Final Environmental Assessment

Impacts of NOAA's National Marine Fisheries Service's Proposed 4(d) Determination under Limit 5 for the Trinity River Hatchery Coho Salmon Program

Prepared by the
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West Coast Region, Northern California Office

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Cover Sheet

Title of Environmental Review: Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service's determination that the Coho Salmon Hatchery Program as described in the Trinity River Hatchery and Genetics Management Plan satisfies the Endangered Species Act Section 4(d) Rule.

Evolutionarily Significant Units: Southern Oregon Northern California Coast Coho Salmon

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Legal Mandate: Endangered Species Act (ESA) of 1973, as amended and implemented – 50 C.F.R. Part 223

Location of Proposed Activities: Trinity River watershed in Northern California

Activity Considered: Operation of a hatchery program for the production of coho salmon. The operators are the California Department of Fish and Wildlife and the U.S. Bureau of Reclamation. The Federal action considered in this environmental assessment is the National Marine Fisheries Service's proposed 4(d) determination under Limit 5 for this hatchery program.

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LIST OF ACRONYMS

BKD	Bacterial Kidney Disease
BY	Brood Year
CDF	California Department of Forestry
CDFW	California Department of Fish and Wildlife (formerly CDFG)
CDFG	California Department of Fish and Game (now CDFW)
CEQ	Council on Environmental Quality
CESA	California Endangered Species Act
cfs	cubic feet per second
CHSRG	California Hatchery Science Review Group
Commission	California Fish and Game Commission
Council	Pacific Fishery Management Council
DOI	United States Department of Interior
DPS	Distinct Population Segment
EA	Environmental Assessment
EPA	United States Environmental Protection Agency
EPIC	Environmental Protection Information Center
ESU	Evolutionarily Significant Unit
FONSI	Finding of No Significant Impact
FRGP	Fisheries Restoration Grant Program
HGMP	Hatchery and Genetics Management Plan
HSRG	Hatchery Science Review Group
lb/day	pounds per day
mgd	million gallons per day
mg/L	milligrams per Liter
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PNI	Proportion of Natural Influence
pNOB	Proportion of Natural-Origin Broodstock
pHOS	Proportion of Hatchery-Origin Spawners
Reclamation	United States Bureau of Reclamation
Regional Water Board	North Coast Regional Water Quality Control Board (aka NCRWQCB)
SONCC	Southern Oregon/Northern California Coast
TMDL	Total Maximum Daily Load
TRH	Trinity River Hatchery
TRRP	Trinity River Restoration Program
USFWS	United States Fish and Wildlife Service

1. PURPOSE AND NEED

1.1. Background

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) is the lead agency responsible for administering the Endangered Species Act (ESA) as it relates to listed salmon, steelhead, and marine species. Section 9 of the ESA prohibits take of endangered species. Section 4(d) of the ESA gives NMFS the authority to promulgate a regulation that extends the take prohibitions of section 9 to threatened species. NMFS issued such a rule in 2000 (65 FR 42422; 50 C.F.R 223.203). That rule broadly prohibits take of threatened steelhead and salmon species, but also lists certain exceptions to that general rule. Because those exceptions limit the otherwise universal applicability of the take prohibition, they are known as "4(d) Limits." 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 Hatchery and Genetics Management Plan (HGMP) that meets certain criteria and has been approved by NMFS (50 C.F.R. 223.203(b)(5)).

The U.S. Bureau of Reclamation (Reclamation) and California Department of Fish and Wildlife (CDFW) provided NMFS with an 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. NMFS will determine if the HGMP meets the criteria of Limit 5 of the 4(d) Rule.

1.2. Description of the Proposed Action

On December 11, 2017, Reclamation and CDFW submitted a final HGMP for the Trinity River Hatchery (TRH) coho salmon program to NMFS' Northern California Office in Arcata, California. Reclamation and CDFW requested review and approval of the HGMP under the 4(d) Rule Limit 5.

The 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. TRH operations are governed by a consent decree and order to release hatchery-origin coho salmon into the Trinity River. The coho salmon propagation program at the TRH is an integrated program that is intended to meet mitigation requirements for the Trinity River Division of the Central Valley Project (Central Valley Project Improvement Act 1992). An integrated hatchery program is managed to achieve hatchery fish that are genetically integrated with the natural population(s) they most directly

influence by allowing some hatchery-origin fish to stray and spawn in the wild, and using natural-origin fish for broodstock in the hatchery (HRSG 2005; CHRSG 2012). Additionally, the TRH coho salmon program aims to reduce ecological and genetic impacts to ESA-listed coho salmon. To incorporate this primary purpose of the hatchery while conserving and recovering ESA-listed coho salmon, Reclamation and CDFW adopted the following practices as part of this HGMP:

(1) marking 100 percent of the hatchery-origin coho salmon with a right maxillary clip to allow the identification of hatchery fish in the fishery, at the hatchery, and on the spawning grounds (until new direction is received from NMFS);
(2) producing and releasing 300,000 coho salmon smolts through 2020, with production numbers potentially adjusted between 150,000 to 500,000 based on the program's ability to achieve performance metrics described in the HGMP; at the end of this period, the managers will review program performance, attainment of performance criteria, and status of natural coho salmon production to determine if fish release numbers and or release location should be altered. The recommended coho salmon production level, and rationale, will be forwarded to NMFS for review and approval.
(3) increasing the effective population size of the hatchery broodstock to reduce the risk of inbreeding depression by splitting the eggs from each female into two lots and fertilizing each lot with one male;
(4) increasing the number of natural-origin fish used for broodstock.

Additional operational elements of the TRH HGMP will be discussed and their effects will be analyzed in detail (Section 2, Alternatives Including the Proposed Action; Section 3, Affected Environment; and Section 5, Environmental Consequences). For the purposes of this National Environmental Policy Act (NEPA) analysis, the approval of the HGMP will be considered the "Proposed Action" (42 USC 4321).

1.3. Purpose of and Need for the Action

The purpose of the Action is to analyze the activities described in the TRH Coho Salmon HGMP to determine if the HGMP meets the requirements of Limit 5 of the 4(d) Rule under the ESA. The need for the Action is to ensure that the propagation of hatchery-origin coho salmon does not reduce the likelihood of survival and recovery for the federally threatened coho salmon in the SONCC Evolutionarily Significant Unit (ESU) (50 C.F.R. § 223.102(c)(18)). The TRH coho salmon program has been identified as an immediate high threat to wild coho salmon populations in the Klamath-Trinity Basin (NMFS 2014;

EPIC v. Lehr et al. 2014). The need for the Action will be satisfied by the reduction in risk to wild coho salmon populations.

1.4. Project Area

The project area is the geographic area where the activities described in the HGMP would take place (Figure 1). The project area includes the locations where the proposed coho salmon hatchery program would (1) collect broodstock, (2) spawn, incubate, and rear fish, (3) release fish, and (4) conduct monitoring and evaluation activities. The project area includes the upper Trinity River Watershed from Lewiston Dam (river mile 110), the upstream limit to anadromy, downstream to the Trinity River's confluence with the Klamath River (river mile 0). The project area also encompasses the section of the Klamath River from the Trinity River confluence to its mouth at the Pacific Ocean, as Trinity River adult coho salmon and juvenile coho salmon migrate through this corridor.

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). Existing beneficial uses have been defined by the North Coast Regional Water Quality Control Board (NCRWQCB, or Regional Water Board): municipal and domestic supply; agricultural supply; groundwater recharge; freshwater replenishment; navigation; water contact recreation; non-contact water recreation; commercial and sport fishing; cold freshwater habitat; wildlife habitat; rare, threatened, or endangered species; migration of aquatic organisms; spawning, reproduction, and/or early development; and aquaculture (NCRWQCB 2005b).

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 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. The prevailing climate is Mediterranean within the Trinity River watershed, meaning there are typically dry, hot summers with wetter, cooler winters. Annual rainfall averages 57 inches per year, but varies from approximately 37 to 85 inches per year depending on elevation and location within the watershed area (NCRWQCB 2005a).

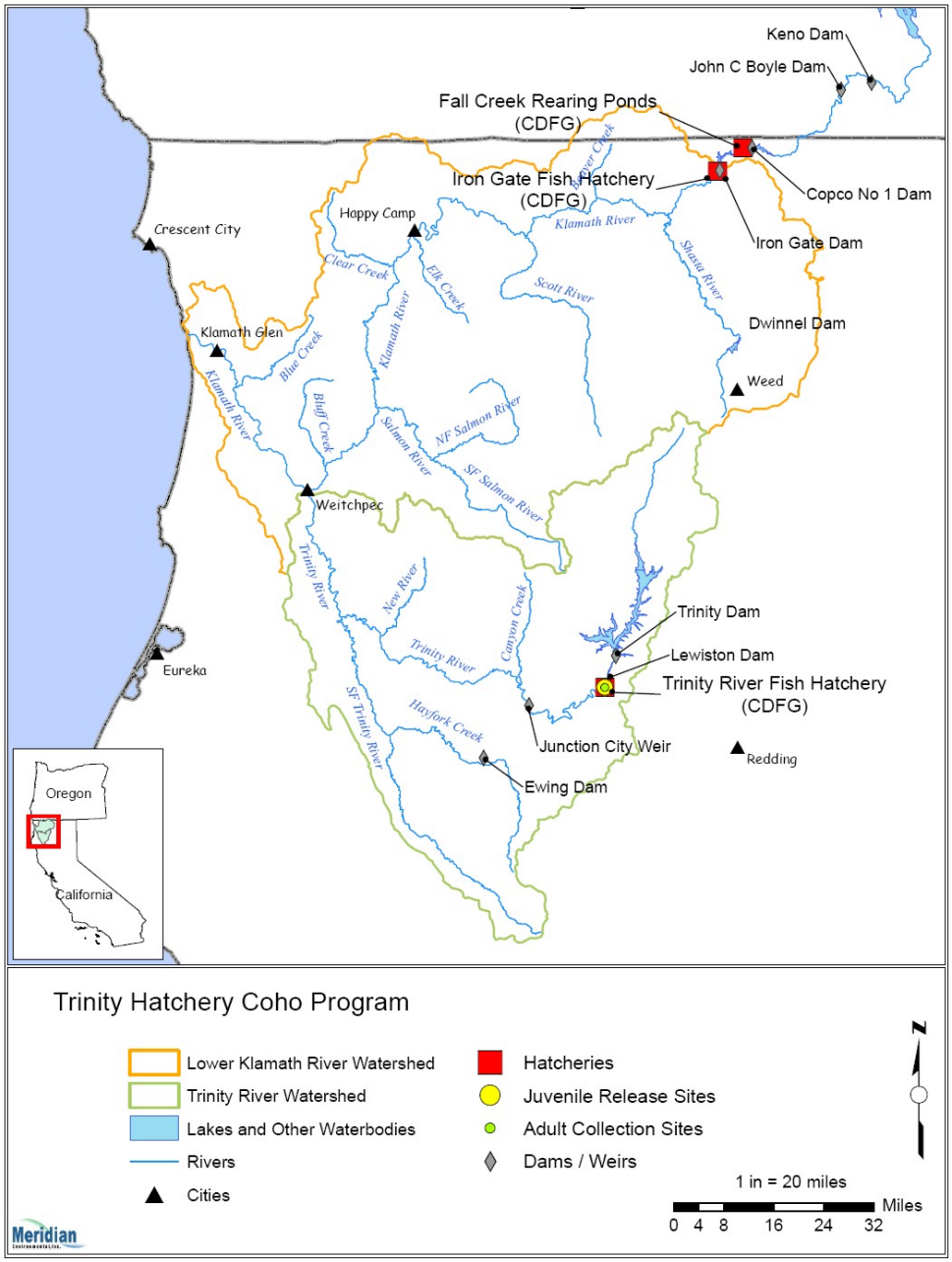

Figure 1. Map of project area (CHSRG 2012 *in* Reclamation and CDFW 2017).

1.5. Relationship to Other Plans and Policies

In addition to NEPA and the ESA, other plans, regulations, agreements, treaties, laws, and Executive Orders also affect hatchery operations in the Trinity River watershed. They are summarized below to provide additional context for the hatchery program and the proposed HGMP.

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. Trinity River Hatchery (TRH) began production of salmon and steelhead in 1958 to mitigate for the loss of 109 miles of anadromous fish habitat upstream of the dam. 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). Hatchery operations are required to comply with the Clean Water Act. More detail about the Clean Water Act regulatory process and the specific water quality requirements for the TRH are discussed in Subsection 3.1, Water Quantity and Quality, and effects are discussed in Subsection 4.2.1, Water Quantity and Quality.

The Bald Eagle and Golden Eagle Protection Act, enacted in 1940, and amended several times since then, prohibits the taking of bald eagles, including their parts, nests, or eggs (16 USC 668-668c). Changes in hatchery production have the potential to affect eagle productivity through changes in its coho salmon prey or other affected prey sources. Effects on eagles and other wildlife species are addressed in Subsection 4.2.4, Wildlife and Mammals.

The Marine Mammal Protection Act of 1972, as amended, establishes a national policy designated to protect and conserve wild marine mammals and their habitats (16 USC 1361). Changes in fish production can indirectly affect marine mammals by altering the number of available salmonid prey and other potentially affected prey sources. Effects on marine mammals are addressed in Subsection 4.2.4, Wildlife and Mammals.

The objectives of the Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-income Populations,* include developing Federal agency implementation strategies, identifying minority and low-income populations where proposed Federal actions could have disproportionately high and adverse human health and environmental effects, and encouraging the participation of minority and low-income populations in the NEPA process. Such communities in the project area are discussed in Subsection 3.6, Environmental Justice and Cultural Resources, and the potential impacts of the Proposed Action in Subsection 4.2.6, Environmental Justice and Cultural Resources. State listed endangered, threatened, and sensitive species are also reviewed in this EA.

1.5.1. Southern Oregon and Northern California Coast Coho Salmon Recovery Plan

A Federal recovery plan is in place for the SONCC ESU (NMFS 2014). The recovery plan specifically identifies that hatchery-related effects from the TRH pose a very high risk to all life stages of coho salmon (NMFS 2014). On average, 88 percent of the coho salmon run in the upper Trinity River was of hatchery-origin from 1997 to 2015, causing significant potential for loss of genetic diversity (NMFS 2014).

1.5.2. *EPIC v. Lehr* et al. Lawsuit and Settlement Agreement

On May 20, 2013, the Environmental Protection Information Center (EPIC) filed a complaint against CDFW and Reclamation in the U.S. District Court for the Northern District of California, San Francisco Division (*EPIC v. Lehr* et al. 2014). EPIC alleged that the TRH operations were in violation of the ESA because the TRH was operating without an authorized HGMP approved pursuant to NMFS' section 4(d) regulations or other explicit authorization by NMFS, and since TRH operations result in take of listed species.

EPIC, CDFW, Reclamation, and the Hoopa Valley and Yurok Tribes as defendant-interveners stipulated to a consent decree on April 25, 2014, which the Court approved in an order. The consent decree required that an HGMP be submitted to NMFS, but allowed for operations to continue in 2015 with decreased

production levels and altered release timing (for steelhead), if the HGMP was not approved before the planned date of 2015 coho salmon releases. The consent decree contained additional provisions for the period before an HGMP submittal occurred. On December 11, 2017, Reclamation and CDFW submitted a request to NMFS for review and approval of the HGMP under Limit 5 of the 4(d) Rule.

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Three alternatives are considered in this EA: (1) NMFS would not make a determination for the proposed HGMP under the 4(d) Rule (No-action); (2) NMFS would make a determination that the proposed HGMP meets the requirements of the 4(d) Rule (Proposed Action); and (3) NMFS would make a determination that a revised HGMP with reduced production levels would meet the requirements of the 4(d) Rule (Reduced Production Alternative).

2.1. Alternative 1 (No-action) – Do Not Make a Favorable Determination under the 4(d) Rule

Under this alternative, NMFS would not make a favorable determination under the 4(d) Rule on the Trinity River Coho Salmon HGMP. Because the HGMP would not be approved, the hatchery actions proposed by Reclamation and CDFW would not be exempt from section 9 take prohibitions. Reclamation and CDFW's operation of the coho salmon hatchery program without an ESA authorization or exemption exposes those entities to liability for take under section 9. NMFS believes it is likely that the coho salmon program would be terminated in the absence of a favorable determination under the 4(d) Rule. For analysis purposes, NMFS treats Alternative 1 as resulting in the termination of the coho salmon hatchery program at TRH because direct take of SONCC coho salmon for the purpose of artificial propagation would violate section 9 of the ESA. The TRH Chinook salmon and steelhead programs would continue as they currently operate because those programs are undergoing separate ESA exemption and authorization reviews.

2.2. Alternative 2 (Proposed Action) – Determine the HGMP Meets 4(d) Rule[a] Requirements

Under this alternative, NMFS would approve the TRH HGMP under Limit 5 of the 4(d) Rule, and the HGMP would be implemented as proposed (Subsection 1.2, Description of the Proposed Action) to provide 300,000 coho salmon annually in a manner consistent with the conservation of Trinity River coho salmon populations while meeting TRH mitigation requirements and tribal trust responsibilities (Reclamation and CDFW 2017). After 2020, a technical team (such as the previously functioning Hatchery Coordination Team) will review the program to determine if fish production levels require adjustment. The production after 2020 would most likely be 300,000, but can range from 150,000 to

500,000 coho salmon depending on the conservation needs of coho salmon and the hatchery program meeting performance metrics. The recommended coho salmon production level, and rationale, will be forwarded to NMFS for review and approval. Factors to be included will include performance metrics as provided in the HGMP and other information as it becomes available. As a result of the 4(d) approval, limits to the take prohibitions would apply to the TRH coho salmon HGMP activities. Implementation of the HGMP would continue as long as the Trinity River Division of the Central Valley Project operates, which for the purposes of this assessment, is considered to be in perpetuity because: (1) the Trinity River Division is a major component of the Central Valley Project that the State of California depends upon, (2) the TRH exists to mitigate for the Trinity River Division, and (3) the TRH is expected to operate according to the HGMP.

