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

4d Limit for the Trinity River Coho Salmon Hatchery and Genetic Management Plan

NMFS Consultation Number: WCRO-2019-03414

Action Agency: NOAA's National Marine Fisheries Service

Table 1. Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Southern Oregon Northern California Coast coho salmon ESU	Threatened May 6, 1997 (62 FR 24588)	Yes	No	Yes	No
Southern Resident Killer Whale DPS	Endangered November 18, 2005 (70 FR 69903)	No	No	No	No
Southern DPS of Eulachon	Threatened March 18, 2010 (75 FR 13012)	No	No	No	No
Southern DPS of Green Sturgeon	Threatened April 6, 2006 (71 FR 17757)	No	No	No	No

Table 2. Essential Fish Habitat and NMFS' Determinations:

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

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

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: June 11, 2020

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1. INTRODUCTION

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

1.1 Background

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

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

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

The U.S. Bureau of Reclamation (Reclamation) and California Department of Fish and Wildlife (CDFW) provided NMFS with a Hatchery and Genetics Monitoring Plan (HGMP) for the Trinity River coho salmon hatchery program and associated monitoring and evaluation actions. The HGMP provides the framework through which Reclamation and CDFW can manage hatchery operations, monitoring, and evaluation activities, while meeting requirements specified under the ESA. The Trinity River Hatchery (TRH) HGMP outlined the Southern Oregon/Northern California Coast (SONCC) coho salmon breeding and associated monitoring and evaluation actions that would occur in the Trinity River watershed. NMFS will determine if the HGMP meets the criteria of Limit 5 of the 4(d) Rule.

The Trinity River is the largest tributary to the Klamath River with a drainage area of approximately 2,900 square miles. The river flows for 172 miles beginning in the Klamath and Coast Ranges, continuing through Trinity and Humboldt Counties, and joining the Klamath River at Weitchpec, CA (43 miles upstream of the Pacific Ocean). The Trinity River supports three distinct coho salmon populations designated by location within the river basin: the Lower Trinity River population, the Upper Trinity River population, and the South Fork Trinity River population (NMFS 2014). Designated as a Wild and Scenic River by the U.S. Department of Interior in 1981, the Trinity River is also valued for its Chinook salmon, steelhead, and trout fisheries, in addition to recreational activities like rafting, kayaking, and canoeing (46 FR 7484).

Upstream anadromous migration ends at Lewiston Dam, which was completed in 1963. Additionally, Trinity Dam was constructed about seven miles upstream to form Trinity Lake in 1962. Trinity Dam, Lewiston Dam, and Clear Creek Tunnel are components of the Trinity River

Division (TRD) of Reclamation's Central Valley Project. The Central Valley Project provides impounded water from the Trinity River to California's Central Valley via the Clear Creek Tunnel. The TRH is located at the base of Lewiston Dam in Trinity County. Artificial propagation on the Trinity River began in 1958, and has continued at the permanent TRH facility since 1963 to mitigate for 109 miles of habitat lost above Lewiston Dam.

Congress's original intent was not to diminish Trinity River fisheries and estimated that about 700,000 acre feet could be diverted for agricultural purposes without any negative effect (H.R. Rep. No. 602, 84th Cong., 1st Sess. 4-5 (1955); S. Rep. No. 1154, 84 Cong., 1st Sess. 5 (1955)). Furthermore, Department of the Interior reports suggested that the Trinity River Division would actually improve conditions for fisheries below the proposed dams. Based on these conclusions, Congress authorized the TRD as part of the Central Valley Project. Section 2 of the 1955 Act (PL 84-386) also directed the Secretary of the Interior to ensure the propagation and preservation of fish and wildlife in the Trinity Basin. The TRD was completed in 1964 and began diverting 75 to 90 percent of Trinity River flow for several decades. By the 1970s, a precipitous decline in habitat and salmon and steelhead populations were evident. As part of efforts to address this decline, the USFWS, Hoopa Valley Tribe, and other agencies began studies that culminated in the Trinity River Flow Evaluation. Completed in June 1999, this study is the foundation of the Trinity River Restoration Program, which is designed to restore naturally-spawning populations of salmon and steelhead to near pre-dam levels. The Trinity River Basin Fish and Wildlife Restoration Act of 1984 (Public Law 98-541) expressly acknowledges the tribal interest in the basin's fishery resources by declaring that the measure of successful restoration of the Trinity River fishery includes the "ability of dependent tribal…fisheries" to participate fully through enhanced in-river "harvest opportunities, in the benefits of restoration." (TRRP 2017).

1.2 Consultation History

On December 11, 2017, NMFS received the final HGMP for coho salmon raised at the Trinity River Hatchery (TRH) near Lewiston, California, submitted by the Reclamation and CDFW. Coho salmon from the TRH are considered part of the Southern Oregon Northern California ESU, which is listed as "threatened" under the ESA. Reclamation and CDFW, pursuant to the ESA, requested that NMFS approve of the coho salmon HGMP under Limit 5 of the 4(d) rule (50 C.F.R. § 223.203(b)(5). Limit 5 of the 4(d) Rule for threatened steelhead and salmon provides that the take prohibition does not apply to activities associated with artificial propagation programs that follow a HGMP that meets certain criteria and has been approved by NMFS (50 C.F.R. 223.203(b)(5)). If NMFS approves the HGMP, then any take of listed SONCC coho salmon caused by TRH operations would not be subject to the ESA's take prohibition. The HGMP and a draft environmental assessment (EA), pursuant to the National Environmental Policy Act (NEPA), were submitted to the Federal Register for public comment on November 7, 2018. On, July 15, 2019, Reclamation clarified the lower and upper boundaries of potential coho salmon production levels that may be considered after 2021. Reclamation further clarified on March 24, 2020, that the upper limit of coho salmon production would remain at 300,000 (plus or minus 10%), until certain conditions outlined in the HGMP are met, at which time production may be adjusted up to 500,000 or down to 150,000. Southern Oregon/Northern California Coast Evolutionarily Significant Unit (SONCC ESU) of coho salmon is listed as threatened under the ESA. Critical habitat includes streambeds and riparian areas throughout the ESU's entire range.

1.3 Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). The proposed action is the NMFS' decision to approve the implementation of the Trinity River Hatchery (TRH) coho salmon program, as described in the HGMP submitted by Reclamation and CDFW, pursuant to Limit 5 of the 4(d) rule. In this section we describe: the proposed hatchery operations that are part of the "proposed action" using information provided in the HGMP. For EFH, a federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

NMFS describes a hatchery program as a group of fish that have a separate purpose and that may have independent spawning, rearing, marking and release strategies (NMFS 2008). The operation and management of every hatchery program is unique in time, and specific to an identifiable stock and its native habitat (Flagg et al. 2004). In this case, the Proposed Action is NMFS' proposed approval of Reclamation and CDFW's Trinity River coho salmon HGMP (Reclamation and CDFW 2017) that proposes to collect and spawn adult coho salmon and release coho salmon smolts (yearlings) into the Trinity River near Lewiston, California. This opinion analyses the effects from the implementation of the Proposed Action on ESA-listed species and their critical habitats.

This opinion does not predetermine the outcome of the 4(d) decision and only provides NMFS' opinion on the anticipated effects of the proposed action and whether it is likely to jeopardize listed species and/or adversely modify critical habitat. In the event that the ultimate 4(d) decision differs from the proposed action analyzed here, NMFS may reinitiate consultation. Reclamation provides funding for Trinity River Hatchery and CDFW operates the facility and neither this opinion nor approval of the HGMP would authorize those programs. The 4(d) rule exempts the take of salmon and steelhead listed as threatened species under the Endangered Species Act (ESA) if the entity follows a Hatchery and Genetics Management Plan (HGMP) that meets the 4(d) rule criteria and is approved by NMFS (July 10, 2000; 65 FR 42422, amended June 28, 2005, 70 FR 37160)—that approval step is informed by but separate from the analysis and conclusion of this biological opinion.

The coho salmon program would be operated as an integrated program as defined by the Hatchery Scientific Review Group (HSRG 2014). The intent 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. A fundamental purpose of an integrated program is to increase adult abundance, productivity and fitness while minimizing genetic divergence of hatchery broodstock from the naturally spawning population.

Managers achieve integration of the two components (hatchery and natural) of the population by incorporating naturally produced fish from the Upper Trinity River population into the broodstock and controlling the number of hatchery origin fish that spawn naturally with this population. Additionally, spawning of TRH coho salmon will be limited to no more than five percent downstream of the Upper Trinity River such that coho salmon populations in the Lower Trinity River and South Fork Trinity River will effectively be segregated from the TRH coho salmon. In the Upper Trinity River, the goal for TRH coho salmon spawning in the natural environment is less than 30% of the total adult spawners. Managers will operate the program consistent with the concepts of hatchery reform as expressed by the CA HSRG (2012) and HSRG (2014, 2015).

A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. We considered whether or not the proposed action would cause any other activities that would have consequences on SONCC coho salmon or its critical habitat and determined that it would cause the following activity:

- may contribute to a prolonged tribal fisheries in the Klamath and Trinity rivers.

The program's working hypothesis assumes that implementing hatchery recommendations of the HSRGs will result in a reduction in the negative effects hatchery fish have on ESA-listed Trinity River Coho populations. A reduction in hatchery effects is expected to increase the productivity, capacity, diversity, fitness and abundance of naturally produced coho salmon in the Trinity River and specifically in the Upper Trinity River coho salmon population. The TRH Coho program will continue as long as the Trinity River Division of the Central Valley Project operates.

1.3.1 Program Phases

Implementation of the TRH coho salmon program will occur in four phases as defined by the HSRG (2014, 2015). The hatchery program priorities will vary by recovery phase and are described in detail below. The four recovery phases are:

- Preservation,
- Re-colonization,
- Local Adaptation,
- Full Restoration.

The program will move between phases based on natural origin (NOR) abundance. The abundance targets for each phase are set based on low, moderate and high extinction risk/ viability thresholds established in the SONCC coho salmon recovery plan (NMFS 2014) (Table 3). The ranges of adult abundance values corresponding to each program phase are shown in Table 4.

Table 3. High, moderate and low extinction risk adult abundance levels for Trinity River coho populations (NMFS 2014).

		Extinction Risk		
Population	Population Type	High (Depensation Threshold)	Moderate	Low (Required for ESU Viability)
Upper Trinity River	Core	365	1,460	5,800

Table 4. Adult natural origin (NOR) spawner abundance range by program phase for the Upper Trinity River coho population.

Population	Preservation Phase	Re-Colonization Phase	Local Adaptation Phase	Full Restoration Phase
Upper Trinity River	0-365	366-1,460	1,461-5,799	5,800+

The key performance metrics for the program that apply to the Upper Trinity River coho population are:

1. Proportion of hatchery origin spawners (pHOS) < 30 percent (3-year running average).
2. Proportion of natural origin broodstock (pNOB) = 100%.
3. Take no more than 400 NOR coho for broodstock in any year.
4. Minimum annual proportionate natural influence (PNI) of 0.5 and 3-year average PNI > 0.67.
5. 1,460+ natural origin (NOR) spawners (3-year running average).
6. Total escapement of > 1,460 (HOR +NOR) (3-year running average).

In addition, the program will strive to achieve a census pHOS of 5 percent for coho populations in the South Fork Trinity River, Lower Trinity River, and portions of the upper Trinity River downstream of the Canyon Creek Weir (e.g., North Fork Trinity River). The blue highlighted cells in Table 5 indicate the NOR adult run sizes at which each performance metric are expected to be achieved or exceeded. All performance metrics will be met when NOR run size is 1,100 fish or greater. The minimum PNI criterion (> 0.5) and 3-year average PNI (> 0.67) will be achieved when NOR coho salmon run size is 500 and ~800 fish, respectively.

Managers' ability to attain the key performance metrics will depend on the accuracy of run size forecasts and efficiency of weirs and other methods to collect broodstock and remove hatchery fish from the spawning grounds. Because it is unknown how effective these actions may be, the program targets a pNOB value of 100 percent to ensure that PNI is never less than 0.5 (regardless of pHOS) when NOR run size permits (~800 NORs, Table 5).[1] At NOR coho run sizes less than 800 adults, a sliding scale is used to determine the number of NORs taken for

[1] Note however that the data in Table 4 shows that a PNI of > 0.5 can be achieved at lower NOR abundance so long as the pHOS value is not greater than ~0.55.

broodstock (Table 5). The sliding scale is used to ensure that some NORs are available to spawn naturally.

1.3.1.1 Preservation Phase

The program is classified as being in the Preservation Phase when NOR adult coho abundance for the Upper Trinity River population is 365 or less (Table 4). This trigger value represents the depensation threshold defined by NMFS for the Upper Trinity River population (Table 3). NMFS considers an independent population with a spawner abundance at the depensation level to have a high extinction risk (NMFS 2014).

Preservation Phase management priorities are:

- Prevent demographic extinction,
- Retain genetic diversity and identity of the population,
- Maintain or increase population fitness,
- Increase adult abundance.

In this phase, the priority for returning NOR adults is for use as hatchery broodstock. However, the number of NORs to use as broodstock at low run-size (<365 NORs) will be made annually in consultation with fisheries managers. Hatchery coho entering the hatchery and not needed for broodstock may be released back to the river to spawn naturally to ensure that the depensation target of 365 naturally (NOR +HOR) spawning adults is achieved. To accomplish this, Reclamation and CDFW may truck adults downstream from the hatchery, approximately 0.5 mile, to the turnout near the Trinity Dam Blvd and Trinity River overpass, to minimize fish from simply re-entering the hatchery as they do now when released nearby.

1.3.1.2 Re-colonization Phase

The program is classified as being in the Re-colonization Phase when NOR adult Coho abundance for the Upper Trinity River population ranges between 366 and 1,460 NORs (Table 4). This range was selected as the trigger criterion because it represents an adult abundance level with a moderate risk of extinction based on the criteria of effective population size (50 < N effective < 500) and population size per generation (250 <N generation < 2,500) (NMFS 2014). The upper value of the range (1,460) is based on achieving the moderate extinction risk threshold of 4 adults per IP-km of currently accessible coho habitat for the Upper Trinity population (4 adults/IP-km*365 IP-km = 1,460) (NMFS 2014).

Re-colonization Phase management priorities are to:

- re-populate restored and/or depleted habitat,
- increase abundance and temporal and spatial diversity (spawning and rearing) of the population,
- retain population genetic identity and diversity,
- increase population fitness.

In this phase, Reclamation and CDFW will target a minimum PNI of 0.5, pHOS < 0.6, pNOB > 0.6 and adult natural escapement target of > 500 (NOR+HOR).

Table 5. Expected performance metric outcomes at NOR run size forecasts of 100 to 5,801 Upper Trinity River population adult coho.

Phase	NOR Run Size Forecast	# NOR Taken For Broodstock	% of NOR Run Taken For Broodstock	pNOB	HOR Broodstock	NOS	Target HOS	Total Escapement	pHOS	PNI
Preservation	100	50	50%	13%	350	50	365	415	0.88	0.12
	200	100	50%	25%	300	100	365	465	0.78	0.24
	300	150	50%	38%	250	150	350	500	0.70	0.35
	365	183	50%	46%	217	182	318	500	0.64	0.42
Re-Colonization	366	183	50%	46%	217	183	317	500	0.63	0.42
	500	250	50%	63%	150	250	280	530	0.53	0.54
	600	300	50%	75%	100	300	240	540	0.44	0.63
	700	350	50%	88%	50	350	290	640	0.45	0.66
	800	400	50%	100%	0	400	290	690	0.42	0.70
	900	400	44%	100%	0	500	290	790	0.37	0.73
	1,000	400	40%	100%	0	600	290	890	0.33	0.75
	1,100	400	36%	100%	0	700	300	1,000	0.30	0.77
	1,200	400	33%	100%	0	800	310	1,110	0.28	0.78
	1,460	400	27%	100%	0	1,060	400	1,460	0.27	0.78
Local Adaptation	1,461	400	27%	100%	0	1,061	400	1,461	0.27	0.79
	1,500	400	27%	100%	0	1,100	400	1,500	0.27	0.79
	1,600	400	25%	100%	0	1,200	400	1,600	0.25	0.80
	1,700	400	24%	100%	0	1,300	400	1,700	0.24	0.81
	1,800	400	22%	100%	0	1,400	400	1,800	0.22	0.82
	1,900	400	21%	100%	0	1,500	400	1,900	0.21	0.83
	2,000	400	20%	100%	0	1,600	400	2,000	0.20	0.83
	5,800	400	7%	100%	0	5,400	1400	6,800	0.21	0.83
Full Restoration	5,801	400	7%	100%	0	5,401	400	5,801	0.07	0.94

NOS – Natural origin spawners, HOS – Hatchery origin natural spawners

1.3.1.3 Local Adaptation Phase

The Local Adaptation Phase begins when NOR adult Coho abundance for the Upper Trinity River population abundance ranges between 1,460 and 5,800 NORs (Table 4). The lower end of the range (1,460) corresponds to the moderate extinction risk threshold of 4 adults per IP-km for the currently accessible Coho habitat below Lewiston Dam for this population (365 IP-km) (NMFS 2014). The upper end of the range (5,800) is the break point above which the Upper Trinity River population achieves the spawner abundance required for ESU viability (NMFS 2014).

Local Adaptation Phase management priorities are to:

- meet and exceed minimum viable spawner abundance for natural origin spawners,
- increase fitness, reproductive success and life history diversity through local adaptation.

The program will be operated to the extent possible to achieve a minimum natural escapement objective of 1,460 (NOR+HOR) adult Coho and a pHOS < 0.30 for the Upper Trinity River population. Broodstock will be managed to achieve a PNI of > 0.80, which exceeds the HSRG recommended standard (0.67) for populations with high biological significance (HSRG 2014).[2] The Upper Trinity River Coho population is considered biologically significant because NMFS (2014) classified it as a Core population.

1.3.1.4 Full Restoration Phase

The Full Restoration Phase begins when NOR adult abundance for the Upper Trinity River Coho population exceeds 5,800 NORs (3-year average) (Table 4). This value exceeds the low extinction risk viability criteria for effective population size, population size per generation, and population size per year as described in the SONCC recovery plan (NMFS 2014).

Full Restoration Phase management priorities (HSRG 2014) are:

- maintain a viable population, based on all viable salmonid population criteria attributes using long-term adaptive management.

1.3.2 Broodstock Collection

Adult NOR and HOR females, males and jacks will be collected for broodstock. The goal of the broodstock collection protocol is to meet egg take goals and at the same time maintain genetic diversity and genetic continuity with the naturally spawning coho salmon population in the Trinity River. The intent is also to establish conditions under which the natural environment drives the adaptation of both the natural and hatchery components of the Upper Trinity River coho salmon population unit.

[2] The 0.67 value is measured as effective PNI. For ease of measurement, the program will use census PNI.

Broodstock will be collected at the TRH fish ladder and at a weir located upstream of Canyon Creek. Coho salmon adult run timing, abundance and composition will be collected at the Canyon Creek weir from August 27 to January 15 each year, dependent on river discharge. The weir will be operated nightly, up to 7 days per week, and open during the day. The amount of time the weir is operated depends on the effort required to remove HOR adults and jacks from the system and collect NOR adults for broodstock. Additionally, if a buildup of salmonids occurs downstream of the weir, which will be monitored visually and with snorkel observations, the weir will be opened to allow passage of delayed salmonids. The handling of non-target species will be minimized by operating the weirs during peak coho salmon migration timing. In addition, handling will be conducted by experienced and trained personnel. If large numbers of non-target species congregate at the weir, fish will be allowed to ascend upstream of the weir unhandled and unharmed and the weir location and/or timing may be changed to reduce interactions with non-target species.

The weir is a traditional Alaskan style picket fence weir. Both NOR and HOR adults and jacks will be collected without conscious selection for specific traits and proportionate to arrival time (i.e., run-timing) and abundance at the collection locations. Preference will be given to collecting broodstock at the weir located upstream of Canyon Creek as this facility is located nearest the downstream extent of the Upper Trinity River population geographic boundary. Fish encountered at this weir are more likely to include the full range of population genetic diversity.

The number and origin (NOR or HOR) of the broodstock collected each year will vary based on run size of each component (Table 4) and in-hatchery culture survival rates. Because weirs have not previously been used to collect broodstock, it will take hatchery staff a few years to refine collection methods. This may lead to more NOR adults collected than are needed for broodstock. Hatchery staff will release surplus NOR adults back to the river. Surplus HOR adults will be: (1) sent to Tribes and food banks, (2) released alive/dead back to the river if directed by fisheries managers, or (3) disposed of in an upland landfill if in extremely poor condition.

1.3.2.1 Identity of Fish Collected for Broodstock

Unmarked and TRH-marked coho captured at weirs and returning to the TRH will be candidates for use as broodstock. Left maxillary (LM) marked fish captured at these locations will not be used for broodstock as they are strays from Iron Gate Hatchery. Disposition of Iron Gate Hatchery coho collected at the Trinity River Hatchery will be made through consultations with NMFS.

1.3.2.2 Proposed Number to be Collected for Broodstock

All adult collections occur at the fish ladder and gathering tank (trap) located directly below Lewiston Dam. Capture efficiency is 100 percent of fish that exit the ladder into the gathering tank. Because 100 percent of TRH-origin fish receive a right maxillary clip, identification between hatchery and natural- origin fish at the trap is highly accurate.

The TRH coho salmon program will collect enough NOR adults (400) to achieve a pNOB of 100 percent when run size allows (Table 6). An additional 200 coho HOR adults will also be collected and used for broodstock until such time as in-hatchery culture survival metrics are achieved. The number of NOR adults required for program broodstock is calculated using the following formula: Broodstock = Release No./Pre-spawn/Egg:Smolt/Fecundity*2.

Where:

Broodstock = Number of female and males to be collected
Release No = Number of smolts released
Pre-spawn = Pre-spawn survival rate
Egg:Smolt = Green egg to smolt survival rate
Fecundity = Number of eggs per female
Bacterial Kidney Disease (BKD) Culling rate = ~15 percent

Assumptions regarding survival and other factors can be found in Reclamation and CDFW (2017). Based on this formula, the program will need to collect 400 NOR adults for broodstock to meet the target release size of 300,000 at a pNOB of 100 percent.

Table 6. The number of NOR male and female coho salmon broodstock required to meet annual release of 300,000 coho salmon smolts at a pNOB of 100 percent and achievement of in-hatchery culture survival metrics.

Release Number	Males (includes Jacks)	Females	Total
300,000	200	200	400

The pre-spawn and green egg to smolt survival rate metrics used in the broodstock calculation above is substantially higher than what the program has historically achieved. Because it will take time to implement and test proposed improvements, and the effectiveness of these improvements may still not achieve the survival metrics, the program will collect an additional 200 HOR for use as broodstock to ensure a release of 300,000 coho salmon smolts. Thus, the total number of coho salmon collected for broodstock each year will be a maximum of 600 at the 300,000 coho salmon release level. This value is approximately 50 percent of the historical number of coho salmon spawned at TRH.

1.3.2.3 Disposition of Surplus Broodstock

Surplus HOR adults will be: (1) sent to Tribes and food banks, (2) released alive back to the river if directed by fisheries managers, or (3) disposed in an upland landfill if in extremely poor condition.

1.3.2.4 Fish Transportation and Holding

Adult coho salmon collected at the weir located above Canyon Creek will be loaded into tanker trucks and transported to Trinity River Hatchery. A transportation procedures plan and Hazardous Analysis and Critical Control Point (HACCP) Plan will be in place and followed when fish are collected at the weir, transported and off-loaded at Trinity River Hatchery. Each tanker truck will be insulated and equipped with oxygenation and a water recirculation system, and will have a salmon discharge gate. Unripe spawners of both natural and hatchery origin will be held in round tanks, in tubes, adjacent to the spawning building and reassessed every 5 to 7 days for sexual maturity. Only NOR fish that are in excess to those needed to meet hatchery program objectives will be released back to the river.

