RECLAMATION

Managing Water in the West

Threatened, Endangered, and Proposed Fish Species that May be Affected by the Trinity River Restoration Program's Mechanical Channel Rehabilitation, Sediment Management, Watershed Restoration, and Monitoring Actions

Biological Assessment and Essential Fish Habitat Assessment For the Trinity River Restoration Program, California

U.S. Department of the Interior
Bureau of Reclamation

December 20, 2019

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Threatened, Endangered, and Proposed Fish Species that May be Affected by the Trinity River Restoration Program's Mechanical Channel Rehabilitation, Sediment Management, Watershed Restoration, and Monitoring Actions

Draft Biological Assessment and Essential Fish Habitat Assessment for the Trinity River Restoration Program, California

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December 20, 2019

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Bureau of Reclamation

December 20, 2019

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Abbreviations and Acronyms

AA	Action Area
ACS	Aquatic Conservation Strategy
AEAM	adaptive environmental assessment and management
BA	Biological Assessment
BDA	beaver dam analogues
BLM	Bureau of Land Management
BMPs	Best management practices
BiOp	Biological Opinion
°C	Centigrade
CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
CEQA/NEPA	California Environmental Quality Act/NEPA
CFPRs	California's forest practice rules
CFR	Code of Federal Regulations
cfs	cubic feet per second
cms	cubic meters per second
CH	Critical Habitat
CNDDB	California Natural Diversity Database
CNRA	California Natural Resources Agency
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
dbh	diameter at breast height
DPS	Distinct Population Segment
DSS	Decision Support System
ECB	erosion control blanket
EFH	Essential Fish Habitat
EFHA	BA/EFH Assessment
EIS/EIR	Environmental Impact Statement/ Environmental Impact Report
ELJ	engineered log jams
ESA	Endangered Species Act of 1976
ESU	Evolutionarily Significant Unit
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FMP	Federal Fishery Management Plan

Forest Service	U.S. Forest Service
FR	Federal Regulation
GATR	Gravel Augmentation Technical Report
GGL	geomorphic grade line
GRTS	general randomized tessellation sampling
HAS	hydrologic subareas
HGMP	Hatchery Genetic Management Plan
HVT	Hoopa Valley Tribe
IAP	Integrated Assessment Plan
IHAP	Integrated Habitat Assessment Plan
IP	Intrinsic Potential
KBO	Klamath Bird Observatory
LAA	Likely to Adversely Affect
LRMP	Land and Resource Management Plan
LSA	lake and streambed alteration
LTOP	long-term operating plan
LWD	large wood debris
MAA	May Adversely Affect
MSA	Magnuson-Stevens Fisheries Conservation and Management Act
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NLAA	Not likely to adversely affect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service
NSO	Northern Spotted Owl
NWFP	Northwest Forest Plan
ODP	online data portal
OHWM	ordinary high-water mark
ORV	Outstandingly Remarkable Values
PBFs	physical and biological features
Reclamation	U. S. Bureau of Reclamation
RIG	Rehabilitation and Implementation Group
RM	river mile
rkm	river kilometers
RMP	Resource Management Plan
ROD	Record of Decision

RRMP	Riparian Revegetation Monitoring Plan
SAB	Science Advisory Board
SEM	stream evolution model
SDU	small domestic use
SLJ	structured log jam
SMARA	Surface Mining and Reclamation Act
SONCC	Southern Oregon/Northern California Coast
STNF	Shasta-Trinity National Forest
SRNF	Six Rivers National Forest
SWRCB	State Water Resources Control Board
SWP	State Water Project
TAMWG	Trinity Adaptive Management Working Group
T&E	threatened and endangered
TCRCD	Trinity County Resource Conservation District
TMAG	Technical Modeling and Analysis Group
TMC	Trinity Management Council
TMDL	Total Maximum Daily Load
TRD	Trinity River Division of the Central Valley Project
TRFES	Trinity River Flow Evaluation Study
TRFEFR	Trinity River Flow Evaluation Study Final Report
TRH	Trinity River Fish Hatchery
Trinity River TMDL	Trinity River Total Maximum Daily Load
TRMFRP	Trinity River Mainstem Fisheries Restoration Program
TRMU	Trinity River Management Unit
TRRP	Trinity River Restoration Program
TRTF	Trinity River Task Force
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WRTC	Watershed Research and Training Center
WSRA	Wild and Scenic Rivers Act

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Chapter 1 Introduction

Overview of the Trinity River Restoration Program

The Trinity River Restoration Program (TRRP) was established upon guidance in the Trinity River Mainstem Fisheries Restoration Program (TRMFRP) Record of Decision (ROD) (U.S. Department of the Interior [USDOI] 2000). The ROD provided a programmatic description and implementation strategy for the restoration of the Trinity River and its salmon populations due to impacts caused by construction and operation of the Trinity River Division (TRD) of the Central Valley Project (CVP). Seven key components of the TRRP include:

- Variable annual instream flows release to the Trinity River from the TRD;
- Physical channel rehabilitation;
- Sediment management;
- Watershed restoration efforts to reduce fine sediment inputs;
- Infrastructure improvements or modifications to accommodate the ROD flow release schedule;
- A restoration program framework based on adaptive environmental assessment and management (AEAM); and
- Environmental compliance and mitigation.

The overarching goal of the TRRP is to restore and sustain natural production of adult anadromous fish populations downstream of Lewiston Dam to pre-dam levels, and to facilitate enhanced harvest opportunities for tribal, commercial, and sport fisheries. The TRRP strives to restore and maintain fish and wildlife resources (including Threatened & Endangered (T&E) species) by restoring the processes that produce a healthy alluvial river system (Integrated Assessment Plan (IAP) 2009).

The ROD directs the U.S. Department of the Interior (USDOI), represented by the U.S. Bureau of Reclamation (Reclamation) and U.S. Fish and Wildlife Service (USFWS), through TRRP[1], to restore the Trinity River and its salmon populations by implementing seven program restoration components. In

[1]The TRRP's Management Council (the Trinity Management Council [TMC]) includes participation of the following eight participating agencies: the Hoopa Valley Tribe, the Yurok Tribe, Trinity County, the California Natural Resources Agency (Department of Water Resources and Department of Fish and Wildlife), the U.S. Forest Service, the National Marine Fisheries Service, the Bureau of Reclamation and the U.S. Fish and Wildlife Service.

addition, nothing in the ROD precludes watershed restoration and monitoring, provided funding is available, below the confluence of the Trinity and Klamath Rivers. Although the Trinity River Flow Evaluation Study (Mcbain & Trush 1999) and TRFER (USFWS and HVT 1999) and the ROD focus on the Trinity River mainstem and Trinity Basin, watershed restoration and monitoring that benefit Trinity River fisheries, below the confluence of the Trinity and Klamath Rivers, may be considered by the Trinity Management Council (TMC).

Proven design criteria and technical approaches for implementation were limited at the time of the ROD. The ROD relies on AEAM using the best available scientific information to ensure effective implementation of restoration actions, scientific monitoring to evaluate efforts and to adjust implementation activities to support the Trinity River anadromous fishery. Since the signing of the ROD and implementation of restoration projects, new information has been evaluated and initial approaches to restoration activities have been refined enabling the TRRP to better implement the ROD.

In addition to new implementation techniques, the status of several species that occur in the Trinity River watershed, which are listed or proposed for listing under the Endangered Species Act (ESA) of 1973, and/or their designated critical habitat (CH), have changed or could not be specifically analyzed in the 2000 TRMFR Environmental Impact Statement/ Environmental Impact Report (EIS/EIR), the ROD, and the 2000 Biological Opinion (BO).

Reclamation is formally requesting re-initiation of consultation with the National Marine Fisheries Service (NMFS) pursuant to Section 7 (a)(2) of the ESA on the ongoing implementation of TRRP activities. 50 CFR 402.16 lists four possible criteria by which re-initiation may be required. The implementing regulations to Section 7 require re-initiation of formal consultation "…if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion" [50 CFR part 402. 16(c)]. This part of the CFR is one of the four possible re-initiation criteria.

The purpose of this Programmatic Biological Assessment (BA) is to present an analysis of effects for the proposed action on NMFS listed threatened and endangered fish species under the ESA in the action area (Figure 1). Variable annual instream flow is excluded from this consultation. This BA analyzes the effects of TRRP program activities associated with physical channel rehabilitation, sediment management, watershed restoration activities, infrastructure improvements or modifications, and the AEAM process, specifically fish monitoring and handling activities (collectively, the action). Overall, program effects are beneficial, however some short-term construction and monitoring activities may adversely affect listed fish species and habitats in the Trinity River basin (Figure 1).

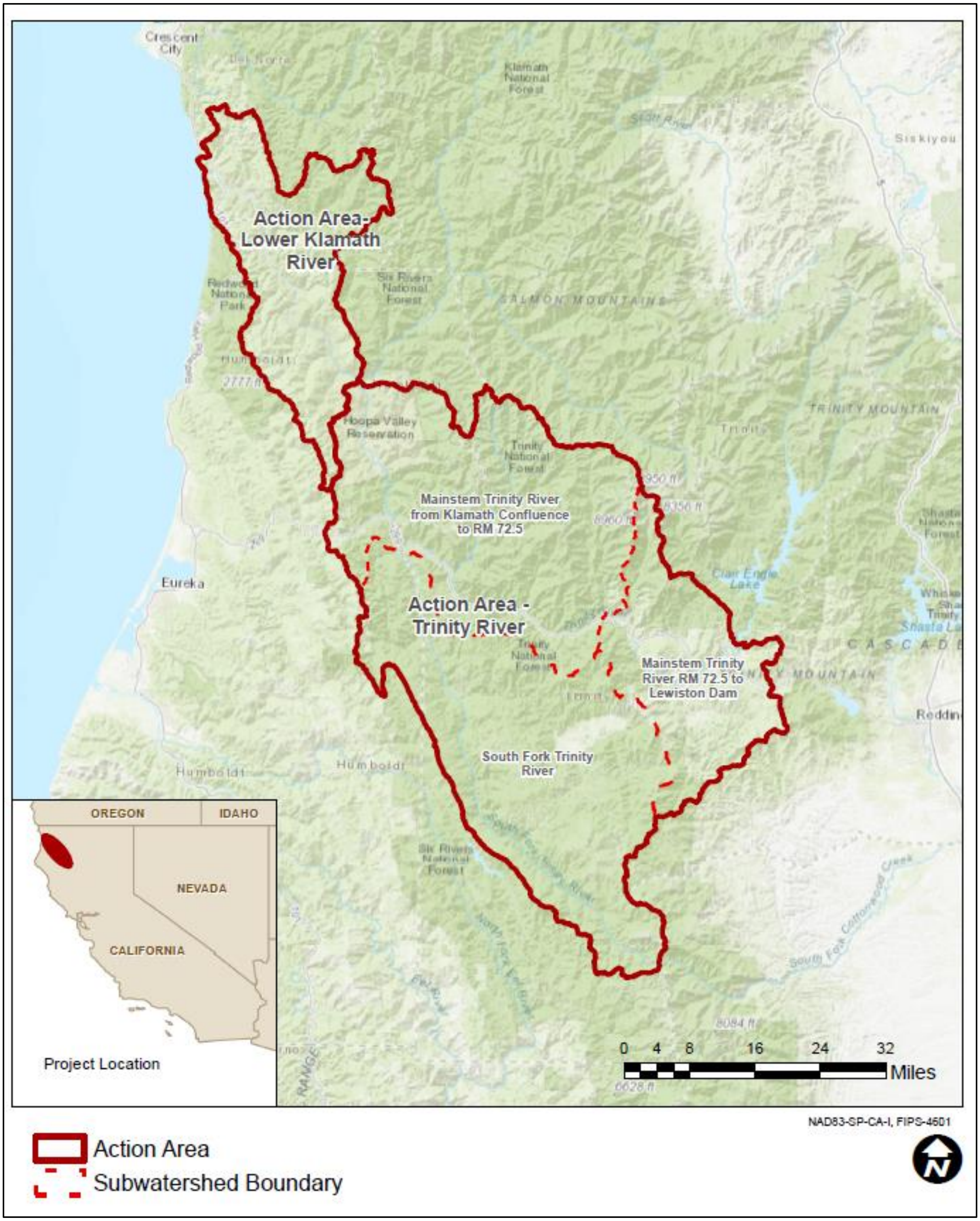

Figure 1. Project Action Area and Trinity River and Lower Klamath Sub-basins.

Consultation with NMFS is also required under Section 305(b)(2) of the Magnuson-Stevens Fisheries Conservation and Management Act (MSA), as amended, to evaluate the effects of the action on Essential Fish Habitat (EFH) for Pacific salmon. EFH analyses are conducted concurrently with the ESA Section 7 consultation. Information and analysis used in this BA is intended to satisfy the EFH consultation requirements. Therefore, a combined BA/EFH Assessment (EFHA) has been prepared.

Record of Consultation

Consultation History

- The 2000 "*Biological Opinion on the Trinity River Mainstem Fishery Restoration Program EIS and its Effect on the Southern Oregon/Northern California Coast Coho Salmon, Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead"* evaluated the proposed recommendations of the TRFE, as the preferred alternative in the EIS, including 1) an increased flow regime; 2) channel rehabilitation program; 3) a coarse and fine sediment management program; 4) infrastructure modifications; 5) upslope watershed restoration; and 6) an adaptive management program. This BiOp concluded that the EIS's preferred alternative, with terms and conditions to minimize the incidental take of Southern Oregon/Northern California Coast (SONCC) Coho Salmon and Sacramento River winter-run Chinook Salmon, would not jeopardize the continued existence of these listed species, nor the Central Valley spring-run Chinook Salmon and Central Valley Steelhead.

- The 2000 *"Biological Opinion of the Effects of Long-term Operation of the Central Valley Project and State Water Project as Modified by Implementing the Preferred Alternative in the Draft Environmental Impact Statement/Environmental Impact Report for the Trinity River Mainstem Fishery Restoration Program; and Request for Consultation on the Implementation of this Alternative on the Threatened Northern Spotted Owl, Northern Spotted Owl Critical Habitat, and the Endangered Bald Eagle within the Trinity River Basin, and Where Applicable, Central Valley Reservoirs"* concurred with Reclamation's determination that proposed implementation activities of the Trinity River Flow Evaluation Study (TRFES), as the preferred alternative in the EIS, would not adversely affect the listed bald eagle and northern spotted owl (NSO), or result in adverse modification or destruction of designated critical habitat for the NSO.

- The 2003 "*Biological Opinion for the Trinity River Bridges Replacement Project"* evaluated Reclamation's activities for the modification or replacement of the existing Salt Flat, Bucktail, Poker Bar, and Biggers Road bridges across the Trinity River to accommodate the future changes to the TRD to achieve the peak flow releases specified in the ROD. This BiOp concluded that proposed modifications to the bridges, with terms and conditions to minimize the incidental take of SONCC Coho Salmon, would not jeopardize the continued existence of the species; furthermore, the BiOp concluded that the modification of the four bridges was necessary to achieve long-term sustainable benefit of the TRMFRP.

- A 2006 amendment to the 2000 NMFS' *"Biological Opinion on the Trinity River Mainstem Fishery Restoration Program EIS and its Effect on the Southern Oregon/Northern California Coast Coho Salmon, Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead"* evaluated and concluded that implementation of in-water construction activities at future channel rehabilitation sites would not cause additional effects to SONCC Coho Salmon beyond those contemplated in the 2000 BiOp and could be conducted under the authorization of the 2000 BiOp.

- A June 14, 2013, Technical Assistance Request and Intra-Service Section 7 Biological Evaluation of the "*Dutch Creek Chanel Rehabilitation Project*" concluded that the design and construction techniques for this project, which is located adjacent to designated CH for the NSO, including pushing over and placement of up to 100 trees and rootwads within the project site (but not within the designated CH for the NSO), would result in No Effect on the NSO (USFWS 2013).

- A June 24, 2019 letter from the USFWS concurs with Reclamation staff determination that the proposed Dutch Creek channel rehabilitation project is Not Likely to Adversely Affect the NSO and that its critical habitat will not be adversely modified.

- A July 2, 2013, updated EFH consultation letter from NMFS (in response to F/SWR/2000/1953) concluded that TRRP high flow gravel placement and site restoration activities (including berm removal, riparian planting, in channel work, watershed restoration, LWD and boulder placement, gravel augmentation, and fine sediment removal) may temporarily adversely affect EFH for Coho and Chinook Salmon. Project effects are expected to be beneficial in the long term (NMFS 2013).

Focus of this Consultation and Exclusions

Reclamation has reinitiated ESA Section 7 consultation to address potential effects of TRRP activities on federally listed SONCC Evolutionarily Significant Unit (ESU) Coho Salmon and its designated CH since current activities differ from those analyzed in the 2000 BiOp. The NSO and its designated CH will be addressed in a separate reinitiated ESA Section 7 consultation with the USFWS. Two TRRP activities are excluded from this Section 7 consultation as follows:

1. The TRRP's variable annual instream flow regime is excluded because it is inseparably linked to the ESA Section 7 consultation between the NMFS and Reclamation as part of the Long-term Operating Plan for the Central Valley Project/State Water Project (LTOP for the CVP/SWP) (Reclamation 2015). Listed species occurring in the Central Valley of California that were addressed in the 2000 BiOp for the TRRP ROD (USDOI 2000) and more recent BiOps for the LTOP for the CVP/SWP are also excluded from this ESA Section 7 consultation. If necessary, at the conclusion of re-consultation on the LTOP for the CVP/SWP, flow related to TRRP activities will be addressed in a separate ESA Section 7 consultation with NMFS.

2. A combination of channel rehabilitation and spawning gravel augmentation activities, known as the "Hatchery Reach Channel Rehabilitation Project," is excluded because of potential interactions with the adjacent Coho Salmon production operations at the Trinity River Hatchery. This TRRP activity will be addressed in a separate ESA Section 7 consultation with NMFS.

Consultation to Date

Below is a chronology of technical assistance and communications related to current TRRP activities:

- **February 19, 2014 Technical Assistance Initiation Meeting.** NMFS, USFWS, and TRRP discuss the purpose and need for reinitiating section 7 consultation and updating the BA. Changes to actions associated with the TRRP implementation program, since inception, are the primary focus. The environmental baseline and effects analysis for listed species will also be updated and will primarily focus on SONCC ESU Coho.

- **March 7, 2014 Draft annotated outline of BA sent to NMFS for technical review.** An outline detailing the scope of content and a preliminary approach to the effects analysis was circulated to co-lead agencies, NMFS, and USFWS for comment and further guidance.

- **June 26, 2014 Federal Agency Coordination Meeting.** NMFS, USFWS, and TRRP meet with Forest Service and BLM and discuss progress towards updating the BA and extending joint coverage under the Section 7 consultation to the USFS and BLM. The Forest Service and BLM agree to be Participating Agencies and designate TRRP to be the Action Agency.

- **December 2019** The TRRP requests to reinitiate formal consultation on Trinity River mainstem channel rehabilitation, fine and coarse sediment management, watershed restoration, and monitoring actions.

Regulatory Setting

Federal Endangered Species Act

Under the ESA, federally listed threatened or endangered species are protected from a take unless a Section 10 incidental take permit is granted or Section 7 consultation and a Biological Opinion with incidental take provisions is provided. "Take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct".

Information provided by this BA will be used by the NMFS to determine effects of the action on federally listed fish species and their designated CH in the action area. In addition, NMFS is required to determine whether or not the action is likely to jeopardize the continued existence of any species proposed for listing under the ESA or result in the destruction or adverse modification of designated CH proposed to be designated for federally listed species.

Magnuson-Stevens Fishery Conservation and Management Act

The Sustainable Fisheries Act of 1996 (Public Law 104-267) amended the Magnuson-Stevens Fishery Conservation and Management Act (MSA) to require federal agencies to consult with NOAA Fisheries on activities that may adversely affect “Essential Fish Habitat” (EFH). Species covered includes all fish species in the fishery management unit.

EFH refers to those waters and substrates necessary for spawning, breeding, feeding, or growth to maturity. As defined, the term “waters” includes aquatic areas (and their associated physical, chemical, and biological properties) that are used by fish or, where appropriate, have historically been used by fish. The term “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities. “Necessary” means the habitat required for a sustainable fishery and the managed species’ contribution to a healthy ecosystem. Finally, “spawning, breeding, feeding, or growth to maturity” refers to a species’ full life cycle. “Adverse effect” means any impact that reduces the quality and/or quantity of EFH, and may include direct, indirect, site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

The MSA requires federal agencies to consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (MSA §305[b][2]). In instances where MSA and ESA issues overlap, NMFS encourages an integrated approach for consultation. The EFH mandate applies to all species managed under a federal fishery management plan (FMP). The FMP applicable to this project is the Pacific Coast salmon fishery. Specifically, this BA/EFHA will consider the impact of the action on EFH for Coho and Chinook Salmon in the Trinity River, pursuant to the Pacific Coast Salmon FMP.

Federal Clean Water Act

The Clean Water Act (CWA) regulates discharges of pollutants into the waters of the United States and establishes water quality standards for surface waters. The CWA makes it unlawful to discharge any pollutant from a point source into navigable waters unless a permit is obtained.

Under the CWA, the U.S. Environmental Protection Agency (USEPA) has implemented pollution control programs setting water quality standards for contaminants in surface waters. Two key sections of the CWA related to the ongoing TRRP and its restoration activities are: 1) Section 404, which regulates the discharge of dredged or fill material into waters of the United States, with permitting overseen by the U.S. Army Corps of Engineers (USACE); and 2) Section 401, which requires certification that any federally authorized, permitted, or licensed project that discharges to waters of the United States is consistent with standards and other water quality goals and implementation plans promulgated pursuant to section 303 (33 USC section 1313) with certification overseen by the USEPA, tribes, and states.

Northwest Forest Plan

The Northwest Forest Plan (NWFP) is a series of federal policies and guidelines governing land use on federal lands within the range of the northern spotted owl (NSO) (*Strix occidentalis*) in the Pacific Northwest Region of the United States. The intent of the NWFP is to protect the northern spotted owl, other federally listed species, and their designated CHs. The Aquatic Conservation Strategy (ACS) was included as part of the NWFP and entails a set of goals, objectives, standards, and guidelines for federal land managers to maintain and restore the ecological functions and processes of watersheds. As parties to the NWFP, the Bureau of Land Management (BLM) and the U.S. Forest Service (Forest Service) are required to ensure that management activities and projects on federal lands under their administration are consistent with objectives of the NWFP, including the ACS. Key provisions of the ACS applicable to a number of TRRP activities are provided in Appendix A.

Federal Wild and Scenic Rivers Act

The Trinity River has been federally designated under the Wild and Scenic System to preserve its Outstandingly Remarkable Values (ORV), which includes the river’s free flowing condition, anadromous and resident fisheries, outstanding geologic resource, recreational, cultural and historic, and water quality values. The Trinity River is also classified as a recreational river by the

BLM and Forest Service. BLM and the Forest Service ensure that all recreational and free-flowing characteristics, in addition to other ORVs, are protected under Section 7 of the Wild and Scenic Rivers Act (WSRA).

Shasta-Trinity and Six Rivers National Forest Land and Resource Management Plan

The Shasta-Trinity National Forest (STNF) and Six Rivers National Forest (SRNF) Land and Resource Management Plans (LRMP) provide guidance for managing federal lands in the STNF (USFS 1995) and SRNF. Approximately 1,165,549 acres of National Forest Lands are within the Trinity River watershed. The LRMP occurs within the framework of regional and national planning and includes forest goals; forest objectives; and forest standards and guidelines. Forest goals state the management philosophy of the LRMP, and the forest objectives describe the purpose of the management prescriptions. The forest-wide management prescriptions apply a management theme to specific types of land (e.g., wilderness, high-density recreation areas). Finally, forest standards and guidelines provide basic direction for implementation of management activities forest wide. The Forest Service is a participating federal partner agency in the TRRP and manages STNF and SRNF lands in the action area where a number of TRRP restoration activities are presently occurring and are planned in the future.

Bureau of Land Management Redding Resource Management Plan

The BLM's Redding Resource Management Plan (RMP) provides guidance for BLM land use management activities within the Trinity River basin (BLM 1993). Approximately 54,644 acres of BLM lands are within the Trinity River watershed. Resource condition objectives, land-use allocations, and management actions provide land use direction. Resource condition objectives are the goals established for the decision area. Land-use allocations prescribe general management categories (e.g., visual resources and recreation opportunity classes), specific limitations to full resource use (e.g., leasable mineral restrictions), or formal designations (e.g., area of critical environmental concern, wild and scenic river corridor) to meet the resource condition objectives and/or to comply with federal law. Management actions are implementation measures to ensure that the resource condition objectives are met and that alert the public and BLM to specific follow-up actions associated with specific land-use management alternatives. The BLM owns lands in the action area where TRRP activities occur.

Other Requirements

In addition to compliance with the federal requirements described above, compliance with state and county requirements may also be required of the federal Action and Participating Agencies.

Surface Mining and Reclamation Act

The Surface Mining and Reclamation Act (SMARA) provides a comprehensive surface mining and reclamation policy regulating surface mining operations to minimize adverse environmental impacts and ensure mined lands are reclaimed to a usable condition.

Gravel placement downstream of Lewiston Dam may create a need for newly permitted mining (gravel processing) operations. Any such operations would be subject to additional environmental review unless adequate gravel can be supplied from existing permitted gravel operations.

Authorities and Responsibilities

This BA/EFHA will inform and support re-initiation of an ESA Section 7 consultation on the ongoing implementation of restoration actions conducted and/or supported by the TRRP overseen by Reclamation and the USFWS, with cooperation and participation of the Forest Service, BLM, and USACE. In addition to their administrative, funding, and permitting roles in the TRRP, Reclamation, the USFWS, and the Forest Service, along with the NMFS, each serve as members of the TRRP-governing Trinity Management Council (TMC). The BLM and USACE are responsible for permitting of TRRP habitat rehabilitation activities. The roles and responsibilities of these federal agencies, and how they pertain to the regulatory setting, are described below.

United States Bureau of Reclamation

Reclamation and the USFWS are charged with implementation of the TRRP. Reclamation, through the TRRP, is responsible for assuring that actions authorized by the ROD (USDOI 2000) are implemented in a timely and lawful manner and that progress reports are submitted to the Secretary of the Interior and to Congress. Reclamation will serve as the federal lead Action Agency for reinitiating this Section 7 consultation.

Reclamation prepares and submits to the North Coast Regional Water Quality Control Board (NCRWQCB) all applications for CWA Section 401 water quality certifications. The TRRP office holds three 5-year 401 certifications for restoration activities: channel rehabilitation **Order No. R1-2015-0028**, gravel augmentation **(WDID No. 1A09154WNTR)** and fine sediment management **(WDID No. 1A09155WNTR).** In addition, the TRRP office holds two section 404 permits with the USACE. One permit is a 10-year gravel augmentation permit that allows for the addition of gravel to the Trinity River at 5 different locations and works with the Water Board’s permit. The second is a Nationwide Permit #27 for Aquatic Habitat Restoration that the TRRP typically applies for and receives each year to cover their approximately annual channel rehabilitation projects.

Reclamation also complies with conditions of the Trinity River Total Maximum Daily Load (Trinity River TMDL) for sediment that was established in 2001 by the USEPA in accordance with section 303(d) of the CWA.

In 2001, the State of California established Total Maximum Daily Loads (TMDLs) for sediment, turbidity, suspended material, and settleable material in the Trinity River. A TMDL is a calculation of the maximum amount of a pollutant (e.g., sediment, temperature) that a waterbody can receive and still meet water quality standards. The Trinity River TMDL specifies that implementation of the TRRP ROD, including the prescribed flow regime, mainstem and watershed restoration, and use of adaptive management be conducted in a manner resulting in a net reduction of fine sediment into the Trinity River.

The TRRP's CWA section 401 water quality certifications must be renewed every five years. The permit renewal process includes (1) development of an updated description of the TRRP's channel rehabilitation, fine, and coarse sediment management activities based on the cumulative experience and evaluation of activities during previous permit cycles; (2) determination of whether these activities are adequately analyzed in the Master EIR (2009 Water Board and Reclamation), and, (2) public disclosure/review of any changes proposed in management plans via a California Environmental Quality Act approved procedure. In 2015 when the Water Board permits were renewed, three environmental checklists were prepared for: the channel rehabilitation, gravel augmentation, and fine sediment management permits, respectively, which determined that the activities were covered under the 2009 Master EIR.

United States Fish and Wildlife Service

The USFWS (Arcata Fish and Wildlife Office: Fisheries Division), in its co-lead role with Reclamation for implementing the TRRP, provides technical leadership in biological and habitat conservation for the restoration of the Trinity River and its anadromous fisheries to sustainable, pre-dam levels. The USFWS is also congressionally authorized to oversee the regulatory implementation of the ESA, for federally listed species within its jurisdiction, and is mandated to conserve, protect, and enhance the nation's fish, wildlife, and their habitat.

United States Forest Service

Land use planning direction for the STNF and SRNF are guided by national legislation, regional forest directives, and forest-specific management directives found in the LRMP. The LRMP requires that land uses be managed in accordance with certain established standards and guidelines.

The Forest Service works cooperatively with BLM, when agency management jurisdictions overlap for activities occurring on federal lands within the corridors of designated Wild and Scenic Rivers, like the Trinity River.

Although, the Forest Service typically completes its own ESA Section 7 consultations for actions that are planned to occur on Forest Service lands, it has agreed to join this consultation as a federal participating agency and is responsible for providing data, assisting in review, conducting analyses, and contributing to the completion of the BA/EFHA. As a party to the NWFP, the Forest Service is required to ensure that projects are consistent with objectives of the NWFP and the ACS. In addition, the Forest Service may authorize Reclamation to complete restoration activities that occur on STNF and SRNF lands consistent with the objectives of the LRMP and NWFP, including the ACS.

Bureau of Land Management

BLM's Redding Field Office currently manages BLM lands in the Trinity River basin in accordance with the 1993 Redding RMP which incorporated, by amendment, the management objectives, standards and guidelines of the NWFP, including the ACS. The RMP discusses the general condition of natural resources in the plan area and prescribes appropriate land use management within the plan jurisdiction.

The BLM has responsibility for activities affecting WSRA designated rivers that results from an interagency agreement between the National Park Service, BLM, and the Forest Service. BLM is the federal river manager for the Wild and Scenic Trinity River, from Lewiston Dam to the North Fork Trinity, and must follow management guidelines in the WSRA.

The BLM has also agreed to join this ESA Section 7 consultation as a federal participating agency and is responsible for providing data, assisting in review, conducting analyses, and contributing to the completion of the BA/EFHA. As a party to the NWFP, the BLM is required to ensure that projects are consistent with objectives of the NWFP and the ACS. The BLM regularly provides Reclamation a Free Use Permits (to allow for processing and movement of mineral materials, e.g., gravel, and Right of Ways to conduct restoration activities on their managed lands) for each project. BLM also works closely with Reclamation to prepare site specific NEPA analysis documents and to evaluate proposals within the Wild and Scenic River corridor to ensure that they are consistent with the objectives of the NWFP, ACS, RMP, and WSRA.

United States Army Corps of Engineers

Section 404 of the CWA authorizes the USACE to issue permits for the discharge of dredged or fill materials into waters of the U.S., including wetlands (33 USC 1344). The USACE is authorized to issue either individual or general permits under Section 404. Under its general permit authorization, the USACE has issued a number of permits that apply on a nationwide basis. As long as an activity has complied with the conditions set forth in an applicable nationwide permit, there is no need to apply for an individual permit from the USACE. For several of these nationwide permits, the USACE requires the submission of a pre-construction notification requesting confirmation of compliance with conditions of the nationwide permit. Most of the TRRP channel rehabilitation projects have been permitted under Nationwide Permit Number 27 (Wetland and Riparian Restoration and Creation Activities). To comply with the Section 404 policy there must be no net loss of wetlands, and discharge into wetlands must be avoided and minimized to the extent practicable. Because there is expected to be no net loss in Waters of the U.S.A. from TRRP activities, Project impacts to wetlands and wetland functions are considered temporary. The TRRP works to increase riparian and wetland area, functions, and values so that no compensatory mitigation is required.

The USACE will issue permits under the CWA to Reclamation. Activities such as construction of any structures in or over navigable waters of the United States, or other work that may affect the course, location, condition, or physical capacity of navigable waters may also require a USACE permit.

Structure and Decision-making of the Trinity River Restoration Program

TRRP's ongoing implementation of restoration activities are enhanced by key elements outlined in its regulations and foundational documents. They include structural and functional relationships of decision-making; project design, construction, and other management measures; the adaptive management process; and development and use of monitoring information on project performance and effects to ESA-listed species.

The following summary describes these important programmatic elements of the action: *Implementation Plan for the Preferred Alternative of the TRFMP EIS/EIR* (Stalnaker and Wittler 2000*), Draft Master Environmental Impact Report for Channel Rehabilitation and Sediment Management for Remaining Phase 1 and Phase 2 Sites* (NCRWQCB and Reclamation 2009), and *Review of the Trinity River Restoration Program's Channel Rehabilitation Strategy, Phase 1* (TRRP SAB 2014*)*. Additional information in this section, obtained from other sources, is cited where appropriate.

Trinity River Restoration Program

The TRRP is a multi-agency program with eight principal program partners and collaborating stakeholders including other federal, state, and local government agencies; non-governmental organizations; recreational and commercial fishers; river-based recreational interests; and private citizens. The structural and functional organization of the TRRP, depicted in Figure 2, consists of the following:

- Trinity Management Council (TMC) – acts much like a Board of Directors; agencies with membership are frequently referred to as the "TRRP Partners" or the "TRRP Program" to refer to the partners as a whole.

- Trinity Adaptive Management Working Group (TAMWG)* – a federally appointed advisory committee under the oversight of the USFWS that provides stakeholder/public advice to the TMC;

- Technical Work Groups – discipline-oriented technical committees who deliberate on and resolve technical matters. Work groups include TRRP program staff/stakeholders. Their meetings are open to the public;

- Science Advisory Board (SAB) – a group of independent scientists who advise the TMC and TRRP staff;

- TRRP staff – includes employees of Reclamation, USFWS, and Hoopa Valley Tribe (HVT), who work at the TRRP office in Weaverville, California;

- TRRP Program staff – includes employees of program partners (i.e., USFWS-Arcata Fish and Wildlife Office, NMFS-Arcata Field Office, Forest Service, Yurok Tribe, HVT, California Department of Fish and Wildlife (CDFW), and California Department of Water Resources (CDWR).