2.2.1 Artificial Propagation Activities

Artificial propagation began at the permanent TRH structure in 1963 to mitigate for 109 miles of habitat lost above Lewiston dam. TRH imported stocks after initial efforts to use natal stocks failed due to water quality and temperature hatchery constraints (CDFG 1962 and CHSRG 2012). Imported broodstock used for propagating coho salmon originated from native fish stocks in the Eel, Cascade, Alsea, and Noyo rivers. Since 1971, only Trinity River fish returning to the hatchery have been used for breeding purposes (CHSRG 2012; Reclamation and CDFW 2017).

Broodstock will be collected for spawning via the TRH fish ladder or an offsite weir in the Upper Trinity River (e.g., Canyon Creek Weir). The collected broodstock will be of natural origin, except in years when the natural-origin coho salmon run is less than 800 fish. The HGMP states that jacks will be incorporated at a rate of 5 to 15 percent to limit genetic divergence of cohorts. Once collected, broodstock will be transported by tank trucks to the TRH. Trucks will be equipped with additional oxygen supplementation, be fitted for 900-gallon aerated and insulated tanks, and 4x4 drive. All collected broodstock will be genetically tested for relatedness, and the results will be used to avoid mating fish that are as related as half-siblings or nearer. Fish will be spawned at a true 1:1 ratio unless a low fertilization rate is observed. Normal hatchery fertilization rates are expected to be above 77 percent. If substantial declines are observed, then Reclamation will work closely with CDFW and NMFS to discuss solutions.

The broodstock holding facilities contain six round tanks. Tubes may be used as a holding method for individual fish. If adult coho salmon are to be collected at upstream weirs (i.e. the Junction City weir) the spawning condition (ripeness) and anticipated holding facilities will be fully assessed to ensure maximum survival and limit any potential impacts on time needed for fish to reach spawning maturity. Additional

studies will be performed, as needed, to ensure such goals are achieved. If mortality of adults surpasses the level in which egg collection goals cannot be met or prespawn mortality is excessive (>10%), alternate handling and holding methods will be explored by the technical team. Alternatives could include holding adults at the weir site, collecting adults closer to the hatchery, warming hatchery holding water, spawning inducement drugs, etc. The spawning facilities will allow for immobilization of fish using carbon dioxide and appropriate facilities for sorting fish by species, sex, degree of ripeness, and identifying marks or tags. The absence of a mark indicates a naturally-produced fish. Unmarked fish may be released back into the river to increase the numbers of unmarked coho salmon spawning in the wild. Ripe fish will be sorted for spawning, while unripe fish will be held for sorting at a later time. Juvenile coho salmon will be reared at the hatchery for one year, then volitionally released annually in March within seven days of the new moon.

2.3. Alternative 3 (Reduced Production) – Determine the Revised HGMP meets 4(d) Rule Requirements

Under this alternative, the hatchery would likely need less broodstock, water, feed, energy, and other resources to produce less fish than the Proposed Action. For the purpose of this analysis, a production goal of 200,000 coho salmon smolts will be assessed. A revised HGMP would be submitted by Reclamation and CDFW to reflect the reduced production level, and NMFS would make a determination that the revised HGMP meets the requirements of Limit 5 of the 4(d) Rule.

This alternative enables NMFS to assess and obtain a thorough understanding of the potential effects from a reduction in the existing and proposed hatchery juvenile release levels. In drafting this alternative, NMFS set out to choose a point that differs meaningfully from the existing operations, the Proposed Action, and the No-action Alternative. The HGMP's reduced production model found that 75,000 coho salmon smolts would not support the recovery of the SONCC coho salmon population. However, a reduced production goal of 200,000 coho salmon smolts would represent a production level of 40 percent of the historical annual releases from TRH of 500,000 coho salmon smolts.

Note that NMFS' 4(d) regulations do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMP. NMFS' 4(d) regulations require NMFS to make a determination that the HGMP *as proposed* either meets or does not meet the standards prescribed in the rule. Nonetheless, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios.

2.4. Alternative Considered But Not Analyzed in Detail

The following alternative was considered, but NMFS determined that it would likely have markedly increased adverse environmental effects relative to the Proposed Action, and would clearly not meet the purpose and need for the action (Subsection 1.3, Purpose of and Need for the Action).

2.4.1 Increased Production Levels

This alternative would increase TRH coho salmon smolt production above pre-lawsuit release goals (*EPIC v. Lehr* et al. 2014). Annual smolt production goals in the recent past were 500,000. Other elements of the HGMP would be scaled appropriately to meet these production levels but no other major TRH operation changes would have occurred. This alternative was not pursued because increased production levels negatively affect natural-origin fish (Kostow 2009; Thériault et al. 2011; Jones et al. 2018). Higher artificial production numbers may exceed the current carrying capacity for the Trinity River and are inconsistent with the California Hatchery Scientific Review Group's (CHSRG) recommendation to reduce production from 500,000 (CHSRG 2012). Additionally, increased production levels conflict with the purpose and need of the HGMP. Other performance metrics and objectives, such as proportion of natural influence (PNI) of 0.67 with a minimum of 0.50 (Reclamation and CDFW 2017) and natural-origin broodstock, would likely be unattainable under this alternative (i.e., with limited natural origin coho salmon in the Upper Trinity River population, there would likely be insufficient natural origin broodstock to produce more than 500,000 smolts and still meet at least 0.5 PNI).

3. AFFECTED ENVIRONMENT

The Affected Environment section describes the relevant existing conditions of the biological, physical, and socioeconomic resources where the Proposed Action or the proposed alternatives would take place. Existing conditions include effects of the past and present operation of the coho salmon program in the Trinity River Watershed, and serves as a baseline to compare the effects of the alternatives (NOAA 2009).

During initial scoping, the following resources were identified as having the potential to be impacted if the Proposed Action or alternatives were implemented:

- Water quantity and quality (Subsection 3.1)
- Salmon and steelhead and their habitats (Subsection 3.2)
- Other aquatic species and their habitats (Subsection 3.3)
- Wildlife and mammals (Subsection 3.4)
- Socioeconomics of the affected activities, including recreational fishing (Subsection 3.5)
- Environmental justice and cultural resources (Subsection 3.6)

3.1. Water Quantity and Quality

Water use within TRH can be broken up into three categories: broodstock collection facilities (fish ladder, trap, and circular holding tanks), the hatchery building proper (incubator stacks, standard California troughs, and deep tanks), and rearing facilities (including the concrete raceways). The inflow is drawn from a vertical intake structure that can draw water from the reservoir at various depths between nine and 20 feet deep. Water volume diverted typically varies, as needed, between 20 cubic feet per second (cfs) and 125 cfs. There are two temperature curtains within Lewiston Lake: one is fixed and the other is semi-adjustable. The fixed temperature curtain allows consistent cool water to flow to the Central Valley via the Clear Creek tunnel. The second temperature curtain, adjacent to the TRH intake structure, is variable and allows for the use of warmer water in winter and cooler water in the summer.

The Trinity River is listed under Clean Water Act section 303(d) as impaired for sedimentation/siltation and was issued a Total Maximum Daily Load (TMDL) allocation (EPA 2001). The Trinity River TMDL requires no net sedimentation increase greater than 25 percent over background and establishes effluent discharge guidelines for the TRH (Table 1).

Table 1. Standards for all Trinity River Hatchery effluent discharges (NCRWQCB 2017). Effluent discharges in excess of the above criteria are prohibited.

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	$7.0 \leq pH \leq 8.5$	$7.0 \leq pH \leq 8.5$
Flow	mgd	42.76	61.0

The Regional Water 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). The TRH is a minor discharger as defined by the EPA. The TRH currently operates under the NPDES permit no. CAG131015, order no. R1-2015-0009, and the associated monitoring and reporting program (Table 1).

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.

TRH submitted a list of chemicals used in their operations (NCRWQCB 2017). Additions to this list must be submitted in writing to the Regional Water Board: potassium permanganate, sodium chloride, tricaine methanesulfonate, oxytetracycline, hydrogen peroxide (35 percent), florfenicol, and PVP iodine.

The use of these chemicals and drugs within the hatchery could result in the release of antibiotics, fungicides, disinfectants, and other agents into the surface water and groundwater. The TRH discharges effluent from four main locations: near the fish ladder, from the hatchery building, out of the settling basin, and from the production ponds (NCRWQCB 2017). A fifth discharge point, located mid-way between the production ponds, is only used during high river flows or when the power generator at the dam is being maintained (Reclamation and CDFW 2017). The TRH is prohibited from discharging detectable levels of chemicals used for cleaning activities and the treatment and control of disease other than sodium chloride (NCRWQCB 2017). CDFW monitors TRH water use and effluent discharges and

provides quarterly NPDES reports to the Regional Water Board. The NPDES permit isolates iodine monitoring from other water quality testing, and states that if iodine is undetectable in the effluent discharged from the hatchery and nursery tanks at EFF-002 for two years, then TRH may cease monitoring for it. The NPDES permit is designed to meet the TMDL allocations, Basin Plan water quality standards, and protect beneficial uses. CDFW monitors effluent for flow, total suspended solids, settleable solids, turbidity, pH, temperature, ammonia, nitrogen, iodine, and total cyanide.

3.2. Salmon and Steelhead

Salmon and steelhead populations in the Trinity River Basin have severely decreased due to a variety of land uses in the region. Mining, timber harvesting, agriculture, road construction, recreational use, and some residential development have all impacted these populations (NMFS 2014). The construction of Trinity and Lewiston dams in the early 1960s, and the subsequent diversion of water to the Sacramento Valley, has severely impacted the natural flow regime of the Trinity River (NMFS 2014). This shift in the natural hydrology of the river has led to substantial degradation of salmonid habitat. Spawning habitat and rearing habitat have been particularly degraded, while the number of deep pools has decreased. Sedimentation, channelization, and channel confinement have also increased within the Trinity River, while flows are often too low to create optimal water temperatures for salmonids (TRRP 2000; NMFS 2014).

Since 1999, NMFS has identified three salmon ESUs in the project area: SONCC coho salmon, SONCC Chinook salmon, and Upper Klamath and Trinity Rivers Chinook salmon. Additionally, the Klamath Mountains Province distinct population segment (DPS) of steelhead is present in the project area. Only SONCC coho salmon are listed under the ESA. Critical habitat for SONCC coho salmon is also found in the project area.

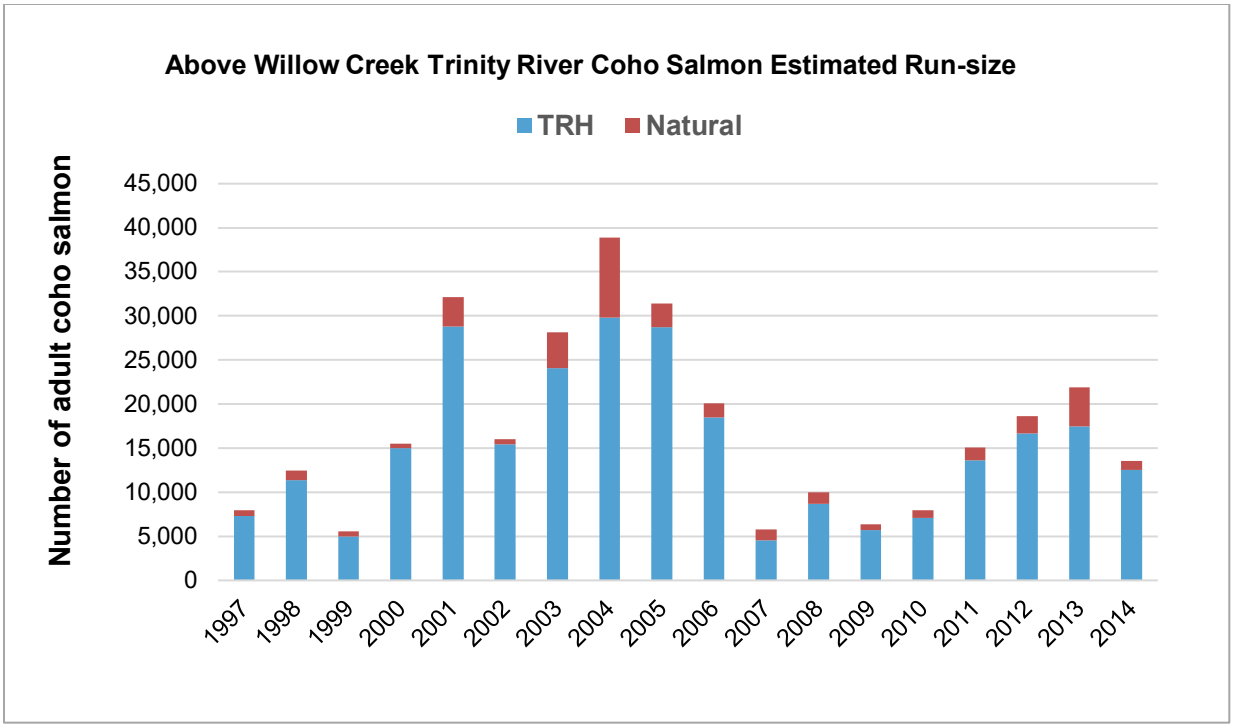

Figure 2. Estimated run-size of hatchery-origin and natural-origin coho salmon in the Trinity River based on data collected at the Willow Creek weir (Reclamation and CDFW 2017).

Escapement totals include coho salmon from all or part of the three Trinity River coho salmon populations: the Upper Trinity River population, the Lower Trinity River Population, and the South Fork Trinity River population (Figure 2). The proportion of coho salmon from each population are unknown, though most are thought to be of the Upper Trinity River Population Unit, as few juveniles or adults are observed in the Lower or South Fork Trinity Population Units. Adult return numbers to the TRH provide rough estimates of the hatchery-origin coho salmon return numbers (Table 2). The TRH escapement goal is 2,100 coho salmon (USFWS 1983), although the average escapement at the TRH from 1997 to 2015 was over 6,000 coho salmon, nearly three times the goal (CDFW 2017a).

Table 2. Number of coho salmon returns to Trinity River Hatchery by sex, age, and females spawned for Brood Year 2000 through Brood Year 2015 (Reclamation and CDFW 2017).

Brood Year	Males	Females	Jacks	Females Spawned
2000	1,699	1,763	932	432
2001	4,844	4,960	986	420
2002	3,550	2,937	688	667
2003	4,989	5,493	1,546	677
2004	4,716	5,107	1,085	503
2005	7,059	9,251	1,977	711
2006	4,466	5,268	760	1,009
2007	1,202	1,737	314	719
2008	1,973	2,594	685	576
2009	1,155	1,424	899	718
2010	1,659	2,232	466	561
2011	974	1,349	2,832	553
2012	3,023	4,197	882	607
2013	2748	3421	452	643
2014	1423	1607	962	560
2015	1437	1731	251	632
Average	2,932	3,442	982	624

Run-size estimates of steelhead and Chinook salmon in the Trinity River are:

- Steelhead: The average number of fall-run steelhead between 1977 and 2016 was estimated at 14,701 fish (CDFW 2017a), which were approximately 75 percent hatchery-origin in the recent past. Winter-run steelhead estimates are not available. Some summer-run steelhead snorkel indices are available, but they would be difficult to use for population estimates.
- Fall-run Chinook salmon: Since 1978, CDFW estimates that the natural-origin adult fall-run Chinook salmon likely averages 23,500 fish per year, and when hatchery-origin adults are included, averages around 40,000 (CDFW 2017b).
- Spring-run Chinook salmon: Since 1991, CDFW estimates that the natural-origin spring-run Chinook salmon likely averages 5,700 fish per year, and when hatchery-origin fish are included, averages around 14,874 (CDFW 2017a).

3.2.1. Genetics

The TRH is operated as an integrated program; therefore the natural-origin coho salmon population may lose genetic diversity if hatchery-origin fish spawn with natural-origin fish. In 2004, the Hatchery

Scientific Review Group (HSRG) released its recommendations for hatchery reform (HSRG 2005). The HSRG recommended that integrated hatchery programs affecting primary populations have a PNI of 0.67. In 2012, a separate group, the CHRSG, recommended that PNI should exceed 0.50 (CHRSG 2012). Estimates for pre-2015 coho salmon PNI values at the TRH are 0.05.

3.2.2. Competition and Predation

Hatchery-origin coho salmon smolts may prey upon juvenile Chinook salmon fry that are encountered in freshwater during downstream migration. Some reports suggest that hatchery-origin fish can prey on fish that are up to one-half their length (Pearsons and Fritts 1999; HSRG 2005), but other studies have concluded that salmonid predators prey on fish one-third or less their length (Horner 1978; Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1992). The risk of hatchery-origin coho salmon predation on natural-origin juvenile fish in fresh water and the estuary is dependent upon three factors: (1) the hatchery-origin fish and their potential natural-origin prey must overlap temporally (Figure 3); (2) the hatchery-origin fish and their prey must overlap spatially; and (3) the prey should be less than one-third the length of the predatory fish. Competition and predation effects on and by hatchery coho salmon are evaluated in Subsection 4.2.2, Salmon and Steelhead.