To improve pre-spawn survival rate, hatchery staff will test holding adults individually in tubes. Initial trials will commence by holding HOR adult coho salmon in tubes and upon documented success NOB coho salmon will be used. Different flow, water temperature and oxygen regimes may be tested over time as a means to increase survival.

1.3.2.5 Fish Health Maintenance and Sanitation

TRH workers use a commercial Iodophor solution to disinfect materials and equipment throughout the hatchery, especially invasive equipment such as spawning needles and knives. Hatchery workers sanitize equipment between and among all incubation and rearing units, especially during disease outbreaks or parasitic infestations. Hatchery workers will take additional precautions, as necessary, to avoid the spread of disease by using equipment in given incubation stack or rearing pond that is specific to that unit.

1.3.2.6 Risk Aversion Measures to Minimize Adverse Genetic or Ecological Effects from Broodstock Operations

- Trinity River Hatchery coho salmon will be maxillary clipped until further direction from NMFS is given. At that time 100 percent externally and internally marked (ad-clipped/coded wire tagged) may be instituted to aid with evaluations including high seas distribution. These marks will enable managers to determine the number and ratio of hatchery and natural fish spawning within and outside of the Trinity River Basin. Managers will use this information to alter hatchery practices to reduce genetic and fitness impacts that hatchery fish spawning naturally pose to natural origin coho populations.

- Broodstock collection facilities will be used to remove excess hatchery origin fish from the system. The objective of these collection efforts would be to achieve program performance indicators for pHOS (<30 percent) and PNI (minimum of 0.5 and average target of > 0.67). Operating the program to achieve a minimum PNI of 0.5 and the average target PNI > 0.67 ensures that the natural environment, rather than the hatchery environment, drives local adaptation of the combined natural and hatchery components of the integrated population.

- Monitoring programs tracking adult coho salmon escapement to other coho salmon populations will be looking for and enumerating marked coho salmon from TRH. This information will be used to determine if the program achieves the < 5 percent pHOS criterion for coho salmon populations not integrated with the hatchery program. If the criterion is exceeded, managers will take action to reduce pHOS levels in these streams.

- If broodstock were not collected from the North Fork Trinity River or Canyon Creek, the < 5 percent pHOS value would apply to these streams. Spawning surveys will be conducted in the streams to determine compliance with criterion.

- The TRH broodstock policy described above and the mating protocol are intended to help reduce demographic extinction risks while preserving genetic diversity of the composite NOR and HOR population. The genetically based spawning matrix is designed to minimize inbreeding effects associated with hatchery production.

- Specific measures to reduce risk include managing composition of hatchery and natural fish in both the hatchery and natural spawning populations to allow the natural environment to drive adaptation of the integrated population. The use of jacks will achieve gene flow among brood years.

- Only local broodstock will be spawned, either hatchery fish originating from TRH or unmarked fish captured at weirs or returning to the Trinity River Hatchery.

- The NOR broodstock incorporation target is 100 percent (pNOB of 100 percent).[3]

- Broodstock will be collected throughout the run with no bias toward physical characteristics (e.g., size) other than those indicating readiness to spawn.

- 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.

1.3.3 Mating Practices

1.3.3.1 Selection Method

Initially, males and females will be selected for mating based on readiness to spawn. Genetic tissue samples will be taken from all broodstock used in the program. Genetic analysis (Parental Based Tagging) of genotypes will be used to confirm broodstock origin (HOR and NOR) and number of sibling crosses (inbreeding) over time. These data will allow managers to confirm pNOB levels and document the rate of mismarked hatchery fish. If the results identify high rates of sibling crosses, a genetically based spawning matrix will be implemented (see Section 8.1.1 of the HGMP).

1.3.3.2 Genetic spawning matrix

Spawner selection will be based on the results of genetic analysis of relatedness among broodstock candidates using tissue samples collected from all potential coho salmon broodstock. The results of this analysis will be used to develop a mating matrix designed by geneticists to

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[3] Until the NOR component and the ability to catch them improves with installation of the weir, the program will likely be unable to achieve a pNOB of 100%. Until that time, a substantial portion of broodstock will be HOR. Priority will be given to incorporating as many NOR fish as possible each year.

minimize inbreeding and to allow for gene flow between brood years. The breeding protocol will specify which male and female crosses will result in the lowest level of inbreeding in their offspring. The threshold will be to avoid spawning fish related at the half-sibling level or greater. The breeding matrix will allow for spawning crosses to occur regardless of fish origin (HOR or NOR) or age.

If the adult pre-spawn survival does not achieve the 90 percent metric, implementation of the genetic spawning matrix may be delayed until it is met. If this occurs, fish will be mated randomly based on readiness to spawn and origin (HOR or NOR). Mating crosses by origin will be performed as described in Section 8.3 of the HGMP.

1.3.3.3 Fertilization

Fish mating will use a true 1M:1F spawning protocol.[4] The broodstock sex ratio will initially be 1M:1F (i.e., same number of male and female broodstock). If there is evidence of a low fertilization rate problem, CDFW and NMFS geneticists and pathologists will be consulted to resolve the issue. If conditions are not met for the use of a genetically informed spawning matrix, mating by origin will be prioritized as follows:

NOR x NOR
NOR x HOR
HOR x HOR

Adult coho salmon entering the spawning house will be anesthetized by applying carbon dioxide to the holding tank for 3 minutes. Eggs will be fertilized using wet spawning by stripping milt of a single male into an egg pan with salt solution (one ounce of salt per gallon of water) prior to adding the eggs of a single female. Eggs will be treated with 100 ppm iodine solution for a minimum of 15 minutes, allowed to water harden, and then transferred to incubation facilities. Male reuse will be strongly restricted. Details of spawning/mating protocols will be documented in annual reports. Deviations from this protocol to solve specific problems will be made only on recommendations from CDFW and NMFS geneticists in coordination with the Hatchery Coordination Team (HCT) and CDFW pathologist. No cryopreserved gametes will be held.

1.3.4 Incubation

Egg take from NOR and HOR coho will be set at a maximum of 750,000, with no more than 500,000 taken from NOR adults. This level of egg take is expected to provide ample "cushion" in the event of unforeseen losses at the hatchery due to BKD, poor fertility, etc. to ensure the smolt production goal can still be met.

1.3.5 Smolt Release

1.3.5.1 Proposed Release Levels

The program will release up to 300,000 coho salmon smolts each year. At the end of 2020, the managers will review program performance and status of natural coho salmon production to

[4] A true 1:1 spawning protocol means that the milt of one, and only one, male is placed in a container with the eggs of one, and only one, female. This is not the same as pooling gametes or sequential milt addition.

determine if fish release numbers and or release location should be altered. Changes to the coho salmon smolt release range from 150,000 to 500,000, depending on whether performance metrics are met. The recommended coho salmon production level, and rationale, will be forwarded to NMFS for review and approval. No offsite releases or transportation of smolts is proposed. Coho salmon will be released at 10 to 12 fish per pound (fpp).

1.3.5.2 Release Date

Aside from the coho salmon smolts used for the timing of release study, smolts will be volitionally released within 7 days of the March new moon (March 1-15). Fish that do no leave the raceways within 7 days will be removed and destroyed. This action is designed to reduce residualization rate and competition with naturally produced coho salmon. Release timing may be altered dependent on the results of the timing of release study.

Under the proposed HGMP, a fish timing of release study will be undertaken for at least three brood years for a subset of the smolts released. Fish will be released in March, April and May. Study protocols will be developed by the HCT. At the end of the time at release study, the three groups will be evaluated by the HCT based on:

- Travel-time from release site to the Willow Creek Screw Trap (quicker is better),
- Smolt-to-adult survival rate (higher is better),
- Mini-jack and jack rates (lower is better),
- Theoretical predation and competition impacts to naturally produced coho salmon (lower is better),
- Adult stray rate to other coho populations (Lower Trinity and South Fork) (lower is better),
- Cost of rearing fish (lower is better).

Study results and proposed program changes, as identified by the HCT and managers, will be forwarded to NMFS for review, possible modification and approval

1.3.5.3 Acclimation Procedures

Fish are currently acclimated on-station in the rearing facilities as the water source is the Trinity River via Lewiston Reservoir. This practice will continue under this HGMP. If the managers decide to pursue acclimation, they will make a recommendation to NMFS and permitting of this facility will be undertaken through a separate approval process, such as the ESA 10(a)1(A) process.

1.3.5.4 Marking Procedures

Historically, all hatchery coho salmon smolts have been marked with a right maxillary clip. Trinity River Hatchery coho salmon will be maxillary clipped until further direction from NMFS is given. At that time 100 percent externally and internally marked (ad-clipped/coded wire tagged) may be instituted to aid with evaluations including high seas distribution.

1.3.5.5 Disposition of Surplus Smolts

Production levels are not expected to exceed 10 percent of target in any release year. NMFS will be notified if the production level is exceeded by more than 10 percent. NMFS' recommendations for disposition of surplus smolts will be followed.

1.3.5.6 Fish Health Certification Procedures

CDFW pathologists conduct annual pre-release fish health analyses. Fish will not be released until certified disease-free by the CDFW pathologist. The pathologist's report will be included in the annual report for the program.

1.3.5.7 Emergency Release Procedures

Flooding and water system failure are minimum risks to the facility because of the protection afforded by the Trinity and Lewiston dam systems. Wildfire risk can also occur though rare. If, based on an assessment of the best available data, the facility manager determines that the facility is in imminent danger of flooding, fire, or water system failure, fish may be forced from the hatchery to the mainstem Trinity River based on the judgement of the facility manager.

1.3.6 Monitoring and Evaluation of Performance Indicators

1.3.6.1 Plans and methods to collect data to respond to each "Performance Indicator"

A number of plans and policies within the hatchery program are already in place to minimize and avoid risks to ESA-listed species and other anadromous fish species. Most of the monitoring and evaluation activities of the TRH Coho salmon program are incorporated into, or facilitated by, routine operations within the hatchery and TRRP activities. In addition, an HCT was established to guide program operations and review program performance.

CDFW will collect and record data concerning all aspects of the fish propagation program, including water quality, hatchery returns, spawners, egg take, rearing number and survival, and number released. These efforts will continue under this HGMP. A summary of the in-hatchery monitoring and evaluation (M&E) activities is included in Table 7. The primary focus of the M&E program will be quantification of program performance indicators of pHOS, PNI, adult natural escapement and pNOB. A report documenting the results of the M&E program will be submitted to NMFS each year by July 1st.

The program's annual Monitoring & Evaluation (M&E) Plan addresses the HGMP's performance standards through assessment of the risk and benefits of associated performance indicators (Table 7).The hatchery program will be operated to achieve performance standards as listed in Table 7.

Table 7. TRH coho salmon hatchery operations indicators, metrics, and M&E methods.

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
Broodstock Composition, Timing, Age Structure	Similar to natural fish	Culture and monitoring staff will collect data at weirs, hatchery and in other streams to determine that the hatchery and wild populations are similar with respect to these attributes. The total number of fish collected daily and the number used for broodstock will be reported. The number of HOR and NOR adult male, female and jack coho salmon used for broodstock will be documented. This data will be reported in annual reports.
Adult Holding and Pre-Spawning Survival Rate	> 95% with a goal of 100%	Culture staff will calculate the survival rate and include the number in the annual report.
Proportion Natural Origin Brood pNOB	100%	Hatchery staff will quantify pNOB for each brood year and report it in annual operating reports.
Proportionate Natural Influence	Minimum of 0.5, average of > 0.67	Culture staff will use pHOS and pNOB data to calculate a PNI value for each brood year. Data to be reported in annual operating reports.
Egg-to-Fry Survival Rate	> 90%	Culture staff will enumerate-data to be reported in annual operating reports.
Fry-to-Parr Survival Rate	> 90%	Culture staff will enumerate-data to be reported in annual operating reports.
Egg-to-smolt Survival Rate	> 80%	Culture staff to enumerate loss by life stage for each brood year. Data to be reported in annual operating reports.
Smoltification Level	Similar to natural fish collected at weir	ATPase data will be collected on both hatchery and natural juveniles
Coho salmon Release Size	10-12 fpp	Size at release information will be collected throughout the rearing period to ensure that growth profiles are appropriate to meet the fish size at release target within the identified range for each program. Length frequency data will also be collected monthly from a sample of fish from each raceway.

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
Average Smolt-to-Adult Survival Rate (SAR).	≥ 2.0%	SAR will be calculated annually. All coho salmon smolts released will be marked
Disease Control and Prevention: Maximize survival at all life stages using disease control and disease prevention techniques. Prevent introduction, spread or amplification of fish pathogens.	Necropsies of fish to assess health, nutritional status, and culture conditions. Performance indicators will be based on test performed.	Pathology staff will conduct health inspections of cultured fish on at least a monthly basis and during any disease or parasite outbreak. Pathologist will implement corrective actions as needed. Pathology monitoring, disease/parasite outbreaks and issues, and corrective actions will be reported in annual reports.
Hatchery effluent discharges monitoring (Clean Water Act)	Various based on regulations	All hatchery facilities will operate under the "Upland Fin-Fish Hatching and Rearing" National Pollution Discharge Elimination System (NPDES) general permit, which conducts effluent monitoring and reporting and operates within the limitations established in the permit. The results of this monitoring will be provided in the annual report.

1.3.6.2 Coho Salmon Spawning Escapement, pHOS and Stray Rate

Estimates of coho salmon spawning escapement and pHOS levels will be identified with weirs and spawning/redd surveys conducted throughout the Trinity River Basin. Hatchery coho salmon stray rates to other basins will be determined based on field monitoring activities conducted by USFS, USFWS, CDFW, Hoopa Valley Tribe, and the Yurok Tribe.

Coho salmon adult run timing, abundance and composition will be collected at the Canyon Creek weir from August 27 to January 15 each year, dependent on river discharge. The weir will be operated nightly, up to 7 days per week, and open during the day. The amount of time the weir is operated depends on the effort required to remove HOR adults and jacks from the system. Removal of hatchery coho salmon at the weir is expected to be the primary tool used by the hatchery program to achieve the pHOS performance criterion.

Weir operators will perform daily checks of the river reach extending from the weir(s) to a point 500 feet downstream to identify if a migration delay is caused by the weir. The presence of a large number of adult coho salmon may be evidence that fish migration is being delayed by weir operations. If large numbers of coho salmon (>100) are observed below the weir for more than 48 hours, portions of the weir may be removed for up to one day to allow fish to pass. At that time, the weir will be placed back in operation. If delay appears to be an issue, evaluation of the weir location and its operation will be conducted by the HCT, in coordination with NMFS, and additional studies may be implemented (e.g., a study using acoustic-tagged coho may be initiated to quantify coho salmon behavior and time of delay).

Coho salmon spawning surveys will be conducted in streams associated with Upper Trinity River population starting in early October and continue until early January (Kier et al. 2014). These surveys will be used to determine total natural spawner escapement and distribution, pHOS, pre-spawn mortality and weir efficiency. Spawning surveys will use the U.S. Environmental Protection Agency (EPA) – Environmental Monitoring and Assessment Program – Generalized Random Tessellation Stratified (GRTS)[5] sampling method to select a spatially balanced random sample of river and stream reaches to survey each year. This is the method recommended by NMFS in their recent *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead* (NMFS 2009).

The spawning surveys will also cover the geographic area associated with the South Fork Trinity River and Lower Trinity River populations. The focus of these surveys is to estimate total natural spawning escapement and pHOS for each population. The program will strive to achieve pHOS values less than five percent in both of these populations. The program may explore the feasibility of installing and operating video counting stations in the larger tributaries to collect this data. The use of video weirs may provide more information at less cost than spawning surveys.

Hatchery coho salmon stray rates to populations outside of the Trinity River Basin will be based on M&E activities conducted by other parties. CDFW, for example, uses video counting stations on the Shasta River and Scott River to determine coho escapement levels and composition (NOR/HOR). These data will be summarized and the resulting number of Trinity River HOR adults found in these streams will be reported in the hatchery's annual report.

1.3.6.3 Number of Coho Harvested and Harvest rate

The number and rate of NOR and HOR coho harvested each year in ocean and freshwater fisheries will be reported on an annual basis. This information will come from reports produced by the PFMC, and for hatchery fish tagged with a CWT (i.e., AD/CWT), from the Regional Mark Information System (RMIS) database (RMIS website). Harvest data will be summarized in the hatchery annual report when made available by fisheries managers.

1.3.6.4 Funding, Staffing, and Logistics for Implementation of the Monitoring and Evaluation Program

The Bureau of Reclamation will fund priority activities in support of the goals of the HGMP, as determined by the HCT and subject to availability of funds.

[5] EPA Environmental Monitoring and Assessment Program Website.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

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

NMFS has determined that the proposed action is not likely to adversely affect the Distinct Population Segment (DPS) of Southern Resident Killer Whales, the Southern DPS of Eulachon, the Southern DPS of North American Green Sturgeon, or their critical habitats. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section 2.12.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402. 02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species.

The designation of critical habitat for SONCC coho salmon uses the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

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

2.1.1 Background and Modeling Methods

For a properly integrated program, the HSRGs require that the proportion of natural origin (NOR) coho salmon incorporated into the hatchery broodstock (pNOB) exceed the proportion of the natural spawning population composed of hatchery fish (pHOS). Maintaining this ratio above 0.5 results in the natural environment having a greater influence on the adaptation of the composite NOR and HOR population than the hatchery environment. Referred to as the proportionate natural influence (PNI), this parameter is calculated as follows:

PNI = pNOB/(pNOB + pHOS)

High PNI values are expected to result in increased fitness, reproductive success, life history diversity and productivity of the population over time (Figure 1). Increasing the fitness of natural populations also increases the benefits that current and future habitat improvements produce with respect to fish production (HSRG 2014). These results show that many generations are required to increase fitness in a hatchery dominated stock, and higher PNI levels result in greater population abundance and fitness.

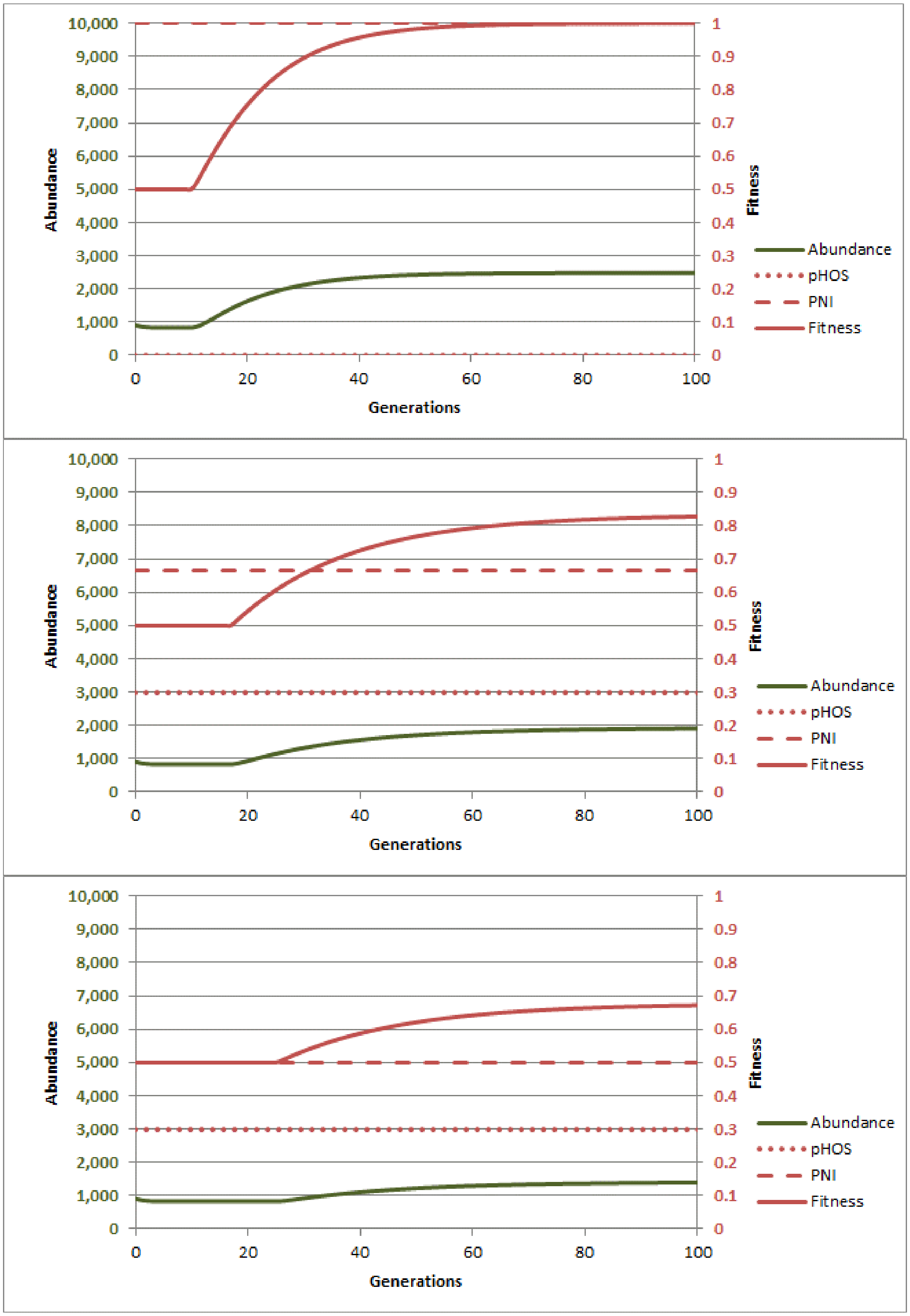

Figure 1. Estimated increase in adult abundance (green line) and fitness (red line) over 100 generations for a hatchery program operated to attain a PNI of 1.0 (Top), 0.67 (Middle) and 0.5 (Bottom). The analysis assumes that the initial hatchery program has a fitness value of 0.5.

As defined by the HSRG (2014, 2015), effective pHOS, which is a measure of gene flow, differs from census pHOS by a factor of less than one, i.e., effective pHOS is less than census pHOS ($pHOS_{cen}$). Effective pHOS discounts the contribution of hatchery origin spawners (HOS) by assuming that HOS have lower reproductive success than natural origin spawners (NOS). For the proposed HGMP actions, $pHOS_{cen}$ is used as a conservative approximation of gene flow. Census pHOS does not apply a discount factor to the reproductive success of HOS, and is calculated as follows (HSRG 2014):

$pHOS_{cen}$ = HOS/(HOS + NOS) where:

HOS = number of hatchery origin spawners in nature

NOS = number of natural origin spawners in nature

The HSRG selected $pHOS_{cen}$ as the preferred gene flow indicator because it can be readily measured based on carcass surveys and weir counts. The use of $pHOS_{cen}$ is conservative in that it assumes that the reproductive success of hatchery fish is similar to naturally produced fish. That is, it does not discount the reproductive success of hatchery fish.

The PCDRISK-1 model was run to develop qualitative estimates of the predation, competition and disease (PCD) risks hatchery coho salmon pose to naturally produced coho salmon fry and yearlings (Busack et al. 2005). The analysis was required because quantitative data on PCD risks were not available for Trinity River Hatchery coho salmon. The assumptions used in the PCDRISK-1 modeling of TRH coho salmon are as follows:

- Hatchery coho salmon release size: 300,000 and 500,000 smolts
- Potential Natural coho salmon production: 1.0 ~1.2 million fry (40mm) and 198,000 smolts (120mm) (fish size data based on Petros et al. 2014)[6]
- Hatchery coho salmon size at release: 160mm
- Average March stream temperature: 8°C (USGS Hoopa stream gage)
- Average amount of time hatchery coho salmon smolts in river: 44 days.

