (BY2007–2008) and a high of 0.57% for RY 2007 (BY2005–2006; Table 10). While smolt releases have occurred in other SCMDS streams, quantitative data on subsequent adult returns are unavailable. It is important to note these data do not consider potential contributions from fry or parr releases, and they largely ignore straying among neighboring watersheds (i.e., metapopulation dynamics).

1.13) Date program started

The program was formally initiated in March 2002 and has been in continuous operation since that time.

1.14) Expected duration of program

The program is expected to be in operation until conservation hatchery intervention is no longer warranted. Although there are many criteria involved in downlisting or delisting an ESU such that it may no longer require support as implemented in the program, a critical consideration is population size. Target population size for downlisting and delisting are provided in the federal CCC Coho Salmon recovery plan (NMFS 2012) and presented for each of the watersheds targeted by the program in Table 11. Hatchery releases to each of the nine populations would be formally evaluated for termination when the three-year running average adult abundance achieves the downlisting criterion for a stream.

1.15) Watersheds targeted by program

Hatchery fish will be distributed by program staff and affiliates (see Section 1.3) to recovery streams within the SCMDS as prioritized in Table 11 and shown in Figure 6. Select attributes of each watershed, including extant and historical fish taxa present, are presented in the following paragraphs.

Table 10. Coho Salmon smolt releases and adult returns to Scott Creek (Santa Cruz, County) by brood year (BY) from 2002–2003 to 2019–2020.

Brood year (BY)	Release year (RY)	No. smolts released in basin	Adult returns to Scott Creek			Smolt to adult survival (%)
			at age-2 (Jack/Jill)†	at age-3 (adult)	Total return	
2002–2003	2004	0	---	---	---	---
2003–2004	2005	0	---	---	---	---
2004–2005	2006	729	1	2	3	0.41
2005–2006	2007	2,279	7	6	13	0.57
2006–2007	2008	3,120	8	1	9	0.29
2007–2008	2009	1,874	0	0	0	0
2008–2009	2010	600	2	0	2	0.33
2009–2010	2011	0	1‡	0	1	---
2010–2011	2012	2,000	3	0	3	0.15
2011–2012	2013	31,857	30	70	100	0.31
2012–2013	2014	28,679	30	2	32	0.11
2013–2014	2015	14,602	0	2	2	0.01
2014–2015	2016	20,104	6	2	8	0.04
2015–2016	2017	11,346	5	3	8	0.07
2016–2017	2018	27,812	4	4	8	0.03
2017–2018	2019	24,525	4	0	4	0.02
2018–2019	2020	22,844	1	79¥	80¥	3.50
Average		11,316				0.42

†Jacks and Jills are defined as sexually precocious 2–year old males and females, respectively.
‡ Presumably, a stray from adjacent San Vicente Creek where 300 smolts were released in May 2011.
¥ Excludes 19 adult fish that were originally released as late parr in the fall of 2019 and returned during winter 2021–2022.
Source: Scott Creek Life Cycle Monitoring Station, NOAA FED, *unpublished data*.

1.15.1) Scott Creek (Group 1)

The Scott Creek watershed drains approximately 70 km^2 of the Santa Cruz Mountains and enters the Pacific Ocean approximately 80 km south of San Francisco (Lat. 37.0405°; Long. –122.2291°). Large waterfalls form impassable barriers on the mainstem and each of the three major tributaries (Little Creek, Big Creek and Mill Creek), thus restricting access by anadromous fish to 23 km of stream. The upper portion of the watershed contains high gradient streams dominated by a thick coast redwood (*Sequoia sempervirens*) canopy. The mainstem below the major tributary confluences is low gradient with a lower density canopy cover primarily of alder (*Alnus* spp.), and an understory dominated by willow (*Salix* spp.).

Land use is predominantly rural residential, selective logging, and agriculture with 95% of the watershed under private ownership. Stream flows in the basin are highly variable among seasons and years. Peak winter flows can exceed 65 m/s, whereas late summer and autumn base flows often decline to ≤ 0.08 m/s during an average water year (Osterback et al. 2018).

Table 11. SCMDS stream priority group, broodstock source and juvenile release priority, population status and adult abundance downlisting criteria for Coho Salmon (NMFS 2012).

Stream Priority Group	Stream	Population Status	Adult Abundance Downlisting Criteria
1	Scott Creek	Dependent	255
	Waddell Creek	Dependent	157
	San Vicente Creek	Dependent	53
	Pescadero Creek	Independent	1,150
2	Gazos Creek	Dependent	140
	San Lorenzo River	Independent	1,900
	San Gregorio Creek	Dependent	682
3	Soquel Creek	Dependent	561
	Aptos Creek	Dependent	466

The Scott Creek fish assemblage is composed of Coho Salmon, steelhead trout, Threespine Stickleback (*Gasterosteus aculeatus*), Prickly Sculpin (*Cottus asper*), and Coastrange Sculpin (*Cottus aleuticus*). The status of the Coho Salmon and steelhead populations in the watershed are well documented due to the operation of a life cycle research and monitoring station by FED and UCSC since 2003. This comprehensive monitoring program has produced a time-series of key viability metrics including abundance, productivity, spatial structure, and diversity. Recent escapement of Coho Salmon to Scott Creek since winter 2002–2003 has ranged from a high of 329 adults in 2004–2005, to a low of one returning adult in both 2009–2010 and 2011–2012. Escapement targets identified for Scott Creek in the final Coho Salmon recovery plan are 255 for downlisting to threatened status and 510 for delisting (NMFS 2012). The Coho Salmon population in this watershed has been classified as a historically dependent population (Bjorkstedt et al. 2005), indicating that its dynamics and long-term persistence were likely dependent on recruits from other populations in the SCMDS.

Figure 6. Location map of Coho Salmon recovery watersheds within the Santa Cruz Mountains Diversity Stratum. Except for Laguna Creek (recognized as a supplemental watershed rather than a recovery watershed), the program targets all watersheds in the diversity stratum.

1.15.2) Waddell Creek (Group 1)
Waddell Creek drains approximately 39 km^2 of the Santa Cruz Mountains and enters the Pacific Ocean 24 km north of Santa Cruz, California (Lat. 37.0963°; Long. –122.2780°). Waddell Creek has two main forks, West Waddell Creek and East Waddell Creek, which join about 8 km upstream from the mouth of the creek to form the mainstem. There are approximately 11 km of stream accessible to Coho Salmon. A large portion of the watershed (86%) is under public ownership as part of the Big Basin Redwoods State Park, with privately owned parcels at the mouth and along the east branch. Dominant land uses are recreation/parks, agricultural, and selective logging. Housing density is low. Land cover is primarily conifer forests (85%) dominated by coast redwood.

The Waddell Creek fish assemblage is entirely native and composed of Coho Salmon, steelhead, Threespine Stickleback, Prickly Sculpin, and Coastrange Sculpin. Waddell Creek was the site of a seminal study on the life histories of Coho Salmon and steelhead in the 1930s and early 1940s (Shapovalov and Taft 1954). During the period of study (1933–1941), annual Coho Salmon escapement to Waddell Creek ranged from a high of 583 adults in 1933–1934 to a low of 84 in 1936–1937 (Shapovalov and Taft 1954). Although there is a lack of contemporary data on adult returns to the watershed, juvenile surveys conducted annually since 1992 indicate that recruitment has been extremely poor over the past 12 years and all three Coho Salmon broodlines are likely functionally extirpated (Smith 2017; NMFS 2012). Also, small numbers of adult Coho Salmon from the program have been detected in Waddell Creek each winter since 2014–2015 via stationary PIT tag antenna arrays in the lower basin (J. Kiernan, SWFSC, *unpublished data*). Escapement targets identified for Waddell Creek in the final Coho Salmon recovery plan (NMFS 2012) are 157 for downlisting to threatened status and 313 for delisting. The Coho Salmon population in this watershed was historically dependent on adult recruits from other populations in the diversity stratum.

1.15.3) San Vicente Creek (Group 1)
San Vicente Creek is a small (28.5 km^2) watershed located 83 km south of San Francisco Bay (Lat. 37.009503°; Long. –122.193964°). Nearly the entire watershed (99%) is privately owned, with 60% owned by a consortium of conservation organizations. Approximately 60% of the watershed is mixed coniferous forest dominated by coast redwood and Douglas-fir (*Pseudotsuga menziesii*) and 28% is classified as shrub and grassland. Logging and mining have historically been dominant land uses. Urban and agricultural areas account for 6% and 4%, respectively, of current land use. Urban development is centered in the lower part of the watershed in the town of Davenport. A key attribute of the San Vicente Creek watershed is the underlying karst geology, which results in elevated stream flow and relatively cool water temperatures during the summer base flow period. Moreover, unlike other watersheds in the region, San Vicente Creek lacks a seasonal estuary, which was eliminated by the construction of the coast railroad and later Highway (State Route) 1. At the coast, San Vicente Creek presently flows through a man-made tunnel and discharges directly onto the beach.

The fish assemblage in San Vicente Creek is composed of five species: Coho Salmon, steelhead, Threespine Stickleback, Prickly Sculpin, and Coastrange Sculpin. Classified as a dependent watershed in the NMFS (2012) final Coho Salmon recovery plan, San Vicente is the only watershed in the diversity stratum (other than Scott Creek and Waddell Creek) with an extant population of Coho Salmon, albeit generally at low abundance.

Fish from the captive broodstock program have intermittently been outplanted to San Vicente Creek over the past decade principally as smolts. Recently however, multiple life stages (i.e., unfed fry, smolts and adults) have been released in some years. Annual estimates of Coho Salmon escapement to San Vicente Creek have ranged between 0 and 65 individuals as estimated from redd surveys conducted between 2012 and 2018 (Pacific States Marine Fisheries Commission, *unpublished data*). Spawner targets established for San Vicente Creek in the final Coho Salmon recovery plan (NMFS 2012) are 53 for downlisting to threatened, and 105 for delisting. The Coho Salmon population in this watershed was historically dependent on recruits from other populations in the diversity stratum.

1.15.4) Pescadero Creek (Group 1)
The Pescadero Creek watershed is located approximately 23 km south of Half Moon Bay in southern San Mateo County and enters the Pacific Ocean near the town of Pescadero (Lat. 37.266118°, Long. –122.412060°). At 212 km^2, Pescadero Creek is the largest coastal drainage between San Francisco and Santa Cruz. Land use within the watershed includes agriculture, grazing, recreation/parks, rural and urban residence, and selective logging. The watershed is rural, with land cover comprised primarily of mixed-conifer forest (66%) and coastal scrub, chaparral, and annual grassland (29%) with the remainder as urban and agricultural lands. Approximately 23% of the watershed is in public ownership managed by state or county parks, which includes Pescadero Creek Memorial County Park, Portola Redwood State Park, Butano Redwoods State Park, and the Pescadero Marsh Natural Reserve at the estuary. The remainder of the watershed is in private ownership.

The Pescadero Creek fish assemblage is composed of Coho Salmon, steelhead, Threespine Stickleback, Prickly Sculpin, Monterey Roach (*Hesperoleucus venustus subditus*), and Coastrange Sculpin. Both Pescadero Creek and its largest tributary, Butano Creek, historically contained runs of Coho Salmon and steelhead. Similar to other watersheds in the Santa Cruz Mountains, industrial scale logging in the late 19th century and the first half of 20th century had substantial impacts on the health of the watershed, particularly due to hillslope erosion and sedimentation of stream channels, and the removal of large wood from the stream channels. Following the extreme 1976–1977 drought event, Coho Salmon were essentially extirpated from the watershed and have rarely been observed in the basin since that time (NMFS 2012).

Only three releases of program fish have occurred in the Pescadero Creek watershed: 11,475 smolts in 2003, 12,643 smolts in 2006, and 10,000 advanced parr in 2020. In the NMFS (2012) recovery plan, the Pescadero Creek watershed is identified as one of two (along with the San Lorenzo River) historically independent Coho Salmon populations in the SCMDS. As such, reintroduction of fish from the program to the watershed will be central to successful recovery of Coho Salmon within the diversity stratum. Adult spawner targets for downlisting and delisting were set at 1,150 and 2,300, respectively (NMFS 2012).

1.15.5) Gazos Creek (Group 2)
Gazos Creek is a small 31 km^2 coastal watershed in southern San Mateo County. The Gazos Creek catchment contains 11.4 km of anadromous waterway and enters the Pacific Ocean approximately 40 km north of Santa Cruz, California (Lat. 37.166092°; Long. –122.360833°). California State Parks owns and manages approximately 21% of the lower basin including the estuary (seasonal freshwater lagoon) and the remainder of the watershed is under private ownership. Land cover in the watershed is predominantly coniferous forests (73%), with the remainder largely comprised of shrub and grasslands. Housing density within the watershed is low.

The Gazos Creek fish assemblage is composed of Coho Salmon, steelhead, Threespine Stickleback, Prickly Sculpin, and Coastrange Sculpin. While Coho Salmon persisted in the Gazos Creek watershed through at least 2005 (Smith 2017), juveniles have not been observed during annual fall sampling since 2005. In June 2018, approximately 8,200 Coho Salmon fry (BY1718) were released at various locations along mainstem Gazos Creek. Escapement targets for Gazos Creek identified in the final Coho Salmon recovery plan (NMFS 2012) are 140 for downlisting to threatened status and 279 for delisting. The Coho Salmon population in this watershed was historically dependent on recruits from other populations in the SCMDS.

1.15.6) San Lorenzo River (Group 2)
The San Lorenzo River is the largest watershed in the SCMDS (drainage area ~360 km^2) and empties into the Pacific Ocean at the City of Santa Cruz (Lat. 36.963056°; Long. –122.012778°). Much of the watershed (90%) is under private ownership with the remaining 10% owned by the University of California and California State Parks. Most (62%) of the watershed is coniferous forest (coast redwood and Douglas-fir), 22% is shrub and grassland and the remainder are urban development with more than 34,000 housing units in the watershed.

The San Lorenzo watershed has a long history of habitat alteration and degradation. By the early 1900s extensive logging (and accompanying road and rail development) had severely impacted most of the upper basin. Additionally, dams constructed to support lumber mills on most of the salmon-bearing tributaries altered natural flow regimes and restricted access to spawning and rearing habitat. Subsequent urban development of the San Lorenzo Valley during the 1950s and 1960s and large-scale flood abatement programs (i.e., construction of flood control levees to protect the City of Santa Cruz) have substantially altered ecological function in the lower mainstem river and estuary to the detriment of salmonids and other native species.

In contrast to the smaller watersheds in the diversity stratum, the San Lorenzo River contains a fish assemblage that is composed of both native and alien (non-native) taxa. Native fish species include steelhead, Coho Salmon, Pacific Lamprey (*Entosphenus tridentatus*), Threespine Stickleback, Speckled Dace (*Rhinichthys osculus*), Coastrange Sculpin, Prickly Sculpin, Monterey Roach, and Sacramento Sucker (*Catostomus occidentalis*). Alien fish species documented in the watershed include Golden Shiner (*Notemigonus crysoleucas*), Bluegill (*Lepomis macrochirus*), Green Sunfish (*Lepomis cyanellus*), and Brown Bullhead (*Ictalurus nebulosus*) (San Lorenzo Valley Water District 2009).

There is little evidence that Coho Salmon have reproduced successfully in the San Lorenzo River watershed over the last 30 years. Although adults are occasionally captured and released at the Felton Diversion Dam during the winter spawning period, juvenile Coho Salmon have not been observed in the watershed since 2005. Prior to this observation, the last credible report of successful Coho Salmon reproduction in the watershed occurred in 1981. Escapement targets for the San Lorenzo watershed are set at 1,900 for downlisting to threatened status and 3,800 for delisting (NMFS 2012). The San Lorenzo River population is identified as an independent population in the federal Coho Salmon recovery plan and the reintroduction of fish from the program to tributaries of the San Lorenzo River will be central to successful recovery of Coho Salmon in the SCMDS over the long term.

1.15.7) San Gregorio Creek (Group 2)
The San Gregorio watershed has a drainage area of 135 km^2 and contains approximately 64 km of anadromous streams. San Gregorio Creek enters the Pacific Ocean at San Gregorio State Beach (Lat. 37.322392°, Long. –122.403516°) approximately 16 km south of Half Moon Bay. Primary land uses in the watershed include grazing, agriculture, selective logging, recreation/parks, and rural residence. Most of the upper watershed consists of three primary tributaries: La Honda, Alpine, and Harrington creeks. Several smaller tributaries join San Gregorio farther downstream including Bogess and Corte Madera creeks. Nearly the entire watershed is privately owned (98%) with the remaining land contained within county or state parks. Land cover in the watershed is comprised of approximately 32% coniferous forests, 62% as shrub and grasslands, and the remainder as urban and agricultural lands. Industrial logging following the gold rush in the 19th Century resulted in substantial impacts to streams throughout the watershed, particularly in the upper reaches. In addition, numerous water diversions and wells resulted in the state declaring the watershed fully appropriated between 1 June and 31 October.

The San Gregorio Creek fish assemblage is composed of Coho Salmon, steelhead trout, Threespine Stickleback, Prickly Sculpin, and Coastrange Sculpin. Industrial logging following the gold rush in the 19th Century resulted in substantial impacts to streams throughout the watershed, particularly in the upper reaches. In addition, numerous water diversions and wells resulted in the state declaring the watershed fully appropriated between 1 June and 31 October. Coho Salmon have been functionally extirpated from the San Gregorio watershed, with only rare occurrences noted in recent decades including capture of out-migrating smolts in the estuary during the spring of 2006 (Atkinson 2010). Escapement targets for the San Gregorio watershed are 682 for downlisting, and 1,363 for delisting (NMFS 2012). The Coho Salmon population in this watershed was historically dependent on recruits from other populations in the SCMDS.

1.15.8) Soquel Creek (Group 3)
Soquel Creek drains 108.8 km^2 of the Santa Cruz Mountains and empties to the Pacific Ocean at the town of Capitola (Lat. 36.971111°; Long. –121.951944°). Land use within the Soquel Creek watershed includes urban development, rural residential development, agriculture, recreation/parks, mining and timber harvesting. Housing density is low in the upper watershed and high at the creek mouth in the City of Capitola. Roughly 25% of the upper reaches of the creek and its major tributaries are state lands. The upper watershed is dominated by conifer forests (64%), while other areas consist mostly of shrub (20%), and oak woodlands (3%). Like

most coastal California streams, hydrology in the Soquel Creek watershed is highly variable and stream flow can rise rapidly in a matter of hours during heavy winter storms with rapid declines when the rain stops. A sandbar at the mouth of the creek is manually constructed by the City of Capitola in late May each year to create a freshwater lagoon that supports summer growth of juvenile salmonids. The sandbar is breached in late fall (artificially or by storms), allowing adult salmonids to enter the creek to spawn.

The Soquel Creek fish community is composed of steelhead, Coho Salmon, Pacific Lamprey, Three-spine Stickleback, Coastrange Sculpin, Prickly Sculpin, Monterey Roach, and Sacramento Sucker. While both adult and juvenile Coho Salmon have been reported in Soquel Creek during the last decade, their presence is rare and attributed to straying from Scott Creek. It is unlikely that a viable Coho Salmon population has existed in the watershed for at least 50 years. Escapement targets for Soquel Creek identified in the final Coho Salmon recovery plan (NMFS 2012) are 561 adults for downlisting to threatened status and 1,122 for delisting. The Coho Salmon population in this watershed was historically dependent on recruits from other populations in the diversity stratum.

1.15.9) Aptos Creek (Group 3)
The Aptos Creek watershed drains 54 km^2 of the Santa Cruz Mountains and contains approximately 25 km of spawning and rearing habitat for anadromous fishes. Aptos Creek empties into Monterey Bay through a small, confined estuary located near the town of Aptos (Lat. 36.969445°; Long.-121.906506°). Approximately half (52%) of the watershed is publicly owned as state parks (The Forest of Nisene Marks State Park). Nearly 70% of the watershed consists of mixed-conifer forests with pockets of rural and urban development (7%), agriculture (5%). As with other watersheds in the Santa Cruz Mountains, commercial logging in the late 19th and early 20th centuries resulted in substantial removal of virgin conifer forests, hillslope erosion and sedimentation of stream channels. In the lower elevations of the watershed, agriculture, then urbanization replaced oak woodlands and altered a considerable portion of the historic estuary.

The Aptos Creek fish community is composed of steelhead, Pacific Lamprey, Threespine Stickleback, Coastrange Sculpin, and Prickly Sculpin. Coho Salmon have not been observed in the Aptos Creek watershed since the early 1970s. Adult escapement targets identified in the federal recovery plan are 466 for downlisting, and 932 for delisting (NMFS 2012). The Coho Salmon population in this watershed was historically dependent on recruits from other populations in the diversity stratum.

1.16) Alternative actions considered for attaining program goals, and reasons why those actions are not being proposed
The program was initiated as an emergency action in response to the functional extirpation of Coho Salmon from all historical watersheds the Santa Cruz Mountain Diversity Stratum. Preventing regional extinction cannot be achieved without sustained broodstock production coupled with strategic reintroductions and effectiveness monitoring. The continuation of the Southern Coho Salmon Captive Broodstock Program has been identified by NMFS (2012) as a high priority recovery action until a larger regional program or a larger facility in the SCMDS

can be developed. Potential alternative actions to those proposed in this document are described below.

1.16.1) Take no action
Under this alternative the program would be eliminated.

Reason for elimination
This alternative was not selected because its elimination is inconsistent with Federal and State recovery goals and would likely result in the complete extirpation of Coho Salmon from the Santa Cruz Mountains Diversity Stratum.

1.16.2) Elimination of adult captive broodstock element; Increase juvenile rearing space and juvenile production
The current program lacks the rearing facilities needed to meet the 70,000 smolt production target. In this alternative the adult rearing component of the captive broodstock program would be terminated, and its associated facilities used to rear an additional 20,000 smolts. This action would immediately increase program smolt production potential to 55,000 fish.

Broodstock for the program would be sourced from SCMDS streams, Lagunitas/Olema Creeks, and other populations reared at DCFH. Broodstock collection methods would include:

- Operating adult collection stations on Scott Creek, Lagunitas/Olema Creek and the San Lorenzo River.
- Transporting surplus HOR Coho Salmon adults from Don Clausen Fish Hatchery (Russian River Captive Broodstock Program) to Kingfisher Flat Hatchery.
- Using seines and other capture and trapping methods to collect Coho Salmon adults and (or) juvenile in SCMDS streams.

Because it may not be possible to collect enough adults to meet program needs, two additional methods would be used to increase hatchery production:

- Eyed-eggs would be collected from a subsample of Coho Salmon redds in streams[3]. No more than 500 eggs would be taken from a single redd (~25% of redd egg production). (Berejikian et al. 2011).
- Fry (up to 2,500) would be collected in the spring using electrofishing, seines and traps in SCMDS streams.

The benefits and risks of this alternative are presented below.

Benefits
- Elimination of the adult rearing element of the captive broodstock program would free up space to produce an additional 20,000 smolts. The release of more smolts from the program is expected to produce more Coho Salmon adults; thereby increasing Coho

[3] https://www.youtube.com/watch?v=FZv7cqC85V4

Salmon abundance.
- NOR and HOR adults used for broodstock are expected to have higher egg-to-smolt survival rates (>70%) than captive broodstock (currently 19%). The higher survival rate means that fewer adults are needed to produce 55,000 smolts, thereby allowing more adults to spawn naturally.
- Fry collection and egg-pumping of redds increases the program's ability to meet smolt production goals and allows the incorporation of more families into the hatchery program, thus increasing genetic diversity and effective population size.
- Eggs and fry result from natural selection of mates, rather than artificially when using captive adults or adults brought into the hatchery. This eliminates unnatural selection pressures caused by artificial propagation.
- Egg-pumping has the potential to protect a portion of the natural spawning population from losses associated with high and low flows (scour and dewatering). Redd scour during high flow events has been a significant issue in Scott Creek in recent years. Droughts are expected to be more frequent and severe over time.
- Using multiple methods for meeting hatchery production goals increases the probability of meeting the goals.
- Eliminate use of other rearing facilities. Transporting and rearing fish at FED and DCFH would no longer be necessary.

Risks
- Elimination of the captive broodstock program eliminates a safety net for protecting the remaining genetic resources of SCMDS Coho Salmon.
- Fry collection and egg pumping reduces Coho Salmon natural production potential in streams where these life stages were collected.
- Although mortality rates on pumping eggs are low (< 5%), the potential adverse effects of pumping on the remaining eggs in the redd are not well understood. If mortality rates on remaining eggs are high, then risks may outweigh the benefits (Berejikian et al. 2011).
- It may not be able to distinguish steelhead redds from Coho Salmon redds, resulting in the wrong species being collected.
- Electrofishing, pumping of redds, seining, trapping and transport of juveniles and adults has the potential to impact ESA-listed steelhead residing in the streams.
- Removing NOR and HOR Coho Salmon adults from a stream potentially reduces natural production.

Reason(s) for Elimination
The use of egg-pumping was eliminated as a method to collect fish for broodstock due to the uncertainty associated with potential effects on the remaining eggs in the redd. If egg-pumping results in a large loss in remaining eggs then this action could have severe negative effects to natural Coho Salmon production. Instead, the program will collect life stages for use as future broodstock, wherein mortality rates can be measured with high accuracy to ensure that impacts to Coho Salmon are low.

The immediate termination of the captive broodstock program eliminates a safety net for protecting the remaining genetic resources of SCMDS Coho Salmon. Having a source of genetic material (fish) in the hatchery protects the population from adverse environmental effects (e.g., drought, flooding, fire and poor ocean survival) which have largely driven Coho Salmon to the point of regional extirpation. The approach proposed in the HGMP is to slowly replace captive brood as a self-sustaining hatchery program is developed.

SECTION 2. PROGRAM EFFECTS ON ESA-LISTED POPULATIONS

2.1) ESA permits or authorizations in hand for the hatchery program.

Coho Salmon propagation and husbandry activities carried out in support of the program are conducted under interim ESA coverage via draft Section 10(a)(1)(A) permit application 17982, submitted on 29 November 2013. Previously, propagation activities carried out at KFH were covered under Section 10(a)(1)(A) permit 1083 issued to MBSTP, while broodstock collection and transport were covered under Section 10(a)(1)(A) permit 1112 issued to FED.

Per the requirements of CESA, CDFW issued a memorandum of understanding (MOU) to MBSTP on 25 October 2021, which authorized a limited level of take of coho salmon. This MOU includes staff from FED as co-investigators for the program and expires on 31 July 2023.

The research and monitoring components of the program are permitted under Section 10(a)(1)(A) research permit 17292–3R, issued to FED on 14 April 2022. CDFW has also issued a MOU to FED on 15 February 2019 for research and monitoring of Coho Salmon in all streams within the SCMDS.

2.2) Descriptions, status, and projected take actions and levels for NMFS ESA-listed natural populations in the target area

Two NMFS ESA-listed populations are potentially affected by the propagation, release and monitoring activities (conducted by others) in support of the program:

- Central California Coast Coho Salmon (*Oncorhynchus kisutch*) Evolutionarily Significant Unit is federally listed as endangered under the US Endangered Species Act, effective (reaffirmed) 28 June 2005.
- Central California Coast steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS) is federally listed as threatened under the US Endangered Species Act, effective 18 August 1997.

2.3) Descriptions of ESA-listed population(s) affected by the program

2.3.1) Central California Coast Coho Salmon.

The Central California Coast (CCC) Coho Salmon Evolutionarily Significant Unit ranges from Punta Gorda in southern coastal Humboldt County, California, south to Aptos Creek in Santa Cruz County, California. A total of 75 watersheds in the CCC ESU historically supported Coho Salmon populations. These populations have been grouped into five diversity strata (i.e., geographically distinct areas with similar environmental conditions) for recovery planning (NMFS 2012). The program is operated to assist in the conservation and recovery of Coho Salmon populations south of San Francisco Bay in the Santa Cruz Mountains Diversity Stratum (SCMDS). Coho Salmon are especially imperiled within the SCMDS as populations have been functionally extirpated from nearly all historical watersheds. Within the SCMDS, Coho Salmon have rarely been observed in watersheds other than Scott Creek. Nevertheless, the Scott Creek population has experienced substantial declines and few NOR adults have returned to the basin since 2006 (Kiernan et al. 2016, 2018, 2019).

CCC Coho Salmon predominantly exhibit a 3-year life cycle. Adult Coho Salmon generally enter SCMDS streams between December and early April once winter storms produce sufficient streamflow to erode the seasonal sandbars (barrier beach) that form at most creek mouths (Figure 7). Coho Salmon redd construction and spawning generally occur from January to mid-March in the region. After hatching, juveniles spend approximately 12–15 months in freshwater before migrating to the ocean as age-1^{+} smolts. Freshwater habitat requirements for juvenile Coho Salmon include pools with extensive cover, adequate food supplies, cool water temperatures, and moderate to high dissolved oxygen concentration. Smolt outmigration typically occurs over a protracted period between March and early June, with a peak in downstream migrants in late April and early May depending on stream flow. Most individuals spend approximately 18 months in the marine environment and return to freshwater to spawn at age-3. However, some precocious individuals return at age-2 (known as jacks (male) and jills (female)); 4-year-old adults are rarely encountered.

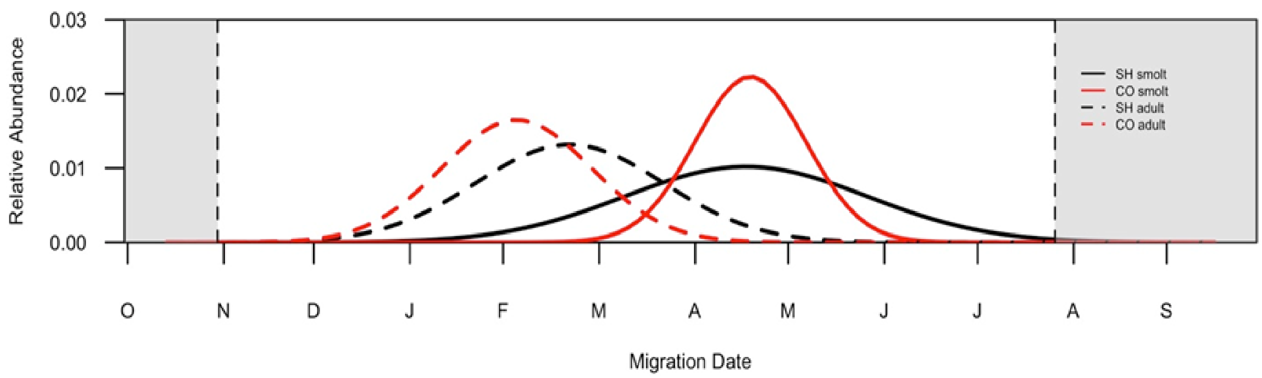

Figure 7. Historical distribution of migration timing for adult and juvenile (smolt) Coho Salmon (CO) and steelhead (SH) in Scott Creek, 2002–2014. The unshaded region in the figure identifies the period the creek mouth is typically open to the Pacific Ocean (30 October to 27 July based on water years 2002 through 2014, whereas the gray shading denotes the period the seasonal sandbar is typically present, and the mouth is closed. Figure modified from Osterback et al. (2018).

2.3.2) Central California Coast steelhead

The CCC steelhead DPS was listed as a federally threatened species on 18 August 1997 (Federal Register 1997, 62 FR 43937). The Central California Coast steelhead DPS includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian River to Aptos Creek, and the drainages of San Francisco and San Pablo Bays eastward to the Green Valley-Suisun Creek drainage (inclusive), excluding the Sacramento-San Joaquin River Basin. Central California Coast steelhead are present in all watersheds targeted for Coho Salmon reintroduction in the SCMDS (NMFS 2016a). Since there is substantial life history overlap between CCC Coho Salmon and CCC steelhead, there is the potential for direct and indirect ecological interactions to occur.

Adult steelhead generally return to streams within the SCMDS between December and May (Figure 7) and most spawning occurs from January through April. Thus, there is considerable temporal overlap in the spawning activities of steelhead and Coho Salmon in the region. After hatching, steelhead exhibit a diversity of life history strategies and may spend from less than one to four years in freshwater, and from one to five years in the ocean (Table 12). Steelhead are iteroparous and may return to spawn multiple times. Freshwater habitat requirements for steelhead rearing are like those for Coho Salmon and include adequate cover, food supply, and cool water temperatures. Emigration to the sea (or recruitment to the estuary/seasonal lagoon) generally occurs between February and June, depending on stream flow and water temperatures.

2.4) ESA-listed population(s) that will be directly affected by the program
The ESA-listed species that will be directly affected by the program is CCC Coho Salmon. Specifically, the program affects the nine populations identified in the federal Coho Salmon Recovery Plan (NMFS 2012) that comprise the SCMDS as well as Laguna Creek (a supplemental population[4]). Direct effects on Coho Salmon populations outside the SCMDS may occur due to collection or breeding based on recommendations from the TOC and with approvals from CDFW and NMFS.

2.5) ESA-listed population(s) that may be incidentally affected by the program
Multiple populations of CCC steelhead may be incidentally affected by hatchery activities carried out by the program. The release of Coho Salmon juveniles has the potential to effect SCMDS steelhead populations in Scott Creek, Waddell Creek, San Vicente Creek, Pescadero Creek, Gazos Creek San Gregorio Creek, Soquel Creek, Aptos Creek, and the San Lorenzo River.

2.6) Status of ESA-listed population(s) affected by the program
Data on Coho Salmon and steelhead ESA-listed species affected by the program are provided below.

2.6.1) Central California Coast Coho Salmon
Coho Salmon have been in decline in California for decades (Brown et al. 1994; Weitkamp et al. 1995; CDFW 2004) and populations are especially imperiled at the southern end of their range (NMFS 2012). Recognition of these declines triggered a federal Endangered Species Act (ESA) listing for the CCC ESU as threatened in 1996 and a subsequent upgrade to endangered status in 2005. The ESU is also listed as endangered under the CESA (CDFG 2004).

There is little historical data on Coho Salmon abundance within the CCC ESU from which critical and viable population thresholds can be determined. Nonetheless, recent status reviews by NMFS have concluded that Coho Salmon have been functionally extirpated from many of their historical watersheds, and that nearly all extant populations have declined over the last two decades and are at risk of extirpation (NMFS 2016b). NMFS (2012) presented adult (spawner) abundances that correspond to downlisting and delisting criteria for each population in the SCMDS (Table 13). Description of the historical status of each of these populations is provided in Section 1.15. These spawner targets are designed to ensure population viability both within

[4] NMFS selected 28 populations (12 independent and 16 dependent) as focal populations for the CCC Coho Salmon ESU recovery strategy. An additional 11 "supplemental populations" (all dependent) were identified to fulfill occupancy and connectivity criteria outlined in Spence et al. (2008). Selection of supplemental populations for the recovery strategy was predicated on the presence, or recent presence, of Coho Salmon (NMFS 2012).

individual watersheds and across the SCMDS to promote metapopulation structure and long-term viability of the ESU.