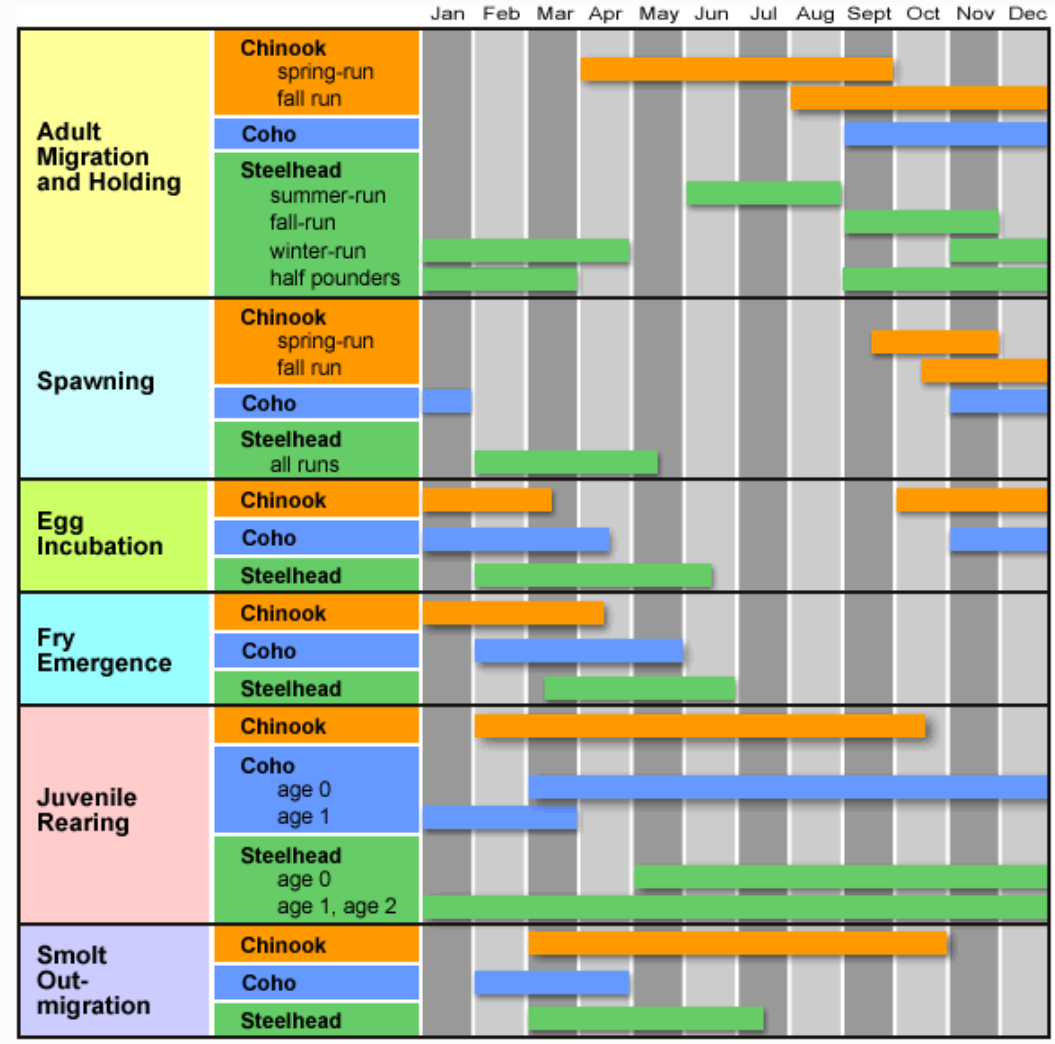

Figure 3. Timing of salmonid species residence in the Trinity River (TRRP 2017).

3.2.3. Hatchery Facility Effects

The TRH operates just below Lewiston Dam on the Trinity River. Independently of the proposed coho salmon hatchery program, the hatchery will continue to run its Chinook salmon and steelhead hatchery programs. The submitted HGMP would also include an in-river weir for broodstock collection. Hatchery and weir effects are discussed in detail in Subsection, 4.2.2, Salmon and Steelhead.

3.2.4. Fisheries

No commercial or recreational coho salmon fisheries exist in California, in accordance with the Federal ESA and the California ESA. Some tribal fisheries exist for Trinity River coho salmon, mostly for subsistence and ceremonial purposes (Table 3). The Hoopa Valley and Yurok Tribes use set nets (anchored gill nets) during salmon runs in the Trinity and Klamath Rivers. In 2016, the Hoopa Valley

Tribe began using a weir near Hoopa, CA to harvest hatchery-origin coho salmon, Chinook salmon, and steelhead. The Hoopa Valley and Yurok Tribes have each enacted fishing ordinances for their tribal members, which outline their regulations for salmonid fishing in the mainstem of the Trinity and Klamath Rivers (Yurok Tribe 2015; Hoopa Valley Tribe 1986). The two ordinances differ in some of their limitations, but both clearly state that tribal fishing is not permitted within certain tributary spawning grounds.

Table 3. Estimated median numbers of individual coho salmon harvested by Hoopa and Yurok Tribes from 1997 to 2014 (Naman and Perkins 2015).

Year	Yurok Harvest	Yurok Harvest	Hoopa Harvest	Hoopa Harvest
	Hatchery-origin	Natural-origin	Hatchery-origin	Natural-origin
Median 1997-2014	126.5	18.5	182	29

Chinook salmon and steelhead fisheries exist in the river and in the ocean, dependent on annual regulatory review. Coho salmon bycatch does occur, and incidental mortalities from the release of coho salmon in the recreational ocean fishery average approximately 400 coho salmon per year. These mortalities are estimated by the Pacific Fishery Management Council (Naman and Perkins 2015).

3.2.5. Risk of Disease Transfer

The TRH is operated in compliance with best culture practices for fish health guidelines. The CDFW fish pathologists conduct pre-release examinations of fish and only release fish that are certified as healthy. Diseases have been detected at the TRH, but data from 2007 to 2011 show low daily fish mortality rates, ranging from 0.02 to 0.12 percent per day (Reclamation and CDFW 2017). Parasites, bacteria, and fungi found at the TRH include the following: *Gyrodactylus* spp, *Apisoma* spp, *Trichodina* spp, *Ichthyobodonecator, Ichthyophthirius multifiliis* (Ich), *Flacobacterium columnare* (Columnaris), *Aeromonad/Pseudomonad*-type fungus, Bacterial Gill Disease (*Flavobacterium branchiophilum*), Cold Water Disease (*Flavobacterium psycrophilium*), and Bacterial Kidney Disease (BKD).

3.2.6. Risk of "Mining" Natural-Origin Trinity River Coho Salmon

Incorporating natural-origin fish into hatchery broodstock can reduce the abundance and spatial structure of the natural-origin population as natural-origin spawners are removed from the natural environment,

commonly referred to as "mining." On average, 372 natural-origin adult coho salmon from the Upper Trinity River population entered the TRH each year from 2001 to 2015 and were used as hatchery broodstock (Table 21 *in* Reclamation and CDFW 2017).

3.3. Other Fish Species

TRH coho salmon may be prey, predators, or competitors for food and space with, or for, other fish species in the Trinity River and nearshore marine areas. The prey, predator, and competitive behaviors depend on the relative life stages and the spatial and temporal overlap of the coho salmon with other fish species (Table 4). There are also several non-native fish species including brown bullhead, brown trout, channel catfish, largemouth bass, crappie, and bluegills that may overlap with the distribution of TRH coho salmon. The non-native fish are primarily competitors with and predators for TRH coho salmon (Alvarez 2017).

3.4. Wildlife and Mammals

The project area supports a variety of birds, large and small mammals, amphibians, and invertebrates (Table 5) that may be prey, predators, or competitors with coho salmon during different portions of their life stages. For example, coho salmon eat invertebrates, such as insects. Coho salmon predators include several species of marine mammals, birds, black bear, river otter, mink, weasels, and some amphibians. Bird species, such as bald eagle and cormorants, scavenge on coho salmon carcasses, as do minks, weasels, and several invertebrate species. Due to their size and caloric value, salmon are a source of efficient nutrition for predators, which can increase predator populations over just a few seasons (Winship and Trites 2003; Trites 2003). Some wildlife species such as river otters, seals, and cormorants compete with coho salmon for food or habitat (Table 5). Coho salmon are not the only species consumed by wildlife and mammals; however, coho salmon may be a larger proportion of their diets during the TRH juvenile release and the adult return period.

Table 4. Range and status of other native fish species that may be affected by Trinity River Hatchery coho salmon.

Species	Federal/State Listing Status	Type of Interaction with Salmon and Steelhead
Pacific lamprey *Entosphenus tridentatus* River lamprey *Lampetra ayresii*	CDFW – Species of Special Concern CDF – Sensitive	• Potential prey item for adult salmonids • May compete with salmonids for food and space • May be a parasite on salmonids while in marine waters • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Eulachon *Thaleichthys pacificus*	Southern DPS – Federally listed as threatened	• Potential prey item for juvenile salmonids
ACIPENSERIDAE (sturgeon)		
Green sturgeon *Acipenser medirostris*	Southern DPS – Federally listed as threatened; NMFS – Species of Concern; CDFW – Species of Special Concern	• May compete with salmonids for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
White sturgeon *Acipenser transmontanus*	CDFW – Species of Special Concern	• May compete with salmonids for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
SALMONIDAE (trout & salmon) (salmon were discussed in the previous subsection)		
Steelhead or Rainbow Trout *Oncorhynchus mykiss*	Northern California DPS – Federally listed as threatened	• Predator of salmonids eggs and fry • Potential prey item for adult salmonids • May compete with salmonids for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Other predatory fish (e.g., rockfish, halibut, and sharks)	Several species are federally listed as threatened and/or have State Candidate listing status	• Predators of juvenile salmonids • Juveniles are prey for salmonids • May compete with salmonids for food

Table 5. Native wildlife and mammals that may interact with Trinity River Hatchery coho salmon as prey, predators, or competitors in freshwater, estuarine, or marine habitats (NOAA 2018, CDFW 2017c).

Animal (ORDER/FAMILY and Genus Species)	Federal and State Listing Status[1]	Type of Habitat	Type of Interaction with Salmon and Steelhead
ACCIPITRIDAE (hawks, kites, harriers, & eagles)			
Bald Eagle *Haliaeetus leucocephalus*	ESA – Delisted CESA – Endangered CDFW – Fully protected CDF – Sensitive	• Freshwater, estuary, and marine	• Predators of salmonids • Scavenger of adult salmonid carcasses
Golden Eagle *Aquila chrysaetos*	CDFW – Fully protected; Watch list CDF – Sensitive	• Freshwater, estuary, and marine	• Predators of salmonids • Scavenger of adult salmonid carcasses
Northern goshawk *Accipiter gentilis*	CDFW – Species of Special Concern CDF – Sensitive	• Freshwater and estuary	• Predators of salmonids • Scavenger of adult salmonid carcasses
Osprey *Pandion haliaetus*	CDFW – Watch list CDF – Sensitive	• Freshwater, estuary, and marine	• Predators of salmonids • Scavenger of adult salmonid carcasses
PHALACROCORACIDAE (cormorants)			
Double-crested cormorant *Phalacrocorax auritus*	CDFW – Watch list	• Freshwater, estuary, and marine	• Predators of salmonids
ARDEIDAE (herons, egrets, and bitterns)			
Great blue heron *Ardea herodias*	CDF – Sensitive	• Freshwater, estuary	• Predators of salmonids
PELECANIIDAE (pelicans)			
American white pelican *Pelecanus erythrorhynchos*	CDFW – Species of Special Concern	• Marine	• Predators of salmonids
California brown pelican *Pelecanus occidentalis californicus*	ESA – Delisted CESA – Delisted CDFW – Fully protected CDF – Sensitive	• Marine	• Predators of salmonids
STRIGIDAE (owls)			
Northern spotted owl *Strix occidentalis caurina*	ESA – Threatened CESA – Threatened CDF – Sensitive	• Freshwater	• Predators of salmonids
MUSTELIDAE (weasels and relatives)			
River otter *Lontra canadensis*	CDFW – Species of Special Concern	• Freshwater, estuary, and marine	• Predators of salmonids • Scavenger of adult salmonid carcasses

3.5. Socioeconomics

Socioeconomics is defined as the study of the relationship between economics and social interactions with affected regions, communities, and user groups. The TRH had an operational and maintenance budget of $1,006,000 in FY 2012, and that number is expected to increase with the implementation of an HGMP

(Reclamation and CDFW 2017). The TRH generates economic activity (personal income and jobs) by providing limited hatchery employment opportunities and through local, commercial services and goods necessary to support the hatchery program operations. The TRH employs a full-time staff of eight CDFW and Hoopa Valley Tribe employees, in addition to three seasonal aides and one half-time secretary. CDFW, the Hoopa Valley Tribe, and the Yurok Tribe provide additional help with fisheries monitoring, spawning ground and redd surveys, determining fish origin, and estimating coho salmon spawning escapement.

No recreational or commercial fisheries for coho salmon currently exist within the state of California. Tribal fisheries do exist in small numbers for traditional purposes and small scale economic gain (Table 3). In the future, surplus hatchery-returning adult coho salmon may be harvested or culled at the Junction City weir, or in fisheries managed by others in the basin, in order to reduce hatchery influence in the natural environment. Representatives from the Hoopa Valley and Yurok Tribes and CDFW have both expressed interest in increasing harvest for hatchery-origin coho salmon. In 2016, 2017, and 2018 the Hoopa Valley Tribe deployed a selective harvest weir within the exterior boundary of the Hoopa Valley Reservation and harvested hatchery coho salmon.

3.6. Environmental Justice and Cultural Resources

Potential environmental justice impacts are evaluated for an area if the percentage of minority, per capita income, and percentage of low-income persons are markedly greater than the percentage of minority, per capita income, and percentage low-income persons in California. While the proportion of Trinity County's overall minority population is less than the proportion of California's minority population, Trinity County's Native American population is 3 times greater than California's Native American population (Table 6), by proportion. Therefore, Trinity County is an environmental justice community of concern for Native Americans, but not for all minority populations. Additionally, Trinity County's low income population meaningfully exceeds the low income population of the state as a whole (Table 6).

Table 6. Trinity County and California population levels, minority populations percentages, annual income, and percentage of persons living below poverty level (i.e., low income population) (U.S. Bureau of Census 2019).

Population Estimates (July 1, 2018)	Trinity County	State of California
Population	12,535	39,557,045
Black or African American	0.7%	6.5%
American Indian/Alaskan Native	5.2%	1.6%
Asian	1.4%	15.3%
Native Hawaiian and Other Pacific Islander	0.2%	0.5%
Hispanic or Latino	7.5%	39.3%
Median Household Income (2013-2017)	$36,563	$67,169
Poverty Rate*	20.3%	13.3%
*Estimates are not comparable to other geographi8c levels due to method differences that may exist between different data sources.		

The Yurok Tribe's ancestral territories are described with a western boundary along the Pacific Ocean, encompassing Trinidad Head and the coast down to Little River, inland toward Rodgers Peak, east to Weitchpec, and north to the beaches south of Crescent City. The Hoopa tribal lands are east of the Trinity River with western and southern boundaries at the River, and a northern boundary shared with the Yurok (near Weitchpec). As described in Subsection 3.5, Socioeconomics, steelhead and salmon fishing has been a focus for tribal economies, lifestyles, and identities for thousands of years. These activities continue to be central to tribal culture for subsistence and ceremonial purposes.

The Yurok and Hoopa (Hupa) native peoples occupied the Trinity River watershed before Euro-American settlement. The Klamath and Trinity rivers are and have always been essential to the livelihood of the tribes. Trinity River fisheries have been characterized as "not much less necessary to the existence of the Indians than the atmosphere they breathed" (TRRP 2017). That every traditional Hoopa village was located and built along the Trinity River also underscores the vital importance of the river to Hoopa culture and traditions (USDOI and CDFG 2012). Salmon and other fish historically provided the primary dietary staple for the Indians in the area; prior to non-Indian settlement in the basin, reports indicate that local Indians consumed over two million pounds of salmon annually (TRRP 2017). Salmon is estimated to have made up to close to 50% of the energy and total protein in the pre-contact Indian diet (USDOI and CDFG 2012). Norgaard (2005) documented the connection between higher diabetes, heart disease,

obesity, and mortality rates and diminishing quantities of traditional foods, particularly salmon, for the Karuk Tribe and indications are that the Hoopa Valley Tribe has suffered a similar experience (USDOI and CDFG 2012).

The profound impacts of a declining fishery extends well beyond health concerns for native peoples. A healthy salmon run supports commercial and subsistence economies for the Hoopa Valley Tribe (HVT), and also plays a significant role in their religious beliefs. The Hoopa celebrate world renewal through the White Deerskin Dance and Jump Dance ceremonies that take place along the Trinity River and depend on abundant salmon populations. The Hoopa bring their salmon catch to share with participants and attendees and offer them for the ceremony. Both ceremonies depend on a healthy river for fish, basket materials, bathing, and ambiance. Declining salmon could make practicing Hoopa religious ceremonies more difficult or essentially impossible in the future (USDOI and CDFG 2012).