The length of time hatchery coho salmon are present in the Trinity River was estimated based on juvenile hatchery fish collected at the Willow Creek Screw Trap (Petros et al. 2014). The trapping data indicate that after release from the hatchery, coho salmon spend on average, 37 to 50 days migrating to the Willow Creek trapping site (Reclamation 2018). The average value was calculated based on the assumption that trap numbers can be used as an index of the total amount of time hatchery coho salmon require to migrate from release at the hatchery to Willow Creek. For example, in 2010, the data indicate that hatchery coho salmon were collected from 3 to 86 days after release from the hatchery (average of 40.1 days). The PCDRISK-1 model runs assume an average of 21 days in the river for a smolt release of 300,000 and an average of 44 days in the river at the 500,000 smolt release level.

[6] Fry and smolt estimates are based on a NOR run-size of 3,800 adults, fecundity of 1,250 eggs per adult, egg-to-fry and egg-to-smolt survival rates of 0.253 and 0.042, respectively (see Quinn 2005 for survival rates).

2.1.2 Factors that are Considered When Analyzing Hatchery Effects

2.1.2.1 Background

NMFS has substantial experience with hatchery programs and has developed and published a series of guidance documents for designing and evaluating hatchery programs following best available science. These documents are available upon request from NMFS. "Pacific Salmon and Artificial Propagation under the Endangered Species Act" (Hard et al. 1992) was published shortly following the first ESA-listings of Pacific salmon on the West Coast and it includes information and guidance that is still relevant today. In 2000, NMFS published "Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units" (McElhany et al. 2000) and then followed that with a "Salmonid Hatchery Inventory and Effects Evaluation Report" for hatchery programs up and down the West Coast (NMFS 2004). In 2005, NMFS published a policy that provided greater clarification and further direction on how it analyzes hatchery effects and conducts extinction risk assessments (NMFS 2005). NMFS then published "Artificial Propagation for Pacific Salmon: Assessing Benefits and Risks & Recommendations for Operating Hatchery Programs Consistent with Conservation and Sustainable Fisheries Mandates" (NMFS 2008).

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

For Pacific salmon, NMFS evaluates extinction processes and effects of the Proposed Action beginning at the population scale (McElhany et al. 2000). NMFS defines population performance measures in terms of natural-origin fish and four key parameters or attributes: abundance, productivity, spatial structure, and diversity and then relates effects of the Proposed Action at the population scale and ultimately to the survival and recovery of an entire ESU or DPS.

"Because of the potential for circumventing the high rates of early mortality typically experienced in the wild, artificial propagation may be useful in the recovery of listed salmon species. However, artificial propagation entails risks as well as opportunities for salmon conservation" (Hard et al. 1992). A Proposed Action is analyzed for effects, positive and negative, on the attributes that define population viability (viable salmonid population, or VSP), including abundance, productivity, spatial structure, and diversity. The effects of a hatchery program on the status of an ESU or steelhead DPS "will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes" (NMFS 2005). The presence of hatchery fish within the ESU can positively affect the overall status of the ESU by increasing the number of natural spawners, by serving as a source population for repopulating unoccupied habitat and increasing spatial distribution, and by conserving genetic resources. "Conversely, a hatchery program managed without adequate consideration can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness and productivity of the ESU" (NMFS 2005). NMFS also analyzes and takes into account the effects of hatchery facilities, for example, weirs and water diversions, on each VSP attribute and on designated critical habitat.

2.1.2.2 Effects

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

The effects, positive and negative, for the two categories of hatchery programs are summarized in Table 8. Generally speaking, effects range from positive to negative for programs that use local fish for hatchery broodstock and from negligible to negative when a program does not use local fish for broodstock. Hatchery programs can benefit population viability but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s).

Table 8. An overview of the range of effects on natural population viability parameters from the two categories of hatchery programs.

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

The term “local fish” is defined to mean fish with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU or steelhead DPS (70 FR 37215, June 28, 2005). Exceptions include restoring extirpated populations and gene banks.

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

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock,
(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities,
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas,
(4) hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean,
(5) Monitoring, evaluation and research (M&E) that exists because of the hatchery program,
(6) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and
(7) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

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

(1) positive or beneficial effect on population viability,
(2) negligible effect on population viability, and
(3) negative effect on population viability.

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

2.1.2.3 Factor 1.

This factor considers the risk to a natural population from the removal of natural-origin fish for hatchery broodstock. The level of effect for this factor ranges from neutral or negligible to negative. A primary consideration in analyzing and assigning effects for broodstock collection is the origin and number of fish collected. The analysis considers whether broodstock are of local origin and the biological pros and cons of using ESA-listed fish (natural or hatchery-origin) for hatchery broodstock. It considers the maximum number of fish proposed for collection and the proportion of the donor population tapped to provide hatchery broodstock. “Mining” a natural population to supply hatchery broodstock can reduce population abundance and spatial structure. Also considered here is whether the program “backfills” with fish from outside the local or immediate area. The physical process of collecting hatchery broodstock and the effect of the process on ESA-listed species is considered under Factor 2.

2.1.2.4 Factor 2.

NMFS also analyzes the effects of hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds. The level of effect for this factor ranges from positive to negative. There are two aspects to this part of the analysis: genetic effects and ecological effects. NMFS generally views genetic effects as detrimental because, at this time, based on the weight of available scientific information, we believe that artificial breeding and rearing is likely to result in some degree of genetic change and fitness reduction in hatchery fish and in the progeny of naturally spawning hatchery fish relative to desired levels of diversity and productivity for natural populations. Hatchery fish can thus pose a risk to diversity and to natural population rebuilding and recovery when they interbreed with fish from natural populations. However, NMFS recognizes that there are benefits as well, and that the risks just mentioned may be outweighed under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity. Conservation hatchery programs may accelerate recovery of a target population by increasing abundance faster than may occur naturally (Waples 1999). Hatchery programs can also be used to create genetic reserves for a population to prevent the loss of its unique traits due to catastrophes (Ford et al. 2011). Furthermore, NMFS also recognizes there is considerable debate regarding genetic risk. The extent and duration of genetic change and fitness loss and the short and long-term implications and consequences for different species, for species with multiple life-history types, and for species subjected to different hatchery practices and protocols remains unclear and should be the subject of further scientific investigation. As a result, NMFS believes that hatchery intervention is a legitimate and useful tool to alleviate short-term extinction risk, but otherwise managers should seek to limit interactions between hatchery and natural-origin fish and implement hatchery practices that harmonize conservation with applicable laws and policies (NMFS 2011).

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

Within-population diversity

Within-population genetic diversity is a general term for the quantity, variety and combinations of genetic material in a population (Busack and Currens 1995). Within-population diversity is gained through mutations or gene flow from other populations (described below under outbreeding effects) and is lost primarily due to genetic drift, a random loss of diversity due to population size. The rate of loss is determined by the population's effective population size (*Ne*), which can be considerably smaller than its census size. For a population to maintain genetic diversity reasonably well, the effective size should be in the hundreds (e.g., Lande and Barrowclough 1987), and diversity loss can be severe if *Ne* drops to a few dozen. Hatchery programs, simply by virtue of creating more fish, can increase *Ne.* In very small populations this can be a benefit, making selection more effective and reducing other small population risks (e.g., Lacy 1987; Whitlock 2000; Willi et al. 2006). Conservation hatchery programs can thus serve to protect genetic diversity.

However, hatchery programs can also directly depress *Ne* by two principal methods. One is by the simple removal of fish from the population so that they can be used in the hatchery. If a substantial portion of the population is taken into a hatchery, the hatchery becomes responsible for that portion of the effective size, and if the operation fails, the effective size of the population will be reduced (Waples and Do 1994). *Ne* can also be reduced considerably below the census number of broodstock by using a skewed sex ratio, spawning males multiple times (Busack 2007), and by pooling gametes. Pooling semen is especially problematic because when semen of several males is mixed and applied to eggs, a large portion of the eggs may be fertilized by a single male (Gharrett and Shirley 1985; Withler 1988). Factorial mating schemes, in which fish are systematically mated multiple times, can be used to increase *Ne* (Fiumera et al. 2004; Busack and Knudsen 2007). An extreme form of *Ne* reduction is the Ryman-Laikre effect (Ryman and Laikre 1991; Ryman et al. 1995), when *Ne* is reduced through the return to the spawning grounds of large numbers of hatchery fish from very few parents. Inbreeding depression, another *Ne*-related phenomenon, is caused by the mating of closely related individuals (e.g., sibs, half-sibs, cousins). The smaller the population, the more likely spawners will be related. Related individuals are likely to contain similar genetic material, and the resulting offspring may then have reduced survival because they are less variable genetically or have double doses of deleterious mutations. The lowered fitness of fish due to inbreeding depression accentuates the genetic risk problem, helping to push a small population toward extinction.

Outbreeding Effects

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

Gene flow from other populations can have two effects. It can increase genetic diversity (e.g., Ayllon et al. 2006) (which can be a benefit in small populations) but it can also alter established allele frequencies (and co-adapted gene complexes) and reduce the population’s level of adaptation, a phenomenon called outbreeding depression (Edmands 2007; McClelland and Naish

2007). In general, the greater the geographic separation between the source or origin of hatchery fish and the recipient natural population, the greater the genetic difference between the two populations (ICTRT 2007), and the greater potential for outbreeding depression. For this reason, NMFS advises hatchery action agencies to develop locally derived hatchery broodstock. Additionally, unusual rates of straying into other populations within or beyond the population's ESU or steelhead DPS can have an homogenizing effect, decreasing intra-population genetic variability (e.g., Vasemagi et al. 2005), and increasing risk to population diversity, one of the four attributes measured to determine population viability. Reduction of within-population and among-population diversity can reduce adaptive potential.

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

Hatchery-influenced selection

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

Genetic change and fitness reduction resulting from hatchery-influenced selection depends on: (1) the difference in selection pressures; (2) the exposure or amount of time the fish spends in the hatchery environment; and (3) the duration of hatchery program operation (i.e., the number of generations that fish are propagated by the program). On an individual level, exposure time in large part equates to fish culture, both the environment experienced by the fish in the hatchery and natural selection pressures, independent of the hatchery environment. On a population basis, exposure is determined by the proportion of natural-origin fish in the hatchery broodstock (called pNOB) and the proportion of natural spawners consisting of hatchery-origin fish (Lynch and O'Hely 2001; Ford 2002), and then by the number of years the exposure takes place. In assessing risk or determining impact, all three levels must be considered. Strong selective fish culture with low hatchery-wild interbreeding can pose less risk than relatively weaker selective fish culture with high levels of interbreeding.

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

Besides the Hood River steelhead work, a number of studies are available on the relative reproductive success (RRS) of hatchery-origin and natural-origin fish (e.g., Berntson et al. 2011; Theriault et al. 2011; Ford et al. 2012). All have shown that generally hatchery-origin fish have lower reproductive success, though the differences have not always been statistically significant and in some years in some studies the opposite is true. Lowered reproductive success of hatchery-origin fish in these studies is typically considered evidence of hatchery-influenced selection.

An HSRG team recently reviewed California hatchery programs and developed guidelines that differed considerably from those developed by the earlier group (California HSRG 2012). They recommended that program-specific plans be developed with corresponding population specific targets and thresholds for pHOS, pNOB, and PNI that reflect these factors. However, they did state that PNI should exceed 50% in most cases, although in supplementation or reintroduction programs the acceptable pHOS could be much higher than 5%, even approaching 100% at times. They also recommended for conservation programs that pNOB approach 100%, but pNOB levels should not be so high they pose demographic risk to the natural population.

Ecological effects for this factor (i.e., hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds) refer to effects from competition for spawning sites and redd superimposition, contributions to marine-derived nutrients, and the removal of fine sediments from spawning gravels. Ecological effects on the spawning grounds may be positive or negative. To the extent that hatcheries contribute added fish to the ecosystem, there can be positive effects. For example, when anadromous salmonids return to spawn, hatchery-origin and natural-origin alike, they transport marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems. Their carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production (Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Bell 2001; Brakensiek 2002).

Additionally, studies have demonstrated that perturbation of spawning gravels by spawning salmonids loosens cemented (compacted) gravel areas used by spawning salmon (e.g., Montgomery et al. 1996). The act of spawning also coarsens gravel in spawning reaches, removing fine material that blocks interstitial gravel flow and reduces the survival of incubating eggs in egg pockets of redds. The added spawner density resulting from hatchery-origin fish spawning in the wild can have negative consequences in that to the extent there is spatial overlap between hatchery and natural spawners, the potential exists for hatchery-derived fish to superimpose or destroy the eggs and embryos of ESA-listed species. Redd superimposition has been shown to be a cause of egg loss in pink salmon and other species (e.g., Fukushima et al. 1998).

Encounters with Natural-Origin and Hatchery Fish at Adult Collection Facilities

The analysis also considers the effects from encounters with natural-origin fish that are incidental to the method of broodstock collection. Here, NMFS analyzes effects from sorting, holding, and handling natural-origin fish in the course of broodstock collection. Some programs collect their broodstock from fish volunteering into the hatchery itself, typically into a ladder and holding pond, while others sort through the run at large, usually at a weir, ladder, or sampling facility. Generally speaking, the more a hatchery program accesses the run at large for hatchery broodstock – that is, the more fish that are handled or delayed during migration – the greater the negative effect on natural-origin and hatchery-origin fish that are intended to spawn naturally and to ESA-listed species. The information NMFS uses for this analysis includes a description of the facilities, practices, and protocols for collecting broodstock, the environmental conditions under which broodstock collection is conducted, and the encounter rate for ESA-listed fish.

Weirs may delay migration, increase the handling of non-target salmonids, and increase the potential for predation. Weirs may also result in physical habitat changes to the stream and riparian areas. NMFS also analyzes the effects of structures, either temporary or permanent, that are used to collect hatchery broodstock. NMFS analyzes effects on fish, juveniles and adults, from encounters with these structures and effects on habitat conditions that support and promote viable salmonid populations. NMFS wants to know, for example, if the spatial structure, productivity, or abundance of a natural population is affected when fish encounter a structure used for broodstock collection, usually a weir or ladder. NMFS also analyzes changes to riparian habitat, channel morphology and habitat complexity, water flows, and in-stream substrates attributable to the construction/installation, operation, and maintenance of these structures.

2.1.2.5 Factor 3.

NMFS also analyzes the potential for competition, predation, and premature emigration when the progeny of naturally spawning hatchery fish and hatchery releases share juvenile rearing areas. The level of effect for this factor ranges from neutral or negligible to negative. Generally speaking, competition and a corresponding reduction in productivity and survival may result from direct interactions when hatchery-origin fish interfere with the accessibility to limited resources by natural-origin fish or through indirect means, when the utilization of a limited resource by hatchery fish reduces the amount available for fish from the natural population (SIWG 1984). Naturally produced fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, are of equal or greater size, when hatchery fish take up residency before naturally produced fry emerge from redds, and if hatchery fish residualize. Hatchery fish might alter naturally produced salmon behavioral patterns and habitat use, making them more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990).

Hatchery-origin fish may alter naturally produced salmonid migratory responses or movement patterns, leading to a decrease in foraging success (Hillman and Mullan 1989; Steward and Bjornn 1990). Actual impacts on naturally produced fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990). Specific hazards associated with competitive impacts of hatchery salmonids on listed naturally produced salmonids may include competition for food and rearing sites (NMFS 2012). In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (SIWG 1984) concluded that naturally produced coho salmon salmon, Chinook salmon and steelhead are all potentially at "high risk" due to competition (both interspecific and intraspecific) from hatchery fish of any of these three species.

Several factors influence the risk of competition posed by hatchery releases: whether competition is intra- or interspecific; the duration of freshwater co-occurrence of hatchery and natural-origin fish; relative body sizes of the two groups; prior residence of shared habitat; environmentally induced developmental differences; and, density in shared habitat (Tatara and Berejikian 2012). En masse hatchery salmon smolt releases may cause displacement of rearing naturally produced juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al. 1994). Pearsons et al. (1994) reported small-scale displacement of juvenile natural-origin rainbow trout from stream sections by hatchery steelhead.

Another potential ecological effect of hatchery releases is predation. Salmon and steelhead are piscivorous and can prey on other salmon and steelhead (Hawkins and Tipping 1999; Naman and Sharpe 2012). Predation, either direct (direct consumption) or indirect (increases in predation by other predator species due to enhanced attraction), can result from hatchery fish released into the wild. Considered here is predation by hatchery-origin fish and by the progeny of naturally spawning hatchery fish and by avian and other predators attracted to the area by an abundance of hatchery fish.

SIWG (1984) rated most risks associated with predation as unknown, because there was relatively little documentation in the literature of predation interactions in either freshwater or marine areas. More studies are now available, but they are still too sparse to allow many generalizations to be made about risk. Newly released hatchery-origin yearling salmon and steelhead may prey on juvenile fall Chinook and steelhead, and other juvenile salmon in the freshwater and marine environments (Hawkins and Tipping 1999; Pearsons and Fritts 1999). Low predation rates (0 to 0.5 fish/hatchery smolt) have been reported for released steelhead juveniles (Hawkins and Tipping 1999; Naman and Sharpe 2012). Hatchery steelhead timing and release protocols used widely in the Pacific Northwest were shown to be associated with negligible predation by migrating hatchery steelhead on fall Chinook fry, which had already emigrated or had grown large enough to reduce or eliminate their susceptibility to predation when hatchery steelhead entered the rivers (Sharpe et al. 2008). Hawkins (1998) documented hatchery spring Chinook salmon yearling predation on naturally produced fall Chinook salmon juveniles in the Lewis River. Predation on smaller Chinook salmon was found to be much higher in naturally produced smolts (coho salmon and cutthroat, predominately) than their hatchery counterparts.

Predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large relative to naturally produced fish (Naman and Sharpe 2012). Due to their location in the stream or river, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation. Their vulnerability is greatest immediately upon emergence from the gravel and then their vulnerability decreases as they grow (Naman and Sharpe 2012). Some reports suggest that hatchery fish can prey on fish that are up to 1/2 their length (Pearsons and Fritts 1999; HSRG 2004) but other studies have concluded that salmonid predators prey on fish 1/3 or less their length (Beauchamp 1990;). Hatchery fish may also be less efficient predators as compared to their natural-origin conspecifics, reducing the potential for predation impacts (Olla et al. 1998).

2.1.2.6 Factor 4.

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

2.1.2.7 Factor 5.

NMFS also analyzes proposed M&E for its effects on listed species and on designated critical habitat. The level of effect for this factor ranges from positive to negative. Generally, negative effects on the fish from M&E are weighed against the value or benefit of new information, particularly information that tests key assumptions and that reduces critical uncertainties. M&E actions including but not limited to collection and handling (purposeful or inadvertent), holding the fish in captivity, sampling (e.g., the removal of scales and tissues), tagging and fin-clipping, and observation (in-water or from the bank) can cause harmful changes in behavior and reduced survival. These effects should not be confused with handling effects analyzed under broodstock collection. In addition, NMFS also considers the overall effectiveness of the M&E program. There are five factors that NMFS takes into account when it assesses the beneficial and negative effects of hatchery M&E: (1) the status of the affected species and effects of the proposed M&E on the species and on designated critical habitat, (2) critical uncertainties over effects of the Proposed Action on the species, (3) performance monitoring and determining the effectiveness of the hatchery program at achieving its goals and objectives, (4) identifying and quantifying collateral effects, and (5) tracking compliance of the hatchery program with the terms and conditions for implementing the program. After assessing the proposed hatchery M&E and before it makes any recommendations to the action agencies, NMFS considers the benefit or usefulness of new or additional information, whether the desired information is available from another source, the effects on ESA-listed species, and cost.

Hatchery actions also must be assessed for masking effects. For these purposes, masking is when hatchery fish included in the Proposed Action mix with and are not identifiable from other fish. The effect of masking is that it undermines and confuses M&E and status and trends monitoring. Both adult and juvenile hatchery fish can have masking effects. When presented with a proposed hatchery action, NMFS analyzes the nature and level of uncertainties caused by masking and whether and to what extent listed salmon and steelhead are at increased risk. The analysis also takes into account the role of the affected salmon and steelhead population(s) in recovery and whether unidentifiable hatchery fish compromise important M&E.

2.1.2.8 Factor 6.

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

2.1.2.9 Factor 7.

There are two aspects of fisheries that are potentially relevant to NMFS' analysis of HGMP effects in a Section 7 consultation. One is where there are fisheries that exist because of the HGMP (i.e., the fishery is an interrelated and interdependent action) and listed species are inadvertently and incidentally taken in those fisheries. The other is when fisheries are used as a tool to prevent the hatchery fish associated with the HGMP, including hatchery fish included in an ESA-listed ESU from spawning naturally. The level of effect for this factor ranges from neutral or negligible to negative. "Many hatchery programs are capable of producing more fish than are immediately useful in the conservation and recovery of an ESU and can play an important role in fulfilling trust and treaty obligations with regard to harvest of some Pacific salmon and steelhead populations. For ESUs listed as threatened, NMFS will, where appropriate, exercise its authority under Section 4(d) of the ESA to allow the harvest of listed hatchery fish that are surplus to the conservation and recovery needs of the ESU, in accordance with approved harvest plans" (NMFS 2005b). In any event, fisheries must be strictly regulated based on the take, including catch and release effects, of ESA-listed species.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of SONCC coho salmon that would be adversely affected by the proposed action. Their status is determined by the level of extinction risk that the listed species faces, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the current "reproduction, numbers, or distribution" of the species as described in 50 CFR 402.02. This opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

In this Opinion, NMFS assesses four population viability parameters to help us understand the status of the SONCC coho salmon ESU and its ability to survive and recover. These population viability parameters are: abundance, population productivity, spatial structure, and diversity (McElhaney et al. 2000). While there is insufficient information to evaluate these population viability parameters in a thorough quantitative sense, NMFS has used existing information, including the Recovery Plan for SONCC coho salmon (NMFS 2014) to determine the general condition of each population and factors responsible for the current status of the ESU. We use these population viability parameters as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.20).

2.2.1 Status of SONCC coho salmon

The SONCC coho salmon ESU was listed as threatened on May 6, 1997 (62 FR 24588). The listing was most recently reaffirmed on June 28, 2005 (70 FR 37160). Critical habitat for SONCC coho salmon was designated on May 5, 1999 (64 FR 24049). In 2005, the Final 4(d) protective regulations were published (70 FR 37160, June 28, 2005). Three hatchery stocks, Trinity River Hatchery, Iron Gate Hatchery, and Cole Rivers Hatchery on the Rogue River are included in the ESU. There are seven diversity strata in the SONCC coho salmon ESU, including the interior-Trinity Diversity Stratum (Table 9; Figure 2). Although long-term data on coho salmon abundance are scarce, the available evidence from short-term research and monitoring efforts indicate that spawner abundance has declined since the last status review for populations in this ESU (Williams et al. 2016). In fact, most of the 30 independent populations in the ESU are at high risk of extinction because they are below or likely below their depensation threshold, which can be thought of as the minimum number of adults needed for survival of a population.

Table 9. Diversity strata of the SONCC coho salmon ESU, including the number of population types (F: functionally independent, P: potentially independent, D: dependent, and E: ephemeral) (Williams et al. 2007).