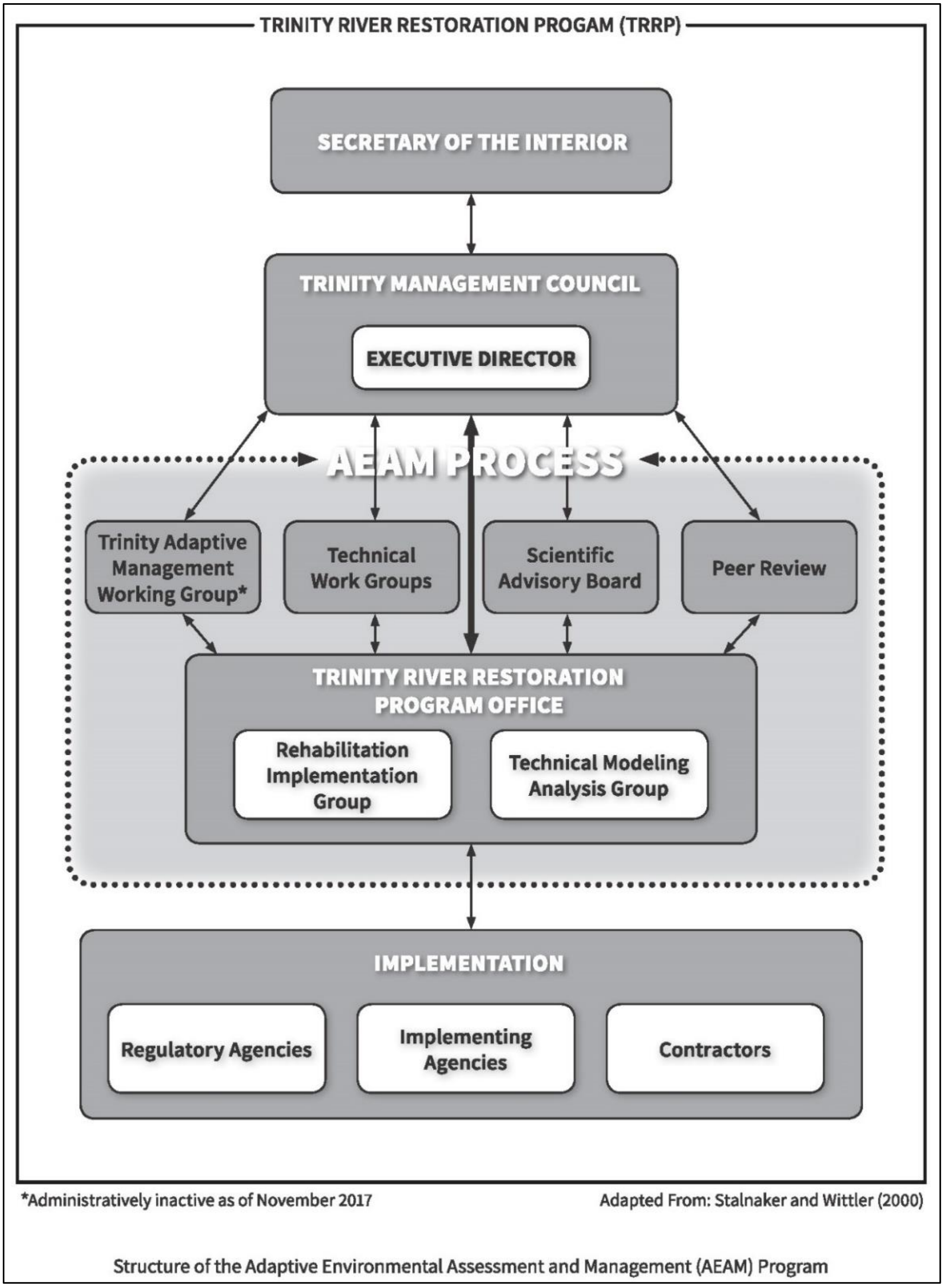

Figure 2. Structure and Functional Relationships of the Trinity River Restoration Program. ***Source: TRRP 2019.***

Trinity Management Council

The TMC is comprised of the eight TRRP Partners, including:

- U.S. Bureau of Reclamation
- U.S. Fish & Wildlife Service
- Hoopa Valley Tribe
- Yurok Tribe
- California Natural Resources Agency
- National Marine Fisheries Service
- U.S. Forest Service
- Trinity County

The TMC acts as a board of directors developing and adopting program policies, making decisions on administration of the TRRP, and providing guidance on program and project-level priorities based on:

- progress of the TRRP in meeting the goals of the ROD;
- balancing year-to-year hydrologic conditions and river flow schedule objectives with habitat restoration objectives;
- overall progress and fulfillment of restoration activities conducted by technical TRRP Program staff;
- individual TRRP Partner agencies' (and their collaborators – e.g., BLM) governmental and tribal legal, regulatory, and policy-level authorities and responsibilities.

Each of the eight TRRP Partner Agencies that hold a seat on the TMC has various roles and responsibilities when providing management direction and technical guidance and complying with regulatory matters. These roles and responsibilities, and how they pertain to TRRP activities, are described below.

The California Natural Resources Agency (CNRA) is represented by both the CDWR and CDFW. The CNRA is mandated to restore, protect, and manage the state's natural, historical, and cultural resources for current and future generations. The CDWR and CDFW provide the TRRP with technical and regulatory guidance that ensures that habitat restoration projects are consistent with statewide and regional resource goals of the CNRA. Additionally, the state agencies manage several parcels of land along the Trinity River and Grass Valley Creek. State property, owned by CDWR, at the mouth of Grass Valley Creek, is the location of a series of fine sediment retention ponds, known as Hamilton Ponds. These are important for reducing fine sediment input to the Trinity River in Lewiston, California.

NMFS is responsible for federal management and habitat conservation planning for commercial marine fisheries, which includes Pacific salmon. Specifically, NMFS is responsible for implementing the federal ESA for marine resources, including anadromous salmonids, and has jurisdiction for ESA-listed salmon in the Trinity River basin. In their role as a TRRP Partner, both on the TMC and as a participant in technical work groups, the USFWS and NMFS provide guidance on ESA-related issues, in addition to their regulatory responsibilities.

The Forest Service manages national forest lands within the Trinity River watershed according to the STNF and SRNF LRMP and ensures that TRRP projects are consistent with the objectives and procedures of the LRMP. In addition, the Forest Service is responsible for complying with Section 7 of the federal WSRA to ensure that the ORVs, for which the Trinity River was designated under the Act, are protected and enhanced. TRRP watershed restoration efforts can include projects on national forest managed lands that focus on sediment control and erosion (e.g., road decommissioning and rehabilitation) and in-stream habitat improvement.

Trinity County ensures that TRRP projects comply with conditions of the Trinity County General Plan, Zoning Ordinance, FEMA floodplain management, and Water Quality Control Ordinance. Trinity County may also require approvals, in addition to federal approvals, before TRRP activities can commence at certain channel rehabilitation sites (e.g., encroachment or floodplain development permits may be required for certain activities to be carried out). The Master EIR, which incorporates many of the activities described in the Trinity River FEIS/EIR (USFWS et al. 2000), was certified by the Regional Water Board on August 25, 2009. Subsequent projects within the scope of the Master EIR undergo a limited environmental review. The Regional Water Board issues 401 water quality certifications for restoration projects and Waste Discharge Requirements. Restoration and habitat enhancement projects in the watershed need to be reviewed for implementation of best management practices (BMPs) and regulated in conformance with these permits to protect water quality.

Adaptive Environmental Assessment and Management (AEAM)

Since 2006, the TRRP has been implementing an AEAM process through a general framework for integrating resource responses to restoration measures and management activities. The TRRP's AEAM function is served by TRRP Program and agency staff working through Technical Work Groups, generally in support of the 2009 Integrated Assessment Plan. The ultimate goal of the AEAM process is to inform a systematic decision-making process for Trinity River restoration and management actions to effectively and efficiently achieve ROD objectives (USDOI 2000). The TRRP's original AEAM structure consisted of two interacting groups, a Rehabilitation and Implementation Group (RIG) and a Technical Modelling and Analysis Group (TMAG).

The RIG worked closely with the TMAG to achieve design objectives and ensure fulfillment of TMC directives related to implementation of projects. The TMAG consisted of an interdisciplinary team of scientists, engineers, and specialists responsible for conducting studies, evaluations, modeling, and interpreting technical products into flow planning, habitat design criteria, and restoration objectives. Based on these assessments, the TMAG made recommendations to the TMC, within the framework of the AEAM process, on channel rehabilitation, coarse sediment augmentation, fine sediment management, watershed restoration, and annual flow release schedules. Currently, the TMAG is more generally referred to as the Science portion of the program, including the technical working groups, and the RIG is the Implementation Branch. Science and Implementation staff work together in the Design Work Group to evaluate and recommend channel rehabilitation designs for construction and environmental compliance and permitting is completed by TRRP staff and consultants.

The AEAM component of the TRRP assesses changes in the river, providing interdisciplinary information to evaluate hypotheses about how the river responded under past natural conditions, how it has responded to man-made activities and water development in the basin, and how it responds to restoration measures. Teams of scientists, managers, stakeholders, and policy makers use this information to develop future restoration and management actions based on quantifiable knowledge gained from assessments. The adaptive management process is repeated in a systematic way, incrementally applying knowledge and successively refining techniques, to rehabilitate physical habitat of the Trinity River and restore its fishery resources. The adaptive management process occurs as a six-step feedback loop shown in Figure 3.

Trinity Adaptive Management Working Group

In addition to the Federal, State, local, and Tribal agencies, the Trinity Adaptive Management Working Group (TAMWG) was a federally appointed committee that involved stakeholders in thoughtful discussion, advice, and input to the TMC on TRRP policy and management of restoration efforts. TAMWG members included representatives from environmental organizations, agricultural water users, small business owners, Trinity County residents, recreational fishermen /commercial fishermen, utility companies, the Natural Resource Conservation Service (NRCS), local landowners, recreational fishing guides, and whitewater outfitters and guides. Previously, the TAMWG annually reviewed habitat restoration activities and technical evaluations and made recommendations to the TMC. The TAMWG was administratively inactivated by the Department of Interior in November of 2017.

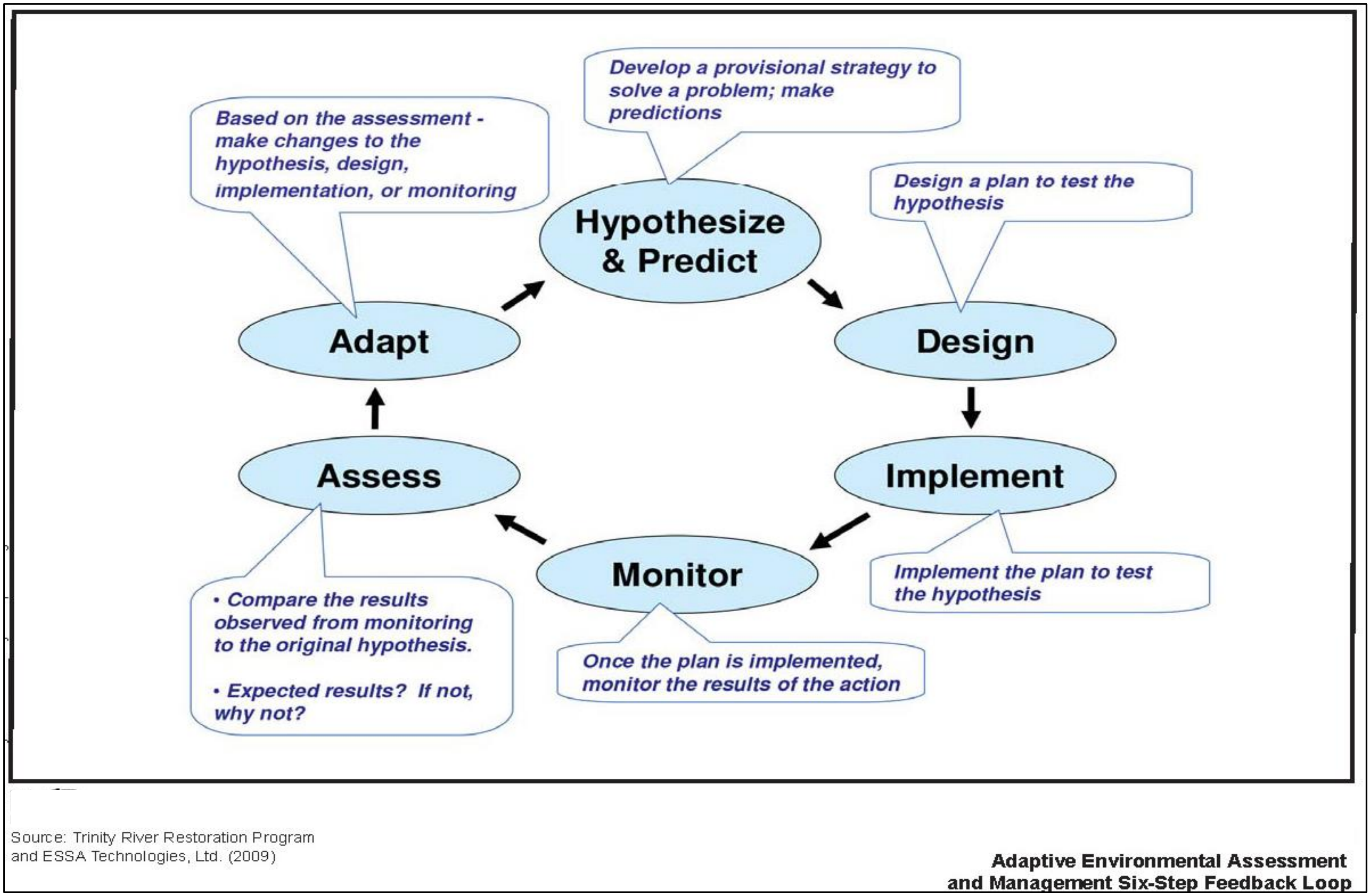

Figure 3. Adaptive Environmental Assessment and Management Six-step Feedback Loop (*Source: Stalnaker and Wittler 2000; TRRP and ESSA 2009*).

Technical Work Groups

A number of collaborative work groups comprised of technical staff from the eight TRRP Partners and other collaborating stakeholders (e.g., BLM) address scientific and technical issues of various disciplines within a framework of adaptive environmental management. Work group meetings are open to the public. Technical work groups include the following:

- Design Team: Provides comprehensive and implementable designs for TRRP's identified channel rehabilitation project sites within the 40-mile Trinity River mainstem restoration reach.

- Flow WG: Focuses on all technical aspects of restoration flow releases from Lewiston Dam to the Trinity River, including but not limited to, scheduling of flow releases, environmental impacts, evaluation of the flow releases in meeting restoration goals and objectives on an annual and multi-annual basis, and reporting. In addition, the flow work group makes management recommendations to ensure water temperatures in the Trinity River are sufficient to meet the needs of native aquatic species.

- Interdisciplinary Team (IDT): Coordinates the activities of TRRP technical work groups and integrates multi-disciplinary assessments into comprehensive management recommendations.

- Watershed WG: Identifies and implements restoration activities as described in the Trinity River ROD. TRRP provides support (staff and funding) for a larger watershed management group. The Watershed WG supports properly functioning watershed conditions using an ecosystem-based watershed restoration approach. The initial focus has been on the watershed located between Lewiston and the North Fork; however, the geographic scope has expanded to all tributaries downstream of Lewiston Dam to the confluence of and including the South Fork Trinity.

- Riparian and Aquatic Ecology WG: Focuses on Program science and management issues related to aquatic and riparian ecology. The Work Group will guide monitoring and data collection, analyze and interpret information that will inform channel rehabilitation designs, flow management, sediment management, and AEAM to better achieve Program goals.

- Fish WG: Provides technical support and guidance to the TRRP concerning fish population and habitat monitoring, assessment and analysis to inform decision-making, and management to help successfully fulfill the goals of the Program. The Fish Work Group will collaborate with other work groups to conduct interdisciplinary analyses and support TRRP adaptive management efforts.

- Physical WG: Guides and coordinates monitoring and data collection, and analysis and interpretation of information that will inform channel rehabilitation designs, flow management, sediment management, and AEAM to better achieve TRRP goals.

All available information from long-term resource monitoring, mitigation monitoring, project performance evaluations, and other pertinent scientific and engineering information are taken into consideration by the work groups. This includes data and analyses concerning the status and condition of listed species in the action area. Feedback and information obtained from these work groups is provided to TRRP staff, and subsequently the TMC, as technical support and advice related to both project implementation and scientific evaluation of restoration progress.

Independent Review Panels

Scientific credibility of the TRRP's technical efforts is assured by using independent review panels of technical specialists to evaluate proposals for technical monitoring and scientific studies. A Scientific Advisory Board (SAB) provides review of the TRRP's science and technical activities and advises the TMC on recommendations related to the AEAM/Work Group process. The SAB consists of scientists, recognized as experts in the disciplines of fisheries biology, fluvial morphology, hydraulic engineering, hydrology, riparian ecology, wildlife biology, and aquatic ecology.

Project Implementation

On-the-ground implementation of restoration measures and projects includes the teamwork of the TRRP Partners, for design and funding; regulatory agencies, for permitting (e.g., USACE, Regional Water Board); implementing agencies (e.g., federal, state, and county landowners; resource conservation districts; non-governmental organizations); private landowners; and construction contractors. Execution of individual projects requires the collaboration and coordination of these various parties to effectively implement TRRP restoration projects. The Implementation Group endeavors to develop pathways for efficient and timely environmental regulatory compliance of restoration actions and to avoid redundant compliance processes among participating agencies.

The Integrated Assessment Plan

The IAP, completed in 2009 (TRRP and ESSA 2009), provides a broad monitoring and assessment framework for the AEAM process. The focus of the IAP is to: 1) to identify key assessments that provide near-term feedback on performance of restoration projects and management actions, and 2) to evaluate long-term progress towards achievement of ROD goals (USDOI 2000).

The IAP identifies pathways and linkages through different types of modeling and implementation strategies. Simulation modeling is emphasized for predicting outcomes of restoration and management actions and for hypothesis testing. Empirical modeling is emphasized for statistical analysis and evaluating trends in environmental responses to restoration actions.

Close integration of the evaluations with the implementation activities informs development of coordinated sampling designs as well as assessments that serve multiple or complementary objectives. The Integrated Habitat Assessment Plan (IHAP) is an ongoing effort that coordinates assessments of geomorphology, aquatic and riparian habitats, and wildlife surveys.

The IAP identified six key TRRP objectives that guide development and prioritization of assessments and analyses as part of the AEAM framework:

- Create and maintain spatially complex channel morphology.
- Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals.
- Restore and maintain natural production of anadromous fish populations.
- Restore and sustain the natural production of anadromous fish populations downstream of Lewiston Dam to pre-dam levels to facilitate dependent tribal, commercial, and sport fisheries' full participation in the benefits of restoration via enhanced harvest opportunities.
- Establish and maintain riparian vegetation that supports fish and wildlife.
- Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation.

Flow and sediment augmentation actions are expected to initiate changes in physical processes almost immediately (e.g., sediment transport, temperature, coarse sediment storage), which over time should increase the area of suitable habitat for fish and wildlife. However, ecosystem response times to the TRRP's activities are hard to predict. Physical channel rehabilitation immediately creates appropriate depths and velocities for juvenile fish but can require another decade after construction for various geomorphic and vegetation processes to fulfill a project site's habitat potential (e.g., bank erosion, coarse sediment transport into the site, and establishment of vegetative cover) and for the cumulative benefit of multiple projects to become apparent. Accordingly, biological responses to restoration and management activities, such as changes in fish populations, also exhibit near-term and long-term phases that are affected both by in river and external changes (e.g., ocean conditions, harvest of fish, etc.). Monitoring studies are being implemented by the Program to provide timely and effective analyses that can inform future restoration designs and management activities.

Education and Outreach

Public information, education, and outreach activities are an important part of the AEAM process, designed to expand public knowledge of the TRRP and improve the likelihood of acceptance and support for TRRP actions. The primary objective is to reach local residents, landowners, schools, elected officials, as well as other non-resident stakeholders through newsletters, brochures, open houses, annual accomplishment reports, and portable exhibits.

Information Management

Because the TRRP Program and its collaborators contribute to monitoring and study efforts used to inform TRRP actions, the need for efficient and timely data sharing is critical. The use and management of data for conducting the TRRP's adaptive management is complex and has been improved through a collaborative effort of the TRRP Partnership. The TRRP Data Management and Utility Plan, now establishes procedures for the development, sharing, and dissemination of data.

An online library (http://www.trrp.net/library/) is a data storage and access system continually under development to provide access to program-level information for TRRP Program, stakeholders, and the public. The online library provides access to over 1,000 reports, other documents and products; over a hundred meeting agendas and summaries; 26 data packages; and millions of data points on streamflow, water temperature, and reservoir operations. Many reports and documents are scanned items dating back as far as 1900. The online library interacts with the TRRP's general website by using web services to automatically provide up-to-date information on data and document holdings. A mapping component of the online library includes aerial photography, dating as early as 1944, and can be used for organizing, visualizing, and analyzing geospatial data. The information management system and the online library has become a valuable tool that has improved the efficiency and accuracy of decision-making by TRRP scientists, managers, and policy makers.

Chapter 2 Background/History

Project History

The Trinity River originates in the rugged Salmon-Trinity Mountains of northern California in the northeast corner of Trinity County, California and is the largest Klamath River tributary. From Lewiston Dam, the most upstream barrier to salmon migration, the Trinity River flows for 112 miles until it enters the Klamath River near the town of Weitchpec on the Yurok Reservation. The Trinity River passes through Trinity and Humboldt counties and the Hoopa Valley (Hoopa Tribe) and Yurok Indian Reservations. The lower Klamath River flows northwesterly for approximately 40 miles from its confluence with the Trinity River before entering the Pacific Ocean.

In 1955 Congress authorized the construction and operation of the Trinity River Division (TRD) of the Central Valley Project (CVP). The TRD oversaw construction of the Trinity Dam and Trinity Lake, Trinity Powerplant, Lewiston Dam and Lake, Lewiston Powerplant, Clear Creek Tunnel, Judge Francis Carr Powerhouse, Whiskeytown Dam and Lake, Spring Creek Tunnel and Powerplant, Spring Creek Debris Dam and Reservoir, and related pumping and distribution facilities. The TRD has had adverse impacts to fish habitats from these facilities. The TRRP is based largely on federal statutory requirements since 1955, as well as the federal government’s trust obligations to the Hoopa Valley Tribe (HVT) and Yurok Tribe. Part of these Trust responsibilities include restoration and maintenance of the Trinity River anadromous fishery resources.

Once the Trinity and Lewiston Dams were completed, migratory fish access to the Trinity River above the dams was blocked. The dams also eliminated sediment recruitment and large wood and nutrient inputs to the river from over 700 square miles of the upper watershed. Due to these impacts, the Trinity River Fish Hatchery (TRH) was constructed and operated to help mitigate for lost production of habitats upstream from the TRD. The TRH is located immediately downstream from Lewiston Dam and operated by the California Department of Fish and Wildlife (CDFW).

Water diversion to the Sacramento River from the TRD changed flows and water temperatures in the Trinity River below Lewiston Dam. Reduced peak flows and flood durations lead to stabilized gravel point bars (known as bar fossilization) and riparian vegetation encroachment on bars and banks from Lewiston to the North Fork Trinity River confluence where tributary inflows were sufficient to maintain natural river dynamics. Encroachment of riparian vegetation into the former active river channel promoted the deposition of fine-textured sediments. This resulted in linear “fossilized” berms that further confined and simplified the channel, reduced riparian plant species and age class diversity, impaired floodplain connectivity, and reduced fish habitat. Additionally, alteration of the hydrologic regime reduced the seasonal water temperature patterns below Lewiston Dam.

In response to the adverse impacts to fish habitat and declines in salmon runs caused by the TRD, the Secretary of Interior directed the USFWS in 1981 to implement a flow study with participation by member agencies of the Trinity River Basin Fish and Wildlife Task Force. Results of the Trinity River Flow Evaluation Study (TRFES) are documented in the 1999 Trinity River Flow Evaluation Final Report ([TRFEFR], USFWS and HVT 1999). The objective was to determine the effectiveness of flow restoration and other measures for impacts of the TRD. Further, Congress enacted the Trinity River Fish and Wildlife Program in 1984, adding legislative authority to the Task Force to promote and support management and fishery restoration actions in the Trinity River basin. Then, in 1992, Congress enacted the Central Valley Project Improvement Act (CVPIA), which provided the legal authority and funding for projects that restore the fishery resources of the Trinity River. The USFWS finalized the TRFEFR which developed recommendations including “instream fishery flow requirements, TRD operating criteria, and procedures for the restoration and maintenance of the Trinity River fishery.” The results of the TRFES indicated the lack of rearing habitat for juvenile salmonids was a primary limiting factor in the recovery of salmonid populations in the Trinity River (USFWS and HVT 1999).

While the TRFES was being completed, a public process began in 1994 for developing the TRMFRP EIS/EIR. In 1999, the USFWS published the Trinity River Flow Evaluation Final Report, which provided a framework for restoration activities below Lewiston Dam.

In October of 2000, the TRMFRP EIS/EIR (USFWS et al. 2000) was finalized and on December 19, 2000 the ROD for the TRFRP EIS/EIR was signed (USDOI 2000). The ROD directed Reclamation and the USFWS to implement the Preferred Alternative identified in the TRMFRP EIS/EIR and established the TRRP. The seven components of the Preferred Alternative, and the resulting TRRP include:

- Variable annual instream flows for the Trinity River from the TRD based on forecasted hydrology for the Trinity River Basin as of April 1st of each year, ranging from 369,000 acre-feet in critically dry years to 815,000 acre-feet in extremely wet years;

- Physical channel rehabilitation, including the removal of riparian berms and the establishment of side channel habitat;

- Sediment management, including coarse sediment augmentation to restore alluvial processes and build alluvial features (e.g., gravel bars and spawning bed gravels), below the TRD and reductions of excessive fine sediments that degrade fish habitats;

- Watershed restoration efforts, addressing negative impacts which have resulted from land use practices in the basin;

- Infrastructure improvements or modifications, including rebuilding or fortifying bridges and addressing other structures affected by the peak instream flows provided by the ROD;

An AEAM process, guided by the TMC, to ensure the proper implementation of a) components of the Preferred Alternative, b) appropriate scientific monitoring and evaluation efforts, and c) adjustments to the annual flow schedule within the designated flow volumes provided for the ROD, or other measures, in order to ensure that the restoration and maintenance of the Trinity River anadromous fishery continues based on the best available scientific information and analysis;

- Environmental compliance to ensure program activities comply with environmental laws, including National Environmental Protection Act (NEPA), Endangered Species Act (ESA), and California Environmental Quality Act (CEQA).

Progress of the Trinity River Restoration Program

The following summary of TRRP progress is adapted from the Channel Rehabilitation and Sediment Management for Remaining Phase 1 and Phase 2 Sites Volume II, Draft Master Environmental Impact Report (Master EIR; NCRWQCB and Reclamation 2009), and the TRRP Science Advisory Board’s Review of the Trinity River Restoration Program’s Channel Rehabilitation Strategy, Phase 1 Report (TRRP SAB 2014).

One of the first priorities for the TRRP was the modification and improvement of infrastructure along the Trinity River to accommodate restoration flow releases prescribed in the ROD. Four bridges, including the Salt Flat Road, Poker Bar Road, Biggers Road, and Brown’s Mountain (Bucktail) Road Bridges, along with houses and outbuildings that would potentially be affected by peak flow releases, were identified in the ROD for modification or relocation (USDOI 2000). To date, the TRRP has completed all of the infrastructural modifications originally identified in the ROD; however, additional modifications are proposed at one house in Junction City.

The ROD acknowledged the benefit of using a phased approach for implementation of the physical channel rehabilitation component of the TRRP (USDOI 2000). This phased approach was deemed necessary because: 1) dam releases greater than 6,000 cubic feet per second (cfs), up to the maximum release of 11,000 cfs, could not occur until infrastructure modifications had been completed; and, 2) the planning, design, and construction of infrastructure modifications to accommodate the full ROD restoration flow regime was originally estimated to take about three years (USDOI 2000). Additionally, because the benefits of higher flows would not be fully realized until a significant number of the channel rehabilitation projects had been completed, the ROD directed Reclamation and the USFWS to complete a preliminary group of channel rehabilitation projects at about half of the proposed locations within three years of the issuance of the ROD, referred to as Phase 1 (Table 1, Figure 4). Subsequent channel rehabilitation projects, referred to as Phase 2, could then be designed and built incorporating lessons learned during Phase 1 construction (Table 1, Figure 4).

To date, most Phase 1 and many of the Phase 2 channel rehabilitation projects have been fully or partially implemented (Figure 4). Follow-up surveys and evaluation of the as-built conditions for geomorphology, aquatic habitat inventories, fish use, and riparian vegetation development over multiple seasons at the sites was used to inform and modify subsequent project designs and implementation. Post-project evaluation procedures throughout the Phase 1 project cycle have evolved to include systematic monitoring and analytic designs. Current predictive modeling of design conditions (e.g., 2D modeling to estimate flow direction, velocity, and depth) supplements monitoring and informs the channel rehabilitation design process.

Table 1. Phase 1 and Phase 2 Channel Rehabilitation Sites (arranged from upstream to downstream)

Channel Rehabilitation Site Name	Other Names Used	River Mile (RM)	EIS Site Numbers	Sub-Site Names	Sub-River Mile (RM)	Phase #	Date of Construction
Lewiston Hatchery - Coarse Sediment Augmentation	Trinity River Coarse Sediment Injection and Rehabilitation Project	RM 112.06	NA	NA		Phase 1	2006-2007
Lewiston 4	LEW	RM 110.2-111.6	1,2,3,4	Lewiston Cableway	RM 110.18-110.46	Phase 1	2008
				Deadwood Creek	RM 110.46-110.96		
				Hoadley Gulch	RM 109.80-110.10		
				Sven Olbertson (Weir Hole, Diversion Pool, Lewiston Upstream)	RM 111.19-111.63		
Sawmill[2]	SM, Cemetery	RM 108.9-109.7	5	NA		Phase 1; Phase 2 (rehab)	2009; TBD
Upper Rush Creek[3]	UR	RM 107.9-108.8	6	NA		Phase 1	TBD
Lower Rush Creek	LRC	RM 107.0-107.9	6	NA		Phase 2	NA (no action needed)
Dark Gulch	Lewiston-Dark Gulch, DRK	RM 105.5-107.0	7,8,9 and SC1	Bucktail	RM 105.5-106.35	Phase 1	2008
				NA			
				NA			
				NA			
Bucktail	Bucktail, Dark Gulch	RM 105.5-106.35	7,8,9	NA	RM 105.5-106.35	Phase 2	2008 and 2016
Lowden Ranch	Lowden at Forced Meander Bend, Lowden at Grass Valley Creek, Bucktail, LR	RM 104.0-105.4	10	Downstream of Bucktail	RM 105.3-105.4	Phase 1	2010
	THG			NA		Phase 1	2010

[2] Rehabilitation/enhancement of site proposed-TDB
[3] Landowners could not agree on designed project, so not implemented, to date

Table 1. Phase 1 and Phase 2 Channel Rehabilitation Sites (arranged from upstream to downstream)

Channel Rehabilitation Site Name	Other Names Used	River Mile (RM)	EIS Site Numbers	Sub-Site Names	Sub-River Mile (RM)	Phase #	Date of Construction
Trinity House Gulch		RM 104.0-104.3	11, and SC2	NA			
Tom Lang Gulch[4]	Upper Poker Bar	RM 103.1-103.9	12	NA		Phase 2	TBD
Poker Bar[5]	Middle Poker Bar, PB	RM 101.7-102.9	13	NA		Phase 2	TBD
China Gulch[5]	Lower Poker Bar, CG	RM 101.0-101.6	14	NA		Phase 2	TBD
Lower Poker Bar[5]		RM __-__	15	NA		Phase 2	TBD
Limekiln Gulch	Upper Steel Bridge, LKG	RM 99.6-100.4	16	NA		Phase 2	2015
Steel Bridge Day Use	Steel Bridge Road, SB	RM 98.6-98.9	17	NA		Phase 1	NA (no action needed)
McIntyre Gulch[3]		RM 91.2-98.0	18	NA		Phase 2	TBD
Indian Creek	Indian Creek-including Vitzthum Gulch, IND	RM 93.9-96.9	19, 20, and SC3	NA		Phase 1	2007
				NA			
				NA			
Douglas City	Middle Indian Creek, Douglas City, DC I, DC II	RM 93.5-94.0	NA	DC Upper		Phase 2	2007 and 2015
				DC Lower		Phase 2	2013
Reading Creek	RC	RM 92.2-93.5	21, 22	Upper Reading Creek[6]		Phase 1	2010
				Lower Reading Creek			
Upper Steiner Flat	Steiner Flat No. 1, Steiner Flat Feathered Edge, SFF	RM 91.4-91.8	NA	NA		Phase 2	TBD
Steiner Flat	Steiner Flat No. 2, SF2, MSF, Steiner	RM 90.1-91.3	23 (MSF); 24 and 25 (LSF)	Middle Steiner Flat		Phase 2	TBD

[4] Poker Bar Suite (4) with major FEMA issues, not likely to be constructed.
[5] Originally ROD site #15, it has been merged within other adjacent vicinity sites.
[6] Only the lower Redding Creek site was constructed in 2010.