Table 12. Age distribution matrices for rainbow trout/steelhead (*N* = 675) and Coho Salmon (*N* = 217) in Scott Creek, California.

			Years in Freshwater									
			Females					Males				
Species	Origin	Years in Ocean	0	1	2	3	4	0	1	2	3	4
Steelhead	Natural	0			1					1	1	1
		1		8	43	17	1		8	47	6	2
		2	2	57	71	20		2	39	45	10	1
		3	2	12	20	2						
		4		3	1							
		5				1						
Steelhead	Hatchery	0				1				2		
		1		24	4	2			18	9		
		2	4	57	17	1		1	40	11		
		3	6	22	2			3	10			
		4		3				1	2			
		5										
Coho Salmon	Natural	0										
		<1							43	2		
		<2		34					58			
		<3										
		<4										
Coho Salmon	Hatchery	0										
		<1		2					50	2		
		<2		17					9			
		<3										
		<4										

Note: matrices indicate the number of years an individual fish spent in freshwater versus the marine environment inferred from scale analyses. Source: Hayes et al. (2013).

2.6.2) Central California Coast steelhead

Analogous to the situation for Coho Salmon, limited historical population-level abundance information for most steelhead DPSs in California has hindered robust assessment of their status and the establishment of critical and viable population thresholds (Williams et al. 2011). Recently, however, the NMFS (2016a) Coastal Multispecies Recovery Plan established spawner density and abundance targets for all historical steelhead populations in each diversity strata

(Table 14). While little information exists concerning contemporary and historical run sizes for most steelhead populations within the SCMDS, the widespread decline in steelhead abundance where data do exist suggests that most populations are on a negative trajectory (Good et al. 2005 and NMFS 2016c).

Table 13. Adult spawner targets for Coho Salmon recovery watersheds in the Santa Cruz Mountains Diversity Stratum.

Population	Population Status	Adult Abundance Downlisting Criteria	Adult Abundance Recovery Criteria
San Gregorio Creek	Dependent	682	1,363
Pescadero Creek	Independent	1,150	2,300
Gazos Creek	Dependent	140	279
Waddell Creek	Dependent	157	313
Scott Creek	Dependent	255	510
San Vicente Creek	Dependent	53	105
San Lorenzo River	Independent	1,900	3,800
Soquel Creek	Dependent	561	1,122
Aptos Creek	Dependent	466	932

Source: NMFS (2012) Final CCC Coho Salmon ESU Recovery Plan.

2.7) The most recent progeny-to-parent ratios, survival data by life stage, or other measures of productivity for the listed population.

Hatchery-origin Coho Salmon smolt to adult (returning spawners) survival is presented in Section 1.12. This metric has averaged 0.42% over the history of the program and has ranged from zero for brood year 2007–2008 to 3.5% for brood year 2018–2019 (Table 10).

Table 14. CCC steelhead distinct population segment (DPS) adult density and abundance targets to delist SCMDS populations.

Population	Population Status	Adult Density†	Adult Abundance
San Gregorio Creek	Independent	36	1,700
Pescadero Creek	Independent	33	2,200
Gazos Creek	Dependent	6–12	73–148
Waddell Creek	Independent	40	500
Scott Creek	Independent	40	700
San Vicente Creek	Dependent	6–12	25–52
Laguna Creek	Independent	6–12	32–66
San Lorenzo River	Independent	22	3,200
Soquel Creek	Independent	35	1,800
Aptos Creek	Independent	39	1,000

† Adult spawner density is number of steelhead adults per IP–km as defined in NMFS (2016) Coastal Multispecies Recovery Plan

There is little information available concerning juvenile productivity or survival for streams within the SCMDS. The best available data are derived from the life cycle monitoring station in the Scott Creek watershed which has generated a continuous time series of VSP metrics for Coho Salmon (Table 15) and steelhead (Table 16) since 2003. Additionally, there are estimates of juvenile steelhead density available for Gazos Creek, Waddell Creek and Scott Creek which are presented in Figure 8. These data indicate that juvenile density per 100 feet of stream ranges from 10 to 61 fish.

Table 15. Downstream migrant production, PIT tagging effort, and marine survival of PIT-tagged Coho Salmon in the Scott Creek watershed, 2003–2019.

Year	No. PIT-tagged downstream migrants		Mean (± SD) fork length (mm)		No. hatchery-origin fish released	Estimated downstream migrant production (natural-origin)	No. PIT-tagged downstream migrants resighted as adults		Estimated marine survival (%)	
	Hatchery	Natural	Hatchery	Natural			Hatchery	Natural	Hatchery	Natural
2003	538	552	162 ± 32	101 ± 13	6,600	1,848 - 7,404[a]	7	4	1.30	0.72
2004	0	65		111 ± 16	0	240 - 790[a]	---		---	
2005	0	63		86 ± 10	0	n.d[b]	---		---	
2006	767	505	171 ± 45	97 ± 10	767	3,005 ± 1,176[c]	3	0	0.39	0.00
2007	513	137	157 ± 31	108 ± 9	2,279	1,659 ± 546	3	0	0.58	0.00
2008	1,033	21	162 ± 30	121 ± 7	3,123	60	7	0	0.68	0.00
2009	980	7	132 ± 14	124	1,848	16[d]	1	0	0.10	0.00
2010	845	3	134 ± 23	107	711	8[d]	4	0	0.47	0.00
2011	0	1	---	114	0	n.d[b]	1	0	[*stray*]	0.00
2012	2,454	1	178 ± 35	146	2,129	n.d[b]	13	0	0.53	0.00
2013	7,814	221	157 ± 46	109 ± 11	31,858	952 ± 148	12	0	0.15	0.00
2014	9,801	200	162 ± 18	110 ± 18	28,679	3,169 ± 1,032	8	0	0.08	0.00
2015	12,327	67	137 ± 13	118 ± 32	14,602	264 ± 159	2	0	0.02	0.00
2016	19,912	519	117 ± 9	102 ± 9	20,104	3,570 ± 1,316	8	0	0.04	0.00
2017	11,269	124	149 ± 12	107 ± 9	11,346	426 ± 73	5	0	0.04	0.00
2018	25,395	65	129 ± 15	115 ± 11	32,165[e]	135 ± 18	1	0	<0.01	0.00
2019	10,139	243	134 ± 11	109 ± 11	24,524	615 ± 50	3	0	0.03	0.00

[a] Downstream migrant estimate based on trapping 3 days per week; low estimate is count adjusted for 7 day/week trapping. High estimate is adjusted for trap efficiency, based on recaptures of marked hatchery fish.
[b] No data (n.d.): too few fish to estimate production
[c] Downstream migrant estimates for 2006 reflect only May and June- high flow prevented Jan-Apr trapping. Smolt estimates based upon two trap design and DARR analysis. Variance is ± 1 standard error.
[d] Coho salmon production adjusted based on trap capture efficiency for steelhead.
[e] Includes 4,353 coho salmon released to Scott Creek in the fall of 2017 (13 November 2017).
Data source: Kiernan et al. 2019, Kiernan et al. 2022

Table 16. Downstream migrant production, PIT tagging effort, and marine survival of PIT-tagged steelhead in the Scott Creek watershed 2003–2019.

Year	No. PIT-tagged downstream migrants		Mean (± SD) fork length (mm)		No. hatchery-origin fish released	Estimated downstream migrant production (natural-origin)	No. PIT-tagged downstream migrants resighted as adults		Estimated marine survival (%)	
	Hatchery	Natural	Hatchery	Natural			Hatchery	Natural	Hatchery	Natural
2003	594	354	158 ± 37	119 ± 37[a]	7,500	1,370 - 5,323[a,b]	2	4	0.34	1.13
2004	516	809	177 ± 20	123 ± 47	3,770	6,000 - 18,850[b]	2	19	0.39	2.35
2005	504 (538)	705	159 ± 28	121 ± 38	8,728 (552)	n.d[c]	24	17	0.10 (3.5)	2.41
2006	654	816	168 ± 22	117 ± 46	6,568	7,357 ± 2,879[d]	0	21	0.00	2.57
2007	487	648	186 ± 31	124 ± 39	5,510	16,563 ± 3,416	2	6	0.41	0.93
2008	1,114	1,107	183 ± 35	141 ± 43	5,185	8,653 ± 531	8	8	0.72	0.72
2009	2,945	1,430	179 ± 30	123 ± 38	4,738	11,695 ± 920	4	5	0.14	0.35
2010	2,132	1,581	105 ± 23	118 ± 40	2,757 (Dec 2009)	8,094 ± 789	2	20	0.09	1.27
			161 ± 30		2,355 (Apr 2010)					
2011	498	623	134 ± 24	100 ± 37	1,629[e]	3,854 ± 1,157	3	19	0.60	3.05
2012	500	372	169 ± 46	92 ± 26	5,630	5,440 ± 790	1	3	0.20	0.81
2013	513	1,400	144 ± 29	124 ± 48	3,220	7,267 ± 620	1	15	0.19	1.07
2014	500	547	151 ± 31	105 ± 35	4,740	7,027 ± 801	3	0	0.60	0.00
2015	0	600	---	152 ± 51	0	4,722 ± 763	---	2	---	0.33
2016	0	513	---	95 ± 30	0	2,088 ± 313	---	7	---	1.36
2017	0	2,150	---	91 ± 20	0	7,962 ± 296	---	40	---	1.86
2018	0	1,612	---	115 ± 30	0	11,943 ± 849	---	10	---	0.62
2019	0	1,224	---	112 ± 26	0	8,368 ± 292	---	15	---	1.23[f]

[a] Count underestimated and size overestimated due to large mesh size.
[b] Downstream migrant estimates based on trapping 3 days per week. Low estimate is count adjusted for 7 days/week trapping.
[c] No data (n.d.): too few fish to estimate production.
[d] Downstream migrant estimates for 2006 reflect only May and June as high flow prevented Jan-Apr trapping. Smolt estimates based upon two trap design and DARR analysis. Variance is ± 1 standard error of the mean.
[e] NOAA experimental fish release.
[f] Marine survival is preliminary, pending expected return of future year classes
Data source: Kiernan et al. 2019, Kiernan et al. 2022

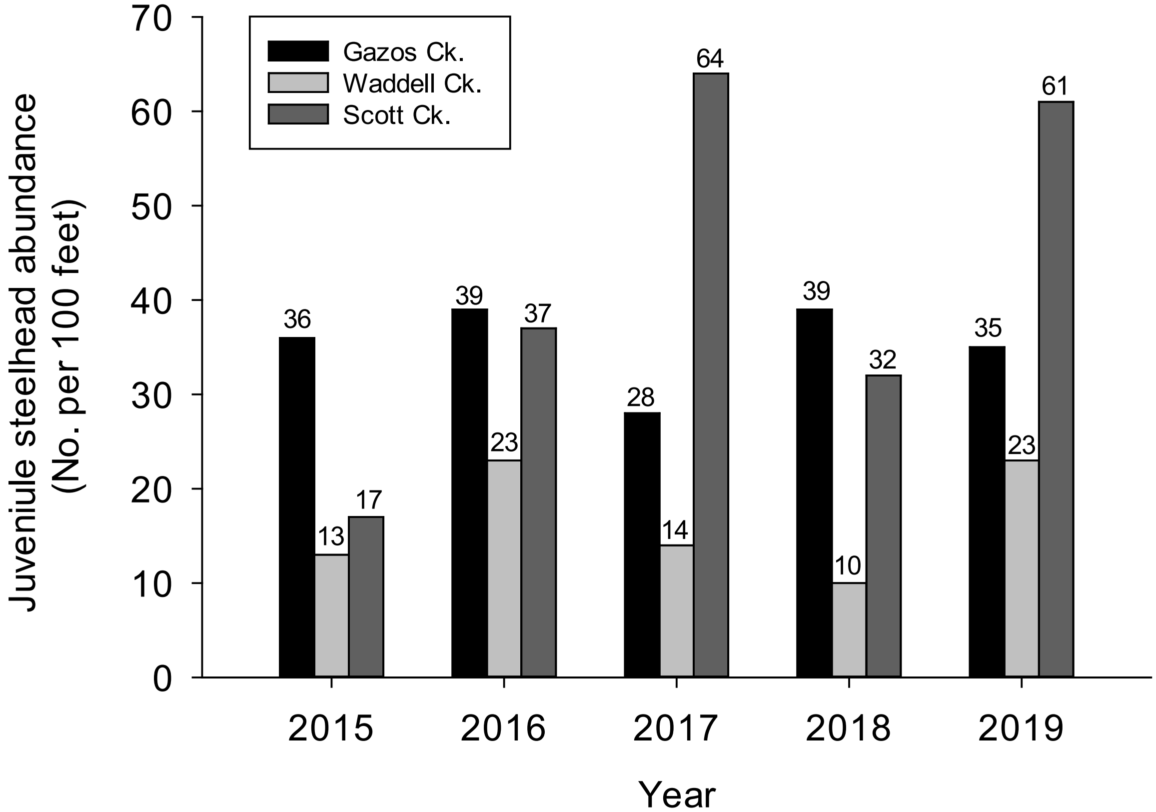

Figure 8. Steelhead juvenile abundance (individuals per 100 linear feet of stream) derived from summer-fall electrofishing surveys of Gazos Creek, Waddell Creek, and Scott Creek (2015–2019). Source: J. Smith, SJSU.

Historical estimated escapement of Coho Salmon and steelhead to Scott Creek (winters 2002–2003 through 2019–2020 is presented in Figure 9. Maximum historical annual releases from the program and estimated habitat capacity for each recovery watershed are presented in Table 17.

2.8) 12-year estimates of annual proportions of direct hatchery-origin and listed natural-origin fish on natural spawning grounds.

Adult returns of HOR and NOR Coho Salmon to the Scott Creek weir from 2002 to 2018 is shown in Table 18. Because weir capture efficiency is less than 100%, the numbers shown in Table 18 provide a relative index of NOR and HOR adult Coho Salmon escapement in Scott Creek. Little data are available on adult Coho Salmon escapement to other streams in the SCMDS (NMFS 2016b).

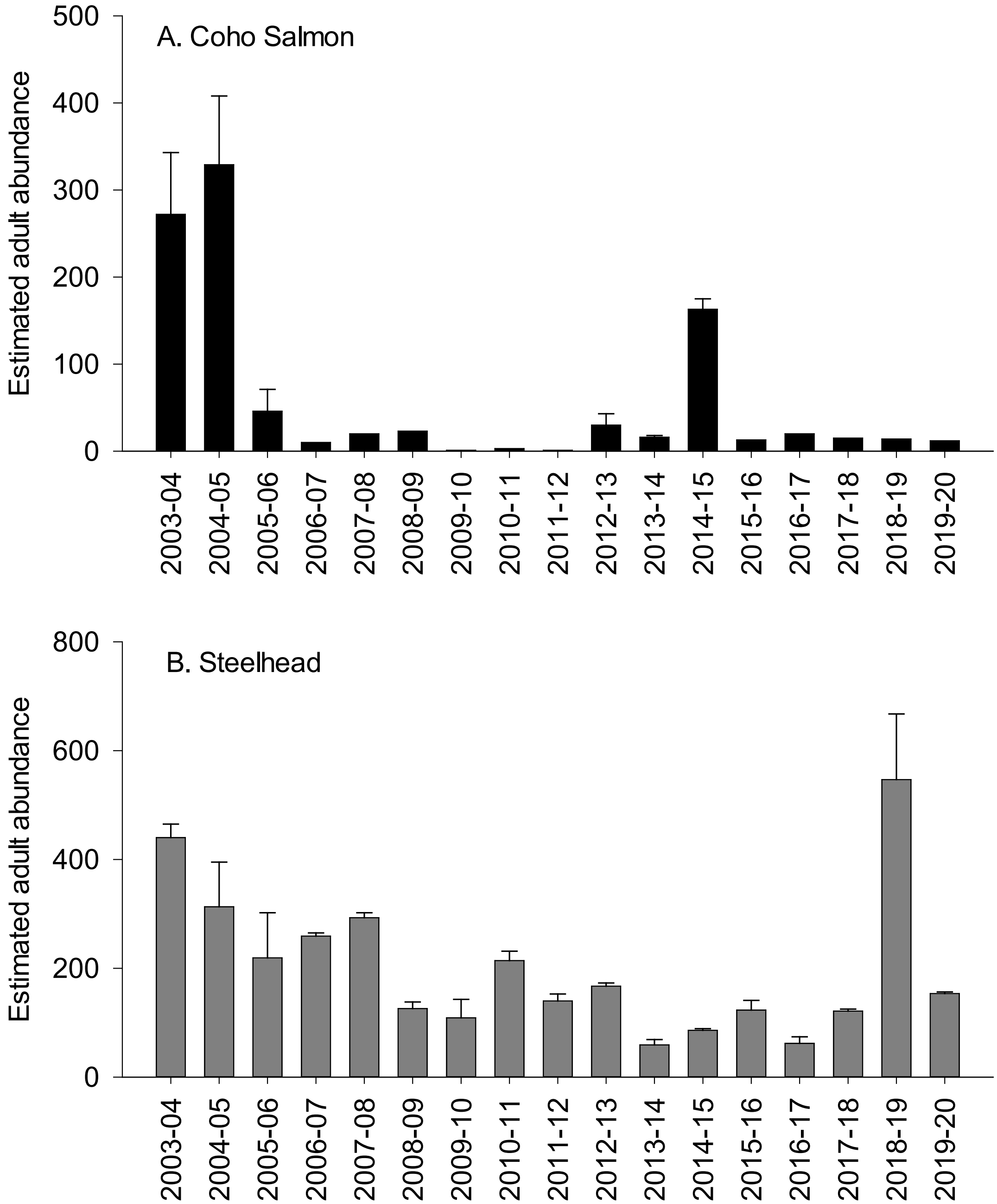

Figure 9. Time series of adult Coho Salmon and steelhead escapement to Scott Creek, spawn winters 2003–2004 through 2019–2020. Point estimates are derived from mark-recapture sampling and error bars represent +1 standard error. Source: Kiernan et al. 2018, 2022.

Table 17. Amount of CCC Coho Salmon intrinsic potential habitat (IP), estimated historical smolt carrying capacity, and maximum historical annual release levels for each recovery watershed in the SCMDS.

Population	Population Status	IPkm	Estimated Historical Smolt Capacity (Thousands)	Maximum No. of Program Fish Released to date	
				Parr	Smolts
San Gregorio Creek	Dependent	40.1	10 to 25		
Pescadero Creek	Independent	60.6	45 to 50		12,643
Gazos Creek	Dependent	8.1	10 to 20	8,203	
Waddell Creek	Dependent	9.1	20 to 35		6,120
Scott Creek	Dependent	15.0	25 to 45		31,857
San Vicente Creek	Dependent	3.1	10 to 15	6,000	497
San Lorenzo River	Independent	142.1	45 to 60		
Soquel Creek	Dependent	33.0	20 to 25		
Aptos Creek	Dependent	27.4	10 to 15		7,140

Notes: Intrinsic potential (IP) values from NMFS (2012). Ranges (number of Coho Salmon) for estimated maximum smolt capacity were derived from expert-opinion of NMFS scientists with direct knowledge of the watersheds.

2.9) Hatchery activities, including associated monitoring and evaluation and research programs that may lead to the take of listed fish in the target area, and estimated annual levels of take

There are three primary activities conducted in support of the program for which the take of ESA-listed fish is anticipated: (1) broodstock collection and transport; (2) hatchery propagation and production; and (3) the tagging and release of hatchery-origin and natural-origin fish at various life stages.

Both NOR and HOR adult and juvenile Coho Salmon will be collected and transported to and from SCMDS streams to hatchery facilities. Additionally, adult and (or) juvenile Coho Salmon may be transported from hatcheries (e.g., Don Clausen) as identified and approved by NMFS and CDFW. Coho Salmon from obtained from DCFH (collected by the Corps or CDFW as part of the RRCSCBP) may include individuals from the Russian River and/or Lagunitas/Olema Creek.

Table 18. Proportion of hatchery-origin (HOR) and natural-origin (NOR) Coho Salmon intercepted at the Scott Creek weir, return years 2008–2009 through 2019–2020.

Return year (winter)	Total weir count	Coho Salmon			
		HOR		NOR	
		N	%	*N*	%
2008–2009	5	5	100.0	0	0.0
2009–2010	0	0	0.0	0	0.0
2010–2011	2	1	50.0	1	50.0
2011–2012	1	1	100.0	0	0.0
2012–2013	4	3	75.0	1	25.0
2013–2014	13	13	100.0	0	0.0
2014–2015	42	37	88.1	5	11.9
2015–2016	3	2	66.7	1	33.3
2016–2017	6	6	100.0	0	0.0
2017–2018	15	7	46.7	8	53.3
2018–2019	4	1	25.0	3	75.0
2019–2020	5	5	100.0	0	0.0

Note: Annual weir counts do not reflect total escapement. Source: UCSC and NMFS.

NOR and HOR adult and juvenile Coho Salmon needed for broodstock may be collected by the program or other parties working in SCMDS streams and (or) hatcheries. The Take associated with broodstock collection from Scott Creek is accounted for in ESA section 10(a)(1)(A) research permit 17292-3R issued to FED.

The program will be responsible for take associated with the collection, incubation, rearing, marking, transport and release of hatchery Coho Salmon to and from SCMDS streams and other hatchery facilities. A detailed description of expected take of Coho Salmon for the program is provided in Attachment D and summarized in Table 19.

Monitoring and evaluation (M&E) of program success and potential effects on natural-origin Coho Salmon and steelhead in SCMDS streams will be conducted primarily through the California Coastal Monitoring Program[5], or other parties working in SCMDS streams. The Take of Coho Salmon and steelhead from these activities are covered in these programs and is not included in the HGMP.

2.10) Contingency plans for addressing situations where take levels within a given year are projected to exceed take levels described in this plan for the program

The program's take levels for Coho Salmon are not expected to be exceeded in any year. Any losses of collected, transported, cultured, or released fish that exceed Take levels will be reported to NMFS and CDFW within 24-hours.

[5] https://www.calfish.org/programsdata/conservationandmanagement/californiacoastalmonitoring.aspx

Table 19. Projected maximum annual take of CCC Coho Salmon by life stage for broodstock collection and hatchery production by phase.

Purpose/Life Stage	Phase 1		Phase 2		Phase 3	
Captive Broodstock	NOR	HOR	NOR	HOR	NOR	HOR
Juvenile Female	300	300	0	0	0	0
Juvenile Male	300	300	0	0	0	0
Total	600	600	0	0	0	0
Purpose/Life Stage	Phase 1		Phase 2		Phase 3	
Hatchery Broodstock	NOR	HOR	NOR	HOR	NOR	HOR
Adult Female	12	108	30	90	60	60
Adult Male	18	162	45	135	90	90
Total	30	270	75	225	150	150
Purpose/Life Stage	Phase 1		Phase 2		Phase 3	
Hatchery Production	HOR		HOR		HOR	
Eyed-eggs	100,000		100,000		100,000	
Fry	100,000		100,000		100,000	
Parr	70,000		70,000		70,000	
Advanced Parr	70,000		70,000		70,000	
Smolt	70,000		70,000		70,000	

Note: Only 600 (HOR/NOR) juveniles will be taken in any year with the intent of producing a total of 380 adult broodstock. Excess fish not used as broodstock will be released back to the stream soon after collecting, or with production fish releases. Also, in any given year the program would not require all 600 juveniles and 300 adults (phase 1)

SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1) Alignment of the hatchery program with any ESU-wide hatchery plan

No ESU-wide hatchery plan currently exists. The SCSCBP is operated consistent with the CDFW (2004) Recovery Strategy for California Coho Salmon and the NMFS (2012) Final Recovery Plan for Central California Coast Coho Salmon Evolutionarily Significant Unit. Both documents explicitly underscore the importance of the program to regional recovery. Activities carried out in support of the program at KFH and DCFH follow established fish culture practices as well as those in the California Hatchery Scientific Review Group (2012) report, to the extent possible.

3.2) Existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which program operates

- The KFH facility is located on lands owned and managed by Big Creek Lumber. A Landowner Access Agreement (LAA) between Big Creek Lumber, CDFW and MBSTP exists to continue hatchery operations at KFH. The LAA expires on 31 July 2023.
- Husbandry of program broodstock at Don Clausen Fish Hatchery is conducted under an agreement between NMFS and USACE signed 28 November 2018.

3.3) Relationship of program to harvest objectives

There are no harvest objectives for the program as no directed commercial or sport harvest of CCC Coho Salmon is permitted in either freshwater or in the Pacific Ocean. Nevertheless, Coho Salmon are incidentally captured in both marine and freshwater sport fisheries targeting Chinook Salmon (*Oncorhynchus tshawytscha*), steelhead and other species.

CDFW freshwater angling regulations allow limited harvest of adipose fin clipped (HOR) steelhead (2 per day) in the region. Any incidentally captured Coho Salmon must be returned to the water unharmed. The risk of Coho Salmon harvest due to misidentification as steelhead was reduced when the program stopped clipping hatchery Coho Salmon adipose fins beginning with run year 2012. Nevertheless, it is likely that some level of Coho Salmon mortality will occur due to incidental capture, handling, and release in the fisheries targeting other species. However, no quantitative estimates of incidental take and/or mortality of Coho Salmon are currently available.

3.4) Relationship of program to habitat protection and recovery strategies

The adverse effects of natural stressors coupled with widespread destruction and degradation of essential freshwater and estuarine habitats has dramatically reduced the productivity, abundance, and diversity of CCC Coho Salmon and prompted listing under the ESA. The hatchery program is designed to retain and increase the genetic diversity of the SCMDS Coho Salmon populations until habitat conditions improve to the point where these populations are once again sustainable on their own.

To ameliorate habitat degradation and advance the recovery of Coho Salmon populations, several restoration and enhancement projects have been implemented in the SCMDS over the last two decades. The following is a summary of such projects in key recovery watersheds. These data were compiled by The Nature Conservancy from publicly available information and other sources.

San Gregorio Creek

- San Gregorio Creek Habitat Enhancement Project- Apple Orchard Project[6]
- Alpine Creek Fish Passage Enhancement Project[7]

Pescadero Creek

- 4 fish passage barriers removed
- 1.6 km of stream made accessible to fish
- 32 km of roads decommissioned or upgraded resulting in 41,290 m^3 of sediment prevented from reaching streams
- 20 stream crossings removed or upgraded
- 2 large woody debris structures added for instream habitat
- Butano Creek Channel Reconstruction Project in 2019[8]

Gazos Creek

- 2 fish passage barriers removed
- 12 km of roads decommissioned or upgraded to resulting in 8,400 m^3 of sediment prevented from flowing into streams
- 3 stream crossings upgraded or decommissioned

Waddell Creek

- 3.2 km of road decommissioned
- 20.2 hectares of wetlands restored

Scott Creek

- 2 fish passage barriers removed
- 0.8 km of instream habitat restored
- 3 large woody debris sites added for instream habitat
- 1.6 km of riparian corridor restored, including 1,000 plantings
- 1 stream crossing removed or upgraded
- Lower Scott Creek Floodplain and Habitat Enhancement Project

San Vicente Creek

- 1 fish passage barrier removed
- 1.6 km of instream habitat restored
- 1 stream crossing removed
- 8 large woody debris structures added for instream habitat

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[6] http://www.sanmateorcd.org/project/sgcreeklwd/
[7] http://www.sanmateorcd.org/alpine-creek-fish-passage-project-complete/
[8] http://www.sanmateorcd.org/project/butano-creek-reconnection-project/

San Lorenzo River

- 44 fish barriers removed
- 3.2 km of stream made accessible to fish
- 35.4 km of instream habitat restored
- 16.1 km of road decommissioned or upgraded resulting in 29,359 m^3 of sediment prevented from reaching streams
- 38 meters (m) of stream bank stabilized

Soquel Creek

- 10 invasive plant species removal projects
- 2 low-flow fish migration impediments removed
- 1.6 km of instream habitat restored
- 8 large woody debris structures added for instream habitat

Aptos Creek

- 2 fish passage barriers removed
- 19.3 km of stream made accessible to fish
- 0.64 km of instream habitat restored

The habitat actions are designed to maintain existing habitat and enhance and restore Coho Salmon habitat within SCMDS streams as outlined in the Coho Salmon recovery plan (NMFS 2012). These actions are expected to increase the survival of released program fish and resulting adult returns, making it easier to attain program goals.

3.5) Ecological interactions

3.5.1) Species that could negatively impact the program

- Avian predators – Heron species (*Ardeas* sp., *Butorides* sp., *Nycticorax* sp.), Caspian Tern (*Sterna caspia*), Double-crested Cormorant (*Phalacrocorax auritus*), and Western Gull (*Larus occidentalis*), kingfisher (multiple species), Common Merganser (*Mergus merganser)* and Hooded Merganser *(Lophodytes cucullatus)*
- Mammalian predators – harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), Steller sea lions (*Eumetopias jubatus*), Northern elephant seals (*Mirounga angustrirostris*). Southern Resident killer whale (*Orcinus orca*)
- Native piscivores – CCC steelhead, CCC Coho Salmon and sculpin (*Cottus* spp.).
- Alien/Non-native species – Striped Bass (*Morone saxatilis*), signal crayfish (*Pacifastacus leniusculus*), New Zealand mudsnail (*Potamopyrgus antipodarums*)

The species identified above may reduce the survival of juvenile HOR Coho Salmon after their release due to direct (density-dependent) ecological interactions such as predation and competition. Avian predation is a particular concern in the region. An empirical study by Frechette et al. (2012) demonstrated that avian predators can remove up to 4.6% of outmigrating Coho Salmon and steelhead from the Scott Creek, Waddell Creek, and San Vicente Creek watersheds annually. Moreover, harbor seals, Steller sea lions, Northern elephant seals, and

California sea lions are present in the region and may represent substantial natural sources of predation on multiple Coho Salmon life stages.

Several alien (non-native) aquatic species may negatively affect fish produced by the program. These include Striped Bass (periodically reported in the estuaries of the San Lorenzo River and Waddell Creek, and a consistent presence in the near-shore marine environment of California), signal crayfish and the New Zealand mudsnail (confirmed present in the San Lorenzo River, Soquel Creek, Liddell Creek and Aptos Creek). The degree to which Coho Salmon interact (via both direct and indirect pathways) with these non-native species is poorly understood.

To avoid the spread of invasive aquatic species, especially New Zealand mudsnail, field staffs adhere to the gear decontamination procedures determined by CDFW's Aquatic Invasive Species Decontamination Protocol. Hatchery Coho Salmon are more susceptible to bacterial, viral, fungal and parasitic disease agents that may be present in the environment (e.g., *Renibacterium salmoninarum*, *Saprolegnia* spp.).

3.5.2) Species that could be negatively impacted by the program

The program operates in all historical Coho Salmon watersheds in the SCMDS. The reintroduction of Coho Salmon in streams where they have been extirpated, or in streams where their abundance has been severely reduced, has the potential to negatively impact other species in the short term, including the following ESA-listed species:

- Natural-origin CCC Coho Salmon
- Natural-origin CCC steelhead

Potential negative impacts on resident taxa resulting from program activities may occur via competition, predation, and disease transmission.

Competition. – Competition between HOR and NOR Coho Salmon for limiting resources may occur when large numbers of HOR Coho Salmon are released into the natural environment. Competitive interactions are most likely to occur between program HOR Coho Salmon and NOR CCC Coho Salmon and steelhead.

Predation. – Predation on subyearling (age-0) juvenile Coho Salmon and steelhead by HOR smolts may adversely affect NOR populations of these species. Predation is likely to be greatest when large numbers of program smolts interact with fry or small parr, and when HOR fish are large relative to wild fish. While it is anticipated that some fraction of the Coho Salmon smolts released each year will residualize and remain in freshwater (Osterback et al. 2018), the vast majority of fish are expected to rapidly emigrate following release (Hayes et al. 2004) and rates of residualization are generally low (< 1%; NMFS Southwest Fisheries Science Center, *unpublished data*). Measures to reduce predation and competition among HOR and NOR fish include releasing hatchery fish at a size comparable to the natural-origin fish, staggering releases among different groups throughout the smolt outmigration period and releasing fish near the mouths of streams (i.e., low in the drainage network). Predation on Tidewater Goby is possible but not expected to be significant during normal water years due to the limited time Coho Salmon generally spend in the estuarine environment (see Osterback et al. 2018).

Disease transmission. – When program fish are released into regional recovery watersheds, they represent a potential source of disease transmission to resident fish. Disease transmission has the potential to occur downstream from release locations, throughout the riverine migration corridor and in estuaries. Although hatchery populations are potential reservoirs for disease pathogens, there is little evidence to suggest that diseases are routinely transmitted from HOR fish to natural populations. The risk of pathogen introduction into the natural environment via the release of HOR Coho Salmon is minimized through pathology screening and pathogen-free certification of program fish—steps required by CDFW prior to the release of any artificially propagated fish.

3.5.2.1) PCD RISK analysis results
The PCD Risk model (Busack et. al. 2005) was used to estimate the predation and competition risk program Coho Salmon potentially pose to natural-origin populations inhabiting release streams. The assumptions and input values used during model construction are provided in Table 20. The results of the PCD Risk analysis are presented in Table 21 and Table 22 for Coho Salmon and steelhead, respectively. Resulting PCD Risk values represent an index of mortality to the natural salmon populations from the Coho Salmon hatchery program.

The results in Table 21 indicate that the risk posed by HOR Coho Salmon to NOR Coho Salmon fry and smolts is quite low over a range of stream temperatures and assumed HOR Coho Salmon residence time in a stream. Risk values range from 0.1 to 2.6 (out of a possible score of 100), with the highest value occurring to NOR fry from the release of 4,000 HOR fish that reside in the stream for 14 days at a temperature of 16°C.

The release of hatchery fry, parr and advanced parr are expected to result in a similar range of risk values. Rather than releasing large numbers of these life stages at a single point, fish will be released to streams with low Coho Salmon abundance and distributed (scatter planted) over a wide area to help reduce interaction(s) with NOR fish. Additionally, mortality rates for HOR fish released at these earlier life stages will likely be higher than NOR fish, which will result in less competition and predation effects to natural populations.

PCD Risk results for steelhead were similar to those obtained for Coho Salmon. Model results indicated that the greatest risk (2.8) was posed to NOR steelhead fry and occurred when 4,000 HOR Coho Salmon smolts were released and the release group didn't outmigrate promptly (i.e., 14 day stream residence at a stream temperature of 16°C) (Table 22).