In the mid- to late-1800s, one of the primary purposes for establishing the reservations of the Hoopa Valley and Yurok Tribes, which are bisected by the Trinity and lower Klamath Rivers respectively, “was to secure to these Indians the access and right to fish without interference from others” in order to preserve and protect their right to maintain a self-sufficient livelihood from the abundance provided by the rivers (Memorandum from Solicitor to Secretary, Fishing Rights of the Yurok and the Hoopa Valley Tribes, M-36979, at 15, 18-21 (USDOI 1993).

4. ENVIRONMENTAL CONSEQUENCES

In Section 4, Environmental Consequences, the potential effects of the three alternatives are evaluated on the biological, physical, and socioeconomic resources described in Section 3, Affected Environment. A goal of this EA is to determine if any alternative's effects are likely to be significant (NOAA 2009). The significance of an effect is determined by the degree to which the actions adversely or beneficially affect the affected environment resources. If there are no significant effects, the decision maker will finalize a Finding of No Significant Impact (FONSI) for the selected alternative. Mitigation, if any, should reduce the magnitude, duration, and/or likelihood of occurrence. Selection of an alternative that requires mitigation to reduce the effects below the level of significance requires a mitigated FONSI.

Evaluation of the alternatives' potential environmental consequences on the affected environment requires placing the actions and effects in context and an estimation of the probability of occurrence, magnitude or intensity, and duration of the effects. Where applicable, the relative magnitude and duration of effects are described using the following terms:

Undetectable:	The effects would not be detectable.
Negligible:	Beneficial or adverse effects would be at the lower levels of detection.
Low:	Beneficial or adverse effects would be slight, but detectable.
Moderate:	Beneficial or adverse effects would be readily apparent and of moderate degree. Depending on the context, the effects may be significant.
High:	The effects would highly beneficial or severe, (i.e., significant).

Under Alternative 1, NMFS would not make a 4(d) Rule determination, and the coho salmon hatchery program would be terminated. Alternative 1 serves as a baseline environmental condition for comparison purposes to the Proposed Action (Alternative 2) and the reduced production level (Alternative 3) alternatives. CDFW operates the TRH very similarly to Alternative 2 in the HGMP (Reclamation and CDFW 2017). Lastly, the effects of the three Alternatives are compared to each other in a summary comparison table (Table 7).

4.1. Alternative 1 (No-action) – Do Not Make a Determination Under the 4(d) Rule

4.1.1. Water Quantity and Quality

Under Alternative 1, the TRH would divert less Trinity River water and discharge less effluent into the settling basin (groundwater return) and the Trinity River; therefore, Trinity River water and groundwater quantity and quality would likely receive a very low to negligible beneficial effect compared to the existing conditions. This alternative would not be expected to change the 303(d) listings for total sediment load and turbidity/suspended sediment load because the contributions from the TRH are extremely small relative to the nonpoint source contributions within the Trinity River watershed that led to the listings. CDFW would still be required to obtain the Regional Water Board general NPDES permit and California water rights to continue operating the other hatchery programs.

4.1.2. Salmon and Steelhead

Because of our assumption that the coho salmon program would terminate, most risks to ESUs, DPSs, non-listed salmon species, and designated critical habitat specific to hatchery-origin coho salmon production would be eliminated (Subsection 3.2, Salmon and Steelhead). Relative to baseline conditions, effects expected from this alternative would include the following:

1. **Genetics –** Gene flow from the hatchery to the natural-origin coho salmon population would decrease to zero as the hatchery production ceased. This could have a low to moderate beneficial genetic effect on the natural-origin Trinity River coho salmon population in the long term. However, immediate cessation of the TRH coho salmon program would likely have moderate to high adverse effects to natural-origin coho salmon populations because TRH coho salmon likely provide ongoing demographic support to natural-origin coho salmon throughout the Interior-Trinity diversity stratum. The TRH coho salmon program likely provides a buffer against both environmental and demographic stochasticity for natural-origin populations of coho salmon that are currently in low abundance. Loss of this demographic support would likely cause a rapid population decline for natural-origin coho salmon stocks in the Trinity River due to depensation.
2. **Predation –** The risk of predation by hatchery-origin coho salmon on natural-origin juvenile coho salmon would be eliminated, and therefore overall predation on natural-origin coho salmon in the river would be reduced (Subsection 3.2.2, Competition and Predation) , which would result in a low to moderate beneficial effect on salmonid populations.
3. **Competition** – The risk of competition between hatchery-origin coho salmon and natural-origin coho salmon, Chinook salmon, and steelhead would be eliminated (Subsection 3.2.2, Competition

and Predation), which would result in a moderate beneficial effect on natural-origin coho salmon, Chinook salmon, and steelhead populations.

4. **Hatchery Facility Effects** – Hatchery facility risks would minimally decrease and would have a negligible to low beneficial effect on salmon and steelhead in the Trinity River. Because the TRH is expected to continue operations for the steelhead and Chinook salmon programs, hatchery facility effects on instream habitat are expected to continue to be negligible to low, even if the coho salmon program under Alternative 1 ceases.
5. **Risk of Disease Transfer –** While the current disease risk is low, the risk of disease transfer from TRH-origin coho salmon would not exist if TRH coho salmon production was eliminated, resulting in a low beneficial effect on the natural-origin salmon and steelhead population relative to current conditions.
6. **Risk of "Mining" Natural-Origin Trinity River Coho Salmon –** The risk of "mining" the Upper Trinity River coho salmon population would be eliminated because natural-origin coho salmon would no longer be collected for broodstock. Although no natural spawners would be removed from the river, the benefit of a hatchery population potentially serving as a buffer against environmental and demographic stochasticity would be lost. However, the wild coho population would be left intact. This would result in a net moderate beneficial effect to natural-origin coho salmon populations.
7. **Fisheries –** Coho salmon may not currently be retained by anglers in California, so the effects to recreational and commercial fisheries from this alternative would be undetectable. Tribal coho salmon fisheries would likely experience a reduction in the amount of coho salmon available for harvest. Southern Oregon non-selective marine fisheries may experience small impacts from reduction of coho salmon production.

4.1.3. Other Fish Species

Under Alternative 1, there would be a short- and long-term reduction in competition for space and food among freshwater species relative to baseline conditions. There would also be a reduction in predation risk by hatchery-origin coho salmon on other fish species, a reduction in the number of prey eaten by coho salmon in the Pacific Ocean, and a reduction in the number of hatchery-origin coho salmon available as prey for other species. However, because (1) the project area is only a small portion of each species' range, and (2) coho salmon are not exclusive predators or prey for any of the fish species, this alternative would be expected to have a negligible effect on other fish species: beneficial for some species (coho salmon prey) and adverse for others (coho salmon predators).

4.1.4. Wildlife and Mammals

Under Alternative 1, fewer juvenile and adult coho salmon would be available as prey, predators, and competitors with wildlife and mammals (Table 5). Approximately 300,000 juvenile coho salmon would not be raised for release under Alternative 1.

While data on the number of juvenile and adult natural-origin salmon and steelhead within the Trinity River are limited, the estimates allow an approximation of the relative effects of each alternative. Although none of the predatory wildlife and marine mammal species (Table 5) feed exclusively on coho salmon, salmonids likely provide a large portion of their diets during the juvenile and adult migration periods.

Eliminating TRH coho salmon production under Alternative 1 could alter the survival and productivity of wildlife and mammals. Due to sparse population data on the wildlife, mammals, and salmonids, it is difficult to make inferences about how the TRH coho salmon population changes affect other species (Table 5). NMFS assumes that the current production levels and adult return levels are proportionate with existing wildlife and marine mammal population levels. However, the majority of wildlife and marine mammal population levels are likely lower than historical levels, as are salmon and steelhead populations, and several wildlife species are extirpated, including grizzly bears.

As discussed in the previous paragraphs, the limited adult return estimates show a wide range of variation. Therefore, the reductions proposed in Alternative 1 would have a low to moderate adverse effect on the diet, survival, or distribution of some of the wildlife and mammals.

4.1.5. Socioeconomics

Assuming that the TRH coho salmon hatchery program would terminate, TRH coho salmon program employees would likely be transferred to the TRH steelhead and Chinook salmon hatchery programs to mitigate for the loss of the coho salmon program. The TRH would still procure the same local goods and services because of the TRH steelhead and Chinook salmon hatchery programs. Therefore, we expect undetectable to negligible adverse effects within the socioeconomic context of Trinity County since the TRH steelhead and Chinook salmon programs are expected to continue.

Additionally, immediate cessation of the coho salmon hatchery program at TRH would likely reduce most opportunities for tribal coho salmon fisheries. Because the Upper Trinity coho salmon population would

likely fall into depensation, the tribal fishery would continue to rely even more on Chinook salmon under this alternative. However, the Hoopa Valley Tribe expects a substantial economic benefit from the restoration of the coho salmon fishery through TRH mitigation. Loss of this program would result in a reduction of available coho salmon harvest (Kautsky 2018).

4.1.6. Environmental Justice and Cultural Resources

Trinity County is not an environmental justice community of concern for minorities as defined by Executive Order 12898 (59 FR 7629, February 16, 1994) and Title VI of the Civil Rights Act of 1964 (Subsection 3.6, Environmental Justice and Cultural Resources). Specifically, the total number of minorities in Trinity County is not meaningfully greater than in the State of California overall. However, the percentage of Native Americans in the Trinity County population, 5.1 percent, is three times greater than California as a whole (1.7 percent; Table 6); therefore, NMFS considers Trinity County an environmental justice community of concern for Native Americans. In addition, any reduction in harvest opportunity poses a disproportionate effect on Native American tribes because of the unique connection of Native American tribes to salmon. While the availability of coho salmon would be reduced, Alternative 1 would have low adverse effects on regional Native Americans that fish the Trinity River in the short term because a high proportion of salmonids harvested by Native Americans are Chinook salmon, and the Chinook salmon hatchery program would not be affected. However, the Hoopa Valley Tribe expects economic benefits from a coho salmon run restored with help from the TRH. Cessation of the program would result in a reduction of coho salmon available for tribal harvest (Kautsky 2018).

Trinity County is also an environmental justice community of concern for the low income population (i.e., persons living below the poverty line) because this population is 19.7 percent of the County's population compared to 15.9 percent of California's population (Table 6). However, there are no recreational or commercial harvest opportunities to fish for coho salmon in California, so Alternative 1 would not impact current harvest opportunities for low income populations. Alternative 1 would likely eliminate future recreational and commercial coho salmon fisheries, which could be considered a long-term moderate adverse effect.

4.2. Alternative 2 (Proposed Action) – Determine the Submitted HGMP Meets 4(d) Rule Requirements

4.2.1. Water Quantity and Quality

Under Alternative 2, CDFW would continue using diverted Trinity River water to support the production of up to 500,000 coho salmon in the TRH. TRH effluent discharges would continue to contain low levels of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, herbicides, and food and fish wastes. In addition, the TRH will likely continue using and discharging chemicals and aquaculture drugs at low levels for the treatment and control of disease and anesthesia (NCRWQCB 2017). The Trinity River water diversion quantities and effluent discharge quantities and water quality are regulated by the State of California as described in the Section 3, Affected Environment. Weir installation could minimally alter stream flow, cause minor turbidity, and cause slight habitat disturbance, but effects from the installation would be undetectable to negligible.

Water quantity and quality effects would likely occur, but the adverse effects would be negligible to low in magnitude and duration because (1) multiple effluent prohibitions exist and/or are proposed under the general NPDES permit (NCRWQCB 2017), and (2) effluent will be monitored quarterly for pertinent physical, chemical, and biological constituents that could adversely affect the water quality standards (Subsection 3.1, Water Quantity and Quality).

Based on the prohibition, effluent, and monitoring and reporting requirements in the proposed general NPDES permit (NCRWQCB 2017), the TMDL (EPA 2001), the Basin Plan (NCRWQCB 2011), and the protocols outlined in the proposed HGMP, NMFS believes there would be negligible to low, localized adverse effects on water quantity and quality relative to Alternative 1. As under Alternative 1, Alternative 2 would not be expected to change any of the 303(d) listings because the effects of the suspended sediment contributions from the TRH could be adverse, but undetectable within the receiving water. Therefore, no significant impacts on water quantity and quality are expected to occur under Alternative 2.

4.2.2. Salmon and Steelhead

Alternative 2 is similar to the existing conditions described under Subsection 3.2, Affected Environment, but proposes fewer hatchery coho salmon than historical production until 2020. After 2020, a technical team (such as the previously functioning Hatchery Coordination Team) will review the program to determine if fish production levels require adjustment. If adjustment is appropriate and performance

metrics are met, the recommended coho salmon production level, and rationale, will be forwarded to NMFS for review and approval. The TRH escapement goal is 2,100 coho salmon, although the average escapement at the TRH from 1997 to 2015 was over 6,000 coho salmon.

The TRH coho salmon program will use a weir in the mainstem Trinity River to collect broodstock upstream of Canyon Creek near Junction City, CA. Reclamation and CDFW will ensure that any weir placed as part of the TRH program would be compliant with the most current NMFS criteria for fish passage. A weir is a barrier to fish movement. The potential biological risks associated with weirs include the following:

- trampling of river habitat during installation and removal
- isolation of formerly connected populations
- limiting or slowing movement of adult coho salmon and large, non-target fish species
- alteration of stream flow
- alteration of streambed and riparian habitat
- alteration of the spawning distribution
- increased mortality or stress due to capture and handling
- increased disease transfer risk, due to contact between individuals during trapping

To reduce the potential of impeding upstream migration, TRH staff operating the weir will monitor for increases of coho salmon abundance below the weir. If a build-up occurs for more than 48 hours the weir will be partially breached for up to a day to allow passage. Due to coho salmon run-timing, a build-up of Chinook salmon or steelhead would be unlikely (Figure 3). Also, any weirs used in the Upper Trinity River are expected to be used upstream of seals and sea lions. Because of the Best Management Practices and cautions noted above, the risk of the potential adverse effects is expected to be negligible.

Expected effects to salmonids would include the following:

1. **Genetics –** Gene flow from the TRH to the natural environment would decrease because the proportion of natural-origin broodstock spawned in the hatchery (pNOB) would increase over time, while the proportion of hatchery-origin spawners in the wild would decrease over time (pHOS). The genetic risks would remain approximately the same as described in the Affected Environment, a low adverse risk. Alternative 2 would also likely lead to a slight decrease in the number of hatchery fish spawning in the wild over time, decreasing the risk of hatchery-origin coho salmon mating with natural-origin coho salmon. This would lead to a low to moderate beneficial effect compared to Alternative 1 because the TRH coho salmon program likely

provides a buffer against both environmental and demographic stochasticity for natural-origin populations of coho salmon that are currently in low abundance. As Reclamation and CDFW propose a PNI goal of 0.67 and a minimum PNI threshold of 0.50, Alternative 2 would increase PNI to the recommended levels. Due to the decreasing influence of hatchery fish on the spawning grounds, NMFS assumes that the genetic risk from the TRH program will decrease over time as PNI increases. With recent TRH changes, the projected PNI for 2015 through 2020 is 0.58 if broodstock are 100 percent natural-origin coho salmon (Reclamation and CDFW 2017).

2. **Predation –** The risk of predation by hatchery-origin coho salmon on natural-origin salmonid fry would be the same as existing conditions (Subsection 3.2.2, Competition and Predation), which would result in a low adverse effect on natural-origin salmonid populations when compared to Alternative 1. Hatchery smolts are similar in size and may prey upon other smaller juvenile salmon or steelhead. Based on comparative fish sizes and run timings, coho salmon smolts that would be released through the hatchery program would have spatial and temporal overlap in fresh water and the estuary with a portion of the existing Chinook salmon and natural-origin coho salmon fry population (Figure 3). Most steelhead have not yet emerged from gravel at the time when coho salmon are proposed for release. Therefore, we expect that older juvenile salmonids will be larger than what hatchery-origin coho salmon could effectively prey upon. However, recently emerged fry and young of the year juvenile salmonids will be vulnerable to some predation by hatchery-origin coho salmon smolts.

   These predation risks likely decrease after the species emigrate and disperse in marine areas because there is a greater concentration of vulnerable fry salmonids closest to the spawning grounds. Chinook salmon grow rapidly after ocean entry, which reduces the likelihood that they would become prey for hatchery coho salmon in the ocean. Because hatchery-origin coho salmon juveniles migrate rapidly in the Trinity River, Chinook salmon have little temporal exposure to predation by hatchery-reared coho salmon juveniles. Therefore, the risk of predation on Chinook salmon and natural-origin coho salmon juveniles is likely to be low.
3. **Competition –** The risk of competition between hatchery-origin coho salmon and natural-origin salmonids would be the same as existing conditions (Subsection 3.2.2, Competition and Predation), and would result in a low, adverse effect on natural-origin coho salmon, Chinook salmon, and steelhead populations. Compared to Alternative 1, this alternative would increase competition, causing a low adverse effect. The TRH program releases coho salmon at the yearling

smolt stage, and they may compete with steelhead, Chinook salmon, and natural-origin coho salmon smolts in the freshwater and estuary habitats.