Table 1. Phase 1 and Phase 2 Channel Rehabilitation Sites (arranged from upstream to downstream)

Channel Rehabilitation Site Name	Other Names Used	River Mile (RM)	EIS Site Numbers	Sub-Site Names	Sub-River Mile (RM)	Phase #	Date of Construction
	Flat No. 3, LSF			Lower Steiner Flat		Phase 2	2012
Lorenz Gulch[2]	Steiner Flat No. 4, LZG	RM 89.4-90.2	26	NA		Phase 2; Rehab	2013
Dutch Creek	DCK	RM 85.1-86.6	27	NA		Phase 2	est. 2020
Evans Bar	EB	RM 84.4-85.1	28	NA		Phase 2	TBD
Soldier Creek	SCK	RM 83.6-84.2	29	NA		Phase 2	TBD
Chapman Ranch	Upper Chapman Ranch, U-CR	RM 82.9-83.6	30	NA		Phase 2	2019
Deep Gulch	Lower Chapman Ranch, DG	RM 82.9-83.6	31	NA		Phase 2	2017
Sheridan Creek	SHC	RM 81.6-82.4	32	NA		Phase 2	2017
Oregon Gulch	OG	RM 80.9-81.6	33	NA		Phase 2	TBD
Sky Ranch	SR	RM 80.3-80.9	34, 35	NA		Phase 2	TBD
				NA			
Upper Junction City	UJC	RM 79.8-80.4	36, 37	NA		Phase 2	2012
				NA			
Lower Junction City	LJC	RM 79.3-79.8	38	NA		Phase 2	2014
Hocker Flat	HF	RM 78.0-79.1	39	NA		Phase 1	2005
Upper Conner Creek	UCC	RM 79.3-79.8	40	NA		Phase 2	TBD
Conner Creek	CC	RM 77.0-77.4	41	NA		Phase 1	2006
Wheel Gulch	WG	RM 75.8-76.4	42	NA		Phase 2	2011
Valdor Gulch	VAL	RM 74.8-75.7	43	NA		Phase 1	2006
Elkhorn	ELK	RM 73.7-74.25	44	NA		Phase 1	2006
Pear Tree Gulch	PRT	RM 72.9-73.2	0	NA		Phase 1	2006

Source: Gutermuth, pers. comm. 2014b; TRRP (2018)

Key: SC= Side Channel; NA=No additional rehabilitation was performed at this site as it was deemed to be functioning adequately at the time of evaluation

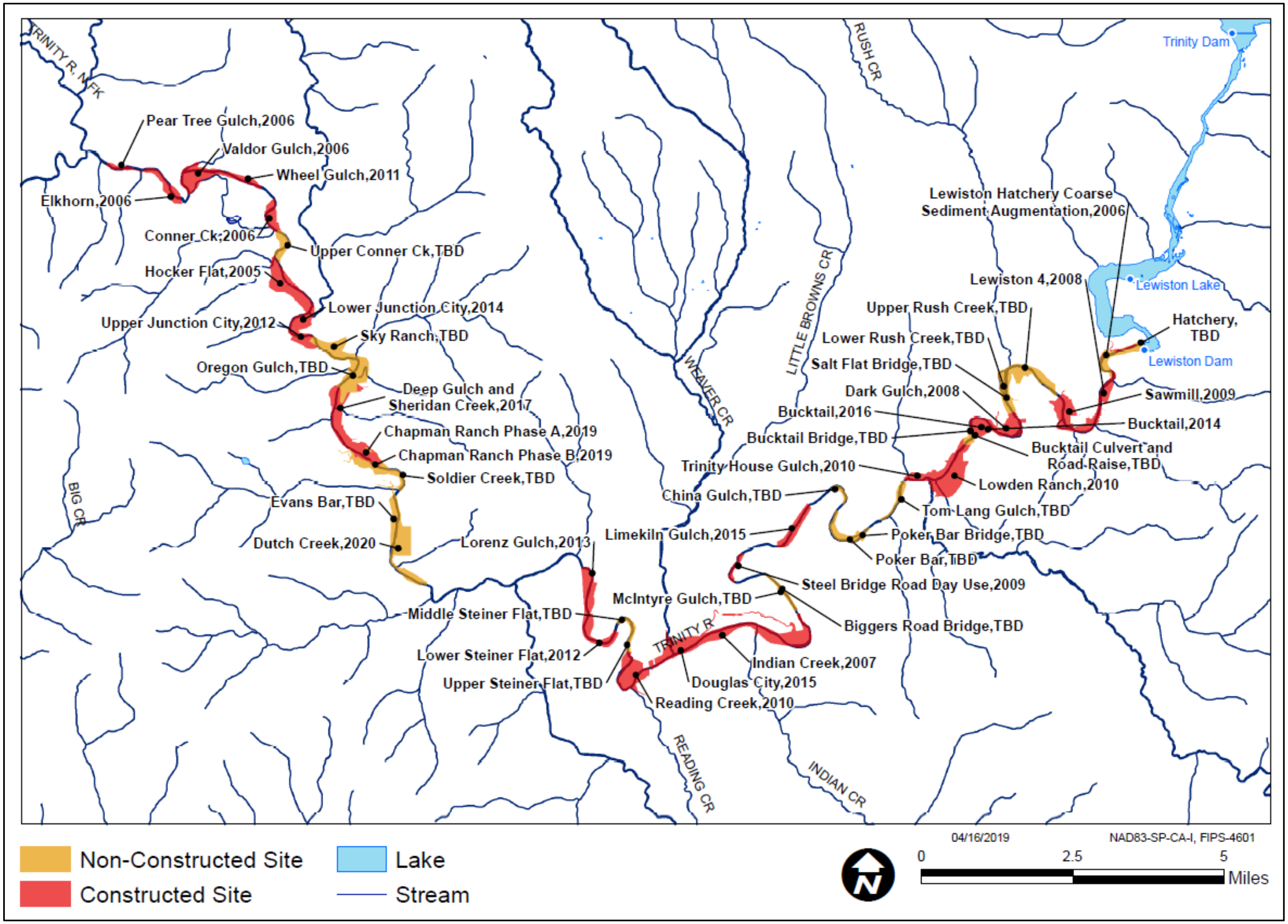

Figure 4. Locations and Distribution of the Trinity River Mainstem Channel Rehabilitation Projects Between Lewiston Dam and the North Fork Trinity River.

The ROD acknowledged that the TRD dams eliminated sediment supplies from upstream sources, which feed alluvial processes that create and maintain aquatic and riparian habitats, and that it would be necessary to augment coarse sediment downstream of Lewiston Dam for the life of the TRD (USDOI 2000). Accordingly, the TRRP incorporates gravel additions into the design of channel rehabilitation projects and conducts stand-alone, coarse sediment augmentation (e.g., gravel injections) during high flow releases in spring at several locations downstream of Lewiston Dam. Permitted sites for gravel injections are currently located near the (non-operational) Trinity River Hatchery (TRH), at Diversion Pool, Cableway, Sawmill, and Lowden reach, which includes sites at the up- and downstream ends of the reach that have been represented as a single site in some documents. In addition to these sites, four other proposed locations are being considered to help restore the coarse sediment transport regime on the Trinity River (Table 2, Figure 5). Additional sites are considered at Bucktail boat launch (RM 105.7), Bucktail bridge (RM 105.4), Steel Bridge Landing (RM 99.0), and Steel Bridge Island (RM 98.8). The Steel Bridge sites are located within the Steel Bridge Road Day Use ESL.

It is now acknowledged that the TRD also stops the routing of wood (e.g., trees and large wood) from upstream through the system. Current research indicates that wood is vital to fisheries rehabilitation and the TRRP uses wood placement (as engineered log jams, habitat structures, individual and group placements, and as debris in structures and soil augmentation.) The TRRP is now developing a large wood management plan that may recommend augmentation of wood for distribution by the river similar to the high flow gravel augmentation program which initiated 2008.

Finally, fine sediment is being considered for addition to the channel at the Hatchery and Diversion Pool locations to remedy the depletion of this sediment size class in the Lewiston Reach. The fine sediments would be augmented by inclusion in coarse sediment mixtures and/or in bulk amounts on their own. Program scientists are currently evaluating fine sediment data in order to quantitatively report existing conditions and to make a defensible fine sediment management recommendation.

Table 2. Current and Proposed Long-Term Coarse Sediment (Gravel) Augmentation Sites

Site Name	Other Names Used	River Mile (RM)	Frequency[a]
Hatchery	"Trinity River Fish Hatchery"	RM 111.8	As needed
Diversion Pool	"Weir Hole," "Sven Olbertson," "Lewiston Upstream"	RM 111.2	1-5 years
Cableway	"Lewiston Downstream"	RM 110.2	As needed
Sawmill		RM 109.0	As needed
Lowden Ranch, Upstream	"Bucktail," "Lowden at Forced Meander Bend"	RM 104.9	1-5 years
Lowden Ranch, Downstream	"Lowden at Grass Valley Creek"	RM 104.4	1-5 years
*Bucktail Boat Launch**		RM 105.7	TBD
*Bucktail Bridge**	Downstream Bucktail Bridge	RM 105.4	TBD
*Steel Bridge Landing**	"Steel Bridge Road Day Use" (Upstream)	RM 99.0	TBD
*Steel Bridge Island**	"Steel Bridge Road Day Use" (Downstream)	RM 98.8	TBD

* Proposed Gravel Augmentation Site

a The annual frequency, amount, and locations of gravel augmentation is currently dependent on hydrology, ongoing monitoring of physical channel conditions, and logistical considerations. The "Frequency - As needed" sites are subject to reassessment due to biological ("Hatchery") and physical ("Sawmill" and Cableway) considerations (see Gaeuman 2014).

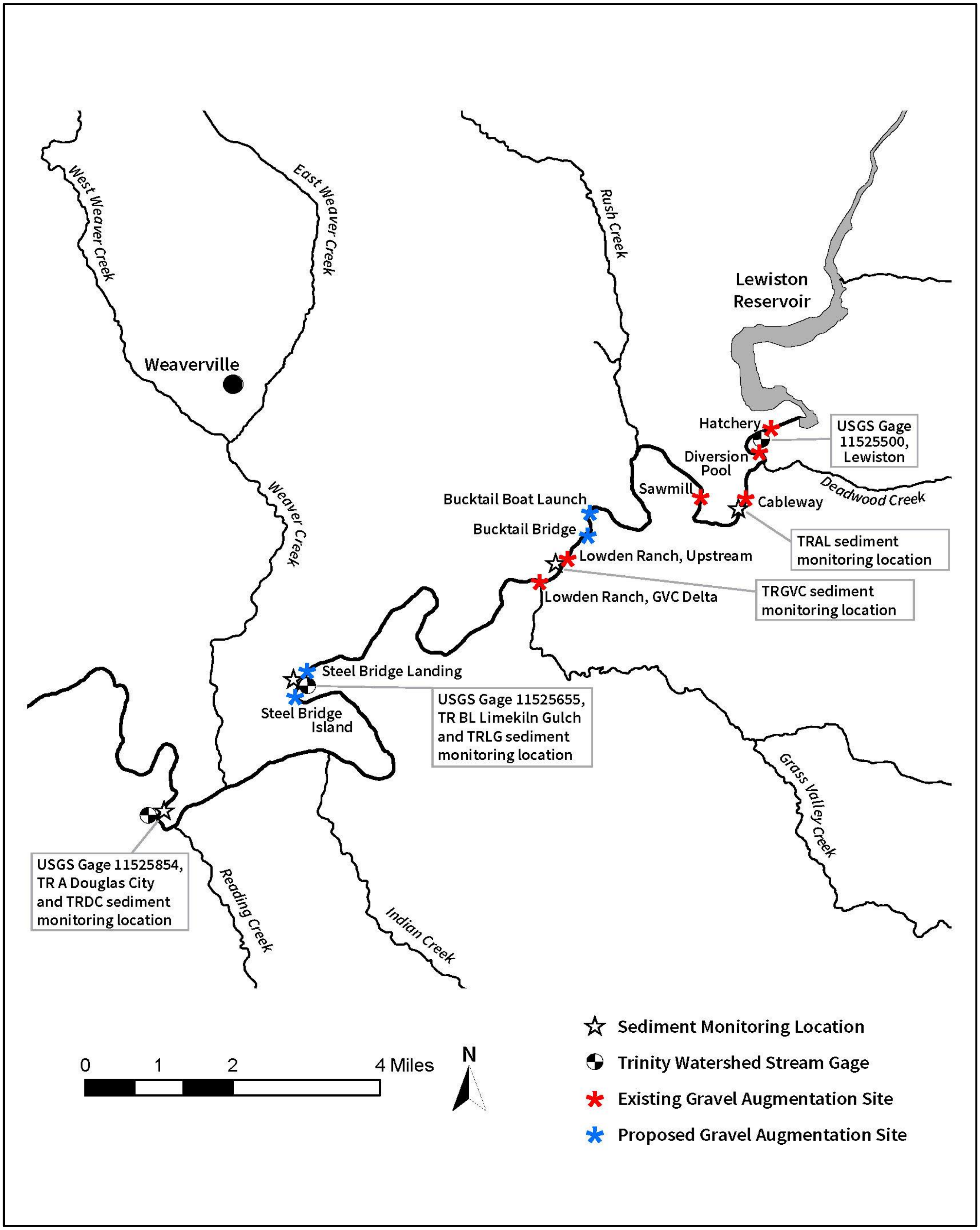

Figure 5. Locations and Distribution of the Trinity River Mainstem Coarse Sediment Spawning Gravel Augmentation Sites (Modified from: Gaeuman 2014).

Additionally, TRRP addresses fine sediment management and watershed restoration through a number of activities, including scheduling flow releases from Lewiston Dam, funding and directing as-needed dredging of the Hamilton Ponds (sediment retention basins), and upslope watershed activities to reduce watershed-generated fine sediment and/or restore fish habitat. As early as 2003, Trinity County managed TRRP funding in a grant program that targeted fish and wildlife improvements in the watershed. Subsequently, the Trinity County Resource Conservation District (TCRCD) assumed management of TRRP funding to achieve watershed objectives that focused on sediment management (Table 3, Figure 6, TRRP 2018).

Similar to the ongoing evolution of channel rehabilitation projects, approaches to coarse and fine sediment management and watershed restoration are continually updated in response to new information and understanding of the sediment transport and geomorphic dynamics of the river and watershed processes within the basin.

Table 3. Trinity River Restoration Program Watershed Restoration Activities

ID	Year Authorized	Restoration Project	Activities
1	2008	Conrad Gulch	Removed 1,883 cy of controllable sediment. Decommissioned 5 stream crossings and 5 swales and removed 2.71 miles of road from the watershed.
2	2008	Lowden Implementation	Implemented small cost-effective road projects in the Lowden Fire area to reduce sediment in the Trinity River
3	2008	Soldier Creek	Implemented road upgrades in the Soldier Creek RAP area to reduce the potential for controllable road-related sediment delivery to Soldier Creek and other named tributaries downstream.
4	2008	Jessup Gulch	Reduced road related sediment delivery to Deadwood Creek and Trinity River by upgrading 0.50 miles of private road adjacent to Jessup Gulch.
5	2008	North Fork	Implemented road upgrades in the area of the North Fork of the Trinity River to reduce the potential for controllable road-related sediment delivery and improved downstream habitat for anadromous fish.
6	2008	BLM/Democrat Gulch	Implemented road upgrades on 1.5 miles of road in the Weaverville Community Forest and Trinity River Watershed to reduce the potential for controllable road-related sediment delivery. Treated sections of Democrat Gulch Road.
7	2008	Little Grass Valley Creek Feasibility/Site Assessment	Assessed and determined the feasibility of upgrading the stream crossing on Little Grass Valley Creek at IOOF Camp opposite State Highway 299W and Trinity Dam Boulevard.
8	2008	SPI Lowden	Revegetated raw bare slide areas and installed check dams on scoured stream channels leftover from the Lowden Fire.
9	2008	Browns Fire Outreach and Inventory	Identified and sent letter to private non-industrial landowners in the Browns Fire area with an explanation of resources issues, as well as a stamped return post card for landowners to request assistance.
10	2008	Junction/Oregon Fire Outreach/Inventory	Identified and sent letter to private non-industrial landowners in the Junction City /Oregon Fire area with an explanation of resources issues, as well as a stamped return post card for landowners to request assistance.
11	2009	Grass Valley and Indian Creek Road Upgrade	Reduced sediment delivery to Trinity River from roads in Grass Valley Creek and Indian Creek Watersheds
12	2009	Democrat Gulch Phase II Road Storm proofing	Treated additional sections of Democrat Gulch Road.
13	2009	Junction City 2008 Fire Rehabilitation	Implemented sediment reduction measures such as Revegetation, mulching, rocking, and installation of culverts within the areas burned by the 2008 Junction City Fire.
14	2009	Dark Gulch Sediment Basin, Sediment Removal	Excavated and enlarged the sediment detention basin near the confluence of Dark Gulch and the Trinity River.
15	2009	China Gulch-Dutch Creek Sediment Reduction	Treated erosion sites within a 1-mile stretch of China Gulch Road (install culvert and dip). Filled failures on Dutch Creek Road (upgrade existing culverts, and installed additional culverts to dewater ditch segments at the base of active slides)

Table 3. Trinity River Restoration Program Watershed Restoration Activities

ID	Year Authorized	Restoration Project	Activities
16	2010	Coffin Fire Road Rehabilitation	Treated roads in Snipe Gulch near Lewiston that were impacted by the 2009 Coffin Fire.
17	2010	Phillips Gulch-Dutch Creek Sediment Retention	Treated roads on BLM land in the Grass Valley Creek watershed near Fawn Lodge that were impacted by the 2009 Coffin Fire.
18	2010	Bierce Creek Road Rehabilitation	Reduced sediment production from a 2.5-mile portion of road in the watershed.
19	2010	Soldier Creek Main Haul Road Sediment Reduction	Stabilized the surface of approximately the first mile of the main haul road into the Soldier Creek watershed.
20	2010	Indian Creek Rehabilitation and Sediment Control, Phase 1	Developed conceptual design to sequester fine sediments and improve habitat along a reach of Indian Creek on BLM land between Frietas Gulch and Mule Gulch.
21	2010	Lower Sidney Gulch Rehabilitation and Sediment Control, Phase 1	Developed conceptual design to sequester fine sediments and improve habitat along a reach of Sidney Gulch through Lee Fong Park in Weaverville.
22	2011	Middle Trinity Road Decommissioning and Road Upgrade	Treated roads on Forest Service, BLM, and private lands in multiple watersheds in the Middle Trinity River area, including Conner Creek, Weaver Creek, Hobo Gulch, and Brock Gulch.
23	2011	Union Hill Road Improvement	Installed rolling dips and rock on Union Hill Road near the Trinity River-Weaver Creek divide.
24	2011	Indian Creek, Phase 2	Sediment reduction- implemented cost effective sediment reduction treatments at County road-related sediment sources on Indian Creek Road.
25	2011	Conner Creek Migration Barrier	Removed a potential sediment source and restore fish access to 2.5 miles of salmonid spawning and rearing habitat by retrofitting two crossings that are currently migration barriers.
26	2011	West Weaver Creek Rapid Assessment	Identified and prioritized critical sediment sources and control options for future implementation in the West Weaver Creek watershed.
27	2011	Browns Creek Road Sediment Assessment	Sediment reduction-implemented road sediment reduction on private roads in the Browns Creek Watershed.
28	2012	Sidney Gulch Forest Service Compound Site Feasibility Study	Conducted Fish passage, riparian, and wildlife habitat feasibility study.
29	2012	Conner Creek Mouth Fish Passage Enhancement Feasibility Study	Conducted Fish passage and wildlife habitat feasibility study to improve migration into the mouth and the first 0.5 miles of Conner Creek.
30	2012	LiDAR Data Acquisition	Obtained LIDAR imaging from several Trinity River tributaries to be used for habitat enhancement and sediment maintenance analyses.
31	2012	Lower East Weaver Creek Habitat and Infrastructure Project	Sediment reduction- installed habitat elements (large wood and grade structures) in East Weaver Creek.
32	2012	BLM Roads Mainstem Sediment Reduction Project	Implemented Sediment reduction of controllable road related sediment.
34	2013	Grass Valley Creek Road Upgrade	Implemented Sediment reduction of controllable road related sediment.

Table 3. Trinity River Restoration Program Watershed Restoration Activities

ID	Year Authorized	Restoration Project	Activities
41	2013	Browns Creek Road Sediment Implementation Project	Implemented Sediment reduction of controllable road related sediment.
42	2013	Schofield Gulch Sediment Reduction Project	Implemented Sediment reduction- reduced controllable road related sediment. Realigned stream crossings and restore stream banks to reduce ~3,000 cy of sediment delivery to East Weaver Creek.
43	2013	Agricultural Practices on Sediment and Nutrient Deliveries in Watersheds	Reduced sediment and nutrient impacts from agricultural processes.
45	2013	Forest Service Road Maintenance	Reduced sediment reduction of controllable road related sediment.
46	2014	Sidney Gulch Fish Passage Improvement Project	Implemented Fish passage-culvert replacement on Weaver Bally Loop Road and restored access to 1.2 miles of seasonal stream habitat for adult and juvenile steelhead and potentially Coho salmon.
49	2014	Browns Creek Road Sediment Implementation Projects (Phase 2)	Implemented Sediment reduction- utilized previously assembled road sediment inventory data to develop, rank, and implement projects that will reduce road-related sediment input to Browns Creek. Implemented road upgrade (storm proofing) projects on up to 50 sites in the Browns Creek Watershed that had been previously identified as major sources of sediment. Projects included rolling dips, culverts, hardening road surfaces, and more.
50	2014	West Weaver Creek-Channel and Floodplain Rehabilitation Implementation	Implemented a comprehensive channel and floodplain rehabilitation project in a severely degraded reach of West Weaver Creek, downstream of Hwy 299.
51	2014	East Weaver Creek Dam Removal Project-Feasibility	Implemented fish passage project-developed a feasibility study to remove a 20' tall dam on East Weaver Creek, installed a new intake and pipeline to open 2.5 miles of Coho habitat in the Trinity Alps Wilderness while maintaining reliable drinking water to Weaverville, Trinity County.
52	2015	Conner Creek Fish Passage Enhancement	Restored fish migration in the lower portion of Conner Creek-via a lengthened step-pool channel design or fish ladder.
53	2015	Grass Valley Creek-Anadromous Pacific Lamprey-Sediment and Connectivity	Sediment management and fish passage-Provided habitat for lamprey ammocoetes in Hamilton Ponds (ca. 4 acres). Assessed Pacific Lamprey passage potential of Buckhorn Debris dam potentially opening 5+ miles of spawning/rearing habitat. Determined distribution of anadromous Pacific Lamprey in Grass Valley and Little Grass Valley creeks.
54	2015	Oregon Street Sediment Reduction Implementation	Implemented sediment reduction of controllable road related sediment.
55	2015	Trinity River Watershed Road Upgrade and Decommission	Reduced controllable road-related sediment delivery to mainstem Trinity River from several tributaries (Little Browns and W. Weaver creeks, and Phillips Gulch) through road upgrade or decommission and create and/or improve Steelhead, Coho and Chinook salmon rearing habitat.

Table 3. Trinity River Restoration Program Watershed Restoration Activities

ID	Year Authorized	Restoration Project	Activities
56	2015	Valdor Upper and Lower Roads Sediment Reduction	Implemented sediment reduction of controllable road related sediment. Reduced approximately 1,160 cy of potential fine sediment to tributaries to the Trinity River and/or Canyon Creek.
57	2015	Weaver Creek Private Roads Sediment Assessment	Inventoried private roads within the Weaver Creek watershed to locate and assess problematic sediment sources to Weaver Creek.
58	2016	Oregon Street Sediment Reduction Implementation	Implemented sediment reduction of controllable road related sediment.
59	2016	Salt Creek Confluence: Millsite Channel Restoration	Improved/restored floodplain function and channel aggrading process by removing man made berms and levees, placing this material in the channel and floodplain, building rock/weir structures, alcoves for salmonid rearing, and improving stormwater treatment on-site.
60	2016	Sidney Gulch Forest Service Compound Fish Passage Improvement-Full design	Restored 0.31 miles of channelized stream for salmon migration with increased habitat complexity (LWD, pool-riffle complexes), enhanced 1.5 acres of riparian vegetation. Overall, project restored access to 1.8 miles habitat.
61	2016	South Fork Trinity River (SFTR)-Instream Salmon Habitat Enhancement Project-2018	Improved instream habitat for Coho and Chinook Salmon by strategically placing whole trees along a 5.2-mile stretch of the SF Trinity River using a helicopter and mobile ground-based methods.
62	2016	Valdor Road Sediment Reduction	Implemented sediment reduction of controllable road related sediment.
63	2017	East Weaver Creek Dam Removal Project	Removed a 20’ tall dam on East Weaver Creek and installed a new intake and pipeline to open 2.5 miles of Coho habitat in the Trinity Alps Wilderness while maintaining reliable drinking water to Weaverville, Trinity County.
64	2017	Grass Valley and Indian Creek Road Improvement Project	Reduced fine sediment delivery (estimated 7,200 cu. yds., 20 miles of road treated or decommissioned) to the Trinity River from Grass Valley and Indian Creek watersheds.
65	2017	Indian Creek Habitat Connectivity Project	Restored aquatic connectivity on a section of Indian Creek in which waters flow subsurface during the critical migration period for Coho and Chinook Salmon by raising the ground water table in this section of the stream.
66	2017	Lower Sidney Gulch Urban Stream Restoration Phase 2	Created complex instream habitat via greater meander, side channel habitat, and large wood placement. Increased flood conveyance, riparian conditions, remove invasives, and remove fine sediment.
67	2017	Manzanita Creek Fish Migration Barrier Removal	Project removed a small dam on Manzanita Creek that was an anadromous fish migration barrier, restoring 1.15 miles of spawning, rearing, and overwintering habitat
68	2017	Salt Creek Stream Crossing Upgrade Project	Reduced controllable upslope fine sediment contributions (estimated 3,000 cu. yds.) to Salt Creek, and South Fork Trinity River, through upgrading two failing stream crossings (chronic erosion of fill and fine sediment delivery). Approximately 0.3 miles of road was treated or decommissioned, 4 LWD added, and created about 2,000 linear feet of pools and sediment storage opportunities.

Table 3. Trinity River Restoration Program Watershed Restoration Activities

ID	Year Authorized	Restoration Project	Activities
69	2017	South Fork Trinity River Road Assessment and Improvement Project	Conducted assessment of ten roads in the SF Trinity River watershed.
70	2017	Forest Service Road Improvements	Implemented sediment reduction of controllable road related sediment.
71	2017	West Weaver Creek Vegetation Resiliency	Revegetated areas associated with the West Weaver Creek habitat rehabilitation project.
72	2018	Browns Creek Water Resiliency Project	Improved fish habitat connectivity throughout the Browns Creek watershed by reducing water withdrawals during low-flow conditions.
73	2018	East Weaver Creek Dam Removal Project	Removed a 20' tall dam on East Weaver Creek and installed a new intake and pipeline to open 2.5 miles of Coho habitat in the Trinity Alps Wilderness while maintaining reliable drinking water to Weaverville, Trinity County.
74	2018	McKnight Ditch Water Conservation	Modified the McKnight ditch diversion to increase downstream flows to East Weaver Creek.
75	2018	Sidney Gulch Riparian Habitat Improvement	Implemented riparian planting in areas associated with Sidney Gulch habitat improvement project
76	2018	South Fork Trinity River Road Upgrade and Maintenance Phase I	Researched previous SF Trinity River assessments which identified the inner gorge region of the South Fork as prone to mass wasting and bank erosion events. Five roads highly susceptible to failure underwent maintenance and improvements to reduce fine sediment associated with poor road drainage.
77	2018	Grass Valley Creek Flows	Increased flows from Buckhorn Dam to Grass Valley Creek to maintain the dam outlet and cue juvenile salmonids to begin their downstream migration. Gravel was also added below Buckhorn Dam to replace sediment retained behind the dam.
78	2019	Oregon Gulch Culvert Replacement	Replaced existing culvert to restore fish passage at all flows at Oregon Gulch under Sky Ranch Road.

Source: Brandt Gutermuth, Personal Communication (2014, 2019) and TRRP (2019) Program

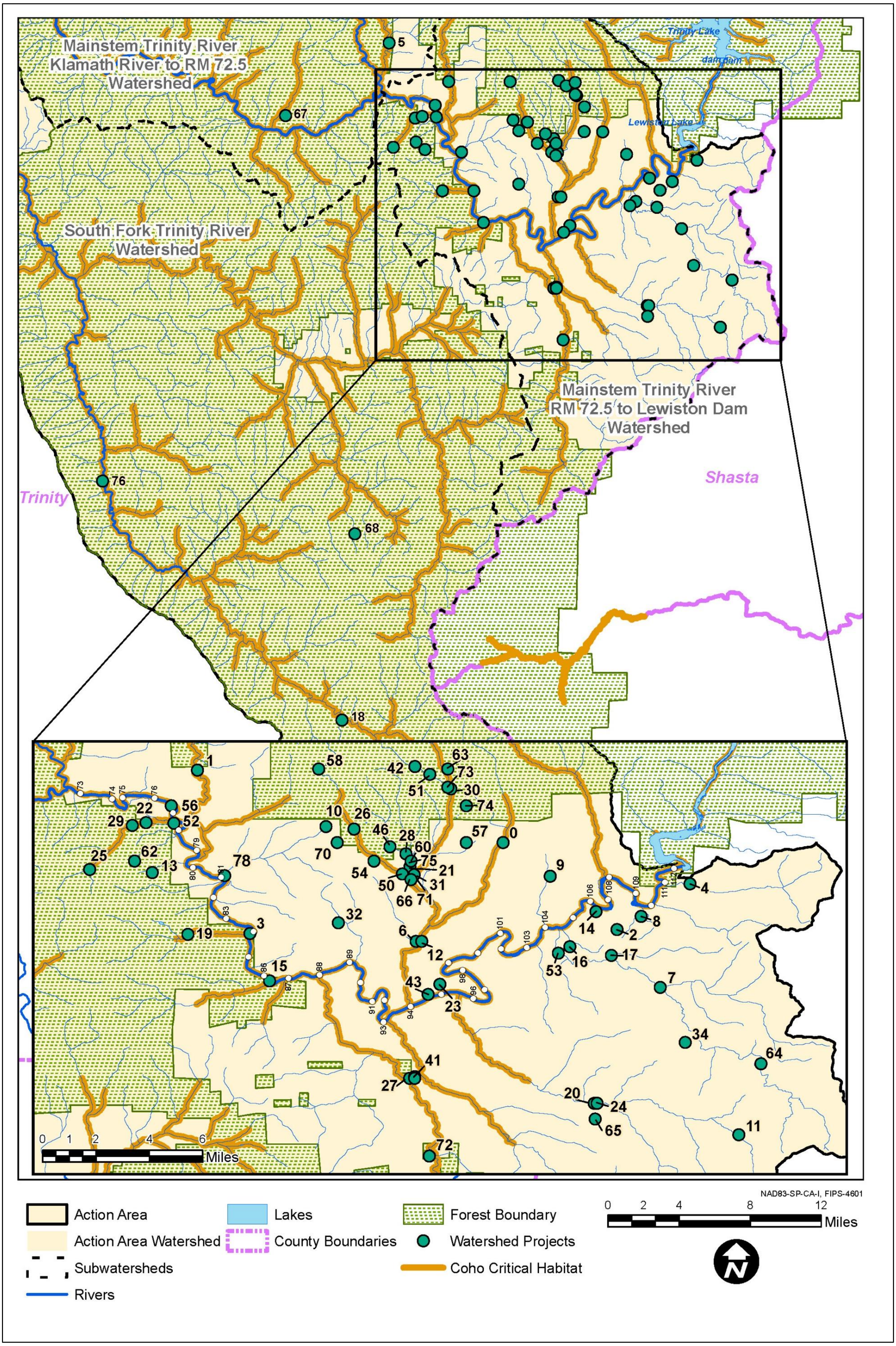

Figure 6. Locations of Fine Sediment Reduction and Watershed Restoration Projects Conducted by Trinity River Restoration Program.

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The progress of the TRRP in meeting the goals of the ROD is summarized in Table 4 as key achievements for the primary program elements (USDOI 2000), along with a brief statement of evolving approaches informed by past experience.