Based on the PCD Risk analysis results, the program will avoid negative interactions by emphasizing small releases of HOR Coho Salmon when stream water temperatures are less than 16°C and when NOR steelhead and Coho Salmon fry abundance is low.

3.5.3) Species that may positively impact the program
Beaver (*Castor canadensis*), if present, may positively impact Coho Salmon by creating dams that increase pool habitat (pool abundance, depth and volume), reduce downstream sediment levels, and provide cover for rearing fry and parr.

Table 20. PCD Risk Model parameters, input values and rationale for value selection.

Model Parameter	Input Value	Rationale
HOR Coho Salmon released (#)	1,000 to 4,000	This is the range of HOR Coho Salmon smolts that may be released at a time in a target stream.
NOR Coho Salmon smolts (#)	5,000	The smolt production estimate is based on the natural Coho Salmon migrant production for Scott Creek (Table 15).
NOR steelhead smolts (#)	7,500	The smolt production estimate is based on the natural Coho Salmon migrant production for Scott Creek (Table 15).
NOR fry (Coho Salmon/steelhead, #)	50,000	Assumption for modeling.
Max. encounters (#)	1	This the maximum number of times a HOR Coho Salmon encounters an NOR fry/smolt (Assumption).
HOR Coho Salmon length (mm)	115 to 145	Expected fork length of HOR Coho Salmon.
NOR Coho Salmon/steelhead fry length (mm)	35 to 40	Typical fork length of fry.
NOR Coho Salmon smolt length (mm)	115	Data from Table 19.
NOR steelhead parr/smolt length (mm)	78 to 155	Data from Table 16. Assumed yearling length is average length; parr is average - confidence Interval
HOR Coho Salmon residence time (days)	7 to14 days	Assume that HOR Coho Salmon smolts will spend 7–14 days in the stream after release. While it is expected the majority of HOR Coho Salmon smolts will migrate quickly from the system after release, modeling a longer residence time accounts for some residualization that could occur.
Population overlap (%)	100%	The analysis assumes that hatchery releases overlap completely with 100% of the NOR populations inhabiting the stream. Actual population overlap will vary based on release locations. Using 100% overlap results in maximum possible effect to NOR populations
HOR Coho Salmon habitat segregation	0 to 0.8	It is assumed that HOR and NOR Coho Salmon smolts uses similar habitat, thus zero segregation. Because of difference in size and habitat preference it is assumed that HOR Coho Salmon smolts have access to 20% of available fry habitat (i.e., 80% segregation)
Habitat protection	0	Because of low quality habitat in most streams, it is assumed that existing habitat (e.g., large woody debris, undercut banks) does not protect NOR fish from HOR fish.
Percentage of HOR fish that will feed on NOR fish (Piscivory, %)	10%	Assumption.
Critical ratio for piscivory	0.4	Assumption - Pearsons and Fritts (1999).
Stream temperature (°C)	10 to 16°C	Range of water temperatures expected during hatchery releases.

3.5.4) Species that may be positively impacted by program

Any freshwater, estuarine, marine, or riparian species that utilizes salmonids as an ecological resource may experience benefits from fish produced by the program.

The program will positively impact Coho Salmon by increasing abundance and reducing the risk of species extirpation. Potential benefits of the program to Coho Salmon include reducing the risk of inbreeding depression in the integrated population through the use of out-of-basin Coho Salmon during spawning, inbreeding avoidance by use of a breeding matrix based on relatedness, as well as the provision of marine-derived nutrients (Coho Salmon carcasses) to the freshwater food web, potentially benefiting Coho Salmon and other organisms that are part of the riverine and riparian communities.

Table 21. PCD Risk results for natural-origin (NOR) Coho Salmon fry and smolts by hatchery-origin (HOR) residence time in the stream and stream temperature. The maximum PCD Risk value possible is 100.0 which results in complete loss of NOR fish.

7-Day Residence Time									
	Fry Release (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0.1	0.2	0.4	0.2	0.5	0.7	0.6	1.0	1.3
12	0.1	0.2	0.4	0.2	0.5	0.8	0.6	1.0	1.4
14	0.1	0.3	0.5	0.2	0.5	0.7	0.6	1.0	1.4
16	0.1	0.2	0.4	0.3	0.5	0.8	0.7	1.0	1.4
	Smolt (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3
12	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.3
14	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4
16	0.1	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.5
14-Day Residence Time									
	N = 4,000 (HOR Coho Salmon)								
Temperature (°C)	Fry Release			Smolt Release					
	Min	Ave	Max	Min	Ave	Max			
16	1.3	1.9	2.6	0.8	0.9	0.9			

Table 22. PCD Risk results for natural-origin (NOR) steelhead fry and parr/yearlings by hatchery-origin (HOR) residence time in the stream and stream temperature. The maximum PCD Risk value possible is 100.0 which results in complete loss of NOR fish.

7-Day Residence Time									
	Fry Release (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0.1	0.2	0.4	0.2	0.5	0.8	0.6	1.0	1.4
12	0.1	0.2	0.4	0.2	0.5	0.8	0.6	1.0	1.4
14	0.1	0.2	0.5	0.3	0.5	0.8	0.6	1.0	1.4
16	0.1	0.2	0.4	0.3	0.5	0.8	0.5	1.0	1.4
	Parr/Smolt Release (HOR Coho Salmon)								
Temperature (°C)	*N* = 1,000			*N* = 2,000			*N* = 4,000		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
10	0	<0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
12	0	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
14	0	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
16	0	<0.1	0.2	0.1	0.1	0.2	0.3	0.3	0.3
14-Day Residence Time									
	N = 4,000 (HOR Coho Salmon)								
Temperature (°C)	Fry Release			Smolt Release					
	Min	Ave	Max	Min	Ave	Max			
16	1.2	1.9	2.8	0.5	0.5	0.6			

SECTION 4. WATER SOURCE

4.1) Quantitative and narrative description of the water source, water quality profile, and natural limitations to production attributable to the water source

A description of the water source for each facility involved in the program is provided below.

4.1.1) Kingfisher Flat Hatchery

Surface water is collected and conveyed to KFH from two nearby sources, Big Creek and Berry Creek. Big Creek is the largest tributary of Scott Creek and provides most of the water utilized by the hatchery.

Big Creek. – Water is diverted from Big Creek via a small dam originally built by CDFW in 1927 and subsequently renovated by MBSTP in 1982. Diverted water is routed through a 20.3 cm diameter PVC underground mainline to the hatchery. Maximum water flow rate is 92 liters per second (L/sec) and average late summer (base) flows are approximately 35 L/sec. However, low flows can approach 13 L/sec during extreme drought conditions. An emergency backup line is used during critical low flows and provides water from Big Creek at a rate of ~8 L/sec. Additional emergency backup water is provided by a 9.5 L/sec sump pump placed in the stream. Big Creek water temperatures range from a mean low of 5°C to a mean high of 18°C (extremes: 3 to 20°C) on an annual basis. Water turbidity is negligible throughout the year except during and after large precipitation events. Incoming dissolved oxygen concentration is high and ranges from 9.0 milligram (mg)/L in summer to 11.0 mg/L in winter.

Berry Creek. – Berry Creek is a high gradient, "non-fish-bearing" tributary of Big Creek that satisfies CDFW fish health protocols for surface source incubation water and serves as the primary source for egg incubation and rearing of fry. Berry Creek water temperatures are typically a degree (°C) or two warmer than Big Creek. The riparian zone adjacent to Berry Creek contains a higher proportion of conifers and less vegetation relative to the Big Creek basin, and the Berry Creek sub-watershed is characterized by a greater fraction of large granite and mudstone cobble. Berry Creek has moderate turbidity during storm runoff and suspended material is removed in the hatchery by screened canister and plastic disc set filter media. A maximum of 19 L/sec of water can be diverted from Berry Creek through a screened inlet. Water is first passed through a sediment removal canister and then continues underground via a 0.10 m PVC mainline to a 757 L storage tank for removal of fine, settleable solids. Water is then gravity fed via a 10.2 cm diameter PVC pipeline to a sand filter system capable of filtration to 30 micrometers (µm). Once filtered, water is directed to a vertical packed column filled with plastic serrated spheres (BioBalls®) to remove dissolved nitrogen (via off-gassing) and increase oxygen solubility, and then to an elevated tank for distribution to the hatchery building and incubator systems. When water is staged in the elevated tank, supplemental aeration is added to maximize dissolved oxygen concentration before delivery.

During extreme rain events, leachate from the underlying geology (mainly Santa Cruz Mudstone) can result in a mildly opaque coloration to both Berry Creek and Big Creek. Although this condition can sometimes persist for protracted periods (i.e., weeks), it has not resulted in adverse conditions to any life stage of Coho Salmon at KFH to date, and it is unlikely that it can be removed during the purification process.

Two major water quality improvement projects have been implemented at KFH since 2014. The first project included installation of a whole-hatchery sand filtration system with accompanying ultraviolet (UV) sterilizers. These sand filters supply water filtered down to 35 µm that is subsequently UV sterilized prior to delivery to rearing tanks at the hatchery. A second project involved installation of recirculation systems (12.5 L/sec) on each captive broodstock rearing tank. These recirculation systems help provide clean water for Coho Salmon during times of low water flow at the hatchery (i.e., summer and fall) and during large winter storm events that have traditionally delivered large quantities of sediment into rearing tanks. During high stream flow events, incoming water to each tank can be shut off and the recirculating systems run to keep the water in the tanks clean. Both systems (i.e., whole system filtration and recirculating systems) help prevent disease issues at the KFH by providing cleaner water than had been available in the past.

4.1.2) Fisheries Ecology Division

Seawater is pumped from the Pacific Ocean seaward of the Long Marine Laboratory (LML) at UCSC's Coastal Science Campus at rates ranging from 57–95 L/sec depending on need. The FED laboratory and LML share a common seawater intake and primary filtration system. Water passes through a sand filter at LML which removes particles > 150 µm, and a secondary sand filter at FED which removes particles > 50 µm. Seawater is then routed through a UV sterilizer prior to being distributed to the rearing tanks. Cartridge filtration can be used to limit particle size to < 2.0 µm, if necessary. Maximum flow rate is 23.4 L/sec through a 10-hp pump with automatic power backup in case of primary power failure. The seawater delivery systems at LML and FED have built-in redundancy to ensure that water delivery will not be interrupted if any single component fails. Seawater delivered to broodstock rearing tanks can be temperature controlled between 8 and 18°C. Since the rearing tanks are single pass flow-through systems, biological filtration is not necessary. Water temperature (°C) and dissolved oxygen concentration (mg/L) are monitored daily and comprehensive water quality analyses (i.e., suspended solids, total suspended solids, turbidity, pH, etc.) are conducted quarterly for the entire seawater system to ensure suitable and stable rearing conditions.

If necessary, removal of pathogens or contaminants from the discharge can be accomplished by redirecting the water to a waste sump and then through activated carbon filters and UV sterilizers prior to discharge. The seawater pumps and air supply systems are connected to an emergency power generator that automatically turns on when power is interrupted for 60 seconds.

4.1.3) Don Clausen Fish Hatchery

Surface water is obtained for hatchery use from the stilling basin of Warm Springs Dam on Lake Sonoma. Water can be released from the lake via four different intake portals, each located at a different elevation in the lake. Three of the intake portals are in the wall of the dam, while the fourth portal is generally referred to as the service gates. When the lake is low, the highest portal may be exposed and no longer available to supply water (this portal was repaired in 2002 after having been out of service for some time, and it is now operable when submerged). Water release rates from the various portals are commonly proportioned so that the temperature of the combined flow is between 9 and 14°C, which provides good conditions for hatchery operations.

Water enters the hatchery inlet structure from an opening in the right wall of the outlet works stilling basin and flows through a combination of open channels with pipe flow to the hatchery. Water flows via a 1.07 m pipe to an aeration basin near the hatchery building. The aeration basin consists of a concrete structure, containing approximately 680,000 L^3 of water, with five mechanical surface aerators that degas and oxygenate the water. Water enters the aeration basin through an inlet chamber and exits through an outlet chamber to the hatchery raceways. At the aeration basin, water is aerated to increase dissolved oxygen concentration and then allowed to settle. The water then passes through a screening process, at which point it can be routed to the main hatchery building for further treatment and use in incubation and early rearing, or to the rearing raceways for use without additional treatment.

To treat water for use in the incubators and start tanks located in the main hatchery building, water from the aeration basin outlet chamber is pumped through sand and charcoal pressure filters and UV sterilization units. The capacity of the water treatment system is 12.6 L/sec. Currently, DCFH does not have the ability to chill incoming water, and only the main hatchery building receives the abovementioned water treatment. The Coho Salmon building does not receive treated water; only coarse filtration is provided by a rotating debris screen located directly in front of the vault to the Coho Salmon building pumps.

The total hatchery water demand for full capacity fish production operations is 1,132 L/sec. During broodstock collection and holding operations the demand increases to approximately 1,699 L/sec, to provide flows to attract adult fish migrating upstream and to provide flows to maintain the fish in holding ponds once they enter the hatchery. Minimum releases from Lake Sonoma are set at 2,265 L/sec in typical water years and 708 L/sec under drought conditions. Whereas it is possible to divert all releases through the hatchery, it has not been a problem to obtain the necessary flow to maintain hatchery operations, even under drought conditions. When broodstock collection and adult holding operations are conducted under the 708 L/sec limitation of drought conditions, the hatchery manager typically adjusts flow regulation gates and weirs at the aeration basin to ensure that adequate flow is still maintained to the holding ponds and ladder.

As mentioned above, water can be released from four different intake portals, each at a different elevation (depth) within Lake Sonoma. Water can be released directly from the bottom of the dam (elevation 220 feet mean sea level (MSL)), and at elevations of 350, 390, and 430 feet MSL. However, because the water level in Lake Sonoma is often lower than elevation 430 feet MSL, there are times when the highest portal is exposed and cannot be used for releases. During late summer and early fall, Lake Sonoma becomes thermally stratified (i.e., the warmer water tends to stay at the top of the lake, and the colder water stays at the bottom of the lake), and, consequently, water of varying temperature is available for release at different depths (elevations) within the lake. The portal from which water is released is determined by the hatchery manager based on water temperatures in Lake Sonoma.

An emergency water supply system is available to minimize risk from potential equipment failure and associated water supply reduction.

4.1.4) National Pollutant Discharge Elimination Permits

Kingfisher Flat Hatchery. – KFH is has been exempted from the NPDES permit by the Central Coast Regional Water Quality Control Board[9].

Fisheries Ecology Division. – The FED facility operates under National Pollutant Discharge Elimination System (NPDES) general permit No. CAG993003, Order No. R3–2008–0059 issued to University of California at Santa Cruz (UCSC), Long Marine Laboratory.

Don Clausen Fish Hatchery. – The National Pollutant Discharge Elimination System (NPDES) permit for DCFH is #CA0024350/I.D. No. 1B84034050N.

4.2) Risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish because of hatchery water withdrawal, screening, or effluent discharge

4.2.1) Kingfisher Flat Hatchery

Big Creek and Berry Creek water intakes are screened in accordance with NMFS fish screening guidelines[10]. At the Big Creek retention dam collection structure, screening is provided at two points to prevent entrainment of resident stream fishes and other large aquatic organisms into its water conveyance system. The primary screening mechanism is a grate (trash screen) that retains large objects and protects the structural integrity of the inner fish-blocking screen. The perforated metal fish screen is porous enough to allow unrestricted flow through it but does not allow entrainment of protected fish species. During periods of low stream flow, hatchery water is managed (via a designated spillway at the retention dam) to ensure freshwater habitats downstream of the dam receive adequate water and remain suitable for salmonid rearing.

Water diverted from Berry Creek to the conveyance system is passed through two screens: a slotted screen at the primary intake point and a secondary screened canister positioned in advance of a temporary settling/staging tank. Whereas Berry Creek is a non-fish-bearing source, entrainment of fish is not a concern. Rather, screening at the Berry Creek intake serves to reduce coarse material that has the potential to clog the conveyance system.

Hatchery effluent is released into Big Creek at various points adjacent to the KFH facility. Outfall structures are elevated above the creek to prevent aquatic organisms from accessing and entering effluent conveyance systems and hatchery rearing tanks. Each hatchery rearing container is screened prior to its outfall to prevent fish from escaping, and likewise to prevent the entry of exogenous animals into the rearing container. KFH is exempted from NPDES permitting

[9] The KFH facility is exempted from NPDES permitting because of the size of the program (density and number of animals maintained) and because there is no release of chemical effluents. The only materials that are allowed to the creek are fish food residue (if any) and feces. This was confirmed with Mark Galloway and Ben Harris on March 15, 2019. In addition, the Central Coast Regional Water Control Board has provided written (March 29, 2017) confirmation to MBSTP that the hatchery operations at KFH do not warrant a NPDES permit. This was subsequently reaffirmed verbally by regional board staff to NMFS, on September 12, 2018.

[10] https://media.fisheries.noaa.gov/2022-08/anadromous-salmonid-passage-design-manual-2022.pdf

due to the size of the facility (i.e., density and number of animals maintained), and the fact that no chemical effluent is released. Under the exemption, the only materials that may be discharged to the creek are fish food and feces as the potential adverse ecological effects from these products are considered negligible.

4.2.2) Fisheries Ecology Division
Seawater is collected from the Pacific Ocean seaward of LML through a screened intake located in the subtidal zone. Discharge water is returned to the Pacific Ocean through several screened discharge pipes in the rocky subtidal zone. No listed or sensitive species are known to occur in the areas of intake or discharge; thus the effects are expected to be minimal.

4.2.3) Don Clausen Fish Hatchery
The water supply intake system for DCFH is in the reservoir (Lake Sonoma) upstream of Warm Springs Dam. There is no fish passage upstream of the dam and no listed species are present in Lake Sonoma. There are remnant *O. mykiss* persisting in a few tributaries upstream of the dam, which theoretically could be affected by the hatchery water withdrawal and intake screening devices. Beyond screening the water intake, no other specific risk aversion measures are in place.

Settling basins have been installed at DCFH to ensure that hatchery effluent discharge complies with the discharge standards and conditions of the NPDES permit. The discharge standards were established by the North Coast Regional Water Quality Control Board based on designated beneficial uses for the subject waters. In Dry Creek and the Russian River, these beneficial uses include cold-water fish fauna, which reflects the general water quality considerations and requirements of ESA-listed Coho Salmon, steelhead, and Chinook Salmon.

DCFH has been in continuous compliance with its NPDES permit requirements with the exception of infrequent periods when DO concentration dropped below the effluent limit. During times of high turbidity in the influent water, the hatchery may discharge water that is less turbid than that received, thereby benefiting the receiving waters. The DO level in the receiving waters during times of low flows may drop below the 7.0 mg/L limit. Effluent from the hatchery contributes to the total load of solids in the receiving waters. Although settleable and suspended solids levels discharged are slightly higher than that of incoming water, they are within the limits of the NPDES permit.

SECTION 5. FACILITIES

5.1) Broodstock collection facilities and methods

Broodstock will be obtained from three primary sources: (1) collection of adult and juvenile NOR Coho Salmon and HOR adult Coho Salmon from SCMDS streams, (2) Lagunitas/Olema Creek, and (3) captive broodstock progeny of adults spawned at the Kingfisher Flat Hatchery.

5.1.1) SCMDS Streams

For adult NOR and HOR Coho Salmon returning to Scott Creek, a resistance board weir and fish trap will be used to collect fish for broodstock.

NOR and HOR adults and juveniles from SCMDS streams may be collected for broodstock using seines or other trapping/collecting methods based on the environmental conditions present in each stream.

5.1.1) Captive Broodstock

The progeny of captive adults spawned at KFH, or NOR juveniles captured in streams, will be used for maintaining the captive broodstock program. For offspring of captive brood adults employed as broodstock, multiple individuals from each female × male cross (i.e., egg sublot; no more than 450 fish in total) are separated from the general population at the swim-up stage and reared in 4.90 m × 0.30 m × 0.20 m shallow troughs until they reach a mean mass of approximately 3.0 g (typically ~65 mm FL). Fish are then transferred to one of three 0.80 m diameter × 0.80 m deep circular tanks and reared to the pre-smolt/smolt stage (age-1).

At age-1, all broodstock individuals are measured (FL and mass), tissue sampled (caudal fin clip) for genetic analyses, and issued a 12 mm PIT tag for permanent identification. Approximately 80 juveniles are delivered via transport truck tank to the saltwater satellite rearing facility at FED, approximately 180 juveniles are trucked and delivered to freshwater holding tanks located at DCFH, and 120 juveniles are transferred to freshwater holding tanks at KFH. Any surplus fish are incorporated into the hatchery (production) population for eventual release into recovery watersheds. Uniquely numbered PIT tags are used to track the growth and development of each individual in the program until final disposition (i.e., pre-spawn mortality, spawn-related mortality, or release).

5.2) Fish transportation equipment

Ocean-returning adult Coho Salmon captured at the Scott Creek weir and (or) opportunistically in other SCMDS stream are typically transferred individually to KFH in a 150 L tank with supplemental aeration.

5.3) Broodstock holding facilities

5.3.1) Kingfisher Flat Hatchery

Adult NOR and HOR adults used as broodstock are held in outdoor tanks until ready to spawn. These are the same tanks described below for the captive brood program.

Approximately 120 age-1 (pre-smolt/smolt) Coho Salmon are transferred from short-term rearing tanks to one circular 6.0 m diameter (45,000 L) tank that receives filtered and UV sterilized water from Big Creek. The tank is shaded and covered by netting. Two manifold systems are deployed for supplemental aeration in the rearing tank during operation to ensure survival in the event of interrupted water delivery. Smaller tanks are available for isolation and treatment of diseased fish and evaluation of growth and maturity. Tank discharge is returned directly to Big Creek at a point just below (downstream of) the hatchery facility. Whereas Big Creek supports both resident and anadromous fish populations, fish pathogens are expected to be present in the water supply and could be introduced into the hatchery rearing vessels if not eliminated by UV sterilization. Fish at KFH are reared under a natural photoperiod and no artificial lighting is used. Because the hatchery relies on supplemental aeration devices in the large (6.0 m diameter) rearing tanks, an emergency backup generator is available to supply power in the event of commercial power interruption or failure. The emergency generator is programmed to automatically turn on when power is interrupted for more than 30 seconds. The emergency power generator is tested weekly and can run continuously for up to 7 days from a dedicated stationary propane tank.

During the spawn season, fully hydrated (ripe) females are transferred from outdoor rearing tanks to one of four indoor rearing troughs. Each indoor trough measures 3 m long × 0.7 m wide × 0.7 m deep and can hold 900 L of water. Plywood covers are used to prevent fish from jumping out of the trough. This staging strategy allows females to be kept in a secured and darkened environment, significantly reducing potential stressors that could result in egg loss prior to spawning. Water is provided to indoor troughs via dual sources (i.e., Big and Berry creeks) to ensure delivery of suitable freshwater in case of interruption or loss of flow from either surface supply.

5.3.2) Fisheries Ecology Division

Coho Salmon captive broodstock are held in circular 3.7 m diameter (19,000 L) tanks serviced by seawater. The 150 m^2 Coho Salmon outbuilding contains four rearing tanks to accommodate two brood years with approximately 40 fish per tank. Filtered, ambient or chilled, flow-through seawater is supplied at a rate of 3.0 L/sec per tank. All water is double sand filtered and sterilized using UV radiation. Each tank is securely covered by nylon netting. A blower is used to provide aeration in each rearing tank and compressed air is available as an emergency backup if necessary. Photoperiod is ambient and daylight enters the outbuilding through screened windows. Fluorescent lights inside the building provide supplemental illumination. The photoperiod on the fluorescent lights is changed every two weeks to match the local photoperiod. Small portable tanks (approximately 5 m^3) are available for isolation and treatment of diseased fish, evaluation of growth and maturity, etc. as needed. Tank discharge is directed into the general seawater discharge system that services all aquaria at FED. If necessary, removal of pathogens or contaminants from the discharge can be accomplished by redirecting the water to a waste sump and then through activated carbon filters and UV sterilizers prior to discharge. The seawater pumps and air supply systems are connected to an emergency power generator that automatically turns on when power is interrupted for 60 seconds.

5.3.3) Don Clausen Fish Hatchery

Approximately 180 yearling (age-1) Coho Salmon are transferred annually from short-term rearing tanks at KFH to one or more circular 6 m diameter tank(s) at DCFH. The receiving tanks are shaded, covered by netting to protect against predators, and receive filtered freshwater from Lake Sonoma. A blower is used for supplemental aeration in the rearing tank. Smaller tanks (~20,000 L) at DCFH are used for isolation and treatment of diseased fish, evaluation of growth and maturity, etc., as necessary. In all cases, tank discharge is directed into the general water discharge at the hatchery facility.

5.4) Incubation facilities

Initial incubation (fertilization to eyed-egg development) of Coho Salmon eggs at KFH occurs exclusively within a moist-air incubator (MAI). The MAI is a self-contained refrigeration unit that maintains a high (100%) humidity environment inside the incubator via small nozzles attached on the front and rear faces of the unit that deliver a constant fog/mist. The MAI envelops the incubating eggs in a confined atmosphere of cool, moist water vapor at a constant temperature of 11°C. Three in-line sediment removal filters, one carbon-based purification filter canister and a UV sterilizer unit under the MAI prevent the introduction and spread of the parasitic aquatic fungi (e.g., *Saprolegnia* spp.). Fertilized eggs from each female × male cross are segregated within the MAI using small, perforated plastic trays.

Once eggs reach the eyed stage, they are transferred from the MAI to standard hatchery vertical (Heath) incubation trays. Each vertical "stack" is comprised of 16 individual water trays that hold an egg containing insert. In each stack, the top tray is used as a settling basin for suspended matter < 100 μm that is not captured during primary filtration and all subsequent lower trays are available for egg incubation. Each stack receives single-pass, filtered and sterilized water at a rate of 0.2–0.3 L/sec. As water enters each water tray, flow upwells through the screened lid and cascades (via gravity) down to the adjacent tray. Within each vertical tray egg insert, Plexiglass® dividers are installed to keep individual female × male crosses (egg sublots) segregated through swim-up stage. This allows selection of potential captive broodstock Coho Salmon fry from each of the available crosses and family groups.

5.5) Production fish rearing facilities

Once Coho Salmon fry reach the swim-up stage, they are moved ("ponded") from vertical tray incubation inserts into indoor rectangular fiberglass tanks at KFH. Two different tank sizes are available for use: 3 m long × 0.7 m wide × 0.7 m deep tanks that contain 900 L of water or 5 m long × 0.7 m wide × 0.7 m deep tanks that hold 1,600 L of water. Tanks have a smooth, black resin interior and are screened at the upstream and downstream ends to prevent fish from escaping. Fry rearing tanks receive sand filtered and UV sterilized water from both Big Creek and Berry Creek on separate systems to prevent catastrophic loss due to interruption or failure of either water conveyance system.

When Coho Salmon fry reach a mean mass of ~1.0 g/fish, they are transferred to one of four 4.6 m (26,600 L) diameter outdoor rearing pools. The pools are covered with shade cloth and receive water from Big Creek at a rate of 12.7–25.0 L/sec depending on the season and creek discharge. The pools are provided supplemented air via lifts that drive water currents and keep dissolved oxygen levels high (> 90% saturation).

5.6) Acclimation/release facilities

The program does not currently operate acclimation or imprinting facilities in support of the program. Fish are transported in tanks (advanced parr, smolts/yearlings and adults) or coolers (fry and parr) containing hatchery water and subsequently released to receiving streams without acclimation.

5.7) Historical operational difficulties or disasters that resulted in significant fish mortality

5.7.1) Kingfisher Flat Hatchery

Over the past 20 years there have been multiple events that have resulted in significant mortality at the Kingfisher Flat Hatchery. These events include (1) heavy rains that resulted in elevated silt/sediment loads in the tanks leading to fungal disease outbreaks in juveniles and adults; (2) fungal outbreaks in incubation jars; (3) broken water lines; (4) a valve that was accidentally closed and eliminated water delivery to Heath trays containing developing fry; (5) fungal outbreaks in advanced parr held in the lower raceway (since decommissioned) prior to release: (6) a major loss of age-0 broodstock in 2019–2020, and (7) the loss of 40,000 age-0 fish and 118 age-2 fish due to wildfire in 2020. All these events were thoroughly investigated, and new protocols were implemented to prevent recurrence, where possible (see Section 5.8).

5.7.2) Fisheries Ecology Division

There have been three significant fish mortality events associated with broodstock rearing at the FED facility. The first event occurred in 2003 when a portion of the broodstock developed swim bladder problems, lost buoyancy control and eventually starved to death. In investigating this event, FED consulted with many captive broodstock program managers and concluded that residual food (pellet) particles likely clogged pneumatic ducts and hindered normal gas exchange by fish. Consequently, new feeding methods were implemented, and the problem has not recurred. The second mortality event was an outbreak of *Vibrio* sp. during the summers of 2008 and 2009 that resulted in the mortality of some maturing individuals. Following necropsy, a high viral load of *Vibrio* sp. was detected, and all program fish were subsequently provided medicated feed. Additionally, a custom vaccine was created to vaccinate all future broodstock fish against the identified *Vibrio* strain. Additional outbreaks of *Vibrio* have not recurred at the facility since these measures were implemented. The last significant mortality event occurred in October of 2013 when red-tide in Monterey Bay resulted in the mortality of approximately 50% of the maturing sub-adults at FED. The seawater delivered to the rearing tanks during this event, despite being filtered and UV sterilized, contained either algae that depleted dissolved oxygen or a toxin. There has not been a mechanical problem or equipment failure at FED to date that has resulted in significant broodstock mortality.

5.7.3) Don Clausen Fish Hatchery

There have been no major disasters or operational difficulties that have led to significant fish mortality since the inception of the Coho Salmon program at Don Clausen Fish Hatchery.

5.8) Available back-up systems, and risk aversion measures that minimize the likelihood for the take of listed natural fish that may result from equipment failure, water loss, flooding, disease transmission, or other events that could lead to injury or mortality

5.8.1) Kingfisher Flat Hatchery

Although water supplies to KFH can experience high sediment loads during periods of elevated discharge associated with winter precipitation events, turbidity generally poses little risk of mortality to juvenile fish at the hatchery. However, adult Coho Salmon may be adversely affected due to mucous layer erosion or loss. Adult fish are unable to fortify their mucous layer when metabolic energy is largely being shunted to gonadal ripening and spawning behavior. This condition leaves adult fish highly vulnerable to horizontal transmission of pathogens, particularly by aquatic fungi (e.g., *Saprolegnia* spp.). To combat this problem and minimize risk, incoming water supplies at KFH are processed and purified via a two-stage process. First, water from the sediment catch flume enters a standard 2.4 m × 1.2 m diameter sand filtration pod, which removes finer material that remains in suspension. Second, sand-filtered water is passed through a UV sterilization array before being introduced into the hatchery mainline for distribution throughout the facility.

During extreme rainfall events, leachate from the underlying geology (mainly Santa Cruz Mudstone) can result in a mildly opaque coloration to water in both Berry Creek and Big Creek. Although this condition can sometimes persist for protracted periods (i.e., weeks), it has not resulted in adverse conditions to any life stage of Coho Salmon at KFH to date. It is unlikely that leachate can be removed during the purification process.

Water supply problems have occurred at various points along the conveyance system. Incubating eggs are generally most susceptible to interruptions or variation in water supply. To minimize this risk, a low-flow alarm sensor was installed at an effluent collection sump below all banks of vertical tray incubators. Once triggered, the sensor activates a visual alarm and a recirculation sump pump to provide water to the developing eggs/alevins in the incubation trays. The sensor does not have capability to “dial-out” to an alarm monitoring central station or to hatchery personnel.

In 2012, a water supply sensor was installed in the elevated Berry Creek incubation water staging tank outside the main hatchery building at KFH. This sensor is affixed at a point 0.45 m below the tank’s overflow outfall and initiates an alarm when dewatered. The alarm is monitored remotely by Sight and Sound Security Systems (Sunnyvale, CA) who immediately notify hatchery personnel if activated. This system is adaptable with capacity to add more alarm zone-sensors when needed. One additional sensor was added in 2015 to monitor pressure within the MAI unit. This sensor has both low- and high-pressure set points. This monitoring is crucial for the MAI’s high-pressure pump operation, which controls pressure of water feed through the mist-producing nozzles. Extreme pressure can result in nozzle line ruptures, dislodging of misting nozzles, or damage to the high-pressure pump itself. Conversely, low pressure will result in insufficient mist to keep developing eggs moist and oxygenated. Both of these deficiencies can quickly be corrected by hatchery staff, but since a problem may occur at any time during the operation, the addition of an alarm sensor ensures that these problems will be identified and corrected expeditiously. All circuitry supporting MAI system operation is routed through the emergency power generation system to ensure continued function during commercial power interruption or failure.

Since the MAI unit is a critical infrastructure for early incubation of Coho Salmon eggs, the hatchery maintains spare system components on-hand; specifically, two spare recirculation pumps, two spare high-pressure pumps, one spare chiller and a spare UV sterilizer. The MAI is set up such that any of these system components can be swapped out quickly. There are also ample supplies available to make repairs to emitter lines, water conveyance tubing and to replace damaged or clogged spray nozzles. The MAI is also equipped with a temperature alarm sensor that activates when the MAI's interior temperature exceeds 11.3°C. This alarm is audio-only with no dial-out capabilities.

The water supply filtration system at KFH requires water to be pumped through both the sand filters and the UV system, and back into the general hatchery conveyance system. A failure of the operational pump would result in the loss of flow and present a potentially life-threatening situation for all fish at the facility. To guard against this risk, a water flow sensor and alarm were installed in the main water supply line before the filter pumps. Hatchery personnel have the experience and knowledge necessary to troubleshoot and address most problems with the water purification system. If a problem is beyond the scope and capacity of hatchery personnel to quickly correct, a series of system bypass valves will be used to redirect all water to gravity-feed lines, although the water will be raw and untreated.

As detailed earlier, all rearing tanks in the main hatchery building at KFH are equipped with redundant influent source water lines (i.e., both Berry Creek and Big Creek) to protect early life stages from catastrophic loss due to the interruption of flow from either source. In addition, KFH has portable aeration devices ready to deploy into several indoor tanks in case of reduced flow for any reason.

Supplemental aeration is provided for all outdoor rearing containers via regenerative blowers. Two 3-phase blowers are installed and connected to a system of PVC and reinforced Tygon® tubing that convey compressed air through either air-stone bubbler-manifolds or current generating aeration lifters. Both devices help increase dissolved oxygen levels and enrich water quality, particularly during periods of low water supply and reduced turnover during the summer and fall. Aeration is also provided for incubation water staged in the elevated storage tank adjacent to the main hatchery building. The hatchery has a spare 3-phase blower and a spare single-phase blower which can quickly be swapped should either commissioned blower fails. Blower circuits are routed through emergency power generator, so in event of commercial power interruption or failure, the blowers will continue to operate.