	Population types (*n*)			
Diversity Strata	F	P	D	E
Northern Coastal Basins	2	2	3	2
Central Coastal Basins	4	2	5	0
Southern Coastal Basins	3	1	2	0
Interior-Rogue River	3	0	0	0
Interior-Klamath	3	2	0	0
Interior-Trinity	2	1	0	0
Interior-Eel	2	4	0	0

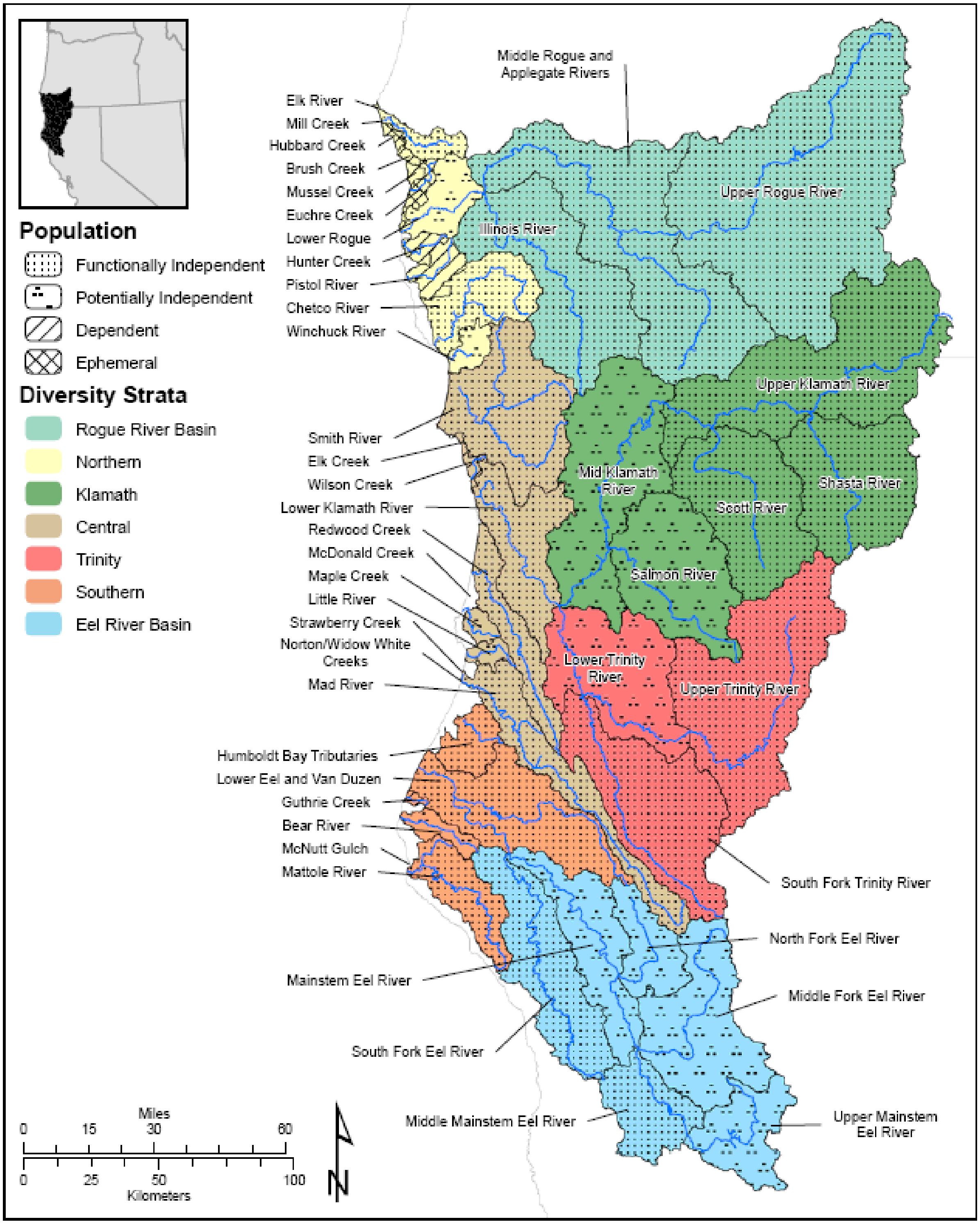

Figure 2. Diversity strata for populations of coho salmon in the SONCC ESU. From Williams et al. (2007).

The distribution of SONCC coho salmon within the ESU's range is reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which SONCC coho salmon are now absent (Williams et al. 2011, Williams et al. 2016). Extant populations can still be found in all major river basins within the range of the ESU (70 FR 37160). However, extirpations, loss of brood years, and sharp declines in abundance (in some cases to zero) of SONCC coho salmon in several streams throughout the range of the ESU indicate that the SONCC coho salmon spatial structure is more fragmented at the population-level than at the ESU scale. The genetic and life history diversity of populations of SONCC coho salmon is likely very low and is inadequate to contribute to a viable ESU, given the significant reductions in abundance and distribution. A viable ESU contains populations that exist as a metapopulation that as an entity is naturally self-sustaining into the foreseeable future, no longer needs the protection of the Endangered Species Act, and therefore can be "delisted" – taken off the list of threatened and endangered species.

2.2.2 Status of SONCC coho salmon Critical Habitat

One factor affecting the range wide status and aquatic habitat at large is climate change. Information since these species were listed suggests that the earth's climate is warming, and that this change could significantly impact ocean and freshwater habitat conditions, which affect survival of all three species of listed salmonids subject to this consultation. In the coming years, climate change will reduce the ability to recover some salmon species in most or all of their watersheds. Coho salmon are particularly vulnerable to climate change due to their need for year-round cool water temperatures, as they rear for one or more years in freshwater, unlike some other salmonid species (Moyle 2002). By increasing air and water temperatures, climate change is expected to decrease the amount and quality of habitat coho salmon, reducing the productivity of populations and exacerbating the decline of the species. Climate change effects on stream temperatures within Northern California are already apparent. For example, in the Klamath River, Bartholow (2005) observed a 0. 5°C per decade increase in water temperature since the early 1960s.

In coastal and estuarine ecosystems, the threats from climate change largely come in the form of sea level rise and the loss of coastal wetlands. Sea levels will likely rise exponentially over the next 100 years, with possibly a 50-80 cm rise by the end of the 21st century (IPCC 2007). This rise in sea level will alter the habitat in estuaries and either provide increased opportunity for feeding and growth or in some cases will lead to the loss of estuarine habitat and a decreased potential for estuarine rearing. Marine ecosystems face an entirely unique set of stressors related to global climate change, all of which may have deleterious impacts on growth and survival while at sea. In general, the effects of changing climate on marine ecosystems are not well understood given the high degree of complexity and the overlapping climatic shifts that are already in place (e.g., El Niño, La Niña, Pacific Decadal Oscillation) and will interact with global climate changes in unknown and unpredictable ways. Overall, climate change is believed to represent a growing threat, and will challenge the resilience of salmonids in Northern California, including SONCC coho salmon.

2.2.3 Factors Responsible for the Decline of Species and Degradation of Critical Habitats

The factors that caused declines include hatchery practices, ocean conditions, habitat loss due to dam building, degradation of freshwater habitats due to a variety of agricultural and forestry practices, water diversions, urbanization, over-fishing, mining, climate change, and severe flood events exacerbated by land use practices (Good et al. 2005, Williams et al. 2016). Sedimentation and loss of spawning gravels associated with poor forestry practices and road building are particularly chronic problems that can reduce the productivity of salmonid populations. Late 1980s and early 1990s droughts and unfavorable ocean conditions were identified as further likely causes of decreased abundance of SONCC coho salmon (Good et al. 2005). From 2014 through 2016, the drought in California reduced stream flows and increased temperatures, further exacerbating stress, disease, and decreasing the quantity and quality of spawning and rearing habitat available to SONCC coho salmon. Ocean conditions have been unfavorable in recent years (2014 to present) due to El Niño conditions and the warm water “Blob” which impacted the U.S. west coast, and reduced ocean productivity and forage for SONCC coho salmon.

2.3 Action Area

Action Area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this proposed action, the Action Area includes TRH (Section 8, Township 40°43'11. 61"N, Range 122°48'4. 90"W), Trinity River, and the Klamath River from its confluence with the Trinity to its mouth in the Pacific Ocean (Figure 3). The Action Area also includes the nearshore portions of Pacific Ocean at the mouth of the Klamath River. While strategies to minimize impacts from hatchery fish on wild populations should be implemented at least at the river basin scale (Kostow 2012), the effects ecological effects of hatchery fish tend to decline as distance from a hatchery increases (Naman and Sharpe 2012). While TRH coho salmon are known to stray to Iron Gate Hatchery, the Rogue River, and into tributaries of the Lower Trinity River, the numbers of TRH coho salmon doing so are small. Most TRH coho salmon return to the upper Trinity River population, where genetic interactions on the spawning grounds are likely to be of greatest concern. For the above reasons, the effect of the action are limited to the Trinity River, and the Klamath River from its confluence with the Trinity to its mouth in the Pacific Ocean (Figure 2).

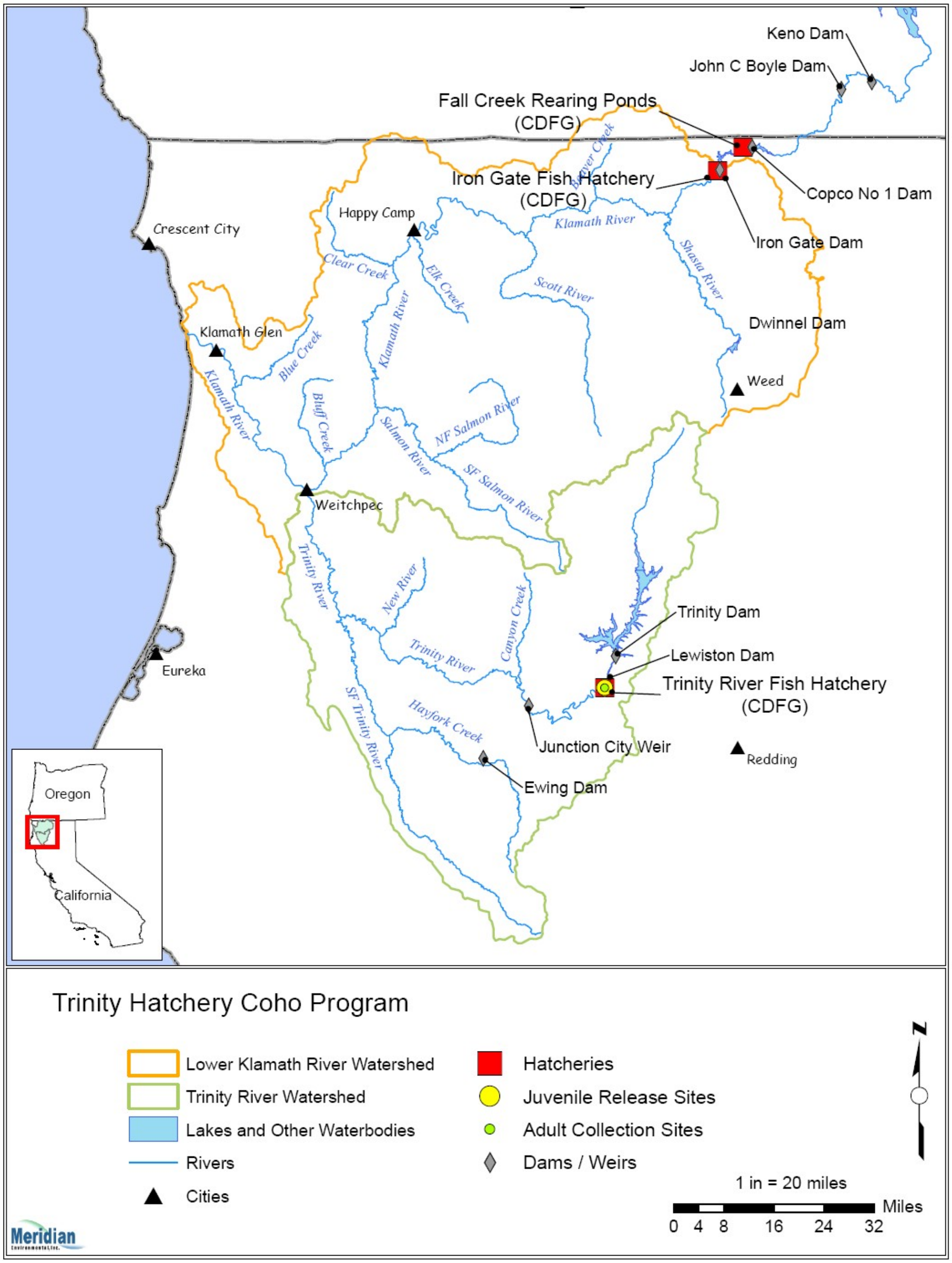

Figure 3. Map of the proposed Action Area (Trinity River basin) and associated anadromous fish hatcheries in the region.

2.4 Environmental Baseline

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

2.4.1 SONCC Coho Salmon Population Units in the Action Area

Within the action area, there are three Trinity River population units and one Klamath River population unit that are in the action area (Table 10). Although they migrate through the lower Klamath River portion of the action area, the population units of the Interior-Klamath Stratum will have little exposure to the proposed action.

Table 10. Population unit boundaries for SONCC coho salmon populations in the action area (Williams et al. 2006).

Population Unit	Boundaries	Adult population needed for recovery
Upper Trinity River	Confluence of North Fork Trinity River (inclusive) upstream to Ramshorn Creek (inclusive).	5,800
Lower Trinity River	Confluence of Klamath River upstream to confluence with North Fork Trinity River (non-inclusive).	3,600
South Fork Trinity River	South Fork Trinity River to the confluence of the Trinity River.	970
Lower Klamath River	Mouth of Klamath River upstream to confluence with Trinity River.	5,900

The Upper Trinity River, Lower Trinity River, and Lower Klamath River Population Units are "core" population units, and need to achieve a robust level of adult spawners for recovery of the ESU (Table 10; NMFS 2014). The South Fork Trinity River Population Unit is not considered a core population unit, and needs to achieve only an amount of adult spawners required to be functionally independent for the recovery of the ESU (Table 10; NMFS 2014). Therefore, the Action Area is very important to the survival and recovery of the ESU because the ESU cannot recover without three of the four population units in the Action Area being recovered.

Population units in the Trinity River have a high conservation value. As mentioned above, at least two of them must be viable for the diversity stratum to be viable and for the ESU to be viable. The Upper-Trinity Population unit is unique within the Trinity River system as these coho salmon are currently the longest migrating adult coho salmon in the stratum. While coho salmon likely used to migrate as far as Hayfork Creek on the South Fork Trinity River, habitat degradation and water utilization on that river has restricted the spatial structure of the population unit. The run timing of the Upper Trinity River population unit is earlier (September and October) than those fish in the Lower Trinity Population unit (November through January). Within the Interior-Trinity diversity stratum, the Upper Trinity River population unit and the Lower Trinity River population unit capture both the coastal winter returning run timing and the inland fall returning run timing. This aids in protecting the diversity stratum from both drought and flood by extending the time during which adults enter the Trinity River. The upper Trinity River population unit may serve as an important "source" population for the Lower Trinity and South Fork Trinity populations which may act as "sinks." The Upper Trinity River population unit also protects the ESU against range shrinkage by maintaining an inland population that is one of the furthest east migrating population units in the ESU. The discharge of the Lower Trinity River is more dominated by rain while discharge of the Upper Trinity River is more of a rain-snowmelt mix. These population units have developed different life history strategies to take advantage of this difference. The Lower Klamath River Population unit is important in order for populations in the Central Coastal Basins Diversity Stratum to maintain connectivity with other populations to the north and south along the California and Oregon coasts. This population unit has access to a wide range of diverse off channel pond and slough habitat types, which aids in a diversity of life history strategies, which protects it and the ESU against environmental change, catastrophes, and natural disasters.

2.4.2 Status of SONCC coho salmon Population Units in the Action Area.

Limited information about the population size of individual SONCC coho salmon population units within the action area is available. No systematic surveys that monitor population sizes in any of the populations are performed. CDFW monitors coho salmon run size at a weir near Willow Creek, California on the lower Trinity River. Because adult coho salmon from all three population units of the Interior-Trinity Diversity Stratum pass through the weir site due to its location, it is not known which population of coho salmon is captured at the weir. As such, the weir estimates provide an aggregate population estimate for all unmarked coho salmon upstream of the weir. All coho salmon marked by maxillary bone removal captured at the weir are known to be of TRH origin. The California drought from 2013 to 2017, combined with poor ocean conditions during the same period pushed adult coho salmon returns to some of their lowest levels in recent decades (Figure 4). The reduced production at TRH also changed the number of returning TRH origin coho salmon in recent years (Figure 4). Hatchery origin adults often make up 80% or greater of the overall run, though there is indication that this proportion has decreased recently with lower production from TRH.

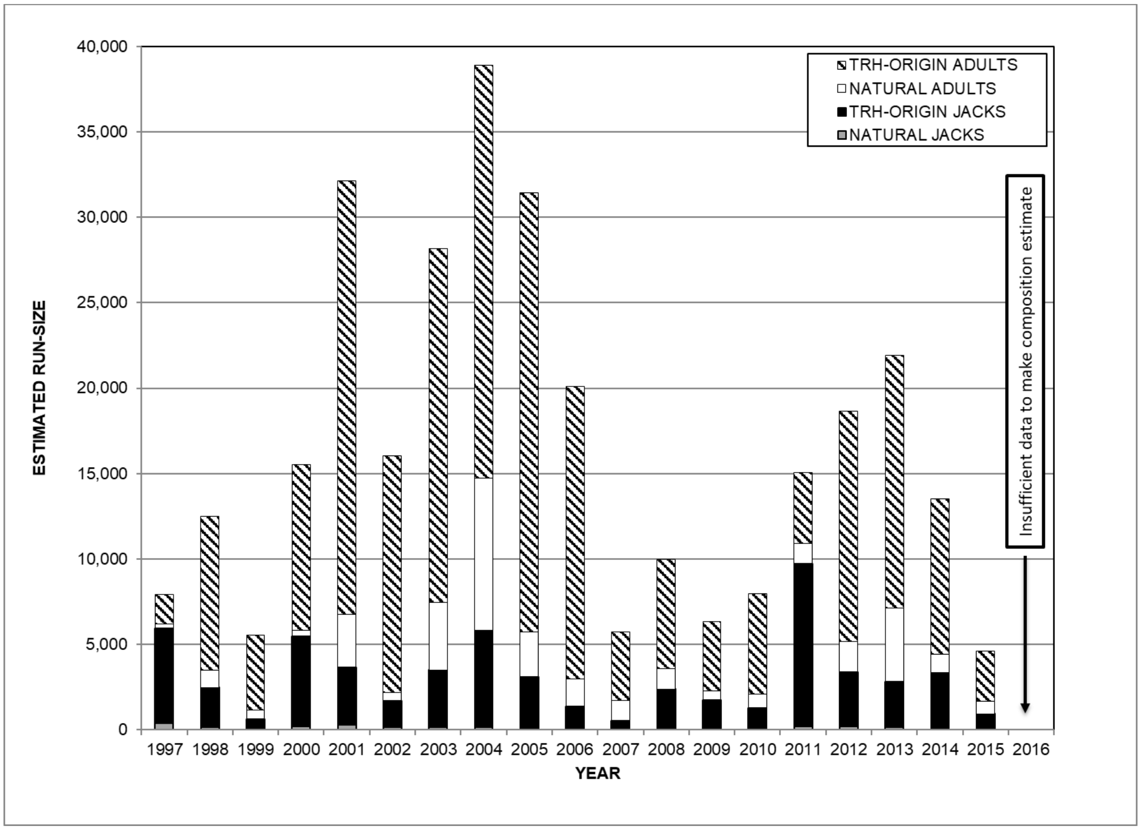

Figure 4. Coho salmon run size estimates for the Trinity River upstream of the Willow Creek Weir 1997 to 2016 (Kier et al. 2017).

2.4.2.1 Upper Trinity River Population Unit

The original spawner-recruit (S/R) analysis (Table 11) was developed for Trinity River coho salmon by NMFS staff using estimates of population composition (NOR, HOR), harvest rates, returns to the hatchery, spawning ground surveys, and adult counts at the Willow Creek Weir (Naman 2016). Adults arriving at the weir could include coho salmon from all three Trinity River populations; however, adult production is more than likely dominated by fish originating from the Upper Trinity coho salmon population where TRH coho salmon originate. Therefore, in the HGMP the S/R analysis results were used as an indicator of the sustainability of the Upper Trinity River coho salmon population (Table 11). The actual number of Coho from each of the three Trinity River coho salmon populations arriving at the weir is unknown.

The data in Table 11 were used to develop estimates of adult productivity (0.547) and capacity (3,305) based on a Beverton-Holt production function. A productivity value of less than 1.0 indicates that the population was not self-sustaining for the years modeled. Of major concern, is the fact that the population had a productivity greater than 1.0 in only one of the 15 years examined. The analysis supports an assumption in HGMP development that observed NORs are highly likely to be the offspring of hatchery fish spawning naturally in the previous generation and that hatchery production should be maintained to sustain the population until better adult escapement data to tributaries can be collected and analyzed.

That analysis assumes that the relative reproductive success (RRS) and fitness of hatchery origin returns (HORs) is identical to that of naturally produced fish (NORs). However, based on their review of the scientific literature of hatchery fish performance, the HSRG concluded that this is not the case for hatchery origin fish (HSRG 2014, 2015). In modeling hatchery impacts to natural populations, the HSRG assumes that the RRS of hatchery fish is 0.8. With respect to fitness, the HSRG models a fitness floor wherein fitness of hatchery fish is 0.5 that of naturally produced fish, based on Ford (2002)

To account for hatchery effects on naturally produced fish, the R/S analysis was performed a second time as part of HGMP development by adjusting hatchery fish fitness and RRS to the levels recommended by the HSRG. The results of this analysis, referred to as ADJUSTED, are presented in Table 12. The results indicate that after accounting for hatchery effects, population productivity increased to above 1.0 (i.e., to 1.288). The analysis implies that if hatchery fitness effects to the natural population can be reduced, the coho salmon population has the potential to be self-sustaining. The expected average abundance for the natural population absent input of hatchery fish would be 799 NOR coho salmon (Table 12). At a run-size of 799 NOR coho salmon, the performance criteria for PNI (0.67) can be achieved (Table 5).

Table 11. Spawner Recruit data used to calculate Beverton-Holt productivity and capacity parameters, unmarked adult spawners (S), unmarked ocean recruits (R), and recruits per spawner (R/S).

Run year	**Marked and Unmarked Adult Spawners (S)**	**Unmarked Ocean Recruits (R)**	**Recruits Per Spawner (R/S)**
1997	969	390	0.402
1998	5,372	3,425	0.638
1999	1,537	532	0.346
2000	5,795	4,389	0.757
2001	17,158	10,024	0.584
2002	6,833	2,901	0.425
2003	12,743	1,736	0.136
2004	20,408	1,255	0.062
2005	10,550	1,375	0.130
2006	8,096	570	0.070
2007	2,411	928	0.385
2008	2,932	1,328	0.453
2009	1,863	1,311	0.704
2010	2,487	5,133	2.064
2011	2,909	1,054	0.362
Average	6,804	2,423	0.501
	Productivity	Capacity	Abundance
Beverton-Holt Parameters	0.547	3,305	0

Source: Original data provided by CDFW. Marked and unmarked adult ocean abundance from S. Naman, NMFS. Adult numbers are based on adult NOR and HOR counts at the Willow Creek Weir, adult returns to the TRH, spawning surveys, and harvest estimates. Adult coho salmon pre-spawn mortality is not included in the analysis.

Table 12. Adjusted Spawner and recruit data used to calculate Beverton-Holt productivity and capacity parameters, unmarked adult spawners (S), unmarked ocean recruits (R) and recruits per spawner (R/S). Adult numbers are based on NOR and HOR counts at the Willow Creek Weir, adult returns to the TRH, spawning surveys, and harvest estimates. Numbers have been adjusted to account for hatchery fish Relative Reproductive Success (RRS of 0.8).