Table 4. Brief History of Trinity River Restoration Program Components

Variable Annual Instream Flow		
	Year	**Description**
Milestones and Achievements	2001 - 2004	Restoration water allocations limited by court order; peak releases ranged 1,760 – 6,200 cfs.
	2004	9th circuit court upheld implementation of full ROD flows. All aspects of the 2000 ROD mandated for implementation beginning in 2005.
	2005	Peak flow releases[1] from Trinity Dam reached 7,640 cfs.
	2006	Peak flow releases from Trinity Dam reached 10,400 cfs.
	2007	Peak flow releases from Trinity Dam reached 4,810 cfs.
	2008	Peak flow releases from Trinity Dam reached 6,890 cfs.
	2009	Peak flow releases from Trinity Dam reached 4,630 cfs.
	2010	Peak flow releases from Trinity Dam reached 7,840 cfs.
	2011	Peak flow releases from Trinity Dam reached 12,300 cfs, the largest in 37 years and the largest prescribed by the ROD for fishery restoration purposes.
	2012	Peak flow releases from Trinity Dam reached 6,180 cfs.
	2013	Peak flow releases from Trinity Dam reached 4,590 cfs. First flow schedule with significant modifications to support year-specific outmigration conditions.
	2014	Peak flow releases from Trinity Dam reached 3,460 cfs.
	2015	Peak flow releases from Trinity Dam reached 8,830 cfs. First flow schedule to include a geomorphically active peak with a dry year volume.
	2016	Peak flow releases from Trinity Dam reached 9,600 cfs. First multiple-peak flow schedule.
	2017	Peak flow releases from Trinity Dam reached 12,000 cfs.
	2018	Peak flow releases from Trinity reached 2,040 cfs. Year was critically dry.
	1. Peak flow numbers as measures by USGS at the Lewiston stream gauge.	
Challenges	2001	Lawsuit requires preparation of a SEIS to analyze additional impacts from 2000 ROD implementation.
	2002	Lawsuit against Department of the Interior regarding compliance with NEPA.
	2003	Appeal to court’s ruling from 2002 Lawsuit.
Evolving Changes	Modification of the 2000 ROD spring hydrographs is ongoing through annual monitoring and evaluation of responses in habitat distribution, fish use, and geomorphic processes. Experimental use of periodic elevated summer flows to	

Table 4. Brief History of Trinity River Restoration Program Components

	prevent fish die-off in lower Klamath River, that began in 2003, added to Trinity River operational releases by a 2017 Reclamation ROD. Trinity River fish appear to be outmigrating earlier than during the TRMFR. TO support outmigrants and synchronize with tributary flows, TRRP releases should be moved earlier in the season. The need for variable flows all winter (as in an unregulated river) is needed to assist in floodplain inundation to support riparian vegetation and increase productivity (e.g., invertebrates) that might be harvested by juvenile salmon.	
Physical Channel Rehabilitation		
	Year	**Description**
Milestones and Achievements	2005	Hocker Flat rehabilitation site completed.
	2006	2006 amendment to the 2000 BiOp allowed in channel work
	2006	Canyon Creek Suite (4 sites) of rehabilitation sites completed. First use of wood to promote geomorphic change.
	2007	Indian Creek (including Vitzthum Gulch) rehabilitation site completed.
	2008	Dark Gulch (including early design at Bucktail) and "The Lewiston 4" rehabilitation sites completed.
	2009	Master EIR and EA/EIR from Remaining Phase One sites was completed
	2009	Sawmill rehabilitation site completed. First use of a constructed log jam.
	2010	Reading Creek, Lowden Ranch, Trinity House Gulch rehabilitation sites constructed. Lowden Ranch included the first channel meander that moved the entire bed of the river, first use of channel widening specifically to promote deposition of a mid-channel bar, first use of multiple log jams, and the test of an 'anastomosing channel' feature.
	2011	Channel Design Guidelines completed.
	2011	Wheel Gulch rehabilitation site completed. First use of combined channel widening and a log jam to promote mid-channel gravel deposition.
	2012	Lower Steiner Flat and Upper Junction City rehabilitation sites constructed. First use of a feature specifically designed for hyporheic flow.
	2013	Douglas City (Lower Portion) and Lorenz Gulch rehabilitation sites completed.
	2014	Lower Junction City rehabilitation site completed.
	2015	Douglas City (Upper Portion) rehabilitation project, which was a remodeling of the lower portions of original Indian Creek channel rehabilitation project completed in 2007. Remodeling brought state-of-the-art side-channel design to channels built under early design concepts.
	2015	Limekiln Gulch rehabilitation site constructed.
	2016	Bucktail rehabilitation site upgraded and completed. Upgrades (to Dark Gulch) included modernized design for channel meander and expanding a wetland with side channel connections. First use of a Beaver Dam Analog (BDA).
	2017	Deep Gulch and Sheridan Creek rehabilitation site. First specifically designed floodplain that backwaters from

Table 4. Brief History of Trinity River Restoration Program Components

		downstream. First use of a constructed log jam designed to direct hyporheic flow to wetlands.
	2018	Dutch Creek geologic exploration. Test pits on Forest Service and BLM managed lands evaluate underlying substrate in future project site.
Challenges	Early designs for floodplain lowering were found to be insufficiently low to provide juvenile salmonid habitat except at the highest flows. Channel generally did not respond geomorphically to restoration flows. Early estimates of rehabilitation costs were not aware of the need to lower floodplains to appropriate levels, therefore rehabilitation costs exceeded initial estimates. Those early floodplain designs also limited revegetation due to difficulties for plant roots to reach sufficient water. Revegetation efforts required increased duration and frequency of inundation as well as augmentation of mined substrate. Early designs for side channels entrances tended to become disconnected at low flows due to deposition (though these were still functional at higher flows). This led to greater evaluation of hydrologic site conditions for placement of side channels and for creating stabile inflow conditions into side channels. Some early constructed point-bars were more mobile than designers intended, which contributed mobile sediment to the channel (a positive) but allowed the river to return to a previously entrenched channel location. Both within the TRRP and in the general river restoration field, an increasing understanding of the value of large wood both for fish habitat and for geomorphic change has led to increasing use of wood in TRRP channel rehabilitation. However, public perception of the values of wood has been more limited and has resulted in public outreach challenges. Some suggested locations mapped during the TRFES in the 1990s may no longer be optimal locations for channel rehabilitation (USFWS and HVT 1999). TRRP understanding of existing conditions has increased over 1990's knowledge, better directing attention on needs to more effective locations; increased knowledge of juvenile salmonid habitat distribution has further redirected attention to maximize effectiveness; and restoration flows have hydrologically induced improvements at some of the sites identified in the 1990s. Many remaining phase 2 rehabilitation sites are among the areas in greatest need of extensive floodplain lowering. While the potential for habitat is great, rehabilitation costs continue to increase. 2016 FEMA: New Floodplain Insurance Rate Maps adopted in July 2016. New Maps require increased regulatory oversite of projects and increased collaboration with Trinity County, the floodplain administrator. Some remaining rehabilitation sites are dominated by private landowners that are not likely to support the changes to their property that channel rehabilitation requires.	
Evolving Changes	Substantial increase in the number of side channels.	

Table 4. Brief History of Trinity River Restoration Program Components

	Inclusion of large wood on the mainstem, in alcoves, in side-channels, on floodplains, and also as soil augmentation to provide nutrients and water for vegetation. Encouragement of lateral channel migration by excavation of dredge tailings and/or terraces. Incorporation of macro-topography and micro-topography into newly created floodplains, including high flow scour channels, lower benches for fish habitat and natural riparian regeneration, as well as constructed terraces for spoil materials. Ever increasing allowance for in channel work. Expansion of seasonal in-river work windows. National Large Wood Manual providing guidance to federal agencies for management of large wood in river ecosystems completed in 2016. Unexpected site evolution (e.g., closure of a side channel inflow, or loss of a wood jam, etc.) suggest that maintenance visits to rehabilitation sites should be a management consideration. Enhancement during site revisits could be more cost effective in habitat/dollar than during new site construction.	
Sediment Management		
	Year	**Description**
Milestones and Achievements	2003	About 3,000 tons of coarse sediment was placed in the Cableway reach of the Trinity River.
	2006	2006 amendment to the 2000 BiOp allowed in channel work.
	2006	About 2,500 tons of coarse sediment was placed at the Lewiston Fish Hatchery
	2007	About 6,500 tons of coarse sediment was placed at the Lewiston Fish hatchery, completing the project.
	2008	About 16,500 tons of coarse sediment was placed in the Trinity River in the form of constructed bars during channel rehabilitation and as high-flow coarse sediment injections. This was the first time TRRP uses placement of gravel during high flows.
	2009	More than 12,000 tons of coarse sediment was placed in the Trinity River, including high-flow coarse sediment injections totaling 3,500 tons at two locations in the Lewiston area.
	2012	Gravel Augmentation Technical Report (2012 Sediment Budget Update) was released.
	2010 – 2019	Annual spring gravel placement (total quantity varies per year and is based on observed recruitment during high flow releases). Methods of gravel addition included high flow augmentation or recruitment from the floodplain. No additions in Critically Dry years (e.g., 2018).
Challenges	Estimates of sediment transport during the flow study were based on very limited data; subsequent sediment monitoring determined lower transport rates during TRRP restoration flows than expected based on the TRMFR anticipated. Transport rates have been demonstrated to be greatest during earlier spans of multi-day restoration flow peaks. Sediment movement patterns and distances are refined with new data. This requires continued adaptive management monitoring and scientific research.	

Table 4. Brief History of Trinity River Restoration Program Components

Evolving Changes	Allowance for in channel work. Expansion of seasonal work windows. Revised augmentation estimates to match sediment transport rates observed during continued adaptive management monitoring. Restoration flow hydrograph design now incorporates higher, shorter, and more numerous peaks in part to increase sediment transport, however the effectiveness of these changes is still being evaluated. Optimal augmentation methods appear to vary depending on site conditions and augmentation history.	
Watershed Restoration Efforts		
	Year	**Description**
Milestones and Achievements	2008	Completion of 8 sediment source control projects and 2 inventory projects.
	2009	Completion of 5 sediment source control projects.
	2010	Completion of 6 sediment source control projects.
	2011	Completion of 4 sediment source control projects, 1 fish passage improvement project, and 1 inventory project.
	2012	Completion of 2 sediment source control projects, 2 fish passage and wildlife feasibility studies, and 1 data acquisition.
	2013	Completion of 5 sediment source control projects.
	2014	Funding for 1 channel and floodplain rehabilitation project, 1 sediment source control project, 1 watershed sediment assessment project, 1 fish passage project, and 1 fish passage feasibility project
	2015	Funding for 1 fish passage project, 3 road related sediment reduction projects, 1 sediment and connectivity improvement project, 1 watershed sediment assessment (road inventory)
	2016	Funding for 1 channel restoration project, 1 LWD placement project, design of 1 fish passage/channel rehabilitation project, 2 road related sediment reduction projects
	2017	Funding for 1 fish passage/dam removal project, 1 road related sediment reduction project, 1 habitat connectivity (restoration of low flow) project
	2018	Funding for 1 fish passage/dam removal project, 1 diversion modification to increase flows, 1 road related sediment reduction project, 1 riparian improvement project, 1 flow improvement project.
Challenges	Identifying and prioritizing efforts with greatest benefit to Trinity River fisheries and ecosystem function.	
Evolving Changes	TRRP Watershed Work Group releases causal linkages to watershed restoration white paper in July 2015 outlining both fine sediment reduction and fish habitat connectivity improvements as priorities for watershed restoration to fulfill fundamental goals of the TRRP.	
Infrastructure Improvements or Modifications		
	Year	**Description**
Milestones and Achievements	2003	EA and FONSI for construction of 3 bridges and one culvert completed.

Table 4. Brief History of Trinity River Restoration Program Components

	2004	Extensive landowner negotiations and realty actions resulted in construction easements at three bridge locations and the culvert replacement.
	2005	Three new bridges and one culvert replacement were completed.
	2006	Floodplain infrastructure modifications were largely completed and allowed peak releases of at least 8,500 cfs in the event of a wet year.
	2007	All remaining floodplain infrastructure modifications were completed to allow future peak releases up to 11,000 cfs in the event of an extremely wet water year. This included construction of four new bridges, multiple road raises, the removal of one residential structure, relocation or replacement of decks, pump houses, ancillary structures, junction/control boxes and other minor infrastructure.
	2009	Well Grant program completed.
Challenges	Effective identification and integration of infrastructure improvements with TRRP program goals. One house in Junction City remains within maximum restoration flow releases (if conducted simultaneous to a major storm event).	
Evolving Changes	Bucktail bridge design evolved from replacement of culvert to replacement of entire bridge structure. Current bridge and culvert limit sediment transport objectives. Junction City house is currently expected to be elevated on-site to avoid maximum restoration flow releases.	
AEAM Process		
	Year	**Description**
Milestones and Achievements	2000	Formation of the TMC.
	2005	First SAB members appointed.
	2007	The first TRRP Science Symposium was held in January 2007. The purpose of the Symposium was to share information, research findings, and accomplishments, and to facilitate cross-disciplinary dialog. The Symposium process also aided in the development of three tasks: 1) the Integrated Assessment Plan (IAP), 2) FY2008 budgeting, and 3) WY2007 flow scheduling.
	2008	Juvenile Outmigrant Monitoring Evaluation completed (Schwarz et al. 2009). Report proposed new statistical methods to better evaluate rotary screw trap data.
	2009	Integrated Assessment Plan (IAP) completed; Conceptual Models and Hypotheses report completed.
	2010	Formation of multi-disciplinary TRRP workgroups.
	2010	The second TRRP Science Symposium held in January 2010. 27 oral presentations and about two dozen poster presentations covering a wide range of fishery restoration topics were heard by more than 100 registered attendees, including program partners, stakeholders, and the public. The purpose of the symposium was to share information, research findings, accomplishments, and to facilitate cross-disciplinary dialog.

Table 4. Brief History of Trinity River Restoration Program Components

	2010	TRRP Science Retreat set the path toward a science workplan proposal system with peer review.
	2012	Data Management and Utility Plan released.
	2013	The third TRRP Science Symposium was held in January 2013. The event was a forum for strategic planning for the Trinity River based on the outcomes of the Phase I Review and other timely results from 2012 studies. The symposium served as a foundation for improving the quality of future management decisions based on up-to-date scientific findings.
	2013	TRRP Objectives Workshop in May 2013 established agreement on two fundamental objectives: (1) restore and sustain natural production of anadromous fish populations downstream of Lewiston dam to pre-dam levels; and (2) restore the processes and attributes of a healthy alluvial river system.
	2014	Review of the TRRP Program Following Phase 1 completed, with emphasis on the Program's Channel Rehabilitation strategy. Prepared by the SAB.
	2016	Fourth TRRP Science Symposium held March 2016 with a focus on Decision Support Systems (DSS). This symposium included a workshop format to improve understanding of DSS concepts across TMC member agencies. Modeling results were presented to support TMC decision-making on the 2016 restoration flow hydrograph.
	2018	River Corridor Management Strategy completed, providing an updated perspective on restoration with a broader perspective than individual channel rehabilitation sites.
	2018	Guidance for Objectives refinement provided to TRRP Interdisciplinary Team and Work Groups to set fundamental and mean objectives, and measurable targets related to mean objectives (Mike Dixon, 2018 memorandum to TRRP Interdisciplinary Team and Technical Work Groups on Guidance for Objectives and Refinements Exercise)
Challenges	Achieving consensus among TRRP program Prioritization of science needs by teams that will receive funding Prioritization of TRRP rehabilitation projects and funding Lack of unified agreement among partners on a TRRP goal statement. Selecting, from a wide range of possible proposals, a set of prioritized core assessments that the TRRP will conduct to measure TRRP progress and to adaptively manage TRRP success Partner agreement on how to apply monitoring and modeling to decision-making through a Decision Support System (DSS)	
Evolving Changes	Need for predictive modeling to supplement monitoring. Revisions to means objectives and targets, for achieving fundamental objectives. Methods for formalizing DSS.	

Updated Guidance on Mechanical Channel Rehabilitation and Gravel Augmentation

Channel Rehabilitation Design Guidelines

The *Channel Rehabilitation Design Guidelines for the mainstem Trinity River* (Channel Design Guide), (HVT et al. 2011), summarizes how the approach and designs for channel rehabilitation have evolved from the Trinity River Maintenance Flow Study (TRMFS [McBain and Trush 1997]), TRFEFR (USFWS and HVT 1999), and ROD (USDOI 2000). Refinements based on what has been learned since inception of the TRRP are included in the Channel Design Guide. It is intended to be used by the TRRP Program as a working design manual for channel rehabilitation project activities. The TRMFRP EIS/EIR and ROD provided a programmatic description of implementation of the TRRP, leaving technical specifications, such as channel dimensions and other design criteria for channel rehabilitation activities, to later project planning phases. New information and approaches have been developed through experience gained from the Phase 1 channel rehabilitation projects to better enable attainment of ROD goals.

The Channel Rehabilitation Design Guide used a combination (and comparison) of observations and reference reach data derived from Trinity River-specific field data to develop guidelines for design dimensions, methods, and features at both the reach and site scale, recommending:

- Substantial increases in the number of side channels incorporated in designs.
- Inclusion of large wood features on the mainstem, in alcoves, side channels, and on floodplains.
- Encouragement of lateral channel migration by excavation of dredge tailings and/or terraces on the outsides of meander bends.
- Relocation of the mainstem channel into a more sinuous pattern through construction of mid-channel islands and/or half-wavelength bends excavated through dredge tailings and/or terraces.
- Incorporation of macro-topography and micro-topography into newly created floodplains, including high flow scour channels, lower benches for fish habitat and natural riparian regeneration, as well as constructed terraces for spoil materials.

Phase 1 rehabilitation designs, beginning in 2005, used simple features and were primarily located in the lower portion of the channel rehabilitation reach. Rehabilitation activities for these sites consisted of extensive vegetation removal and floodplain re-contouring, with little structural complexity built into the floodplain. After monitoring and assessment indicated that few fish used these sites (Goodman et al. 2012), designs for the remaining Phase 1 rehabilitation sites included additional physical channel features that would provide more habitat complexity and cover.

Phase 2 rehabilitation designs encourage lateral channel migration by excavating dredge tailings or terraces on the outside of meander bends and reconfigure the mainstem channel into a more sinuous pattern through the construction of mid-channel islands. Phase 2 designs include side channels, alcoves, and large wood placement to create immediate juvenile salmonid rearing habitat at rehabilitation sites. Banks and floodplains now contain more roughness, patchiness (including riparian vegetation), and topographic diversity to encourage local hydraulic interaction, scour, and deposition. Some of this is accomplished as part of the site design, by leaving patches of mature riparian vegetation and the use of variable flood plain elevations, and some by directing work in the field during construction.

The scale for Phase 2 channel rehabilitation project designs has expanded in both size and complexity, where site conditions and opportunities are favorable. Rehabilitation designs also take advantage of proximity to bedrock by incorporating design features that direct flow into bedrock outcrops to increase channel complexity and local bed scour, both of which restore fluvial processes. Additionally, wood placement has been added to designs to impede channel migration, promote local scour, and provide habitat for salmonids.

Large Wood Management Plan

The TRMFRP EIS/EIR and ROD did not mention wood placement as part of the original channel rehabilitation strategy. Wood placement and the increase in creation of side channels, have been the most substantial changes to the original rehabilitation design strategy. TRRP’s wood strategy includes wood placement (single or multiple pieces of wood placed in the floodplain) as well as construction of large wood habitat structures and larger engineered log jams (ELJ), collectively referred to as structured log jams (SLJ).

Due to the significant ecological role of wood in river systems, the TRRP now routinely uses wood in its channel rehabilitation. An inventory and analysis of large wood along the mainstem Trinity River from the Lewiston Dam to the confluence with the North Fork Trinity River, along with recommendations for incorporating large wood at channel rehabilitation sites, was completed in 2011. The recommended number of large wood pieces (average size is 30 cm by 5 m in length) per river kilometer was between 500-600 pieces (CardnoEntrix and CH2M Hill 2011). This Trinity River specific analysis, along with a recent assessment, planning and design guidelines manual entitled, *National Large Wood Manual, Assessment, Planning, Design, and Maintenance of Large Wood in Alluvial Ecosystems: Restoring Process, Function, and Structure*, developed by the USACE and Reclamation (Reclamation and ERDC 2016), provides guidance for incorporation of large wood in habitat restoration projects.

A Draft Trinity River Large Wood Management Plan (LWMP; Smith et al. 2014) is currently under development for the TRRP. The LWMP will provide guidance on wood use, outlining current understanding of required wood quantities, types, sources, longevity, transport rates, capture mechanisms, and other processes necessary to create and maintain aquatic habitat in support of Trinity River salmonid populations. Augmentation of wood supplies to move through the system from introduction points, much as the gravel augmentation program adds coarse sediment downstream of the dam, is also proposed in the LWMP. The goal of the Trinity River LWMP is to develop a self-sustaining wood supply that fosters natural fluvial processes and improves aquatic habitat in support of short- and long-term ROD objectives.

A recent inventory of large wood augmentation efforts at 27 channel rehabilitation sites constructed from 2006 to 2016 revealed the number of large wood pieces and constructed wood jams has increased over time. Fifty-nine percent of the large wood was incorporated into weirs, deflectors, and constructed wood jams. Over 80% of large wood pieces and structures were placed in off-channel areas (high and low flow side channels) and 60% were within the bankfull channel. This wood database will be used in future efforts to assess large-wood dynamics, installation longevity, and additional information for future restoration efforts (Boyce and Goodman 2018).

A variety of SLJ design options can be configured, four of which are identified for rehabilitation projects on the Trinity River, including 1) bar apex jams, 2) meander jams, 3) flow deflection jams, and 4) floodplain jams (CardnoEntrix and CH2M Hill 2011). The purpose of bar apex jams is to divert and decelerate flow upstream of the jam, to accelerate flow into the river bed and around upstream margins, and to aid in the formation of bars and islands. Meander jams limit or force channel migration and are primarily used to protect banks. Flow deflection jams also protect banks, but deflect flow instead of forcing channel migration. Lastly, floodplain jams are used to create habitat complexity and form vegetation islands during periods of high flows.

Each of the SLJs described above has several design options that include a variety of available tree species, large wood size and shape, density, and other characteristics identified in the draft LWMP. Typically, species that are native and decay slowly are preferred (e.g., conifers), but freshly cut species capable of regeneration can also be strategically utilized. Some local conifers include incense cedar (*Calocedrus decurrens*), Douglas fir (*Pseudotsuga menziesii*), and Ponderosa pine (*Pinus ponderosa*). Determining the size of these species (e.g., rootwad diameter, trunk diameter, tree length) to be used in jam designs is dependent on bankfull channel dimensions (NRCS 2007).

Coarse Sediment Management Plan and Gravel Augmentation Technical Report

Alteration in the quantity and composition of the sediment supply into streams and rivers has been identified as a serious stress to Coho Salmon (NOAA 2014). Increased sedimentation has been shown to have direct negative effects on Coho

Salmon through interfering with their physiological and biological processes and indirect effects through degradation of their habitat (Cordone and Kelly 1961, Koski 1966, Kondolf 2000), as well as decreasing the production of macroinvertebrates that are an important food source for fry, juveniles, and smolts (Suttle et al. 2004, Cover et al. 2008). Reduced sediment supply can also reduce spawning substrate, alter availability of velocity refugia and macroinvertebrate habitat, and can cause large scale changes in the morphology of downstream reaches (Cordone and Kelly 1961).

A conceptual description of coarse sediment needs and management on the Trinity River is provided by the *Coarse Sediment Management Plan: Lewiston Dam to Douglas City, Trinity River, California* (McBain and Trush, Inc. 2007). The 2014 *Analysis to support gravel augmentation recommendations for the Trinity River, California,* (Gravel Augmentation Technical Report (GATR); Gaeuman 2014) describes the latest monitoring and sediment transport analyses which have resulted in current implementation plans, including the best locations and quantities for coarse sediment augmentation and the particle size ranges needed to create and maintain high quality physical habitat in the Trinity River.

Short-term coarse sediment management activities were intended to immediately replenish gravel stores in deficit areas, whereas long-term coarse sediment management activities are intended to ensure that the supply of mobile gravel is maintained as the river routes gravel downstream. Because the Trinity River gravel deficit has been largely eliminated through initial coarse sediment injections since the TRRP began, long-term coarse sediment management activities have become the primary focus of the program. Therefore, the GATR focuses on the continuing need for long-term coarse sediment management activities and places less emphasis on short-term coarse sediment management activities at specific locations to achieve local habitat improvements.

Five long-term coarse sediment augmentation locations and four sediment sampling locations are identified in the GATR (Figure 5). The augmentation sites are commonly referred to as the “Hatchery,” “Sven Olbertson” (aka Weir Hole, Diversion Pool, or Lewiston Upstream), “Cableway” (upstream of Old Lewiston Bridge),” “Sawmill” (downstream from Cemetery Hole),” and “Lowden Ranch,” which includes an upstream augmentation site at the “meander bend” and downstream site by the mouth of Grass Valley Creek: Located in the upper restoration reach, all locations are upstream of natural tributary gravel sources and were selected by the Program to ensure that introduced material is transported downstream to replenish the alluvial material that will be remobilized over time.

Coarse sediment monitoring occurs at the four gravel locations displayed in Figure 5 (TRAL, TRGVC, TRLKG, and TRDC). Monitoring occurs at these sites primarily during high spring flows to measure and contrast sediment transport where gravel has been introduced (TRAL and TRGVC) and where it has not (TRLKG and TRDC).

The GATR recommends that future annual injection of gravels during high flows should occur at the “Diversion Pool” or “Lowden Ranch” sites. Placement of gravels would likely occur at the “Cableway” during low-flows as the reach is relatively narrow reach with an above average potential to entrain and move injected gravels downstream. The GATR recommends that coarse sediment management at the “Sawmill” location, be reevaluated/modified prior to its use again to ensure that overbank conveyance would move introduced gravel out of the “Sawmill Burner Hole” just downstream. The Sawmill site was used to introduce gravel during spring 2019 (a wet year) when gravel was placed on the floodplain, prior to flow peaks, so that the material was swept into the river during the highest flows. Assessment of how the gravel moved through reach is now in process.

Based partly on the new information that indicates that gravel does not transport as far, or in such volume as believed prior to recent monitoring, the Physical Work Group has been tasked with identifying additional locations for coarse sediment augmentation. Sites in the Bucktail and Steel Bridge areas have been potentially identified (Figure 5) but these locations must be satisfactory not only from a logistic sense (river access by many gravel laden trucks) but also, in order to improve habitat and ecological function. Program scientists will continue to use ongoing sediment monitoring, in conjunction with water year projections and bathymetry, in order to determine precise locations and quantities of coarse sediment to add to the river each year.

The GATR relies on empirical transport measurements and models for its recommended gravel augmentation rates. Long-term average coarse sediment management targets vary from year to year, depending on water availability, current physical conditions on the river, and logistical considerations. The GATR suggests the following annual targets for coarse sediment management (Table 5).

Current TRRP gravel specifications call for a maximum particle size of 5 inches (128 millimeters [mm]). The GATR evaluated various particle size classes and determined that a larger proportion of all sediments greater than 2.5 inches (64 mm) in diameter were transported during high flow years, whereas the remaining years transported a larger proportion of sediments finer than 1.5 inches (32 mm). This analysis also indicated that the TRRP’s current specification for maximum gravel size remains appropriate.

Table 5. Annual Coarse Sediment Management Targets* based on Water Year Type.

Water Year Type	Gravel Needed (in cubic yards)
Critically Dry	0
Dry	670
Normal	1670
Wet	3000
Extremely Wet	5000

Source: Gravel Augmentation Technical Report (TRRP 2014);
**Targets are implemented as needed.*

Finally, the GATR suggests that gravel transport in the Trinity River is limited to relatively short movements within a single geomorphic unit. In years with low to moderate flow, gravel typically moves from the point of injection to the first downstream pool or run it encounters. Modeling of the variability in bedload transport capacity between Lewiston Dam and Douglas City is currently underway, and will further inform the understanding of gravel transport, and subsequent adjustments of the gravel augmentation program.

Long-term Monitoring

The long-term monitoring and focused investigations conducted under the IAP framework are overseen and coordinated by the discipline-specific technical work groups. The specific monitoring efforts and studies can be grouped into three categories: 1) physical environment, 2) biological, and 3) mitigation monitoring. The findings and data provided by these investigations are used by the TRRP to assess performance and long-term benefits of restoration and management actions for Trinity River fish populations, including listed Coho Salmon.

Based on observations made during monitoring efforts, certain methods can be used during future project implementation to avoid and minimize the short-term detrimental effects of channel rehabilitation, fine and coarse sediment management, and watershed restoration projects on salmonid species, including listed Coho Salmon. Brief descriptions of the key long-term monitoring that inform TRRP activities follow.

Physical environment monitoring
River flow: A network of streamflow gaging stations on the mainstem Trinity River and its major tributaries and the lower Klamath River are used to monitor and manage flow releases and annual fishery restoration water allocations. In-season and annual summaries of flow records are used to evaluate hydrographic performance with prescribed flow schedules and natural storm events.

River temperature: Water temperatures are recorded at a number of strategically located stream flow gages to monitor compliance with water quality objectives for the Trinity River basin. In addition, thermographs are frequently deployed to measure site specific temperatures to investigate local conditions (e.g., within floodplain wetlands or near spring inflow areas) and potential effects on aquatic life. In-season and annual summaries of thermographic records are used to evaluate thermal conditions of instream habitat.

Sediment, bed mobility, and scour monitoring: Sediment transport, bed mobility, and scour monitoring occurs during spring at the four sediment monitoring sites (Figure 5). This extensive dataset is used to measure sediment transport and assess progress in restoring the balance between coarse and fine sediment. Recent findings show that coarse sediment storage has increased, and fine sediment has decreased in the vicinity of Lewiston, marking progress in restoring beneficial riverine processes. Monitoring results have also indicated that riverbed sediment particles mobilize in response to flow levels as generally predicted, but that the extent and distribution of bed scour is more localized than anticipated, particularly on point bars and riparian areas. These findings are informing ongoing evolution of channel restoration designs to incorporate features that contribute to localized scour on frequently inundated floodplain surfaces.

Implementation monitoring: Implementation monitoring informs a range of activities, including rehabilitation site design and gravel augmentation. In recent years, implementation monitoring has concentrated on an assessment of the potential impacts of rehabilitation actions and gravel augmentation on pool habitats because of public interest in maintaining holding habitat for adult salmon and steelhead during summer. Preliminary findings indicate that aggradation and degradation of gravel sediments in pools occurs throughout the action area and is an expected feature of dynamic mobile, alluvial bedded streams. Monitoring of channel bathymetry in channel rehabilitation and gravel augmentation reaches sites will continue in the future to verify and refine initial findings.

Biological monitoring

Riparian vegetation: Riparian vegetation monitoring is conducted as part of the Riparian Revegetation Monitoring Plan (RRMP), including mapping of planted and volunteer vegetation at recently completed channel rehabilitation sites as well as along the restoration reach. Vegetation is monitored for structural complexity, extent, species richness, age diversity, and floodplain regeneration and function. The data are used to evaluate riparian performance and how well targets are being met. Vegetation monitoring also integrates data from sediment and scour monitoring to evaluate the balance of vegetation establishment on upper floodplains and inhibition on lower floodplains.

Riparian wildlife: Monitoring of the abundance and productivity of riverine and riparian birds has provided information for assessing quality and quantity of habitat in the action area in response to restoration and management activities. Additionally, foothill yellow-legged frogs and western pond turtle populations along the mainstem Trinity River have been monitored to evaluate effects of channel rehabilitation and streamflow and temperature management for fishes on the native herpetofauna (amphibians and reptiles). This information is used to evaluate TRRP's wildlife enhancement objectives, environmental compliance and mitigation commitments, and is considered in the subsequent design of channel rehabilitation projects.

Juvenile salmonid outmigration abundance: A relatively long record of juvenile salmonid outmigrant assessment has accumulated, since 1989, and is conducted annually with rotary screw traps (Near the North Fork Trinity and at Willow Creek), to assess juvenile Chinook Salmon production from the upper 40 miles of the Trinity Basin and to estimate salmon and steelhead emigration timing from the Trinity River basin. Species occurrence, relative abundance, fish growth, health, and timing of outmigration relative to river flows and temperature are assessed. Provided that there is adequate seeding of Trinity River spawning areas, evaluation of numerical outmigration trends is considered one of the best success metrics available to the TRRP which primarily endeavors to enhance river function and dependent juvenile rearing habitat. In contrast, adult escapement is strongly affected by factors that are not controlled by the program (e.g., hatchery interactions, harvest, and ocean conditions).

Juvenile salmonid rearing density: A pilot-level evaluation of juvenile salmonid density surveys along the action area as one measure of the biological response of salmonids to in-stream channel rehabilitation efforts is presently permitted but currently not active.

Fish habitat assessment: Habitat assessments are conducted at channel rehabilitation sites and at untreated river segments using a general randomized tessellation sampling (GRTS) design[7]. The boundaries of the habitat are mapped using numeric criteria for suitable water depth, velocity and presence of cover or substrate. Most rehabilitation sites have shown increased areas of suitable juvenile fish habitat after construction. To evaluate longer term performance of channel rehabilitation sites and effect of spatiotemporal changes on constructed and natural off channel features, a trend analysis of data from 2005-2015 was conducted. Juvenile salmon (defined as Age-0) rearing habitat at 12.7 cubic meters per second (cms) flow was evaluated using a random-sampling design described in Goodman et al 2016. The effect of construction from 2005-2015 at 13 rehabilitation sites surveyed before and after construction was assessed as well as trends in the amount of rearing habitat at 22 rehabilitation sites. Rearing habitat increased at 12 of 13 rehabilitation sites; however, the trend analysis indicated the initial benefit of construction was not sustained over longer time periods with 10 of 19 sites showing less total habitat than the first survey after

[7] A general randomized tessellation sampling (GRTS) design refers to a statistical sampling technique in which a "probability sample" variable can be produced given a set of design-based variance estimators. A GRTS design provides a spatially balanced, random sample than allows for further in-depth probability sampling.

construction. Natural off-channel features persisted longer than constructed features with trends in rearing habitat related to creation and sustainability of off-channel features. Results from this analysis will be used to further refine TRRP future channel restoration designs (Boyce and Goodman 2018).

Coho Salmon survival and migration: An assessment of emigration survival of hatchery-origin juvenile Coho Salmon was reported in 2009 (Beeman, et al. 2009). This study compared survival in the Trinity River to the Klamath River and provided information on differential suitability of sections of the Trinity River for migrating Coho Salmon smolts. Survival was reduced in the upper 32 miles of the Trinity River compared to reaches farther downstream, which was similar to patterns of juvenile Coho Salmon survival in the Klamath River. The lowest estimated survival was from Lewiston Dam for 6 miles downstream and the highest estimated survival was in the lowest 12 miles of the Klamath River.

From 2006-2009, an assessment of juvenile Coho Salmon movement and behavior in relation to rehabilitation projects was conducted using snorkel surveys and mark-recapture techniques (PIT tags, elastomer tags, and radio transmitters). Rehabilitation did not have a significant effect on natural Coho at the site level. Survival of hatchery reared Coho Salmon was lower in the first 10 km downstream from the release site than other areas between Lewiston Dam and the Klamath River estuary. Migration occurred primarily at night in the upper Trinity River but lessened as yearlings moved through the lower Trinity River (Chase et al. 2013).

Fish disease: The USFWS' California-Nevada Fish Health Center and the Yurok Tribe monitor for diseases during the fall spawning run of Chinook Salmon in the lower Klamath River and in juvenile Coho and Chinook Salmon produced by fish hatcheries in the Klamath-Trinity basin and among the out-migrating juvenile salmonid populations. Unprecedented Ich and Columnaris disease outbreaks in the adult fall-run Chinook Salmon spawning population in 2002 has resulted in regular disease monitoring and coordinated flow management to better control future disease outbreaks. To improve understanding of the potential role of disease in the dynamics of Klamath-Trinity basin salmon populations, juvenile Chinook Salmon are monitored for the incidence of two infectious diseases caused by parasites, *Ceratomyxa (Ceratonova) shasta* and *Parvicapsula minibicornis*, which are prevalent in the basin. An important finding, to date, has been that of these two parasitic organisms *C. shasta* is largely responsible for disease and mortality of juvenile Chinook and Coho Salmon, particularly those stocks originating in the upper Klamath River (True et al. 2012).

Adult salmonid harvest and spawning escapement: Run-size estimates for Trinity River spring- and fall-run Chinook Salmon, Coho Salmon, and fall-run Steelhead are made annually using two mainstem weir sites at Junction City and Willow Creek to assess TRRP program objectives and attainment of escapement goals in the IAP. The current escapement goals in the Trinity River basin for naturally produced adults are 62,000 fall-run Chinook; 6,000 spring-run Chinook; 1,400 Coho; and 40,000 Steelhead. Similar goals for hatchery adult escapement are 9,000 fall-run Chinook; 3,000 spring-run Chinook; 2,100 Coho; and 10,000 Steelhead. Estimates of age-specific returns to hatcheries and spawning grounds, as well as harvest by tribal and recreational fisheries are reported annually by the CDFW's Trinity River Project (Trinity River, specifically), and in a Klamath basin-wide cumulative database for Chinook Salmon, *Klamath River Fall Chinook Salmon Age-Specific Escapement, River Harvest, and Run Size Estimates,* commonly referred to as the "Mega Table." The harvest in the HVT fishery and the Trinity River recreational fishery is composed of both naturally and hatchery produced fall-run Chinook Salmon. The harvest in the Yurok Tribal fishery and the lower Klamath recreational fishery is composed of naturally produced Chinook Salmon from both the Klamath and Trinity rivers, as well as the major tributaries to both rivers and Chinook Salmon produced at Trinity River Hatchery and Iron Gate Hatchery on the Klamath River.