Disease problems are addressed using procedures identical to those described for the FED facility. Hatchery staff at KFH have ample experience preventing, diagnosing, and treating pathogens common to Coho Salmon. Bacterial kidney disease (BKD) was detected in Coho Salmon adults at KFH in the early 1990s and resulted in prophylactic inoculation of adult females for more than seven days prior to egg take to prevent vertical transmission of BKD. Aquatic fungus (*Saprolegnia* spp.) is another historical pathogen that has impacted all Coho Salmon life stages beyond late-parr at KFH. Along with addition of water purification, the only treatments available to combat fungal outbreaks are salt and/or hydrogen peroxide baths. Beyond the use of salt baths, all necessary chemotherapeutic treatments are administered as prescribed by the CDFW Fisheries Chief Pathologist. Fish pathologists from CDFW provide consultation on disease problems when needed.

To reduce fungal outbreaks among the pre-yearling/yearling production group, the lower raceway at KFH was decommissioned (filled) in 2015 and four 4.6 m diameter (26,600 L) circular pools were installed in its stead. The pools are covered with shade cloth and fed with water from Big Creek at a rate of 12.7–25.0 L/sec depending on the season and surface flow in Big Creek. The pools are supplemented with air via lifts that drive water current and keep dissolved oxygen levels high (≥ 90% saturation).

5.8.2) Fisheries Ecology Division

Water systems

Pumps. – There are two redundant 10-hp motors that supply water for the FED seawater system. Motors are rotated monthly to ensure that both remain functional. If one pump motor were to fail the other would immediately be brought online.

Sand Filters. – Seawater is passed through one of two redundant sand filters at the facility before delivery to the rearing tanks. The sand filters are rotated monthly to ensure both are kept in operational shape. If one sand filter were to fail the other would immediately be brought online. If both units failed, incoming seawater would still receive primary filtration via sand filters at the FED/LML shared reservoir.

UV Sterilizer. – There are two UV sterilizer units at the FED facility. Both units are necessary to filter the volume (16–19 L/sec) of seawater required for rearing. Sterilizer units are monitored daily, and UV bulbs are replaced annually as per manufacturer's recommendation. In the event of UV sterilizer unit failure, the system(s) will be repaired or replaced as quickly as possible.

Water quality. – If poor influent water quality is detected, the seawater system can be operated in a recirculated mode with supplemental aeration and/or oxygen.

Disease incidence. – Disease issues are evaluated and treated based on diagnoses and recommendations provided by pathologists from CDFW and/or the University of California at Davis (UCD). *Renibacterium salmoninarum* infection, the source of bacterial kidney disease (BKD), is a common pathogen in NOR Coho Salmon collected from Scott Creek and adjacent Waddell Creek. Consequently, female Coho Salmon broodstock are treated with Draxxin injectable antibiotic (Tulathromycin; 0.05 mg/kg) within 10 days of spawning. This procedure has effectively eliminated BKD in broodstock progeny to date. Nevertheless, if BKD or other diseases occur in the program, procedures developed and approved by CDFW fisheries pathologists will be implemented (Attachment C).

Air systems

The blower system at FED that supplies aeration to rearing tanks has two redundant blowers with only one operating at a time. In the unlikely event that both blowers fail, an oil-less air compressor is plumbed and can supply adequate aeration until the main system can be repaired or replaced.

5.8.3) Don Clausen Fish Hatchery

Information for this section was taken directly from the HGMP for the Don Clausen Fish Hatchery Coho Salmon Captive Broodstock program (CDFW and USACE 2017).

Equipment failure risk aversion measures. – In February 2013, three vertical turbine pumps were installed in the DCFH aeration basin to serve as the new, primary water supply method for the Coho Salmon building. A single pump provides up to 158 L/sec but total capacity with more than one pump is not additive (i.e., two and three pumps operating together will provide up to 284 L/sec and 379 L/sec, respectively). Only one operating pump is required to meet the current Coho building demand. Consequently, the other two pumps are operated alternatively or serve as back-ups in the event that one pump becomes inoperable. Once the planned expansion of the spawning and incubation facilities in the Coho building are fully completed, two pumps operating concurrently will be required to meet the facility's peak water demand, leaving one pump as a back-up. In the event that the Coho building continues to expand further, a fourth pump can be added to the existing pump vault.

This primary water supply pump system is also backed up by the original two pumps for the Coho Salmon building that are located in a pump vault between the aeration basin and the building. Each pump supplies approximately 284 L/sec but cannot be operated concurrently. A standby generator is available to provide power for operations during a power outage. In the unlikely event that all main and back-up pump systems become inoperable (e.g., complete electrical power outage that includes utility as well as generator power), the Coho Salmon building would be limited to an emergency water supply of about 2.0 L/sec, supplied by a gas-powered suction-type portable pump. In this situation, oxygen would also be supplied to each tank in the building via six oxygen supply stations strategically located throughout the building. Each oxygen supply station consists of a 250 L bottle of compressed oxygen, along with air stones and air lines for each of the tanks it is intended to supply. The back-up pump system and emergency equipment are inspected monthly, and emergency situation training is provided biannually to all DCFH staff.

The DCFH main hatchery building has been modified to provide additional backup components, including:

- addition of a bypass pipeline for an emergency water supply (EWS) system
- provision for gravity flow from aeration pond to new raceways
- additional alarm system modifications
- gasoline-powered pump assembly and associated collapsible pipeline to enable pumping from treatment sump to the hatchery building head box
- a digital Day Tank assembly for the generator, along with implementation of a weekly exercise routine

Training of personnel now includes routine practice drills for appropriate response to emergency conditions. These practice drills are conducted two times per year.

Water loss aversion measures. – The EWS system was constructed in 1992 to be used to supply a sufficient quantity of water to the hatchery in the event both the outlet works, and power plant are not operating. When the EWS is needed, hatchery personnel contact the local USACE office to request activation of the system. If the EWS system is needed after normal working hours, USACE gate operators located in Sacramento are contacted to activate the EWS system remotely. Flow to the hatchery can be controlled by the energy dissipation valve in the stilling well at the dam. Water can be drawn from the reservoir if the water surface elevation is at least 107 m (350 feet) above the National Geodetic Vertical Datum of 1929 (NGVD 29). USACE personnel follow procedures to fill the EWS pipeline with water from the stilling well. Between uses, the EWS system is left un-watered to minimize stress and potential damage to the pipeline. Two standby generators (350 kW each) are available to provide power for hatchery operations during a power outage.

While the EWS system is in operation, the aeration basin can supply sufficient water to the DCFH facility for 8–10 minutes. Longer equipment outage delays could affect fish survival. However, other emergency sources of water, though not as reliable as the EWS system, are available. Wells E and F, downstream of the hatchery complex along Dry Creek, were originally provided as an emergency water source. The wells can supply the hatchery with approximately 0.06–0.09 m^3/s of water, but this limited supply would support only approximately 10% of the typical facility demand. Wells E and F are not available as an emergency water source during power outages since they are not supported by a back-up generator. Another option are two 75-hp pumps located near the effluent discharge location (normally used to prevent backflow inundation of the facility under high stream flow conditions) which can recirculate effluent water from the settling basins to the aeration structure. Past use of this recirculation system, however, was associated with high mortality, and as a result, its use is generally discouraged. If no other options are available, and survival of the fish is threatened, the fish can be released into the water pollution control pond for later retrieval or released directly into Dry Creek.

Flooding risk aversion measures. – The Warm Springs Dam and associated flood control operations generally minimize the risk of flooding at DCFH. Flood control operations are managed by the USACE maintenance staff located at Lake Sonoma and Warm Springs Dam. In the event of backflow inundation of the facility due to high stream flow conditions, or in case of a blockage to the effluent discharge pipes, two 75-hp pumps are located near the DCFH effluent discharge location. As described above, these pumps can be used as an EWS system to pump water back to the aeration basin, or alternatively as a flood-control measure to pump water from the effluent settling pond directly to Dry Creek.

5.8.4) Emergency use facilities

In 2021, extreme drought conditions in California caused surface water temperatures to exceed levels that are suitable for the rearing of Coho Salmon at KFH. Because KFH uses surface water for rearing fish it was necessary to identify emergency hatchery facilities with a suitable rearing environment to maintain production when water quality is unsuitable at KFH. Descriptions of each emergency rearing facility, and how they are to be utilized by the program, are described in Attachment E. The emergency facilities that may be used by the program are: (1) Don Clausen Fish Hatchery, Sonoma County; (2) United Anglers of Casa Grande Rearing Facility, Sonoma County; and (3) Powder Mill Rearing Facility, Santa Cruz County.

SECTION 6. BROODSTOCK ORIGIN AND IDENTITY

6.1) Source

Program Coho Salmon originated from progeny of NOR Coho Salmon collected from Scott Creek and propagated at KFH. NOR fish captured in other SCMDS watersheds—predominantly adjacent San Vicente and Waddell creeks—have intermittently been added to the broodstock population over the years. This practice is continued, and expanded to other SCMDS streams, with the implementation of the HGMP.

Genetic monitoring conducted by NMFS revealed that diversity within the Scott Creek broodstock had begun to decline after multiple years of fish being produced exclusively from captive broodstock parents (i.e., predominantly closed-system captive broodstock × captive broodstock mating). Consequently, beginning in 2011, supplemental brood fish were acquired from DCFH from their Lagunitas/Olema Creek strain and crossed with Scott Creek fish to increase genetic variability within the Scott Creek population. Annual outbreeding has continued using fish from DCFH (Russian River and Lagunitas/Olema Creek stocks). In all cases, outbreeding crosses have been conducted using a genetic spawning matrix to ensure offspring will have the highest possible genetic diversity. Outbreeding of program fish with out-of-basin broodstock from genetically suitable populations (in the southern CCC ESU) will continue under this HGMP at least through Phase 1.

6.2) Supporting information

6.2.1) History

Efforts to propagate Coho Salmon in the Santa Cruz Mountains region began in earnest around 1929 at a pair of facilities: Brookdale Hatchery in the San Lorenzo watershed and the newly established Big Creek Hatchery on Scott Creek. Spence et al. (2011) reported that between 1929 and 1941, approximately 1.2 million Coho Salmon fry were outplanted to Santa Cruz and San Mateo County streams, with the majority released to the San Lorenzo River, Scott Creek, and Soquel Creek. While egg sources for most of these early plantings are equivocal, Coho Salmon from Scott Creek (also adults from Fort Seward and Prairie Creek in Humboldt County, California) served as broodstock during this period (Spence et al. 2011). Coho Salmon production at the Big Creek Hatchery ceased in 1940 when the hatchery facility and associated mainstem Scott Creek egg collecting station were both severely damaged by winter floods. While Brookdale Hatchery continued to operate until 1953, hatchery records indicate that Coho Salmon were not reared at the facility or released after 1941.

In 1976, the Monterey Bay and Trout Project was formed, and small-scale propagation of Coho Salmon resumed that same year. Between 1976 and 1978, MBSTP produced approximately 20,000 juvenile Coho Salmon from Ten Mile River and Noyo River (Mendocino County) broodstock and these fish were released directly into Monterey Bay. Thereafter, the program began outplanting smolts (age-1) produced at the Kingfisher Flat Hatchery to numerous regional watersheds (i.e., San Lorenzo River, Scott Creek, Pescadero Creek, Waddell Creek, Gazos Creek, Aptos Creek, and San Vicente Creek). During the 1980s, broodstock included Coho Salmon from the Noyo River, Russian River and Prairie Creek; however, all broodstock used between 1991 and 2001 were chiefly from Scott Creek and the San Lorenzo River (Spence et al.

2011).

The SCSCBP was formally established by MBSTP, NOAA, and CDFW in 2002 to protect against the extirpation of Coho Salmon south of the Golden Gate. Broodstock for the program were primarily selected from the progeny of NOR Coho Salmon captured in Scott Creek and subsequently spawned at KFH. Additional fish were sourced from adjacent San Vicente and Waddell creeks during the first few years of program operation. Outbreeding experiments have been conducted annually since 2011 incorporating broodstock from Lagunitas/Olema Creek and the Russian River Basin (discussed in section 6.1).

6.2.2) Annual size

The total number of broodstock required each year will be highly dependent on in-hatchery survival rates by life stage. Based on past life stage survival rates, the maximum number of broodstock required to achieve hatchery fish release targets will be no more than 380 fish per brood year. As adult run sizes in Group 1 streams increase, broodstock composition will shift away from a majority of captive brood toward the use of HOR and NOR adult returns. The number of fish required for broodstock at that point in the program will be approximately 300 per brood year.

6.2.3) Past and proposed level of natural fish in broodstock

The number of adult fish by origin used for hatchery spawning from winters 2004–2005 through 2019–2020 is presented in Table 23.

Natural-origin and hatchery-origin fish are taken into the broodstock either as adults returning from the ocean to spawn, or as juveniles collected from Scott Creek or other SCMDS streams. Captive-origin broodstock are born and reared to adulthood in the hatchery. To date, most fish spawned at KFH have been of captive-origin. Outbreeders have been imported each year as adults from DCFH. The majority of NOR individuals incorporated as broodstock have been collected as juveniles (age-0 and age-1) from SCMDS streams. Outbreeders are composed of a mix of NOR and HOR from Lagunitas/Olema Creek and Russian River. Since 2010, only four NOR adults from Scott Creek have been used as broodstock.

The number of NOR Coho Salmon adults to be used for broodstock is presented in Table 24. The program may collect up to 75 NOR adults (30 females, 45 males) in Phase 1 and Phase 2. This number may increase to 150 NOR adults (60 females, 90 males) in Phase 3 if sufficient NOR adult production occurs in SCMDS streams.

In Phase 1 and Phase 2, the program may use 100% of the NOR adult returns to Group 1 streams as broodstock. In Phase 3, the program may use up to 50% of the NOR adults returning to Group 1 streams for broodstock. However, because of expected adult trapping inefficiency it is highly unlikely that 100% of the NOR adult run could ever be intercepted and removed from a stream.

6.2.4) Genetic or ecological differences

The majority of broodstock will come from SCMDS streams, which are genetically and ecologically representative of NOR fish in the diversity stratum.

To minimize inbreeding, and thus reduce average relatedness of adults used as broodstock, the program will continue to import outbreeders from Don Clausen Fish Hatchery (Russian River/Lagunitas/Olema Creek origin) for use as broodstock as directed by program geneticists.

Table 23. Number (*N*) and percentage (%) of Coho Salmon used in spawning by sex and origin, winters 2004-2005 to 2019-2020. Outbreeding experiments were initiated during winter 2010–2011.

Spawn year	Sex	Origin							
		Captive		Hatchery		Natural		Outbred	
		N	%	*N*	%	*N*	%	*N*	%
2004–2005	Female	12	37.5	5	15.6	15	46.9	---	
	Male	14	43.8	0	0.0	18	56.3	---	
2005–2006	Female	14	87.5	0	0.0	2	12.5	---	
	Male	19	95.0	0	0.0	1	5.0	---	
2006–2007	Female	16	94.1	0	0.0	1	5.9	---	
	Male	20	100.0	0	0.0	0	0.0	---	
2007–2008	Female	17	100.0	0	0.0	0	0.0	---	
	Male	14	73.7	0	0.0	5	26.3	---	
2008–2009	Female	6	100.0	0	0.0	0	0.0	---	
	Male	7	70.0	2	20.0	1	10.0	---	
2009–2010	Female	11	100.0	0	0.0	0	0.0	---	
	Male	9	100.0	0	0.0	0	0.0	---	
2010–2011	Female	3	50.0	0	0.0	0	0.0	3	50.0
	Male	4	80.0	0	0.0	1	20.0	0	0.0
2011–2012	Female	76	96.2	0	0.0	0	0.0	3	3.8
	Male	89	90.8	0	0.0	0	0.0	9	9.2
2012–2013	Female	37	84.1	1	2.3	0	0.0	6	13.6
	Male	34	54.8	1	1.6	0	0.0	27	43.5
2013–2014	Female	32	69.6	0	0.0	0	0.0	14	30.4
	Male	33	51.6	9	14.1	0	0.0	22	34.4
2014–2015	Female	30	66.7	0	0.0	2	4.4	13	28.9
	Male	61	80.3	0	0.0	1	1.3	14	18.4
2015–2016	Female	40	80.0	0	0.0	0	0.0	10	20.0
	Male	71	79.8	0	0.0	0	0.0	18	20.2
2016–2017	Female	59	85.5	0	0.0	0	0.0	10	14.5
	Male	66	72.5	0	0.0	0	0.0	25	27.5
2017–2018	Female	68	88.3	0	0.0	0	0.0	9	11.7
	Male	98	84.5	0	0.0	0	0.0	18	15.5
2018–2019	Female	71	86.5	0	0.0	1	1.2	10	12.2
	Male	65	69.9	0	0.0	1	1.1	27	29.0
2019–2020	Female	96	92.3	0	0.0	0	0.0	8	7.7
	Male	146	85.9	0	0.0	0	0.0	24	14.1

Table 24. The proposed number of natural-origin and hatchery-origin adult and juvenile Coho Salmon sourced from SCMDS streams and DCFH to be used as program broodstock during each phase of the program.

Source	NOR	HOR	NOR	HOR	NOR	HOR
Captive Broodstock	Phase 1		Phase 2		Phase 3	
Juvenile Female	152	0	0	0	0	0
Juvenile Male	228	0	0	0	0	0
Total	380	0	0	0	0	0
Hatchery Broodstock	Phase 1		Phase 2		Phase 3	
Adult Female	30	108	30	90	60	60
Adult Male	45	162	45	135	90	90
Total	75	270	75	225	150	150
Target Minimum pNOB	10%		25%		50%	
Don Clausen Fish Hatchery	Phase 1		Phase 2		Phase 3	
Adult Female	0	13	0	0	0	0
Adult Male	0	37	0	0	0	0
Total	0	50	0	0	0	0

6.2.5) Reasons for choosing

The goal of the program is to assist in the conservation of SCMDS Coho Salmon. Currently, the program provides the vast majority of Coho Salmon in the region. Therefore, broodstock for the program will be obtained from the nine streams of this diversity stratum with emphasis on fish produced in Scott Creek, Waddell Creek, San Vicente Creek and Pescadero Creek.

6.3) Risk aversion measures to minimize the likelihood for adverse genetic or ecological effects to listed natural fish because of broodstock selection practices

Measures that will be implemented to reduce the likelihood of genetic or ecological effects to listed Coho Salmon include:

- A genetic spawning matrix will be used to direct all fish mating's to avoid inbreeding and maximize genetic diversity in offspring of hatchery crosses.
- Adult Coho Salmon used for broodstock will be collected and spawned over the full adult migration period to prevent a shift in adult run timing.
- Outbreeders will continue to be incorporated into broodstock to maintain or increase genetic diversity of the cultured population until natural abundance increases.
- The number of natural-origin adults that may be used as broodstock is limited to 75 in Phase 1 and Phase 2, and 150 in Phase 3. Limiting the number of NOR adults used as broodstock will limit demographic effects to the naturally spawning populations.

SECTION 7. BROODSTOCK COLLECTION

7.1) Life history stage to be collected

Adult Coho Salmon (NOR and HOR), and NOR juveniles may be collected for use as program broodstock.

7.2) Collection or sampling design

Adult Coho Salmon (NOR and HOR) will be collected, in proportion to their return timing and abundance, for use as broodstock from SCMDS streams between December 1 and April 1 annually.

Most of the adults (NOR and HOR) collected for broodstock will come from Scott Creek. This stream is equipped with a resistance weir and fish trap that has been shown to be moderately effective (30 to 50%) at capturing adult Coho Salmon during periods of low to moderate stream flow. During periods of high stream flow, trap efficiency is substantially reduced (< 30%). The inability to collect NOR adult Coho Salmon during high flows may result in unequal representation of portions of the run in the broodstock. Over time, this could alter adult run timing and survival rates for eggs and juvenile, thus decreasing productivity and abundance. To reduce this risk, the program will also collect adults returning to other SCMDS streams for broodstock.

Natural-origin juvenile Coho Salmon used for captive broodstock may be collected from regional streams (Emphasizing Group 1 streams but also opportunistically from other basins in the diversity stratum) using a variety of approved sampling methods (e.g., traps, seining, and backpack electrofishing). Careful spatiotemporal sampling and collection of juveniles will be conducted to represent the full spatial distribution and timing of Coho Salmon in the SCMDS.

7.3) Identity

All adult and juvenile NOR fish collected for broodstock will come from the SCMDS, and therefore from the populations targeted for conservation[11]. Whereas all fish used as broodstock are genetically screened, it will be possible to determine if Coho Salmon outside the SCMDS are being included in the program. This genetic screening will allow managers to remove these fish from the program if desired. These fish would be returned to the stream from which they were collected or to other locations at the direction of CDFW and NMFS and any permit requirements.

As noted previously, program fish were historically adipose fin clipped to differentiate hatchery-origin production from natural-origin individuals. However, concerns about the potential for Coho Salmon produced by the program to be captured as sub-adults and adults in the Oregon recreational fishery led to the use of internal tags rather than adipose clipping (thereby requiring release by Oregon anglers). Since 2013, Coho Salmon produced by the program have been implanted with coded-wire tags (CWT) prior to release, and a proportion of fish > 65 mm FL have also received a secondary PIT tag. Returning adult Coho Salmon are interrogated for the presence of a CWT and/or PIT tag to determine origin. These practices will continue under this HGMP.

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[11] Adults may also come from Lagunitas/Olema Creek as long as outbreeding continues.

7.4) Proposed number to be collected

The number and source of Coho Salmon for broodstock will vary by Phase (Table 24).
In Phase 1, NOR juveniles (380) captured in Group 1 streams will be the primary broodstock source for the captive brood component of the program. Adult Coho Salmon will be imported as needed from Don Clausen Fish Hatchery to reduce inbreeding.

If 380 NOR juveniles are not available each year, then up to 380 juveniles from that brood year's captive broodstock production will be incorporated into the program. Decisions about which HOR and NOR juveniles to retain each year will be based on results of genetic analyses. The goal is to have a captive broodstock with the highest possible genetic diversity, given abundance limitations of natural Coho Salmon populations.

As Phase 1 progresses, adult returns to Group 1 streams are expected to increase to levels where broodstock can be met with NOR and HOR adults only. This will require approximately 300 adult Coho Salmon if in-hatchery survival rates by life stage are achieved. Of the 300 adults, 30 will be of natural-origin to meet the minimum pNOB target of 10%, a level identified by the HSRG to prevent genetic divergence between the hatchery and natural components of the population.

In Phase 2, the captive broodstock program and imported fish from non-SCMDS streams is expected to be discontinued. The same number of adult Coho Salmon (300) needed in Phase 1 will be required to achieve broodstock requirements in Phase 2 and Phase 3.The primary difference between Phase 2 and Phase 3 is the number of NOR adults incorporated into broodstock. In Phase 2 and Phase 3, pNOB is set at 25% and 50%, respectively. pNOB increases over time so that local adaptation is driven by the natural, rather than the hatchery environment.

7.4.1) Broodstock collection levels for the last twelve years

The number of juvenile and adult Coho Salmon collected for broodstock from 2004 to 2018 is provided in Table 23 (see above).

Captive Broodstock. – Between 2002 and 2010, approximately 200 juveniles per year were retained from the general release lot of adult NOR × captive broodstock spawning at KFH. In 2011, the number of individuals from the captive broodstock production that were selected and retained at the hatchery as captive broodstock was increased from ~120 to 380. This increase in captive broodstock number promoted the incorporation of more genetic input across family groups to maximize effective population size of the breeding pool.

Adult HOR and NOR Returns. – Since 2006 a total of 25 adult NOR and HOR adults have been collected from the wild and used as broodstock.

Imported Broodstock. – Beginning in 2011, fish from outside of the SCMDS (specifically Lagunitas/Olema Creek and Russian River watershed) were incorporated into the breeding program for the purposes of increasing diversity and providing unrelated mates for Scott Creek broodstock. In general, the number of Coho Salmon imported from Sonoma and Marin County streams through DCFH has ranged from about 10 to 65 fish annually.

7.5) Disposition of hatchery-origin fish in surplus of broodstock needs
The disposition of any natural-origin or hatchery-origin Coho Salmon in surplus of broodstock needs is decided each year by the TOC. Fish not required for the program will be released to SCMDS streams consistent with the priorities identified in Section 10.

7.6) Fish transportation and holding methods
Adult and juvenile Coho Salmon will generally be transported in insulated 1,500 L tanker trucks to maintain appropriate water temperatures. All tanks are equipped with aeration to maintain dissolved oxygen levels at saturation.

Juvenile fish are starved for two days prior to transport for release or transfer between facilities to reduce excretion in transfer tanks. To reduce stress effects associated with transport, salt is added to the tank water (1%). Stress coat® water conditioner is added to the water to maintain slime integrity of the fish, and AQUI-S® antifoam is added to minimize foam production due to aeration and fresh-flow pumps.

Transportation to the FED facility from KFH is less than one hour. Once at FED, seawater is pumped into the transfer tank to gradually increase the salinity of the transport water to that of rearing conditions before fish are transferred to rearing tanks. This same procedure is used to transfer fish from KFH to DCFH; except that no salt is added to the transfer tanks since DCFH is a freshwater facility. Transit time between KFH and DCFH is approximately 3.5 hours. Transport times between SCMDS streams and Kingfisher Flat Hatchery is less than two hours.

7.7) Fish health maintenance and sanitation procedures applied

7.7.1) Kingfisher Flat Hatchery
To promote and facilitate disinfection of fish husbandry equipment and wet gear at KFH, several disinfection stations have been deployed and filled with an iodophor solution (≥ 300 ppm). Each disinfection station is regularly monitored, and vats are refreshed or emptied and recharged, as needed. All gear is air dried after disinfection and rinsing. All equipment used for broodstock spawning is disinfected using iodophor prior to use.

After transport of any Coho Salmon from KFH to locations outside of the Scott Creek watershed, the fish transfer truck is disinfected with a solution of 300 ppm iodine applied to all surfaces. This solution is rinsed after a minimum of 20 minutes exposure to all applied surfaces. After final rinsing, tank lids remain open to air dry, and sunlight exposure further eradicates pathogens remaining after iodine disinfection. All other equipment (e.g., nets, buckets, waders, hip boots, knee boots, rain gear) used during the transfer the fish is cleaned with a dilute iodine solution, rinsed, then left to air-dry in sunlight. To prevent the potential spread of invasive species (e.g., New Zealand mudsnail; see Section 3.5) waders, hip boots and knee boots used away from KFH are placed in cold storage (≤ -15°C) for a minimum of 24 hours before and after use.

7.7.2) Fisheries Ecology Division
All captive brood holding tanks are inspected, maintained, and cleaned daily. Each rearing tank has dedicated cleaning equipment and sampling gear. Items are cleaned by soaking/storage in

200 ppm iodine until use, at which point they are thoroughly rinsed using tap water. Iodine vats are refreshed or emptied and recharged, as necessary. FED gear is never taken off site.

7.7.3) Don Clausen Fish Hatchery
General fish health maintenance and sanitation procedures include daily cleaning of captive broodstock tanks. All cleaning equipment and nets are disinfected in Argentyne® (iodine-based disinfectant) prior to use, and separate cleaning instruments are designated to each rearing tank. Iodine vats are refreshed or emptied and recharged, when necessary. DCFH gear is never taken off site.

7.8) Disposition of carcasses
Carcasses will be disposed of in a local landfill or distributed in streams and riparian areas to mimic natural nutrient transfer from the marine environment. A limited number of carcasses may be provided to various entities such as UCSC, Cabrillo College, and the Watershed Stewards Program (California Conservation Corps) for educational purposes (e.g., classroom dissections).

7.9) Risk aversion measures applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program
Adult and juvenile Coho Salmon used as broodstock will be collected using a combination of capture methods. Fish collection activities follow handling and transport protocols designed to result in low injury and high survival rates for collected fish.

A limited number of NOR juveniles and adults are collected from a stream, which ensures that some natural production occurs each year, thereby maintaining natural life history diversity and abundance.

SECTION 8. MATING

8.1) Selection method

Spawner mate selection is based on relatedness determined by genetic analysis of tissue samples collected from all potential captive broodstock, outbreeders imported from Don Clausen Fish Hatchery, and returning adult Coho Salmon captured in SCMDS streams. The results of these analyses are used to develop a breeding matrix designed to minimize inbreeding and facilitate gene flow between brood years. The matrix identifies which male and female crosses will result in the least likelihood of inbreeding regardless of fish origin (captive broodstock origin, NOR, or HOR return) or age (Figure 10).

8.2) Males

A matrix of relatedness estimates ("spawning matrix") between all possible pairs of females and males that might mature in each spawning season (see Section 8.3) is produced by estimating relatedness from genotype or haplotype data. Mates are chosen based on the level of genetic relatedness between the pair (see Section 11.1.1). This procedure includes all potentially mature fish, including precocious (age-2) individuals. Up to four males may be used per female, with milt from a genetically suitable "back-up" male reserved for substitution in case a selected milt sample is not viable. An individual male may be spawned a maximum of four times (i.e., with four different females), after which he will be sacrificed. Males spawned in the hatchery will not be subsequently released to the wild. Precocious individuals are included in the spawning matrix and are used as needed for spawning. If a male has no available acceptable mates (i.e., no females related to him below the do-not-mate first cousin threshold; $r_{xy} = 0.125$), that male will not be spawned in the hatchery and may instead be released to SCMDS streams.

The effectiveness of the spawning matrix to reduce inbreeding is shown in Figure 10. In winter 2019–2020, the relatedness of the Coho Salmon spawned in support of the program was less than if a random mating scheme was used for breeding, and results approximated the optimal genetic outcome (Figure 10). Nine percent of the crosses in winter 2019–2020 exceeded the do not mate threshold established by geneticists. In the future, eggs and fish from any cross that exceeds the do not mate threshold will not be released to SCMDS streams.

8.3) Fertilization

Spawning procedures are as follows: candidate male mates for a ripe female are identified and ranked using the genetic spawning matrix. Selected males are temporarily immobilized during milt collection using electric fish handling gloves (Smith-Root, Inc.). Milt is collected into individually labeled test tubes and then checked for motility and viability under magnification. The female is then sacrificed and all eggs are collected. The collected egg lot is typically divided into ≤ 4 egg sublots and each sublot is subsequently fertilized with milt from a different male. After fertilization, standard hatchery protocols are followed. Eggs are disinfected with iodine, all water hardened and dead eggs are removed, and the remaining eggs are placed into the MAI (segregated by sublot). After each spawning event, all spawning equipment is thoroughly cleaned with an antimicrobial soap, rinsed with water, sterilized with an iodine dip (300 ppm iodine), rinsed again, and dried with a clean towel or left to air dry overnight. Hormone injections may be used to induce spawning if required. For these injections, fish are handled according to best practices as defined by CDFW. The type, lot number, and amount of therapeutant injected are recorded along with individual fish identity (PIT tag number), date and time.

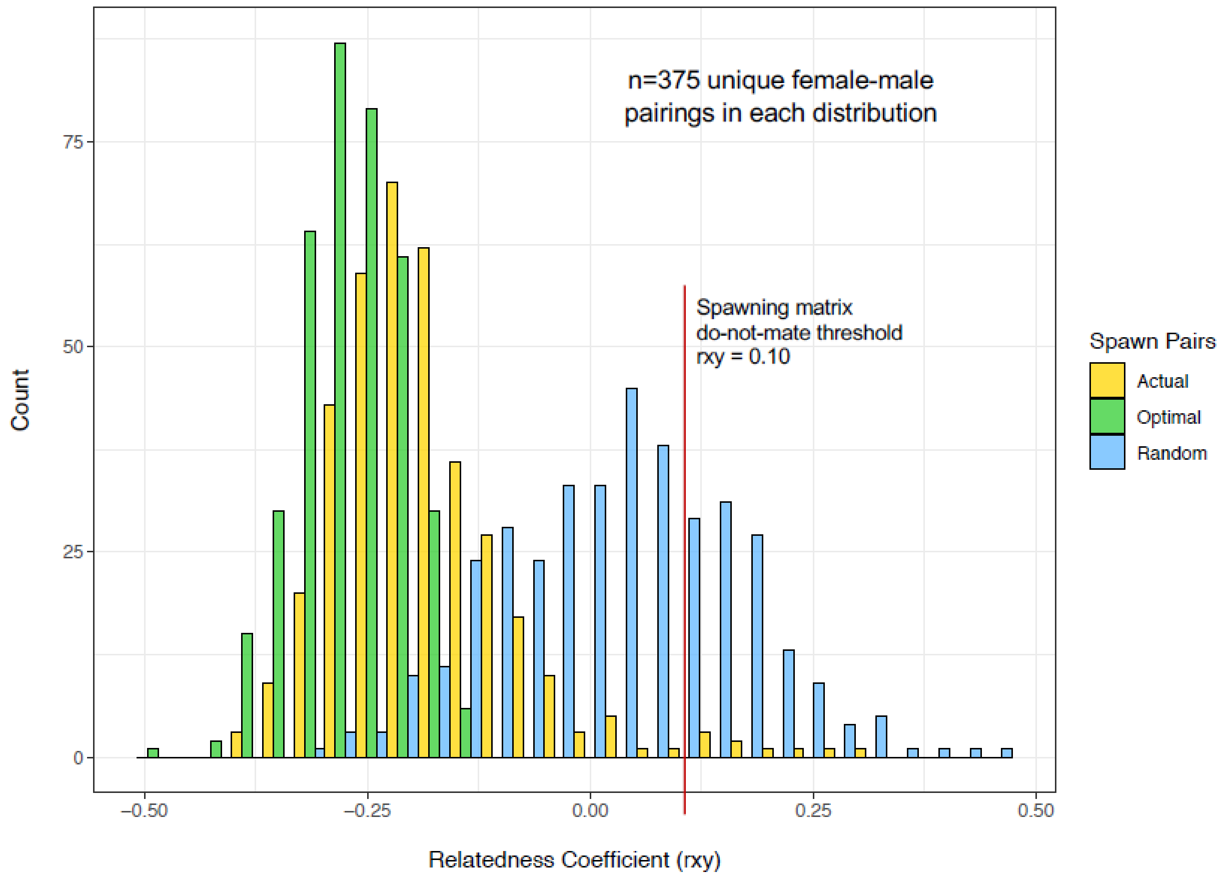

Figure 10. Distributions of the relatedness coefficient for three categories of spawn pairs: actual (fish spawned at KFH); optimal (top mate choices in the spawning matrix); and random (mates chosen using a random number generator), for the 2019–2020 spawn season. Vertical orange bar denotes the do-not-mate (r_{xy} > 0.1, currently 0.125) threshold in the spawning matrix.