Run Year	Adjusted Marked and Unmarked Adult Spawners (S)	Unmarked Ocean Recruits (R)	Recruits Per Spawner (R/S)
1997	409	390	0.95
1998	2,242	3,425	1.53
1999	659	532	0.81
2000	2,348	4,389	1.87
2001	7,142	10,024	1.40
2002	2,771	2,901	1.05
2003	5,422	1,736	0.32
2004	8,911	1,255	0.14
2005	4,436	1,375	0.31
2006	3,375	570	0.17
2007	1,060	928	0.88
2008	1,273	1,328	1.04
2009	787	1,311	1.67
2010	1,061	5,133	4.84
2011	1,248	1,054	0.84
Average	2,876	2,423	1.19
	Productivity	Capacity	Abundance
Beverton-Holt Parameters	1.288	3,305	799

For the All-H Analzer (AHA) results provided below, the adjusted spawner-recruit data (Table 12) was used for model inputs including productivity and capacity. Other inputs including smolt release numbers and other factors are specific to the historic conditions or the actions proposed in the TRH HGMP (Section 1.3 above).

2.4.3 AHA Results – Historic Hatchery Operations

AHA modeling results for Historic Hatchery Operations (pre-2015) are presented in Table 13. Key findings of the AHA analysis are as follows:

- pHOS (78%) and PNI (0.04) values **do not** meet program objectives (pHOS < 30%, minimum PNI of 0.5, average PNI > 0.67). The PNI of 0.04 indicates that the population is adapted to the hatchery rather than the natural environment.

- A 0.5 fitness value indicates that hatchery effects to the NOR population are substantial. This value represents the minimum fitness (i.e., HSRG fitness floor) assumed for a salmon population in AHA modeling as determined by the HSRG.

- The number of broodstock (1,250) is larger than that required to produce 500,000 coho salmon smolts (~500). This is due to the extensive culling of HOR eggs for BKD and to represent the full extent of adult run-timing (eggs from NOR adults are not culled unless they test positive for BKD).

- The number of hatchery surplus adults is large (average of 4,396, maximum of 12,159). A large surplus of hatchery fish was an issue identified by the CA HSRG in its review of the program.

Table 13. AHA modeling results for historic hatchery operations (pre-2015; 500,000 HOR coho salmon smolts).

	Adult Coho Salmon		
Parameter	Maximum	Minimum	Average
NOR Escapement	3,566	195	1,346
HOS Escapement	14,471	1,151	6,060
Total Natural Escapement	18,027	1,346	7,406
Total Harvest All Fisheries	3,377	271	1,435
Hatchery Broodstock	1,250	1,230	1,250
Hatchery Surplus	12,159	-	4,396
Total Run Size	34,822	2,847	14,487
Performance Indicators			
pHOS	78%		
pNOB	4%		
PNI	0.05		
Fitness	0.5		
% of HOR Adults Returning to Hatchery or Removed with Weirs	48%		
NOR Harvest Exploitation Rate	9.9%		

The Upper Trinity River population is at moderate risk of extinction as described in the SONCC coho salmon salmon recovery plan (NMFS 2014). Coho salmon continue to be present in many of the tributary streams in this population unit, but low adult returns in recent years have left some habitat unoccupied. Although there may be robust numbers of spawners occasionally in some years, the overall number of naturally produced coho salmon in the Upper Trinity River watershed is low compared to historic conditions, and hatchery fish dominate the run. The Upper Trinity River Population unit has the greatest degree of temporal and spatial exposure to hatchery fish of any of the population units in the action area. SONCC coho salmon in this population unit are exposed to both genetic interactions through breeding with TRH coho salmon, as well as ecological interactions (predation, competition and disease transfer) with hatchery coho salmon, Chinook salmon, and steelhead. This population needs to have adult returns of 5,800 for the SONCC coho salmon ESU to be viable as described in the SONCC coho salmon salmon recovery plan (NMFS 2014).

Estimated harvest numbers and rates for Trinity River Hatchery and NOR coho salmon combined are shown in Table 14. Because they are not ad-clipped, and due to their similar distribution in the ocean, it is assumed that harvest rates are similar for NOR and HOR TRH coho salmon. Between 1997 and 2014, annual harvests of NOR coho salmon in the Yurok Tribe fishery ranged from an estimated 2 to 168 and averaged 42 fish (Naman, unpublished data). In the Hoopa tribal fishery from 1997 and 2014, annual harvests of NOR Trinity River coho salmon ranged from 3 to 134 and averaged 42 fish. SONCC coho salmon experience incidental morality due to hooking and handling in Chinook salmon directed ocean fisheries. Incidental ocean mortality rates from 1997 to 2014 ranged from 14 to 862, and averaged 155 fish (Table 14). Additionally, a small amount of mortality occurs in freshwater when anglers hook and release coho salmon, or inadvertently or purposefully keep coho salmon, which is prohibited. Ocean incidental mortality for TRH HOR coho salmon ranged from 94 to 2,358 adults. In the Yurok Tribe fishery, harvest of adult HOR coho salmon ranged from 6 to 1,214 fish (Table 14). In the Hoopa Tribe fishery, harvest of HOR coho salmon ranged from 39 to 505 adults (Table 14).

Table 14. Estimated harvest numbers and rates of NOR Trinity River coho salmon in ocean and freshwater fisheries. Run size estimates provided by CDFW, Trinity River project. Ocean incidental mortality rate provided by the Pacific Fisheries Management Council. Ocean incidental mortality calculated on presumed ocean abundance prior to river return.

Run Year	NOR adult run size estimate	Ocean Incidental Mortality	Ocean Incidental Mortality Rate	Estimated Yurok Tribal harvest	Estimated Hoopa Tribal harvest	Tribal Harvest Rate
1997	252	14	5.0%	2	3	2.0%
1998	1,101	155	11.7%	13	54	5.1%
1999	555	32	4.9%	14	36	7.7%
2000	342	23	6.0%	3	22	6.3%
2001	3,075	104	3.0%	142	101	7.1%
2002	458	41	7.7%	13	16	5.4%
2003	3,930	421	9.6%	21	17	0.9%
2004	8,901	862	8.6%	168	83	2.5%

Run Year	NOR adult run size estimate	Ocean Incidental Mortality	Ocean Incidental Mortality Rate	Estimated Yurok Tribal harvest	Estimated Hoopa Tribal harvest	Tribal Harvest Rate
2005	2,659	160	5.5%	61	21	2.8%
2006	1,586	90	5.2%	21	38	3.4%
2007	1,157	68	5.4%	16	14	2.4%
2008	1,223	22	1.6%	71	53	9.0%
2009	525	14	2.4%	15	17	5.6%
2010	817	20	2.2%	26	65	9.8%
2011	1,205	50	3.8%	2	21	1.7%
2012	1,205	89	6.8%	12	5	1.3%
2013	4,305	580	11.3%	114	134	4.8%
2014	902	52	4.9%	42	53	9.0%
Avg.	1,900	155	5.9%	42	42	4.8%

Table 15. Estimated harvest numbers and rates of HOR Trinity River coho salmon in ocean and freshwater fisheries. Run size estimates provided by CDFW, Trinity River project. Ocean incidental mortality rate provided by the Pacific Fisheries Management Council. Ocean incidental mortality calculated on presumed ocean abundance prior to river return.

Run Year	HOR adult run size estimate	Ocean Incidental Mortality	Ocean Incidental Mortality Rate	Estimated Yurok Tribal harvest	Estimated Hoopa Tribal harvest	Tribal Harvest Rate
1997	1,732	94	5.0%	21	39	3.2%
1998	9,008	1,221	11.7%	117	88	2.0%
1999	4,357	238	4.9%	120	65	3.8%
2000	9,704	634	6.0%	70	211	2.6%
2001	25,395	848	3.0%	1,214	505	6.1%
2002	13,849	1,209	7.7%	327	276	3.8%
2003	20,721	2,225	9.6%	121	85	0.9%
2004	24,162	2,358	8.6%	553	309	3.1%
2005	25,678	1,541	5.5%	640	153	2.8%
2006	17,123	977	5.2%	241	442	3.6%
2007	4,048	238	5.4%	61	68	2.9%
2008	6,381	116	1.6%	472	262	10.2%
2009	4108	107	2.4%	132	124	5.7%
2010	5852	142	2.2%	211	237	7.0%
2011	4,113	167	3.8%	19	107	2.9%
2012	13,494	999	6.8%	102	89	1.3%
2013	14,782	1,987	11.3%	445	368	4.6%
2014	9,297	492	4.9%	6	252	2.6%
Avg.	11,878	866	5.9%	271	204	3.8%

2.4.3.1 Lower Trinity River Population Unit

Limited data exists for this population as few surveys have been completed. The limited data available from the U.S. Forest Service and the Hoopa Valley Tribe for the Lower Trinity River population suggests that much of the habitat in the Lower Trinity River is currently unoccupied or only sporadically occupied. Brood year coho salmon may be missing and the adult coho salmon population is likely less than the depensation threshold of 112 adults. The population growth rate in Lower Trinity River sub-basin has not been quantified. The Lower Trinity population is at high risk of extinction as described in the SONCC coho salmon salmon recovery plan (NMFS 2014). This population needs to have adult returns of 3,600 for the SONCC coho salmon ESU to be viable as described in the SONCC coho salmon salmon recovery plan (NMFS 2014).

2.4.3.2 South Fork Trinity River Population Unit

The only population estimates for the South Fork Trinity River are based on work by Jong and Mills (1992) who estimated that 127 adult and jack coho salmon returned to the South Fork Trinity River in 1985 and 99 returned in 1990. With 35.8 percent (46) of the adult coho salmon captured in 1985 being of hatchery origin, the total wild population was likely under 100 adults during these years (Jong and Mills 1992). However, in other years, few or no hatchery coho salmon were trapped on the South Fork Trinity River (Jong and Mills 1992). Although we have no current population estimates, if we assume abundances are similar to those found in 1985 and 1990, the South Fork Trinity River population does not meet the depensation threshold of 242 adults and is at high risk of extinction. The population growth rate in South Fork Trinity River basin has not been quantified but is likely negative based on loss of habitat and declining water quality. The South Fork Trinity River population is at high risk of extinction as described in the SONCC coho salmon salmon recovery plan (NMFS 2014). This population needs to have adult returns of 970 for the SONCC coho salmon ESU to be viable as described in the SONCC coho salmon salmon recovery plan (NMFS 2014).

2.4.3.3 Lower Klamath River Population Unit

NMFS (2014) determined that based on criteria established by Williams et al. (2008), the Lower Klamath River population is at high risk of extinction because the spawner abundance has likely been below the depensation threshold of 205 adult coho salmon. The productivity of the population, based on the limited information available, appears to be declining (NMFS 2014). This population needs to have adult returns of 5,900 for the SONCC coho salmon ESU to be viable as described in the SONCC coho salmon salmon recovery plan (NMFS 2014).

2.4.4 Status of SONCC coho salmon Critical Habitat in the Action Area.

2.4.4.1 Upper Trinity River Population Unit

The Trinity River Division of the Central Valley Project has caused loss of hydraulic function, habitat loss, and habitat simplification. The juvenile life stage of the Upper Trinity River population unit of SONCC coho salmon salmon is the most limited of the life stages and suitable quality summer and winter rearing habitat is lacking for the population. Loss of flow variability and reduced rearing habitat during the fall and winter months as a result of water storage and flow management is expected to reduce the ability of the habitat in the Upper Trinity River to support winter rearing of juvenile coho salmon. Water withdrawals from important tributaries like Weaver and Rush creeks reduce baseflows in the summer and fall months, contributing to low flows and high water temperatures. Variability of the natural flow regime is inherently critical to ecosystem function and native biodiversity (Bunn and Arthington 2002, Beechie et al. 2006). In the summer, flow regimes and the lack of large woody debris (LWD) and off-channel habitat leads to poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality in tributaries and the mainstem during dry years. Floodplain disconnection and poor riparian function as a result of reduced flow and variability is being addressed through restoration efforts but will continue to be a limiting factor for the population.

2.4.4.2 Lower Trinity River Population Unit

There is no critical habitat on the Hoopa Valley Tribe Reservation, which is located in the lower Trinity River area. Lack of floodplain and channel structure impacts has a major impact on the productivity of this population. Rearing opportunities and capacity are low due to disconnection of the floodplain, a lack of LWD inputs, poor riparian conditions, and sediment accretion. Low-lying areas of streams such as Supply, Mill, and Willow Creek have been channelized, diked, and disconnected from the floodplain. Many tributaries in low-gradient areas of the Lower Trinity experience similar habitat characteristics due to development of the floodplain, sedimentation and changes in flow. The mainstem river also lacks side channel, backwater, and wetland habitat where juvenile coho salmon could find habitat in the winter. A lack of floodplain and channel structure impacts winter rearing because high flow events can displace juveniles from streams and there exists very little low-velocity rearing habitat. Lack of complex habitat also impacts summer rearing due to the loss of predatory refugia, low-flow refugia, and foraging habitat. In some portions of this population unit cannabis farming impacts summer rearing areas for juveniles, due to runoff and pollution, as well as contributing to poor water quality and quantity.

2.4.4.3 South Fork Trinity River Population Unit

The South Fork originates in the North Yolla Bolly Mountains about 50 miles southwest of Redding and runs northwest for approximately 90 miles before reaching its confluence with the Trinity River. A large portion of the South Fork Trinity River watershed is publicly owned and managed by the Shasta-Trinity National Forest. Much of the basin is still recovering from the effects of the 1964 flood that introduced massive volumes of sediment into the South Fork Trinity River and most tributary reaches. Due to the substantial sediment influx, much of the mainstem South Fork Trinity River and Hayfork Creek still lack deep pool holding habitat for adult salmon (NMFS 2007). In addition, temperatures in the lower South Fork and selected tributaries, particularly the lower portion of Hayfork Creek, have been implicated as being too high to fully support salmon. Deforestation, dewatering, illegal grading, and pollution associated with cannabis farming has significantly altered water quality and fish habitat in this population unit.

2.4.4.4 Lower Klamath River Population Unit

There is no designated critical habitat for this population unit, as the population boundaries lie entirely within the Yurok Tribe Reservation. Altered sediment supply, lack of floodplain and channel structure, degraded riparian forest conditions and impaired estuary function are the biggest stresses to this population. The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking for the population. Juvenile summer rearing habitat is impaired from subsurface flow conditions in the tributaries and poor water quality of the mainstem Klamath River. Winter rearing habitat is severely lacking because of channel simplification, disconnection from the floodplain, degraded riparian conditions, poor large wood availability, and an estuary which has been altered and reduced in size due to development, channelization, and diking. Large wood has been removed and is not naturally replacing at the rates required to maintain key components of habitat complexity. Altered sediment supply in many tributaries has hindered fish passage, resulted in poor summer survival, poor spawning and incubation habitat suitability, and the loss and degradation of stream and off-channel habitat. Most potential spawning reaches have excessively embedded and armored substrate, making redd construction more challenging for adults and reducing permeability in constructed redds. Agricultural practices, channelization and diking, roads, and timber harvest are the biggest threats to this population.

2.4.5 Factors Affecting SONCC coho salmon Population Units and Critical Habitat in the Action Area.

There are a variety of factors affecting SONCC coho salmon in the action area, most of which have a negative effect on SONCC coho salmon and their critical habitat (Table 16). The California drought, combined with the warm water "Blob" in the northeast Pacific Ocean had a toll on SONCC coho salmon in the action area, contributing to low returns of adult coho salmon. Limited and poor quality freshwater habitat, disease, and lack of forage in the ocean environment for multiple years in a row appears to have pushed adult returns to their lowest levels throughout the region. Restoration activities in the Trinity River basin and the lower Klamath River will likely benefit coho salmon populations by reducing several stressors in the action area like sedimentation or loss of LWD.

Table 16. Factors affecting coho salmon in the action area.

Factors affecting coho salmon in the Action Area	Effects	Stressors
Forestry Activities	Negative	Sedimentation of spawning gravels, increased water temp, loss of LWD, poor water quality, reduced pool frequency and depth
Roads	Negative	Sedimentation, habitat blockage, reduced pool frequency and depth
Hatchery Activities	Negative and positive	Negative: Genetic and ecological interactions. Positive: Demographic support at low run sizes, marine derived nutrients.
Climate Change	Negative	Warming water temperatures, reductions in summer and fall streamflow
Agriculture	Negative	Sedimentation, decrease in water quality, decrease in summer base flows, riparian habitat loss
Urban, residential, and industrial development	Negative	Urban non-point pollution runoff, increased water utilization, channelization, riparian habitat loss
Water Diversions	Negative	Loss or reduction of summer baseflow (tributaries other than mainstem Trinity River), habitat reduction, increase in water temperatures, hydrologic alteration, habitat reductions.
Restoration	Positive	Addition of LWD, increase in habitat quantity and quality
Fisheries	Negative	Mortality of returning adults and jacks

Effects from timber harvest including sedimentation, riparian habitat loss, reduced LWD recruitment, and water temperature impacts, are expected to continue through the action period. Impacts from roads are expected to remain similar or slightly decrease throughout the Proposed Action as more roads are decommissioned. Road decommissioning and culvert replacement will help to reduce sedimentation in the future. Boutique wineries, organic farms, and residential development exacerbate late summer and fall water shortages, which impacts summer rearing areas for coho salmon. Marijuana cultivation and associated water utilization and unchecked grading and deforestation poses a significant threat to coho salmon in some locales, such as areas on the South Fork Trinity River. Residential growth in the Trinity basin and Lower Klamath River is expected to continue at a moderate pace, and its effects are negative due to increasing runoff and water use. Mortality of marked and unmarked Trinity River coho salmon averaged 6.2% (range 3.0% to 12.1%) in ocean fisheries and 3.8% (range 0.9% to 10.2%) in tribal fisheries in the lower Klamath and Trinity Rivers.

2.4.6 Iron Gate and Trinity River Hatchery Chinook Salmon and Steelhead Production

While Iron Gate Hatchery (IGH) is not in the action area, the hatchery produces Chinook salmon and coho salmon that migrate and rear in the lower Klamath River. Trinity River Hatchery also produces Chinook salmon and steelhead that are released at the hatchery and migrate and rear from the hatchery to the Pacific Ocean. Reclamation (2018) determined that the release of Chinook salmon and steelhead from TRH would result in the loss of 4.4% of fry and 5.1% of juvenile coho salmon. IGH Chinook salmon and coho salmon are expected to adversely affect coho salmon in the action area through competition in the lower Klamath River.

Table 17. Iron Gate and Trinity River hatcheries Production Goals.

Hatchery	Species	Number released	Released	Adult Run timing
IGH	Chinook Salmon	5,100,000 smolts	May-June	Mid-September to early November
		900,000 smolts	November	
	coho salmon	75,000 smolts	March-May	October to January
TRH	Chinook Salmon	3,000,000 smolts	May-June	Mid-September to early November
		1,300,000 smolts	November	
	Steelhead	448,000 smolts	April	November to March
TRH coho salmon are not included in the table as the effects of the coho salmon program are evaluated in Section 2.5.				

When released into the freshwater, HOR fish compete with NOR fish for food and habitat, and can predate on smaller NOR salmonids already in the system (Fleming et al. 2000, Kostow et al. 2003, Kostow and Zhou 2006). Chinook Salmon are released from IGH and TRH in May and June and the release overlaps with the coho salmon smolt peak emigration period in the Klamath River Basin (near the middle of May), which is also the same period that the river flows are in sharp decline. Accordingly, HOR Chinook salmon from the hatcheries that remain in the river system for weeks at a time compete for food and habitat with NOR coho salmon, though there are some interspecifc differences in habitat selection. As the hydrograph declines and suitable rearing habitat diminishes in quantity and quality, ecological interactions between HOR Chinook salmon and HOR steelhead, and juvenile NOR coho salmon increase. Suitable summer rearing habitat likely becomes limited as juvenile salmonids are forced to rear into increasingly small thermal refugia areas with high salmonid density and limited feeding opportunities. These interactions likely have an adverse effect on juvenile NOR coho salmon if they are displaced from suitable rearing areas or outcompeted for prey resources.

NMFS (2018) required that Reclamation ensure that at least 95% of adipose clipped TRH Chinook salmon fingerling emigration will occur prior to July 31, as measured near the North Fork Trinity River. Similarly, Reclamation must ensure at least 75% of adipose clipped Chinook salmon yearling emigration past the North Fork Trinity River will occur prior to October 20. The volitional release approach for HOR Chinook salmon from TRH and IGH likely reduces the severity of ecological interactions, although to what level is still unknown.

The exact extent of effects of the release of HOR Chinook Salmon from IGH and TRH and salmon and steelhead from TRH are unknown. However, NOR coho salmon are exposed to increased competition with HOR Chinook salmon and steelhead. These ecological interactions likely have an adverse effect on NOR coho salmon.

2.4.7 Climate Change in the Action Area

Figure 5 shows downscaled projections for representative climate pathway 4.5 (RCP 4.5) developed by the International Panel on Climate Change for 32 climate models for the region near Lewiston, California, the location of TRH (cal-adapt.org 2019). The RCP 4.5 projections for air temperatures are expected to be lower than the more recent RCP 8.5 projections. For precipitation, the projections for RCP 4.5 and RCP 8.5 are expected to be similar. Assuming emissions peak around 2040 and then decline, the modeled annual mean maximum and minimum air temperatures are expected to increase approximately 3°F from the historical period (1961-1990) to the modeled future period (2020-2050). Average annual mean precipitation is expected to increase approximately 2.3 inches from 35.9 inches to 38.2 inches from the historical period to modeled future period. There has already been a significant loss of snowpack in northern California, particularly at low elevations (Mote et al. 2018), and warming caused by climate change will continue to exacerbate future snowpack loss, regardless of any potential increases in precipitation (Zhu et al. 2005, Vicuna et al. 2007). A transition to a warmer climate state and sea surface warming may be accompanied by reductions in ocean productivity which affect fisheries (Ware and Thomson 2005; Behrenfeld et al. 2006). Due to the corresponding increase in water temperatures, decrease in summer and fall stream flows and potential declines in ocean productivity, the amount of habitat available to all life stages of SONCC coho salmon in the action area is expected to shrink and/or become less suitable. This is expected to reduce the number of successful offspring produced per adult spawner, and challenge the resiliency of SONCC coho salmon in the action area.