Spawning distribution and abundance: The TRRP Program annually survey the mainstem Trinity River to count and map Chinook Salmon redds and obtain data from spawner carcasses. In addition to providing data for estimating spawner escapement and the relative run size of natural versus hatchery origin fish, these surveys also provide a measure of biological response to the habitat restoration efforts of the TRRP. The USFWS posts regular updates on redd surveys throughout each spawning season. Distribution and abundance of Chinook Salmon redds in the mainstem Trinity River from 2002-2011 showed spawning distribution responded to alterations at a local feature scale (i.e. a newly constructed side channel), but the proportion of redds had not significantly changed at the reach scale. High density spawning locations remained consistent year to year. An increase in the mean distance from the Lewiston Dam for natural origin Chinook redds occurred over the study time (Chamberlain et al. 2012).

Mitigation Monitoring

Riparian wildlife: The TRRP protects sensitive state and federally listed wildlife species during implementation activities to comply with environmental mitigation commitments and ensure that cumulative negative impacts from ROD implementation are mitigated. The TRRP replaces impacted riparian vegetation on a 1:1 areal basis through a combination of planting and creating conditions suitable for natural revegetation. Many migratory birds rely on riparian vegetation for shelter, food, and nesting. Pre-construction monitoring and avoidance ensures that these birds are not impacted by our channel rehabilitation. Past migratory bird monitoring has indicated that TRRP projects are not negatively impacting migratory bird populations (Miller et al. 2010). Moreover, the Klamath Bird Observatory (KBO) has been monitoring the success of TRRP restoration sites since 2002 and have elucidated the following findings:

- Methods for monitoring common bird species (such as Song Sparrow [*Melospiza melodia*]) appear to be effective in estimating productivity of the restoration sites. The capture rate of adult birds correlated with productivity indices at the site scale, suggesting that reduced productivity at a site can result in a reduction in adult abundance the following year (Alexander et al. 2013).

- The total number of riparian focal species' territories increased in the areas of survey from 2013 to 2015, suggesting that restoration and enhancement efforts by the TRRP in the years prior to surveying, were successful in increasing habitat and productivity (Rockwell et al. 2015).

- In an analysis of riverine and riparian bird abundance and diversity from 2002-2014, KBO biologists found that, of the eight target riverine species, two increased significantly and five species showed no trend (suggesting these populations were stable). The results suggested that the TRRP has been largely successful in maintaining riparian and riverine bird abundance and diversity. Two thirds of the species we studied exhibited either increasing trends or stable populations (Rockwell and Stephens 2016).

- From 2012 to 2015, KBO biologists examined the short-term success of TRRP restoration efforts, using territory characteristics and reproductive success for three riparian bird species (Song Sparrow, Yellow-breasted Chat [*Icteria virens*], and Yellow Warbler [*Setophaga petechia*]). The results of the study suggested that restoration activities have achieved short-term success as measured by reproductive success—however to achieve long-term restoration goals (e.g. increased territory density of riparian bird species) restoration sites must continue to mature and sites should continue to be monitored (Stephens and Rockwell 2019).

Mitigation monitoring occurs prior to and during construction to avoid harming sensitive and protected species. Post-construction monitoring occurs for one to five years to evaluate the development of habitat and use by sensitive wildlife at channel rehabilitation sites.

Riparian vegetation and wetlands: The TRRP replaces impacted riparian vegetation and wetland on a one-to one basis. Performance monitoring of revegetated areas is conducted as part of Reclamation's riparian mitigation commitment. Monitoring data obtained over the course of the first phase of channel rehabilitation has led to refined replanting techniques to improve survival and better meet revegetation mitigation objectives. Native plant revegetation efforts and maintenance not only compete with noxious weed and invasive species but also eradicate these species using mechanical methods (e.g., physical removal) during implementation. To date, the TRRP program has adhered to Trinity County planning department guidance that does not allow herbicide use for vegetation management.

Recent Advancements of the AEAM Process

The performance and success of the TRRP is supported by periodic reviews of key technical and scientific elements of the AEAM process by independent scientists and analysts. Critical reviews of AEAM elements have contributed to improvements in TRRP activities. As a result of specific external reviews, improvements in protocols and evaluation techniques have been made in both the juvenile salmonid outmigrant and, adult salmonid monitoring programs. In addition, the SAB's 2014 Phase I review of the Program (TRRP SAB 2014) provided insight and direction to enhance Program documentation and scientific methodology, but also substantiated that the Program was moving in the right direction during implementation.

The following sections are brief summaries of the key findings, recommendations, and context for ongoing refinement and improvements of AEAM activities and the TRRP.

Juvenile Salmonid Outmigration Monitoring Evaluation

This review provided an independent evaluation of the juvenile salmonid outmigrant monitoring efforts of the TRRP Program including assessment of field techniques (NSR, et al. 2008) and analytic techniques (ESSA, et al. 2009). Recommendations were made as part of this evaluation to 1) identify refinements and alternative field monitoring techniques, 2) metrics that are easier to measure and less sensitive to sampling errors, and 3) procedures that increase statistical and analytical power for assessing fish population responses to habitat restoration.

Tradeoffs were evaluated between alternative monitoring and analytic methods for assessing smolt abundance, run timing, and condition. Additionally, this review assessed the ability of the juvenile outmigrant monitoring data to inform TRRP restoration goals for salmon species. The key challenge in evaluating across-year trends using the outmigrant dataset is the small time series available for most measures. A new Bayesian spline-based methodology to estimate salmon abundance and run timing[8] was demonstrated using Trinity River monitoring data illustrating ways to supplement traditional stratified Peterson-estimator approaches in use by TRRP Program.

Additionally, several fish size and condition metrics were considered for use in long-term evaluations. Fork length had the longest and most substantial dataset for all three species of interest (i.e., Coho, Steelhead, and Chinook Salmon) and

[8] Data from traditional mark-recapture experiments are often stratified by time to allow for possible changes in capture probabilities, however mark-recapture methods of statistical analysis fail to take advantage of the temporal relationship in the stratified data. Therefore, Bayesian, semiparametric methods that explicitly model the expected number of fish as a smooth function of time. Bayesian methods provide more precise estimates of population size and more accurate estimates of uncertainty than other types of analyses (Schwarz and Bonner 2011).

was the only factor with sufficient historic data to complete any detailed analyses for Coho Salmon. The TRRP Technical Fish Work Group has ongoing implementation and adaptation of these recommendations as part of its oversight of monitoring projects.

Adult Salmonid Monitoring Evaluation

This review by Michael Bradford and David Hankin (Bradford and Hankin 2012) evaluated the effectiveness of adult salmonid assessments and monitoring supported by the TRRP. Specifically, salmonid population abundance relative to the goals of increasing catch and escapement and measuring responses of the Trinity River ecosystem to restoration actions was evaluated. Most adult salmon monitoring efforts on the Trinity River pre-date the TRRP and were initiated for stock assessment or fisheries management objectives. Accordingly, the assessments provide consistent long-term data collection programs, and personnel that have been with the programs for many years, attributes that contribute to the value of the long-term data record.

Results of the review recommended that refinements and expansions of existing programs include: 1) analysis of the uncertainty in salmon abundance estimates, 2) tests of assumptions of the methods and biases, 3) estimates of Trinity fish in mixed-population fisheries, 4) standardization of procedures for data compilation and analysis for each monitoring program, and 5) development of simple and consistent annual reporting.

In response to this review, the Fish Work Group has taken on several of these recommendations and is synthesizing information from adult monitoring projects into a form that can be used to evaluate TRRP hypotheses and objectives identified in the IAP. The emphasis has been on fall-run Chinook Salmon, for which the datasets are the richest, but recommendations extend to Coho Salmon, as well.

Review of channel rehabilitation strategy, Phase I

The TRRP completion of the first phase of mechanical channel rehabilitation projects underwent a comprehensive examination by the SAB in 2014. This was reported in the "Review of the Trinity River Restoration Program Following Phase 1, with Emphasis on the Program's Channel Rehabilitation Strategy" (TRRP SAB 2014). The SAB's Phase 1 Report concluded that substantial progress in achieving the ROD goals has been made by the TRRP and rehabilitation projects are creating more complex habitat. However, the effects on fish production are less clear given limited data sets and analysis available to date. The SAB identified areas where the TRRP can improve, specifically by integrating activities around the overarching goal of restoring in-river fish production.

The key recommendation from this review was to develop a Decision Support System (DSS), which is a series of linked physical and biological models that will allow the TRRP to: 1) predict site and system responses to management actions in relation to the ROD and stakeholder objectives; 2) make predictions ahead of monitoring results; 3) focus and refine monitoring efforts; and, 4) provide a tool for adaptive management. Additionally, it will help structure and integrate TRRP activities and increase the defensibility and transparency of management and restoration actions. The DSS shifts TRRP from its current focus on *means objectives* (i.e., creating fish rearing habitat) toward a focus on the *fundamental objective* (i.e., restoring in-river fish production) through better understanding of the roles and synergistic effects of TRRP actions, including flow and temperature management, fine and coarse sediment management, and channel rehabilitation on fish production over time and space. The DSS is used to critically assess channel rehabilitation actions needed to achieve fish population objectives.

The initial Program action for DSS was development of a quantitative model that incorporates channel structure, flow, and water temperature as variables for estimating suitable habitat conditions over space and time through the restoration reach. This information is used to estimate fish populations via a model known as the SSS (Stream Salmonid Simulator or S3). The developed a This dynamic simulation model, developed in cooperation with the USFWS, mimics growth, movement, and survival of juvenile salmonid populations in streams and rivers and estimates fish abundance at any date. Models have been developed for the Klamath and Trinity Rivers (Perry et al 2018).

The following summary characterizes ongoing TRRP efforts. It is primarily taken and modified from the *Implementation Plan for the Preferred Alternative of the TRMFRP EIS/EIR* (Stalnaker and Wittler 2000), the SAB Phase 1 Report (TRRP SAB 2014), and a September 16, 2014 memorandum from D.J. Bandrowski, TRRP Implementation Branch Chief, to the TMC regarding the Phase 2 planning for channel rehabilitation.

- In use of the DSS to critically evaluate the design strategy that has occurred (i.e., minimal vs. intensive mechanical intervention), a key factor is the response time for creating desired channel conditions and increases in fish populations. The desired response time influences the type of management actions (i.e., size, frequency and degree of manipulation). Similarly, consider the potential benefits of several large projects vs. many small ones. Are large channel rehabilitation projects more effective at meeting TRRP objectives than small ones, and which objectives are best met by each approach?

- To address the SAB's recommendations, planning and analysis tools were used in 2014 as part of the Phase 2 Planning and Analysis. This set of analytic tools, termed "Two-Dimensional Hydrodynamic Based Logic Modeling," consisted of 1) a system-wide 2D hydraulic model for the 40-mile restoration reach, 2) evaluation metrics and development of a habitat module based on hydraulic model output, and 3) the logic model's statistical analysis framework for prioritization.

These planning tools are supplemented by the fish production model (the SSS) to further refine and improve the project planning process.

- Phase 2 projects should continue to use design strategies to promote dynamic alluvial reaches while working with local constraints on channel morphology in this semi-alluvial river. However, because the river is less alluvial than originally envisioned, a dichotomy of project designs may be needed (i.e., those that specifically drive geomorphic processes over time, producing dynamic habitat responses in alluvial river sections vs. building static habitat features intended to persist over time in less alluvial reaches).

- Continue to use and evaluate a diversity of design elements in Phase 2 projects, which have been documented to increase juvenile fish habitat and reduce the historically observed habitat bottlenecks at modest flow levels. Side channels offer a potential means for maximizing habitat availability but may be prone to aggradation so their potential benefits depend on their longevity. Consequently, side channels should only be located in reaches that have a natural potential for anabranching morphology. A diversity of design elements and habitats is recommended as this promotes species resilience to changing environmental conditions.

- Design objectives for Phase 1 projects initially invoked the TRRP's ROD and IAP objectives without demonstrating how they would be achieved. In contrast, recent efforts are more defensible—employing mechanistic, predictive models to evaluate as-built channel condition, design alternatives, and site evolution. Phase 2 projects should continue with a DSS and fish production model.

- Incorporate metrics for quantifying juvenile fish numbers, growth, and health as major components of fish population modeling for estimating annual in-river fish production. Also, examine the role of annual water temperatures with regard to fish growth and health across years. As the river system evolves in response to post-ROD management actions, the TRRP's foundational hypothesis of juvenile rearing habitat as the primary limiting factor may change. The DSS and fish population modeling can be used to periodically examine alternative population limiting hypotheses. For example, (1) juvenile fish production vs. adult escapement and (2) carrying capacity of physical habitat vs. water temperature and its effect on fish growth and health.

- Adopt rigorous hypothesis testing for TRRP activities and scientific investigations, which is critical for improving the effectiveness of such actions. Treat rehabilitation projects as opportunities to formally test the hypotheses and goals articulated by the ROD and IAP.

- Integrate Workgroup activities to better achieve TRRP objectives. The Workgroups include interdisciplinary membership but need better coordination and exchange of information across workgroups. In addition, the internal review process of TRRP reports should be streamlined to disseminate findings more rapidly. Publication in peer-review journals is encouraged to have peer input and disseminate TRRP findings.

Additional Watershed Monitoring Activities and Studies

Monitoring and numerous studies have been conducted in the Trinity River watershed. These include 1) watershed assessments by the Forest Service (Shasta-Trinity and Six River national forests), 2) water quality monitoring projects by the TCRCD, CDFW, CDWR, Yurok Tribe, HVT, BLM, US Reclamation, USFWS, NMFS, USGS, and 3) various agency consultants, universities, and watershed groups.

Recent reviews of the Trinity River SONCC Coho Salmon population, such as the California Hatchery Review Report (CA HSRG 2012) and the NMFS Recovery Plan (NMFS 2014), have concluded that there is insufficient data for all life stages of Coho Salmon throughout the entirety of the SONCC ESU (including the Trinity River population) and that additional monitoring and research is needed (Quinn et al. 2017).

A Hatchery Genetic Management Plan (HGMP) for the TRH has been developed as a result of Coho Salmon ESA listing and to comply with federal law. This plan outlines informational needs and monitoring activities providing fisheries managers the ability to administer and implement protocols designed to recover the Trinity River Coho Salmon to historic levels (Quinn et al. 2017). Under the HGMP a fish timing release study will be undertaken for at least three brood years and fish will be released in March, April, and May with study protocols developed by a technical team (CDFW 2017).

One of the most critical information requirements for the HGMP is the adult Coho Salmon return population size (escapement) to natural spawning grounds, including the natural/hatchery composition of that population (Quinn et al. 2017). The current method for estimating this population is provided by a mark-recapture effort performed by the CDFW (Kier et al. 2017), utilizing adult returns caught and tagged at the Willow Creek Weir site, and recaptured at TRH and during surveys of the natural spawning areas in the mainstem Trinity River (Quinn et al. 2017). During the late-fall of 2014 the Yurok Tribal Fisheries program-Trinity Division began conducting TRH Coho Salmon spawning surveys in the tributaries of the Upper Trinity River close to TRH (Quinn et al. 2017). The Forest Service Trinity River Management Unit (TRMU) has been conducting annual fall-run Chinook Salmon spawning surveys in the tributaries of the Upper Trinity River, within the jurisdiction of their agency, on a regular basis since 1999 (Quinn et al. 2017). However, these Forest Service surveys are only intended to encompass the fall-run Chinook Salmon spawning season, resulting in an incomplete assessment of Coho Salmon spawning for the tributaries surveyed.

The SRNF (USFS 2015) lists 18 types of watershed and fisheries restoration activities planned for 2015 to 2030, on national forest land in the Trinity River basin.

The STNF had sediment source inventories and aquatic and riparian resources road risk analyses conducted in Upper Trinity River tributaries (Grass Valley, Weaver, Brown's, and Canyon creeks) watersheds and South Fork Trinity River and Hayfork Creek watersheds (North State Resources Inc. (2012). These analyses involved inventorying 862 miles of road (and 309 miles of additional road data) on Forest Service, BLM and private lands to characterize the existing condition of the sub-watersheds and identify sub-watersheds that contained roads which were hydrologically sensitive (high hydrologic connectivity) and had the greatest potential for increased erosion and sedimentation.

North State Resources, Inc. (2012) reports that various monitoring efforts are conducted in the Canyon Creek watershed by the Forest Service to assess the in-stream habitat conditions. During monitoring, stream temperature is continuously recorded, Redd and dive surveys are conducted on an annual basis to identify spatial distribution and abundance trends in holding and spawning adult fish in Canyon Creek (Chilcote 2012).

Chapter 3
Description of the Action

The action, which is the ongoing program of the TRRP's habitat restoration activities, has been evolving in terms of approaches and extent of these activities since the 2000 ROD. A range of program-level considerations and decision-making processes related to the design and implementation of restoration projects are used to achieve goals and objectives of the TRRP.

Habitat restoration as used in this action includes: 1) channel rehabilitation (including reconnecting the floodplain to the river channel, and incorporation of engineered log jams, side channels, alcoves, hard points and boulders to direct scour); 2) fine and coarse sediment management (including dredging of sediment retention ponds and addition of coarse sediment to the river channel); 3) infrastructure modifications and improvements (including limited bridge replacement and the Well Grant Program to mitigate for adverse effects of restoration flows on water supplies of private riverside landowners); 4) watershed restoration (including watershed projects to reduce erosion and fine sediment production and improve watershed connectivity and habitat); and 5) fish monitoring activities to evaluate and improve restoration activities.

Action Area

The action area is defined as all areas directly or indirectly affected by the federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area consists of the South Fork Trinity River, the mainstem Trinity River from the confluence of the North Fork Trinity River to the confluence with the Klamath River, and the 40 miles of the Trinity River from the confluence of the North Fork Trinity River to the Lewiston Dam, including tributaries (Figure 7). In addition, fisheries research and monitoring activities conducted in the Lower Klamath River watershed are included in this consultation (Figure 8).

The action area for this BA/EFHA is defined to include all stream channels, riparian areas, and hydrologically linked upslope areas that will be affected by implementation of the action. Tributaries in the action area include, but are not limited to, Rush Creek, Indian Creek, Weaver Creek including the East and West Forks of Weaver Creek, Little Brown's Creek, Sidney Gulch, Canyon Creek, Conner Creek, Soldier Creek, Dutch Creek, Brown's Creek, Grass Valley Creek, Deadwood Creek, Reading Creek, Rush Creek, Manzanita Creek, Price Creek, the North Fork of the Trinity River, East Fork of the North Fork Trinity River, Hayfork Creek including Big Creek, Salt Creek, Summit Creek, Butter Creek, and Rattlesnake Creek (HVT et al. 2011). For the purpose of this description, the action area includes from the tributary confluences with the mainstem Trinity River, and to the extent that each tributary provides designated CH for the listed species, up to roadless boundaries on federally administered lands (Figure 7). No habitat impacts will result from fisheries and research activities in the lower Klamath River watershed as no construction activities will occur.

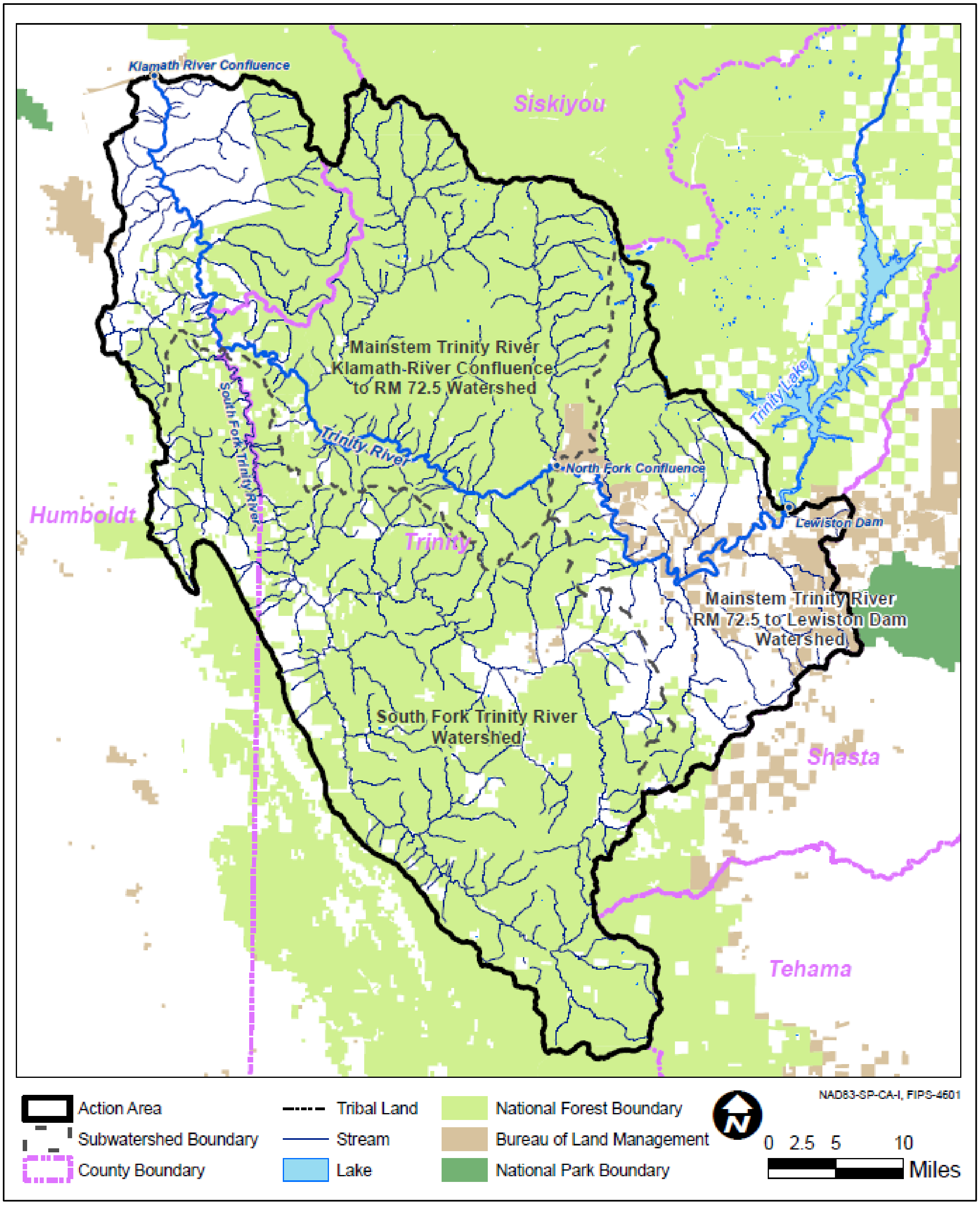

Figure 7. Map of the Trinity River Restoration Program Action Area. The area includes the Trinity River from Lewiston Dam to the Klamath River confluence and the South Fork watershed.

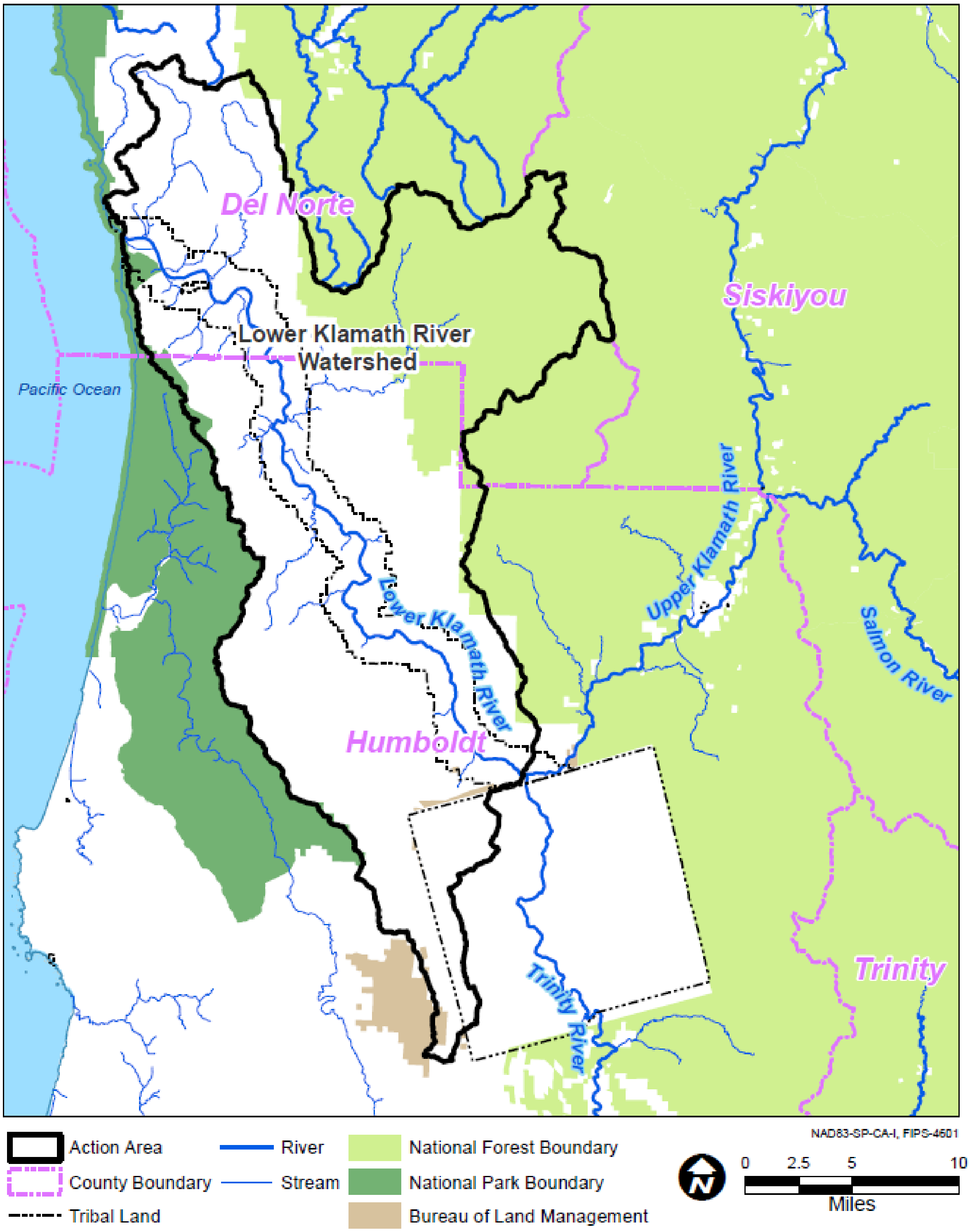

Figure 8. Map of the Trinity River Restoration Program Action Area-Lower Klamath River watershed (fisheries research/monitoring only).

Purpose and Need for the Action

The purpose of the Program is to mitigate impacts of the TRD of the CVP on anadromous fish populations in the Trinity River by successfully implementing the 2000 Trinity River Record of Decision and achieving Congressionally-mandated restoration goals. TRRP's ongoing restoration activities, defined as the action for this BA/EFHA, is to increase in-river Salmon and Steelhead production by reestablishing habitat forming processes and complex instream habitat for salmonids within the Action Area. Ultimately, the TRRP is responsible is to restore and sustain natural production of anadromous fish populations in the Trinity River to pre-dam levels.

Implementation of habitat restoration actions has been ongoing since 2000. During this time, several of the habitat restoration activities have evolved from those originally contemplated by the 2000 ROD and analyzed in the associated BiOp. Although these activities have been identified as being important to the overall, long-term success of fish habitat restoration, implementation of these activities may cause short-term impacts to federally listed species and their designated CH in the Trinity River. Therefore, the federal lead agencies (Reclamation and USFWS) and participating agencies agree that reinitiating Section 7 consultation is needed to ensure that current habitat restoration activities, design strategies, fish monitoring activities, and the AEAM process used for implementing the action remain in compliance with the ESA.

The need for this BA/EFHA, and reinitiating Section 7 consultation, is based on the following factors:

- The ongoing evolution and advances in channel rehabilitation project activities (e.g., structured log jams (SLJ), in-water construction activities, extended seasonal work windows for certain construction activities) that were not anticipated or analyzed in the TRMFRP EIS/EIR and ROD, but which are proposed for incorporation into future channel rehabilitation project designs.

- Updates to the original scope and techniques used in implementing channel rehabilitation, coarse and fine sediment management activities, infrastructure modifications, and watershed restoration activities.

- Expansion of the restoration action area to include Trinity River watershed tributaries.

- Updates to the status of federally listed species and their designated CH since the 2000 BiOp.

- Updates to the decision-making process and advancements of the AEAM process have occurred over time that better ensure that the experience obtained through the planning, design, and implementation of successive projects is incorporated into future TRRP restoration efforts.
- Inclusion of monitoring activities that evaluate the effects of restoration activities on fish populations.
- The need for an EFHA to support consultation under the MSA.

Program Activities: Channel Rehabilitation, Fine and Coarse Sediment Management, Watershed Restoration Activities, Limited Infrastructure Modification, and Fisheries Monitoring

TRRP ongoing actions include Program activities associated with: 1) physical channel rehabilitation, 2) fine sediment management, 3) coarse sediment augmentation, 4) watershed restoration activities, 5) limited infrastructure modification, and 6) fisheries monitoring. Projects may have one or more major components which may affect listed species and/or their aquatic habitat including:

1. heavy equipment operation in or adjacent to water;
2. in-water excavation or dredging;
3. grading operations (in-channel or floodplain);
4. in-water gravel augmentation;
5. riparian vegetation removal or management;
6. in-water work area exclusion and dewatering;
7. fish salvage and handling;
8. in-water and adjacent pile driving;
9. fish passage-barrier removal or retrofit;
10. bank stabilization

The ongoing action includes a continuation and expansion of mechanical channel rehabilitation projects along the mainstem Trinity River originally described by the ROD. Channel rehabilitation projects are intended to restore dynamic alluvial riverine function by increasing the spatial extent and temporal frequency of the Trinity River’s inundation and channel meander through its floodplains. Restoring alluvial structure and function to the Trinity River will result in the development of a larger and more complex expanse of river and floodplain habitats, which support anadromous salmonid production and benefits other native fish and wildlife species (USFWS and HVT 1999). Substantial progress has been made and localized structural and functional improvements in habitat have been documented for some individual channel rehabilitation sites (Goodman et al. 2010, 2012; TRRP SAB 2014).

In order to provide complex in-river juvenile habitat, the TRRP's channel rehabilitation activities have evolved to require in-channel construction. Depending on the project, extended in-water work periods, bedrock fracturing, SLJ installation using pile-driving techniques, and site restoration and revegetation techniques to enhance the development of diverse and functional riverine and riparian habitats, including alternate point bars, alcoves and side-channels, and floodplain habitat may also be required.

The ongoing action also includes continuation of both fine and coarse sediment management activities. Coarse sediment management activities consist of placement of appropriately sized gravels at a number of gravel augmentation locations, including five long-term injection sites between Lewiston Dam and Indian Creek as well as in-river placement during channel rehabilitation site construction. Gravel augmentation includes high-flow injection and low-flow installation techniques, depending on the project site characteristics. In the Lewiston Reach, due to high flow scouring and little replacement, TRRP scientists are evaluating the potential need to add fine sediment (< ½ inch in diameter). If appropriate, a proposal for implementation would suggest locations, techniques, quantities, size of material, and periodicity for such additions.

Fine sediment management activities continue to focus on maintenance of the sediment retention basins at the mouth of Grass Valley Creek (Hamilton Ponds), in addition to watershed restoration efforts that reduce the amount of fine sediment entering the mainstem Trinity River from upslope locations. Periodic removal of fine sediment from the retention ponds has evolved to include techniques to avoid and minimize effects of sediment removal. Impact avoidance is focused on rearing salmonids which include Coho Salmon, as well as Pacific (*Entosphenus tridentatus*) and Klamath River (*E. similis*) lamprey ammocetes, that are known to reside in pond sediments targeted for removal. Bioengineered bank stabilization for civil structures and private property to address bank erosion and fine sedimentation, where compatible with TRRP habitat restoration objectives, will also be supported.

Watershed restoration activities on public and private lands in the action area will continue to be supported by the TRRP. Excessive sediment production that affects the mainstem Trinity River and key tributaries can be effectively reduced, and watershed connectivity and salmonid habitat can be restored and/or enhanced.

At the time of the Phase 1 review (TRRP SAB 2014), the effects of channel rehabilitation on fish production were uncertain, however natural chinook salmon juvenile outmigration numbers from the post-ROD implementation period (since 2005), show a general increasing trend (Pinnix unpublished data 2017). In addition, at the time of reporting, the elapsed time since restoration may have been insufficient to detect responses in fish populations given the measurement techniques and metrics that have been used to date (ESSA, et al. 2009). To evaluate effects of Program activities on fish production in the Trinity River watershed, fisheries monitoring activities are currently being conducted and/or proposed. Research activities include fish habitat and abundance and fish monitoring and escapement studies. Studies include juvenile salmonid outmigrant monitoring, juvenile Chinook Salmon density monitoring, Chinook redd and carcass surveys, Brown Trout predation on Coho Salmon research, juvenile Coho Salmon ecology (migration) studies, and salmonid distribution studies.

Channel Rehabilitation Project Activities

Phase 1 channel rehabilitation project activities initially focused on removing fossilized riparian berms that encroached on the river channel following completion of the TRD and lowering floodplains to match the post-ROD flow regime. The intent was to remove the berms and other restraining features so that fluvial processes would be able to create and maintain a scaled-down, but more dynamic and complex river offering more productive habitat for fish and wildlife (McBain and Trush 1997; USFWS and HVT 1999; USDOI 2000). Built based on this approach, the early Phase 1 projects did not produce an immediate increase in rearing habitat or geomorphic response. This is at least partly because the river was expected to do most of the work. ROD restoration flow rates do not have the potential to cause geomorphic change at the rate envisioned in the TRFES. More recent channel rehabilitation projects have increased in size and complexity, including construction of medial bars, side channels, flow benches, alcoves, wood placement, and re-planting of riparian corridors – all in an effort to increase complexity, river function, and the rate at which aquatic habitat evolves (HVT et al. 2011).