8.4) Cryopreserved gametes

This element of the captive broodstock program was discontinued due to a lack of viable sperm from cryopreserved samples. There are no plans to reinitiate gamete preservation.

8.5) Risk aversion measures applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme

All Coho Salmon spawned in support of the program are genotyped using single nucleotide polymorphism (SNP) markers and assessed for relatedness prior to spawning. Fish are spawned to minimize relatedness of each pair. This approach minimizes potential inbreeding, which in turn serves to protect as much genetic variation as possible. This measure also allows for expression of a full range of phenotypic variation and plasticity and as much ecological function as remains in the population. Moreover, the entire window of spawn timing (as determined by the natural population) will be incorporated into the hatchery progeny to carry forth the acquired diversity of that brood year and to avoid artificially creating a divergence between the hatchery and natural populations (Figure 11).

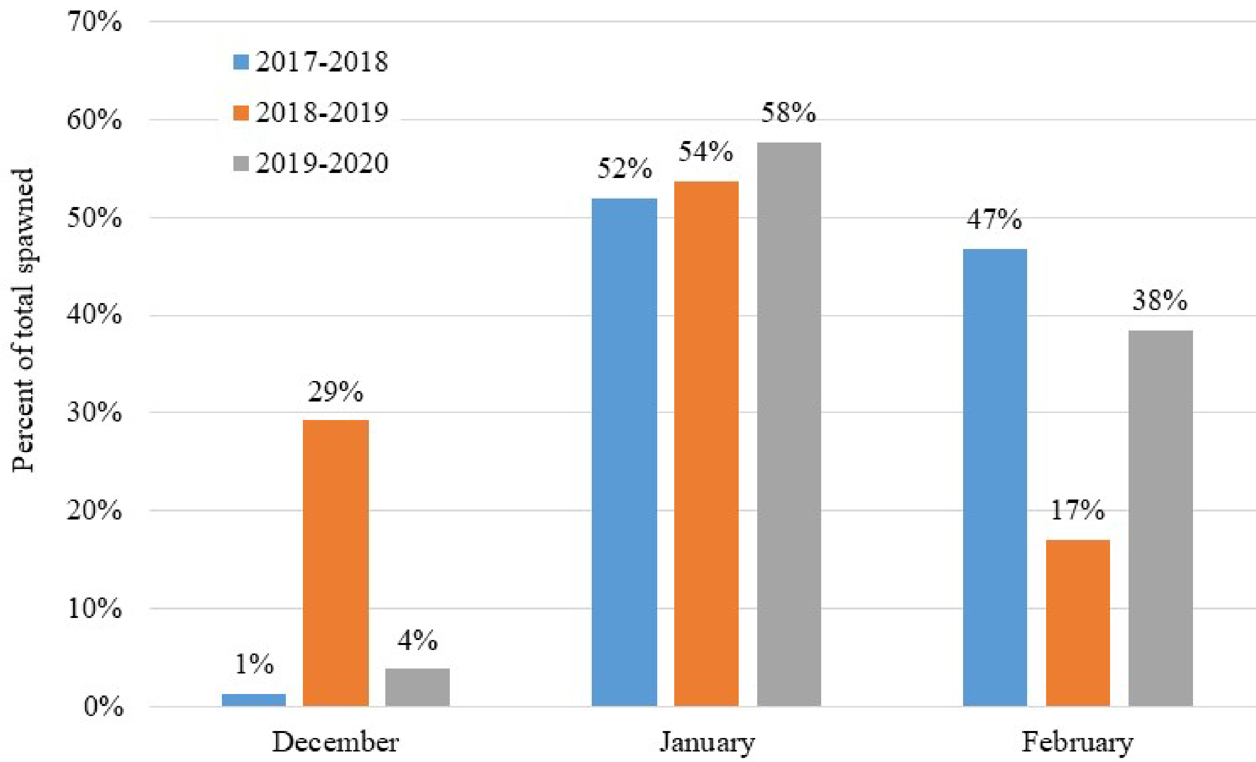

Figure 11. Percent of total captive broodstock spawning by month for winters 2017–2018 to 2019–2020.

SECTION 9. INCUBATION AND REARING

9.1) Incubation

9.1.1) Number of eggs taken and survival rates to eye-up and ponding

Egg take for both NOR and HOR adults combined will not exceed 300,000. The number of NOR eggs taken for broodstock will not exceed 150,000 in any phase of the program.

Since the 2004–2005 brood year, total egg take has ranged from 7,073 (2007–2008) to 201,614 (2019–2020) with fecundity averaging approximately 1,870 eggs per female (Table 25 and Figure 12). The program has seen an increasing trend in Coho Salmon fecundity since 2004–2005 due to improvements in husbandry and culture practices. The number of fertilized eggs has ranged from 5,888 (2007–2008) to 172,459 (2019–2020), and the number of eyed-eggs has ranged from a low of 2,301 (2008–2009) to 108,135 (2019–2020). Egg survival from the green to eyed stage has ranged from 13.1% (2005–2006) to 70% (2012–2013), with an average of 48% since 2004–2005.

Table 25. Summary of females spawned, number of eggs harvested, average fecundity, green and eyed eggs, fry ponded, and their survival rates for brood years 2004–2005 to 2019–2020.

Brood Year	Females	Eggs Harvested†	Mean Fecundity (eggs/female)	Green eggs Fertilized	Eyed-eggs	Green to eyed-egg survival (%)	Fry Ponded	Eyed-eggs to fry ponded (%)
2004-2005	32	62,978	1,968	59,435	39,482	66	27,162	68.8
2005-2006	16	ND	ND	21,654	5,006	23	2,223	44.4
2006-2007	18	30,737	1,708	28,229	8,441	30	3,540	41.9
2007-2008	20	28,303	1,415	27,508	5,600	20	2,680	47.9
2008-2009	6	7,073	1,179	5,888	2,301	39	1,776	77.2
2009-2010	11	13,276	1,207	10,843	ND	ND	660	ND
2010-2011	6	13,107	2,185	11,371	ND	ND	4,304	ND
2011-2012	79	127,272	1,611	122,028	73,246	60	45,510	62.1
2012-2013	45	102,693	2,282	87,756	61,441	70	48,851	79.5
2013-2014	47	83,969	1,787	76,458	44,255	58	21,471	48.5
2014-2015	44	89,541	2,035	70,702	40,776	58	23,991	58.8
2015-2016	50	120,468	2,409	91,123	38,302	42	13,437	35.1
2016-2017	69	175,476	2,543	153,902	53,295	35	35,867	67.3
2017-2018	77	173,470	2,253	155,010	84,911	55	49,197	57.9
2018-2019	83	150,137	1,808	126,985	71,458	56	53,693	75.1
2019-2020	104	201,614	1,938	172,459	108,135	63	70,706	65.4
Average	44	92,008	1,852	76,334	45,475	48	25,317	59.3

†Number of eggs taken includes all eggs harvested, including non-viable eggs.
ND = Data not available or unreliable.

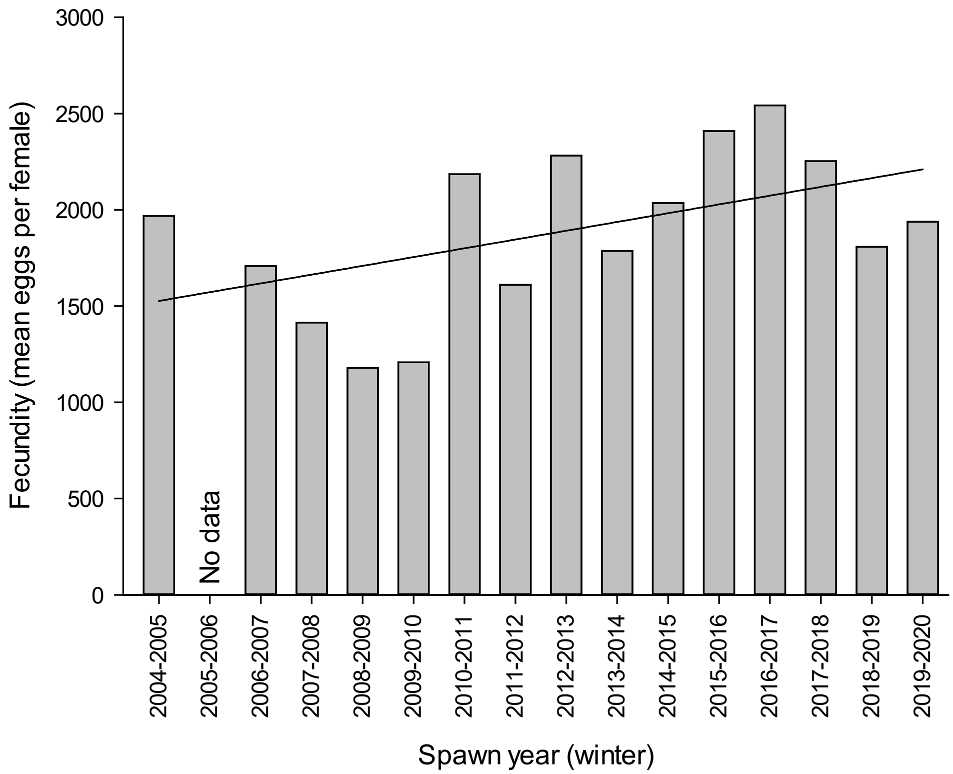

Figure 12. Mean number of eggs per Coho Salmon female (fecundity) during spawn winters 2004–2005 through 2019–2020.

The percentage of fertizlied eggs from all eggs collected per brood year is provided in Figure 13. Since winter 2004–2005, this percentage has average 86.5%. There has been a decreasing trend in this metric as the program has (1) relied more on captive brood, rather than NOR and HOR adult returns for eggs, and (2) experienced fungal outbreaks between 2014 and 2016. The program sees potential to achieve an egg to green egg survival rate of 95% as culture practices improve and more NOR and HOR adult Coho Salmon are incoporated into broodstock.

Green egg to eyed-egg survival rates, by brood year, are shown in Figure 14. Survival rates for this performance metric have ranged from 20% to 70% and averaged 46.5%. The survival rate has been improving over time but is still less than its performance target of 95%.

9.1.2) Cause for and disposition of surplus egg takes

Owing to inter-annual variability in female fecundity, the number of eggs taken each year could exceed program needs. Any surplus eggs will be released to SCMDS streams as eyed-eggs or fry. These egg and fry releases will be prioritized to Pescadero Creek, Group 2, and Group 3 streams, as these streams do not have sustainable runs of Coho Salmon that may be impacted by the releases.

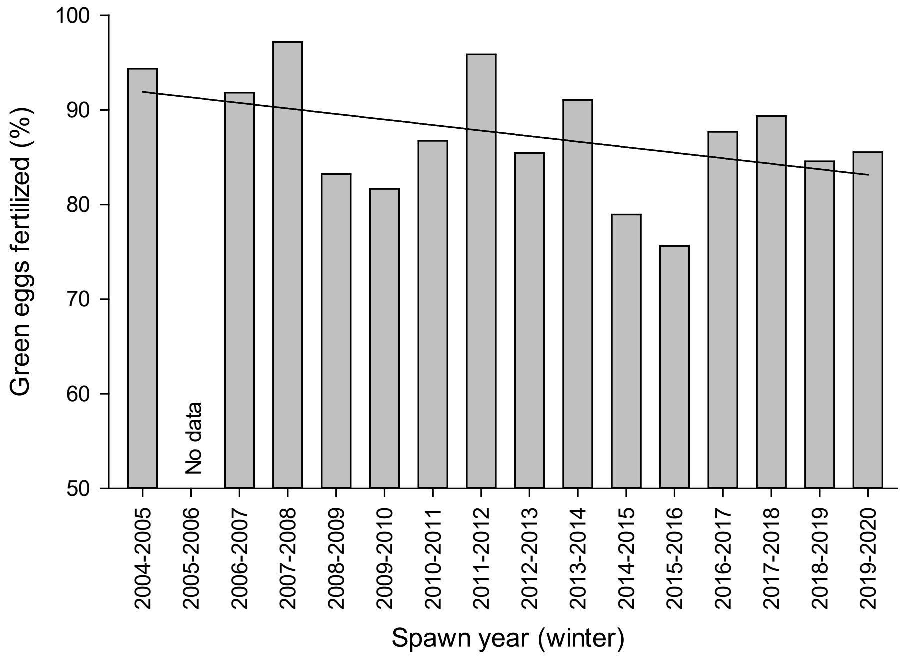

Figure 13. Percentage of green eggs fertilized from total eggs collected for spawn years 2004–2005 to 2019–2020.

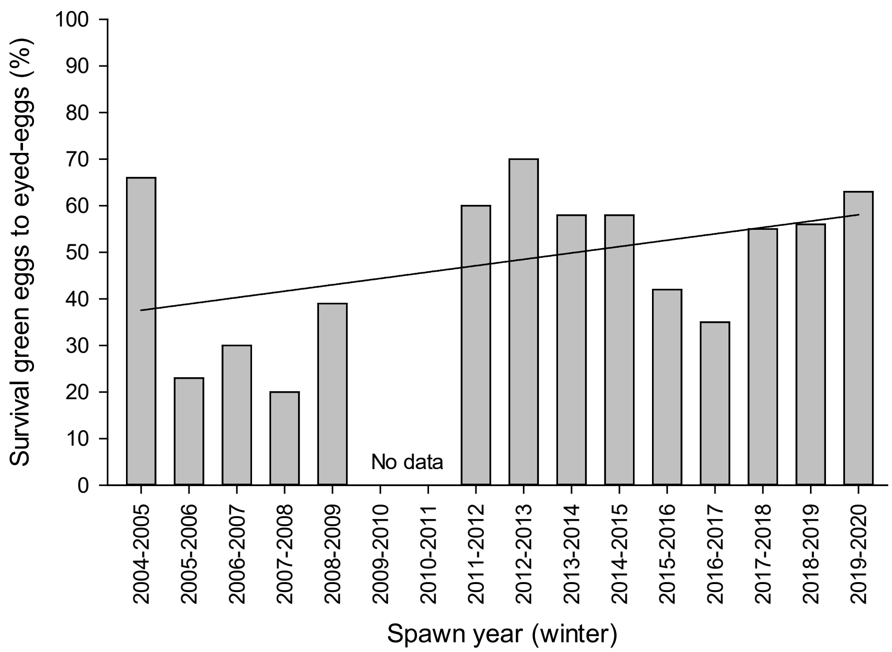

Figure 14. Percentage survival from fertilized green eggs to eyed-eggs for spawn years 2004–2005 to 2019–2020.

9.1.3) Loading densities applied during incubation

Loading densities in the MAI typically do not exceed 1,500 per tray. Once eggs reach the eyed-egg stage they are transferred to vertical Heath tray incubators where they remain resting in a single layer along the bottom of the tray until the swim-up stage. Normal loading densities are between 2,000 and 3,000 eggs per Heath tray and trays are never loaded with more than 3,500 eggs per tray insert. Each individual Heath tray generally contains the egg lot of a single female that has been subdivided into egg sublots (corresponding to different males used during fertilization). These egg sublots are physically separated during incubation by Plexiglas inserts that divide tray compartments into sections of two, three, or four, as necessary based on the number of males used in fertilization. In the case of an exceptionally fecund female, two egg trays are utilized to avoid eggs resting in multiple layers.

9.1.4) Incubation conditions

A MAI and vertical incubation stacks are used to rear fertilized eggs to the swim-up stage, whereupon they are transferred to indoor rearing troughs. The MAI supplies filtered and UV sterilized water, distributed as a fine mist over the eggs at a rate of 0.35–0.7 L/sec. Temperature in the MAI is maintained at a constant 11°C.

Although water conveyed from the Berry Creek supply is screened and filtered before reaching the hatchery, some suspended material (< 30 µm) from the creek is unavoidably delivered to the vertical incubator stacks. To mitigate the effects of this suspended material on development, the uppermost tray in each stack is left without eggs, serving as a final settling basin to capture finer debris before reaching eggs. Each individual egg tray is also equipped with a debris removal rod which can be used to remove settleable materials without disturbing the eggs. Water flow through the trays is 0.2–0.3 L/sec and water temperature is maintained below 11°C using inline chillers. Minimum dissolved oxygen concentration in the incubation stacks remains between 9.0 and 10.0 mg/L for both influent and effluent. A portable water quality meter is used daily to measure dissolved oxygen and to confirm water temperature readings obtained from the analog gauge.

When eggs hatch and reach the swim-up stage (fry) they are transferred to indoor rearing troughs. Environmental parameters that are monitored and recorded daily during incubation include flow, temperature, dissolved oxygen, and sediment load.

9.1.5) Ponding

All development during the incubation phase is tracked via standard daily thermal unit (DTU) accumulation. When cumulative DTU's approach 1,200 for any Coho Salmon fry group, a sample of fry is visually examined to evaluate yolk sac absorption levels. Emergent fry are ponded when yolk sac absorption in a subsample (5–10%) of fry ≥ 95%, typically at around 1,275 DTU's. Ponding of emergent Coho Salmon fry typically begins in early March and ceases by early May. Average size of fry at ponding is 3,225 fish/kg (mean FL = 34 mm, and mean mass = 0.31 g/fish).

The performance target for eyed-egg to ponding survival is 95%. Between spawn year 2004–2005 and 2019–2020, survival rates for this metric have ranged from 35 to 80% and averaged approximately 59% (Table 25 and Figure 15). While eyed-egg to fry ponding survival rates have generally increased over time, the program has never achieved the 95% performance target.

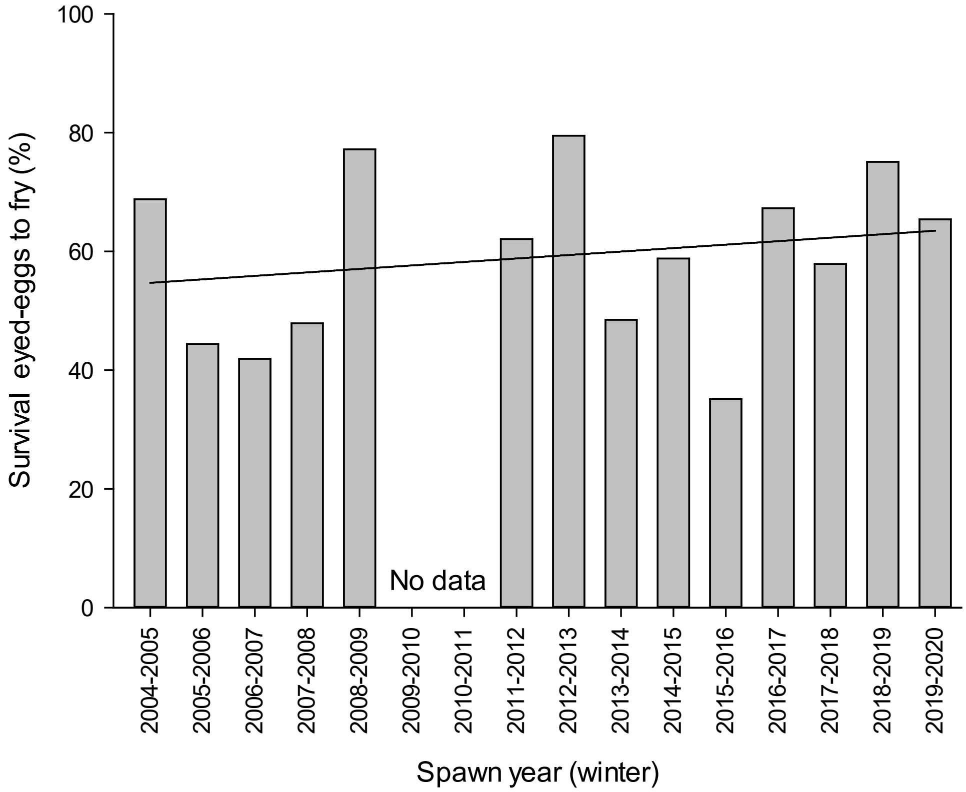

Figure 15. Percentage survival from eyed-eggs to fry ponded for spawn year 2004–2005 to 2019–2020. Data not available for winters 2009–2010 or 2010–2011.

9.1.6) Fish health maintenance and monitoring

Aquatic fungi that may infect eggs are controlled using UV sterilization. Eggs are inspected daily and all dead eggs encountered are removed from the trays. Moreover, deformed alevins are removed during inspections when this can be accomplished without causing undue stress or potential injury to healthy fish.

9.1.7) Risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation

Risk aversion measures include:

- Use of moist air incubation
- Family group (egg sublot) segregation
- UV sterilization and sediment filtration

Eggs are incubated in well-oxygenated water at a temperature (11°C) known to result in high survival rates. A high survival rate for all eggs ensures that a survival advantage does not occur for any family nor shift survival between fish spawned earlier or later in the run.

9.2) Rearing

The historical number of fry, parr and smolts produced and released by the program is shown in Table 26 and also detailed in section 10. These numbers are expected to nearly triple when/if program production can be increased to 70,000 smolts.

9.2.1) Survival rate data by hatchery life stage

Survival rates for fry to parr, parr to smolt, and fry to smolt are shown in Table 26 and have averaged 88.3%, 78.4%, and 69.1% respectively since winter 2004–2005.

Table 26. Early life-stage survival rates for the Southern Coho Salmon Captive Broodstock Program through the 2018–2019 spawn year.

Spawn year (winter)	No. fry ponded	No. fry released	No. parr	No. parr released	Fry to parr survival (%)[†]	No. smolts	Parr to smolt survival (%)[†]	Fry to smolt survival (%)[†]
2004–2005	27,162	0	ND	0	---	25,917	ND	ND
2005–2006	2,223	0	2,174	0	97.8	ND	ND	ND
2006–2007	3,540	0	3,444	0	97.3	3,141	91.2	88.7
2007–2008	2,680	0	2,649	0	98.8	1,874	70.7	69.9
2008–2009	1,776	0	1,717	0	96.7	600	34.9	33.8
2009–2010	660	0	260	0	39.4	300	ND	45.5
2010–2011	4,304	0	2,265	0	52.6	2,000	88.3	46.5
2011–2012	45,510	4,000	38,305	0	92.3	31,857	83.2	76.7
2012–2013	48,851	6,000	41,094	0	95.9	28,679	69.8	66.9
2013–2014	21,471	2,016	15,683	0	80.6	14,602	93.1	75.1
2014–2015	23,991	0	23,081	0	96.2	20,104	87.1	83.8
2015–2016	13,437	0	12,524	0	93.2	11,346	90.6	84.4
2016–2017	35,867	0	35,583	4,353	99.2	27,812	89.1	88.3
2017–2018	49,197	12,203	36,835	4,164	99.6	24,495	75.0	74.6
2018–2019	53,693	0	51,800	15,273	96.5	24,561	67.2	63.9
Average	22,291	---	19,101	---	88.3	15,521	78.4	69.1

Note: ND = data not available or unreliable.
[†] Rates of survival are corrected to account for release(s) of fish at various juvenile life stages.

9.2.2) Density and loading levels (actual levels and targets)

Mean egg to smolt (yearling) survival rate between 2004–2005 and 2019–2020 has been 18.2%, and rates have been highly variable ranging from 2.8% to 43.6% annually (Figure 16). These survival rates are significantly below the 75% performance metric established for the program with the implementation of this HGMP. Survival rates for this metric are expected to increase as the program shifts from the use of captive brood to meet egg take goals to NOR and HOR adult Coho Salmon returns.

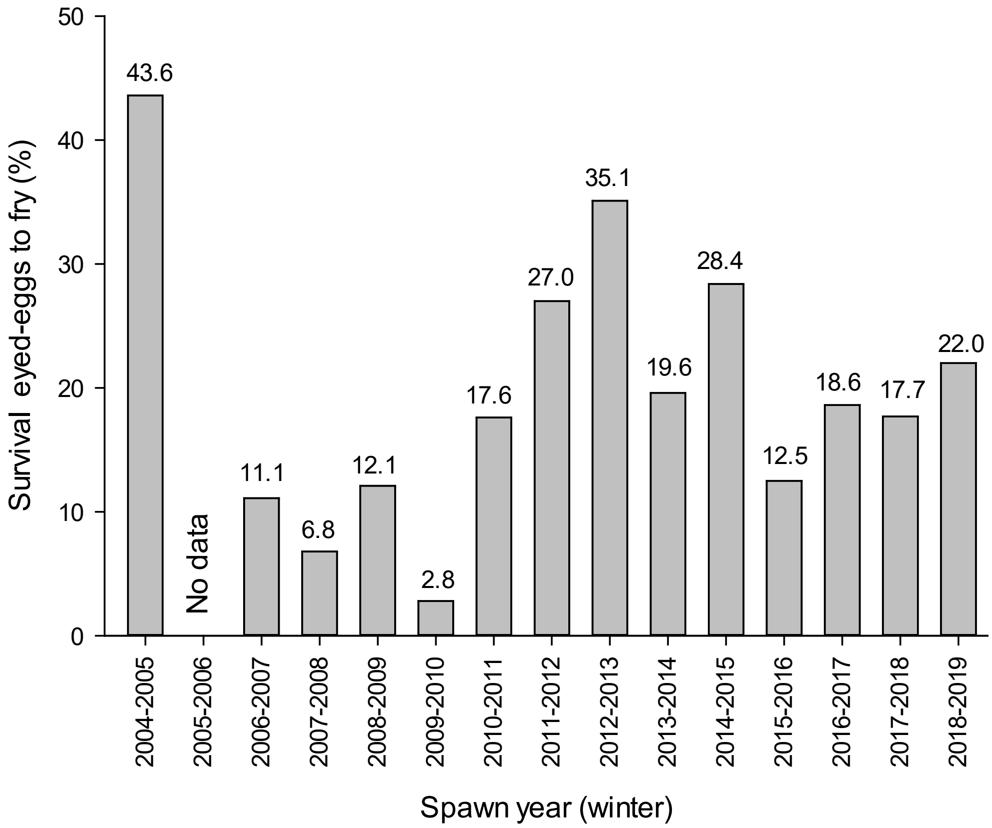

Figure 16. Egg to smolt survival rate for spawn years 2004–2005 to 2019–2020. Rates of survival are corrected to account for release(s) of fish at various juvenile life stages.

Captive Broodstock

Kingfisher Flat Hatchery. – The desired initial juvenile Coho Salmon loading density at KFH is 0.4 kg/m^3, based on a mean mass of 40 g and 120 fish per tank. When fully mature, the density target is 7.0 kg/m^3, based on a mean mass of 3.0 kg and a density of 100 fish per tank.

Fisheries Ecology Division. – The target initial juvenile Coho Salmon loading density is 0.3 kg/m^3, based on a mean fish mass of 150 g and 40 fish per tank. When fully mature, the loading target is 4.6 kg/m^3, based on a mean mass of 2.5 kg and 35 fish per tank.

Don Clausen Fish Hatchery. – The desired initial juvenile Coho Salmon loading density at DCFH is 0.6 kg/m^3, based on a mean mass of 150 g and 180 fish per tank. When fully mature, the density target is 10.0 kg/m^3, based on 120 fish per tank with a mean mass of 3.5 kg per fish.

Production Fish

Fish density and loading levels are based on fish size and follow the United States Fish and Wildlife Service (USFWS) hatchery management guidelines (Piper et al. 1982).

9.2.3) Fish rearing conditions

The program rears juvenile Coho Salmon for use as captive brood and for production releases to SCMDS recovery streams. The following sections provide a description of rearing conditions at each facility.

Captive Broodstock

Kingfisher Flat Hatchery. – Rearing conditions for captive brood fish maintained at KFH vary depending on fish size and life stage. From the swim-up stage until fish obtain a mass of approximately 5 g, they are reared in 4.90 m × 0.30 m × 0.20 m shallow troughs (294 L). The inflow rate of single-pass water is held at approximately 0.6 L/sec. Thermal condition are dictated by the natural water temperature regime of the source water (Big Creek), but temperatures rarely exceed 15°C. When fish reach a mean mass of ≥ 3.0 g they are moved to one of three 0.80 m diameter × 0.80 m deep circular tanks (402 L) with a flow rate of 0.2–0.6 L/sec., where they rear to the pre-yearling/yearling stage (age-1). From age-1 to maturity they are reared in large tanks (6.1 m diameter × 1.2 m deep; 35,630 L) at flows of 1.0–6.3 L/sec, depending on water flow budgeting. For all rearing tanks at KFH, year-round dissolved oxygen saturation levels are ≥ 90% and supported by supplemental aeration. Use of single-pass water minimizes the buildup of ammonia and nitrogenous waste. Routine removal of organic waste and debris eliminates the risk of hydrogen sulfide gas. Because ambient daylight is the only lighting source used at the facility, fish are exposed to a natural photoperiod.

Fisheries Ecology Division. – Captive brood fish are reared in 3.7 m diameter tanks containing 19,000 L of seawater. Water depth is maintained at ~1.5 m. Each tank has a central drain and provides circular water flow at a maximum rate of 3.0 L/sec. Water temperatures are monitored daily. Ambient water temperatures are used unless the temperature exceeds 14°C, whereupon supplemental cooling is used. The temperature range of supply water to FED is 10 to 19°C, based on temperature records from 2002–2019. The chiller unit at FED can reduce the temperature of supply water by up to 5°C if necessary. Dissolved oxygen concentrations are continuously monitored and maintained above 8.0 mg/L using supplemental aeration delivered through submerged air stones. Oxygen saturation of supply water ranges from 90 to 100%. Salinity in the seawater tanks is monitored daily and ranges from 30 to 34 ppt. Ammonia concentrations are not monitored as all tanks are flow-through with water turnover rates ≥ 10× per day. Fish are maintained under ambient photoperiod and reduced light intensity.

Don Clausen Fish Hatchery. – Water temperature data loggers programmed to record water temperature every hour are maintained in each rearing tank. Water temperature generally ranges from 10–14°C throughout the year. Dissolved oxygen (DO), pH, turbidity, salinity, and suspended and settleable solids are recorded on a bi-weekly schedule. Influent and effluent DO are analyzed bi-weekly via Winkler Titration and are checked as needed at other times with a DO meter. DO levels fluctuate between 9–11 mg/L, and pH ranges from 6.5–7.5.

The flow rate for each tank is adjusted depending on fish life stage and rearing density, with younger fish receiving lower flow rates than older fish. The flow rate for the starter tanks is typically maintained at approximately 1.6 L/sec, while the flow rate in the larger circular tanks is maintained at a minimum of 6.3 L/sec. Flow meters are used to monitor rates in the large circular tanks, whereas flow rates for the starter tanks are determined manually.

Production Fish

Kingfisher Flat Hatchery. – Water temperatures and dissolved oxygen concentrations are measured at least once per day Monday through Friday; other water quality parameters (ammonia, nitrate, and nitrite) are measured weekly to monthly. Supplemental aeration devices are deployed and operated to ensure dissolved oxygen remains at 90–100% saturation. Flow rate of 3.2–6.3 L/sec, depending on available surface-source water and water budgeting.

9.2.4) Fish growth information (*average program performance*), including length, weight, and condition factor data collected during rearing

Growth rates for the production fish across multiple life stages at all three facilities is shown in Table 27. Sampling and monitoring of early life stages (from swim-up fry to yearling) occurs twice monthly. Sampling is accomplished via grab samples and captured fish are weighed in bulk and counted to determine mean mass. Once captive brood reach the yearling (pre-smolt/smolt) stage, they are issued 12 mm PIT tags and the 15-digit PIT tag number serves as a unique identifier. Growth is subsequently quantified for each broodstock individual on a quarterly basis.

Table 27. Mean daily change (Δ) in fork length (FL, millimeters per day) and mass (grams per day) of SCMDS broodstock Coho Salmon at each rearing facility by brood year.

Brood year (BY)	Rearing facility	Mean growth period (days)	Δ FL (mm/day)			Δ Mass (g/day)		
			Mean	Range		Mean	Range	
BY1011	DCFH	551	0.59	0.14	1.07	3.48	0.17	7.77
	FED	511	0.51	0.34	0.91	2.61	0.99	6.19
	KFH	493	0.53	0.20	0.94	2.55	0.17	6.49
BY1112	DCFH	558	0.59	0.17	0.80	3.07	0.70	6.07
	FED	534	0.41	0.12	0.62	1.52	0.33	3.30
	KFH	520	0.50	0.10	0.71	2.35	0.18	4.48
BY1213	DCFH	593	0.57	0.27	0.84	3.55	0.76	7.46
	FED	597	0.40	0.20	0.56	1.47	0.35	3.07
	KFH	594	0.49	0.10	0.77	2.66	0.23	6.24
BY1314	DCFH	613	0.57	0.21	0.87	3.48	0.44	7.25
	FED	639	0.34	0.16	0.55	1.09	0.67	1.89
	KFH	595	0.38	0.09	0.50	1.57	0.40	2.29
BY1415	DCFH	540	0.52	0.21	1.57	2.58	0.37	5.49
	FED	575	0.36	0.09	0.56	1.25	0.10	2.82
	KFH	589	0.58	0.19	1.39	3.08	0.26	4.96

Source: NMFS SWFSC FED

9.2.5) Monthly fish growth rate and energy reserve data (*average program performance*), if available

Mean daily growth rates for captive brood fish are presented as changes in fork length (mm/day) and mass (g/day) in Table 27. Target fish weight by month for production Coho Salmon is presented in Table 28.

Table 28. Target monthly weight (fish/lb.) for Kingfisher Flat Hatchery production Coho Salmon (Brood Year 2019)

Month	Weight Count (fish/lb.)	Month	Weight Count (fish/lb.)
March	867	October	62
April	601	November	42
May	412	December	33
June	304	January	26
July	167	February	21
August	121	March	17
September	76		

Source: MBSTP

9.2.6) Food type used, daily application schedule, feeding rate range, and estimates of total food conversion efficiency during rearing

Captive Broodstock

Captive broodstock at all three rearing facilities are fed commercial dry pellets (BioOregon/Skretting Feed Company) designed for Pacific salmonids (*Oncorhynchus* spp.), at varying sizes corresponding with the mean size of the fish. Pellets are composed primarily of ground fish meal and fish oils. For larger captive Coho Salmon brood fish, typically after age-1, frozen, unblanched krill top coated with cod liver oil and vitamin powders becomes the bulk of their diet, supplemented with pellets. Captive brood Coho Salmon are fed at an average of 3–4% of total tank biomass per day. Following each inventory and measurement event (bimonthly for age-0 fish, 3-month intervals after age-1) feed amounts are adjusted to account for growth. The pellet food is provided seven days a week to sub-yearling captive brood Coho Salmon via belt feeders, whereas krill is hand fed to brood fish beyond age-1 at least five days a week. Maturing captive brood Coho Salmon age-2^{+} are gradually tapered off all feed during November to encourage gonadal development.