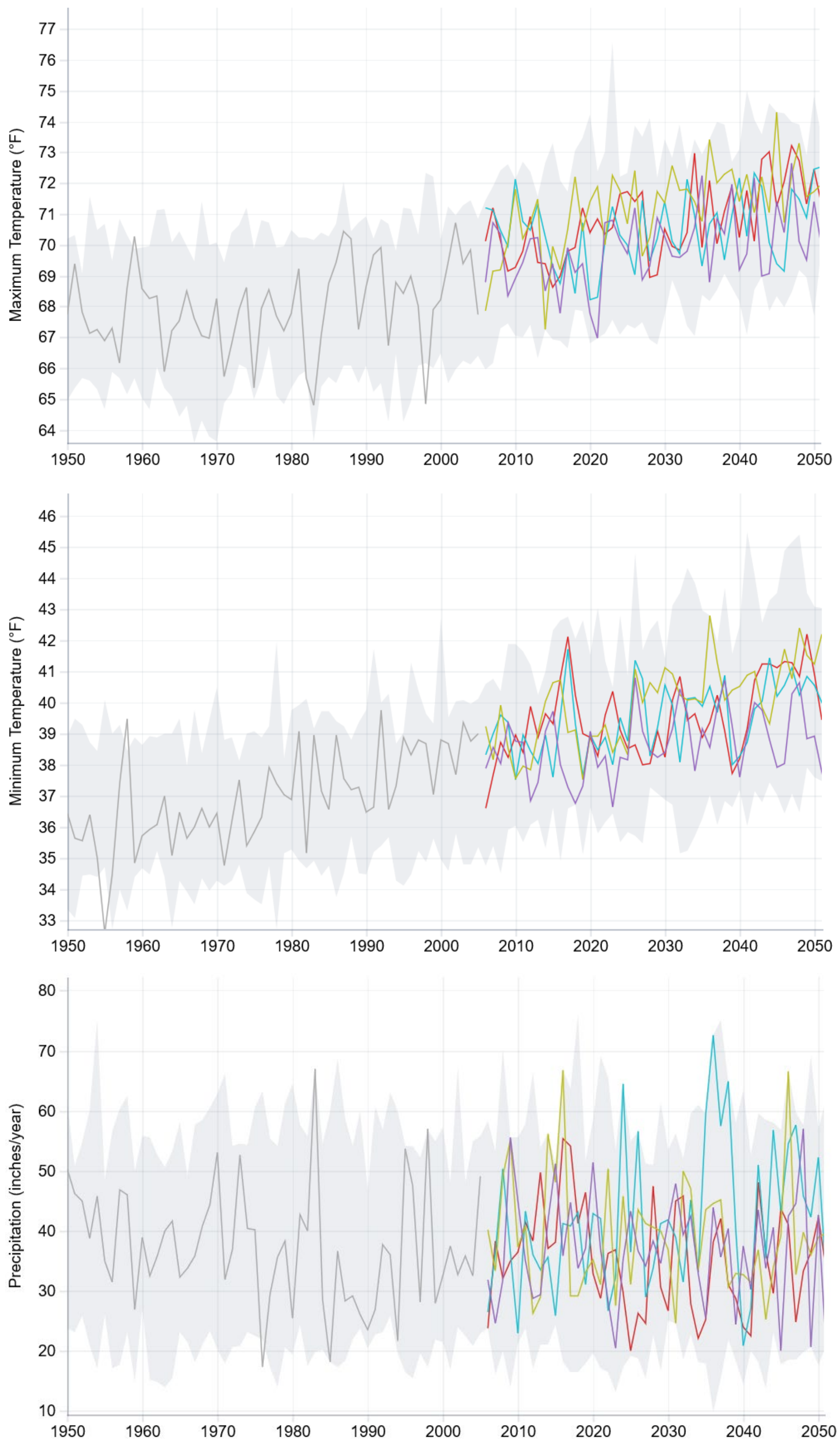

Figure 5. Panel figure showing predicted top) maximum temperature, middle) minimum temperatures, and bottom) precipitation through 2050 for the region near Lewiston, California. Data are from cal-adapt.org.

2.5 Effects of the Action

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

2.5.1 AHA Results – HGMP

AHA modeling results for hatchery operations as proposed in the HGMP for the period 2015-2020 are presented in Table 18. The analysis assumes that the proportion of hatchery fish removed from the system remains similar to historical levels (~48 percent)[7] and that the population has a Beverton-Holt productivity and capacity of 1.288 and 3,305 (Table 17), respectively. Again, because the data used to generate these values were collected at the Willow Creek Weir, model results are simply used as an indicator of likely minimum change in the key performance metrics with implementation of the HGMP. The values are considered minimums as they assume that managers will not be able to increase the percentage of HOR adults removed at weirs or returning to the hatchery.

Analysis shows that HGMP hatchery operations at 300,000 smolt production will result in an increase in population fitness and PNI, a decrease in pHOS and slight decrease in NOR abundance, when pNOB is 100%. In addition, the number of surplus hatchery fish, harvest numbers and fish used for broodstock also decrease under the HGMP at 300,000 production (Table 18). The number of surplus fish could also be harvested by removing HOR adults at weirs or fisheries managed and operated by others in the basin. The implementation of these actions would increase the probability of achieving the pHOS criterion. At the 150,000 smolt production level, the pHOS criterion as well as a higher PNI would likely be achieved. However, with a low population productivity initially, the large drop in the number of HOR spawners could lead to a low number of NORs in subsequent years. In particular, low freshwater and/or low ocean productivity could contribute to not enough NORs, possibly leading to difficulty in obtaining natural origin broodstock. Fewer NOR broodstock would be required, approximately 200 adults total, reducing the number of NOR coho salmon that would need to be removed from the river.

At the 500,000 smolt production level, many more HOS would need to be removed from the system in order to achieve a PNI that exceeds 0.5. This would require effective weirs and fisheries that have a much higher catch efficiency than current weirs or fisheries. Should freshwater and/or ocean productivity decline such that few NOR spawners are returning to streams in the Trinity Basin, increasing production to the 500,000 smolt level may be desirable

[7] CDFW data tables

in terms of generating enough spawners for demographic support while the population rebuilds. However, more NOR coho salmon would be needed for the 500,000 production to achieve PNI targets, which may not be sufficient in years with low returns of Upper Trinity River population NOR coho salmon. Close tracking of the PNI, potential competition in the river and ocean for limited resources with NOR coho salmon, recovery of the species, and other factors would be needed.

Table 18. Adult coho salmon AHA modeling results for HGMP hatchery operations (2015-2020; 300,000 HOR coho salmon smolts).

Parameter	Maximum	Minimum	Average
NOR Escapement	3,956	0	1,239
HOS Escapement	10,510	836	4,387
Total Natural Escapement	13,468	836	5,626
Total Harvest All Fisheries	2,592	208	1,108
Hatchery Broodstock	400	299	400
Hatchery Surplus	9,703	773	4,051
Total Run-size	27,161	2,116	11,184
Performance Indicators			
pHOS	74%		
pNOB	100%		
PNI	0.57		
Fitness	0.72		
% of HOR Adults Returning to Hatchery or Removed with Weirs	48%		
NOR Harvest Exploitation Rate	9.9%		

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

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock,
(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities,
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas,
(4) hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean,
(5) Monitoring, evaluation and research (M&E) that exists because of the hatchery program,
(6) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and

(7) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

In the action area, coho salmon are likely to be negatively affected as a result of four of the seven factors described in Section 2.1.2. They are: the removal of natural-origin adults for broodstock; hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities; hatchery fish and progeny of naturally spawning hatchery fish in juvenile rearing areas (i.e., competition, and predation); and M&E that exists because of the hatchery program. At low NOR abundance, HOS can be beneficial by providing demographic support. An overview of the analysis is described below.

2.5.2 Factor 1.

Negative demographic effect: The removal of natural-origin coho salmon for broodstock would reduce the overall abundance of the upper Trinity River natural-origin coho salmon population by up to 50% in some years, with a median of 38%, given similar return rates as 1994 to 2018. Under the Proposed Action, Reclamation and CDFW would annually collect a minimum of 50 and potentially up to 400 natural-origin coho salmon for broodstock at the 300,000 smolt production level? (Table 5). The range of the number of broodstock would be approximately 50 percent less than that amount at the 150,000 smolt release level, or 40% greater at the 500,000 smolt release level. Based on estimated natural origin coho salmon run sizes (Table 2-11), the percentage of the population removed for broodstock would range from 6% up to 50% in some low run size years. For run sizes less than 800 NOR coho salmon, the percentage of the population removed for broodstock would be 50%, with that percentage declining as NOR run size increases (Table 5). These percentages would remain the same throughout the range of potential production from 150,000 to 500,000 smolts.

This assumes all of the returning unmarked adult coho salmon to the Willow Creek Weir would be migrating to the Upper Trinity River. This would result in the loss of gametes in the Trinity River and tributaries of the Trinity River where NOR coho salmon captured and used for broodstock would have otherwise returned. In the near term, this is expected to lower the overall productivity of the upper Trinity River population by removing natural origin spawners from natural spawning areas and reducing the subsequent numbers of rearing juveniles. In the long term as this population becomes integrated in accordance with CAHSRG (2012) recommendations, NMFS expects productivity (recruits produced per spawner) of the overall population to exceed the current level.

One of the results of removing these fish from the river and using them as broodstock is to reduce the amount of marine derived nutrients (MDN) in the Upper Trinity River population, thereby limiting invertebrate production as well as adult salmonid flesh and eggs that are also food for rearing juvenile coho salmon. Kaylor et al. (2020) found that in test stream reaches where carcasses were added, juvenile Chinook salmon and steelhead growth rates were 1.1 to 5 and 6 to 23 times greater relative to control reaches, respectively. The proposed action would remove up to 560 adult NOR coho salmon from the upper Trinity River population for use as broodstock at the 500,000 smolt release level. This is expected to reduce the growth and survival to individual coho salmon resulting from the loss of feeding opportunities associated with the loss of flesh and eggs from adult carcasses in the short term (Kaylor et al. 2020), and reduced MDN and primary and secondary productivity in the long term. This negative effect would likely occur on tributaries to the Trinity River where natural origin coho salmon used for broodstock would have returned, even if hatchery strays increase MDN overall in the mainstem Trinity River. Because tracking the decrease in growth of juvenile coho salmon resulting from the loss of feeding opportunities on salmonid flesh and reduction in MDN would be complex and infeasible (e.g., would require capture, tagging, and recapture of juveniles and time consuming analysis of data to measure growth over time each year), NMFS will rely on the number of NOR coho salmon used for broodstock for tracking the extent of this effect.

Table 19. Unmarked coho salmon run size estimates at the Willow Creek weir from 1997 to 2014 and the numbers and percentage of unmarked adult coho salmon that would be used for broodstock at TRH given the proposed action (Table 5).

Run Year	Unmarked adult estimated run size at WC weir	Number of coho salmon that would be used for broodstock	Percentage of natural origin coho salmon that would be used for broodstock
1997	252	126	50%
1998	1,101	374	34%
1999	555	278	50%
2000	342	171	50%
2001	3,075	584	19%
2002	458	229	50%
2003	3,930	747	19%
2004	8,901	534	6%
2005	2,659	505	19%
2006	1,586	397	25%
2007	1,157	393	34%
2008	1,223	379	31%
2009	525	263	50%
2010	817	384	47%
2011	1,205	374	31%
2012	1,205	374	31%
2013	4,305	818	19%
2014	902	370	41%
2015	748	374	50%
2016	635	318	50%
2017	57	29	50%
2018	42	21	50%
Median	1,002	374	38%

2.5.2.1 AHA Model Results

Because of the uncertainty associated with the ability of managers to collect NOR fish for broodstock and the uncertain effectiveness of weirs to remove hatchery fish, the AHA model was run for various combinations of percent HOR removal (Table 20). The cells highlighted in green and red in Table 20 indicate the performance metrics where the HGMP outperforms or underperforms the Historic Hatchery Operations (pre-2015), respectively. The conclusions below are applicable to the proposed action. Major conclusions from this analysis are:

- Average NOR abundance increases as fewer hatchery fish are removed using weirs or other methods.
- Allowing more hatchery fish to spawn naturally increases NOR abundance but results in lower PNI, fitness and higher pHOS for the population.
- Average NOR fish abundance decreases as the percent of hatchery fish removed from the spawning grounds increases. This is turn results in an increase in PNI, fitness and lower pHOS.
- Because increased fitness requires generations to achieve, the short-term decrease in NOR abundance from removal of hatchery fish from the spawning grounds poses a risk to continued natural production.
- The HGMP results in higher PNI and fitness values regardless of the percent of the hatchery population removed from the system. This is the direct result of setting pNOB at 100 percent, which ensures that PNI is always at least 0.5 and that the natural component of the population drives local adaptation.
- The average PNI (> 0.67) and pHOS target of <30 percent cannot be achieved (on average) given current assumptions regarding natural population productivity and capacity, program size and assumed effectiveness of weirs (< 81 percent) to prevent HORs from spawning naturally. As described in Table 5, the PNI target can be achieved at large NOR coho salmon run-sizes (800+).

Table 20. AHA modeling results for hatchery operations as described in this HGMP for various levels of percent removal of hatchery fish from the system. Data are average values based on a model run over 100 generations. Green and red values define conditions where the HGMP outperforms or underperforms Historic Hatchery Operations, respectively.

Percent of HORs Removed	Proportion Natural Origin Broodstock (pNOB) 100 Percent			
	Average NOR Escapement	PNI	pHOS	Fitness
10%	1,510	0.56	80%	0.70
20%	1,455	0.56	79%	0.71
30%	1,390	0.56	77%	0.71
40%	1,309	0.57	76%	0.72
50%	1,218	0.58	73%	0.72
60%	1,097	0.58	71%	0.73
70%	933	0.59	68%	0.73
80%	680	0.60	66%	0.73

As stated above, increased fitness requires generations to achieve (Figure 1) and the short-term decrease in NOR abundance from removal of hatchery fish from the spawning grounds poses a risk to continued natural production. The AHA model results provide more evidence for what has been well described in the scientific literature: a spawning population of salmonids in the wild comprised of approximately 90% HOR will in turn yield a spawning population of 10% NOR that are entirely dependent on the HOR population for demographic support. Decades of genetic introgression of the TRH coho salmon population with a much smaller natural coho salmon population is one factor that has led to a continually small percentage (~ 10%) natural coho salmon in the overall run annually. Therefore, a balance needs to be struck in the interim so that reductions in hatchery production do not cause a catastrophic decline in the naturally reproducing Trinity River coho salmon population while the overall fitness of the population continues to grow during implementation of the TRH HGMP.

2.5.2.2 Summary

Achieving the average PNI target of 0.67 over the majority of coho run-sizes would require population productivity and/or capacity to be approximately double what has been estimated using data from monitoring weirs in the Trinity River (Reclamation and CDFW 2017). As such, NMFS does not expect to reach the PNI goal of 0.67 until several years after the HGMP is implemented (Figure 1). The TRH coho salmon program will be able to achieve an interim 0.5 PNI goal in the short term (Table 18), assuming a pNOB of 100%. A pNOB of 100% may be challenging to achieve in the short term, though the upper Trinity River population is expected to benefit as pNOB increases over time and the river environment begins to drive the selection pressure process. The removal of a median of 38% of the Trinity River natural-origin coho salmon population (Table 19) for hatchery broodstock purposes is expected to reduce the abundance of coho salmon in tributaries in the Upper Trinity River population unit in the near term. However, additional hatchery coho salmon on the spawning grounds are expected to provide needed demographic support as this population rebuilds over the long term. The productivity of the upper Trinity River population is expected to increase over time as HGMP actions are implemented at TRH. The effects of the proposed action on coho salmon resulting from the removal of coho salmon from the natural population are summarized below in Table 21.

Table 21. The effect of the proposed action on coho salmon resulting from the removal of coho salmon from the natural population.

Effect	Life stage	Production origin	Stressor	BMP
Removal and spawning of NOR adults	Adult	NOR	Death	Minimum PNI 0.5, 3-year average PNI > 0.67, pHOS < 30%
Removal and spawning of HOR adults	Adult	HOR	Death	Minimum PNI 0.5, 3-year average PNI > 0.67, pHOS < 30%
Loss of MDN in tributaries	Juveniles	NOR	Loss of feeding opportunities, reduction in growth of individuals	None

2.5.3 Factor 2.

Negative genetic effect: Genetic effects on populations in the Trinity River are likely to occur from interactions on the spawning grounds between hatchery fish or progeny of naturally spawning hatchery fish and natural-origin coho salmon.

2.5.3.1 Genetic Effects

The Proposed Action would manage the Trinity River Hatchery coho salmon program as an integrated program, with a pNOB of 50% to 100%. These criteria meet the CHSRG's guidelines for an integrated program. The HGMP results in a modeled pHOS of 74% over the long term (Table 18), given the current productivity (Table 12). Both fitness and PNI improve under the proposed action, though pHOS remains similar. Based on recent experience and the proposed operations, NMFS concludes that hatchery-influenced selection from the TRH coho salmon program pose a low risk to the natural-origin Upper Trinity River coho salmon population.

As discussed above, the previous decades of unchecked genetic introgression of TRH coho salmon with natural coho salmon on the Trinity River, combined with other pressures such as inter- and intra-specific competition and predation and lack of habitat have left the Upper Trinity River coho salmon population with a low productivity rate, and dependent on the constant input of hatchery origin spawners to support the natural origin population. Therefore, removing too many hatchery origin spawners too quickly, before the fitness of the overall population has a chance to improve, could potentially result in an unintentional detrimental decline of the natural population. The AHA model results, as well as the historically high pHOS in the Upper Trinity River, are lines of evidence that can be used to draw this conclusion. Therefore, NMFS believes that the proposed level of pHOS modeled in the HGMP, 74%, is necessary in the interim while productivity of this population and fitness increases as a result of lower production levels (decline in ecological interactions) and an increase in pNOB (improvement in PNI and gene flow from the wild to TRH). As such, a pHOS of 74% is not expected to reduce the survival and recovery of the Upper Trinity River coho salmon population.

For tracking the effect of genetic interactions on the spawning grounds, NMFS will rely on PNI, as it is a measure of gene flow between the hatchery and natural environments. NMFS will use both short and long term measures of PNI to track the effects of the action because as described above, the Upper Trinity River population unit of coho salmon is heavily dependent on hatchery origin spawners for demographic support. NMFS will consider the period 2020 to 2032, 4 coho salmon generations as short-term, while the period after 2032 will be considered long-term. As the productivity and fitness of this population increase over time, NMFS expects attainment of both short and long term PNI metrics to provide protection for this species.

The proposed action includes monitoring of the lower Trinity River population and South Fork Trinity River. The pHOS is not expected to exceed 5%, which is sufficient to ensure that the populations are segregated from the upper Trinity River population (CA HSRG 2012). The effect of a pHOS of less than 5% is expected to have negligible effects to the Lower Trinity and South Fork Trinity River populations because CAHSRG (2012) determined this functionally equates to TRH being segregated from this population and outbreeding depression and other potential effects are not a concern. After capture, NOR and HOR adult coho salmon would be transported using a tanker truck from the weir location to TRH. At TRH, unripened adults would be held in round tanks or tubes until spawning. Mortality of NOR and HOR adults holding prior to spawning is expected to be less than 5 percent because the proposed action includes BMPs such as adult holding density and handling protocols which are expected to minimize any unexpected adult holding mortality.

2.5.3.2 Rearing Density

While selection in the hatchery environment occurs at all life history stages, beginning with unnatural mating processes (Hankin et al. 2009) and continuing through juvenile release, one factor in a hatchery that can be controlled and can reduce the amount of domestication selection (Thompson and Bluin 2015) is the monitoring and adherence to an appropriate raceway rearing density. For coho salmon, some studies have found densities less than 0.21 lbs/ft^3 of having substantially greater survival advantage than control densities ranging from double to orders of magnitude larger (Banks 1995; Fuss and Byrne 2002; Ewing et al 1995). Because the control groups had densities that were so much higher than the treatment density in the aforementioned studies, NMFS will consider densities of 0.25 lbs/ft^3 or less as limiting the amount of domestication selection to the extent practicable for coho salmon in a hatchery. The proposed action includes a maximum rearing density of 1.0 lb/ft^3 (Reclamation and CDFW 2017), though current coho salmon rearing densities are less or equal to 0.30 lbs/ft^3 (Muir 2019). A rearing density of 1.0 lb/ft^3 is expected to exacerbate domestication selection occurring on coho salmon at TRH. When these smolts return as adults to spawn, they would be expected to have a negative effect on the genetic composition of the upper Trinity River coho salmon population.

2.5.3.3 Weir Operations

The proposed weir used for broodstock collection will likely delay migration for a portion of NOR coho salmon returning to the Trinity River and increase the handling of non-target salmonids. NMFS expects that providing regular weir openings daily and on weekends will help to limit the effect of the weir on migration delay. Additionally, if a buildup of salmonids occurs downstream of the weir, which will be monitored visually and with snorkel observations, the weir will be opened to allow passage of delayed salmonids. Additional methods that may be used for broodstock collection include seining or hook and line. The handling of non-target species will be minimized by operating the weirs during peak coho salmon migration timing. In addition, handling will be conducted by experienced and trained personnel. Combined mortality from handling is not expected to exceed one percent (CDFW and Reclamation 2017) of the amount of adult coho salmon that are trapped. Weir installation may also result in physical habitat changes to the stream and riparian areas. NMFS expects only minor effects to coho salmon individuals from the minor changes to habitat from the installation of the weir because there will be negligible levels of suspended sediment and any disturbance created by weir installation is expected to be short in duration and individuals can move to other suitable areas in the river.

However operation of the weir and the blocking of the migration corridor is expected to have negative effects to coho salmon as they congregate below the weir before entering the weir trap. The slowed migration is expected to negatively impact some individuals by causing stress, weir rejection leading to spawning in non-natal tributaries, and reduced adult productivity. Because it is challenging to estimate exactly how many adults will be impacted by weir rejection or weir delay (e.g. would require annual studies that capture, tag, and track adults and adult abundance is highly variable year to year), NMFS will rely on the number of adults captured at the weir to track the extent of this effect because the number of adults captured has a correlation with the number of adults affected by weir delay or weir rejection. NMFS expects no more than 600 adults would be captured, as this meets or exceeds the number of NOR adults needed for broodstock.

2.5.3.4 Jacks in the Broodstock

The proposed action recommended that jacks to be incorporated into broodstock such that they do 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. Although developed by CAHSRG (2012), the recommendation provides no lower limit for incorporating jacks in the broodstock. A jack percentage of zero in the broodstock meets this recommendation. However, the proposed action also states that jacks will be incorporated into the broodstock at a rate of 5 to 15 percent of the males spawned. NMFS will assume there is a possibility that as few as zero jacks could be utilized in the broodstock. Appropriately incorporating jacks into the TRH broodstock is critical in providing gene flow between cohorts and ensuring that cohorts within one population do not diverge genetically more than the divergence of populations themselves. Incorporating zero jacks in the broodstock would be expected to negatively affect the upper Trinity River population unit when HOR coho salmon return to spawn in the Trinity River.

2.5.3.5 Summary

The proposed action results in several different effects related to the hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities. A summary of the effects of the proposed action on coho salmon resulting from the removal of coho salmon from the natural population are provided below in Table 22.

Table 22. The effect of the proposed action on coho salmon resulting from the removal of coho salmon from the natural population.

Effect	Life stage	Stressor	BMP
Prespawn mortality of adults in the hatchery (adult holding)	Adult	Death	Handling/holding/density protocol mortality < 5%
High stray rate of HOR adults (pHOS of 74%)	Adult	Reduction in adult productivity (poor survival of progeny)	Minimum PNI 0.5, 3-year average PNI > 0.67, pHOS < 30% 3 year moving avg
High rearing density, 1.0 lb/ft^3	Juvenile	Increased domestication, poor survival, genetic effect	Not proposed
Weir delay	Adult	Loss in adult productivity, displacement to different spawning areas	Snorkel surveys, observations, pull weir panels
Weir handling, seine or hook and line	Adult	Death/Injury/disturbance/ harass	Handling protocols

2.5.4 Factor 3.

Negative ecological effect: The most important considerations here are competition and predation by juvenile hatchery fish and the progeny of naturally spawning hatchery fish, and premature emigration of natural-origin fish caused by hatchery fish.

PCDRISK-1 results are provided in Table 23 for a hatchery release of 300,000 and 500,000 coho salmon smolts. The model results should be considered index values of predation, competition and disease risks hatchery fish pose to naturally produced coho salmon fry and yearlings. Higher values are indicative of higher risk. Data represent the percentage of the natural coho fry and yearling populations that may be lost due to the release of 300,000 and 500,000 hatchery coho salmon smolts based on size at release (160mm) and time in the river (average of 21 and 44 days; Table 22).

On average, the total loss of NOR coho fry from a release of 300,000 and 500,000 hatchery yearlings is 0.4 percent and 1.3 percent of coho salmon natural production potential, respectively. For NOR yearlings, the average loss for these same two release sizes is 1.6 percent and 3.3 percent. For fry, predation is the major cause of mortality. In contrast, competition with hatchery fish is the major risk associated with possible losses in NOR smolts (Table 23).