The intent of the larger and more complex suite of channel rehabilitation designs for the later Phase 1 projects and Phase 2 projects is to create immediate habitat and construct large-scale channel features that interact with flood flows and drive habitat-producing channel evolution. Although the observed physical and biological responses to channel rehabilitation projects have been slower than expected, they have informed refinement of project designs. It is also noted that flow caused changes result more frequently during wet water years. River flows between 2011 and 2016 were generally limited due to low water conditions.

To improve the information feedback loop and to increase the rate of achieving TRRP objectives, monitoring efforts have been recently supplemented by predictive models to better inform subsequent channel rehabilitation projects and to facilitate adaptive environmental management. The experience and evaluation for channel rehabilitation projects has been incorporated into the approaches and designs of current Phase 2 projects as shown in Table 6 below.

Table 6. Comparison and Differences in Key Design Criteria of Initial Phase 1 and Current Phase 2 Channel Rehabilitation Projects

Design Criteria – Implementation Activity	Early Design (Evaluated by the 2000 BiOp)	Current Design
In-Channel Work (Working Within the Wetted Channel)	None	Most sites, including follow-up maintenance. A 2006 amendment to the 2000 BiOp provided extended ESA authorization for this activity.
Construction Work Period ("Work Windows")	No in-river work was planned in the ROD. None evaluated in the BiOp. Floodplain work (at the edge of the active channel) was allowed July 15 to September 15). With the 2006 BiOp amendment, in-water construction was scheduled between July 15 and September 15, to minimize impacts to anadromous salmonids. Some extension, were allowed via communication with the NMFS. However, it was contemplated that construction during other seasons should not be precluded.	Based on other environmental clearances (e.g., bird nesting), construction activities may occur at all times of the year outside of the Ordinary High Water Mark (OHWM). Construction on the floodplain (within the OHWM) may occur when not inundated (e.g., from May through December). Construction within the wetted river channel will be limited to between June 15 to October 15 for Trinity River Tributaries and July 15 and October 15 for the Trinity River mainstem, with the use of BMPs such as anti-spawning mats after September 15 in construction areas that may be suitable spawning habitat for Coho or Chinook Salmon. Construction activities in riparian habitat, will be scheduled to avoid the bird nesting period, to the extent possible (typically after August 1). If this is not possible, a bird survey will be conducted no more than 15 days prior to the initiation of construction. If an active nest is found, a qualified biologist will determine the extent of a construction-free buffer zone to be established around the nest. The majority of excavation and grading activities within the OHWM would occur between July 15 and October 15, though excavation on dry floodplain surfaces may begin earlier than June 15 (for tributaries) and continue later than October 15 as long as surface water runoff does not increase Trinity River turbidity by > 20 percent over background levels. Large projects like Oregon Gulch and Sky Ranch may need to excavate outside the June 15 to October 15 window.
Design Scale	Modest in excavation because only floodplain work involved; however early projects cover several meander lengths.	Expansion of design scale to exceed two meander wavelengths in length and potentially extend across the river valley floor, where practicable. Larger projects create new meander bends.

Table 6. Comparison and Differences in Key Design Criteria of Initial Phase 1 and Current Phase 2 Channel Rehabilitation Projects

Design Criteria – Implementation Activity	Early Design (Evaluated by the 2000 BiOp)	Current Design
Fluvial Processes	Use of vertical bed scour as the primary process for preventing recurrence of detrimental riparian encroachment and channel confinement.	Use of excavation and filling with alluvial material, as well as vertical bed scour, (e.g., directing the channel into bedrock outcrops and irregularities in valley walls, in addition to large wood placement) to achieve habitat creation objectives and recruit sediment and large wood.
Coarse Sediment Supply and Gravel Bars	Coarse sediment augmentation only upstream of Indian Creek. Construction of skeletal bars with larger (immobile grain size) may be used as appropriate.	Construction of gravel and skeletal bars below the Indian Creek confluence primarily for geomorphic, structural, and gravel deficit purposes (USFWS and HVT 1999). The shape, elevation and location of constructed gravel bars within a given site have been adjusting from site to site, and morphometric measurements of these evolving bars are used to refine subsequent bar design guidelines.
Floodplain Topography	Use of vertical bed scour as the primary process for preventing detrimental riparian encroachment. Lateral scour was expected to create and maintain alluvial bars in select locations.	Construction of floodplain surfaces with elevations allowing periodic inundation at prescribed flows to achieve combined fluvial process and habitat objectives. Use of local and lateral scour in addition to vertical bed scour (e.g., directing the channel into bedrock outcrops and irregularities in valley walls, in addition to large wood placement) to contribute to topographic and hydraulic complexity.
Secondary Channels	Three side channel restoration projects were originally recommended by the TRFES study.	Consideration and implementation of secondary channels (e.g., side channels, split channels, high flow channels, anastomosing channels) in site designs, as appropriate.
Alcoves	None	Designed in combination with high flow scour channels and on the back side of bars/meanders. These contribute to additional topographic diversity on floodplains.
Large Wood	None	Addition of large wood placement (as individual and multiple pieces, habitat structures, and in SLJs in all rehabilitation designs. Used in low flow channel, floodplain, side channels, and alcoves), where appropriate. The LWMP is now considering introduction of wood in the upstream reach much as gravel is now introduced.

Table 6. Comparison and Differences in Key Design Criteria of Initial Phase 1 and Current Phase 2 Channel Rehabilitation Projects

Design Criteria – Implementation Activity	Early Design (Evaluated by the 2000 BiOp)	Current Design
Riparian Vegetation	Removal of riparian berms and associated vegetation with no subsequent mechanical maintenance or restoration of riparian vegetation.	Removal of riparian berms, with revegetation of restored flood plain surfaces and in proximity to the main channel and other water features in a manner that is compatible with channel geomorphic objectives. A combination of planting of hardwood cuttings or rooted stock, replanting salvaged willow clumps, and planting wetland species. Floodplain edge riparian vegetation is maintained as habitat. Direct removal of Himalayan blackberries
Consideration of Additional Species	General management objectives for flow regime and consideration of conditions for foothill yellow-legged frog egg masses.	In addition to the primary objective for Chinook Salmon habitat, restoration designs will accommodate habitat requirements for other important species, including Coho Salmon, steelhead, western pond turtle, foothill yellow-legged frogs, Pacific lamprey, and riparian and riverine birds. Riparian vegetation and topographic diversity, upland habitat function (natural forest health to aid future large wood recruitment) in proximity to projects, and hydrologic diversity is considered for all native species in rehabilitation designs.

Channel Rehabilitation Project Locations

The channel rehabilitation project area is divided into five restoration reaches based on present-day alluvial characteristics and future alluvial potential: (1) Lewiston Reach (RM 112.1-107.9), (2) Limekiln Reach (RM 107.9 to 95.5), (3) Douglas City Reach (RM 95.5 to 88.0), (4) Junction City Reach (RM 88.0 to 79.3), and (5) North Fork Reach (RM79.3 to 72.2). Within these reaches a total of 44 channel and three side-channel rehabilitation sites, for a total of 47, were originally identified in the TRFES (USFWS and HVT 1999) and the 2000 ROD (USDOI 2000) (Figure 4).

The first channel rehabilitation projects (Hocker Flat 2005 and the Canyon Creek suite 2006) occurred downstream of Junction City because ROD flows were not yet fully authorized and these sites would be maintained by natural flows. Later, Phase 1 projects targeted areas nearest to Lewiston Dam to provide rearing habitat in the area with the highest salmon spawning density. The locations and range of restoration treatments proposed for the remaining Phase 2 channel rehabilitation projects are described and summarized in Appendix B. The priority of implementation and combination of restoration features to be constructed will be refined during Phase 2 planning.

Activities for implementation of Phase 2 channel will create geomorphic and hydraulic features within the wetted channel and floodplain of the Trinity River to achieve design objectives for the channel rehabilitation sites. One or more of the channel rehabilitation activities listed in Appendix B may be implemented at Phase 2 sites. Each activity has been assigned an alphabetic label. Additionally, these channel rehabilitation activities are done in concert with scheduled flow releases from Lewiston Dam.

Overview of Channel Construction Criteria and Process

The following provides a general overview of the construction process common to all of the proposed channel rehabilitation sites and designs. The construction criteria and methods are specific features incorporated into the channel rehabilitation projects designed to minimize and avoid localized and transient environmental impacts as well as to meet long-term ecological restoration objectives. The design of the channel rehabilitation sites will vary.

Construction equipment, techniques, and conservation measures protecting ESA-listed and proposed species common to channel rehabilitation activities, are described below.

Equipment: Implementation of channel rehabilitation activities requires the use of both manual labor and heavy equipment. Chainsaws and other hand tools for cutting vegetation and digging in soils and setting and removing of sandbag coffer dams will be common manual labor. Heavy equipment, such as excavators, bulldozers, scrapers, dump trucks, and vegetation masticators will be used for earth moving and vegetation clearing.

Bedrock fracturing: Because the semi-alluvial channel of the restoration reach makes frequent contact with valley walls and bedrock, it has been described as "an alluvial channel working through a tapestry of bedrock controls" (HVT, et al. 2011). It became apparent during construction of the 2015 Limekiln project that bedrock may need to be fractured and excavated using rock-hammers, mining-jacks, and other rock-fracturing techniques, to achieve channel rehabilitation design objectives at some sites.

Rock-hammers and mining jacks will be attached to excavators and used, where appropriate, and in preference to other techniques to fracture bedrock, only to the extent needed to construct design elements. In instances where the two former methods cannot be used, expanding grout compounds and blasting with explosives, in decreasing order of preference, may be used to fracture the bedrock. Fractured bedrock will be removed from the floodplain and river channel using excavators. The use of expanding grouts would be limited to applications outside the wetted channel or within areas isolated from the active channel.

Pile-driving: Installation of certain channel rehabilitation design elements may require driving of log or peeler core piles into the riverbed as an anchor for wood structures (e.g., habitat structures and SLJs). Log piles will be prepared by using chainsaws to carve a conical shape on the end to be driven into the streambed or floodplain. Pile driving will be conducted using small- to medium-power impact hammers (rated at 500-1000 kilojoules [369-738 Kft•lbs]) and vibratory drivers (e.g., hoe-packs) mounted and operated from a crane or excavator. The number and duration of pile strikes will vary depending on the competency and resistance of the substrate. Piles will generally be driven to a depth below the surface of eight to twelve feet or to the point of rejection, indicating that the pile hit bedrock.

Water use: Water will be used at all sites, in accordance with the following guidelines:

- Riparian water rights held by public and private landowners on the Trinity River will be used to withdraw Trinity River water to support restoration including, but not limited to gravel processing and cleaning. Dust abatement water may also be obtained from existing or constructed on-site seep wells, or directly from the Trinity River.

- When irrigation is necessary for revegetation efforts, the primary water source will be the Trinity River. Any surface water sources used for irrigation will comply with the water rights of land management agencies and landowners at the location of use.

- When drafting from the Trinity River, pump intakes will be operated and screened in conformance with criteria established by NMFS and CDFW to protect aquatic organisms.

TRRP project BMPs include:

- Vegetation removal would occur as necessary and in compliance with all regulatory requirements. Clearing and grubbing of vegetation would be limited to the period from August 1 to March 14, which is outside the March 15 to July 31 nesting (aka breeding) season for migratory birds in Trinity County. Vegetation removal and other site preparation may occur sooner if the absence of nesting birds has been determined. Site mobilization typically occurs in June.

- Existing roads would be used to access the activity areas, where available. New access roads and haul routes would be constructed, when necessary, and restored to a stable condition in accordance with appropriate landowner/manager requirements at the completion of the project.

- Floodplain excavation and terraforming would bring riparian surfaces to design grades.

- Quality resource material found during construction (e.g., quality soils, woody material, sand, trees, etc.,) may be stockpiled for use at in construction use areas located in upland or other activity areas.

- At Project completion, generally riverine treatment areas (e.g., constructed inundation surfaces) that were compacted from construction activities would be ripped to a depth of approximately 18 inches. The furrows developed by this ripping will ensure that most storm water runoff is retained and filtered on-site so that there is little or no construction-related turbidity. Ripping in this manner eliminates the release of storm water runoff and turbidity from the site by increasing infiltration. Consequently, post-construction non-biodegradable sediment-control measures, such as silt fences, are removed. Terraforming to increase onsite infiltration (using CA DOT-BMP and site stabilization standards) will be completed

- The timing for work adjacent to the river may be affected by river flows. If for some reason the flow is low when construction starts, but it is anticipated that flows will increase before the floodplain can be excavated, excavation would occur at the lower elevations (adjacent to river) first and at the higher floodplain elevations last. In cases where flows will be increased and will scour recently constructed surfaces, BMPs will isolate the work areas only against summer base flow conditions. Consequently, boat dance flows which peak at >6 times the summer Trinity base flow of 450 cfs, will temporarily cause short-term increases in downstream turbidity (boat dance flows in odd years on the Trinity River have recently peaked at approximately 2,600 cfs in 2017 and 2019).

- In-channel activities, including removal of grade control features and introduction of coarse sediment, would generally take place during low flows (July 15 to October 15). After September 15 precautions to avoid or minimize effects on rearing juvenile salmonids and spawning adults and their redds (see *Conservation Measures) will be in place.*

- High flow coarse sediment augmentation would occur at permitted strategic injection sites. In addition, potential to add gravel at other appropriate locations to enhance habitat or reduce transport deficit (e.g., Steel Bridge RD or Bucktail Bridge locations), is included in concept in this BA until a detailed proposal is provided. Coarse sediment would be introduced at prescribed high flow sites annually by pushing gravel into the river with heavy equipment, using a conveyor system to carry the gravel to mid-channel locations, or by leaving sorted coarse sediment in the floodplain during low flows to be recruited into the river during high flows[9].

- Alcoves and side channels would be constructed from the existing grade to lower elevations. Measures will be taken (e.g., sediment plug, sandbags) to isolate work areas from flowing water. If necessary, pumps will be used to dewater excavation zones to control turbidity levels entering the river. Reconnecting these features to the river relies on water management so that downstream turbidity levels remain below 20 NTUs at 500 ft below construction activities. If necessary, the TRRP will remove materials used to isolate these side channels after they have been constructed.

- Final grading seeding and mulching would occur, as necessary, for all activity areas. TRRP channel rehabilitation construction sites receive authorization to work through enrollment in the California State Water Board’s General Construction Permit (Order No. 2009-0009-DWQ as amended by 2010-0014-DWQ). Consequently, contractors follow the BMPs specified therein.

- Demobilization of construction equipment and site clean-up would be accomplished consistent with permits and land owner/manager requirements.

- Revegetation measures to salvage impacted vegetation during construction are routinely made (e.g., willow clump and poles planting). Post-project revegetation would take place during wet conditions (fall/winter) and would generally occur in riparian areas to maximize use by fish and wildlife species. At a minimum, impacted areas approximately 3 foot above the low river water elevation will be seeded and mulched post construction. Where appropriate, revegetation efforts will be also be implemented to establish native vegetation in upland spoils areas. Projects are generally designed and implemented to achieve no net loss in riparian vegetation (within the project site boundaries) from planting and natural revegetation consistent with the Draft TRRP Riparian Revegetation and Monitoring Plan (TRRP 2016a).

Construction compliance monitoring: The TRRP has the potential to create short-term impacts during construction of channel rehabilitation projects and implementation of sediment management activities. The TRRP is responsible for both implementing environmental mitigation measures associated with

[9] This method was utilized at Sawmill and Lowden Ranch sites during high flows in 2019.

direct and cumulative effects of large-scale environmental restoration projects, as well as monitoring effectiveness of mitigation performance. Monitoring occurs prior to and during construction to ensure compliance with environmental commitments, including:

- pre-construction surveys and periodic inspections during construction for birds and other wildlife;
- pre-construction records searches and surveys for cultural resources;
- pre-construction mapping and quantification of wetlands and riparian vegetation;
- fencing and marking of vegetation and other habitat features, and cultural resources, that are to remain undisturbed and protected, or used as salvage material, during construction, and periodic inspection during construction to ensure regulatory compliance;
- during in-water work by heavy equipment, inspections of shallow water areas in order to carefully displace any juvenile salmonids, allowing them to redistribute under their own volition, away from work sites;
- salvage, transport, and release of fish, including ESA-listed SONCC Coho Salmon, and sensitive herptofauna (amphibians and reptiles) from work locations to the main river channel or other safe locations in the vicinity outside construction areas; and,
- All in-water work must comply with conditions of the TRRP's programmatic CWA Section 401 Water Quality Certification (see pg. 1-9 for permit numbers) and federal water quality objectives in the Water Quality Control Plan for the North Coast Region (Basin Plan; NCRWQCB 2011). During in-water construction activities, sediment and turbidity levels are monitored to avoid increasing turbidity over 20 NTUs above background levels in order to protect the Trinity River's "beneficial uses" (e.g., domestic supply, aesthetic enjoyment, and preservation of fish, wildlife, and other aquatic resources or preserves as defined in NCRWQCB 2011). The TRRP is also required to monitor turbidity released from channel rehabilitation sites during the first post-construction high flow. Monitoring has shown that the impact of channel rehabilitation on mainstem Trinity River water clarity is evident as the first high flows moves overland through the rehabilitation sites after construction. Construction impacts during dam releases at upstream sites, where mainstem water clarity is not frequently degraded by tributary input, is especially evident. The duration of this increased turbidity is usually less than a week.

- As a result of turbidity monitoring, the TRRP has continued to increase its capability to control turbidity during channel rehabilitation construction activities. Channel rehabilitation now includes creation of side channels, split-flow conditions, new river meander bends, wetlands, and placement of large wood and skeletal bar features. All require isolation of low-flow construction features -and control of water releases (and turbidity) downstream from these.

Post-construction monitoring for compliance with environmental commitments and permit conditions include:

- mitigation will be met when impacted riparian areas are revegetated with planted stock or with conditions that promote natural vegetation recruitment. One-to-one areal riparian replacement goals are achieved when monitoring within 10 years of project implementation measures that the spatial extent of functional riparian vegetation recovery areas (the sum of planted and natural recovery areas) is greater than the impacted riparian vegetation area. (TRRP 2016a Draft RRMP);

- monitoring, evaluation, and reporting of coarse sediment movement and deposition patters will be completed by the Program. Filling of adult holding habitat will be addressed respond to public and stakeholder concerns. Changes should be consistent with long-term management objectives to support river function, fishery resources, tribal and public trusts.

Other monitoring and annual evaluations occur for program-level compliance on the performance of the fishery flow release schedule and management of water temperature in accordance with the TRFE and the Water Quality Control Plan for the North Coast Region.

Implementation of Channel Rehabilitation Project Activities

A stream-lined example of the implementation process used in 2014 is displayed in Figure 9. The duration of the planning process is typically at least-24 months for any one project or group of projects. TRRP Program and stakeholders, including NMFS staff, collaborate throughout the planning, conceptual design and final design stages. The environmental compliance process begins during project design, continues through public disclosure (e.g.., NEPA, CEQA, and ESA) and applications for project implementation are applied for up to year prior to proposed construction. This process ensures final consistency with programmatic environmental permits and authorizations, including ESA BiOps and agency management plans (LRMP and RMPs) and facilitates authorization of work on land of all ownerships.

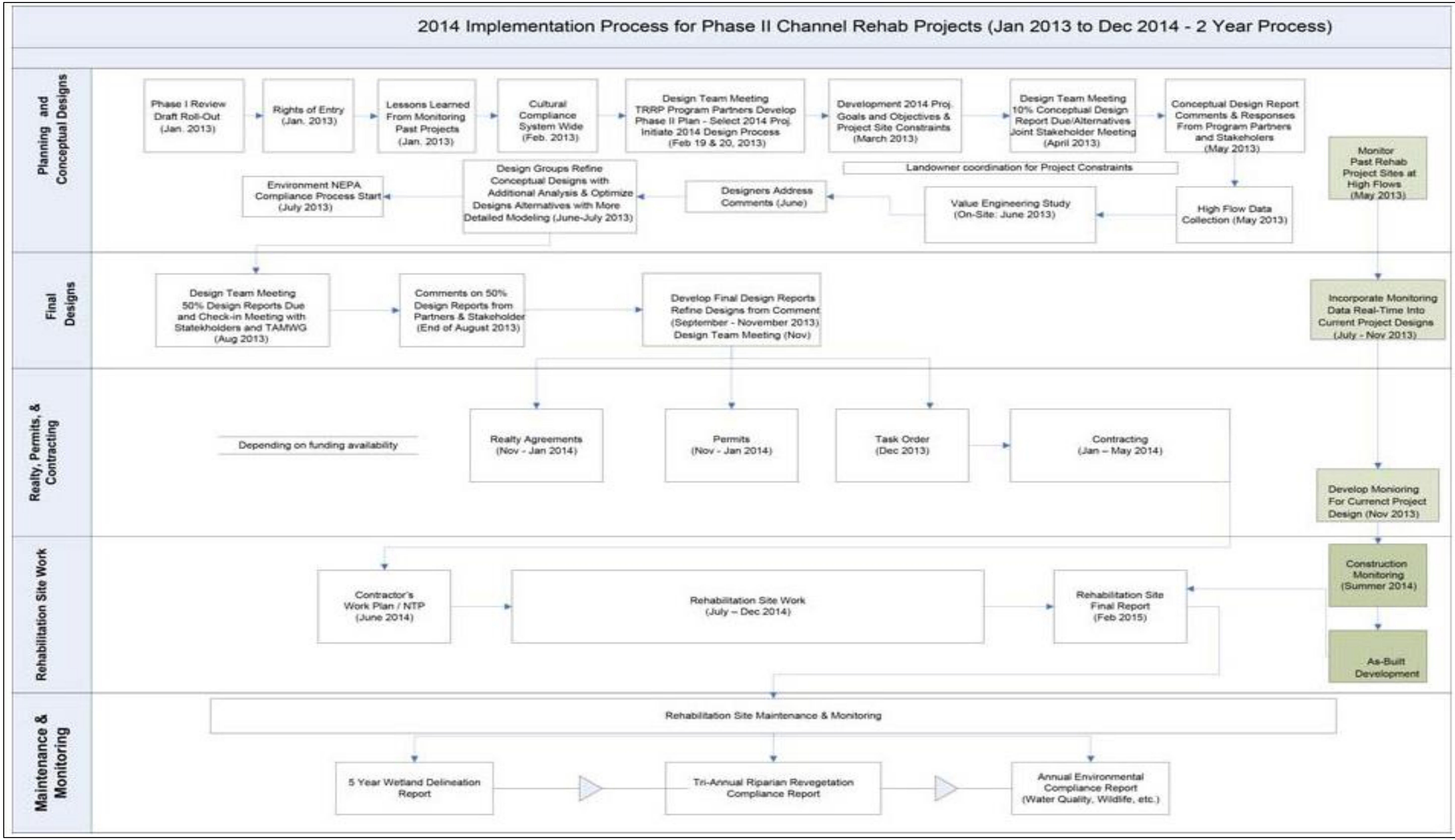

Figure 9. Example of Implementation Process for Phase 2 Channel Rehabilitation Projects ***Source: Gutermuth, personal communication, 2014***

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Coarse and Fine Sediment Management Activities

Early coarse sediment management activities focused on the immediate placement of coarse sediment to provide spawning and rearing habitat for anadromous salmonids as well as annual supplementation of coarse sediment to balance the coarse sediment transported out of the reach between Lewiston Dam and Rush Creek. Fine sediment management activities focused on BMP implementation within the watershed and periodic dredging of the Hamilton Ponds (sediment retention ponds on Grass Valley Creek). Fine sediment management activities also occurred on watershed restoration activities designed to reduce and control fine sediment originating in the upper watersheds from entering the Trinity River.

The experience, and results obtained from these early sediment management projects, has been incorporated into the designs of current coarse and fine sediment management practices. A comparison of the early and current practices is shown in Table 7 below.

Table 7. Comparison of Approaches and Designs of Early and Current Sediment Management Practices

Sediment Management Activity	Early Design (Evaluated by the 2000 BiOp)	Current Design
In-Channel Work (Working in the Wetted Channel)	In-river placement of graded coarse sediment at 2 established locations (a 1,500-foot reach immediately downstream of Lewiston Dam (River Mile (RM) 111.9) and a 750-foot reach immediately upstream of the USGS cableway at Lewiston (RM 110.2). Annual placement at these sites and one additional location at the “weir hole” site located at the Lewiston gaging station (RM 110.9) were evaluated. At the weir hole placement could occur during or after peak flows (USFWS and HVT 1999). Periodic dredging of Hamilton Ponds with an excavator.	Immediate placement has been completed. Annual coarse sediment augmentation above Indian Creek has been established at 5 locations. Coarse sediment size mix recommendation continues to include various proportions of river-run gravel and cobble 5/16- to 5-inches diameter, not to exceed 6-inches diameter. Fisheries scientists are considering a recommendation to add a smaller size fraction (<5/16 inch) in the Lewiston Reach where this fraction has been winnowed. Periodic dredging of Hamilton Ponds with an excavator.

Table 7. Comparison of Approaches and Designs of Early and Current Sediment Management Practices

Sediment Management Activity	Early Design (Evaluated by the 2000 BiOp)	Current Design
Construction Work Period ("Work Windows")	No in-river work. Most construction was scheduled between July 15 and September 15 to minimize impacts to anadromous salmonids. However, it was contemplated that construction during other seasons should not be precluded, with proper safeguards to avoid and minimize impacts. Placement of coarse sediment occurred during periods of low flows and potentially during peak flows at the weir hole. Dredging of Hamilton Ponds was conducted between July 1 and October 15, in years when ponds filled.	Low flow placement is proposed to occur generally between July 15 and September 30 before spawning begins, when impacts can be minimized or avoided. High flow gravel injection at select Lewiston reach sites is proposed to occur between April and May but may occur earlier as pre-peak flow floodplain placements. Gravel may be placed in the floodplain (below the OHWM) whenever flows allow so that recruitment to the river will occur when flows increase. Dredging and watershed restoration projects scheduled between June 15 and October 15 (in Trinity River tributaries) to minimize or avoid impacts to anadromous fish in perennial and intermittent tributaries. Hamilton Pond dredging is not expected to occur for more than 10 days over a 2-week period and will occur during low flow conditions.
Immediate Coarse Sediment Placement to reduce sediment deficit	Immediate placement of gravel quantities based on the water year type from 0 cy in critically dry years up to 67,000 CY to be added in extremely wet years. Two sites between Lewiston Dam and Rush Creek were selected to restore the gravel deficit caused by blockage of upstream coarse sediment supply at the TRD. An average augmentation of 10,000 cy per year was expected.	Immediate placement has been completed. The river gravel deficit in most areas has been filled. Early augmentation was approximately 6,700 cy/year (Gaeuman 2008) to reduce storage deficits. 2014 analyses (Gaeuman 2014) reduced annual targets to less than 2,000 cy a year.
Annual Coarse Sediment Augmentation	Annual supplementation of coarse sediment was intended to balance the coarse sediment supply along the Lewiston Dam to Rush Creek segment.	Similar to early design, with revised water year target gravel augmentation volumes (see Table 8).
Construction of Skeletal Bars	Construction of skeletal bars was considered upstream of Indian Creek with a provision that they might be used downstream if monitoring downstream of Indian Creek showed no bar formation in the first couple years of high flows.	Annual coarse sediment augmentation above Indian Creek has been established and continues at 5 locations. Additional locations are being considered including but not limited to Near Bucktail Bridge and Steel campground. Channel rehabilitation below the Indian Creek confluence constructed gravel bars and skeletal (cobble) bars primarily for geomorphic purposes.

Table 7. Comparison of Approaches and Designs of Early and Current Sediment Management Practices

Sediment Management Activity	Early Design (Evaluated by the 2000 BiOp)	Current Design
Fine Sediment Management through Flow Releases	Mobilization and reduction of fine sediment (<1/32-inch) storage in the mainstem was facilitated by recommended flow releases.	Same. Data are under review to determine the fine sediment budget in the Lewiston Reach and if augmentation in that reach would be beneficial. If TRRP analyses indicate that fine sediment addition is needed a proposal would follow that includes: rationale, locations, sizes and quantity of material, and methods. It is expected that additions could be made at coarse sediment augmentation sites.
Fine Sediment Management through dredging of Hamilton Ponds	Prevention of fine sediment input from Grass Valley Creek was achieved by mechanical removal from sediment retention ponds.	Same. Authorization for mechanical removal remains.
Fine Sediment Management through Mechanical Removal	Reduction of fine sediment storage in the mainstem was achieved by berm removal and ROD flow implementation.	Removal of or augmentation of sediment from the active channel and on floodplains at channel rehabilitation sites continues to be included in site designs. Designs consider effect of construction on long-term habitat development and riverine processes. Organic material often now amends riverine areas to mitigate for historic mining impacts and to support riparian establishment. Efforts undertaken by single-family land owners to reduce fine sediment via erosion control and streambank stabilization techniques (such as those highlighted in Appendix C). Routine large wood placement and installation of bank-stabilizing plant species continues at localized sites on private land.

The following summary of sediment management activities is primarily taken and modified from the Master EIR (NCRWQCB and Reclamation 2009) and a 2014 analysis and recommendation of the gravel augmentation program (Gaeuman 2014). Additional information in this section, obtained from other sources, is cited where applicable.

Focused fine and coarse sediment management activities, in addition to those included in channel rehabilitation designs (described in Appendix B), will continue to occur, and may be expanded, at various sites within the action area. These sediment management activities consist of:

- Long-term injection and augmentation of coarse sediment (spawning gravel) (e.g., sediment particles ranging from 5/16- to about 5-inches in diameter) during high-flow events on the mainstem Trinity River at strategic locations upstream of Weaver Creek.

- Wood placement and management in areas that are lacking in-stream habitat structures.
- Removal of fine sediment (e.g., sand and silt particles < 1/32-inch [0.8 mm]) captured at the Hamilton Ponds sediment retention facility.
- Encourage Bank stabilization (bioengineering use of wood and vegetation) measures to remedy bank erosion that could affect infrastructure (e.g. private property - wells, levees, drain fields) along the Trinity River.
- Watershed restoration efforts to reduce erosion and fine sediment input to the mainstem Trinity River.

Coarse Sediment Augmentation

Recent analysis of sediment transport monitoring data, hydrologic patterns, and performance of gravel augmentation efforts since TRRP inception provides updated recommendations on annual gravel volumes to guide future augmentation activities (Gaeuman 2014). The recommendation revises annual gravel augmentation volumes compared to the original targets included in the ROD (Table 8). The gravel quantity recommended for augmentation varies by injection location and total augmentation targets are proportionally keyed to the Water Year Classification (Gaeuman 2014).

Table 8. Comparison of Early and Current Annual Total Coarse Sediment Augmentation Targets based on Water Year Classification

Water Year Classification	Early Design (Cubic Yards per Year)	Current Design (Cubic Yards per Year)
Extremely Wet	31,000-67,000	5,000
Wet	10,000-18,000	3,000
Normal	1,800-2,200	1,670
Dry	150-250	670
Critically Dry	0	0

Sources: USDOI (2000); Gaeuman (2014)

Coarse sediment augmentation (injections) at most sites is expected to occur primarily during high spring flows, when coarse sediment may be introduced to the river mechanically and be entrained by river flows and transported downstream. Injection areas would be of sufficient velocity to ensure that juvenile fish would not be holding there.

The TRRP intends to continue sediment transport monitoring, in conjunction with water year projections, to determine locations and gravel augmentation volumes on a yearly basis. The gravel augmentation targets will be adjusted as new information is acquired. Specifically, continued sediment monitoring data at Douglas City will likely be used to estimate annual gravel loads and augmentation volumes load, and the occurrence of a greater frequency of wet and extremely wet water years could make it necessary to temporarily increase the augmentation rate to balance the coarse sediment budget. For annual gravel augmentations, generic water year augmentation volumes are adjusted to the transport capacity of the water year flow release at augmentation locations using sediment transport rates measured on the Trinity River at Douglas City (Gaeuman 2014). Sediment monitoring at Lewiston (TRAL; Figure 5) evaluates transport under the effects of gravel augmentation, and at Limekiln Gulch (TRLG) (and Douglas City; TRDC – Figure 5) where gravel transport is only from tributary sediment inputs.

Activities associated with coarse sediment management include gravel processing, transport, and introduction to the mainstem Trinity River in the rehabilitation reach. Coarse sediment augmentation requires the use of heavy equipment, such as excavators, bulldozers, scrapers, gravel conveyors, and dump trucks at the injection sites. Gravel is may be graded by bulldozers, excavators, and loaders into lateral bars along the riverbank for low-flow installations. During high-flow installations, gravel is often placed directly into the high-velocity current in the river channel from high banks. Conveyor belts cantilevered over the river may be used to extend the distance into the channel for injecting gravels at some sites. In 2019, coarse sediment was piled in the floodplain during low flows and washed into the river during high flow peaks. Coarse sediment management also includes efforts to secure and provide a supply of processed gravel (of needed sizes and cleanness – generally sorted on BLM managed lands) in perpetuity for delivery at augmentation locations to maintain optimal Trinity River conditions.

Coarse Sediment Management Project Locations

In 2014, coarse sediment augmentation locations and injection methods were evaluated by the Gravel Augmentation Work Group, based on sediment transport monitoring data and performance of gravel augmentation (GATR; Gaeuman 2014). The locations of these sites are shown in Figure 5. In keeping with the intent of adaptive management, there will be further evaluation of locations (and potentially methods) to augment gravel in the future. A brief description of the five existing recommended primary locations for future long-term gravel augmentation is summarized from the TRRP Master EIR (NCRWQCB and Reclamation 2009) and the GATR as follows:

- **Hatchery.** The Hatchery location refers to a reach of river approximately 0.4 miles in length, located at RM 112.2 – 111.8, immediately downstream from Lewiston Dam and adjacent to the TRH. Several constructed spawning riffles were placed in the reach in 2006 and 2007, and planning was initiated to revisit the site in 2015. Initial design concepts favor coupling mechanical modifications with ongoing gravel augmentations that will increase local channel complexity and supply gravel to downstream reaches over the long term. The Program has not used the site since 2007 and is addressing concerns that gravel introductions here would increase hatchery fish spawning in-river and that changes channel rehabilitation efforts might increase overall hatchery-wild fish interactions.