4. **Hatchery Facility Effects** – There is a negligible, adverse effect to natural-origin salmonids in the Trinity River expected from this alternative due to the small surface water diversion and the low level of hatchery effluent that is discharged to the Trinity River. Relative to Alternative 1, this alternative would slightly increase hatchery facility effects, leading to a negligible adverse effect to natural-origin salmonids. Operating hatchery facilities can impact instream fish habitat in the following ways: (1) reduction in available fish habitat from water withdrawals; (2) reduction of water quality from hatchery discharge; (3) operation of instream structures (e.g., water intake structures, fish ladders, and weirs); or (4) maintenance of instream structures (e.g., protecting banks from erosion or clearing debris from water intake structures).

   Water withdrawals may affect instream fish habitat if they reduce the amount of water in a river between the hatchery's water intake and discharge structures. The effect of the TRH water withdrawal on instream habitat for salmon and steelhead in the Trinity River is expected to be negligible. Hatchery discharge may affect water quality for salmon and steelhead if it increases water temperature, reduces dissolved oxygen, or adds elements that are toxic to salmon and steelhead. The TRH operations (e.g., fish ladders, spawning, raceways, and facilities cleaning) use Trinity River water from Lewiston Reservoir, upstream of Lewiston Dam, which is approximately 100 feet upstream of the hatchery. Other factors affecting water quality are discussed above (Subsection 0, Water Quantity and Quality).

5. **Risk of Disease Transfer –** Despite recent improvements in hatchery management, diseases continue to infect salmonids inside and outside of hatchery facilities. Interactions between hatchery-origin fish and natural-origin fish in the environment may result in the transmission of pathogens if either the hatchery-origin or the natural-origin fish are harboring fish disease. This impact may occur at the point of release for hatchery-origin fish and anywhere within the migration corridor that hatchery-origin and natural-origin fish may interact. As the pathogens responsible for fish diseases are present in both hatchery-origin and natural-origin populations, there is some uncertainty associated with determining the source of the pathogen (Williams and Amend 1976; Håstein and Lindstad 1991).

Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because of relatively high rearing densities that increase stress and can lead to greater manifestation and spread of disease within the hatchery-origin population. Consequently, it is possible that the release of hatchery-origin coho salmon may lead to an increase in disease in natural-origin salmon and steelhead populations. The risk of disease transfer to natural-origin salmonid populations would depend on the number of affected fish, pathogen or parasite movement patterns, and whether the wild fish interact with infected hatchery-origin fish. Alternative 2 would likely cause a low adverse risk of disease transfer to natural-origin salmonid populations because of fish health monitoring, disease treatment, and sanitation procedures established in the HGMP.

6. **Risk of "Mining" Natural-Origin Trinity River Coho Salmon –** Returning adult hatchery fish can be released (or allowed to remain) in the river to backfill the numbers of natural-origin fish removed, though this is often subject to adult (genetic) management criteria. The TRH coho salmon program is an integrated program, which means the hatchery will remove some natural-origin adults from the river to use as broodstock and some hatchery fish will spawn in the natural environment. To decrease the effects of mating of hatchery-origin and natural-origin fish in the river, the hatchery fish must remain genetically similar to the natural-origin fish. Therefore, natural-origin fish will be incorporated into the hatchery broodstock to reduce the divergence potential. Both the HRSG (2004) and the CHRSG (2012) address incorporating natural-origin broodstock into the hatchery broodstock. The CHRSG (2012) recommended the PNI exceed 0.5.

   Alternative 2 would increase the risk of mining in comparison to Alternative 1. This would result in a moderate adverse effect to the Upper Trinity River coho salmon population because up to 372 natural-origin adults would be used for broodstock and would not be available to spawn in the wild at the 300,000 release level. At higher production levels, more natural-origin adults may be used if criteria in the HGMP are met, and NMFS approves the adjustments. The number of natural-origin adults used for spawning would fluctuate based on the population return for that year. When the natural-origin coho salmon run-size is below 366, the maximum proportion of the natural-origin coho salmon run that may be used for broodstock is 50 percent. The natural origin coho salmon run will eventually be determined with a Trinity specific coho salmon forecast model. Model development has been initiated with NOAA, tribal, and state partners and will allow for delineation of preseason targets (e.g. brood stock needs, natural produced population levels, and harvest levels). Until this new tool is developed, use of the existing Willow Creek weir can provide real time estimates of escapement. For example, historical capture efficiencies

may be 5% of the run, therefore trapped totals would be multiplied by 20 to estimate the number of coho salmon migrating upstream of the site (Zedonis 2019).

The TRH will target a PNI of 0.67 with a minimum of 0.50 (Reclamation and CDFW 2017). This should bring the genetics of the existing broodstock closer to the genetics of the overall population and reduce the risk of further divergence of the population. By bringing the genetics of TRH coho salmon closer to the genetics of the natural population and maintaining this condition over time, the productivity of offspring from hatchery-natural matings is expected to increase when compared to the historical condition (e.g., Reisenbichler and Rubin 1999; Araki et al. 2007). For an indication of past return population sizes, see Subsection 3.2 (Table 2).

7. **Fisheries –** Coho salmon may not currently be retained by anglers in California, so the effects to fisheries would be undetectable from this alternative. Tribal fisheries could experience moderate beneficial effects, since the coho salmon hatchery program would increase the number of adult coho salmon available for tribal harvest relative to Alternative 1. For this alternative, Tribal fisheries could experience negligible to moderate beneficial effects, when compared to Alternative 3. However, additional hatchery-origin coho salmon may compete with natural- and hatchery-origin Chinook salmon, which could have a low adverse effect to Native American Chinook salmon fisheries (Taylor 1991).

4.2.3. Other Fish Species

Under Alternative 2, there would be a short- and long-term increase in risk of competition for space and food among freshwater species relative to Alternative 1. There would also be an increase in the risk of predation by hatchery-origin coho salmon on other fish species, and an increase in the number of prey eaten by coho salmon in the Pacific Ocean relative to Alternative 1. However, because (1) the project area is only a small portion of each species' range, and (2) coho salmon are not exclusive predators or prey for any of the fish species, Alternative 2 would be expected to have a negligible to low effect on other fish species: adverse for some species (coho salmon prey) and beneficial for others (coho salmon predators), relative to Alternative 1.

Weir operational risks may affect other freshwater fish species in the Trinity River. Specific effects are described in Subsection 4.2.2, Salmon and Steelhead. A build-up of non-salmonid species behind the weir would be unlikely, but the weir still poses a partial barrier to fish passage. Due to the limited temporal and

spatial use of this weir, operating the weir under Alternative 2 would be expected to have negligible effects on other fish species.

4.2.4. Wildlife and Mammals

Compared to the number of natural-origin salmon in the Trinity River watershed, this alternative provides a low increase in the total number of coho salmon adults and juveniles. These fish would be available as prey, competitors, and predators for wildlife and mammals including federally and state listed species (Subsection 3.4, Wildlife and Mammals). None of the predatory wildlife and marine mammal species (Table 5) feed exclusively on coho salmon; however, TRH coho salmon might make up a small portion of their diet during the juvenile release and adult return periods. TRH coho salmon are expected to be a minor source of prey for, predation on, or competition with the wildlife and mammals throughout the distribution and range of habitats found in the Trinity River.

Based on modeling provided in the HGMP, NMFS conservatively estimates that the total number of adult hatchery-origin coho salmon returning to the Trinity River under Alternative 2 could range from 778 to 9,774 coho salmon adults. Alternative 2 would have a low beneficial effect to wildlife and mammals because a greater number of prey items (i.e., hatchery coho salmon) would be available to wildlife and mammals. TRH adult coho salmon would also continue to return marine-derived nutrients to the Trinity River when they are eaten by wildlife or decompose in, or adjacent, to tributaries. The return of hatchery-origin adult coho salmon would provide a negligible to low beneficial quantity of marine-derived nutrients. Therefore, Alternative 2 would have a low beneficial effect to wildlife and mammals in comparison to Alternative 1.

TRH operations also affect wildlife and mammals with adult coho salmon collection methods (weirs which could block or trap wildlife, or conversely, make salmon and steelhead easier to catch through their corralling effect), predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities), and have the potential to transfer toxic contaminants directly into the water or through consumption of hatchery-origin fish.

CDFW has several wildlife deterrent structures in place, such as high fences around the rearing ponds, to exclude wildlife from eating juvenile coho salmon at the hatchery. This method of passively excluding potential predators likely has an undetectable effect on wildlife species, as it prevents wildlife from adapting to unnatural prey opportunities.

4.2.5. Socioeconomics

Alternative 2 would continue to provide full-time and seasonal jobs and promote the local procurement of goods and services, which would contribute to personal income or jobs in the regional economy. This alternative would provide the same level of economic benefit to local communities, including CDFW and HVT employees as the existing condition and likely a low beneficial effect over Alternative 1. Tribal fisheries would likely see a moderate beneficial effect over Alternative 1, since the availability of coho salmon would be enhanced by this alternative's hatchery efforts. In addition, Alternative 2 has a conservation purpose that, if successful, would lead to a more robust coho salmon population and tribal fisheries.

4.2.6. Environmental Justice and Cultural Resources

Trinity County is an environmental justice community of concern for Native Americans and persons living below poverty because their numbers meaningfully exceed the same sub-populations in California (Table 6). Native American communities would continue to have opportunities to fish for returning Trinity River coho salmon adults, provided they can afford equipment and transport to and from the Trinity River. The tribal fishing opportunities would be approximately the same as under existing conditions, so the effects would be undetectable under Alternative 2. There are no recreational harvest opportunities to fish for coho salmon in California, so Alternative 2 would have undetectable effects on current harvest opportunities for low income populations. However, if the metrics of Alternative 2 are met, the program could support a future coho salmon fishery, which would result in a moderate beneficial effect for environmental justice groups when that fishery exists.

4.3. Alternative 3 (Reduced Production) – Determine the Revised HGMP Meets 4(d) Rule Requirements

4.3.1. Water Quantity and Quality

Under Alternative 3, adverse effects on water quantity and quality would be proportionately smaller than under existing conditions and under Alternative 2, but more than under Alternative 1 where less water would be diverted and less effluent generated. Weir installation could alter stream flow and increase disturbance, but effects from the installation would be undetectable to negligible.

Adverse effects to water quantity and quality would likely occur, but would be negligible in magnitude and duration because (1) multiple effluent prohibitions exist and/or are proposed under the proposed general NPDES permit (NCRWQCB 2017), and (2) effluent will be monitored on at least a quarterly

basis for pertinent physical, chemical, and biological constituents that could adversely affect the water quality standards (Subsection 3.1, Water Quantity and Quality).

There would be a reduction in the discharge of physical, chemical, and biological constituents such as ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Trinity River relative to existing conditions and Alternative 2. A reduction in the discharge of these substances would be low near the hatchery discharge structures, but, downstream from the hatchery, dilution effects would make the reduction undetectable. Overall, Alternative 3 would provide low to negligible, localized beneficial impacts on water quality relative to Alternative 2, and would have negligible to low adverse effects relative to Alternative 1.

4.3.2. Salmon and Steelhead

Under this alternative, the hatchery would likely need less broodstock, water, feed, energy, and other resources to produce less fish than Alternative 2. The TRH escapement goal is 2,100 coho salmon (USFWS 1983), although the average escapement at the TRH from 1997 to 2015 was over 6,000 coho salmon (CDFW 2017b). Relative to historic production, Alternative 3 would reduce production by 60 percent of historic production levels, proportionate to the difference between the escapement goal and the average historical escapement. Although TRH did not meet the 300,000 mitigation production target consistently from 2013 to 2017, escapement goals in the past have been regularly exceeded and release numbers under Alternative 3 would likely be sufficient to meet performance metrics for broodstock management, genetic conservation, and recovery objectives.

The TRH coho salmon program will use a resistance board weir in the mainstem Trinity River to collect broodstock near Junction City, CA. Reclamation and CDFW will ensure that any weir placed as part of the TRH program would be compliant with the most current NMFS criteria for fish passage. A weir is a barrier to fish movement. The biological risks associated with weirs are described in Subsection 4.2.2, Salmon and Steelhead.

To reduce the potential of impeding upstream migration, TRH staff operating the weir will monitor for increases of coho salmon abundance below the weir. If a build-up of more than 100 fish does occur for more than 48 hours, the weir can be partially breached for up to a day to allow passage. Due to coho salmon run-timing, a build-up of Chinook salmon or steelhead would be unlikely (Figure 3). 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 the NMFS, and additional studies may be implemented (e.g., a study using acoustic-tagged coho salmon may be initiated to quantify coho behavior and migration speed). Any weirs used on the Trinity River are expected to be conducted upstream of seals and sea lions and operated with complete coverage by CDFW personnel. Because of the limited temporal and spatial use of weirs, the risk of the potential effects described above is expected to be negligible.

Expected effects to salmonids would include the following:

1. **Genetics –** The effects of gene flow from TRH to the natural environment would be undetectable in comparison to Alternative 2 because pNOB and pHOS would be the same. Relative to Alternative 1, this alternative would have a moderate to high beneficial effect to population genetics because under Alternative 3, TRH coho salmon would likely provide a buffer against both environmental and demographic stochasticity for natural-origin of coho salmon.
2. **Predation –** The risk of predation by hatchery-origin coho salmon on juvenile salmonid fry would be reduced compared to Alternative 2 (Subsection 3.2.2, Competition and Predation), which would result in a low beneficial effect on juvenile salmonids. However, when compared to Alternative 1, this alternative would increase predation by hatchery-origin coho salmon, leading to a low adverse effect.
3. **Competition –** The risk of competition between hatchery-origin coho salmon and natural-origin juvenile salmonids would be reduced compared to Alternative 2 (Subsection 3.2.2, Competition and Predation), which would result in a low, beneficial effect on natural-origin coho salmon, Chinook salmon, and steelhead populations. Compared to Alternative 1, this alternative would increase competition between hatchery-origin coho salmon and natural-origin salmonids, leading to a low adverse effect.
4. **Hatchery Facility Risks –** Hatchery facility risks would slightly decrease because water use and discharge would decrease; therefore, Alternative 3 would have a negligible beneficial effect on salmonids in the Trinity River compared to Alternative 2. Compared to Alternative 1, Alternative 3 would have a negligible adverse effect on salmonids in the Trinity River due to water use and effluent discharge.
5. **Risk of Disease Transfer –**While higher than Alternative 1, Alternative 3 would have a low disease risk to natural-origin salmonids. Because coho salmon production would be reduced over Alternative 2, Alternative 3 would have a negligible reduction in disease transmission risk over Alternative 2.
6. **Risk of "Mining" Natural-Origin Trinity River Coho Salmon –** Alternative 3 would result in an increase in the risk of mining in comparison to Alternative 1, but a decrease in the risk of

mining in comparison to Alternative 2. In comparison to Alternative 1 – which does not require the removal of any natural spawners from the population, Alternative 3 would result in a moderate adverse effect to natural-origin coho salmon by directly removing some natural spawners. However, Alternative 3 would also retain the benefit of increasing the likelihood of population persistence with hatchery supplementation of the natural population when natural abundance is low. Compared to Alternative 2, Alternative 3 would result in a low beneficial effect to natural-origin coho salmon because fewer natural-origin coho salmon would be needed for broodstock.

7. **Fisheries Effects –** Coho salmon may not be retained by anglers in California, so the effects to recreational and commercial fisheries would be undetectable from this alternative. Tribal fisheries could experience low to moderate beneficial effects when compared to Alternative 1, since the coho salmon hatchery program would contribute 200,000 coho salmon smolts to the river basin under this alternative. Alternative 3 could have a low to moderate beneficial effect on the coho salmon fishery compared to Alternative 1, and a low to negligible adverse effect to the coho salmon fishery compared to Alternative 2.

4.3.3. Other Fish Species

Under Alternative 3, there would be short- and long-term increases in the risk of competition for space and food among freshwater species that would occur (relative to Alternative 1). In comparison to Alternative 2, Alternative 3 would result in short- and long-term decreases in the risk of competition for space and food among freshwater fish species. Relative to Alternative 1, there would also be a slight increase in the risk of predation by coho salmon on other fish species, an increase in the number of prey eaten by coho salmon in the Pacific Ocean, and an increase in number of coho salmon available as prey for other species. Relative to Alternative 2, there would be a slight decrease in the risk of predation by coho salmon on other fish species, a decrease in the number of prey eaten by coho salmon in the Pacific Ocean, and a decrease in number of coho salmon available as prey for other species. However, because (1) the project area is only a small portion of each species range, and (2) coho salmon are not exclusive predators or prey for any of the fish species, Alternative 3 would be expected to have negligible effects (beneficial for fish that eat coho salmon and adverse for fish that are eaten by coho salmon) relative to Alternatives 1 and 2.

4.3.4. Wildlife and Mammals

Relative to Alternative 1, Alternative 3 would increase the number of juvenile and returning adult coho salmon in the Trinity River. These fish would be prey, predators, and competitors to the species listed in Table 4 and Table 5 (Subsection 3.4, Wildlife and Mammals). Given the relatively low numbers of other salmon and steelhead in the project area compared to historical populations (before European settlement), Alternative 3 would likely have a low adverse effect on coho salmon prey, and a low beneficial effect on coho salmon predators and competitors. Compared to Alternative 2, Alternative 3 could have a minor change in the diet, survival, and distribution of wildlife and marine mammal species during the adult return and the juvenile outmigration periods. None of the wildlife and marine mammal species feed exclusively on coho salmon; therefore Alternative 3 would most likely only have a negligible adverse effect on the diet, survival, and distribution of these species relative to Alternative 2.