Since juvenile production from each NOR brood year is exposed to hatchery fish as both fry and one year later as yearlings, the combined values for fry and yearling losses shown in Table 23 represent the total hatchery impact to a single brood year (i.e., 2.0 to 4.6 percent depending on release number). In other words, the release of 500,000 yearling HOR smolts has the potential to reduce potential NOR production by as much as 4.6%.

Table 23. PCDRISK-1 modeling results for coho salmon.

PCDRISK-1 Modeling Results				
Percent of Total NOR Coho Salmon Fry Population Lost				
Release Number	**Fish Size at Release (mm)**	**Days in River**	**Parameter**	**Mean (%)**
300,000	160	21	Predation	0.4
			Competition	0
			Total	0.4
			Parameter	**Mean (%)**
500,000	160	44	Predation	1.3
			Competition	0
			Total	1.3
Percent of Total NOR Coho Yearling Population Lost				
Release Number	**Fish Size at Release (mm)**	**Days in River**	**Parameter**	**Mean (%)**
300,000	160	21	Predation	0
			Competition	1.6
			Total	1.6
			Parameter	**Mean (%)**
500,000	160	44	Predation	0
			Competition	3.3
			Total	3.3

Hatchery smolts and the juvenile progeny of naturally spawning hatchery coho salmon are expected to have a negative effect on natural-origin juveniles by reducing the potential NOR production by up to 4 percent at the 300,000 smolt release level. At the 500,000 release level, potential NOR production could be reduced by approximately 4.6 percent (Table 24). At the 150,000 smolt release level, the percentage impact on the population of NOR coho salmon would be expected to be approximately half of the modeled results of the 300,000 smolt release level.

Table 24. The effect of the proposed action on coho salmon resulting from competition and predation at the 500,000 smolt release level.

Effect	Life stage	Stressor	Proposed BMP
Competition and predation	Juvenile	Death (up to 4.6 percent of NOR coho salmon production)	Smolts will be volitionally released within 7 days of the March new moon (March 1-15) to reduce residualization of hatchery fish. Timing may change depending on timing of release study.

2.5.5 Factor 4.

Negative ecological effect: The TRH coho salmon is expected to increase the numbers of smolts entering the lower Trinity River, the Klamath River and estuary, as well as the nearshore ocean environment. Some authors have found that competition for food and resources in the ocean (e.g., Ruggergone and Connors 2015); however, that effect was not modeled.

The PCDRISK-1 results for the Action Area provided above show a reduction in potential NOR production by up to 2.0% (300,000 smolt release level) and 4.6 (500,000 smolt release level) resulting from ecological interactions with HOR coho salmon smolts between Lewiston Dam and the Willow Creek rotary screw trap. Little if any predation effect in the migration corridor is expected because fry are not concentrated in the migration area like they are in spawning and rearing areas. Ecological interactions decline as spatial and temporal overlap between HOR and NOR conspecifics decreases (Naman and Sharpe 2012), and due to few opportunities for predation on coho salmon fry over time as smolts move downstream, NMFS believes that the mortality from competition in the migration corridor would be less than the 1.6% or 3.3% of NOR production lost from competition upstream of the Willow Creek trap site (Table 24). The lower mortality rate attributable to ecological interactions in these areas are due to a declining number of HOR coho salmon smolts as distance from TRH increases, increasing size over time of NOR coho salmon juveniles, as well increasing streamflow volume that occurs as tributary flow increases, providing more physical habitat and more spatial separation between HOR and NOR coho salmon. Though the ecological effect is lower in the migration corridor than in the upstream juvenile rearing areas, NMFS concludes that this factor will have a negative effect on population viability. This severity of the effects of this factor on coho salmon are not expected to rise to a level which would impair the ability of the three Trinity River coho salmon populations to achieve viability in the future.

Table 25. The effect of the proposed action on coho salmon resulting from competition in the migration corridor and nearshore areas at the 500,000 smolt release level.

Effect	Life stage	Stressor	Proposed BMP
Competition	Juvenile	Death (less than 3.3 percent of NOR coho salmon production)	Smolts will be volitionally released within 7 days of the March new moon (March 1-15) to reduce residualization of hatchery fish. Timing may change depending on timing of release study

2.5.6 Factor 5.

Negative demographic effect: The Proposed Action includes M&E activities that will continue to monitor the Performance Indicators identified in Table 8, ensure compliance with this opinion, and inform future decisions regarding how the hatchery program can be adjusted to meet their goals while further reducing effects on SONCC coho salmon.

Limited lethal and sub-lethal effects on NOR coho salmon are expected to occur from the handling of adults during broodstock collection, which will include the use of a weir, and HOR coho salmon from this program will not confuse or conceal the status of a natural population or the effects of the hatchery program on any natural population because hatchery coho salmon will be 100 percent marked for easy identification. The timing of juvenile release study will use HOR coho salmon to determine how quickly HOR smolts migrate to the rotary screw trap located near Willow Creek. While some HOR smolts may be injured or killed (less than two percent) if they are tagged prior to being released, these effects are likely to be minimal (Reclamation and CDFW 2017).

The proposed action includes the potential tagging, experimentation, and research on HOR adult and juvenile coho salmon for various monitoring and research projects. Survival, migration, movement, growth, distribution and other factors may be assessed by monitoring and research projects. Adult and juvenile coho salmon would experience stress, and could be injured or killed during capture, handling, and tagging. The effects of the proposed action proposed action on coho salmon resulting from monitoring and evaluation in the proposed action are summarized below in Table 26. NMFS expects no more than 560 NOR adults would be affected during transportation or adult holding experiments, as this exceed the number needed for broodstock collection, and no more than 5% captured for broodstock may be killed. The ATPase study may require up to 50 NOR juvenile coho salmon for lethal sampling to determine if TRH smolts differ from their NOR counterparts.

Spawning grounds surveys may disturb adult coho salmon; however, no injuries or mortalities or other adverse effects are expected. Other studies on survival and movement of NOR coho salmon could require up to 1,000 juveniles; however, mortality is expected to be less than 1%. Additional studies requiring adult tagging (e.g., studies of weir migration delay) may use up to 2,000 NOR adults; however, mortality is expected to be less than 1% as BMPs in the proposed action are expected to keep mortalities from experimentation to a minimum. The action agencies clarified after submitting the proposed action that a thiamine deficiency study may be implemented to assess how coho salmon eggs and their development into subsequent life stages may be negatively affected by a diet high in thiaminase, an enzyme that metabolizes thiamine. Up to 10 g of eggs from 30 HOR or NOR individuals would be collected annually. In years of low HOR returns, this may reduce the number of smolts available for release from a particular brood. In years of high HOR returns, there would be little to no effect to hatchery production since there would be surplus eggs for production. The overall effect from this study is expected to be minimal as the potential loss of 10 g of eggs from 30 HOR or NOR individuals is not expected to cause a large decline in hatchery production or negatively affect NOR production in the long term and results from the study could be used to improve hatchery coho salmon health.

Table 26. The effect of the proposed action on NOR and HOR coho salmon resulting from monitoring and evaluation in the proposed action.

Effect	Life stage	Stressor	Proposed BMP
Adult tagging	Adult	Death/Injury/harass	Handling protocol
Juvenile tagging	Juvenile	Death/Injury/harass	Handling protocol
Adult transportation	Adult	Death/Injury /harass	Handling/transportation/density protocol
Spawning grounds survey	Adult	Disturbance/harass	Minimize stepping on redds, avoidance, etc.
ATPase study	Juvenile	Death/Injury/harass	Handling protocol
Holding experiment	Adult	Death/Injury /harass	Handling/transportation/density protocol
Thiamine deficiency experiment	Egg	Death	None

2.5.7 Factor 6.

Negligible effect: Trinity River Hatchery is a minor discharger as defined by the EPA. The North Coast Regional Water Quality Control Board uses National Pollutant Discharge Elimination System (NPDES) permits to ensure the TRH meets the water quality standards and protects the beneficial uses (NCRWQCB 2015). TRH currently operates under the NPDES permit no. CAG131015, order no. R1-2015-0009, and the associated monitoring and reporting program (Table 27). Effluent discharges in excess of the criteria below are prohibited.

Table 27. Standards for all Trinity River Hatchery effluent discharges (NCRWQCB 2015).

Parameter	Unit	Monthly Average	Daily Maximum
Suspended Solids	mg/L	8.0	15.0
Suspended Solids	lb/day	334	626
Settleable Solids	mg/L	0.1	0.2
Hydrogen Ion	pH	$7.0 \leq pH \leq 8.5$	
Flow	mgd	42.76	61.0

In addition to the Regional Water Board's water quality regulatory processes described above, the California Toxic Rule (40 C.F.R. Part 31) establishes numeric water quality criteria for priority toxic pollutants and other water quality standard provisions, and Division 4 Title 22 of the California Code of Regulations establishes maximum containment levels for various toxins to protect drinking water. The Regional Water Board requires the TRH to provide data on all California Toxic Rule and Title 22 constituents so that pertinent effluent regulations can be included in the NPDES permit. Because Reclamation and CDFW will monitor water quality in accordance with the above standards and the water quality standards do not adversely affect coho salmon, effects from effluent discharges into the Trinity River are expected to be minor in nature.

These permit requirements are set to ensure that water quality is not reduced to the extent that fisheries or aquatic habitat are adversely affected. Trinity River Hatchery uses surface water (up to 80 CFS), but the water is taken directly from Lewiston Reservoir, which is fed by water from Trinity Reservoir. Because there is no fish passage upstream of Lewiston Reservoir, water diversion into TRH is not expected to have an effect on any ESA listed salmonids. Reclamation has not proposed any new construction at TRH as part of the HGMP. Therefore, NMFS concludes that this factor will have a negligible effect on population viability.

2.5.8 Factor 7.

Negative demographic effect: In 1993, the retention of coho salmon in ocean commercial fisheries was prohibited from Cape Falcon, Oregon south to the U.S./Mexico border. The following year, coho salmon retention was prohibited in ocean recreational fisheries from Cape Falcon, Oregon to Horse Mountain, California, and expanded to include all California waters in 1995. These regulations have continued to prohibit direct sport and commercial harvest of coho salmon off the California and Southern Oregon coast, the lone exceptions being a mark-selective recreational coho salmon fishery that took place between 1998 and 2002 and again in 2009 in Oregon waters.

To reduce bycatch impacts in the ocean, the Pacific Fishery Management Council (PFMC) has set the bycatch limit at 13 percent consistent with the 1999 biological opinion for SONCC coho salmon (NMFS 1999). Given the above non-tribal incidental mortality rate plus the tribal harvest rate on NOR coho salmon, NMFS considers this factor a negative demographic effect on population viability of Trinity River coho salmon. However, the fisheries described above that impact Trinity River SONCC coho salmon, would likely operate with or without the proposed action.

Coho salmon fisheries conducted by the Yurok Tribe and Hoopa Valley Tribe are considered dependent on TRH coho salmon production. Without the TRH coho salmon program, few coho salmon would be available for capture by the Yurok Tribe or Hoopa Valley Tribe. From the period 1997 to 2016, estimated harvest of NOR coho salmon in the Yurok Tribe fishery ranged from 2 to 168. For HOR coho salmon, harvest in the Yurok Tribe fishery ranged from 6 to 1,214 adult coho salmon. In the Hoopa Valley Tribal fishery, 3 to 134 NOR coho salmon and 20 to 505 HOR coho salmon were harvested from 1997 to 2016. Approximately 2.1% to 11.1% of NOR coho salmon were harvested in these two fisheries combined (Table 28). Over this same time period, modeled incidental mortality in commercial fisheries in the ocean ranged from 1.6% to 12.1%.

Table 28. Run size estimates for Willow Creek Weir provided by CDFW for marked (HOR) and unmarked (NOR) coho salmon, and harvest estimates in the Yurok Tribe and Hoopa Tribe fisheries.

Run Year	Estimated NOR adult run size	Estimated Yurok NOR Trinity harvest	Estimated Hoopa NOR harvest	Estimated HOR adult run size	Estimated Yurok HOR Trinity harvest	Estimated Hoopa HOR harvest	NOR Tribal Harvest (%)	HOR Tribal Harvest (%)
1997	252	2	3	1,732	21	39	2.1	3.4
1998	1,101	13	54	9,008	117	88	6.1	2.3
1999	555	14	36	4,357	120	65	9.0	4.2
2000	342	3	22	9,704	70	211	7.2	2.9
2001	3,075	142	101	25,395	1,214	505	7.9	6.8
2002	458	13	16	13,849	327	276	6.3	4.4
2003	3,930	21	17	20,721	121	85	1.0	1.0
2004	8,901	168	83	24,162	553	309	2.8	3.6
2005	2,659	61	21	25,678	640	153	3.1	3.1
2006	1,586	21	38	17,123	241	442	3.7	4.0
2007	1,157	16	14	4,048	61	68	2.6	3.2
2008	1,223	71	53	6,381	472	262	10.2	11.5
2009	525	15	17	4,108	132	124	6.0	6.2
2010	817	26	65	5,852	211	237	11.1	7.7
2011	1,205	2	21	4,113	19	107	1.9	3.1
2012	1,205	12	5	13,494	102	89	1.4	1.4
2013	4,305	114	134	14,782	445	368	5.8	5.5
2014	902	42	53	9,297	6	252	10.5	2.8
2015	748	9	12	2,936	34	100	2.8	4.6
2016	134	3	10	983	23	20	9.9	4.4
Average	1,754	38	39	10,886	246	190	5.6	4.3

The degree of effects resulting from the Proposed Action's facilitation of the Tribal coho salmon fisheries on coho salmon in the Trinity River is difficult to quantify, but is likely less than the percentages observed in Table 28 above. Some of these coho salmon may be killed in Tribal fisheries regardless of TRH coho salmon production because the fishing would continue to occur in the pursuit of other species, like Chinook salmon and steelhead. The abundance of the upper Trinity River population is expected to be negatively affected by the operation of these fisheries. However, over time as HGMP actions are implemented at TRH, the fisheries are not expected to cause long term negative growth rates. For those coho salmon that are harvested by the dependent Tribal coho fisheries, the effects are summarized below in Table 29.

Table 29. The effect of the proposed action on NOR and HOR coho salmon resulting from dependent Tribal coho salmon fisheries.

Effect	Life stage	Stressor	Proposed BMP
Fishing	Adult	Death	None

2.5.9 Effects of the Action on Critical Habitat

Adverse effect: We analyzed the Proposed Action for its effects on designated critical habitat and determined that operation of the hatchery program will have a low to negative effect on PBFs in the action area. Some negative effects to critical habitat are expected to occur from the installation and operation of an adult broodstock collection weir. The weir is expected to have an adverse effect on the function of the adult migration corridor by slowing adult upstream migration. Weir operators will perform daily checks of the river reach extending from the weir(s) to a point 500 feet downstream to identify if a migration delay is caused by the weir. The presence of a large number of adult coho salmon may be evidence that fish migration is being delayed by weir operations. If large numbers of coho salmon (>100) are observed below the weir for more than 48 hours, portions of the weir may be removed for up to one day to allow fish to pass. At that time, the weir will be placed back in operation. If delay appears to be an issue, evaluation of the weir location and its operation will be conducted by a technical team in coordination with NMFS, and additional studies may be implemented (e.g., a study using acoustic-tagged coho salmon may be initiated to quantify coho salmon behavior and migration speed.

Juvenile rearing areas will be negatively impacted by the increase in density of coho salmon after TRH coho salmon smolts are released. The hatchery releases are expected to affecting PBFs by reducing the amount of food available for forage effectively limit the amount of physical habitat available.

Removal of NOR coho salmon for broodstock is expected to reduce the growth and survival to individual coho salmon resulting from the loss of feeding opportunities associated with reduced MDN. This negative effect would likely occur on tributaries to the Trinity River where natural origin coho salmon used for broodstock would have returned, even if hatchery strays increase MDN overall in the mainstem Trinity River. Spawning surveys, studies on juvenile coho salmon habitat, snorkel surveys, and other habitat evaluations are not expected to negatively affect coho salmon critical habitat.

The hatchery facility itself would not require additional construction or disturbance of riparian or streambed habitat, and any effects of effluent are expected to be small and transitory. Operation of the Trinity River Hatchery is not expected to reduce the amount of water in the Trinity River because water taken from Lewiston Reservoir is returned to the Trinity River. Operation of the Trinity River Hatchery is not expected to degrade water quality because the hatchery operates under an NPDES permit, which requires that no adverse effects on beneficial uses, including fish and their habitats, will occur. To date NMFS is not aware of any water quality impacts from TRH that have resulted in negative effects to coho salmon in the Trinity River.

Operation and maintenance activities would include building maintenance and ground maintenance. These activities would not be expected to degrade water quality or adversely modify designated critical habitat, because they would occur infrequently, and only result in minor temporary effects. Non-routine maintenance (e.g., construction of facilities or reconstruction of in-river hatchery structures) is not considered in this opinion and would require separate consultation.

2.6 Cumulative Effects

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

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

NMFS believes that the SONCC coho salmon ESU may be affected by State, tribal, local, or private entities' actions that are reasonably certain to occur in the action area. These actions that will result in cumulative effects include, but are not limited to, those discussed below. Some of the actions that will result in cumulative effects have already been discussed in the *Environmental Baseline* section, and the effects of non-Federal actions on coho salmon that were discussed in that section are likely to be similar. Although each of the following actions is reasonably certain to occur, we lack definitive information on the extent or location of many of these categories of actions. The following discussion provides available information on the expected effects of these activities on salmonids.

2.6.1 Control of wildland fires on non-federal lands

Control of wildland fires may include the removal or modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. This removal of vegetation can trigger post-fire landslides as well as create chronic sediment erosion that can negatively affect coho salmon habitat. Also, the use of fire retardants may adversely affect salmonid habitat if used in a manner that does not sufficiently protect streams, causing the potential for coho salmon to be exposed to lethal amounts of the retardant. This exposure is most likely to affect summer rearing juvenile coho salmon. As wildfires are stochastic events, NMFS cannot determine the extent to which suitable coho salmon habitat may be removed or modified by these activities.

2.6.2 Residential development and existing residential infrastructure

Human population growth in the action area is expected to remain relatively stable over the next 10 years as California's economy continues to recover from a long-lasting nationwide recession. The recession has had significant economic impacts at both the statewide and local scales with widespread impacts to residential development and resource industries such as timber and fisheries. However, some development will continue to occur which, on a small-scale, can impact coho salmon habitat. Once development and associated infrastructure (e.g., roads, drainage, and water development) are established, the impacts to aquatic species are expected to be permanent.

Anticipated impacts to aquatic resources include loss of riparian vegetation, changes to channel morphology and dynamics, altered hydrologic regimes (increased storm runoff), increased sediment loading, and elevated water temperatures where shade-providing canopy is removed. The presence of structures and/or roads near waters may lead to the removal of LWD in order to protect those structures from flood impacts. The anticipated impacts to Pacific salmonids from continued residential development are expected to be sustained and locally intense. Commonly, there are also effects of home pesticide use and roadway runoff of automobile pollutants, introductions of invasive species to nearby streams and ponds, attraction of salmonid predators due to human occupation (e.g., raccoons), increased incidences of poaching, and loss of riparian habitat due to land clearing activities. All of these factors associated with residential development can have negative impacts on salmon populations.

2.6.3 Cannabis Regulation

In 2018, the State of California legalized the recreational use of cannabis, as well as the cultivation and manufacture of cannabis plants and products. The state's regulatory framework is in place or under development and is likely to reduce the number of illegal cannabis farms, and cannabis farms that cause detrimental impacts to SONCC coho salmon critical habitat. However, there are many cannabis farms which cumulatively reduce flow volume and increase discharge of waste and pollutants in streams which effects water quantity and water quality in the action area. Presently, there is no landscape scale evaluation of the effects of cannabis farming in the SONCC coho salmon ESU or the effects to particular streams from multiple farms. NMFS expects that continued operation of cannabis farms throughout the ESU will continue to negatively impact SONCC coho salmon.

2.6.4 Recreation

Expected recreation impacts to salmonids include increased turbidity, impacts to water quality, barriers to movement, and changes to habitat structures. Streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Campgrounds can impair water quality by elevating nutrients in streams. Construction of summer dams to create swimming holes causes turbidity, destroys and degrades habitat, and blocks migration of juveniles between summer habitats. Impacts to salmonid habitat are expected to be localized, mild to moderate, and temporary. Fishing within the action area, typically for Steelhead or Chinook salmon, is expected to continue subject to CDFW regulations. Fishing for coho salmon directly is prohibited in the Klamath River. The level of impact to coho salmon within the action area from angling is unknown, but is expected to remain at current levels because there is no information suggesting that angling will increase or decrease.

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

2.7 Integration and Synthesis

2.7.1 Introduction

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

The SONCC coho salmon ESU is currently considered likely to become endangered within the foreseeable future in all or a significant portion of its range (Williams et al. 2016). Williams et al. (2016) in their review found that there has been no trend toward recovery of SONCC coho salmon since their listing in 1997. The lack of increasing abundance trends across the ESU for the populations with adequate data are of concern (e.g., Shasta River). Moreover, the loss of population spatial scale estimates from coastal Oregon populations is of great concern. The new information since Williams et al. (2011) while cause for concern, did not appear to suggest a change in extinction risk at this time (Williams et al. 2016).

The status of SONCC coho salmon population units in the action area mirrors that of the ESU overall, with declining abundance apparent in the Willow Creek Weir counts and seemingly throughout all of the populations (Section 2.4.2). The unprecedented drought (2013-2016), combined with poor ocean conditions over the same time period, reduced stream flows, reduced ocean forage, and increased ocean and stream temperatures, further exacerbating stress, disease, and decreasing the quantity and quality of spawning and rearing habitat available to population units in the action area. While some improvements in factors affecting population units in the action area have improved habitat in some areas (e.g., Trinity River restoration, improvements in hatchery practices), populations and their critical habitat in the action area overall have not trended toward recovery.

Cannabis cultivation is expected to continue to negatively impact coho salmon and their critical habitat throughout the ESU. Climate change will continue to shrink the amount of habitat available to coho salmon in the action area and throughout the ESU. This will likely reduce the number of successful offspring produced per adult spawner, and challenge the resiliency of SONCC coho salmon in the action area and throughout the ESU. Trinity Reservoir may provide a buffer to mainstem Trinity River water temperatures because water can be drawn from the cold bottom layer of the reservoir.

2.7.2 Proposed Action

The proposed action is also expected to result in the loss of up to 50% (range 6%-50%) of returning NOR adult coho salmon to the upper Trinity River population unit (Table 19) for use as broodstock. As the upper Trinity River population unit rebuilds through controls on pNOB, pHOS, and juvenile release levels tied to the ability to meet metrics, and other measures provided in the proposed action, the percentage of the total NOR adult coho salmon run used for broodstock is expected to decline (Table 5), which will enable more NOR to spawn naturally. In the short term, the proposed action is expected to locally reduce the number NOR spawners and reduce MDN in some tributaries of the upper Trinity River.

The proposed action is expected to result in a rearing density of 1.0 lb/ft^3 which would exacerbate domestication selection occurring on coho salmon at TRH. A short-term pHOS of 74% is not expected to reduce the abundance or the population productivity of Upper Trinity River coho salmon population in the near term because the Upper Trinity River is currently dependent on these hatchery spawners for demographic support. As a higher and higher level of pNOB is incorporated into the broodstock and pHOS can be slowly reduced over time, the long-term pHOS is expected to be significantly less than 74%. The proposed action is expected to result in no greater than 5% pHOS in the lower Trinity River and South Fork Trinity River coho salmon population units, which meets the CAHSRG (2012) recommendations for a segregated population. Therefore, this is unlikely to have a negative effect on the interior-Trinity River diversity stratum or SONCC coho salmon ESU.