- **Sven Olbertson (AKA Weir Hole, Diversion Pool, Lewiston Upstream).** This site, located at RM 111.15, has been used for high-flow coarse sediment injection since 2008 (low-flow augmentation was done here in 2002 and earlier) and is recommended for continued long-term use. It is located between Lewiston Dam and the New Lewiston Bridge. A concrete weir spans nearly the entire valley floor and constricts flow into a narrow rapid in the right half of the channel that drops into a deeply scoured pool. A level surface above flood stage on the right bank is suitable for stockpiling coarse sediment and operating heavy equipment that can inject gravel directly into the main flow during flood events. Flood flows at the injection point are characterized by large standing waves and strong turbulence that immediately entrains the injected sediment. This site has easy access to the river and a low risk of adverse impacts. When augmentation occurs here consideration to introduce gravel at less than peak flows is examined so that introduced sediment will transport within the river channel and not be deposited outside typically inundated areas.

- **Cableway.** The Cableway Reach, located between RM 110.18 and 110.46, is between the New Lewiston Bridge and the Old Lewiston Bridge in the center of Lewiston. It is a relatively straight, narrow channel about 0.6 miles in length that is bisected by a suspended cable historically used by the U.S. Geological Service (USGS) to measure streamflow. Due to its simple morphology, gravel placed in the channel during low-flow periods is likely to be entrained and transported downstream. Initial gravel augmentation occurred during August 2003 low flow placement in-river and a channel rehabilitation project was completed in 2008. Habitat gains have been documented for this site and it is recommended for continued gravel augmentation.

- **Sawmill.** The designation "Sawmill" refers to a channel rehabilitation site, as well as a high flow gravel augmentation location, located between RM 108.89 and 109.73. The Sawmill rehabilitation project, constructed in 2009, spans about 0.8 miles of river, and includes locations where constructed lateral bars have been revisited for gravel augmentation purposes: Sawmill "Upstream" and "Downstream," as well as the bluff on river right above the Sawmill Burner Hole. The Sawmill Burner site was last used for 2009 high flow placement with a conveyor belt. Adjacent dredge tailings are the primary source of processed upstream coarse sediment from BLM managed lands. Access to the river-left floodplain and constructed gravel bar allows low-flow (<3,000 cfs) delivery of a quantity of coarse sediment to the flood plain so that it may be recruited to the river during high flows

- **Lowden Ranch.** "Lowden Ranch" designates two high-flow gravel injections sites located between RM 104.4 and 104.95. The upstream Lowden Ranch site is considered suitable for future high-flow injections in wet and extremely wet years, when Lewiston Dam release magnitudes are sufficient to distribute the material downstream. The upper site also has good access and nearby contractor use areas to stockpile gravel. The second injection point at Lowden Ranch is located at the Grass Valley Creek delta (aka the "Fenceline") where the creek delta terrace provides a high surface from which to access the left bank of the river for delivery with front end loaders at high flow. Properly scaled gravel injections appear to be reasonable at this location in normal water years, when dam release magnitudes are modest. The "Fenceline" site was used to place approximately 1,400 cy of gravel during low flow periods between peak 2019 flows in the ROD hydrograph. Preliminary data indicate that the high flow recruitment of floodplain gravel from here was successful as at the lower Sawmill site. Both sites are recommended for long-term gravel augmentation.

Fine Sediment Management

Fine sediment management has evolved from a priority focus on abatement and removal of excess accumulations of fine sediment from the mainstem Trinity River channel and floodplain and the Grass Valley Creek watershed (prior to the ROD) to a focus on activities to prevent excess fine sediment from entering the river from upslope areas throughout the Trinity River watershed. These activities include accelerated road decommissioning, road maintenance, and road rehabilitation on public and private lands, however, all watershed management activities with a high value for reducing erosion from the upper watershed may be considered for future projects. The relative importance of sediment retention by the Hamilton Ponds to achieve fine sediment goals in the mainstem Trinity River is a subject of ongoing review, but operation and maintenance of these ponds, located near the mouth of Grass Valley Creek remains part of the TRRP's fine sediment management strategy (NCRWQCB and Reclamation 2009).

Fine Sediment Management–Sediment Retention (Hamilton Ponds)

The Grass Valley Creek sediment retention basin, known as Hamilton Ponds, is located on Grass Valley Creek just off Lewiston Road and consists of two basins, in series, on the creek creating the upper and lower Hamilton ponds (Figure 10). Periodic dredging of the ponds removes coarse granitic sand and bedload from the Trinity River system. However, due to revegetation efforts in the Grass Valley Creek watershed, the need for dredging has decreased. The TRRP last dredged the upper pond in 2006 and the lower pond in 2007.

When the upper pond has open volume, it captures the majority of the Grass Valley Creek sediment load. The lower pond captures sediment when the upper pond is full and/or when high flow conditions carry fine sediment through the first pond.

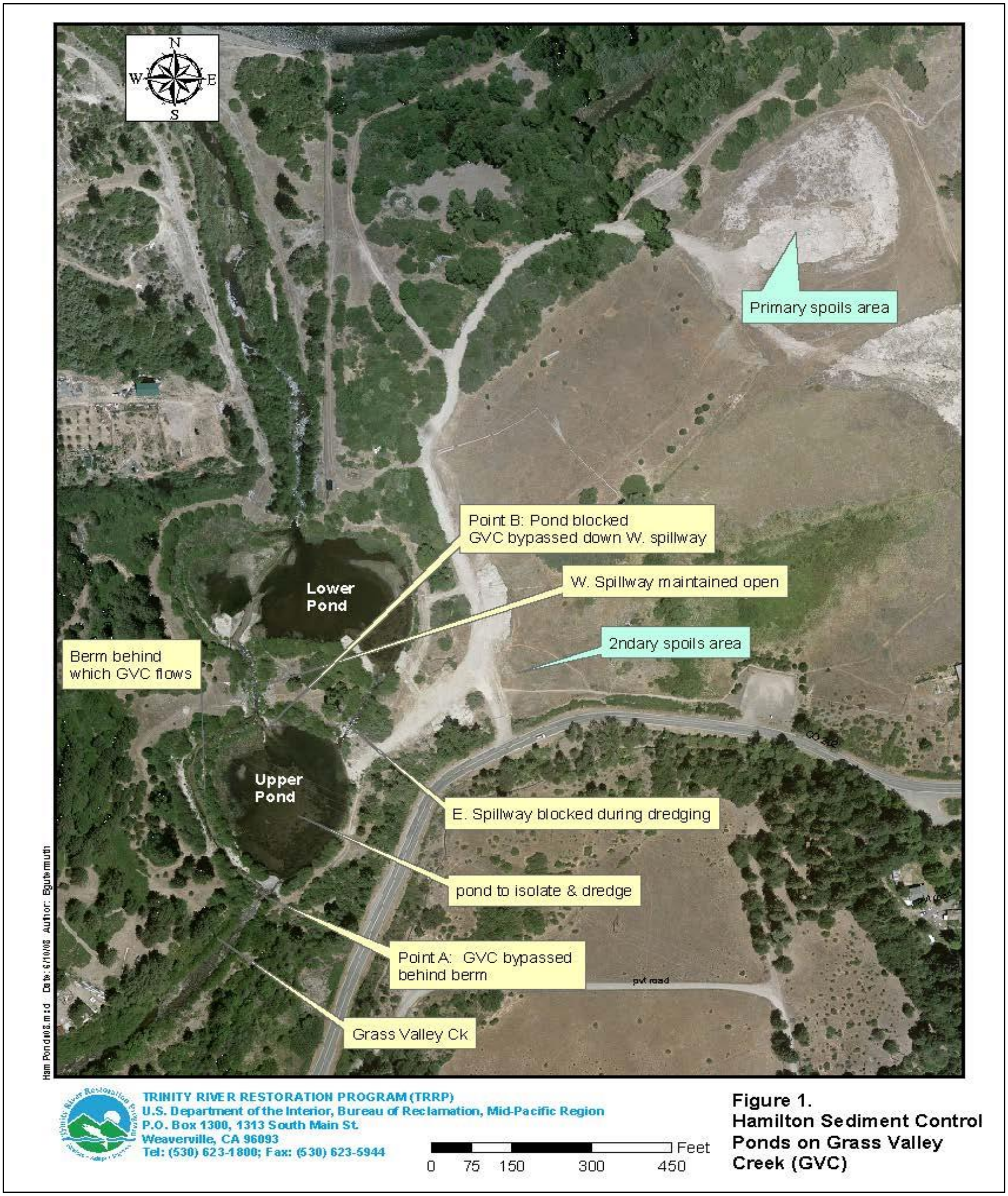

Figure 10. Upper and Lower Hamilton Sediment Retention Ponds on Grass Valley Creek.

The need for dredging the Hamilton ponds is dependent on 1) the water year type; 2) the accumulation of fine sediment during a particular water year; and 3) the benefits to local habitat for juvenile salmonids and Pacific lamprey. Typically, in years of heavy winter precipitation, sediment discharge is higher, and the ponds accumulate more fine sediment than dry years. Erosion and sediment production have been greatly reduced by watershed restoration and land management practices in the Grass Valley Creek (GVC) watershed over the last decade; however, wildfire in the upper and middle GVC watershed has exposed highly erosive soils that have recently released fine sediment to the system. It is anticipated that the upper Hamilton Pond may require dredging every 5-10 years. If the upper pond is dredged, the lower pond may serve as slow water habitat and may not need to be dredged. Removal of fine sediment from these retention basins will typically be conducted between July 1 and October 15 over approximately a 2-week period.

Sediment pond maintenance consists of the following construction steps:

- Recent observations of juvenile salmonids and lamprey ammocoetes rearing in the ponds has necessitated techniques to encourage volitional movement of fish out of the upper pond. It was thought that this could be accomplished by lowering the pond surface elevation by several inches (2-6) per day over a 2 to 7-day period. However, this was tried in 2018 and lamprey ammocoetes did not move in response to decreasing water elevations. They remained in their burrows. BMPs to minimize lamprey impacts from excavation are now being considered.

- Inflow to the upper pond may be closed by diverting GVC flow into a bypass channel. This channel, behind an earthen berm on the west side of the upper pond, will be re-excavated and flows will be diverted into the bypass channel with sandbags or a plug of native alluvial material. . Additional pumps or pond levelers may be used to lower the pond and fish are expected to leave to downstream areas away from the excavation zone or to avoid the area via the by-pass channel. Seines will be used to further push fish downstream out of the pond. The permeability of the alluvial substrate is such that some water remains in the pond during dredging activities.

- The dredging/excavation area is isolated from the rest of the pond using a silt/turbidity curtain. Recent observations of juvenile salmonids and lamprey ammocoetes in the ponds have necessitated techniques to install the silt curtains in a manner that “herds” fish away from the area to be eventually surrounded by the curtain. Additional dewatering and fish removal using seining and electrofishing may be used to salvage fish from within the enclosed work area prior to dredging. Fish will also leave volitionally as water quality degrades. Salvaged fish will be released into bypass channel of GVC.

- Fine sediment consisting of silt, clay, sand (< 1/16-inch [2 mm]), and decomposed granite granules (~6-8 mm) is removed from the pond using an excavator and a dump truck. Monitoring of water quality and spoils will occur during excavation to minimize impacts to juvenile Coho and Lamprey ammocetes.
- Excavated material is placed at a disposal site within the Lowden Ranch site boundary on California Department of Water Resources managed property. The Department of Water Resources also manages ponds on the Hamilton property specifically for the purpose of reducing Trinity River sediment delivery.
- Revegetate area near the inlet of GVC and around the upper pond to provide in-water cover for juvenile fish.
- Slowly remove plugs moving downstream to upstream to minimize water quality impacts.
- The silt/turbidity curtain is removed after turbidity has settled, and inflow to the basin is restored.

Streambank Stabilization

As described in the Master EIR (2009) bank stabilization measures to minimize bank erosion may be implemented at channel rehabilitation sites or at other locations (such as private property). Techniques to stabilize streambanks and reduce fine sediment input range from upslope erosion control activities to stabilizing stream banks with in-stream structures. Bioengineered bank stabilization techniques and mitigation measures (e.g., wood placement and vegetation) which enhance or create salmonid habitat are incorporated into the designs outlined in Appendix C, Table C-1 (ESA 2019). Proposed streambank stabilization techniques are outlined below and were generally grouped by location, either above the OHWM, below the OHWM, or both. Streambank stabilization techniques are continually evolving; therefore, the proposed techniques are not meant to be exclusive of additional designs.

Above OHWM designs include but are not limited to:

- removal/relocation of infrastructure away from eroding banks;
- exclusionary fencing to prevent human or livestock trampling of vegetation and compaction along banks;
- Flow spreading where concentrated flows are converted to sheet flow by filling rills and small gullies
- Preventing rill and gully formation and promoting infiltration by ripping soil on terrain contours to break flow patterns and reduce compaction
- Adding floodplain roughness elements such as native plantings and live stakes to slow flows and facilitate fine sediment deposition

Above and below OHWM designs include but are not limited to:

- Revegetate and manage native planting on floodplain and banks to slow flows, promote infiltration, stabilize soils, and gather fine sediment. Management includes removal of non-native, invasive plant species that may compete with native species.
- Install biodegradable erosion control blanket (ECB) or fabric on slopes to stabilize soils and revegetate by seeding, planting, or live staking (e.g., with willow and cottonwood poles).
- Install biodegradable wattles to promote soil stabilization and prevent rilling on slopes
- Plant live poles or pole fascines (bundles) of riparian species to stabilize banks and as part of slope revegetation.
- Install brush mattresses or brush layering which involves excavation of perimeter trenches along the bank toe, planting live poles (that are laid on the soil surface to encourage rooting all along the poles), then backfilling with fines, gravels and cobbles, and anchoring with biodegradable ropes and stakes.
- Install vegetated soil lifts (VSL) to reconstruct overly steep or slumping streambanks. Steep banks are reconstructed in steps composed of biodegradable fabrics filled with soil for a planting medium. Seeding and staking occurs between steps. Often a rock toe revetment is constructed to protect against scour and provide a stable base for the VSLs.
- Bank grading may lay back slopes to stable angles, and slopes will be replanted to increase soil stability.
- Bank grading and revegetation with a rock toe treatment can be used to stabilize eroding banks.
- A vegetated rock toe can be used in locations with high scour potential. This can include VSLs or brush mattresses installed above the rock toe.
- Large wood crib walls are constructed in locations with very limited space (e.g., a 1:1 slope) and may use a vegetated rock toe as a foundation.
- Willow siltation baffles may place live poles in shallow trenches, anchor with ballast cobbles, and backfill with native soil.

Below the OHWM designs include but are not limited to:

- Wood placement installed at the toe of banks to redirect flow and provide a foundation for other bank stabilization techniques.
- Site-specific placement of native alluvium (gravels and cobbles) may be used for short-term protection against toe erosion. Gravel and cobble size selection and the appropriate placement location vary widely based on the general variability of a particular river system, e.g. site-specific criteria in relation to the river cross-section, proximity to Lewiston Dam, and upstream tributary flows.

Appendix C includes a list of proposed streambank stabilization designs, location of method, and design references for each technique (ESA 2019).

Watershed Restoration Activities

Watershed restoration efforts outlined broadly in the ROD were to address negative impacts resulting from land use practices in the Trinity River Basin. Previously, only watershed restoration and management projects that were not likely to adversely affect (NLAA) ESA-listed and proposed species or adversely modify designated or proposed critical habitat were supported and funded by the TRRP. Watershed projects now include project activities that may result in short-term adverse effects to SONCC Coho Salmon and its designated critical habitat. Past Projects have focused minimizing sediment input from tributaries and included road maintenance, rehabilitation, and decommissioning on private and public lands with the Basin. To meet the goal of the TRRP to restore and maintain the Trinity River's anadromous fishery, activities have expanded to also restore and enhance aquatic habitat, hydrologic and ecologic connectivity, and overall aquatic function within watershed tributaries and the mainstem Trinity River.

The TRRP teams with partner and local agencies as well as the community to conduct watershed restoration projects. Upslope restoration needs are identified by the TRRP Program, the Watershed Work Group, and local entities and priorities are set by the TMC. Selection of watershed restoration projects is informed by watershed assessments and erosion inventories that have been prepared by local, state, and federal land managers. The BLM's 1995 watershed assessment (BLM 1995) for the mainstem Trinity River and the USFS's 2005 Upper Trinity River watershed assessment, including Trinity and Lewiston reservoirs (USFS 2005), supplemented by periodic updates, additional watershed assessments, and agency expertise, are used to inform the TRRP's decisions to support watershed projects.

Projects proposed on private lands and lands under municipal, county, and state jurisdictions are screened to ensure compliance with local ordinances and state and federal laws. Projects proposed for TRRP support on federal lands, administered by the USFS and BLM, are designed and implemented to be consistent with all applicable agency land and resource management plans and current guidelines for achieving aquatic resource conservation objectives. The TRRP watershed projects proposed on federal lands, will be screened for consistency with the ESA consultation guidance in the *Analytic Process for Developing Biological Assessments for Federal Actions Affecting Fish within the Northwest Forest Plan Area* (USFS et al. 2004) to ensure that proposed watershed restoration activities will contribute to improvements in watershed function compared to the environmental baseline and will avoid and minimize direct effects on listed and proposed species.

Watershed restoration activities are intended to maintain, enhance, and/or restore watershed processes that affect salmonids. Not all activity types have known locations; however, they are included due to potential benefits from implementation. All applicable general and specific conservation measures/BMPs will be applied to watershed restoration projects to avoid and minimize activity impacts on listed and proposed species.

Fish Passage

Activities associated with restoring fish passage include road crossing improvements (culvert or bridge), and removal and/or retrofitting barriers (small dams/diversions) for upstream fish access. Other barriers that may be encountered such as overly steep stream grades (due to anthropogenic actions such as mining) are covered under instream habitat enhancement activities. Removal of barriers or installation of fish passage is one of the most effective ways to increase fish numbers and a high priority habitat improvement measure for salmon, steelhead, and other fishes (Roni et al. 2002, 2008). Barrier removal also restores transport and channel forming processes (i.e. gravel and wood movement). Fish passage projects will be designed to meet NMFS's fish passage criteria (NMFS 2011c).

Upcoming projects include the Manzanita Creek Fish Migration Barrier Removal, East Weaver Creek Dam Removal, and the Oregon Gulch Culvert Replacement projects, propose to remove barriers and restore access to spawning, overwintering, and rearing habitat for salmonids including listed Coho. The project along Manzanita Creek will remove a small (unused) dam that is a migration barrier, restoring access to 1.5 miles of upstream salmonid habitat (NCRCD and 5C Program 2017). The East Weaver Creek project proposes to remove a 20-foot tall dam opening up approximately two miles of potential spawning/rearing habitat for salmonids including listed Coho. In addition to a migration barrier, the diversion can divert nearly all of the flow from East Weaver Creek, contributing to high stream temperatures and loss of downstream habitat connectivity. The East Weaver Creek dam does supply water for the Weaverville community so a new intake and pipeline will need to be installed to maintain a drinking water source (NCRCD and 5C Program 2017).

Instream Habitat Restoration and Enhancement

Habitat restoration and enhancement actions along tributaries include installation of habitat elements such as large wood, in-stream boulders, and spawning gravel as well as larger in-channel and floodplain rehabilitation projects.

Wood placement. Methods may include floodplain or in-channel tree placement with helicopter or mobile ground based mechanical systems. . Tree placement through helicopter and mobile ground-based methods do not require heavy equipment operation within the wetted channel compared to traditional in-channel placements. Whole trees with intact rootwads can be placed using a large helicopter in a short time period. As part of the South Fork Trinity River Instream Salmon Habitat Enhancement Project (2018), a 5.2-mile reach of the South Fork Trinity River was enhanced with about 270 salvaged trees placed singly as well as in structural configurations within three days. Trees were a maximum 100-feet long and 24-inches diameter at breast height (dbh). A mobile ground-based cable rigging system was used for trees larger than the maximum allowed for helicopter placement. This system could be driven to a site, set up on a road, and effectively reach trees up to ½ mile away. Using a series of block and tackle assembly's, trees up to 200 feet tall and 50-inches dbh have been tipped in place while keeping their canopy and root structure intact (Wiseman and Brock 2018). Traditional in-channel placements involve the use of heavy machinery in the active stream channel for excavation and/or wood placement. Conservation measures for in stream construction and water quality protection will be applied.

Channel and floodplain rehabilitation. Projects occur along degraded tributary reaches and may include channel re-grading and/or the addition of weirs, logs, and streambed substrate to facilitate passage and provide in-stream habitat. Lowering and reconnecting floodplain habitat as well as riparian restoration may occur.

The West Weaver Creek Salmonid Habitat Rehabilitation project recently reconstructed a 490-foot section of channel bed to provide fish passage to upstream habitat and improve in-stream spawning and rearing habitat for salmonids. The reconstructed channel included riffle-pool, step-pool, and cascade habitat features and two secondary side channels for additional habitat. A section of the floodplain was graded to provide high flow refuge, slow flows, and expand the riparian corridor. Habitat features such as large boulders, large wood, and spawning gravel were included to create in-stream habitat such as pools, provide cover, and retain sediment. Riparian revegetation with native plantings occurred along the channel and within the floodplain (Trinity County Resource Conservation District (TCRCD) and ESA 2017).

The Sidney Gulch (also known as Middle Weaver Creek) Forest Service Compound Fish Passage Restoration project proposes to restore 0.31 miles of stream that has been impacted by channelization through the town of Weaverville. The project proposes to construct a moderately entrenched plane bed channel with introduced gravel and small cobble as well as frequent small pools and other habitat features. The design has some sinuosity and would be able to convey sediment similar to upstream and downstream reaches. In-stream habitat features and riparian planting (1.5 acres) would provide habitat, shade, and bank stability. Weaver Creek has been identified as a priority watershed for Coho populations. The project will allow Coho Salmon to access 1.8 miles of upstream habitat (NCRCD and 5C Program 2017).

The Lower Sidney Gulch Urban Stream Restoration (Phase 2) project proposes to reconstruct between 17,945-43,275 square feet of floodplain area and between 495 to 845 feet of new side channels to create complex instream habitat via a meander bend, side channel, alcoves, wood, boulders, and riparian improvements. Currently, this section of Weaver Creek is urbanized and degraded. Coho have been observed migrating and spawning in Weaver Creek (NCRCD and, 5C Program 2017).

Stage 0 A relatively new process-based approach to channel restoration, Stage 0, may be used on upcoming projects in the Indian Creek and Salt Creek (S. Fork Trinity River watershed) drainages, and potentially in future TRRP mainstem projects. Stage 0 employs the stream evolution model (SEM) and strives to restore degraded stream reaches in depositional river systems to the pre-manipulated condition. Based on recent research, a multi-threaded channel configuration with broad floodplain inundation better represents the pre-manipulated condition. This can include construction of a Geomorphic Grade Line (GGL) based on GIS and field-based analyses, basically filling incising channels and installing floodplain elements to provide roughness (Powers et al. 2018).

The Indian Creek habitat connectivity project aims to restore low flow connectivity and raise groundwater elevation within a 1.5-mile pilot project reach. A section of Indian Creek goes subsurface (dry) during the critical migration period for Coho and Chinook Salmon (typically August and September) causing a barrier to migration and disconnection from upstream habitat. The project intends to construct hyporheic exchange structures and Beaver Dam Analogues (BDA) to force groundwater to the surface; capture and deposit fine sediments in the riparian and floodplain corridor; wood habitat and hydraulic structures will maintain pool habitat, provide cover and thermal refugia; and planting of the riparian zone will increase ecological and geomorphic function. Pre- and post- biological, water quality, and as-built monitoring will occur (Yurok Tribal Fisheries Program 2018).

The Salt Creek project, in the Hayfork Valley (S. Fork Trinity watershed), will restore floodplain connectivity and reconnection to the groundwater table within a ¼ mile stretch of the creek. Under certain conditions, Salt Creek can function as a season tributary to the larger Hayfork Creek. Salt Creek has been impacted by mining, building of levees, installation of riprap and a bridge that has caused significant channel incision, 10-12 feet, disconnecting the channel from the groundwater table. Salt Creek lacks habitat complexity, has high water temperatures, and warm water invasive species that negatively impact salmonid survival. Project elements include removing man-made berms/levees to reconnect the floodplain, using removed materials to fill the incised channel for immediate channel aggradation (Stage 0), installing rock weir/wood jams to facilitate aggradation and raise surface water elevations, and providing in-stream habitat (pool-riffle complexes, hyporheic flow, cover), and constructing a series of ditches to take stormwater to a treatment pond. The combination of floodplain improvements, channel aggradation, wood jams, and stormwater system will raise the groundwater table so that Salt Creek reconnects to its groundwater aquifer.

Revegetation

Revegetation may occur as a stand-alone project and/or part of larger watershed restoration activities to reduce upslope erosion from past land management such as timber harvest, mining, and poor road construction. Reoccurring wildfire also contributes to fine sediment and erosion reaching downslope aquatic habitats. Watershed revegetation efforts in the Grass Valley Creek, Hoadley Gulch, and Indian Creek watersheds will target reducing sedimentation rates into the Trinity River to restore fisheries.

In-stream Flow Restoration from Diversions

Projects will be designed to reduce water withdrawals especially during low flow conditions. Small diversions can cumulatively result in large water withdrawals which may result in low flows, high temperatures, and loss of habitat connectivity detrimental to salmonids. Projects include:

- Water conservation and efficiency outreach and education;
- Monitoring to determine low flow thresholds;
- Designing, permitting, and implementing individualized water conservation systems. New systems may include more efficient intake hoses and low volume pumps, the installation of slow flow systems such as trickle fill, solar, and ram pumps, and full forbearance systems to eliminate stream withdrawal during lowest flow periods (40,000 gallons plus in storage to completely forbear during the driest period).

A current project, the Brown’s Creek Water Resiliency Project proposes providing residents with water conservation and transaction products including low flow thresholds, voluntary forbearance agreements (landowners agree to curtail or forbear water diversions during critical low flow time periods), and conservation measures. Forbearance agreements will target all or most of the diverters in a watershed to effectively reduce withdrawals during low flow. Low flows and high temperatures have led to juvenile fish kills in 2014-2015 in the Browns Creek watershed. Brown’s Creek is a primary tributary to the Trinity River, providing more than 22 miles of anadromous salmon spawning habitat (WRTC 2018).

Projects will obtain required federal, state, and local permits such as: 1600 Lake and Streambed Alteration (LSA) authorization with CDFW; 1707 water transactions with CDFW; and Small Domestic Use (SDU) storage permitting with local Water Boards.

Road Related Actions

Support of watershed restoration and management activities to address excessive fine sediment production that can impact the mainstem Trinity River and tributaries will continue to be part of the TRRP into the foreseeable future.

Road-cut, fill-slope and stream channel erosion, resulting from old, poorly engineered and maintained roads, which could affect aquatic and/or riparian habitat or the infrastructure (e.g., wells, levees, drain fields) that has been constructed along the Trinity River will remain a priority for TRRP watershed restoration support activities. The Implementation Plan for the Preferred Alternative of the TRMFRP EIS/EIR (Stalnaker and Wittler 2000) identified potential road related watershed management activities supported by the TRRP to include:

- **Road Maintenance Activities.** Includes only activities where the impacts on water quality would result in insignificant or discountable effects on Coho Salmon habitat (e.g., working in dry conditions), and may include grading, rocking and clearing of drainage structures on existing roads.

- **Road Rehabilitation Activities.** May include replacing undersized culverts with new culverts or bridges capable of accommodating a 100-year storm, associated debris, out sloping, rocking of roads, energy dissipaters, and the addition of new drainage structures to reduce the accumulation of water in inboard ditches. Measures to minimize impacts to aquatic species include working in dry conditions or in isolated waters.

- **Road Decommissioning Activities.** May include the removal of stream crossing structures, culverts, "Humboldt Crossings[10]," and sometimes reshaping, ripping, seeding and mulching of the road surface, depending on slope, soil type and other conditions. Measures to minimize impacts to aquatic species include working in dry conditions or in isolated waters.

Implementation Process for Watershed Restoration Activities

Planning and implementation of the TRRP's watershed restoration activities follow an annual process of developing, implementing, and evaluating individual watershed restoration projects.

The annual planning and implementation of watershed restoration activities includes: (1) development of alternative watershed restoration projects; (2) screening and ranking of these alternatives by the multi-agency, multi-disciplinary watershed technical work group; (3) sharing technical recommendations with stakeholders; (4) sharing recommendations with the TMC; (5) implementing the activities; and, (6) monitoring and evaluating the ecological responses. Watershed workgroup technical proposals are vetted with stakeholders and the TMC will consist of (1) a description of the activities, (2) rationale and justification, (3) a prediction of the response of the project, (4) supporting analysis, (5) evaluation plan, and (6) a list of uncertainties and

[10] A stream crossing constructed with logs set parallel to the stream channel and covered with fill.

potential risks. The annual cycles of project implementation and evaluation of performance and outcomes will be documented and used, within an adaptive management framework, to inform future TRRP management decisions.

Scientific Research for Restoration Effectiveness (Fisheries Monitoring)

The TRRP supports and/or conducts fisheries research and monitoring activities including but not limited to: Snorkel and/or dive surveys; fish collection through various means such as electrofishing, nets (fyke net, seine, hand nets), collection at rotary screw traps, minnow trapping, and hook-and-line capture; acoustic tagging and biotelemetry, and passive integrated transponder (PIT) tagging; spawner surveys (redd counts) and carcass surveys; and tissue sampling and fish disease monitoring.

TRRP research activities on listed salmonids currently is permitted under the authority of an ESA Section 10(a)(1)(A) Scientific Research Permit (Permit 17877 and 17877-2A). The existing permit expires December 31, 2020, and Reclamation proposes to continue these research activities and other studies under this Section 7 consultation following yearly take limits, permit conditions (conservation measures), and annual reporting requirements. Specific take limitations per authorized activities are included in Appendix D. These studies include: (1) Trinity River juvenile salmonid outmigrant monitoring, (2) juvenile Chinook Salmon density monitoring, (3) Trinity River Chinook Salmon redd and carcass survey, (4) Trinity River invasive Brown Trout predation on Coho Salmon investigation, (5) Trinity River juvenile Coho Salmon ecology studies, and (6) watershed rehabilitation/research. Collection methods include rotary screw trap, boat electrofishing, hook-and-line, beach seine, fyke net, or minnow trapping. Fin tissue samples are collected from carcasses. Captured juvenile Coho Salmon are anesthetized, measured to fork length and a subsample of fish PIT (Passive Integrated Transponder) tagged, before all fish are released.. Conservation measures analogous to the 10(A)(1)(a) permit conditions are outlined in *Specific Conservation Measures for Fish Research Activities*.

There are six studies authorized under the current TRRP permit (Permit 17877 and 17877-2A) and these may continue to monitor restoration effectiveness:

- Study 1: Trinity River, Willow Creek and Pear Tree Trapping Sites- Data are being collected to assess juvenile salmonid production and emigration target dates (the date at which 80% of the juvenile salmonid population reaches Willow Creek). This collection assessment will help manage and evaluate the effect of water temperatures, flow releases, and restoration efforts in the Trinity River on outmigrating fish. Rotary screw traps are authorized to run from December to January at both locations with an emphasis on data collection between February and August. The goal of monitoring at the Pear Tree Bar site (rkm 118) is to estimate juvenile salmonid population size in the upper 65 kilometers of the Trinity River, the primary restoration reach. The goal of monitoring at the Willow Creek site (rkm 34) is to estimate the juvenile salmonid population size and emigration timing through the lower Trinity River. Technical reports synthesizing multi-year datasets are published to evaluate trends in outmigrant salmonid production, timing, and hatchery/natural composition of the population.

- Study 2: Restoration site surveys (snorkel/dive) between Lewiston Dam and the Trinity River North Fork, Direct count snorkeling methods are used to estimate spatial and temporal differences in relative abundance of juvenile Chinook Salmon within the approximately 40 mile (64 km) restoration reach. Recent surveys conducted from January through April (2012) revealed significant differences at the reach, site, and habitat scales. Early in the season, more fish were observed lower in the system, but later abundance was higher closer to the dam where spawning is higher. In addition, higher abundance was observed in areas with more bank cover. Increases in abundance occurred over time as the season progressed (Pinnix et al. 2013).

- Study 3: This study conducts annual monitoring of Chinook Salmon redd and carcass abundance and distribution in the mainstem Trinity River and selected tributaries from Lewiston Dam to the Klamath River confluence. Monitoring occurs from early September through mid-December. The goal of this study is to estimate total natural mainstem spawning escapement and temporal and spatial response of spawning to restoration over time. As habitat conditions improve, spawning distribution is expected to be driven by distribution of habitat, rather than proximity to the hatchery.

- Study 4: Brown Trout Predation Effects Evaluation (including capture, removal, energetics model, etc.). This study conducted electrofishing from February to April as well as other capture methods year-round in the Trinity River from Lewiston Dam to Weitchpec (Klamath confluence). Specifically, this study focused on capture of non-native Brown Trout via boat electrofishing, hook and line, hand netting, and through a fish weir near Junction City. Specific measures to avoid electrofishing impacts on Coho Salmon included electrofishing when adult Coho are not present (February to April) and only in deep pools or runs where juvenile Coho (and Chinook) would not normally be present (Alvarez 2014). The effects of Brown Trout predation on native fishes and endangered salmonids were evaluated by estimating abundance, age structure, and collection of diet information. Information was used to create an energetic model to determine the potential extent and magnitude of Brown Trout on native fishes. Results of this study showed Brown Trout at 6.5% of the biomass of Trinity Hatchery fish with consumption equivalent to 23% of the biomass of wild salmon in the study reach (Alvarez 2017). This study has been completed but the methods remain available.

- Study 5: This study performs research from April to December in the Trinity River and tributaries from Lewiston Dam to Weitchpec (Klamath confluence). Specifically, this study proposes to use PIT (Passive Integrated Transponder) tags inserted into juvenile Coho Salmon to determine the overwintering strategy of Trinity River Coho and extent of juvenile Coho use at specific study sites being monitored by PIT equipment. Presence of juvenile Coho within the Trinity River and tributaries will be surveyed via snorkeling and trapping (minnow, fyke, seine netting). Tagging of up to 3,000 juvenile Coho per year and PIT monitoring stations will be set up. This study has not been implemented yet.