TRH operations also affect wildlife and mammals through adult coho salmon collection methods (weirs which could block or trap wildlife, or conversely, make salmon and steelhead easier to catch through their corralling effect), predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities), and transfer toxic contaminants directly into the water or through hatchery-origin fish.

CDFW has several wildlife deterrent structures in place, such as high fences around the rearing ponds, to exclude wildlife from eating juvenile coho salmon at the hatchery. This method of passively excluding potential predators would be no different under Alternative 3 than under Alternative 2, and it likely has an undetectable effect on wildlife species, as it prevents wildlife from adapting to unnatural prey opportunities.

4.3.5. Socioeconomics

Alternative 3 would allow TRH employees associated with the coho salmon program to continue working and would allow the TRH to continue to receive help from volunteers. Additionally, the TRH would procure some local goods and services, which would have a low beneficial effect compared to Alternative 1. However, these benefits would be negligibly reduced relative to Alternative 2, which is similar to the current employment and revenue into local businesses. Tribal fisheries under Alternative 3 would see a low benefit over Alternative 1, and a low to moderate adverse effect compared to Alternative 2.

A reduction in hatchery production has the potential to depress available hatchery coho salmon for tribal fisheries, as there is some correlation between the number of hatchery juveniles released, and the number of returning adults. Decreasing hatchery production by 100,000 (relative to Alternative 2 at the 300,000 coho salmon release level) would be expected to result in 33 percent less hatchery adults for tribal harvest than in Alternative 2.

4.3.6. Environmental Justice and Cultural Resources

Trinity County is an environmental justice community of concern for Native Americans and persons living below poverty because their numbers meaningfully exceed the same sub-populations in California (Table 6). Therefore, although opportunities may be slightly reduced when compared to Alternative 2 and historical production, Native American communities would continue to have opportunities to fish for returning Trinity River coho salmon adults. This would result in a low to moderate adverse effect compared to Alternative 2, and a low to moderate beneficial effect compared to Alternative 1. There are no recreational harvest opportunities to fish for coho salmon in California, so Alternative 3 would have an undetectable effect on current harvest opportunities for low income populations. However, a reduced production plan for coho salmon may result in a more robust natural-origin coho salmon population, which would likely create opportunities for recreational fisheries in the future and result in a moderate beneficial effect for environmental justice groups.

Table 7. Summary of effects analysis under each alternative (Section 4, Environmental Consequences).

Resources	Alternative 1 (No-action)	Alternative 2[1] (Proposed Action)	Alternative 3[2] (Reduced Production)
Water Quantity and Quality	Negligible to Low benefit	Negligible to Low adverse impact	Same as Proposed Action
Salmon and Steelhead:			
Genetics	Moderate to High adverse	Low benefit over No-action	Moderate benefit over Proposed Action
Predation	Moderate benefit	Low adverse impact over No-action	Low benefit over Proposed Action
Competition	Moderate benefit	Low adverse impact over No-action	Low benefit over Proposed Action
Hatchery Facilities	Negligible to Low benefit	Negligible adverse impact over No-action	Same as Proposed Action
Disease	Low benefit	Low adverse impact over No-action	Same as Proposed Action
Mining NOR Coho Salmon	Moderate benefit	Moderate adverse impact over No-action	Low benefit over Proposed Action
Fisheries	No impacts to recreational/commercial; Negligible adverse impacts for tribal fisheries	No impacts to recreational/commercial; Low benefit for tribal coho harvest; Low adverse impact to tribal Chinook fishery	Same as Proposed Action, except negligible benefit for tribal Chinook fishery over Proposed Action.
Other Fish Species	Negligible: beneficial for prey, adverse for predators	Negligible to Low impacts: beneficial for prey, adverse for predators	Same as Proposed Action
Wildlife and Mammals	Low to Moderate adverse	Low benefit over No-action	Negligible adverse impact over Proposed Action
Socioeconomics	Low adverse	Low to Moderate benefit over No-action	Low adverse impact over Proposed Action
Environmental Justice and Cultural Resources	Low adverse impact for tribes; Moderate adverse impact for future recreational/commercial fisheries	Low to high benefit for tribes; Moderate benefit for future recreational/commercial fisheries	Low to moderate adverse impact for tribes compared to Proposed Action; Moderate benefit for future recreational/commercial fisheries

[1]Alternative 2 assumes production rate at 300,000, although in some years the production could range between 150,000 to 500,000 depending on meeting performance metrics and other needs. [2]Alternative 3 is included for analysis purposes only, and was not proposed by the action agencies.

5. CUMULATIVE EFFECTS

5.1. Introduction

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 C.F.R. 1508.7). Council on Environmental Quality (CEQ) guidelines recognize that it is not practical to analyze the cumulative effects of an action from every conceivable perspective, but rather, the intent is to focus on those effects that are truly meaningful (CEQ 1997). In other words, if several separate actions have been taken or are intended to be taken within the same geographic area, all of the relevant actions together (cumulatively) need to be reviewed, to determine whether the actions *together* could have a significant impact on the human environment. Past, present, and reasonably foreseeable future actions include those that are Federal and non-Federal. For this EA analysis, they also include those that are hatchery-related (e.g., hatchery production levels) and non-hatchery related (e.g., human development).

The HGMP would be in effect after the associated ESA 4(d) determination is signed, and would remain in effect until Reclamation and CDFW replace or retract it, or until NMFS determines that the HGMP is no longer effective. NMFS would review annual reports provided by Reclamation and/or CDFW to determine whether the hatchery operations were consistent with activities and take levels described in the approved HGMP, and with NMFS' implementation terms.

5.2. Geographic and Temporal Scales

The cumulative effects assessment area is the entire project area (Figure 1). All potentially affected resources will be assessed using the Trinity River Watershed area (Subsection 1.4, Project Area). The scope of the action considered here includes the rearing and release of hatchery-origin coho salmon in the Trinity River as well as capture of natural-origin adult coho salmon. The direct, indirect, and cumulative reviews address potential effects in the entire project area, although adult collection, rearing, and release activities would occur in localized areas only.

Given the scale and scope the past, present, and future actions, this assessment will not be able to distinguish the differences between Alternative 2 (Proposed Action) and Alternative 3 (Reduced production), or conduct a detailed cumulative effects assessment of all project-level activities that have occurred, are occurring, or are planned in the future. Therefore, this assessment will qualitatively assess Alternatives 1 and 2 to determine whether the effects of the Proposed Action will combine with the past, present, and reasonably foreseeable future action effects to degrade or lead to declining resource conditions when compared to the No-action alternative.

5.3. Past and Present Actions

NMFS recognizes that all past actions in the Trinity River watershed resulted in substantially altered watershed conditions (e.g., USFWS and HVT 1999), degraded habitats (e.g., NMFS 2014), and depressed wildlife and fish populations (e.g., NMFS 2014). These cumulative effects have led to coho salmon population declines, even with supplemental hatchery operations at TRH. This conclusion is strongly supported in literature including Trinity River Annual Reports (e.g., Kier and Hileman 2016), sediment budgets and sediment erosion and transport studies (e.g., GMA 2014; EPA 2001), wildlife listings (Table 5), the HGMP's purpose and need statement (Reclamation and CDFW 2017), documentation of the original hatchery's purpose (Murray 1968), the SONNC coho salmon listing, and the California and SONNC coho salmon recovery plans (CDFW 2004; NMFS 2014).

Adverse watershed and in-river effects seem to have peaked during the 1950s through 1980s when the highest rates of landscape extraction activities (e.g., timber harvesting and gravel mining) occurred in conjunction with a wetter climate period that produced several of the largest floods on record (e.g., 1955, 1964, and 1975). Wildlife and fish populations were already declining from over-harvesting and degraded habitats, but the continued loss of habitat and shifting baseline conditions continued to suppress populations, with some species reaching critically low or depensation levels (e.g., coho salmon).

Major human-driven actions are best defined by the magnitude, duration, frequency, and timing of the action or in some cases the environmental response to the actions (e.g., larger floods and sediment erosion). A brief historical description will provide context of the numerous other past and present actions that affect the Trinity River watershed.

Before Europeans arrived, the indigenous inhabitants occupied the Trinity River watershed for thousands of years. They were primarily hunter-gatherers and steelhead and salmon were a vital food source. They harvested various resources (e.g., fish, wildlife, and trees) and used fire as a land management tool to maintain certain vegetation and wildlife habitats. In general, their harvest methods and population sizes limited their effects.

Shortly after the arrival of Europeans, resource extraction including wildlife hunting and trapping, salmon, steelhead, and other fish harvest (e.g., canneries), mining, and logging occurred at a large scale throughout Northern California. As natural resource extraction and the number of people in the area increased, the quantity and quality of the resources of the Trinity River watershed and adjoining areas declined. Most of the old-growth forest was harvested, and the majority of the fertile bottom lands were converted to agricultural and urban uses. The quantity and availability of tidally-influenced and freshwater estuarine areas declined, floodplains were altered, the lower mainstem Trinity River and tributary creeks were channelized and/or modified, dams were built in the upper Trinity River, water quality declined, pollution increased, and species and habitat were lost. As a result, the number of species at risk increased (Table 4, Table 5), as did the presence of non-native species.

The six major action categories (resource extraction, Trinity River water management, climate change, ocean fish harvest, fire management, and watershed and aquatic rehabilitation and management actions) will be discussed in context with Alternative 1 and Alternative 2.

5.3.1. Resource Extraction Actions

Resource extraction actions have affected numerous aspects of the environment and provided wood, gravel, water, and salmon and steelhead for human use.

Timber harvest, road systems, hydraulic mining, dredging, and other similar land disturbances within the Trinity River watershed have decreased large wood sources, juvenile fish recruitment, and in-channel large wood; altered riparian corridors; altered hydrologic pathways; decreased soil productivity; increased surface erosion and landslides, and the quantities of sediment entering and transporting down river (GMA 2014). Although timber harvest and road management practices have improved in recent decades with changes in regulations and reductions in older trees, the major legacy effects have left lasting impacts, and as in any managed watershed, elevated and prolonged suspended sediment and turbidity during runoff events. As discussed in Subsection 3.1, Water Quantity and Quality, the EPA established a TMDL for addressing sediment/turbidity and temperature exceedances. The TMDL used the Basin Plan and NPDES permit to limit the TRH effluent discharges, ensuring that actions within the watershed would not exceed water quality standards that support beneficial uses.

Large-scale marijuana cultivation occurs throughout the Trinity River Watershed, and diverts water from the Trinity River and its tributaries, dumps chemicals and waste into the environment, damages stream channels (e.g., streambank and channel alterations), and disturbs soil and forest resources (Bauer et al. 2015). Some cultivation sites are permitted by the state and county, and others are unpermitted. Marijuana is a high water-use plant, and its cultivation reduces stream flows, increases chemical pollution, and potentially increases stream temperatures (Bauer et al. 2015). Many species listed in Table 4 and Table 5 are adversely affected by chemical pollution from these cultivation sites.

Downstream of the Trinity River's confluence with the Klamath River, low water flows in the Klamath cause annual toxic algal blooms, elevate late summer and fall water temperatures (during coho salmon adult migrations), and restrict fish passage (Reclamation and CDFG 2012; NMFS and USFWS 2013). The four lower dams in the Klamath River are scheduled for removal at some point in or after 2021, contingent on approval by the Federal Energy Regulatory Commission. Although short-term adverse effects of sedimentation and water quality are expected, conditions are expected to significantly improve in less than two years after dam removal (USDOI and CDFG 2012). Salmonids may suffer short-term challenges while the river goes through a "self-regulating" phase, but passage between the ocean and the confluence of the Trinity River is expected to become easier after the Klamath River has re-stabilized.

The HGMP's economic impacts are rather small compared to all of the resource extraction activities, likely less than three percent of the total from all other resource extraction revenue.

5.3.2. Trinity River Water Management

Before 1957, Trinity River water was used by the people who lived nearby. For thousands of years, the river was a source of food and life for the indigenous peoples in the Trinity River watershed. After the arrival of Europeans in the late 19th century, the river was heavily diverted and dredged for mining, forestry, and other extraction efforts. However, more water was needed to sustain the booming populations in central and southern California, so the Trinity River Division of the Central Valley Project began.

Between 1957 and 2000, 70 to 90 percent of Trinity River water was redirected to the Central Valley, which led to sediment fill in the Trinity River Basin. High river flows are necessary to "flush" the riverbed, and these high flows directly support healthy salmon populations (USFWS and Hoopa Valley Tribe 1999). In 2000, the Trinity River Restoration Program was charged with recommending how and when flow releases occur from Lewiston Dam. Now, water releases are scheduled according to reservoir status and rainfall, and at least 50 percent of the Trinity River water is kept within the river. The Bureau of Reclamation (within the US Department of Interior) makes the final decisions on each year's flow releases.

Concerns remain about appropriate flow conditions for restoring the Trinity River as a healthy ecosystem. Water temperature and quality, sediment transport, and gravel size are dependent upon the timing and volume of water that is released from the upstream dams (NMFS 2014). Dams and diversions are also usually barriers to fish passage, blocking habitat and spawning grounds (e.g., 47 percent of the Upper Trinity River) (NMFS 2014; Asarian 2014). The use of NMFS-approved fish screens can prevent fish from entering unsafe diversions or unhealthy habitats.

5.3.3. Climate Change

Anthropogenic climate disruption or climate change driven by human-produced greenhouse gases is occurring and the changes are beginning to accelerate (NOAA's climate webpage; IPCC reports). While the effects of climate change vary across the globe, the changes in Table 8 will and are affecting resources within the cumulative effects area (GHD 2014). These changes include:

- Increased variation in vegetation growth and water quality with warming air and water temperatures;
- Warmer oceans and summer air temperatures combined with extensive fire suppression and timber management may lead to increasing fires frequency and post-fire sediment influxes (e.g., debris flows);
- Changes in plant, fish, and wildlife species' distributions and increased potential for invasive species;
- Changes in streamflow runoff and river and ocean temperatures may shift the timing of life history events, changes in growth and development rates, and changes in habitat availability;
- Less spring runoff and changes in Reclamation operations with less snowpack.

Table 8. Likelihood of climate change effects within the cumulative effects area.

Effects of Climate Change	Likelihood of Occurrence
Increasing air and water temperatures	High
Reduced winter and spring snowpack	High
Earlier spring peak flow	High
Reduced summer stream flow into the Trinity River	High
Higher air and water temperatures	High
Warmer ocean temperatures	High
Increased ocean acidity	High
Changing precipitation patterns	Moderate
Changing flood frequency	Moderate
Rising sea level	Moderate
Shifting offshore upwelling patterns	Moderate

5.3.4. Salmon and Steelhead Harvest

Marine and in-river coho salmon harvest opportunities exist in southern Oregon. Coho salmon harvest opportunities do not exist in California, due to the complete harvest closure in 1996 (Subsection 3.2.4, Fisheries). However, incidental take of coho salmon is allowed in the marine Chinook salmon fishery. The California Fish and Game Commission (Commission) has adopted a recovery strategy for the SONCC ESU, with a primary goal of returning coho salmon populations to ". . . a level of sustained viability while protecting [their] genetic integrity. . ." and eventually de-listing the species (CDFW 2004 *in* CDFW 2015). The Hoopa Valley Tribe has also installed a selective harvest weir to remove up to 1,000 surplus TRH coho salmon for tribal use. Sustainable harvest by tribal, recreational, and commercial fisheries is an additional, eventual goal. Discontinuing the coho salmon hatchery program at the TRH under Alternative 1 would delay these goals, since hatchery-origin fish make up a large portion of the

current coho salmon population in the Trinity River. Pursuing Alternative 2 and reaching a PNI > 0.67 should continue to benefit coho salmon stocks offshore from the Trinity River, eventually leading to sustainable harvest opportunities. Chinook salmon are harvested in the Pacific Ocean offshore from the Trinity River and in-river during specified seasons. Steelhead are rarely harvested in marine fisheries and only hatchery-marked individuals are allowed for sport harvest in the Trinity River. Over a 33 year period of monitoring by CDFW, fall run-size estimates for steelhead have ranged from a minimum of 2,972 in 1998 to a maximum of 53,885 in 2007. An average of 7.3 percent of the total fall steelhead run was harvested by recreational anglers annually over this period (Kier et al. 2017). The effects of salmon fisheries are managed by NMFS, the Pacific Fishery Management Council (the Council), Tribes, and CDFW, organizations that all work together to promote sustainable fisheries. Management measures developed by the Council are recommended to the Secretary of Commerce through NMFS. The Council's Salmon Fishery Management Plan describes the goals and methods for salmon management. The Council proposes the salmon harvest and NMFS reviews and implements the harvest levels. The Council's management boundary for Chinook and coho salmon fisheries extends three miles seaward of state territorial waters. CDFW also solicits comments on their fishery recommendations. NMFS, Tribes, and CDFW have a complex system of data collection and monitoring to maintain sustainable and viable salmon and steelhead fisheries. Therefore, NMFS expects that harvest effects upon the sustainability and recovery of salmon will be considered during the harvest recommendation process to ensure the survival and recovery of salmon and steelhead within the Trinity River watershed.