Production Fish

Production fish are fed commercially available salmon pellets appropriate for the size of the fish. They are fed at rates that range from 3 to 6% of the total tank biomass per day depending on the size of the fish and the desired growth rate.

9.2.7) Fish health monitoring, disease treatment and sanitation procedures

For disease prevention, each tank and its associated equipment are isolated from the others (i.e., each tank has its own feeder, cleaning equipment, water supply, and air supply). Tanks are thoroughly cleaned at least once a week at KFH (more frequently if needed), and at least twice per week at the FED and DCFH facilities. During cleaning all fish are carefully observed for signs of disease and (or) abnormal behavior. Fish are also observed during hand feedings and quarterly inventory (i.e., weighing and measuring) events. In the event that a disease is diagnosed and chemotherapeutics are prescribed by CDFW fish health center personnel, the treatment is applied to the entire cohort. Additionally, the mortality of any captive brood fish age-1 or older is followed by an on-site necropsy and (or) the fish is delivered to FED for evaluation by pathologists.

9.2.8) Smolt development indices (e.g., gill ATPase activity), if applicable

Indices of smoltification are not utilized by the program. All smolts are released into riverine environments and are presumed to undergo smoltification in response to the natural photoperiod and other environmental cues during freshwater rearing and emigration. There is no evidence from monitoring data to indicate that significant numbers of program fish residualize and remain in freshwater past the expected March to June smolt outmigration window.

9.2.9) Indicate the use of "natural" rearing methods as applied in the program

The use of “natural” rearing methods at KFH and DCFH are limited to water source (temperature regimes and water chemistry profiles), photoperiod, and the feeding of krill to captive brood adults. Local seawater is used for rearing at the FED facility and laboratory lighting is mechanically timed to mimic the natural photoperiod. Fish rearing in outdoor vessels only receive ambient daylight, no artificial lighting is provided.

9.2.10) Risk aversion measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation

Coho Salmon captive brood and production fish are all raised under similar environmental conditions and feed regimes to ensure equal survival of the production of each brood year.

SECTION 10. RELEASE

10.1) Proposed fish release levels

The goal of the program is to release up to: (1) 100,000 eyed-eggs or fry; (2) 70,000 parr, advanced parr, or smolts; and/or (3) up to 240[12] adult captive brood origin Coho Salmon annually into recovery watersheds within the SCMDS. Thus, the total number of eggs, fry and juveniles that may be released in a single year is 170,000.

The maximum number Coho Salmon (by life stage) that may be released to each stream is provided in Table 29. Except for Scott Creek, the release numbers by life stage are designed to not produce more adult returns than the adult downlisting criteria for each stream (Table 30). This approach is expected to reduce negative density-dependent effects on natural-origin Coho Salmon present in the receiving streams.

Smolt releases to Scott Creek are expected to produce more adults than the adult downlisting criterion but the majority will be removed at a weir (or by other capture methods) for use as broodstock.

10.2) Specific locations of proposed releases

The streams where program Coho Salmon may be released is summarized in Table 29. Streams categorized as Group 1 are prioritized for hatchery Coho Salmon supplementation over Group 2 and Group 3 streams.

Because of genetic concerns associated with releasing both production fish and captive brood to the same streams, some captive brood adults may be released to Group 1, Group 2 or Group 3 streams if recommended by the TOC and approved by NMFS and CDFW.

The goal of the hatchery releases outlined in this HGMP is to achieve the adult downlisting criteria for Scott Creek (255), Waddell Creek (157) and San Vicente Creek (53)—a total of 465 returning adult fish (Table 30). As natural production increases in these streams over time, it is expected that the adult downlisting criteria will be met with natural Coho Salmon production and hatchery releases shifted to Group 2 and Group 3 streams.

10.3) Numbers and sizes of fish released by age class through the program

In support of Coho Salmon recovery, fry (Table 31), advanced parr (Table 31), smolts (Table 32), and adults (Table 33) from the SCSCBP have been released to SCMDS streams during the last decade. Most fish have been released as smolts, and this life stage has been released nearly every year since 2003 (except for 2004 and 2005). Fry, advanced parr, and adult releases began in 2012, 2017, and 2011, respectively.

[12] The release of 240 adult captive broodstock is the target when in-hatchery survival rates identified in the HGMP are achieved. If survival rates are lower, the program will have up to 380 adults for release.

Table 29. Coho Salmon release location and maximum number that may be released by life stage. Adult captive broodstock numbers based on achieving in-hatchery survival rates per life stage.

Stream Priority Group	Broodstock Source and Juvenile Release Priority	Stream	Maximum Release Number by Life Stage					
			Eggs	Fry	Parr	Advanced Parr	Smolts	Captive Brood
1	1	Scott Creek	100,000	100,000	70,000	35,000	35,000 to 70,000	240
	2	Waddell Creek	100,000	100,000	70,000	29,600	11,822	157
	3	San Vicente Creek	100,000	79,819	53,213	9,977	3,991	53
	4	Pescadero Creek	100,000	100,000	70,000	35,000	35,000	240
2	5	Gazos Creek	100,000	100,000	70,000	26,355	10,542	140
	6	San Lorenzo River	100,000	100,000	70,000	35,000	35,000	240
	7	San Gregorio Creek	100,000	100,000	70,000	35,000	35,000	240
3	8	Soquel Creek	100,000	100,000	70,000	35,000	35,000	240
	9	Aptos Creek	100,000	100,000	70,000	35,000	35,000	240

10.4) Actual dates of release and description of release protocols

Captive Brood (Adults). – Broodstock adults may be released between 1 December and 1 April each year. Adults selected for release will be netted from holding tanks at KFH, placed in trucks, and transported to streamside release sites. Fish will be released into the stream using water to water transfer protocols whenever possible. If this is not possible, then adult Coho Salmon may be netted from the transport truck, placed into a portable container and then delivered to the stream for release. Staff will record location and tag numbers prior to release and report them to the TOC once complete. Highly related adults will not be released to the same stream.

Eyed-Eggs. – Eyed-eggs may be planted in the stream or in remote stream incubators (RSI's) from January to March. Eggs will be transported in insulated ice chests.

Fry. – Fry are released (scatter planted) from March to May. They will be transported in aerated and insulated ice chests.

Table 30. Expected adult Coho Salmon production from the release of eyed-eggs, fry, parr, advanced parr, smolts, and captive broodstock.

Stream Priority Group	Broodstock Source and Juvenile Release Priority	Stream	Population Status	Naturally Produced Coho Salmon Present	Adult Abundance Downlisting Criteria	Expected Adult Production by Life Stage*					
						Eyed-Eggs	Fry	Parr	Advanced Parr	Smolts	Captive Brood
1	1	Scott Creek	Dependent	Yes	255	33	66	70	186	465–930	240
	2	Waddell Creek	Dependent	Yes	157	33	66	70	157	157	157
	3	San Vicente Creek	Dependent	Yes	53	33	53	53	53	53	53
	4	Pescadero Creek	Independent	No	1,150	33	66	70	372	465	240
2	5	Gazos Creek	Dependent	No	140	33	66	70	140	140	140
	6	San Lorenzo River	Independent	No	1,900	33	66	70	186	465	240
	7	San Gregorio Creek	Dependent	No	682	33	66	70	186	465	240
3	8	Soquel Creek	Dependent	No	561	33	66	70	186	465	240
	9	Aptos Creek	Dependent	No	466	33	66	70	186	465	240

*Survival rate from release to adult production for eyed-eggs, fry, parr, advanced parr and captive brood was set at 0.03%, 0.07%, 0.10%, 0.53%, 1.33% and 100%, respectively.

Table 31. Releases of fry and advanced parr life stages from the program into regional streams, release years 2012–2020.

Brood year (BY)	Release year	No. fry released	No. advanced parr released (fall)	Release watershed(s)
BY1112	2012	4,000		San Vicente Creek
BY1213	2013	6,000		San Vicente Creek
BY1314	2014	2,016		San Vicente Creek
BY1415	2015			---
BY1516	2016			---
BY1617	2017		4,353	Scott Creek
BY1718	2018	8,203		Gazos Creek
BY1718	2018	4,000		San Vicente Creek
BY1718	2018		4,164	Waddell Creek
BY1819	2019		10,303	Scott Creek
BY1819	2019		4,790	Waddell Creek
BY1920	2020		9,833	Pescadero Creek

Note: No fry or parr were released prior to 2012. Source: NMFS Southwest Fisheries Science Center.

Parr and Advanced Parr. – Parr and advanced parr may be released from May through September, and from October to December, respectively. Nets or fish pumps will be used to transfer fish from their rearing vessels to transport trucks for delivery to the release location. The water in the transfer truck is aerated with oxygen and mechanical water lifts. At the release sites, fish will either be released directly from the truck to the stream or netted from the truck tank into 18.9 L buckets and hand carried to release sites where the buckets will be submerged into the water to allow fish to swim out on their own.

Smolts. – Coho Salmon smolts will be released between March and June each year. Transport protocols are the same as for parr and advanced parr.

10.5) Fish transportation procedures

Adults and juveniles (smolts, advanced parr, parr) are transported to stream release sites in an insulated 1,500 L transfer truck designed specifically for fish transport. The transfer truck is equipped with an effective integrated aeration system that has been used to successfully transport juvenile and adult Coho Salmon and steelhead for many years. Release sites are generally located within 32 km of the rearing facilities. Transfer tank water temperature is ambient stream temperature, as the transfer tank is filled with water taken directly from the hatchery water supply which comes directly from the stream.

Eyed-eggs and fry are transported in ice chests using smaller vehicles or attached to the 1,500 L transfer truck when convenient.

Table 32. Spring releases of Coho Salmon smolts from the program into regional streams, 2003–2020.

Brood year (BY)	Release year	No. smolts released	Mean mass (g)	Mean FL (± SD, mm)	Release watershed(s)
BY0102	2003	6,120	44.5	162 ± 32	Waddell Creek
		6,120	44.5		Scott Creek
		7,140	44.5		Aptos Creek
		11,475	44.5		Pescadero Creek
BY0203	2004	0		---	---
BY0304	2005	0		---	---
BY0405	2006	12,643	69.8	171 ± 45	Pescadero Creek
		729	69.8		Scott Creek
		6,175	69.8		Waddell Creek
		6,370	69.8		Aptos Creek
BY0506	2007	2,279	52.7	157 ± 31	Scott Creek
BY0607	2008	3,141	58.2	162 ± 30	Scott Creek
BY0708	2009	1,874	30.6	132 ± 14	Scott Creek
BY0809	2010	711	60.5	134 ± 23	Scott Creek
BY0910	2011	300	28.3		San Vicente Creek
BY1011	2012	2,129	73.3	178 ± 35	Scott Creek
BY1112	2013	31,857	40.9	157 ± 46	Scott Creek
		497	40.1		San Vicente Creek
BY1213	2014	28,679		162 ± 18	Scott Creek
BY1314	2015	14,602		137 ± 13	Scott Creek
BY1415	2016	20,104		117 ± 9	Scott Creek
BY1516	2017	11,346		149 ± 12	Scott Creek
BY1617	2018	27,812		129 ± 15	Scott Creek
BY1718	2019	24,524		134 ± 11	Scott Creek
BY1819	2020	22,844		120 ± 8	Scott Creek

10.6) Acclimation procedures

Currently there are no acclimation facilities on any creek in the SCMDS and no plans to develop acclimation facilities in the future. All life stages are planted directly into the streams (or in remote site incubators [RSI's]) at locations where NMFS and CDFW staff believe survival will be high. Typically, adults are placed directly into receiving streams near or above known spawning areas, smolts are released near the mouth of streams to reduce interactions with NOR Coho Salmon. Juvenile life stages and fry are also placed in habitat that is appropriate for their life stage and expected to result in high survival.

Table 33. Releases of adult captive broodstock fish from the program into regional streams, winters 2011–2012 through 2019–2020.

Brood year (BY)	Release winter (W)	Release date or range of dates	No. adults released			Release location (watershed)
			Male	Female	Total	
BY0809	W1112	29-Dec to 5-Mar	154	50	204	Scott Creek
		20-Jan to 21-Feb	15	12	27	San Vicente Creek
BY0910	W1213	27-Dec to 29-Jan	32	0	32	Scott Creek
		16-Jan to 29-Jan	10	10	20	San Vicente Creek
BY1011	W1314	13-Jan to 20-Feb	9	0	9	Scott Creek
		15-Jan	5	6	11	San Vicente Creek
BY1112	W1415	22-Dec to 29-Jan	29	40	69	Scott Creek
BY1213	W1516	27-Jan to 9-Mar	32	11	43	Scott Creek
		2-Mar to 9-Mar	13	20	33	San Vicente Creek
BY1314	W1617	31-Jan to 24-Mar	60	36	96	Scott Creek
	W1718	9-Mar	0	2	2	Scott Creek
BY1415	W1718	12-Jan to 20-Mar	21	21	42	Scott Creek
BY1516	W1718	9-Mar to 23-Mar	14	0	14	Scott Creek
BY1516	W1819	11-Jan to 31-Jan	3	9	12	Scott Creek
BY1617	W1819	25-Jan to 22-Feb	1	0	1	Scott Creek
BY1617	W1819	22-Feb	2	0	2	San Vicente Creek
BY1617	W1920	10-Jan to 6-Mar	29	35	64	Scott Creek

Notes: Released as sexually mature adults during the natural spawning season. Prior to winter 2011–2012 there were insufficient numbers of adults to be considered excess to the needs of the spawning program.

10.7) Marks applied, and proportions of the total hatchery population marked, to identify hatchery-origin adults

Captive Brood (Adults). – All program adults released to spawn in the wild are marked with an external dorsal tag (Petersen Disc or Floy T-Bar) that contains a unique number and is color coded for sex and rearing facility. Additionally, all program adults contain a PIT tag that can be used to identify individual live fish and carcasses.

Eyed-Eggs. – Tissue samples for genetic analysis are collected from all Coho Salmon spawned in the program. Eggs from these adults that are planted in SCMDS streams can be identified when recaptured at later life stages using genetic parentage analyses.

Fry. – All Coho Salmon fry will be tagged with half-length coded-wire tags (CWT), if feasible, prior to release. Fry will not be adipose fin-clipped. All CWT data are uploaded to the Regional

Mark Information System database maintained by the Pacific States Marine Fisheries Commission Many of these fish will subsequently receive a 12 mm PIT tag upon (re)capture during field surveys and monitoring.

Juveniles. – All program smolts, parr, and advanced parr will be tagged with CWTs prior to release. Juveniles will not be adipose fin-clipped. All CWT data are uploaded to the Regional Mark Information System database maintained by the Pacific States Marine Fisheries Commission. Moreover, each year a varying fraction (target fraction ≥ 25%), of the production juveniles may receive a secondary 12 mm PIT tag prior to release.

10.8) Disposition plans for fish identified at the time of release as surplus to programmed or approved levels

If fish production levels exceed the maximum number permitted under the HGMP, program staff will contact NMFS and CDFW for guidance on their disposition. Because the program is likely to only be planting fish in just Group 1 streams in the near future, it is expected that surplus fish may be released to Group 2, and Group 3 streams as needed. However, fish production that exceeds program maximum levels will not be released without the guidance and permission of NMFS and CDFW.

10.9) Fish health certification procedures applied pre–release

Prior to each release or transport event, a sample of 60 individuals (eggs or fish) are sacrificed for disease screening by CDFW pathologists. Disease prevention and control guidelines established by the CDFW Fish Health Laboratory will be used to determine fitness for release of all life stages. Fish deemed unsuitable for release due to disease concerns will be sacrificed.

10.10) Emergency release procedures in response to flooding or water system failure

The three rearing facilities that carry out this program are not susceptible to flooding. Rearing tanks are 1.8 m high and positioned in areas that have never been inundated during prior flood (high water) events. Moreover, water system failure is unlikely due to the redundancy of water conveyance systems and power at each facility. However, if deemed necessary due to some unforeseen emergency, fish from one freshwater facility (e.g., KFH) can be moved to temporary holding tanks at the other freshwater facility (e.g., DCFH). If fish must be released, they will be released to suitable sites in SCMDS streams in consultation with NMFS and CDFW. In the event of an emergency at the FED seawater facility, Coho Salmon could be released into the Pacific Ocean near the mouth of Scott Creek, or anywhere along the coast, as authorized by NMFS. In the case of a catastrophic system failure at DCFH, all hatchery Coho Salmon will be released into Dry Creek adjacent to the hatchery facility.

10.11) Risk aversion measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases

Risk aversion measures implemented for captive brood adult releases are as follows:

- To the extent possible, full siblings will either be released in separate streams or spread out geographically in the release stream to reduce inbreeding risk
- The number of adults released each year will be set such that program targets for pHOS and PNI by phase are achieved. This approach is designed to reduce risks hatchery fish may have on fitness, productivity, and abundance of natural Coho Salmon populations.

- Except for Scott Creek, adult releases will not exceed the adult downlisting criterion for each SCMDS stream[13]. This action is designed to decrease competition between HOR and NOR individuals for spawning habitat. Additionally, controlling the number of adults released will reduce competition risks their offspring pose to NOR offspring.
- All fish released will undergo a health inspection and receive a health certification from pathologist(s) prior to release.

Risk aversion measures implemented for juvenile releases are as follows:

- In Scott Creek, most smolts will be released in freshwater just upstream (~500 m) of the estuary to reduce competition and the risk of predation on natural-origin Coho Salmon and steelhead populations[14].
- Fry, parr and advanced parr releases will be prioritized to streams where Coho Salmon abundance is extremely low. This approach to stocking will reduce the competition, predation and disease risks hatchery-origin fish pose to these populations.
- The number of Coho Salmon juveniles (fry, parr or advanced parr) released in streams with natural populations of steelhead will not exceed measured steelhead juvenile densities in those streams. This action is designed to reduce competition and predation risk program fish may have on this species.
- All fish released will undergo a health inspection and receive a health certification from pathologist(s) prior to release.

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[13] The number of HOR adults entering Scott Creek is dependent on weir trapping efficiency that varies based on stream flow.

[14] Some yearlings may be released higher in the watershed for monitoring or to attract resulting adults to specific locations.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

11.1) Monitoring and evaluation of Program Performance Indicators in Section 1.10

The program will be responsible for conducting monitoring and evaluation (M&E) of performance metrics associated with the collection, transport and release of hatchery fish, in-hatchery operations, genetic analysis, fish marking, and hatchery effluent discharge monitoring.

Staff from the UCSC, CDFW and NMFS will be responsible for M&E associated with hatchery effects on natural populations of Coho Salmon and steelhead, annual juvenile and adult production, estimates of pHOS, collection of juvenile and adult Coho Salmon needed for broodstock, and the performance of hatchery fish released to the natural environment. Some of these activities may be conducted under separate permits held by each party.

11.1.1) Plans and methods proposed to collect data necessary to respond to each Program Performance Indicator

M&E is intended to ensure that performance standards are achieved and to provide the information necessary to manage the program effectively and adaptively. Results generated through data collection and analyses will be reported to NMFS and CDFW as both monthly and annual hatchery reports, and progress towards all program performance standards will be presented at TOC meetings. A comprehensive synthesis will be produced annually as a program Operations Report. Information provided in the Operations Report will follow assessment and reporting guidelines established by the California Hatchery Scientific Review Group (California HSRG 2012). The report will contrast realized annual performance metrics with historical data to assess status, progress, and trends. Study plans will be updated as needed to incorporate new information, emerging research needs, and advancements in fisheries management and broodstock husbandry.

<u>Hatchery Monitoring</u>

All performance indicators (Table 7) related to hatchery rearing and spawning are monitored, and relevant data recorded, synthesized, and reported by program staff. During spawning activities, data on individual spawner performance are documented. The numbers of male and female broodstock available for spawning, the number and percentage of NOR fish spawned, the number and percentage of out-of-basin fish spawned, and the PIT tag identities of each Coho Salmon spawned will be recorded and continuously reported/updated during the spawning season. From spawning to release, program staff will collect data on life stage-specific survival at each facility. During hatchery rearing, environmental conditions will be continuously monitored to assure the health of all fish in each facility. A detailed list of the annual monitoring, record keeping, and reporting responsibilities is provided as Attachment B.

<u>Genetic and Molecular Analyses and Monitoring</u>

To maximize genetic diversity within the program and avoid inbreeding, crosses at KFH incorporate both captive broodstock fish and ocean returns of both NOR and HOR when available. All potential spawners will be uniquely marked with a PIT tag, tissue sampled (fin clip), and genotyped before mating is carried out with guidance from a spawning matrix (detailed below). Captive broodstock individuals are typically genotyped in the year prior to reproductive maturation, while the inclusion of additional fish into the spawning matrix (e.g., ocean returns) is accomplished by quick-turnaround genotyping and a revised spawning matrix. The molecular and population genetic analyses described in the subsequent paragraphs inform performance standards concerning relatedness among broodstock individuals and the estimated fitness potential (PNI) of the program population.

Tissue Sampling and DNA Extraction. – Fin tissue samples are the source material for DNA that is used in genetic analyses. At the time of tissue sampling, each individual fish is given a unique identifying code (PIT tag number) that remains associated with that individual sample throughout the genetic analysis process.

Genetic Marker Data. – Genotyping historically was done with microsatellite DNA markers, and later, single nucleotide polymorphism (SNP) DNA markers. Going forward, a microhaplotype panel will be employed to generate haplotype data. While the suite of genetic markers used is updated periodically to keep pace with advancing technologies, each set of markers has sufficient statistical power to identify and discriminate populations, individuals, and close relatives. Details about contemporary DNA marker sets are available from the Molecular Ecology Team at NOAA FED upon request.

Genetic Sex Determination. – DNA-based sex determination is advantageous because the sex of individuals can be determined at any life stage, and its accuracy does not rely upon the maturation state and appearance of the fish. Hence, sex can be known well in advance of the spawning season, allowing equalization of sex ratio among broodstock or adult release groups. For broodstock individuals, sex is determined using the *GH*-Y assay (Du et al. 1993) originally developed for Chinook Salmon.

Relatedness-based Spawning Matrix. – Coho Salmon mating at KFH is directed by a spawning (breeding) matrix derived from genetic marker data. The spawning matrix is created by using the R package *related* to estimate the relatedness coefficient (r_{xy}) of Queller and Goodnight (1989) for all possible male-female pairs available for breeding. Under random mating conditions, the expectation for the relatedness coefficient is $r_{xy} = 0$ for unrelated individuals, 0.25 for half-siblings, and 0.50 for full siblings. The matrix is female-focused, such that every female has a column with all potential mates listed beneath her, ranked according to their coefficient of relatedness with the focal female. The most desirable (i.e., least closely related) mates are at the top of the list and the least desirable (most closely related) mates are at the bottom. Note that a male who is a poor mate for one female could be a highly ranked (i.e., distantly related) mate for a different female.

To reduce hatchery inbreeding, potential males related to the focal female at $r_{xy} \geq 0.125$ (first cousin level) are flagged as undesirable mates for that female. At DCFH, crosses between fish related at the first cousin level or above were found to produce deformed offspring and significantly lower survival than offspring of crosses between unrelated mates (Conrad et al. 2013). Such pairings will be avoided.

Population Genetic Analyses. – The genetic analyses of Coho Salmon broodstock and specimens collected by others during population monitoring may be used to inform hatchery practices and assess the success of various recovery strategies. Other population genetic estimators that will be calculated for each brood year or group of interest include heterozygosity, mean relatedness, inbreeding coefficient, and allelic richness to assess genetic "health" and relatedness among different groups.

Outbreeding. – Outbreeding activities for the program will be assessed and monitored yearly. Outbreeding began at KFH in the winter of 2010–2011 with the transfer of 17 Coho Salmon broodstock of Lagunitas Creek origin from DCFH to KFH. Three females and 14 males were crossed with Scott Creek broodstock to increase genetic diversity and provide unrelated mates for the remaining mature adults from the small 2008–2009 Scott Creek brood year. Without the Lagunitas Creek fish, there would have been few or no unrelated mates available to spawn with Scott Creek fish. Since the 2010–2011 spawn season, outbreeding has continued each year at KFH using Russian River or Lagunitas Creek-origin captive broodstock transferred from DCFH. An outcrossing target is set for out-of-basin ancestry incorporated into the offspring of hatchery crosses each spawn season. For example, if 25% of crosses are outbred (Scott Creek × DCFH or DCFH × Scott Creek), then approximately 12.5% of offspring produced at KFH will possess out-of-basin ancestry (assuming equal survival across spawn pairs). Scott Creek mates for out-of-basin broodstock will be chosen based on their pairwise relatedness, using the spawning matrix.

Analysis of Family Groups. – Fish sampled during stream monitoring by others (UCSC) will be used to determine reproductive success and spawning behavior in the wild. Samples acquired from instream monitoring will be used to infer spawning activity by released HOR adults and ocean returns. Colony 2 software (Jones and Wang 2010) will be used for parsing sets of samples into full-sibling groups, and for assessing parentage of individuals. This method will be used to estimate the number of spawners giving rise to a sample of young-of-year (YOY), and to infer the number of redds that produced the YOY present in the stream.

11.1.2) Funding, staffing, and other support logistics committed to implementation of the monitoring and evaluation program

Monitoring, evaluation, and reporting of hatchery-related performance metrics are a collaborative effort between MBSTP, FED and UCSC. Funding is currently provided via an award from CDFW issued to MBSTP and UCSC (D2181004, through 31 May 2025), with additional financial support from NMFS FED base funds. Molecular and genetic analyses in support of program are conducted by FED with supplemental funding provided by CDFW (D2181004). Field monitoring in support of performance standards and indicators is conducted jointly by UCSC and FED and relies on extramural funding, the majority of which is presently provided by CDFW (award P2281001, through 30 June 2025).

11.2) Risk aversion measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from monitoring and evaluation activities

The program will only be responsible for M&E associated with the collection, transport, culture, and release of program fish. There is little risk to listed fish from program M&E activities as most of it requires minimal handling; thus, mortality is expected to be low (< 5%). Risk aversion measures to be implemented include:

- Care will be taken to reduce the number of disturbances the hatchery population undergoes, thereby reducing fish stress and susceptibility to disease. Fish are sampled daily to quantify performance indicators associated with life stage survival and disease loss. Sampling is done quickly and is coordinated with tank cleanings. All gear used in sampling efforts is sterilized to prevent disease transfer among tanks.

- Fish are anesthetized to reduce handling mortality and stress, and work is performed at times when fish are not undergoing substantial physiological changes (e.g., smoltification).
- The number of specimens collected will be kept to the minimum number required to accomplish study goals.
- Marking techniques involving tissue removal or modification (genetic, fin-clips, etc.) will be preceded by local anesthetic (tricaine methanesulfonate, MS-222) and followed by the application of a topical antiseptic.
- Tags selected for marking will have a proven history of having minimal effect on acute or chronic fish mortality.

11.3) Reporting

The results of all hatchery operations and monitoring activities will be summarized in monthly and annual reports. Progress toward the achievement of the program performance standards will be documented in the report. If a program performance standard is not met, the report will describe the actions proposed to achieve each standard the following year. This report will be sent to the TOC and TAC for review and agreement with any proposed program changes.

SECTION 12. RESEARCH

Research and monitoring of CCC Coho Salmon and CCC steelhead in streams of the SCMDS is, or will be, covered under section 10(a)(1)(A) research permits, including permit numbers 17292-3R (FED), 18012-3R (CDFW Region 3), 15824-2R (County of Santa Cruz), and others.

In addition to the above and the monitoring and evaluation of program performance indicators (Section 11), research may include various health assessments involving the collections of tissues, otoliths, or other parts from program Coho Salmon (i.e., eggs, juveniles, and adults). Examples may include egg Thiamine Deficiency Complex (TDC) assessments, where up to 10 g of unfertilized eggs (< 100 eggs) collected from up to 30 females (targeting ocean returning fish) during spawning will be assessed for thiamine concentrations by outside laboratories under contract by CDFW and or FED. Eggs for TDC would only be collected for this purpose if there is a sufficient quantity to meet program production and captive broodstock goals. Other potential research could include collection of tissues/organs for bioassays for disease or contaminant concentration assessments conducted by either internal or external laboratories. When appropriate, incidental mortalities or culled specimens during the spawning or juvenile rearing phase of the program would be used for this research. The final disposition of tissues or other parts of Coho Salmon from the program would be the entities/laboratories they were shipped to for analysis. In all cases, the shipment of these samples to external entities would be transmitted with a chain of custody letter.

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SECTION 14. ATTACHMENTS

14.1) Attachment A: California HSRG Standards

The program will follow the California HSRG standards and guidelines presented in the following table.

Culture Phase	Standard	Guideline
Broodstock Source	Standard 1.1: Broodstock is appropriate to the basin and the program goals and should encourage local adaptation.	Guideline 1.1.1. Broodstock should be chosen from locally adapted stocks native to the basin and with life history characteristics appropriate to program goals. Guideline 1.1.2. Broodstock should be representative of the natural population with which the hatchery program is integrated. Spatial distribution of the integrated population should not be based on straying associated with off-site releases.
Broodstock Collection	Standard 1.2: Trapping is done in such a way as to minimize physical harm to both broodstock and non-broodstock fish.	
	Standard 1.3: Collection methods are appropriate for the program goals.	Guideline 1.3.1. Trapping locations should include mechanisms for collecting sufficient numbers and diversity of both hatchery- and natural-origin fish to meet program goals. If inadequate numbers of natural-origin fish are available with current collection methods, then additional collection methods are required.
	Standard 1.4: Trapping is designed to collect sufficient fish as potential broodstock to be representative of the entire run timing and life history distribution of the population or population component with which it is integrated.	Guideline 1.4.1. Fish traps should be operated for at least the entire temporal period of the run and should not exclude fish with any life history characteristics. An exception to this is allowable when non-representative broodstock collection is necessary to achieve program goals, such as separating broodstock of differing ecotypes.
Broodstock Composition	Standard 1.5: Hatcheries have effective facilities for the extended holding of unripe fish and males that will be used for multiple spawning.	Guideline 1.5.1. Holding facilities in hatcheries should provide adequate space, water flows and temperature requirements to hold the expected number of unripe adult fish for extended periods of time with minimal hatchery-caused mortality (see Senn et al. 1984 for specific water quality, flow and temp parameters). Guideline 1.5.2. Holding facilities should permit appropriate antibiotic and /or chemical treatments when deemed necessary to control adult mortality or prevent vertical transmission of diseases to progeny.

Culture Phase	Standard	Guideline
	Standard 1.6: Broodstock is primarily comprised of fish native to the hatchery location, with incorporation of fish from other locations not exceeding the rate of straying of natural-origin fish.	Guideline 1.6.1. Broodstock should originate in the sub basin in which the hatchery is located, except when estimates of natural straying from proximate locations are known, in which case, incorporation of returning adults from those location should not exceed the natural stray rate. Guideline 1.6.2. Strays from other hatchery programs should not be used as broodstock.
	Standard 1.7: The levels of natural-origin broodstock are appropriate for program goals.	Guideline 1.7.1. For conservation-oriented programs, the proportion of natural-origin broodstock proportions should be approaching 100%. Guideline 1.7.2. For integrated programs, pNOB should be at least 10% to avoid run divergence. Higher pNOB may be applied to avoid/minimize domestication but should not be large enough to pose a demographic hazard to the natural population(s).
	Standard 1.10: For Coho Salmon, fish from all age classes and sizes are incorporated into broodstock at rates that are commensurate with their relative reproductive success in natural areas, when known.	Guideline 1.10.2. For Chinook Salmon and Coho Salmon, when the number of males available as broodstock is less than or equal to 50, or when less than or equal to 50 broodstock are used to accomplish specific program objectives, the acceptable number of two-year-olds is unlimited. Guideline 1.10.3. For Coho Salmon, the number of jacks to be incorporated into broodstock should not exceed the lesser of (1) 50 percent of the total number of jacks encountered at the hatchery, and (2) 10 percent of the total males used for spawning. Guideline 1.10.4. For all programs, broodstock should be selected to not induce changes in the maturation schedule of the natural population with which the hatchery population is integrated.

Culture Phase	Standard	Guideline
Mating Protocols	Standard 1.11: The program uses genetically conscious mating protocols to control or reduce inbreeding and genetic drift (random loss of alleles), to retain existing genetic variability and avoid domestication, while promoting local adaptation for integrated stocks.	Guideline 1.11.2. For broodstock number between 50 and 250 females, female's eggs should be split into 2 egg lots and each lot should be fertilized with a different male in a separate pan. Limit the reuse of males to two egg lots (or the equivalent of one female), except for unavoidable situations (e.g., where loss of eggs might result if males are not reused and loss of eggs threatens program goals). Guideline 1.11.3. For broodstock numbers less than 50 females, egg lots should be split into greater than 2 with each lot fertilized by a different male in a separate pan. Limit the reuse of males to no more than 4 egg lots, but ideally males will not be reused. Guideline 1.11.5. For integrated programs including conservation programs: • Maximize incorporation of NOR fish into broodstock to the extent that the number of NOR broodstock used does not substantially reduce the population viability of the donor stock. • HOR fish should be preferentially mated with NOR fish. HOR×HOR mating's should be considered least desirable. In conservation-oriented programs, relatedness between mated pairs may be more important than HOR vs. NOR.
	Standard 1.12: Inbreeding is avoided.	Guideline 1.12.1. For Conservation-oriented programs, populations that have experienced known bottlenecks, populations that exhibit evidence of inbreeding depression, and programs where broodstock numbers are regularly less than or equal to 50 individuals, 0 mating's should be between fish related at the half-sibling level or higher. Guideline 1.12.2. For Conservation-oriented programs, genetic broodstock mgmt. techniques should be used to reduce mating of related individuals. Guideline 1.12.3. For conservation-oriented programs that cannot institute genetic broodstock mgmt. but where inbreeding is of concern, or as a transition protocol prior to eventual genetic broodstock mgmt., mate HOR × NOR fish as frequently as possible to reduce inbreeding potential. When possible and appropriate, mate individuals from different Coho Salmon. Guideline 1.12.4. Census size of small natural populations should be increased in order to reduce

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		the probability of inbreeding. Guideline 1.12.5. Assume that inbreeding is an issue, esp. for small populations or small numbers of broodstock, to avoid unintentional diversity loss (Hedrick and Kalinowski 2000).
	Standard 1.13: The proportion of natural-origin fish used as broodstock does not negatively affect the long-term viability of the donor population. For conservation-oriented programs, extinction risk of the ESU may take precedence.	Guideline 1.13.1. For integrated programs, the number of NOR broodstock should not substantially decrease the viability of the donor stock. Guideline 1.13.2. For conservation-oriented programs, maximize incorporation of NOR fish into broodstock. Generally, the number of NOR broodstock should not decrease viability of donor stock. However, some conservation-oriented programs may need to take the entire run into the hatchery to protect existing diversity of very small, very threatened, high value stocks. (e.g., unique diversity element).
Program Size	Standard 2.1: Program size is established by several factors including mitigation responsibilities, societal benefits, and effects on natural fish populations.	Guideline 2.1.1. Program purpose should be identified and expressed in terms of measurable values such as harvest, conservation, hatchery broodstock, education or research.
	Standard 2.2: Program size is measured as adult production.	Guideline 2.2.1. Production goals (program size) should be expressed in terms of number of adult recruits just prior to harvest (age-3 ocean recruits for Chinook in California) or at freshwater entry (age-3 adults returning to freshwater for Coho Salmon; anadromous adults returning to freshwater for steelhead).
	Standard 2.3: Annual assessments are made to determine if adult production goals are being met.	Guideline 2.3.1. Consider variation in environmental conditions when evaluating the performance of a hatchery program, recognizing that poor environmental conditions in one or more years can temporarily preclude attainment of production goals in the best of hatchery programs and do not necessarily call for modification of the hatchery program size or release strategies. Guideline 2.3.2. A program that consistently fails to achieve its adult production goals by a substantial margin, especially if it fails to meet broodstock needs, should be judged a failure and remedial action should be taken. Naturally spawning populations should not be depleted to maintain such failed programs. Guideline 2.3.3. A program that consistently exceeds its adult production goals by a substantial margin should be reduced in size.