The use of a broodstock collection weir is expected to negatively affect migrating adult salmonids by slowing their migration, with some individuals likely rejecting the weir and spawning downstream. Handling at the weir is also expected to result in a low amount of mortality, approximately one percent of adult coho salmon trapped. A low proportion (as low as zero) jacks in the broodstock would be expected to cause a higher than normal degree of genetic divergence between brood years.

The proposed action is expected to result in mortality of up to 1.3 % of fry and 3.3 % of juvenile coho salmon, mainly from the Upper Trinity River population unit at the 500,000 smolt release level (Section 2.5). The amount of NOR coho salmon lost in the migration corridor is expected to be less than that in juvenile rearing areas. This level of mortality is in addition to the estimate of Reclamation (2018) that the releases of Chinook salmon and steelhead from TRH would result in the mortality of 4.4% of fry and 5.1% of juvenile coho salmon. The extent to which the mortality resulting from ecological interactions will impact the numbers of returning adult coho salmon to the Trinity River is difficult to assess, as it is unknown if the mortality is additive or compensatory. If the mortality is additive, then some of the fry and juvenile coho salmon killed as a result of the proposed action would have returned as adults, but for the mortality associated with TRH. If the mortality is compensatory, then there would be little effect on the overall numbers of returning adult coho salmon to the Trinity River. At this time, NMFS does not have enough information to quantify the effect of the fry and juvenile mortality on adult returns to the Trinity River. However, even if all of the predation and competition mortality from TRH is additive, the effect of this source of mortality is unlikely to be enough to reduce NOR adult returns to a level that would have a negative effect on the SONCC coho salmon ESU.

Monitoring and evaluation in the proposed action includes potential studies of juvenile migration, adult migration, as well as spawner surveys. Handling, tagging, holding, and experimentation with coho salmon is expected to cause stress, temporarily slowed growth, and mortality in a small percentage of tagged individuals. Spawner surveys may temporarily cause disturbance to spawning coho salmon or their habitat. The effects of TRH on water quality are expected to be negligible. Most if not all fisheries in the Trinity and Klamath rivers, as well as the ocean would continue to operate in the absence of the proposed action. The overall effect from the thiamine deficiency study is expected to be minimal as the potential loss of 10 g of eggs from 30 HOR or NOR individuals is not expected to cause a large decline in hatchery production or negatively affect NOR production in the long term.

2.7.1 Summary

The proposed action is likely to reduce the rearing habitat quality of critical habitat in the mainstem Trinity River during March and April when the densities of TRH coho salmon are at their highest. The releases of steelhead from TRH in April and Chinook salmon in June will have similar effects of reducing the rearing habitat quality due to high densities of hatchery smolts. However, the proposed action will also result in the addition of marine derived nutrients (MDN) to the upper Trinity River from returning adult TRH coho salmon, which will have a positive effect on coho salmon and their critical habitat in the mainstem Trinity River where hatchery fish likely stray. However, the removal of natural origin coho salmon to be used for broodstock is expected to locally reduce the amount of MDN in tributaries of the Trinity River where these natural origin coho salmon likely would have returned. Over the long term, the expected benefits to NOR coho salmon productivity in tributaries of the Upper Trinity River population unit will reduce this effect to the upper Trinity River population unit, the interior-Trinity River diversity stratum, and the SONCC coho salmon ESU. The use of a broodstock collection weir is expected to reduce the quality and function of adult salmonid migratory habitat by adding a physical impediment to fish passage which is expected to slow coho salmon migration. However, the weir is not expected to impair the function of the adult migration corridor to a level which inhibits the three Trinity River coho salmon populations from achieving viability because the blockage is temporary and proposed BMPs are sufficient to ensure the migration corridor remains largely unimpeded.

The proposed action also contains many of the recommendations required to reduce the threat of TRH to the Upper Trinity River population of SONCC coho salmon, which was identified as one of the key limiting threats in the SONCC coho salmon Recovery Plan (NMFS 2014). For example, NMFS (2014) identified that the low PNI of the population likely reduces the productivity of NOR coho salmon in the Upper Trinity River, reduces their fitness and increases their extinction risk. The proposed action contains adequate measures to reduce this threat of TRH coho salmon on SONCC coho salmon in the long term. The proposed action includes several best management practices aimed at reducing effects to coho salmon. After factoring the improvements to the proposed hatchery practices, the negative and beneficial effects of the proposed action, the environmental baseline, the status of SONCC coho salmon and its critical habitat, and cumulative effects, the proposed action is unlikely to appreciably reduce the ability of the SONCC coho salmon ESU to achieve viability and is not likely to reduce the overall conservation value of critical habitat at the diversity stratum or ESU level.

2.8 Conclusion

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

2.9 Incidental Take Statement

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

If NMFS approves this HGMP under Limit 5 of the ESA 4(d) Rule (50 C.F.R. § 223.203(b)(5)), then the ESA's take prohibition would not apply to activity associated with implementation of the HGMP. However, our jeopardy analysis is based on anticipated levels of take, so the take indicators described below would nevertheless function as a reinitiation check for our no-jeopardy conclusion.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take on NOR coho salmon is reasonably certain to occur resulting from Factors 1 through 5 listed in Section 2.5. For factor 6, NMFS determined that the effect of the action on NOR coho salmon were negligible. For Factor 7, NMFS determined that fisheries which impact NOR coho salmon would likely continue despite the proposed action.

Adverse effects from a proposed action are often not possible to quantify. In such cases, NMFS relies on surrogates for take. Because it is not possible to estimate exactly how many adults will be impacted by weir rejection or weir delay (e.g., adult abundance is highly variable year to year), NMFS will rely on the number of adults captured at the weir to track the extent of this effect because the number of adults captured has a correlation with the number of adults affected by weir delay or weir rejection.

It is not possible to quantify the number of individual fry and juvenile coho salmon taken as a result of predation and competition with hatchery fish because locating small, dead fish is practically impossible due to predation, decomposition, poor water visibility, and limited access to deeper parts of the Trinity River. Therefore, NMFS will rely on the numbers of coho salmon released from TRH as well as their average travel time to the Willow Creek rotary screw trap (≤21 days for 300,000 hatchery release, ≤44 days for 500,000 hatchery release, and travel times interpolated between these two estimates for other hatchery production levels; Table 23) as a surrogate to estimate the extent of this effect. For take resulting from competition downstream of Willow Creek, NMFS uses the same surrogate and assumes speed of travel of TRH coho smolts to Willow Creek rotary screw trap is correlated with speed of travel downstream of Willow Creek rotary screw trap. NMFS has determined that incidental take is reasonably certain to occur resulting from the following adverse effects Table 28 below.

Table 30. Annual expected take of coho salmon resulting from the proposed action.

Factor	Adverse effects	Life stage	Stressor	Amount or Extent of take
1	Loss of MDN in tributaries	Juveniles	Loss of feeding opportunities, loss of insect growth, reduction in growth of individuals	Surrogate: Removal of up to 560 NOR coho salmon (adult and jacks) for broodstock
2, 5	Prespawn mortality of adults in the hatchery (including adult holding experiment)	Adult	Death	Mortality of up to 28 adults or jacks (560*0.05)
2	Genetic interactions on spawning grounds (short term-2020-2032)	Adult	Reduction in adult productivity, domestication selection (poor survival of progeny)	Surrogate: 3-year average PNI $\geq$ 0.5; 3 year avg. pHOS < 75% for the Upper Trinity River coho population upstream of Canyon Creek broodstock weir
2	Genetic interactions on spawning grounds (long term-after 2032)	Adult	Reduction in adult productivity, domestication selection (poor survival of progeny)	Surrogate: Minimum PNI 0.5, 3-year average PNI > 0.67, 3 year moving avg pHOS < 30% for the Upper Trinity River coho population upstream of Canyon Creek broodstock weir
2	Weir delay	Adult	Loss in adult productivity, displacement to non-natal spawning areas	Surrogate: Capture of up to 600 NOR
2	Weir handling, seining, and/or hook and line	Adult	Death/Injury/disturbance/harass	Up to 10% of captured NOR (or up to 6) may be killed
3	Competition and predation upstream of Willow Creek	Juvenile	Death/reduced growth	Average downstream migration between hatchery and Willow Creek: $\leq$21 days for 300K release, $\leq$44 days for 500K release, and days will be interpolated from the numbers above for other proposed release levels
4	Competition downstream of Willow Creek	Juvenile	Death/Reduced growth	Same as above
5	Adult tagging	Adult	Death/Injury/disturbance/harass	Up to 2000 captured at fish ladder and weir, and up to 11 killed
5	Juvenile tagging	Juvenile	Death/Injury/disturbance/harass	Up to 1000 captured, up to 10 killed
5	Adult transportation	Adult	Death/Injury/disturbance/harass	Up to 6 killed
5	ATPase study	Juvenile	Death/Injury/harass	Up to 50 killed
5	Thiamine deficiency study	Egg	Death	10 g of eggs from 30 females

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize take of the SONCC coho salmon ESU:

1. Reclamation must ensure that genetic interactions on the spawning grounds between natural-origin fish and hatchery-origin fish are monitored and maintained at appropriate levels.
2. Reclamation must limit competition and predation by juvenile hatchery fish on wild fish by reducing the co-occurrence of hatchery and wild fish to lowest feasible levels.
3. Reclamation must ensure that broodstock collection impacting coho salmon are kept to the lowest feasible levels.
4. Reclamation must ensure that take resulting from encounters at adult collection facilities and from the operation of weirs is minimized.
5. Reclamation must ensure that all monitoring and research activities required to assess hatchery operations objectives outlined in the proposed action (Reclamation and CDFW 2017) and other studies to better understand the effects of the hatchery program on SONCC coho salmon are funded and implemented.
6. Reclamation must provide reports to NMFS annually for all funded hatchery operations, and for all M&E activities associated with the Proposed Action.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the NMFS or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). NMFS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

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

    a. Reclamation must annually monitor the abundance, timing, distribution, and origin of Trinity River coho salmon adults escaping to the Trinity River watershed using methods sufficient to provide estimates of the status of the natural- and hatchery-origin components of the three Trinity River populations. For the lower Trinity River and South Fork Trinity River population units, methods such as such as juvenile population estimates, index reach spawner surveys, or sonar counts would be sufficient to provide an estimate of population status. Reclamation shall develop a monitoring plan detailing how it will implement this term and condition, and provide it to NMFS by December 31, 2021.

b. Reclamation shall develop and collect all information sufficient to annually calculate the proportionate natural influence (PNI), including the proportion of natural origin broodstock (pNOB), and the proportion of hatchery origin spawners in the Trinity River basin upstream of the North Fork Trinity River.

c. Reclamation must annually review the status of the Trinity River coho salmon relative to population viability parameter triggers identified for each restoration phase to guide decisions regarding transition between the preservation, recolonization, and local adaptation phases.

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

Reclamation shall use smolt release strategies, such as limitation of feed rations and synchrony of juvenile releases with increased river flows, to ensure hatchery smolts emigrate at the maximum rate possible in order to limit co-occurrence of hatchery and wild fish.

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

a. Starting in March 2021, Reclamation shall provide all eggs, fry, juvenile, or adult coho salmon in excess of those needed to produce smolts released at TRH to an entity with a supplementation plan approved by NMFS, for supplementation of tributaries (in any of the three Trinity River coho salmon population units) for conservation of the populations. Reclamation shall report the number of eggs or fish provided, entity the eggs or fish were provided to, and location(s) fish or eggs were used for supplementation.

b. By December 2021, Reclamation shall obtain the necessary permits required to place an amount of adult coho salmon (or adult Chinook salmon or steelhead) carcasses equal to or greater than the number of NOR coho salmon used for broodstock into tributary streams during each winter in order to increase MDN in tributaries. By December 2022, Reclamation shall begin to supplement carcasses in tributary streams equal to or greater than the number of NOR coho salmon used for broodstock annually. In years when sufficient carcasses from salmon or steelhead are not available, salmon flesh analogs shall be utilized. Information on numbers of carcasses supplemented and locations shall be included in an annual report to NMFS.

c. Reclamation shall ensure that jacks are incorporated into the broodstock at no less than 5% and no more than 15% of males spawned to ensure sufficient gene flow occurs between cohorts.

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

Reclamation shall ensure that the take of coho salmon at the adult collection weir is minimized by reducing stress, carefully handling all fish, frequently checking trap boxes during peak migration periods to reduce densities within trap boxes, and reducing or eliminating sharp or rough surfaces on the weir or trap box.

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

   a. Reclamation shall collect all data and information necessary to calculate the rearing densities of all raceways or other such containers used to rear coho salmon and report this annually to NMFS. If rearing densities exceed 0.25 lbs/ft^3, measures shall be taken to reduce densities below this level such as using available raceways.

   b. Reclamation shall sufficiently fund data collection necessary to document all aspects of the HGMP including, but not limited to numbers, pounds, lengths, weights, dates, tag/mark information of fish, results of monitoring and evaluation activities that occur within and outside the hatchery environment, and adult return numbers by fish origin to naturally spawning areas and to the hatchery program

   c. Reclamation shall fund research that quantifies migration delays associated with the adult fish collection weir(s), and provide NMFS the migration delay analysis by February 2023.

   d. Reclamation shall fund data collection sufficient to calculate the cumulative juvenile migration of hatchery coho salmon to the North Fork of the Trinity River for at least three years and provide the analysis to NMFS by February 2023. If production levels increase to the 500,000 smolt release level, this analysis should be repeated.

   e. Reclamation shall notify NMFS two weeks before changing sampling locations or research protocols

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

   a. Reclamation must allow any NMFS employee to inspect any facilities related to hatchery program monitoring, evaluation, and research activities.

   b. Reclamation shall notify NMFS, as soon as possible, but no later than four days, after any incidental take is exceeded or if such an event is likely. This includes the take of any ESA-listed species not otherwise included in this incidental take statement. Reclamation shall submit a written report detailing why the authorized take level was exceed or is likely to be exceeded.

c. Reclamation must provide annual reports to NMFS that summarize numbers, pounds, lengths, weights, dates, tag/mark information, carcasses supplemented, excess eggs or fry provided for supplementation, results of monitoring and evaluation activities that occur within the hatchery environment, and adult return numbers by fish origin to naturally spawning areas and to the hatchery program. Reports shall also include any analyses of scientific research data; any problems that may have arisen during conduct of the authorized activities; a statement as to whether or not the activities had any unforeseen effects; and steps that have been and that will be taken to coordinate the research or monitoring with that of other researchers. The reports shall be submitted to NMFS annually by July 31. All reports, as well as all other notifications required in the permit, be submitted to NMFS at:

    NMFS – California Coastal Office
    Attn: North Coast Branch Supervisor
    1655 Heindon Rd
    Arcata, CA 95521
    Phone: (707) 822-7201

2.10 Conservation Recommendations

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

1. NMFS recommends that Reclamation integrate both the TRH Chinook Salmon and Steelhead programs in accordance with the recommendations of the CAHSRG (2012). Properly integrating the wild and hatchery populations for these two species would entail setting metrics for the Proportionate Natural Influence (PNI) and successfully monitoring and maintaining these metrics. Because population boundaries for Upper Klamath and Trinity Rivers Chinook Salmon and Klamath Mountain Province Steelhead have not been described by NOAA, the Chinook Salmon and Steelhead programs could use the same geographical boundaries for integration as the upper Trinity River population unit of SONCC coho salmon, in accordance with CAHSRG (2012).
2. NMFS recommends that Reclamation fund research into rearing salmonids at TRH in semi-natural rearing environments at various rearing densities including those less than 0.25 lbs/ft^2, and placing structures or artificial substrates into raceways. The research should evaluate the smolt-to-adult return rates of fish reared in different treatments and fitness and performance of returning adults in the wild and compare costs and benefits.
3. NMFS recommends that Reclamation begin to distribute as many salmon and steelhead carcass from TRH as possible within the maintstem Trinity River and tributaries of the Trinity River. This is expected to substantially improve conditions for individual rearing coho salmon as well as their critical habitat. The flesh from decaying salmon and marine

derived nutrients are an important component of healthy salmon stream and would greatly improve the ecology of the river system including benthic macroinvertebrates that coho salmon prey upon, riparian plant species, wildlife, and other ecological processes.

4. Reclamation should continue to collaborate with the Hoopa Valley Tribe, Yurok Tribe, CDFW, and NMFS to quickly and effectively achieve HGMP performance metrics, recover coho salmon populations in the Trinity River, and help facilitate meaningful Tribal fisheries.

These conservation recommendations will help further recovery of SONCC coho salmon because successfully integrating these two species will ultimately increase the productivity of these species in the wild. As the populations of steelhead and Chinook salmon in the wild increase, hatchery production could be decreased, thereby reducing the effects of the TRH Chinook salmon and steelhead programs on SONCC coho salmon and its critical habitat. Increasing the survival rates of TRH coho salmon once released will also result in more coho salmon available for harvest. Furthermore, implementation of this conservation recommendation will be expected to help the resiliency of steelhead and Chinook salmon in the Trinity River in coming decades as climate change and other threats grow.

2.11 Reinitiation of Consultation

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

2.12 "Not Likely to Adversely Affect" Determinations

2.12.1 Effects on Southern Resident Killer Whales DPS

The Southern Resident Killer Whale (SRKW) DPS is present throughout the coastal waters of Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands, British Columbia. Designated critical habitat for SRKW is in the Strait of Juan de Fuca, Puget Sound, and the San Juan Islands, none of which are in the action area. In the summer months, the distribution of SRKW is generally near the San Juan Islands. During the winter months, they travel along the Pacific Coast as far south as Point Reyes, California. The major prey base for SRKW is Chinook salmon, with other species such as coho salmon or chum salmon being seasonally or regionally important (NMFS 2015). Though rarely detected in SRKW fecal samples, they are thought to consume steelhead occasionally (NMFS 2015).

SRKW are expected infrequently in the action area, mainly transiting the near coast off the Klamath River in the winter months. As previously described, they primarily occur in the inland waters of Washington State and southern Vancouver Island, although individuals from this population have been observed off coastal California in Monterey Bay, near the Farallon Islands, and off Point Reyes (NMFS 2008). SRKW survival and fecundity are correlated with Chinook salmon abundance (Ward et al. 2009, Ford et al. 2009). Many salmon populations are themselves at risk, with 9 ESUs of Chinook salmon listed as threatened or endangered under the ESA.

The proposed action would result in the release of 150,000 to 500,000 coho salmon from TRH. As such, the proposed action is expected to result in providing slightly more food for SRKW, particularly in the fall and winter months, as they frequent coastal waters off the Pacific Coast where their range overlaps with the ocean distribution of TRH coho salmon. Because the effect of the proposed action on SRKW is expected to be completely beneficial by slightly increasing their prey base, the proposed action "may affect but is not likely to adversely affect" SRKW.

2.12.2 Effects on the Southern DPS of North American Green Sturgeon

While the Southern DPS of North American Green Sturgeon (SDPS green sturgeon) have not been documented in the action area, according to NMFS, the presence of SDPS green sturgeon is likely (based on limited records of confirmed Northern DPS fish or green sturgeon of unknown DPS), but not confirmed within the Klamath/Trinity River estuary (74 FR 52300). Adult and sub-adult SDPS green sturgeon may be present in the Trinity River and Klamath River estuary in the summer and fall. There is no designated critical habitat in the Klamath or Trinity rivers for SDPS green sturgeon; however, the near shore area of the action area off the Pacific coast is designated critical habitat. Although hatchery fish could reduce the prey base for SDPS green sturgeon in the action area, their prey species are not similar, therefore this is unlikely to occur. The spatial and temporal overlap between TRH coho salmon in the Klamath River estuary and SDPS green sturgeon is very limited. Substantive differences of life history and habitats between SDPS green sturgeon and salmonids propagated at the hatchery make interactions between these species unlikely to occur. SDPS green sturgeon do not spawn in Klamath Basin, so no juveniles are expected to be co-occurring with TRH smolts. Hatchery fish may be a benefit for SDPS green sturgeon as a food source, particularly if they perish and become food for this bottom-feeding species. For the reasons listed above, the effects of the proposed action on SDPS green sturgeon are considered insignificant. Therefore, the proposed action "may affect but is not likely to adversely affect" SDPS Green Sturgeon.

2.12.3 Effects on Southern DPS of Eulachon

Historically, large aggregations of eulachon were reported to have consistently spawned in the Klamath River. Allen et al. (2006) indicated that eulachon usually spawn no further south than the Lower Klamath River and Humboldt Bay tributaries. The California Academy of Sciences ichthyology collection database lists eulachon specimens collected from the Klamath River in February 1916, March of 1947, and 1963, and in Redwood Creek in February 1955. During spawning, fish were regularly caught from the mouth of the river upstream to Brooks Riffle, near the confluence with Omogar Creek (Larson and Belchik 1998), indicating that this area contains the spawning and incubation, and migration corridor essential features. Peak spawning migration

in the Klamath River occurs between March and April (Larson and Belchik 1998) and that eulachon begin migration in the Klamath in January in small numbers (Young 1984).
The only reported commercial catch of eulachon in northern California occurred in 1963 when a combined total of 56,000 pounds was landed from the Klamath River, the Mad River, and Redwood Creek (Odemar 1964). Since 1963, the run size has declined to the point that only a few individual fish have been caught in recent years. However, in January 2007, six Eulachon were reportedly caught by tribal fishers on the Klamath River. Another seven Eulachon were captured between January and April of 2011 at the mouth of the Klamath River (McCovey 2011).

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

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

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

3.1 Essential Fish Habitat Affected by the Project

The Proposed Action would adversely affect EFH for Pacific Coast salmon (PFMC 2014) for Chinook salmon and coho salmon in the Trinity River.

3.2 Adverse Effects on Essential Fish Habitat

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

1. Temporary reduction in the quality of feeding and rearing areas needed for growth (reduction in abundance of prey species) to rearing Chinook salmon and coho salmon when TRH coho salmon densities are highest in March and April.
2. Reduction in MDN and decaying salmonid flesh needed for growth of juvenile Chinook salmon and coho salmon when broodstock are removed from the river system.
3. Reduction in the quality of habitat used for migration and spawning when the broodstock weir is operational.

3.3 Essential Fish Habitat Conservation Recommendations

1. NMFS recommends that Reclamation and CDFW seek ways to minimize density of TRH coho salmon to reduce the effect of hatchery releases on the quality of EFH feeding areas for growth such as making multiple releases in the spring to lower the density of TRH coho salmon at any one time. Additionally, NMFS recommends these releases be synchronized to the extent practicable with dam releases from Lewiston Dam to help redistribute TRH coho salmon and increase the amount of physical habitat to Chinook salmon and coho salmon managed under the MSA.
2. NMFS recommends that Reclamation and CDFW distribute as many salmon and steelhead carcass from TRH as possible within the maintstem Trinity River and tributaries of the Trinity River. This is expected to substantially improve conditions for Chinook salmon and coho salmon EFH. The flesh from decaying salmon and marine derived nutrients are an important component of healthy salmon stream and would greatly improve the ecology of the river system including benthic macroinvertebrates that coho salmon prey upon, riparian plant species, wildlife, and other ecological processes.
3. NMFS recommends that use of the broodstock weir be minimized to the extent practicable. NMFS recommends that Reclamation fund research that quantifies migration delays associated with the adult fish collection weirs.

Fully implementing these EFH conservation recommendations would protect EFH and HAPC, by avoiding or minimizing the adverse effects described in section 3.2 above.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, NMFS must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is Reclamation. Other interested users could include California Department of Fish and Wildlife. Individual copies of this opinion were provided to the Reclamation. This opinion will be posted on the Public Consultation Tracking System website (PCTS website). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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