5.3.5. Fire Management Actions

The State of California, Federal agencies, and private landowners implement a range of fire management actions ranging from total suppression to an integrated approach using prescribed fire, fuels treatments, and wildfire emergency response (e.g., suppression). In general, fire management actions consist of vegetation and ground disturbance that can reduce ground cover, and increase water runoff and sediment erosion. These results also increase suspended sediment and turbidity levels in the Trinity River. Changes in water quantity and quality may interact with TRH withdrawals or effluent discharges. The state and Federal agencies have numerous Best Management Practices and post-fire rehabilitation efforts to reduce ground disturbances and sediment erosion.

Burned areas are more susceptible to sediment erosion than unburned areas, and can induce pulses of sediment that can affect fish survival by increasing the magnitude and duration of suspended sediment and turbidity events leading to increased severity of ill effects (Newcombe and Jenson 1996). Fire suppression efforts and climate change have increased the likelihood of larger fires and thus, sediment

runoff pulses within the Trinity River watershed. Many factors (e.g., drought and fire suppression efforts) helped create recent fires within the Trinity River watershed, including the 2018 Carr Fire and the 2017 Helena Fire. These fires and recently proposed post-fire actions (e.g., hazard tree, fuels reduction treatments, and salvage logging) will likely increase sediment runoff. Fire severity and risk are expected to increase with future climate change (NMFS 2014).

5.3.6. Watershed and Aquatic Habitat Rehabilitation and Management Efforts

Habitat loss was identified as a key reason for the decline of salmon populations in the Trinity River (CDFW 2004; NOAA 2014). Improvements to and increases in habitat will benefit natural-origin coho salmon and their prey, which should increase the number and distribution of natural-origin coho salmon. More natural-origin coho salmon in the rivers would beneficially shift the PNI, and shifts in the habitat distribution could reduce competition with hatchery-origin coho salmon. Additionally, rehabilitation efforts would increase sediment runoff in the short-term (one to five years), but would lead to reductions in the longer-term (> five years).

The State of California, Federal agencies, local tribes, and private companies and organizations have worked to change management policies and actions to rehabilitate the watershed, tributaries, and estuary and recover listed species and their habitats. Approximately 70 percent of the land in the Trinity Basin is owned by the public, either the US Forest Service or Bureau of Land Management (EPA 2001). The Forest Service and Bureau of Land Management have reduced timber harvest, roading, and significantly changed their land management policies over the last 20 years by implementing the Forest Service's Northwest Forest Plan and developing a restorative approach to watershed management. The largest threat to timber is from private landowners in the Upper Trinity River, where much of the harvest occurs by large industrial practices (CalFire 2009).

CDFW and NMFS have provided action plans and lists of specific rehabilitation projects and management actions that will aid in rehabilitating aquatic habitats and recovering coho salmon and other aquatic species (CDFG 2004; NMFS 2014). Priorities for recovering the Trinity River watershed include increasing instream flows by reducing illegal water diversions, constructing off-channel ponds, and protecting and recovering salmon and freshwater resources. In marine and freshwater areas, development will continue to be encouraged away from ecologically important and sensitive nearshore areas and estuaries, and reducing pollution is a priority. Preserving the natural functions of the ecosystem and supporting sustainable economic growth will encourage overall improvement. Local community efforts,

such as smaller community habitat restoration and protection efforts, will help protect sensitive areas in the Trinity River watershed.

There are multiple state and Federal grant programs that fund restoration actions including the Fisheries Restoration Grant Program (FRGP), which uses the recovery plans to restore anadromous salmonid habitat with the goal of ensuring species survival and protection. Over the past 30 years, the FRGP has funded projects throughout California with multiple projects inside the project area. It is expected that California State and Federal Agencies will continue to support habitat-based recovery. California created the Salmon Recovery Funding Board, which administers Federal and California State funds to protect and restore salmon and steelhead habitat. Federal agencies and organizations are expected to continue to support habitat protection, and inter-agency restoration initiatives like the Trinity River Restoration Program will make those efforts even more efficient.

In summary, the rehabilitation and management actions conducted by Federal, Tribal, state, corporate, and private entities are helping, and will continue to help, restore degraded habitat conditions. Collectively, these programs will help to counterbalance habitat degradation and long-term detrimental cumulative impacts on natural resources in the cumulative effects project area, which have previously contributed to Federal and state listings of fish and wildlife species (Subsection 3.2, Salmon and Steelhead; Subsection 3.3, Other Fish Species; and Subsection 3.4, Wildlife and Mammals).

5.4. Cumulative Effects by Resource

The following provides an assessment of the cumulative effects of Alternative 1 and Alternative 2, in context with the past, present, and on each resource analyzed in this EA: water quantity and quality, salmon and steelhead, other fish species, wildlife, socioeconomics, and environmental justice. The effects of the six major past and present management action categories formed the affected resources' existing conditions and all the actions will continue as the foreseeable future actions.

5.4.1. Water Quantity and Quality

The TRH existing operations (Subsection 3.1, Water Quantity and Quality) closely mimic Alternative 2. The Basin Plan has surface water temperature objectives that must be applied to the river downstream of the Lewiston Dam (NCRWQCB 2011). Water diverted for hatchery operations must not exceed the river's capability to adhere to these temperature standards, with the understanding that temperature is

controlled by additional influences, such as the climate and the diversions to the Sacramento Basin (NCRWQCB 2011).

To address temperature and sediment issues, TMDL allocations ensure that water quality standards are met (EPA 2001). Resource extraction actions such as timber harvest and gravel mining use water in a variety of operations (e.g., road dust abatement, growing trees, and washing sediments). While the exact amount of water currently diverted for marijuana cultivation within the project area is unknown, recent field reviews by CDFW and law enforcement have revealed water contamination from pesticides, herbicides, and fuels (Bauer et al. 2015). The effects of marijuana cultivation are expected to continue until legalization and/or proper enforcement, permitting, and oversight can be obtained. When all these resource extraction efforts are considered, negligible cumulative adverse effects on water quality would be expected with the implementation of Alternative 2, given the upstream flow manipulation and the limited TRH diversion and effluent quantities.

Fire management will likely have a negligible to low adverse long-term effect on Trinity River water quantity or quality because suppression actions are typically mitigated through post-fire Burned Area Emergency Response actions and other rehabilitation work. In addition, prescribed fire and fuel treatments will likely have a short-term low adverse effect if all the Best Management Practices and Forest Plan standards and guidelines are followed. Smoke and air borne particulates from fires have a short-term cooling effect on air and water temperatures, which can have a low beneficial effect. Moderate and high burn severity areas have a high likelihood of increasing sediment runoff in the first three to five years after fires because of the loss of ground cover vegetation, increased soil disturbance, and declining root cohesion. The short-term increases in suspended sediment runoff can lead to moderate adverse effects to water quality; however, these effects are usually short-duration and the suspended sediment and turbidity effects are diluted by the watershed area above the TRH.

Climate change is expected to continue increasing air and water temperatures, leading to effects like reduced snowpack quantities and shifting precipitation regimes. There is a moderate probability that the annual average precipitation quantities will remain relatively similar for decades, but with less snow and more rain and a wider range of total annual precipitation, given the location of the Trinity River watershed between the Pacific Northwest and the southern storm tracks. There is a moderate likelihood that Reclamation's Trinity River water management will buffer (i.e., benefit) some of the climate change effects and some of the TRH diversions because of the current surplus of water for downstream release during low flows. Releases result in higher and cooler summer flows than would normally occur.

Overall, changes in precipitation from climate change during the foreseeable future are expected to have a low adverse effect on the Trinity River water qualities.

Watershed and aquatic rehabilitation and management actions will likely help improve water quantities and quality by reducing sediment erosion (e.g., further disconnecting the road system from the stream system) and improving wood loading. These effects are expected to have a low beneficial effect on the water quantities and quality unless these actions can help address marijuana cultivation issues and encroachment of the river from levees and infrastructure. Watershed rehabilitation efforts to reconnect tributaries and improve habitat can increase the number of natural-origin coho salmon and improve water quality.

In summary, there is a high likelihood that there will be low, cumulative adverse effects on water quantity and quality from the various action categories in combination with either Alternative 1 or Alternative 2.

5.4.2. Salmon and Steelhead

Salmon and steelhead abundance naturally alternates between higher and lower levels on large temporal and spatial patterns that may last centuries and on more complex ecological scales than can be easily observed (Rogers et al. 2013). Current run-sizes of salmon and steelhead in the cumulative effects project area are depressed and SONCC coho salmon are federally listed. This subsection provides brief overviews of the anticipated future action's effects on salmon and steelhead.

Cumulative effects from climate change, particularly changes in air and water temperatures, would likely impact hatchery-origin and natural-origin salmon and steelhead life stages in various ways as described below (Table 9). Under Alternative 1 and Alternative 2, the low level adverse impacts on salmon and steelhead from climate change are expected to be similar, because climate change would impact fish habitat under each alternative in the same manner.

Fire management practices will continue to impact salmonids in the Trinity River watershed when water quality is affected, and even Best Management Practices may increase sedimentation rates into the river while improving the quality of life for people in the area. Climate change is expected to compound these effects, causing more severe and high-risk fires (NMFS 2014).

Salmonid harvest directly impacts the salmon and steelhead populations in the Trinity River. As regulations change to fit each season's forecast, the direct effects will be evaluated in subsequent years.

Sustainable recommendations from the Pacific Fisheries Management Council, NMFS, and CDFW must be implemented to continue supporting the depressed populations in the Trinity River watershed.

Table 9. Examples of potential impacts of climate change by salmon and steelhead life stage under all alternatives.

Life Stage	Effects
Egg	1) Increased water temperatures and decreased flows during spawning migrations for some species would increase pre-spawning mortality and reduce egg deposition. 2) Increased maintenance metabolism would lead to smaller fry. 3) Lower disease resistance may lead to lower survival. 4) Changed thermal regime during incubation may lead to lower survival. 5) Faster embryonic development would lead to earlier hatching. 6) Increased mortality for some species because of more frequent winter flood flows as snow level rises. 7) Lower flows would decrease access to or availability of spawning areas.
Spring and Summer Rearing	1) Faster yolk utilization may lead to early emergence. 2) Smaller fry would be expected to have lower survival rates. 3) Higher maintenance metabolism would lead to greater food demand. 4) Growth rates would be slower if food is limited or if temperature increases exceed optimal levels; growth could be enhanced where food is available, and temperatures do not reach stressful levels. 5) Predation risk would increase if temperatures exceed optimal levels. 6) Lower flows would decrease rearing habitat capacity. 7) Sea level rise would eliminate or diminish the rearing capacity of tidal wetland habitats for rearing salmon and would reduce the area of estuarine beaches for spawning by forage fishes.
Overwinter Rearing	1) Smaller size at start of winter is expected to result in lower winter survival. 2) Mortality would increase because of more frequent flood flows as snow level rises. 3) Warmer winter temperatures would lead to higher metabolic demands, which may also contribute to lower winter survival if food is limited, or higher winter survival if growth and size are enhanced. 4) Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival.
Sources: ISAB (2007), Glick et al. (2007), Beamish et al. (2009), and Beechie et al. (2013).	

The ongoing effects described in Subsection 5.3.1, Resource Extraction Actions, continue to affect aquatic habitat used by salmon and steelhead. Although regulatory changes for increased environmental protection such as new California forest practice rules, monitoring, and enforcement have helped reduce the effects of resource extraction on salmon and steelhead in fresh and marine waters, resource extraction

continues to have low to moderate adverse effects to salmon and steelhead habitat, to water quality, and contribute to salmon and steelhead mortality. Resource extraction actions would more likely affect species that reside in the lower river and estuary because the effects accumulate along the river and are compounded by development in the lower reaches. Effects from most resource extraction are expected to have a low to moderate adverse effect on salmon and steelhead under all alternatives.

Trinity River water management actions may provide some low moderate beneficial effects including increased habitat with higher summer and early fall flows and cooler temperatures and some buffering effects from the increasing air and water temperatures associated with climate change. While the community responses to Reclamation's water planning process emphasize the need and desire to support instream flows for fish, economics will ultimately drive Reclamation's water management scenario selection. Reclamation's water management may not fully mitigate for the adverse impacts of climate change and resource extraction actions on salmon and steelhead and their associated habitats.

About 50 percent of Trinity River flow is currently diverted by the Trinity River Division (TRD) of the Central Valley Project. Completion of the TRD in 1963 denied access to about 109 miles of habitat and severely altered the natural hydrograph and sediment transport regime below Lewiston Dam. Salmon and steelhead populations experienced a steep decline in the years following project completion (TRRP 2017). Dam removal would restore fish access to the upper river, reestablish the natural disturbance regime governing habitat creation that salmonids have adapted to over millennia, and likely produce more stable populations of salmon and steelhead. However, there are currently no plans to remove TRD impoundments and for purposes of this evaluation, NMFS considers the Trinity River dams to be in place for perpetuity. Under the existing conditions of TRD impoundment and diversion, we expect adverse effects to salmon and steelhead under all alternatives will be similar given that the TRD will affect habitat in the same manner under each alternative.

Rehabilitation of habitat in the cumulative effects project area will improve salmon and steelhead habitat under all alternatives, with particular benefits to freshwater and estuarine environments that are important for the survival and reproduction of fish. However, the low beneficial effects from watershed and habitat rehabilitation will not substantially increase survival and abundance of salmon and steelhead without other improvements. In addition, rehabilitation is dependent on continued funding, which is difficult to predict over time. Benefits from watershed and habitat rehabilitation are expected to affect salmon and steelhead survival similarly under all alternatives.

In summary, the management actions may maintain or continue to improve salmon and steelhead habitat over time under all alternatives, which may have a negligible or low beneficial cumulative effect on the abundance and productivity of natural-origin salmon and steelhead and hatchery-origin populations. Because Alternative 2 would use a local native broodstock, the hatchery programs could be used to reduce the extinction risk of natural-origin populations resulting from cumulative effects such as habitat degradation. Although neither of the alternatives would affect the overall trend in cumulative effects on salmon and steelhead, Alternative 2 would likely help mitigate some adverse effects on coho salmon.

5.4.3. Other Fish Species

Other fish species that have a relationship to coho salmon include rainbow trout, sturgeon, lamprey, forage fish, and resident freshwater fish. Like coho salmon, these fish species require and use a diversity of habitat and may also be affected by the six major action categories because of the overall potential for loss or degradation of aquatic habitat or the inability to adapt to shifting climatic conditions. The extent to which Trinity River water management and watershed and aquatic rehabilitation actions may mitigate the impacts from resource extraction and climate change are difficult to predict but are likely to mitigate the relative low adverse effects in the short-term.

In summary, the cumulative effects of the various future actions under the three alternatives would have negligible adverse and/or beneficial cumulative effects on the abundance on fish species that compete, prey on, or are prey items for coho salmon. None of the alternatives would affect the overall trend in cumulative effects on other fish species because the production levels under Alternative 1 or Alternative 2 (zero or 300,000 coho salmon smolts) would be a small fraction of the total salmon and steelhead in the project area that these other fish species could interact with.

5.4.4. Wildlife and Mammals

As described in Subsection 5.4.2, Salmon and Steelhead, the six major action categories may reduce the abundance and productivity of natural-origin salmon and hatchery-origin salmon populations. Consequently, the total number of salmon available as prey to wildlife may be lower than that considered in Subsection 3.4, Wildlife and Mammals. Effects would be greatest on wildlife species that have a strong relationship with salmon, including seals, sea lions, common merganser, bald eagle, and osprey. Effects on these species may include changes in distribution in response to changes in the distribution of their food supply, decreases in abundance, and decreases in reproductive success. Effects on other wildlife species that have a recurring relationship with coho salmon may also occur depending on how their

overall aquatic prey base responds to future climate change, resource extraction, Trinity River water management, watershed and aquatic rehabilitation, and fire management actions.

In summary, the reasonably foreseeable future actions would lead to negligible to low adverse and beneficial effects on wildlife species with strong predator, competitor, and/or prey relationships with salmon. During the proposed implementation of the HGMP, the cumulative low adverse effects are not expected to be significant because the range of production levels under Alternative 1 or Alternative 2 (zero or 300,000 coho salmon smolts) would be just a portion of the total number of salmon, steelhead, and other prey items for wildlife in the project area.

5.4.5. Socioeconomics

The socioeconomic effects from either ending the TRH's coho salmon program (Alternative 1) or approving the HGMP (Alternative 2) are likely undetectable to negligible when compared to the low to moderate beneficial socioeconomic effects from resource extraction, Trinity River water management, salmon and steelhead harvest, fire management, and watershed and aquatic rehabilitation and management actions. These activities provide highly beneficial social and economic effects in Trinity County through jobs, taxes, community, and a general improvement in the environment.

The chronic press condition imposed on the Trinity River watershed resources from resource extraction, flow alterations, and climate change will continue to have moderate adverse socioeconomic effects by limiting various watershed-provided ecosystem services such as aquatic habitat, fish populations, tree growth, large wood inputs to the river, and aquatic and terrestrial habitat, and would lead to elevated sediment erosion.

A recovery of the SONCC ESU and re-opening the coho salmon fishery would provide economic opportunities for businesses that serve anglers: bait, tackle, guides, and other services that support fishing tourism. Alternative 1 would likely delay or prevent a future coho salmon fishery, while Alternative 2 is expected to have an overall moderate beneficial effect on the future fishery.