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	Standard 2.4: Program size is based on consideration of ecological and genetic effects on naturally spawning populations, in addition to harvest goals or other community values.	Guideline 2.4.1. If deleterious ecological or genetic effects result in substantial reduction of productivity for high-priority naturally spawning populations, and these effects cannot be alleviated by other changes, program size should be reduced. Under certain circumstances, conservation-oriented programs might increase program size to eliminate deleterious effects, for example to reduce inbreeding. Guideline 2.4.2. Managers should consider program changes, including reducing program size, to mitigate disease issues. Large numbers of naturally spawning fish may increase the incidence of *C. Shasta* through the release of myxospores from carcasses, which in turn increases the probability of severe juvenile infection relates the following spring and summer.
	Standard 2.5: Natural spawning populations not integrated with a hatchery program should have less than five percent total hatchery-origin spawners (i.e., pHOS less than five percent). Spawners from segregated hatchery programs should be absent from all natural spawning populations (i.e., pHOS from segregated programs should be zero).	
Release Strategy	Standard 2.6: Size, age, and date at release for hatchery-origin fish produce adult returns that mimic adult attributes (size at age and age composition) of the natural population from which the hatchery broodstock originated (integrated program) or achieve some other desired size or condition at adult return (segregated programs).	Guideline 2.6.1. Size and date at release should generally mimic size and period of emigration of naturally migrating smolts in the river system on which a hatchery is located. Deviations from this guideline require substantial justification that addresses both the ecological and genetic consequences of such a strategy, particularly when extended rearing is proposed. Consider retaining some flexibility in release date to take advantage of beneficial flow, turbidity, or temp conditions without increasing deleterious ecological effects on natural populations. Guideline 2.6.2. Size and date at release of smolts should ensure physiological readiness to migrate rapidly to the sea (to limit predation on or competition with NOR fish). Guideline 2.6.3. When hatchery fish are released at sizes and dates that substantially differ from those of the NOR fish with which they are integrated, they should all be distinctively marked so that they can be recognized as adults and excluded from hatchery broodstock and spawning in natural areas.

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Fish Health Policy	Standard 3.1: Fishery resources are protected, including hatchery and natural fish populations, from the importation, dissemination, and amplification of fish pathogens and disease conditions by a statewide fish health policy. The fish health policy clearly defines roles and responsibilities, and what actions are required of fish health specialists, hatchery managers, and fish culture personnel to promote and maintain optimum health and survival of fishery resources under their care. The Fish Health Policy includes the California HSRG's Bacterial Kidney Disease (BKD) management strategy (see Appendix V).	Guideline 3.1.1. Develop and promulgate a formal, written fish health policy for operation of CDFW anadromous fish hatcheries through the Fish and Game Commission policy review process. Such a policy may be formally identified in regulatory code, Fish and Game Commission policy, or in the CDFW Operations Manual.
Hatchery Monitoring by Fish Health Specialists	Standard 3.2: Fish health inspections are conducted annually on all broodstocks to prevent the transmission, dissemination or amplification of fish pathogens in the hatchery facility and the natural environment, as follows: a) Inspections are conducted by or under the supervision of an AFS certified fish health specialist or qualified equivalent. For state-operated anadromous fishery programs, specific standards and qualifications are to be defined during development of a fish health policy. b) Annual inspections follow AFS 'Fish Health Bluebook' guidelines for hatchery inspections. c) Broodstock are examined annually for the presence of BKD and where the causative bacterium *Renibacterium salmoninarum* recurs; the California HSRG's control strategy will be implemented.	Guideline 3.2.1. Number of individuals examined per stock may vary according to management objectives, but the minimum number should be at the 5 percent Assumed Pathogen Prevalence Levels (APPL), generally 60 fish. Guideline 3.2.2. Methodology and effort should meet or exceed AFS "Fish Health Blue book" procedures. Guideline 3.2.3. Develop a fish health management plan to address BKD when present (see California HSRG BKD protocols-APP V).
	Standard 3.3: Frequent routine fish health monitoring is performed to provide early detection of fish culture, nutrition, or environmental problems, and diagnosis of fish pathogens, as follows: a) Monitoring is conducted by or under the supervision of an AFS certified fish health specialist or qualified equivalent. b) Monitoring is conducted on a monthly, or at least bimonthly basis,	Guideline 3.3.1. The frequency of monitoring should depend on the disease history of the facility, the importance of the species being reared, and the variable environmental conditions that occur in a particular rearing cycle (e.g., elevated water temperatures in spring and summer months). Guideline 3.3.2. Review fish culture practices with manager including nutrition, water flow and chemistry, loading and density indices, handling methods, disinfection procedures, and preventative

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	for all anadromous species at each hatchery facility. c) A representative sample of healthy and moribund fish from each lot is examined. Results of fish necropsies and laboratory findings are reported on a standard fish health monitoring form.	treatments. Guideline 3.3.3. The number of fish examined is at the discretion of the fish health specialist.
	Standard 3.4: All antibiotic or other treatments are pre-approved by the appropriate fish health specialist for each facility. If antibiotic therapy is advised, fish health personnel will culture bacterial pathogens to verify drug sensitivity. Post-treatment examinations of treated units are conducted to evaluate and document efficacy of antibiotic or chemical treatments.	Guideline 3.4.1. Re-occurring mortality, or repeated use of antibiotics or chemicals to control mortality, generally indicates that underlying fish culture, nutritional or environmental problems are not being fully remediated and should be further investigated.
	Standard 3.5: Examinations of fish are conducted prior to release or transfer to ensure fish are in optimum health condition, can tolerate the stress associated with handling and hauling during release, and can be expected to perform well in the natural environment after release.	Guideline 3.5.1. Review transportation protocols with appropriate hatchery staff to ensure fish are handled and hauled in a manner that minimizes stress and provides the best opportunity for survival.
	Standard 3.6: Annual reporting standards and guidelines will be followed for fish health reports, including results of adult inspections, juvenile monitoring and treatments administered, and pre-liberation examinations for each hatchery program. A cumulative five-year disease history will be maintained for each program and reported in annual or other appropriate facility reports.	Guideline 3.6.1. Include an annual fish disease assessment for each program in the hatchery annual report (see Standard 3.14).
	Standard 3.7: Fish health status of stock is summarized prior to release or transfer to another facility.	Guideline 3.7.1. Written reports should include findings of monitoring and laboratory results. For fish transfers, feeding regime and current growth rate, and any other information necessary to assist fish culturists at the receiving station, should be provided.
Facility Requirements	Standard 3.8: Physical facilities and equipment are adequate and operated in a manner that promotes quality fish production and optimum survival throughout the rearing period. If facilities are determined to be inadequate to meet all program needs, and improvements are not feasible, then the hatchery program(s) must be re-evaluated within the context of	Guideline 3.8.1. Facilities and equipment should allow effective capture and holding of adults, appropriate incubation and rearing units with adequate capacity to meet program size, equipment and/or methods for effective predator control, and release of fish out undue stress or harm. (see Section 4.1.1, Broodstock Management for additional adult holding requirements).

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	what the facility can support without compromising fish culture and/or fish health, or causing adverse interactions between hatchery and natural fish populations	Guideline 3.8.2. Hatchery managers, fish health specialists, biologists and fish culturists should identify facility/equipment deficiencies that constrain hatchery operations and/or prevent the facility from meeting program goals. Such facility deficiencies or constraints should be communicated to resource managers for remedy or redress. Guideline 3.8.3. When physical facility and/or equipment needs exist, resource managers and appropriate funding source(s) should actively pursue facility maintenance, upgrades or equipment needs through a prioritized budget process. In the interim, modifications should be made to program goals to minimize adverse impacts to fish culture and/or fish health.
	Standard 3.9: Distinct separation of spawning operations, egg incubation, and rearing facilities is maintained through appropriate sanitation procedures and biosecurity measures at critical control points to prevent potential pathogen introduction and disease transmission to hatchery or natural fish populations, as follows: a) Disinfect/water harden eggs in iodophor prior to entering "clean" incubation areas. In high-risk situations, disinfect eggs again after shocking and picking, or movement to another area of the hatchery. b) Foot baths containing appropriate disinfectant will be maintained at the incubation facility's entrance and exit. Foot baths will be properly maintained (disinfectant concentration and volume) to ensure continual effectiveness. c) Sanitize equipment and rain gear utilized in broodstock handling or spawning after leaving adult area. d) Sanitize all rearing vessels after eggs or fish are removed and prior to introducing a new group. e) Disinfect equipment, including vehicles used to transfer eggs or fish between facilities, prior to use with any other fish lot or at any other location. Disinfecting water should be disposed of in properly designated areas. f) Sanitize equipment used to collect	Guideline 3.9.1. Use dedicated equipment and rain gear that is not moved between adult spawning, incubation and rearing areas of the hatchery; otherwise, thoroughly scrub and disinfect gear when moving between these areas. Guideline 3.9.2. A critical control point is defined as the physical location where pathogen containment occurs from a "dirty" to a "clean" area (i.e., between functional areas such as spawning and incubation). In addition to egg disinfection, ensure that spawning buckets/trays are surface-disinfected before entering incubation area.

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	dead fish prior to use in another pond and/or fish lot. g) Properly dispose of dead adult or juvenile fish, ensuring carcasses do not come in contact with water supplies or pose a risk to hatchery or natural populations.	
	Standard 3.10: All hatchery water intake systems follow federal and state fish screening policies.	Guideline 3.10.1. Follow existing statutes, including NEPA, CEQA, ESA, CESA, and current court decisions.
Fish Health Management Plan	Standard 3.11: Fish Health Management Plans (FHMP) like or incorporated within an HGMP have been developed. The FHMP will: a) Describe the disease problem in adequate detail, including assumptions and areas of uncertainty about contributing risk factors. b) Provide detailed remedial steps, or alternative approaches and expected outcomes. c) Define performance criteria to assess if remediation steps are successful and to quantify results when possible. d) Include scientific rationale, study design, and statistical analysis for proposed studies aimed at addressing disease problems or areas of uncertainty pertaining to disease risks.	Guideline 3.11.1. Compliance with the FHMP should be reviewed annually, through the hatchery coordination team, and include any new data or information that may inform actions or decisions to address disease concerns.
Water Quality	Standard 3.12: Water chemistry and characteristics at any new hatchery site meet the water quality required by salmonids, as identified in Hatchery Performance Standards (IHOT 1995), or a comparable reference such as Fish Hatchery Management (Wedemeyer 2002)	
Water Quality	Standard 3.13: Existing facilities strive for suggested water chemistry and characteristics (IHOT 1995, Wedemeyer 2002) which may require water filtration and disinfection, additional heating or cooling, degassing and/or aeration, or other modifications to the quantity and quality of an existing water supply, as follows: a) Pathogen-free water supplies will be explored for each facility, particularly for egg incubation and early rearing.	Guideline 3.13.1. When surface water is used, a biosecurity evaluation should be performed, and water supplies protected to the extent feasible, to avoid direct contamination of hatchery water supply by potential disease vectors (i.e., live fish, amphibians, birds, or mammals). Guideline 3.13.2. Cooling and/or heating of water supplies may be necessary to meet water quality standards and program goals, for example, when egg incubation and early rearing water temperatures are too low in fall and winter months to consistently achieve desired fish size-at-release.

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	b) Water supplies must provide acceptable temperature regimes for egg incubation, juvenile rearing and adult holding. c) Water supplies will have appropriate water chemistry profiles, including dissolved gases: near saturation for oxygen, and less than saturation for nitrogen. d) Water supplies for egg incubation must not contain excessive organic debris, non-settleable solids or other characteristics that negatively affect egg quality and survival. e) Disinfect equipment, including vehicles used to transfer eggs or fish between facilities, prior to use with any other fish lot or at any other location. Disinfecting water should be disposed of in properly designated areas. f) Sanitize equipment used to collect dead fish prior to use in another pond and /or fish lot.	Guideline 3.13.3. Degassing columns or aeration devices may be necessary to meet water quality standards throughout the rearing cycle. Guideline 3.13.4. If unable to remediate siltation problems for egg incubation, alternative incubation sites, water supplies, or incubation methods should be considered. Guideline 3.13.5. Source water is adequately filtered to reduce turbidity. (added by WSH HCT)
Best Management Practices	Standard 3.14: The rationale, benefits, risks, and expected outcomes of any deviations from established best management practices for fish culture and fish health management are clearly articulated in the hatchery operational plan (including specific fish culture procedures), Hatchery and Genetic Management Plan (HGMP), Fish Health Management Plan, the hatchery coordination team process, and/or in annual written reports.	Guideline 3.14.1. Develop required plans.
	Standard 3.15: Information on hatchery operations is collected, reviewed, and reported in a timely, consistent and scientifically rigorous manner (see requirements and list of reporting parameters in Section 4.4, Monitoring and Evaluation (M&E)).	Guideline 3.15.1. An annual report containing monitoring and evaluation information (see M&E standards), including pathogen prevalence, fish disease prevalence, and treatment efficacies, should be produced in a time such that the information can be used to inform hatchery actions during the following brood cycle.
	Standard 3.16: Eggs are incubated using best management practices and in a manner that ensures the highest survival rate and genetic contribution to the hatchery population, as follows: a) Eggs are incubated at established temperatures, egg densities, and water flows for specific species. Appropriate egg incubation parameters are identified in Hatchery Performance	Guideline 3.16.1. Culling should be done to minimize unintentional selection. Guideline 3.16.2. Excess eggs are culled in a manner that does not eliminate representative families or any temporal segment of the run; and culled in portions that are representative of the entire run. Culling may be done to change the variance in family size.

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	Standards (IHOT 1995, Chapter 4) or Fish Hatchery Management (Wedemeyer 2002). b) Incubation techniques should allow for discrimination of individual parents/families where required for program goals (e.g., for conservation-oriented programs and steelhead programs, or to exclude families for genetic (hybridization) or disease culling purposes). c) Eggs in excess of program needs are discarded in a manner that is consistent with agency policies and does not pose disease risks to hatchery or natural populations.	Guideline 3.16.3. Non-representative culling may occur to achieve specific program goals but must be justified based on genetic considerations of maintaining or rebuilding desired characteristics of the spawning stock. Guideline 3.16.4. Eggs, fry, or juvenile fish in excess of production needs are disposed of in a manner that is consistent with agency policies on egg culling and fish disposal and will not be released, and should have no effects on natural populations. Guideline 3.16.5. For conservation-oriented programs, individual reproductive output should be as close to equivalent as possible, while avoiding selection for egg size and age at maturity, and not unduly reducing overall production. These stipulations generally require that families be kept separate until staff can move eyed-eggs for separate rearing for specific program types. Avoid loss of within population diversity resulting from reduced effective population size in the hatchery stock.
	Standard 3.17: Fish are reared using best management practices and in a manner that promotes optimum fish health to ensure a high survival rate to the time of release, and provides a level of survival after-release appropriate to achieve program goals, while minimizing adverse impacts to natural fish populations, as follows: a) Fish performance standards (i.e., species-specific metrics for size, weight, condition factor, and health status) will be established for all life stages (fry, fingerling, and smolt) at each facility. b) Fish nutrition and growth rates are maintained through the proper storage and use of high-quality feeds. Appropriate feeding rates will be closely monitored and adjusted as needed to accommodate fish growth/biomass in rearing units. c) Juvenile fish will be reared at density and flow indices and temperature that promote optimum health. Appropriate density and flow requirements for anadromous fish are identified in Hatchery Performance Standards Policy (IHOT 1995, Chapter 4) or in a comparable	Guideline 3.17.1. Feeding practices should supply feed at a rate that is quickly consumed by juvenile fish and does not permit excess feed to accumulate in rearing units. Excess or uneaten food has a high potential to increase organic loads in the rearing unit that can lead to fish pathogen amplification and disease outbreaks. Guideline 3.17.2. Fish Health specialists should be promptly contacted when fish feeding behavior appears abnormal or when fish stop feeding. Guideline 3.17.3. Stress induced infections or diseases, related to crowding or high rearing densities, should be minimized to promote optimal growth, and to avoid excessive use of therapeutics (antibiotic medicated feed or chemical treatments). Guideline 3.17.4. Rearing strategies will optimize the physical layout and use of rearing units at the facility to minimize handling of juvenile fish for inventory, transfer between rearing units, or tagging purposes. Preferably, fish are placed in units that allow adequate space and flows to permit extended periods of growth with no handling.

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	reference such as Fish Hatchery Management (Wedemeyer 2002). d) Appropriate growth strategies will be developed, with particular attention to photoperiod, temperature units and feeding rates to optimize parr-to-smolt transformation, to ensure juvenile fish reach target size-at-release and are physiologically ready to out-migrate and survive salt-water entry.	
Hatchery Genetic Management Plans	Standard 4.1: Each hatchery program is thoroughly described in a detailed operational plan such as an HGMP or Biological Assessment. Operational plans are regularly updated to reflect updated data, changes to goals and objectives, infrastructure modifications, and changing operational strategies.	Guideline 4.1.1. Funding entities should provide the necessary resources to prepare and implement HGMPs for all CA anadromous fish hatchery programs.
Hatchery Evaluation Programs	Standard 4.2: For each hatchery, a Monitoring and Evaluation program dedicated to reviewing the hatchery's achievement of program goals and assessing impacts to naturally produced fishes must be established. Each M&E program will describe and implement a transparent, efficient, and timely process to respond to requests for experimental fishes, samples, and data.	Guideline 4.2.1. Hatchery Monitoring and Evaluation programs should be outside the direct hatchery line-of-command so they have a large degree of independence and autonomy from decisions made at the hatchery level. Program member expertise should include fish biology, population ecology, genetics, field sampling methods, experimental design and survey sampling strategies, database creation and management, and statistical analysis. Descriptions of specific monitoring and evaluation programs may be included as part of HGMPs.
Hatchery Coordination Teams	Standard 4.3: A Hatchery Coordination Team has been created for each hatchery	Guideline 4.3.1. HCT's should be comprised of hatchery managers, hatchery biologists/fish culturists, monitoring and evaluation biologists, fish health specialists, regional fish biologists, and fishery managers.
In Hatchery Record Keeping	Standard 4.4: The monitoring and record keeping responsibilities listed below are carried out on an annual basis in-hatchery for each anadromous program. Summaries of data collected, with comparisons to established targets, are included in annual hatchery program reports, and individual measurements (unless otherwise indicated) are store in electronic data files. Sample sizes indicated are provisional pending further consideration (see Section 6.2). A complete list of required and recommended data section and reporting is provided in Appendix IV. a) Record date, number, size, age (if available), gender, and origin (natural	

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	or hatchery; hatchery- and basin-specific when available) of (1) all hatchery returns and (2) fish actually used in spawning. (Summaries in annual reports; individual measurements in electronic files.) b) Record age composition of hatchery returns, as determined by reading scales and/or tags, from a systematic sample of the hatchery returns ($N > 550$, or all returns for programs with less than 550 returns). c) Record sex-specific age composition of the fish spawned, as determined by reading scales and/or tags, from a systematic sample of the fish spawned ($N > 550$, or all spawned fish for programs with less than 550 spawned fish). d) Describe in detail the spawning protocols used for each program (by family group for conservation-oriented programs), including the number of times individual males were used. e) Describe in detail the culling protocols used for each program, including purpose. f) Calculate and record effective population size (in conservation-oriented programs). g) Measure and record mean egg size, fecundity, and fish length for each individual in a systematic sample of spawned females ($N > 50$), to establish and monitor the relation between fecundity, egg size, and length in the broodstock. (Include a table of all measurements in annual report.) h) Record survival through the following life stages: green egg to eyed-egg, eyed-egg to hatch, hatch to ponding, ponding to marking/tagging, and marking/tagging to release, i) Record mean, standard deviation, and frequency distribution based on $N > 100$ measurements of fish length, by raceway, at periodic intervals (no less than monthly) prior to release and at time of release for all release types, to assess trends and variability in size throughout the rearing process. (Report means and standard deviations in annual reports; individual	

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	measurements and frequency distributions in electronic files.) j) Maintain records of disease incidence and treatment, including monitoring of treatment efficacy. k) Report CWT releases and recoveries to relevant databases (i.e., RMIS) on a timely annual basis.	
Marking and Tagging Program	Standard 4.6: Coho Salmon marking and tagging programs allow for: a) Estimation of natural area and hatchery escapement, b) Estimation of the proportion of hatchery-origin fish in natural spawning areas, c) Real-time identification of hatchery-origin juveniles and adults (i.e., hatchery vs. non-hatchery-origin), d) Identification of stock of origin for hatchery-origin fish, e) Non-retention in mark-selective fisheries targeting adipose fin-clipped fish.	Guideline 4.6.1. All fish released should receive a hatchery-specific (Iron Gate Hatchery vs. Trinity River Hatchery) external mark (not an adipose fin-clip). Program fish receive an internal tag (CWT and/or PIT tag). This guideline (4.6.1) will not be followed.
	Standard 4.8: The quantities listed below are monitored in the freshwater environment following release of juvenile Chinook and Coho Salmon. Summaries of collected data and associated estimates, along with comparisons to established targets, are included in annual or periodic (every 5 to 10 years) reports produced by the monitoring agencies/entities. a) Annual: Document length (mean, standard deviation, and frequency distribution) of hatchery fish at release as compared to naturally produced smolts. b) Periodic: Document the number of days (mean, standard deviation, and frequency distribution) from release of hatchery fish to passage at a location near entry to salt water (e.g., using PIT tags/detectors or acoustic tags/arrays) and the degree of overlap with natural-origin fish. c) Periodic: Estimate the percent hatchery-origin fish among outmigrating juveniles and, where feasible, estimate total juvenile production.	

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Adult Monitoring	Standard 4.11: Monitoring programs for Coho Salmon allow estimation of the following on an annual basis: a) Probable fishery impacts in ocean and freshwater (recreational and tribal), b) Hatchery returns of hatchery- and natural-origin fish by age, stock and release type, c) Total escapement to individual tributaries important for natural production, d) Proportion of hatchery-origin fish among natural area spawners (pHOS) in individual tributaries important for natural production.	
Evaluation Programs	Standard 4.14: Evaluation programs for Coho Salmon estimate the following attributes on a brood-specific basis: a) Age-3 recruitment (tributary escapements plus hatchery returns). If non-selective ocean fisheries for Coho Salmon are resumed, age-3 recruitment would include ocean catches at age-3. b) Survival from release to age-3 recruitment. Evaluation programs for Coho Salmon evaluate the following fundamental issues on a periodic basis (e.g., every 5 to 10 years): c) Long-term trends in phenotypic traits (age, maturity, fecundity at size, run/spawn timing, size distribution) and genetic traits (divergence among year classes, effective size, divergence from natural populations) of hatchery populations. d) Spatial and temporal overlap and relative sizes of emigrating juvenile hatchery- and natural-origin fish and total (hatchery- plus natural-origin) spawner distribution and densities to assess the likelihood or magnitude of deleterious effects of hatchery-origin fish on naturally spawning fish due to competition, predation, or behavioral effects.	

Culture Phase	Standard	Guideline
Direct Hatchery Effects	Standard 5.1: Hatchery operations/infrastructure is integrated into local watershed restoration efforts to support local habitat restoration activities.	Guideline 5.1.1. Hatchery staff should participate in local habitat restoration planning efforts to help assess the effects of current hatchery operations on future habitat enhancement or vice versa and to plan for operational changes that may become necessary.
	Standard 5.2: Hatchery infrastructure is operated in a manner that facilitates program needs while reducing impacts to aquatic species, particularly listed anadromous salmonids.	Guideline 5.2.1. Water supply intake structures located in anadromous waters should conform with NMFS and CDFW fish screen criteria or other appropriate criteria that matches screen size and approach and sweeping velocity to the target organism. Guideline 5.2.2. Consider screening needs of facility water supply intakes in non-anadromous waters to protect other ESA or CESA listed organisms. Design and operation of facility water diversion/supply structures also needs to consider operational flexibility to avoid catastrophic facility water loss due to debris loading or other failure. Guideline 5.2.3. Barrier weirs should effectively block adult passage either for broodstock congregation/collection or as required for in river fishery management. Guideline 5.2.4. Fish ladders used to circumvent barrier weirs or impoundment structures or that provide access to hatchery adult holding ponds should allow adequate capture of appropriate numbers of target species over the full spectrum of the run and limit passage delay and injury to target species and also to non-target organisms as required by in river fishery management. Guideline 5.2.5. Limit reach specific impacts of hatchery water diversions, such as diminishment of instream flows between diversion and discharge return points. Guideline 5.2.6. All general facility construction and operation should limit effects on the riparian corridor and be consistent with fluvial geomorphology principles (i.e., avoid bank erosion or undesired channel modification).
	Standard 5.3: Effluent treatment facilities are secure and operated to meet NPDES requirements.	

Culture Phase	Standard	Guideline
	Standard 5.4: Current facility infrastructure and construction of new facilities avoid creating an unsafe environment for the visiting public and staff and provide adequate precautions (e.g., fencing and signage) where unsafe conditions are noted.	

14.2) Attachment B: Required monitoring and record keeping responsibilities for evaluation of the long-term performance of the program.

It is expected that the following metrics will serve, in part, as the basis for monthly and/or annual hatchery operations reports submitted to NOAA and CDFW. Additionally, a comprehensive presentation and discussion of the metrics described herein should occur during the fall TOC meeting. Metrics adopted and modified from *California Hatchery Review Project*, *Appendix IV: Required and recommended data collection and reporting* (California HSRG 2012).

1. **Broodstock Collection**
   1.1. Date of Scott Creek weir trap initial opening, and schedule of operation thereafter, including closures or days without successful operation (FED, UCSC).
   1.2. Dates, locations, and life stage(s) collected of any auxiliary trapping/sampling to obtain broodstock from the diversity stratum or elsewhere (FED, UCSC, and MBSTP).
   1.3. Summary of Coho Salmon collections including initial handling date, age (or life stage), gender, origin, and any tissue or scale samples taken (FED, UCSC).
   1.4. Summary of steelhead encountered during trapping/sampling, including collection date, gender, origin, condition, marks/tags issued, any tissue or scale samples taken, and life history information, if known (FED, UCSC).
   1.5. Number of adult Coho Salmon examined for marks/tags; number of marks/tags observed; list of decoded CWT recoveries and all associated biological data collected for those fish (i.e., fork length, age, gender); CWT recoveries submitted to RMIS on a annual basis (FED, UCSC).

2. **Broodstock Selection, Rearing and Inventory Control**
   2.1. Detailed description of broodstock selection protocol (initial fry sorting process) and procedures to ensure maximization of family groups and minimization of full siblings in the broodstock (MBSTP).
   2.2. Report of all PIT tags issued to broodstock population; mean, standard deviation, and frequency distribution of fork length (± 1.0 mm) and mass (± 0.1 g) at time of tagging; and tissue samples collected (FED, UCSC).
   2.3. Report date, location, and identity (PIT tag number) of any fish moved or transported within or among the three broodstock rearing facilities on a timely basis (FED, MBSTP).
   2.4. Report date, location, identity (PIT tag number), and necropsy information for any broodstock mortality on a timely basis (FED, MBSTP, USACE).

3. **Broodstock Spawning**
   3.1. Detailed description of spawner selection protocol, outbreeding strategy, and the selection of excess adults for release (FED, MBSTP).
   3.2. Detailed description of mate partnering protocol (e.g., factorial design), including the number of times individual males were used (FED, MBSTP).
   3.3. Detailed description of spawning method (e.g., rip or air spawn, live or dead) (MBSTP).
   3.4. For each spawn pairing: identity (PIT tag and any secondary marks/tags), spawn date and time, gender, and origin (MBSTP).
   3.5. For each fish euthanized: identity (PIT tag and any secondary marks/tags), date and time, and rationale for euthanasia (MBSTP).
   3.6. For each fish released: identity (PIT tag and any secondary marks/tags), release date and

time, and exact release location (MBSTP).

3.7. Number, identity (PIT tag and any secondary marks/tags) and method used to dispose of carcasses (MBSTP).

3.8. Report calculated effective population size, mean heterozygosity, and mean relatedness coefficient (r_{xy}) and comparisons with historical program data (FED).

4. Egg Fertilization and Collection

4.1. Detailed description of fertilization method and use of extender solutions (e.g., eggs and milt expressed into dry pan then water added) (MBSTP).

4.2. Detailed description of post-fertilization egg disinfection protocol (MBSTP).

4.3. For each female: identity (PIT tag and any secondary marks/tags), estimated mean egg size (eggs per gram from ovary subsample), fecundity (eggs per gram times total ovary weight), by origin and rearing facility (MBSTP, FED).

4.4. For each spawning date (MBSTP):

a) Number and identity (PIT tag <u>and</u> external marks/tags) of females spawned.
b) Number and identity (PIT tag <u>and</u> external marks/tags) of males spawned.
c) Number and identity (PIT tag <u>and</u> external marks/tags) of jacks spawned.

4.5. For each spawning season (MBSTP):

a) Number of green eggs taken (and comparison with historical program data).
b) Mean number of eggs per female (and comparison with historical program data).
c) Mean number of eggs per gram (and comparison with historical program data).
d) Mean number of eggs retained per female (and comparison with historical program data), include description of estimation method.

5. Incubation

5.1 Detailed description of incubation methods (e.g., trays or jars, flow rates, and loading rates for green eggs and eyed-eggs) (MBSTP).

5.2 Detailed description of culling/disposal protocol used, including purpose (MBSTP).

5.3 For each spawning date and female × male spawn pairing:

a) Number of eyed-eggs retained (MBSTP).
b) Number of eggs culled/disposed of (MBSTP).

5.4 Survival through the following life stages tracked independently for female × male cross, and the comparison of season rates with historical program data:

a) Green egg to eyed-egg (MBSTP).
b) Eyed-egg to hatched egg (MBSTP).
c) Hatched egg to ponding (MBSTP).

6. Ponding and Rearing

6.1. Detailed description of ponding/rearing facilities used (MBSTP).

6.2. Detailed description of diet and feeding regimen (MBSTP).

6.3. For each spawning season:

a) Number of fish ponded (and comparison with historical program data) (MBSTP).
b) Size of fish ponded (and comparison with historical program data) (MBSTP).

6.4. For each rearing unit/tank, at periodic intervals (no greater than monthly):

a) Flow index (MBSTP).
b) Density index (MBSTP).

c) From a representative sample of fish ($N \geq 100$): mean, standard deviation, and frequency distribution of fork lengths (and comparison with historical program data) (MBSTP).
d) Size: mean mass (fish per pound), include description of method (MBSTP).
e) Fulton's condition factor: paired measurements of fork length and mass ($N \geq 50$) (MBSTP).

6.5. Survival through the following life stages, and comparison of annual rates with historical program data (MBSTP):
a) Ponding (fry) to parr.
b) Parr to smolt.
c) Ponding (fry) to release, if not captured in above growth intervals.

7. Marking/Tagging of Production Fish

7.1. Detailed description of methods used for marking/tagging fish prior to release, including method of selecting fish that receive marks/tags (FED, MBSTP, UCSC).
7.2. For each rearing unit/tank, number and percentage of fish marked/tagged by mark/tag-type and date (FED, MBSTP, and UCSC).
7.3. For each rearing unit/tank, number of fish culled during marking/tagging and reason (e.g., deformity, injury, disease, etc.) (FED, MBSTP, UCSC).
7.4. Number of marks/tags lost prior to release by mark/tag-type (FED, MBSTP, and UCSC).
7.5. Report tag/batch codes to relevant databases (i.e., those maintained by RMIS and FED) on a timely basis (FED, MBSTP).

8. Juveniles Released

8.1. Detailed description of methods used to release fish (FED, MBSTP).
8.2. For each rearing unit/tank, just prior to release: mean, standard deviation, and frequency distribution of fork length ($N \geq 100$) and tank temperature (FED, MBSTP)
8.3. For each group released (FED, MBSTP):
a) Date of release.
b) Number of marked/tagged fish released.
c) Location of release.
d) Water temperature at release site.
e) From a representative sample of fish released: fork length (mean, standard deviation, and frequency distribution; $N \geq 100$), if different from 8.2.
f) Release method, including transport method, transport container water temperature and acclimatization process (if applicable).
g) Report PIT tag/CWT release information to relevant databases on a timely basis.

9. Fish Health

9.1. Detailed records of disease monitoring, prevalence and treatments, including:
a) Five-year adult disease history, including BKD control strategy and efficacy (FED, MBSTP).
b) Pre-spawn mortality rate of broodstock collected by gender (if known) and origin (FED, MBSTP).
c) Diagnostic and routine juvenile fish health monitoring, including health status at release/pathology reports (FED, MBSTP).

d) Efficacy of treatments including drug sensitivity testing of bacterial pathogens and efficacy of antibiotic medicated feed treatments (FED, MBSTP).
e) Annual status of specific fish pathogen management strategies identified in Fish Health Management Plans or by the Technical Oversite Committee (MBSTP).

10. Water Supply

10.1. Detailed description of water source and quality (FED, MBSTP).
10.2. Detailed description of water temperature controls (FED, MBSTP).
10.3. Daily mean, minimum, and maximum water temperatures at KFH (daily temperature units) (FED, MBSTP).
10.4. Summary of daily stream flows from stream gage on mainstem Scott Creek (FED).
10.5. Summary of annual sandbar dynamics (FED).
10.6. Any water supply problems (FED, MBSTP).