In summary, there is a low likelihood that the effects from resource extraction and climate change in combination with Alternative 1 would decrease the amount of goods and services required from local businesses. Although Alternative 2 would result in producing only a small fraction of the total salmon in the project area (150,000-500,000 coho salmon smolts in the rivers and Pacific Ocean within and bordering Humboldt and Trinity Counties), sustainable coho salmon production under Alternative 2 may

lead to a future coho salmon fishery, which would support economic growth in this rural area. This would have a moderate beneficial effect.

5.4.6. Environmental Justice and Cultural Resources

Regardless of the effects of resource extraction, Trinity River water management, climate change, ocean fish harvest, fire management, and watershed and aquatic rehabilitation and management actions, Alternative 1 would likely eliminate the future of a coho salmon fishery in Northern California. This would have a high likelihood of moderately adversely affecting any environmental justice user groups and communities of concern within the cumulative effects project area that have the economic ability to purchase a fishing license, gear, and to travel to coastal locations to fish for coho salmon. Therefore, selection of Alternative 2 would still potentially provide communities of concern within the cumulative effects project area the ability to fish and harvest TRH coho salmon in the future, which would result in a moderate beneficial effect to environmental justice user groups.

5.5. Cumulative Effects Summary

NMFS recognizes that the Trinity River watershed has experienced substantial effects from a wide array of human-related activities since European settlement, which led to degraded watershed conditions, degraded habitats, local fish, wildlife, and mammal species extinction (e.g., grizzly bears) and population reductions, depressed steelhead and salmon populations (NMFS 2016a; NMFS 2016b), and ESA-listed species. This conclusion is strongly supported by the references listed throughout this document and all recent regulatory actions (e.g., ESA listings, recovery plans, and TMDLs), the HGMP's need statement, the original hatchery's purpose and need (Murray 1968), and the SONCC coho salmon recovery plan (NMFS 2014). These past and current effects helped lead to the construction of the TRH to supplement the declining salmon and steelhead populations, and the proposed continued use of the TRH to produce SONCC coho salmon. However, this assessment found that there are regulations and processes in place to mitigate and limit most of the adverse effects to affected resources (EPA 2001; NMFS 2014). In addition, multiple agencies, local tribes, and private companies and organizations have worked to change management policies and actions to rehabilitate the watershed, river corridor, and estuary and to recover listed species and their habitats. While all the beneficial actions may not fully mitigate the impacts of climate change and other management actions, this assessment finds that the direct and indirect effects of the Proposed Action on the affected resources, in combination with effects from past, present, and foreseeable future actions on the same affected resources are not expected to be significant.

6. AGENCIES AND PERSONS CONSULTED (INCLUDING TRIBES)

U.S. Bureau of Reclamation

California Department of Fish and Wildlife

Hoopa Valley Tribe

Karuk Tribe

Nor Rel Muk Wintu Nation

Resighini Rancheria

Wintu Tribe

Yurok Tribe

7. LITERATURE CITED

Alvarez, J. S. 2017. Abundance, growth, and predation by non-native brown trout in the Trinity River, CA. Humboldt State University, Master's Thesis.

Araki, H., B. Cooper, and M. S. Blouin. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science 318(5847):100.

Asarian, E. 2014. Assessment of altered hydrologic function, dams, and diversions within the Southern Oregon/Northern California Coast evolutionarily significant unit of coho salmon. Prepared for the NOAA Fisheries, Arcata CA office. 72 pages plus appendices.

Bauer, S., J. Olson, A. Cockrill, M. van Hattem, L. Miller, and M. Tauzer. 2015. Impacts of surface water diversions for marijuana cultivation on aquatic habitat in four northwestern California watersheds. PLoS ONE 10(3): e0120016. https://doi.org/10.1371/journal.pone.0120016.

Beamish, R. L., B. E. Riddell, K. L. Lange, E. F. Jr., S. Kang, T. Nagasawa, V. Radchenko, O. Temnykh, and S. Urawa. 2009. The effects of climate on Pacific Salmon - a summary of published literature. North Pacific Anadromous Fish Commission: Special Publication No. 1. 11 pages.

Beauchamp, D. A. 1990. Seasonal and diet food habits of rainbow trout stocked as juveniles in Lake Washington. Transactions of the American Fisheries Society. Volume 119, pages 475 to 485.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, J. Kimball, J. Stanford, G. Pess, P. Roni, P. Kiffney, and N. Mantua. 2013. Restoring salmon habitat for a changing climate. River Research and Applications 29(8), pages 939 to 960.

Central Valley Project Improvement Act. 1992. Pub. Law No. 102-575. Page 7.

CDFG (California Department of Fish and Wildlife, formerly California Department of Fish and Game). 1962. Inland Fisheries Administrative Report No. 62-11. Trinity River Salmon and Steelhead Hatchery: Fourth Year of Operation, 1961-1962.

CDFG (California Department of Fish and Wildlife, formerly California Department of Fish and Game). 2004. Recovery strategy for California coho salmon. Report to the California Fish and Game Commission. 594 pages. 1416 9th Street, Sacramento, CA 95814, or online: https://www.wildlife.ca.gov/Conservation/Fishes/Coho-Salmon.

CDFW (California Department of Fish and Wildlife). 2015. Recovery strategy for California coho salmon progress report 2004 - 2012. Report to the California Fish and Game Commission. 296 pages. http://www.fgc.ca.gov/public/reports/FGC_Coho_Report_2015.pdf.

CDFW. 2017a. Annual report, Trinity River Basin salmon and steelhead monitoring project: Chinook and coho salmon and fall-run steelhead run-size estimates using mark-recapture methods 2016-17 season. Published November 2017. https://nrm.dfg.ca.gov/documents/docviewer.aspx.

CDFW. 2017b. 2016 Fall Chinook mega table. Klamath River Basin fall Chinook salmon spawner escapement, in-river harvest and run-size estimates, 1978-2016. Published March 20, 2017. https://nrm.dfg.ca.gov/documents/docviewer.aspx.

CDFW. 2017c. Natural Diversity Database, Special Animals List. Periodic publication. October 2017. 65 pages. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109406&inline.

CalFire. 2009. Forest practice watershed mapper: statewide inventory of timber harvesting activities at the planning watershed level to provide information on past and present timber harvesting activities. Available from: http://frap.cdf.ca.gov/watersheds/mapper.html.

California Hatchery Scientific Review Group (CHSRG). 2012. California Hatchery Review Statewide Report. Prepared for the USFWS and Pacific States Marine Fisheries Commission. April.100 pages.

Council on Environmental Quality (CEQ). 1997. Considering cumulative effects under the National Environmental Policy Act. 64 pages.

Cannamela, D. A. 1992. Potential impacts of releases of hatchery steelhead trout smolts on wild and natural juvenile Chinook and sockeye salmon. A White Paper, Idaho Department of Fish and Game, Boise, Idaho.

EPA (U.S. Environmental Protection Agency). 2001. Trinity river total maximum daily loads for sediment. December 20, 2001. 81 pages.

EPIC v. Lehr et al. 2014. Consent decree and order. Case No. 13-02293-MMC. April 28, 2014, San Francisco, CA.

GHD. 2014. District 1 Climate Change Vulnerability Assessment and Pilot Studies: FHWA Climate Resilience Pilot Final Report. Report on behalf of Caltrans and Humboldt County. December 2014. 64 pages.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-level rise and coastal habitats in the Pacific Northwest: an analysis for Puget Sound, Southwestern Washington, and Northwestern Oregon. National Wildlife Federation. 106 pages.

Graham Matthews & Associates (GMA). 2014. Trinity River WY2012 sediment transport monitoring final report. Report with appendices to the U.S. Bureau of Reclamation, Trinity River Restoration Program. Graham Matthews & Associates, Weaverville, CA.

Håstein, T., and T. Lindstad 1991. Diseases in wild and cultured salmon: possible interaction. Aquaculture. Volume 98, pages 277 to 288.

Hatchery Scientific Review Group (HSRG). 2005. Lars Mobrand (chair), John Barr, H. Lee Blankenship, Donald Campton, Trevor Evelyn, Tom Flagg, Conrad Mahnken, Paul Seidel, Lisa Seeb and Bill Smoker. Hatchery reform in Washington State: Principles and emerging issues. American Fisheries Society. Volume 30(6), pages 11 to 23.

Hillman, T. W., and J. W. Mullan. 1989. Effect of hatchery releases on the abundance and behavior of wild juvenile salmonids. Pages 266–285 in Don Chapman Consultants, editors. Summer and winter ecology of juvenile Chinook salmon and steelhead trout in the Wenatchee River, Washington. Don Chapman Consultants, Inc. Boise, Idaho.

Hoopa Valley Tribe (HVT). 1986. Title 16: Ordinance of the Hoopa Valley Tribe. May 28, 1986, Hoopa CA. 13 pages.

Horner, N. J. 1978. Survival, densities, and behavior of salmonid fry in streams in relation to fish predation. Master's thesis, University of Idaho, Moscow, Idaho.

Independent Scientific Advisory Board (ISAB). 2007. Climate change impacts on Columbia River Basin fish and wildlife. May 11, 2007. Report ISAB 2007-2. Northwest Power and Conservation Council, Portland, Oregon. 146 pages.

Jones, K. K, T. J. Cornwell, D. L. Bottom, S. Stein, and K. J. Anlauf-Dunn. 2018. Population viability improves following termination of coho salmon hatchery releases. North American Journal of Fisheries Management. Volume 38, pages 39 to 55.

Kautsky, G. 2018. Comments on the draft environmental assessment (EA) for the National Marine Fisheries Service's Proposed 4(d) Determination under Limit 5 for the Trinity River Hatchery Coho Salmon Program. Hoopa Valley Tribe. December 7.

Kier, M. C., and J. Hileman. 2016. Annual report, Trinity River Basin salmon and steelhead monitoring project: Chinook and coho salmon and fall-run steelhead run-size estimates using mark-recapture methods, 2015-16 season. Report to the Trinity River Restoration Program under U.S. Bureau of Reclamation agreement R13AC20027. CDFW, Redding, California. 96 pages.

Kier, M. C., J. Hileman, and K. Lindke. 2017. Annual report, Trinity River Basin salmon and steelhead monitoring project: Chinook and coho salmon and fall-run steelhead run-size estimates using mark-recapture methods, 2016-17 season. Report to the Trinity River Restoration Program under U.S. Bureau of Reclamation agreement R13AC20027. CDFW, Redding, California. 97 pages.

Kostow K. 2009. Factor that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Reviews in Fish Biology and Fisheries. Volume 19(1), pages 9 to 31.

Murray, R. 1968. Annual report, Trinity River salmon and steelhead hatchery, tenth year of operation 1967-68. Inland Fisheries Administrative Report No. 68-9.

Naman S. and L. Perkins. 2015. Spawner-recruit analysis for Trinity River coho salmon. NOAA Fisheries, May 2016. Arcata CA. 18 pages.

NMFS and USFWS. 2013. Biological opinions on the effects of proposed Klamath Project operations from May 31, 2013 through March 31, 2023, on five federally listed threatened and endangered species. Arcata, CA, May 2013. 607 pages.

NMFS. 2014. Final recovery plan for the Southern Oregon/Northern California coast evolutionarily significant unit of coho salmon (*Oncorhynchus kisutch*). Available from NMFS, Arcata, CA, or online: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/southern_oregon_northern_california_coast/SONCC_recovery_plan.html

NMFS. 2016a. 5-Year Review: Summary and evaluation of California Coast Chinook salmon and Northern California steelhead. April 2016. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016_cc-chinook_nc-steelhd.pdf.

NMFS. 2016b. 5-Year Status Review: Summary and Evaluation of Southern Oregon/Northern California Coast coho salmon. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/coho/2016_soncc_coho.pdf.

National Oceanic and Atmospheric Administration (NOAA). 2009. National Environmental Policy Act Handbook. Developed by NOAA Program Planning and Integration. Version 2.3, May 2009.

NOAA. 2018. Species directory: Threatened & endangered. Accessed February 23, 2018.

Norgaard, K.M. November 2005. The effects of altered diet on the health of the Karuk people. Submitted to FERC docket #P-2082 on behalf of the Karuk Tribe of California.

Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. Volume 16, pages 693 to 727.

North Coast Regional Water Quality Control Board (NCRWQCB). 2017. National Pollutant Discharge Elimination System (NPDES) Permit No. CAG131015, Order No. R1-2015-0009. December 1, 2017. Letter to Trinity River Hatchery, Lewiston, CA, Trinity County.

NCRWQCB. 2015. Permit No. CAG131015. Cold Water Concentrated Aquatic Animal Production facility discharges to surface waters: General NPDES permit waste discharge requirements. No. R1-2015-0009 for the State of California, Department of Fish and Wildlife: Trinity River Hatchery, Trinity County. 17 pages.

NCRWQCB. 2005a. N. Coast Water Board watershed initiative chapter, Trinity River WMA. Section 2.6. https://www.waterboards.ca.gov/northcoast/water_issues/programs/wpc/wpc.pdf

NCRWQCB. 2005b. North Coast Regional Water Quality Control Board Basin Plan. Section 2. https://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/083105-bp/03_bu.pdf

NCRWQCB. 2011. Water Quality Control Plan for the North Coast Region.

Pearsons, T. N., and A. L. Fritts. 1999. Maximum size of Chinook salmon consumed by juvenile coho salmon. North American Journal of Fisheries Management. 19(1), pages 165 to 170.

Reclamation and CDFG. 2012. Klamath facilities removal: Final Environmental Impact Statement/Environmental Impact Report. Sacramento, CA, December 2012. 2092 pages.

Reclamation and CDFW. 2017. Hatchery and Genetics Management Plan for Trinity River Hatchery coho salmon. Shasta Lake, CA, December 2017. 117 pages.

Reisenbichler, R. R., and S. P. Rubin 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. ICES Journal of Marine Science. Volume 56, pages 459 to 466.

Rhodes, J.S., and Quinn, T.P. 1998. Factors affecting the outcome of territorial contests between hatchery and naturally reared coho salmon parr in the laboratory. J. Fish Biol. 53: 1220–1230.

Rogers L. A., D. E. Schindler, P. J. Lisi et al. 2013. Centennial-scale fluctuations and regional complexity characterize Pacific salmon population dynamics over the past five centuries. Proceedings of the National Academy of Sciences of the USA. 110(5), pages 1750 to 1755.

Taylor, E.B. 1991. Behavioural interaction and habitat use in juvenile chinook, *Oncorhynchus tshawytsch*a, and coho, *O. kissutch*, salmon. Animal behaviour. 42: 729-744.

Thériault V., G. R. Moyer, L. S. Jackson, M. S. Blouin, and M. A. Banks. 2011. Reduced reproductive success of hatchery coho salmon in the wild: insights into most likely mechanisms. Molecular Ecology. Volume 20, page 1868.

Trinity River Restoration Program (TRRP). 2000. Summary of the United States Secretary of the Interior Record of Decision, December 19, 2000, pamphlet edition. Arcata, CA. 10 pages. https://www.usbr.gov/mp/ncao/trinity_river/trinity_river_mainstem_brochure.pdf

Trinity River Restoration Program (TRRP). 2017. Fish of the Trinity. (http://www.trrp.net/program-structure/background/fish-of-the-trinity/). Web site accessed January 17, 2018.

Trites A. W. 2003. Food webs in the ocean: Who eats whom and how much? Pages 124 to 141 *in* Sinclair, M. and G. Valdimarsson. 2003. Responsible fisheries in the marine ecosystem. Food and Agriculture Organization of the United Nations, CABI Publishing, Cambridge MA.

U.S. Bureau of Census. 2019. State/County QuickFacts. Accessed at: https://www.census.gov/quickfacts/fact/table/trinitycountycalifornia,CA/PST045216.

U.S. Code. Appendix A, National Environmental Policy Act. 1969.

U.S. Code. Title 16 § 668-668c. Bald and golden eagles. 1940.

U.S. Code. Title 16 § 1361. Marine Mammal Protection Act. 1972.

U.S. Department of the Interior (DOI), Memorandum from Solicitor to Secretary, Fishing Rights of the Yurok and Hoopa Valley Tribes, M-36979, Oct. 4, 1993.

U.S. Department of Interior (DOI) and CDFG. 2012. Klamath Facilities Removal: Final EIS/EIR. Volume 1, Page ES-39. Sacramento, CA. December 2012. 56 pages.

U.S. Department of Interior (DOI). 2012. Reclamation - Managing Water in the West: Hoopa Valley Tribe Sociocultural/ Socioeconomics Effects Analysis Technical Report. Denver, CO. July 2012. 178 pages.

United States Fish and Wildlife Service (USFWS). 1983. Trinity River Basin fish and wildlife management program. Final Environmental Impact Report.

USFWS and HVT 1999. Trinity River flow evaluation. Final report. Arcata CA, June 1999. 513 pages.

Williams, L. V., and D. E. Amend. 1976. A natural epizootic of infectious hematopoietic necrosis in fry of sockeye salmon (*Oncorhynchus nerka*) at Chilko Lake, British Columbia. Journal of the Fisheries Research Board of Canada. Volume 33, pages 1564 to 1567.

Winship A. J., and A. W. Trites. 2003. Prey consumption of Steller sea lions (*Eumetopias jubatus*) off Alaska: How much prey do they require? Fishery Bulletin. Volume 101(1), pages 147 to 167.

Yurok Tribe. 2015. Yurok tribal fishing rights ordinance. July 23, 2015, Klamath, CA. 28 pages.

Zedonis, P. 2019. Email to NMFS clarifying the Trinity Coho HGMP and addressing public comments. May 29.