11. Maintenance and Equipment

11.1. Major maintenance issues (FED, MBSTP, UCSC).
11.2. Equipment acquisition (FED, MBSTP, UCSC).
11.3. Infrastructure acquisition and/or modification (FED, MBSTP, UCSC).

14.3) Attachment C: Fish Health Management Plan

Performance Standards

To protect anadromous fishery resources, health care standards must be followed to prevent the importation, dissemination, and amplification of pathogens and disease known to adversely affect fish. These standards will include:

1. Hatchery visits by CDFW fish pathologists or veterinarians
   - 1.1. Visits will be conducted when hatchery managers have fish health concerns, fish exhibit signs of disease or stress, or fish losses increase.
   - 1.2. Disease investigations/necropsies will be conducted by a qualified fish health specialist or veterinarian.
   - 1.3. A representative sample of fish from each lot of concern will be examined. Number of fish examined is at the discretion of fish health specialist or veterinarian.
   - 1.4. Fish culture practices may be reviewed with hatchery manager if needed.
   - 1.5. Disease investigations/fish necropsies will be recorded in a pathologist report.
   - 1.6. Appropriate drug or chemical treatments may be recommended. Recommendations will be recorded in a pathologist report. Any required prescriptions or veterinary feed directives will be included with report.
   - 1.7. Fish health status may be assessed prior to release or transfer to another facility.

2. Broodstock inspection programs for fish pathogens
   - 2.1. All broodstock will be examined annually examine for the presence of reportable viral pathogens. Number of individuals examined per stock will vary according to management objectives. However, the minimum number would be at the 5% Assumed Pathogen Prevalence Levels (APPL), with a 95% confidence of finding the pathogen (generally 60 fish). Tissues and fluids tested may include kidney, ovarian fluid and possibly milt following American Fisheries Society (AFS) "Fish Health Blue Book" procedures.
   - 2.2. All broodstock will be screened annually for the presence of *Renibacterium salmoninarum* (the causative agent of bacterial kidney disease or BKD). Methodology should follow AFS "Fish Health Blue Book" procedures. If stocks allow, culling of eggs from females testing positive for *R. salmoninarum* may be indicated.
   - 2.3. Inspections and sample collection will be conducted by, or under the supervision of a CDFW fish health professional or veterinarian.

3. Hatchery sanitation procedures
   - 3.1. The acquisition of pathogen-free water at each facility will be investigated and pursued, especially for incubation and early rearing.
   - 3.2. The following hatchery sanitation procedures are recommended and should be implemented and monitored:
     - a. Disinfect/water harden eggs in iodophor. Eggs should be disinfected prior to entering "clean" incubation areas. In high-risk situations, disinfect eggs again after shocking and picking.
     - b. Place foot baths containing disinfectant at the incubation facility's entrance and exit.

c. Use separate equipment/raingear in spawning and rearing areas. Sanitize equipment between tanks or use separate equipment for all rearing tanks.
d. Disinfect equipment, including vehicles used to transfer eggs or fish between facilities, prior to use with any other fish lot or at any other location. Disinfecting water should be disposed in designated areas in compliance with water board requirements.
e. Sanitize rearing vessels after fish are removed and prior to introducing a new fish lot or stock.
f. Properly dispose of dead fish.

4. Water quality parameters
   4.1. Water supplies that provide acceptable temperature regimes for eggs, juvenile, and adult salmonids should be used.
   4.2. Dissolved gases should be near saturation for oxygen and below saturation for nitrogen.
   4.3. Water chemistry at any site must meet the quality required by salmonids.
   4.4. Chemical parameters should be measured to establish baseline data. If disease occurs, water chemistry may be checked for variance from the baseline, if recommended by a fish health specialist.
   4.5. Pathogen-free water is desirable at all facilities for both incubation and rearing.
   4.6. When using surface water for rearing, the source should be screened to prevent fish and other aquatic biota from entering and to minimize inflow of debris.

5. General culture practices
   5.1. Refer to hatchery performance standards.

6. Egg and fish transfer requirements
   6.1. Any non-routine egg or fish transfers into this facility must be approved by a CDFW fish health professional or veterinarian, the CDFW Fish Health Coordinator, and the CDFW program manager for fish production.
   6.2. Any natural-origin fish brought into the facility will be treated to minimize the risk of pathogens and held in isolation from all other fish in the facility. Isolation tank(s) should have their own cleaning and maintenance equipment.

7. Communication among program partners
   7.1. MBSTP, the Corps, and FED will communicate any matters related to hatchery operations and health concerns specific to the Program to NMFS, FED, and CDFW representatives listed in Section 1.3.

8. Regulatory compliance
   8.1. Only therapeutants approved by federal and state regulators, "low regulatory priority" therapeutants, therapeutants authorized under an Investigational New Animal Drug (INAD) application or authorized by extra-label prescription by a California licensed veterinarian, will be used to treat fish. All treatments will be approved by an appropriate fish health professional or veterinarian.
   8.2. Hatchery managers will be responsible for obtaining proper authorization prior to use of any therapeutants.

8.3. Use of therapeutants must be in compliance with established water quality discharge regulations and permits.

9. Research
    9.1. Applied research will be developed and implemented on an as-needed basis.

10. Identification of future needs of the fish health program
    10.1. Future fish health needs will be identified and implemented, as they arise, depending on priority, funding, and availability of personnel.

14.4) Attachment D: Authorized Take of CCC Coho Salmon Associated With Program Activities: Broodstock Collection, Spawning, Captive Rearing at Program Facilities, and Releases to Program Streams.

Table 34. Authorized annual take of CCC Coho Salmon associated with broodstock collection. Fish collection, using existing traps (e.g., Scott Creek adult weir and juvenile outmigrant traps) and other methods such as backpack electrofishing and seining, is covered under section 10(a)(1)(A) research permit 17292-3R, or research permits held by program partners for other regional monitoring activities.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Observe/Collect Method	Procedures	Details
Natural	Adult	Male and Female	150	3	Collect, Sample, and Transport Live Animal	Weir (only if associated with fish handling)	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale	Transport of fish from SCMDS streams to KFH for spawning. Coverage for capture (trap, seine, etc.) is provided under research permit 17292-3R, or permits held by other regional partners. Tagging may include Petersen disc tags.
Listed Hatchery Intact Adipose	Adult	Male and Female	150	3	Collect, Sample, and Transport Live Animal	Weir (only if associated with fish handling)	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale	Transport of fish from SCMDS streams to KFH for spawning. Coverage for capture (trap, seine, etc.) is provided under research permit 17292-3R, or permits held by other regional partners. Tagging may include Petersen disc tags.
Natural	Juvenile	Male and Female	600	30	Collect, Sample, and Transport Live Animal	Electrofishing, Backpack	Anesthetize; Tag, Coded-Wire; Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale	Transport of fish from SCMDS streams to KFH for captive rearing and spawning. Coverage for capture (electrofishing, seine, etc.) is provided under research permit 17292-3R, or permits held by other regional partners.

Table 35. Authorized annual take of CCC Coho Salmon associated with spawning activities. No more than 300 Age 2+ coho salmon (NOR or HOR) will be spawned annually. Includes transport and spawning up to 50 outbreeders provided by the Russian River Coho Salmon Captive Broodstock Program. *Spawning may occur at DCFH in an emergency.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Observe/Collect Method	Procedures	Details
Natural	Adult	Male and Female	300	--	Intentional (Directed) Mortality	Adult Fish Facility		Sacrifice for spawning.
Listed Hatchery Intact Adipose	Adult	Male and Female	300	--	Intentional (Directed) Mortality	Adult Fish Facility		Sacrifice for spawning.
Listed Hatchery Intact Adipose	Adult	Male and Female	50	--	Intentional (Directed) Mortality	Adult Fish Facility		Sacrificed for spawning. Outbreeders from the Russian River Coho Salmon Captive Broodstock Program

Table 36. Authorized annual take of CCC Coho Salmon associated with captive rearing and procedures implemented at Kingfisher Flat Hatchery. *rearing may occur at emergency use facilities - see HGMP.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
Listed Hatchery Intact Adipose	Egg	Male and Female	300,000	150,000	Collect, Sample, and Transport Live Animal		Annual maximum number of viable eggs harvested. Assumes indirect mortality up to ponding of fry.
Listed Hatchery Intact Adipose	Juvenile	Male and Female	200,000	60,000	Collect, Sample, and Transport Live Animal	Anesthetize; Tag, Acoustic or Sonic (Internal); Tag, Coded-Wire; Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale	Rearing of Age 0+ (fry to parr) production fish and broodstock.
Natural	Adult	Male and Female	120	24	Collect, Sample, and Transport Live Animal	Tag, Floy; Tissue Sample Fin or Opercle	Rearing of NOR Age 2+ captive broodstock at KFH. Tagging may include Petersen disc tags.
Listed Hatchery Intact Adipose	Adult	Male and Female	120	24	Collect, Sample, and Transport Live Animal	Tag, Floy; Tissue Sample Fin or Opercle	Rearing of HOR Age 2+ captive broodstock at KFH. Tagging may include Petersen disc tags.
Natural	Juvenile	Male and Female	120	24	Collect, Sample, and Transport Live Animal	Anesthetize; Tag, Acoustic or Sonic (Internal); Tag, Coded-Wire; Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale	Rearing of NOR Age 1+ captive broodstock at KFH

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
Listed Hatchery Intact Adipose	Juvenile	Male and Female	120	24	Collect, Sample, and Transport Live Animal	Anesthetize; Tag, Acoustic or Sonic (Internal); Tag, Coded-Wire; Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale	Rearing of HOR Age 1+ captive broodstock at KFH
Listed Hatchery Intact Adipose	Juvenile	Male and Female	240	--	Intentional (Directed) Mortality		Intentional mortality for CDFW pathology assessment. Up to 4 groups of 60 fish per year.

Table 37. Authorized take of CCC Coho Salmon associated with captive rearing, transport, and procedures implemented at SWFSC's FED facility. A combined total of 80 Age 1+ and 80 Age 2+ NOR and/or HOR fish reared in captivity annually.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
Natural	Juvenile	Male and Female	80	16	Collect, Sample, and Transport Live Animal		Transport of Age 1+ fish from KFH to SWFSC FED for rearing to adult. Procedures covered in KFH Rearing Table.
Listed Hatchery Intact Adipose	Juvenile	Male and Female	80	16	Collect, Sample, and Transport Live Animal		Transport of Age 1+ fish from KFH to SWFSC FED for rearing to adult. Procedures covered in KFH Rearing Table.
Natural	Adult	Male and Female	80	16	Collect, Sample, and Transport	Tag, Floy; Tissue Sample Fin or Opercle	Rearing of Age 2+ fish at SWFSC FED, and transport to KFH for spawning. Other procedures covered in KFH

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
					Live Animal		Rearing Table. Tagging may include Petersen disc tags.
Listed Hatchery Intact Adipose	Adult	Male and Female	80	16	Collect, Sample, and Transport Live Animal	Tag, Floy; Tissue Sample Fin or Opercle	Rearing of Age 2+ fish at SWFSC FED, and transport to KFH for spawning. Other procedures covered in KFH Rearing Table. Tagging may include Petersen disc tags.

Table 38. Authorized take of CCC Coho Salmon associated with captive rearing, transport, and procedures implemented at Don Clausen Fish Hatchery. A combined total of 180 Age 1+ and 180 Age 2+ NOR and/or HOR fish reared annually. Includes transport of Age 2+ fish to Kingfisher Flat Hatchery for spawning.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
Natural	Juvenile	Male and Female	180	36	Collect, Sample, and Transport Live Animal		Transport of Age 1+ fish from KFH to DCFH for rearing to adult. Procedures applied to these fish covered under KFH Rearing Table.
Listed Hatchery Intact Adipose	Juvenile	Male and Female	180	36	Collect, Sample, and Transport Live Animal		Transport of Age 1+ fish from KFH to DCFH for rearing to adult. Procedures applied to these fish covered under KFH Rearing Table.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
Natural	Adult	Male and Female	180	36	Collect, Sample, and Transport Live Animal	Tag, Floy; Tissue Sample Fin or Opercle	Rearing of Age 2+ fish at DCFH, and transport to KFH for spawning. Tagging may include Petersen disc tags.
Listed Hatchery Intact Adipose	Adult	Male and Female	180	36	Collect, Sample, and Transport Live Animal	Tag, Floy; Tissue Sample Fin or Opercle	Rearing of Age 2+ fish at DCFH, and transport to KFH for spawning. Tagging may include Petersen disc tags.

Table 39. Authorized take of CCC Coho Salmon associated with the transport of fish from program facilities and release into program streams in the Santa Cruz Mountains Diversity Stratum.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
Listed Hatchery Intact Adipose	Egg	Male and Female	100,000	2,000	Collect, Sample, and Transport Live Animal		Transport of fertilized eggs from KFH and released to SCMDS program streams. May include use of Remote Site Incubators.
Listed Hatchery Intact Adipose	Fry	Male and Female	100,000	2,000	Collect, Sample, and Transport Live Animal		Transport of Age 0+ (fry) from KFH and released to SCMDS program streams. Procedures covered in KFH Rearing table.

Production/Origin	Life Stage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures	Details
Listed Hatchery Intact Adipose	Juvenile	Male and Female	70,000	1,400	Collect, Sample, and Transport Live Animal		Transport of Age 0+ (parr or advanced parr) from KFH and released to SCMDS program streams. Procedures covered in KFH Rearing table.
Listed Hatchery Intact Adipose	Smolt	Male and Female	70,000	1,400	Collect, Sample, and Transport Live Animal		Transport of Age 1+ from KFH and released to SCMDS program streams. Procedures covered in KFH Rearing table.
Listed Hatchery Intact Adipose	Adult	Male and Female	380	8	Collect, Sample, and Transport Live Animal		Transport of Age 2+ from KFH and released to SCMDS program streams. Procedures covered in KFH, DCFH, or FED Rearing tables.
Listed Hatchery Intact Adipose	Spawned Adult/ Carcass	Male and Female	380	--	Observe / Sample Tissue Dead Animal	Maxillary Clip	Transport of spawned carcasses from KFH for release into SCMDS program streams for nutrient enrichment. Carcasses would receive external hog/jaw tag. Carcasses may also be shared with academic institutions for scientific purposes.

14.5) Attachment E: Emergency Use Facilities

In the event of unforeseen emergencies, the primary facilities used by the program may be deemed unsuitable, or have reduced capacity, to maintain Coho Salmon in safe conditions. Emergencies may stem from drought, flood, wildfires, or operational constraints/damage sustained at any of the primary facilities. During these emergencies, the program may rely upon alternative (emergency use) facilities located in the Central California region to accommodate program activities (Figure 17). The use of these facilities, including the transport, rearing and spawning activities, will not alter the take authorizations outlined in Attachment D. The program already includes the transport of Coho Salmon between KFH and DCFH, which are approximately 270 km (or approximately 3.5 hours) apart. Each of the emergency use facilities are located within this distance and therefore would not introduce a larger transport distance, but would increase the number of potential transport trips (Figure 17).

14.5.1) Don Clausen Fish Hatchery, Sonoma County (Spawning)

Under emergency conditions and with approval from the Corps, up to 200 adult (age-2^{+}) Coho Salmon may be transferred to DCFH where they would join the approximately 180 age-2^{+} fish normally reared there, and spawned. DCFH was used for spawning during the winter of 2020–2021, following the severe damage to facilities at KFH where program spawning typically occurs.

Transport. Coho Salmon will be transported by program staff from FED or MBSTP using the tanker trucks and equipment described in Section 7.6 of the HGMP. Transport times will be approximately 3.5 hours (KFH or FED to DCFH). Adult fish will not be fed for two days prior to transfer. Adult fish not used for spawning will be transported back to SCMDS streams and released.

Facility. A description of DCFH is provided in Section 5 of the HGMP.

Spawning. Spawning would occur in an indoor facility at DCFH per the direction of the Corps. Spawning would be conducted by program staff from MBSTP and FED and would follow the protocols and procedures outlined in Section 8 of the HGMP.

Final Disposition. Adult Coho Salmon would be spawned at DCFH and fertilized eggs would be immediately transported to other program facilities for incubation and subsequent rearing. Carcasses may be retained for nutrient enhancement in SCMDS streams, or disposed of as outlined in Section 7.8 of the HGMP.

14.5.2) United Anglers of Casa Grande Facility, Sonoma County (Incubation and Rearing)

Under emergency conditions, up to 80,000 fertilized eggs and/or 50,000 juvenile Coho Salmon from KFH, DCFH, or FED facilities may be transported to and temporarily incubated/reared at the United Anglers of Casa Grande Facility (UACG). The juvenile Coho Salmon may consist of multiple age classes (age-0 and age-1) and include both captive broodstock and production fish. The SCSCBP will utilize UACG when rearing conditions at one or more of the program facilities is deemed a risk to the health and survival of the Coho Salmon.

Transport. Coho Salmon will be transported by program staff from FED or MBSTP using the tanker trucks and equipment described in Section 7.6 of the HGMP. Transport times will range from approximately 1 hour (DCFH to UACG) to approximately 2.5 hours (KFH to UACG). Juvenile fish will not be fed for two days prior to transfer.

Facility. UACG is located at Casa Grande High School in the City of Petaluma, Sonoma County, California. A full description of UACG, including its water supply, available rearing space and standard operating procedures and risk aversion measures, is described in the draft Rescue and Rearing Management Plan (RRMP) for Petaluma River Steelhead (UACG 2021). The UACG facility is supplied with groundwater from a well located onsite. The well water is filtered and chilled to as low as 13°C and then is ran through a UV filtration system before discharging to rearing areas. UACG has four indoor cement raceways (9.5 m × 1.5 m × 1.5 m) and two fiberglass troughs (0.6 m × 0.6 m × 3 m). In addition, FED can relocate four, 2.4 meter circular rearing tanks with a capacity of approximately 6,800 L to UACG for additional rearing space. Actual rearing location for fish will depend on the abundance of fish at the facility and life stage. The age-1^{+} broodstock will be prioritized for rearing in the circular tanks. UACG utilizes a recirculated aquaculture system (RAS) to conserve water and to increase the quality and reliability of source water to the facility. The RAS system uses a process of physical and biological filters to remove waste and recirculate treated water back into the facility. UACG has an alarm system that will contact the facility manager in case of a power outage, or if flows become too low in any of the raceways or rearing tanks. If a power outage occurs, UACG has a generator onsite that is capable of running the water circulation system. In the event of a failure of the well pump, the system can temporarily run-on recycled water until the failure is corrected.

Rearing. Rearing protocols and procedures will follow Section 9.2 of the HGMP including life stage specific feeding protocols (food and ration), monthly growth checks, and fish health monitoring (i.e., disease checks and treatment). Fish densities will follow USFWS guidelines (Piper et al. 1982). Juvenile fish at program facilities will receive a pathology screening by CDFW prior to transport to UACG. Authorized staff from UACG, MBSTP, FED, and potentially the Corps would provide husbandry for the Coho Salmon held at UACG.

Final Disposition. Once local conditions have improved at the program's facilities, Coho Salmon broodstock transferred incubated and or reared at UACG will be returned to KFH, FED, and or DCFH. All production fish temporarily reared at UACG will be brought back to KFH and acclimated for a minimum of two weeks prior to release into SCMDS streams. Coho Salmon will from the program will not be released into the Petaluma River watershed under any circumstances. All fish will be transported back to program facilities using the equipment outlined in Section 7.6.

14.5.3) Powder Mill Rearing Facility, Santa Cruz County (Rearing)

Under emergency conditions, up to 25,000 juvenile Coho Salmon from KFH, DCFH, or FED facilities may be transported to, and temporarily reared at, MBSTP's Powder Mill Creek satellite rearing facility (Powder Mill) located in Paradise Park, Santa Cruz.

Transport. Coho Salmon will be transported by program staff from FED or MBSTP using the tanker trucks and equipment described in Section 7.6 of the HGMP. Transport times would range from approximately 0.5 hours (FED to Powder Mill) to approximately 4.0 hours (DCFH to Powder Mill). However, the use of Powder Mill would most likely be for juvenile fish reared at KFH. Juvenile fish will not be fed for two days prior to transfer.

Facility. Powder Mill consists of one, 6-meter circular tank fed by two unscreened diversion intake points on Powder Mill Creek. Powder Mill will only be used for rearing when water quantity and quality (temperature) in Powder Mill Creek are suitable for Coho Salmon.

Rearing. Rearing protocols and procedures will follow Section 9.2 of the HGMP including life stage specific feeding protocols (food and ration), monthly growth checks, and fish health monitoring (i.e., disease checks and treatment). Fish densities will follow USFWS guidelines (Piper et al. 1982). Juvenile fish at program facilities will receive a pathology screening by CDFW prior to transport to Powder Mill.

Final Disposition. Once local conditions have improved at the program's facilities, broodstock fish transferred to Powder Mill will be returned to their facility of origin. All production fish temporarily reared at Powder Mill Rearing Facility will either be brought back to KFH or released directly into SCMDS streams. All fish will be transported back to program facilities or SCMDS streams using the equipment outlined in Section 7.6.

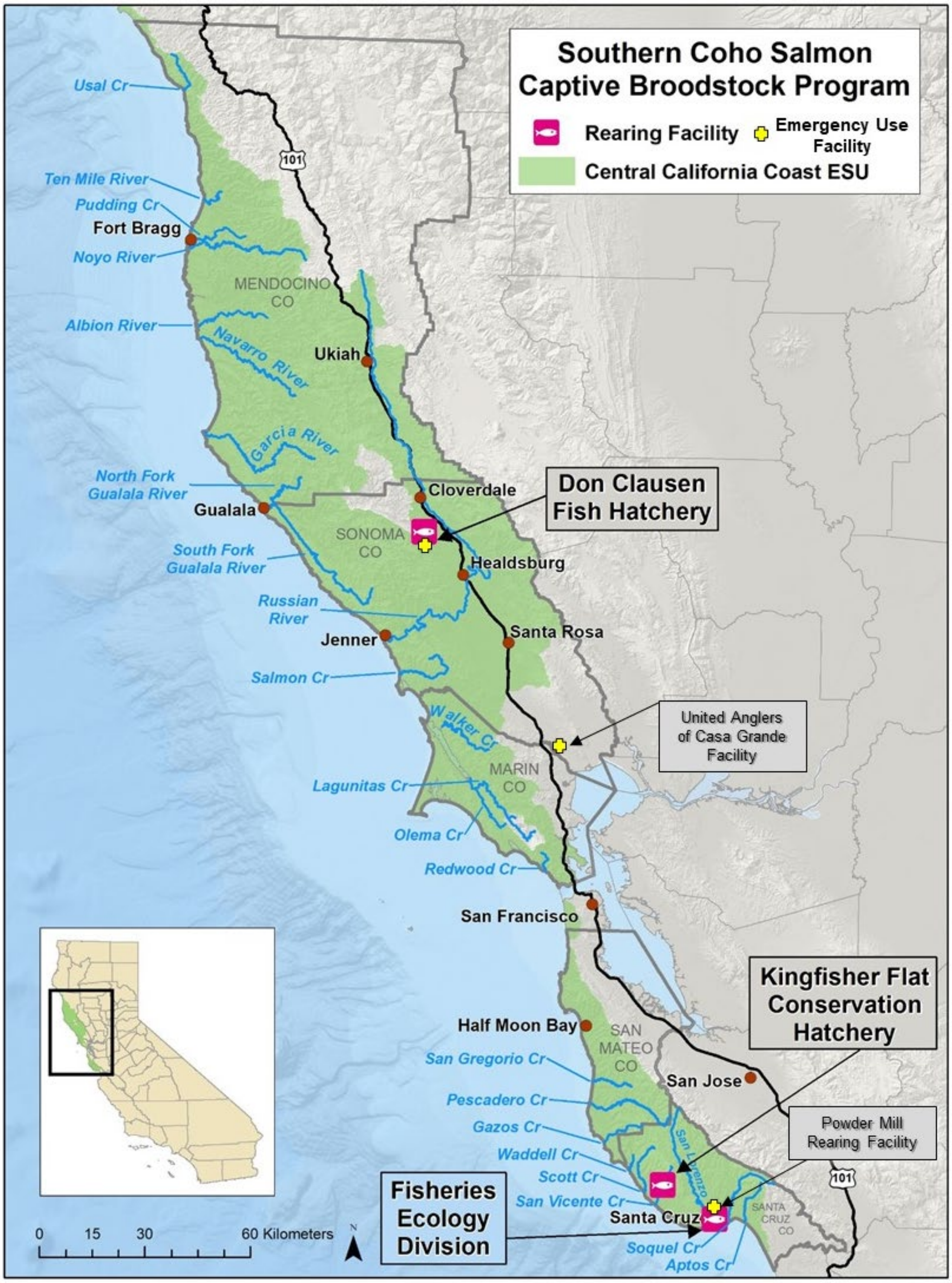

Figure 17. Locations of the primary (KFH, FED, and DCFH) and potential emergency use (Casa Grande and Powder mill) facilities for the SCSCBP.

SECTION 15. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the foregoing information is complete, true and correct to the best of my knowledge and belief. I understand that the information provided in this HGMP is submitted for the purpose of receiving limits from take prohibitions specified under the Endangered Species Act of 1973 (16 U.S.C.1531–1543) and regulations promulgated thereafter for the proposed hatchery program, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or penalties provided under the Endangered Species Act of 1973."

Name, Title, and Signature of Applicant:

Digitally signed by Steve Lindley
Date: 2023.02.14 11:50:17 -08'00'

Certified by: ______________________ Date :____________

Name: Steve Lindley

Title: Director, Fisheries Ecology Division, SWFSC

Finding of No Significant Impact for the Issuance of an Endangered Species Act Section 10(a)(1)(A) Enhancement Permit to the National Marine Fisheries Service Southwest Fisheries Science Center Fisheries Ecology Division for the Operation of the Southern Coho Salmon Captive Broodstock Program

EAXX-006-48-1WC-1727751168

I. Purpose of Finding of No Significant Impact (FONSI):
The National Environmental Policy Act (NEPA) requires the preparation of an Environmental Impact Statement (EIS) for any proposal for a major federal action significantly affecting the quality of the human environment. 42 U.S.C. § 4332(C). Agencies may issue a Finding of No Significant Impact (FONSI) if they determine that a proposed agency action will not have a significant effect on the human environment and therefore does not require the issuance of an EIS.

In preparing this FONSI, we reviewed the Final Environmental Assessment (EA) for the Issuance of an Endangered Species Act Section 10(a)(1)(A) Enhancement Permit to the National Marine Fisheries Service Southwest Fisheries Science Center Fisheries Ecology Division (FED) for the Operation of the Southern Coho Salmon Captive Broodstock Program (Program) which evaluates the affected environment and the environmental effects of the proposed action and alternatives (including the duration of impact, and whether the impacts were adverse and/or beneficial and their magnitude).

II. Approach to Analysis:
The following two alternatives were evaluated in the EA:

- Alternative 1 (No-Action) - NMFS does not issue the ESA Section 10(a)(1)(A) enhancement permit 25803 such that coho salmon production would cease until a new permit application and HGMP are submitted and the applicants are granted an ESA section 10(a)(1)(A) enhancement permit.

- Alternative 2 (Proposed Action) - NMFS issues the ESA Section 10(a)(1)(A) enhancement permit 25803 for the program such that coho salmon production would be conducted in accordance with the HGMP.

III. Context:
The Program consists of three primary activities – collection of Central California Coast (CCC) coho salmon (*Oncorhynchus kisutch*) from Program watersheds for use as broodstock, artificial propagation and rearing at existing Program facilities, and the release of hatchery-origin coho salmon into Program watersheds for population enhancement. FED will be the permit holder; however, the Program will be jointly operated with the Monterey Bay Salmon and Trout Project (MBSTP), with other logistical support provided by the United States Army Corps of Engineers (Corps) and the California Department of Fish and Wildlife (CDFW).

The Program is operated at three existing facilities in California – Kingfisher Flat Hatchery, located in the Scott Creek watershed of Santa Cruz County, FED laboratory, located in the City of Santa Cruz, and at the Don Clausen Fish Hatchery, located in Sonoma County. Don Clausen Fish

Hatchery is owned and operated by the Corps. Adult and juvenile coho salmon are collected from coastal watersheds of the Santa Cruz Mountains for use as broodstock. Juvenile (and some adult) fish produced by the Program are mostly released into streams of the Santa Cruz Mountains in accordance with the release strategies set forth in the Hatchery Genetic Management Plan (HGMP), and a smaller subset of the production fish are retained for use as captive broodstock.

The coastal watersheds of the Santa Cruz Mountains included in the Program extend from San Gregorio Creek in San Mateo County to Aptos Creek in Santa Cruz County. These watersheds are largely rural and primarily covered in coniferous forests consisting of coast redwood and Douglas fir. Land uses include recreation (i.e., parks and other protected areas), selective timber harvest, agriculture, and urban (e.g., City of Santa Cruz). Other sensitive resources that may be affected by the Program include natural-origin CCC steelhead (*O. mykiss*), which are listed as threatened under the ESA and are widely distributed throughout each of the Program watersheds.

The primary natural resource used by the Program is water – See Section 3 Affected Environment of the EA. The use of fresh and saltwater at the three program facilities is non-consumptive. Intakes are screened to prevent entrainment of organisms, and the effluent from each of the facilities is managed for compliance with California Regional Water Quality Control Board criteria and applicable National Pollution Discharge Elimination System (NPDES) permits that are designed to protect water quality and other beneficial uses.

The issued permit would allow the Program to continue as described in the HGMP for a period of up to 10 years. However, due to the imperiled status of coho salmon populations in the Santa Cruz Mountains Diversity Stratum, NMFS anticipates the Program will be needed beyond 10 years and into the foreseeable future. In addition to the HGMP, implementation of the Program is guided by a Technical Oversight Committee (TOC) that consists of staff from NMFS, FED, MBSTP, and CDFW. The TOC meets regularly throughout the year to discuss Program performance, the need for corrective measures, and the implementation of Program strategies (e.g., annual release plans, broodstock needs, etc.).

IV. Intensity:

As described in the HGMP, the operation of the Program would include implementation of several risk aversion measures to minimize the likelihood for adverse genetic and ecological effects, effects to water resources (described above), and other listed species. Fish collection and release activities are not expected to have any adverse effects on the natural environment (i.e., no new infrastructure, no physical alterations to creek banks or bottom, or to riparian vegetation).

The Program is expected to result in low or negligible adverse effects and high to negligible beneficial effects on coho salmon and CCC steelhead. The release of juvenile hatchery-origin coho salmon into Program watersheds is expected to have low, adverse effects on wild coho salmon and steelhead juveniles through increased potential for predation and competition. To reduce or avoid these effects, the Program has adopted measures such as using downstream release locations and smaller batched releases. Also, many CCC coho salmon populations have been extirpated and therefore releases into these watersheds are not likely to result in adverse effects to natural-origin CCC coho salmon. To reduce the risk of inbreeding depression and to boost depleted genetic diversity in these watersheds, the Program uses a genetically-based spawning matrix each year for selecting mates for spawning. This approach reduces relatedness among spawn pairs compared to traditional random mating. Also, to further diversify regional genetics, the Program may import

CCC coho salmon from other neighboring regions (i.e., sourced from the Russian River Broodstock Program). NMFS expects that future increases in the abundance of adult coho salmon returning to these watersheds as a result of the Program will have an overwhelmingly beneficial effect to coho salmon recovery by increasing the numbers and diversity of fish, expanding occupancy and spatial structure, and enhancing genetic diversity, in addition to ecology benefits to streams stemming from carcass nutrient enrichment.

The proposed action is not expected to have significant effects on essential fish habitat (EFH) for Pacific Coast Salmon. NMFS evaluated the potential impacts of the proposed action on Pacific Coast salmon EFH pursuant to Section 305(b)(2) of the Magnuson-Stevens Act. During hatchery releases, competition for habitat between hatchery and natural-origin fish may occur and will be minimized by adaptively managing releases to account for natural abundances and habitat capacity. As noted above, the proposed action may benefit EFH for Pacific Coast Salmon by increasing the quantity of marine-derived nutrients in the riparian areas from returning adults thereby enhancing stream food webs.

The program will use existing facilities and roadways, which already avoid culturally important artifacts, and as such there will be no significant effects to cultural resources. If the Program is successful, and coho salmon populations recover, tribal trust assets and use for cultural purposes may be reinstated resulting in negligible beneficial effects to tribal cultural practices. Lastly, the Program will not interact with any resources listed or eligible for listing in the National Register of Historic Places.

V. Other Actions Including Connected Actions:
In Section 5 of the EA, NMFS evaluated the reasonably foreseeable effects of the proposed action with other actions that have occurred, are occurring, or are reasonably certain to occur in the same geographic area as the Program. These actions include timber harvest, water diversions, habitat restoration, a potential steelhead hatchery program by MBSTP, and the ongoing California recreational steelhead fishery. As described in the EA, when considered together, the effects of these ongoing or future activities with the anticipated effects of continuing the Program are not expected to result in synergistically significant impacts. Instead, NMFS expects the Program, coupled with ongoing habitat restoration, will improve salmon recovery by: restoring species to their historically occupied basins; increasing abundance; and making populations more resilient to disturbances. The proposed continuation of the hatchery program is not connected to or reliant upon other actions.

VI. Mitigation and Monitoring:
There are no mitigation measures proposed or required. FED will track performance of the Program through in-hatchery and field monitoring. In-hatchery performance monitoring will consist of several activities including tracking survival across life stages of each cohort in captivity (e.g., egg to fry survival), as well as genetic diversity and relatedness of spawning pairs. Field monitoring will include both passive and active monitoring, where passive monitoring will consist of detections of previously tagged fish at fixed counting (tag detection) stations, and active monitoring will consist of juvenile abundance surveys, or adult trapping, and or spawning ground surveys. These ongoing monitoring activities are already authorized under existing section 10(a)(1)(A) research and enhancement permits held by FED as well as other regional partners (e.g., CDFW, and the County of Santa Cruz). Annual reports for these monitoring activities are a requirement of the issued section 10(a)(1)(A) permits held by FED and other program partners.

DETERMINATION

Based on the *Final Environmental Assessment for the Issuance of an Endangered Species Act Section 10(a)(1)(A) Enhancement Permit to the National Marine Fisheries Service Southwest Fisheries Science Center Fisheries Ecology Division for the Operation of the Southern Coho Salmon Captive Broodstock Program*, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service has determined in this Finding of No Significant Impact (FONSI) that preparation of an EIS is not required because the proposed action will not have significant effects. All adverse impacts of the proposed action as well as mitigation measures have been evaluated to reach this conclusion of no significant impacts.

Jennifer Quan Regional Administrator West Coast Region National Marine Fisheries Service	6/12/2025 Date