- Study 6: This study performs research from April to October in the Trinity River and tributaries from Lewiston Dam to Weitchpec (Klamath confluence). Snorkel surveys and trapping (fyke, minnow, and seine nets) will be used to determine presence and abundance of salmonids where distribution information is unknown or poorly understood. This study has not been implemented yet.

- An additional mark-recapture study has been proposed to study the relationship between flow release timing and outmigration timing by juvenile salmonids, and to establish a causal link between outmigration timing and juvenile survival. This study may involve the implantation of PIT tags in out-migrating fish captured at screw traps and recapturing them in the lower Trinity River, lower Klamath River and/or the Klamath River estuary.

Conservation Measures

This section provides a detailed summary of the conservation measures and practices common to all ongoing and proposed TRRP activities described above.

General Conservation Measures (CM)

CM 1-Reclamation will ensure that all environmental permit compliance requirements and other authorizations with NMFS and USFWS, are integrated through design and technical work group notification and review. Inclusion of these measures will ensure that ESA-listed species protection objectives are met during implementation of restoration projects. The TRRP will coordinate schedules of restoration construction activities with various limited operating periods to protect ESA-listed species (both fish and wildlife) and other species (e.g., state-listed, BLM/USFS sensitive), as needed. Reclamation will coordinate with the NMFS, and its TRRP partner state and federal resource and land management agencies, or contractors, to perform any necessary surveys for presence of all life stages of listed SONCC ESU Coho Salmon and review available data and maps of annual spawning usage in vicinity of project sites for all species of Pacific salmon prior to implementation of habitat restoration projects.

CM-2 Channel rehabilitation at sites along the mainstem Trinity River often involves removal of fossilized riparian sediment berms. Some of the riparian vegetation associated with these berms will be protected and left undisturbed, where it provides immediate cover value for fish and shade to the river channel. Native vegetation that must be removed to achieve aquatic and riparian restoration objectives will be salvaged, to the extent possible, and used, with augmentation by nursery stock, for re-planting of willows, cottonwoods, and other native shrub and tree species. Planting will be designed to meet ACS ecological function objectives[11] incorporated in the STNF's and BLM's Redding Field Office management plans. Ecological objectives include establishing self-sustaining stands of native vegetation in the riparian zone, providing habitat elements for selected species of wildlife (including ESA-listed species), and providing a long-term source of large wood to enhance geomorphic processes (TRRP and ESSA 2009). Regulatory compliance criteria and ecological objectives will be specified in site-specific revegetation plans. Performance will be evaluated by a variety of monitoring activities, such as periodic assessments of natural riparian vegetation establishment and mortality, riparian vegetation mapping, avian studies, and assessing the performance of planted vegetation in riparian plantations[12].

CM-3 Performance monitoring and assessment of habitat restoration projects will be coordinated under an adaptive monitoring framework. (e.g., under guidance of the IAP, conceptual models' framework, or effectiveness monitoring of channel rehabilitation sites). The responses of habitat conditions and of fish and wildlife production, health, and condition attributed to TRRP restoration activities will be evaluated and used to inform program decision-making. Monitoring results will inform future designs with the goal of minimizing short-term adverse effects to special-status species and maximizing effectiveness of restored river function and habitats to improve long-term anadromous fish production, including Trinity River SONCC Coho Salmon.

CM-4 Prior to bringing construction equipment on site, it shall be thoroughly washed and inspected to be free of plant parts, soils, mud, and other debris that may carry weed seeds. All equipment to be used in water bodies, including heavy equipment, vehicles, boats, barges, oars and paddles, outboard engines, workers' wading boats, and water quality monitoring equipment shall be cleaned, decontaminated, and inspected to prevent the spread of aquatic invasive species per the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, Executive Order 13112 – Invasive Species (Clinton), and

[11] Primary aquatic ecosystem-level functional objectives for riparian reserves include water and nutrient regulation, large wood recruitment, shading and temperature regulation, and invertebrate prey production for fish.
[12] A draft Programmatic Riparian Mitigation and Monitoring Plan for the Trinity River Restoration Program is currently under development with an expected completion by 2020.

Reclamation's Technical Memorandum No. 86-68220-07-05, *Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species*, 2010 edition (Reclamation 2010).

CM-5 Restoration projects, either individually or cumulatively, will not remove or downgrade suitable habitat (on public or private land) for any listed species.

CM-6 Reclamation, through the TRRP scientists, will be responsible for ensuring that correct effects determinations are made for each project and that project implementation minimizes take of listed species. Disturbance distances and protective buffers may be adjusted according to the best available science and site-specific conditions.

Specific Conservation Measures to Minimize Disturbance from Instream Construction

CM-7 All restoration projects in the mainstem Trinity River and tributaries will restrict in-channel work to the in-water work window (June 15 to October 15 for tributaries and July 15 to October 15 for the mainstem). This is generally during the dry season and before listed Coho salmon begin their spawning migration. In-water work conducted after September 15 and before October 15 will be authorized using the most current Willow Creek weir Coho and Chinook Salmon counts and be based on the expectation that the potential to interfere with Coho or Chinook Salmon spawning will be minimized.

After September 15, the TRRP will employ mitigation measures, as needed, to preclude spawning (e.g., monitoring of site conditions to ensure that no spawners are present, placement of anti-spawning mats and/or large rock) within proposed disturbance areas. Restoration, construction, stream work, channel isolation, dewatering, and fish salvage activities within any wetted or flowing channel will occur only in this time period. Revegetation outside of the active channel may continue after October 15 in compliance with BMPs to protect water quality. Gravel injection may be directly placed in high velocity locations during high flows or on the floodplain during lower flows for "high flow" recruitment - both outside the in-water work window.

CM-8 Restoration, construction, fish relocation, and dewatering activities proposed within any wetted or flowing channel of tributaries to the Trinity River shall be restricted to the dry season (June 15 to October 15 for tributaries and July 15 to October 15 for the mainstem), before listed Coho Salmon begin spawning in tributaries. Revegetation outside of the active channel is typically implemented during the wet season, between October and April. Work in intermittent streams may continue beyond November 1, as long as weather conditions permit, and the stream channel remains dry. Construction and restoration work within intermittent stream channels must be completed before cumulative seasonal rainfall is sufficient to result in surface flow in the channel.

CM-9 Any water drafting from the Trinity River for dust abatement or irrigation will ensure pump intakes are operated and screened in conformance with criteria established by NMFS and CDFW to protect aquatic organisms. Intake screens will be designed with maximum 3/32-inch openings and a maximum intake velocity of 0.8 feet per second (fps).

CM-10 Fish passage will be provided for any adult and juvenile fish likely to be present in the project area during construction, unless passage did not exist before construction or where the stream reach is naturally impassable at the time of construction. After construction, and where appropriate, adult and juvenile fish passage that meets NMFS's fish passage criteria (NMFS 2011c) shall be provided for the life of the project.

CM-11 When fill is required to construct any low-water crossings, only clean, spawning-sized gravel fill from within river basin sources and/or native alluvium from on-site shall be used. Adequate water depths (≥ 12-inches) and velocities (≤ 2-feet per second), comparable to hydraulic conditions in local riffle-and-run features, shall be maintained for adult and juvenile salmonids to pass safely at any low-water crossing. Crossings which span the active channel (i.e., bridges or in-channel culverts) are preferred. If wet fords will be used beyond September 15, in-water fill shall be composed of materials that preclude spawning for the duration of work. Alternatives may include anti-spawning mats, or use of sufficiently large cobbles (8-12 inches in diameter) to inhibit use by spawning salmonids (particularly early spawning spring-run Chinook Salmon). Larger cobbles shall be removed, or moved to appropriate in-river locations (to provide habitat) when in-water construction is complete.

CM-12 Portable gravel sorting and wash plants for processing and stockpiling gravels for later use may be temporarily set up and used at some of the restoration sites.

CM-13 Where feasible, floodplain, riparian, and in-river construction methods will employ methods to minimize habitat disturbance.

CM-14 If use of heavy equipment will occur instream or access to the work site requires crossing a stream, rubber-tired equipment will be preferred. Use of tracked equipment will be minimized. If required, tracked vehicles shall use minimal hard turn paths and use temporary mats or plates within areas of sensitive soils.

CM-15 The amount of time heavy equipment is stationed, working, or traveling within a streambed or wet area shall be minimized. When heavy equipment is used within stream channels, areas with actively spawning fish shall be avoided. All heavy equipment will be pressure washed before entering work sites, and will be free of oil and grease residues prior to entering the wetted channel.

CM-16 Large wood and vegetation on banks and in the channel shall not be disturbed if not specifically included as part of the restoration design criteria.

CM-17 To avoid impacts to juvenile salmonids during high flow gravel augmentation, gravel shall only be injected in locations where water velocities are too high for suitable salmon holding and staging by fish.

CM-18 To avoid pile driving impacts, wooden piles only will be used for SLJ placement below the OHWM. Wooden piles may be driven by an excavator, or when needed, a vibratory pile driver will be used in preference over an impact driver.

CM-19 When work site isolation is necessary to protect species, critical habitat, and/or water quality, coffer dam(s) shall be built with non-erosive materials (e.g., clean river gravel, native alluvium (usually from on-site), concrete k-rails, or sand bags, and may be sealed with sheet plastic. Foreign materials such as sandbags and sheet plastic shall be removed from the stream upon project completion. Post construction, isolated areas shall generally be breached to return the stream flow to the natural channel. Clean gravel or alluvium may be left in the stream and spread to match river elevations when work is complete.,.

CM-20 When block nets are used to isolate and prevent fish from entering construction areas, nets shall be installed up- and downstream of construction zones and secured to the streambed and banks and left in place until work in the stream channel is completed. If left in place, nets shall be monitored, at least daily, to ensure that they remain secured and free of organic accumulation.

CM-21 Any fish and herpetofauna (amphibians and reptiles) trapped within isolated work areas by block nets or cofferdams shall be captured and released as prudent to minimize risk of injury, then released at a safe site, preferably upstream or downstream of the isolated reach in a nearby pool or other area that provides cover and flow refuge[13]. Holding time will be minimized. Fish and herpetofauna will be captured by seines, dip nets, by hand, or in minnow traps set overnight. Animals will be handled with extreme care and under the supervision of qualified biologists. Animals shall be kept in water to the maximum extent possible during handling and transfer procedures. Large containers (e.g., 5-gallon buckets) with covers and well oxygenated water shall be used to move captured fish. Fish will be segregated by size in separate buckets, as necessary, to prevent predation of small fish by larger fish. Fish shall not be subject to excessive jostling or noise, shall not be overcrowded in buckets, and water temperature shall be monitored and prevented from increasing by more than 4°F (2°C). Records of species, life-stages, numbers, and disposition of all fish captured shall be kept.

[13] In cases where the stream is intermittent upstream of the construction site, release fish downstream away from the influence of construction activities.

CM-22 If seining, dip-netting, or trapping of fish is infeasible or otherwise ineffective, electrofishing may be used to capture fish from isolated work areas under the supervision of a qualified fishery biologist. Electrofishing will primarily be used to ensure fish removal (salvage) from areas where construction will otherwise result in the death of fish that are not removed (e.g., side-channel reconstruction). NMFS's (2000b) electrofishing guidelines shall be followed. If possible, electrofishing shall not occur when water temperatures are greater than 64°F (18°C) or are expected to rise above this temperature prior to concluding fish capture. No electrofishing shall be conducted in the vicinity of spawning fish or active redds. If electrofisher-induced mortality of fish occurs, capture shall be immediately discontinued (unless this would result in additional fish mortality) until current procedures are re-evaluated and any necessary adjustments are made to prevent or reduce further injury and mortality.

CM-23 When diverting flow around a work site is necessary (e.g., via pump, bypass culvert, or waterproof lined ditch) pumps shall be screened to prevent fish entrainment and culvert outfalls shall be fitted with energy dissipation devices to prevent damage to riparian areas and streambeds. Suction pump intakes shall be fitted with fish screens that meet CDFW and NMFS (NMFS 1997a; NMFS 2001) criteria to prevent entrainment or impingement of small fish. If diversion allows for upstream and downstream fish passage, place diversion entrances in locations to promote safe entry and reentry of fish to stream channels, preferably in pool habitat with cover. When necessary, pump turbid seepage water from dewatered work sites for disposal into upland locations, where it will not drain directly into any stream channel or where suspended materials will be filtered before flowing back into the stream.

Specific Conservation Measures to Minimize Degradation of Water Quality

CM-24 Alluvial materials used for coarse sediment additions and for creating low-water crossings shall be composed of clean, spawning-sized gravels (0.375 – 5 inches diameter) from local or on-site within river basin sources[14]. Gravels shall be processed to remove silts, sand, clay, and organic matter and shall be free of contaminants, such as petroleum products and heavy metals.

CM-25 To minimize short-term degradation to water quality during construction of stream restoration projects, and maintain state water quality standards and objectives for the Trinity River Basin, all provisions of the TRRP's current CWA section 401 water quality certification shall be followed, including meeting turbidity thresholds during project construction (i.e.,≤20 Nephelmetric Turbidity Units (NTU) at 500 feet downstream of in-river construction, when background turbidity is ≤20 NTU; and ≤20 percent increase in turbidity above background at 500 feet downstream, when background is > 20 NTU)[15]. If standards are not met, construction activities will cease until such

[14] Water Quality Certifications WDID 1A09154WNTR

[15] General Water Quality Certification Order R1-2015-0028; and Water Quality Certifications WDID 1A09154WNTR, and WDID 1A09155WNTR

a time that operations or alternatives can be completed within compliance standards.

CM-26 When appropriate to meet water quality objectives, construction areas shall be isolated from flowing water until project work is complete. Isolation methods include but are not limited to silt curtains, and sandbag cofferdams.

CM-27 Bedrock fracturing within the active river channel shall be conducted in an enclosure coffered with sandbags and dewatered using submersible pumps, when necessary. Sandbags and other temporary barriers will be erected surrounding the bedrock-fracturing work area to contain flying rock fragments. Similarly, sandbags (or other barriers) will be layered around and over blasting sites to contain flying rock fragments and to absorb and attenuate percussive pressure waves caused by blasting.

CM-28 Effective erosion control measures shall be in place at all times during construction. All temporary erosion control devices (e.g., straw bales with sterile, weed free straw, silt fences) shall be placed downslope or downstream of project site within the riparian area, where the likelihood of sediment input exists. These devices shall be in place during and after construction activities to minimize fine sediment input to flowing water and to detain sediment-laden water on site. If continued delivery of sediment to the waterway via runoff is likely to occur after construction is complete, then appropriate erosion prevention measures shall be implemented and maintained until risk of erosion has subsided.

CM-29 Erosion control devices, such as biodegradable coir rolls or erosion control blankets shall not contain plastic netting.

CM-30 Sediment shall be removed from erosion controls once it has reached one-third of the exposed height of the control. Whenever straw bales are used, they shall be sterile and weed free, staked and dug into the ground, at least, 4-inches. Catch basins shall be maintained so that no more than 6-inches of sediment depth accumulate within traps or sumps.

CM-31 Sediment-laden water created by construction activity in upslope areas, floodplain terraces, and dewatered work areas shall be directed to temporary storage and treatment sites (e.g., settling pond or Baker tank) or into upland areas to allow water to filter through vegetation prior to reentering stream network or other aquatic resource areas.

CM-32 All erosion control devices shall be inspected, maintained, and repaired prior to and after any storm event, at 24-hour intervals during extended storm events, and a minimum of every two weeks until all erosion control measures have been completed.

CM-33 Excavated material shall be stockpiled in areas where it cannot enter the stream channel and other waters of the United States. Prior to start of construction, locations shall be clearly identified and approved for depositing excavated materials well away from watercourses with the potential for sediment delivery into streams supporting, or historically supporting populations of listed salmonids. Spoils shall be contoured to disperse runoff and stabilized with mulch and (native) vegetation. As needed, use devices such as plastic sheeting held down with rocks or sandbags over stockpiles, silt fences, or berms of hay bales, to minimize movement of temporarily stockpiled soils.

CM-34 Debris, soil, silt, excessive bark, rubbish, creosote-treated wood, raw cement/concrete or washings thereof, asphalt, paint or other coating material, oil or other petroleum products, or any other substances which could be hazardous to aquatic life, resulting from project related activities, shall be prevented from contaminating the soil or entering the waters of the United States. Any of these materials, placed within or where they may enter a stream or lake, by the applicant or any party working under contract, or with permission of the applicant, shall be removed immediately. During project activities, all trash that may attract potential predators of salmonids will be properly contained, removed from the work site, and disposed of daily.

CM-35 If feasible, conserve topsoil for reuse within the restoration project site or use at other restoration sites, where appropriate. Haul spoils away from watercourses as soon as possible to minimize potential sediment delivery.

CM-36 When needed, use instream grade control structures to control channel scour, sediment routing, and headwall cutting.

CM-37 For relief culverts or structures, if a pipe or structure that empties into a stream is installed, an energy dissipater shall be installed to reduce bed and bank scour. This does not apply to culverts in fish bearing streams.

CM-38 Where slope protection is needed along rocky banks, stream bank stabilization measures, such as toe-of-rock slope protections, shall be placed below the bed scour depth to ensure stability.

CM-39 The use or storage of petroleum-powered equipment shall be accomplished in a manner to prevent the potential release of petroleum materials into surface and ground waters.

CM-40 Areas for fuel storage, refueling, and servicing of construction equipment must be located at least 150 feet from the active river channel or within an adequate secondary fueling containment area. On-site fuel storage (e.g., diesel and oil) will be maintained in double walled containment systems. In addition, the construction contractor will be responsible for maintaining spill containment booms onsite at all times during construction operations and/or staging of equipment or fueling supplies. Fueling trucks will maintain a spill containment boom at all times.

CM-41 All construction equipment must be in good working condition, showing no signs of fuel or oil leaks. Prior to construction, all mechanical equipment shall be thoroughly inspected and evaluated for the potential of fluid leakage. All mechanical equipment shall be inspected on a daily basis to ensure that no motor oil, transmission fluid, hydraulic fluid, or coolant leaks develop and that leaking equipment is not used until repaired. All leaks shall be repaired in the equipment staging area or other suitable location prior to resumption of construction activity.

CM-42 When equipment on site requires cleaning to remove dirt and mud, the wash sites shall be located in upland locations so wash water does not flow into a stream channel or adjacent wetlands.

CM-43 Oil absorbent and spill containment materials shall be located on site when mechanical equipment is operated with 100 feet of watercourse crossings. If an in-water spill occurs, no additional work shall commence in-channel until: (1) the mechanical equipment is inspected by the contractor, and the leak has been repaired; (2) the spill has been contained; and, (3) the onsite government representative, NMFS, CDFW, and the NCRWQCB have been notified of the situation. Depending on the severity of the spill, on-site evaluations by trustee agencies (e.g., NMFS, CDFW, and the WQCB) may be required.

CM-44 Hydraulic fluids (typically mineral oil) in mechanical equipment working within the stream channel shall not contain organophosphate esters. Vegetable-based hydraulic fluids are preferred.

Specific Conservation Measures to Minimize Loss or Destruction of Riparian Vegetation and Wetlands

CM-45 Project designs will create suitable conditions for riparian vegetation recovery over an area that is, at least, as large as areas impacted by restoration construction activities. Current mitigation compliance requires recovering an area equivalent to the area of impacted riparian habitat within 10 years of impact.

CM-46 Project designs will identify and use access routes and staging areas that minimize disturbance to riparian and wetland areas without affecting less stable areas, which may increase the risk of channel instability. Prior to construction, equipment access routes shall be marked that minimize riparian disturbance and avoid entering unstable areas.

CM-47 Project designs shall retain upslope trees and brush, as feasible, emphasizing shade-producing and bank stabilizing trees and brush in these areas.

CM-48 Project designs will specify hazard tree removal (amount and type), where appropriate. Fell hazard trees in riparian areas when they pose a safety risk. When possible fell trees toward the stream channel. Keep felled trees, with root-wads maintained as possible, on site when needed to meet large wood placement objectives.

CM-49 Prior to construction, qualified biologists shall clearly identify and mark biologically sensitive areas (e.g., wetlands and other jurisdictional waters, special-status plant species, riparian vegetation to be avoided) to be protected. Reclamation will inspect and maintain marked areas regularly throughout construction periods.

CM-50 To minimize disturbing areas of riparian vegetation and to minimize soil compaction, use equipment with the greatest practicable reach and minimize adverse impacts on soils (e.g., hand tools, minimally sized, low-pressure tires, minimal hard turn paths for tracked vehicles, temporary mats or plates within wet or sensitive soils).

CM-51 If riparian vegetation is to be removed with chainsaws, use saws that operate with vegetable-based bar oil.

CM-52 If feasible, re-use harvested trees for habitat restoration purposes (e.g., wood installation in the stream channel).

CM-53 Removed vegetation will be recycled for use in wood structures, to the extent possible, or disposed of by using as mulch, chipping, hauling offsite, burning, ripping into soil surfaces, burying within spoils areas, or other appropriate methods. The TRRP will continue to work with local agencies to encourage the efficient use of chipping as a priority method of disposing of vegetative waste.

CM-54 De-compact disturbed soils at project completion as the heavy equipment exits the construction area.

CM-55 Barren areas identified for revegetation shall be seeded and mulched, planted with a combination of willow stakes, native shrubs and trees, and/or erosion control native grass mixes.

CM-56 Native plant species shall be used for revegetation of disturbed and de-compacted areas. The species used shall be specific to the microclimate and conditions where the project is located and comprise a diverse community structure (plantings shall include both woody and herbaceous species).

CM-57 All plastic exclusion netting placed around plantings will be removed within 3 years.

Specific Conservation Measures Applicable to Fisheries Research/Monitoring Activities

CM-58 Reclamation or partners must ensure that listed species are taken only at the levels, by the means, in the areas and for the purposes stated in the permit application, and according to the conditions in Appendix D.

CM-59 Reclamation or partners must not intentionally kill or cause to be killed any listed species unless the permit specifically allows intentional lethal take.

CM-60 Reclamation or partners must handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, the permit holder must process listed fish first to minimize handling stress.

CM-61 Researchers must stop capturing and handling listed fish if the water temperature exceeds 70 degrees Fahrenheit at the capture site. Under these conditions, listed fish may only be identified and counted. Electrofishing is not permitted if water temperatures exceed 64 degrees Fahrenheit.

CM-62 If the handler anesthetizes listed fish to avoid injuring or killing them during handling, the fish must be allowed to recover before release. Fish that are only counted must remain in water and not be anesthetized.

CM-63 The handler must use a sterilized needle for each individual injection when passive integrated transponder tags (PIT-tags) are inserted into listed fish.

CM-64 If any listed adult fish are unintentionally caught while sampling for juveniles, the adult fish must be released without further handling and such take reported.

CM-65 Care must be used during spawning ground surveys to avoid disturbing listed adult salmon when they are spawning. To the extent possible, researchers shall avoid walking in salmon streams where listed salmonids have spawned and are likely to spawn. Visual observation must be used instead of intrusive sampling methods, especially when just determining fish presence.

CM-66 Backpack electrofishing equipment must comply with NMFS Backpack Electrofishing Guidelines (NMFS June 2000).

CM-67 Electrofishing is not permitted if listed adult salmon or Steelhead are present. The permit holder must avoid listed adult salmon and Steelhead. Any listed adult salmon or steelhead encountered while electrofishing is considered take and must be reported in the annual report.

CM-68 Reclamation must obtain approval from NMFS before changing sampling locations or research protocols.

CM-69 Reclamation must notify NMFS as soon as possible but no later than two days after any authorized level of take is exceeded or when exceedance is imminent. The permit holder must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

CM-70 Reclamation is responsible for any biological samples collected from listed species as long as they are used for research purposes. Reclamation may not transfer biological samples unauthorized recipients without prior written approval from NMFS.

CM-71 Researchers in the field must carry a copy of these conservation measures/conditions while conducting the authorized activities.

CM-72 Reclamation or partners must allow any NMFS employee or representative to accompany field personnel while they conduct the research activities.

CM-73 Reclamation or partners must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.

CM-74 Reclamation may not transfer or assign this permit to any other person. This permit ceases to be in effect if transferred or assigned to any other person without NMFS authorization.

CM-75 NMFS may amend the conditions of the research activities as long as reasonable notice is given to Reclamation or partners.

CM-76 Reclamation or partners must obtain all other federal, state, and local permits/authorizations needed for the research activities.

CM-77 On or before January 31st of every year, Reclamation must submit to NMFS a post season report in the prescribed form describing the research activities, the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, the take dates, and a brief summary of the research results. The report must be submitted electronically on NOAA's permit website; the forms can be found at https://apps.nmfs.noaa.gov/. Falsifying annual reports or records is a violation of this permit.

CM-78 If Reclamation violates any condition, they will be subject to any and all penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not conducted in compliance with the requirements of the ESA.

CM-79 Listed fish mortalities will be returned to the capture location. As required, tissue samples will be analyzed/archived at the NMFS Fisheries Science Center, Santa Cruz Laboratory Repository.

Specific Conservation Measures to Protect Wildlife Resources, Including Special-Status Species

CM-80 TRRP partners and federal action agency wildlife biologists shall participate in planning, design, and review of all activities affecting ESA-listed and other sensitive terrestrial species.

CM-81 Site-specific surveys to determine presence of habitat suitable for the reproductive phases of any special-status species shall be conducted by qualified biologists during the design phase, prior to construction. When suitable reproduction habitat is found to be present within project boundaries, or within known disturbance distances of suitable habitat for special-status and sensitive species, construction activities that could disturb or disrupt denning, roosting, breeding, nesting, brooding, and rearing activities shall be scheduled to avoid these reproductive periods (generally February 15 through July 31, covers the duration for all special-status/sensitive wildlife species in the region), to the greatest extent practicable.

CM-82 When vegetation or other structures are to be removed by a project and all necessary approvals have been obtained, potential denning, roosting, and nesting substrates or structures (e.g., shrubs, trees, culverts, bridges, old buildings) for special-status/sensitive species shall be removed before the onset of the breeding and rearing seasons, if feasible. This measure will help preclude denning, roosting, and nesting and substantially reduce the likelihood of direct impacts to breeding and young individuals.

CM-83 When scheduling of all construction activities with potential to disturb or disrupt reproductive phases of special-status and sensitive species is not practicable, pre-construction surveys shall be conducted within the timeframes and distances of project sites specified for each species of interest (usually 10-15 days prior to beginning work) to determine if active breeding sites exist. If active breeding sites are identified during any pre-construction surveys, appropriate measures for protection of resources will be recommended (e. g., determining construction buffer zones around individual nesting sites, establishing daily timing of construction activities to minimize disturbances of breeding individuals, relocation of egg masses/nests (herpetofauna), and removal of roosting structures during seasonal or diel periods of absence (e.g., bats). state and federal resource agencies shall be contacted to verify appropriate mitigation.

CM-84 Any known spotted owl nest tree may be removed only when it is an immediate danger, or when the tree is unoccupied by nesting birds or their young, and when the restoration project will only have insignificant and discountable effect ("not likely to adversely affect") on northern spotted owls due to habitat modifications.

CM-85 Other than in an immediately dangerous situation, tree removals must not contain spotted owl nests. In general, the minimum suitable nest tree size ranges from 11-to 18-inches (diameter at breast height) but local habitat suitability maps and individual tree suitability shall be verified by TRRP and/or program-partner wildlife biologists and used to inform site-specific restoration designs and implementation plans to protect northern spotted owls and critical habitat.

Upper Limits Anticipated on Actions

The expected maximum project implementation levels are based on current practicality and funding short-term implementation effects to listed fish species and trend accordingly; however, long-term restoration benefits would arguably be worth the increased impacts (Table 9). It is noted that in 2010 the TRRP used American Recovery and Reinvestments Act funding to construct 3 channel rehabilitation projects. Projects with no effect or insignificant, discountable effects were not included. Activities may include but are not limited to in-water work, fish salvage, changes to streambed, banks, and floodplains, gravel augmentation, fine sediment removal, infrastructure modifications, watershed restoration projects with in-stream work, and fish handling and/or take associated with fisheries research and monitoring activities. Depending on the level of implementation impacts, annual take would be less in some years than others. As needed Reclamation may request additional take.

Table 9. Annual Project Limit

Restoration Activity	**Annual Project Limits**
Mainstem Channel Restoration Projects	Expect up to 2 per year based on funding. Project sizes vary and include wood placements, alcoves, channel and floodplain and upland recontouring, side channel and wetland construction, riparian impacts and revegetation, and associated construction activities.
Coarse Gravel Augmentation	Up to 4-6 locations per year as needed. Addition of up to 8,000 cy mobile gravel added in a single year. Gaueman 2014 estimates up to 5,000 cy is reasonable in an extremely wet year.
Fine Sediment Removal	Mechanical removal from Hamilton ponds, up to once every 5 years
Infrastructure Modifications (i.e. bridge placement)	1 total per year
Watershed Restoration Projects (In-stream) Assumes implementation of planned projects all in one year.	2 Fish Passage/Dam removal projects 4 Channel/floodplain rehabilitation projects 2 In-stream habitat enhancement projects 2 In-stream flow/diversion restoration project (may be sub watershed-wide) 2-3 Streambank stabilization projects 4 Road related projects per year with in-water activities (i.e. de-commissioning with culvert removal)
Restoration Monitoring and Effectiveness	6 studies per year-see take limits and reported take in Appendix D

Reporting for Fish and Aquatic Species

For fish and other aquatic species, TRRP staff will provide an annual report to the NMFS. Reporting requirements for T&E wildlife species are provided in a draft BA to be submitted in early 2020 (TRRP, in preparation). Reporting efforts in the context of fish and aquatic species referenced in this BA will include:

- A list of all projects using the Programmatic BA within the past year. This list will include the name of the project, location information, the species and/or critical habitats affected, and if the project was informal or formal;
- The amount of allowable take that was used in the reporting period. Take will be reported for the year of occurrence (when the project was built); and
- The NMFS may request for additional reports on a project-specific basis. These reports may include, but are not limited to, hydroacoustic, turbidity, and fisheries research monitoring.

The TRRP will meet with the NMFS as needed to improve use of the Programmatic BA for all Program members.

Chapter 4
Status of Listed and Proposed Species and Critical Habitat

Listed and Proposed Species

This section describes species that are listed or proposed for listing as threatened or endangered under the ESA and proposed or designated critical habitats having the potential to occur in the action area and that may be exposed to TRRP activities. Special-status species were determined, in part, by review of a species list provided by the USFWS, database and website searches, and conversations with local experts. Federal special-status species and species of special concern occurring in the action area, or that may otherwise be affected by the action, and their current listing status, are identified in Table 10.

The NMFS West Coast Region website (http://www.westcoast.fisheries.noaa.gov) was consulted to augment information obtained on special-status anadromous fish and marine species. The combined lists for these map units, with information from the NMFS website, identified a total of nine anadromous fish species and one marine mammal species. These species are currently listed under the ESA as threatened or endangered and one is noted as a species of special concern.

A search of the California Natural Diversity Database (CNDDB; http://www.dfg.ca.gov/ biogeodata/cnddb/mapsanddata.asp) and Cal-Fish Database (http://www.calfish.org/) for distribution data on special-status species, based on records of actual observations, was performed to refine the list of species listed under the ESA and species proposed for listing under the ESA with potential to occur in the action area. Winter- and summer-run Steelhead Trout (*Oncorhynchus mykiss irideus*), fall- and spring-run Chinook Salmon (*Oncorhynchus tshawytscha*), and Coho Salmon (*Oncorhynchus kisutch*), were included in the CNDDB and/or the Cal-Fish database search results.

Table 10. Species included on the list generated by query of the US Fish and Wildlife Service's endangered and threatened species database, and augmented by the National Marine Fisheries Service website, for the Trinity River Restoration Program action area from Lewiston Dam to the confluence of the Klamath River and the Lower Klamath River.

Common Name[1] (Scientific Name)	Federal Status[2]	General Habitat	Potential to Occur in the Action Area
Southern DPS of North American Green Sturgeon *(Acipenser medirostris)* **Critical Habitat Designated**	T	Known to spawn in the Sacramento River, and historically in the Eel and Umpqua Rivers. Spawning occurs in cool, deep water, with turbulent flows over clean hard substrate.	**Absent from Action Area.** Known range of the species is outside of the action area and does not include the Klamath-Trinity Basin. Current range of species includes the Pacific Ocean and large river tributaries of the Sacramento-San Joaquin Delta.
Northern DPS of North American Green Sturgeon *(Acipenser medirostris)*	SC	Known to spawn in the Klamath and Rogue rivers. Uses both freshwater and saltwater habitat. Spawning occurs in freshwater rivers in cool, deep water with turbulent flows over clean hard substrate.	**Present in Action Area.** Known range in Trinity River extends up to a migration impediment at Gray's Falls (near RM 43). Sturgeon have been observed coming down Gray's Falls, so some make it above. However, mainstem channel work is more than 34 river miles upstream in the TRRP mainstem rehabilitation area.
Southern Oregon-Northern California Coasts ESU Coho Salmon (*Oncorhynchus kisutch*) **Critical Habitat Designated**	T	Spawn and rear in mainstem Trinity River and suitable perennial tributaries. Require cool year-round water temperatures. Prefer complex channel structure and dense overhead cover, and side-channel and floodplain connectivity. Spawns in shallow riffles with medium to large gravel substrate.	**Present in Action Area.** Known to occur in the mainstem Klamath River, Trinity River and perennial tributary streams. Suitable spawning and rearing habitat occur throughout the action area. The entire action area is included within the designated critical habitat for the SONCC ESU Coho Salmon.
California Coastal ESU Chinook Salmon (*Oncorhynchus tshawytscha*) **Critical Habitat Designated**	T	Spawn and rear in rivers south of the Klamath River to the Russian River. Estuaries and transitional habitats between the river and ocean are very important to CA Coastal ESU Chinook salmon.	**Absent from Action Area.** Known range for the species is outside of the action area and does not include the Klamath-Trinity River Basin. Northern-most extent of range is in Redwood Creek, Humboldt Co., CA.

Table 10. Species included on the list generated by query of the US Fish and Wildlife Service's endangered and threatened species database, and augmented by the National Marine Fisheries Service website, for the Trinity River Restoration Program action area from Lewiston Dam to the confluence of the Klamath River and the Lower Klamath River.

Common Name[1] (Scientific Name)	Federal Status[2]	General Habitat	Potential to Occur in the Action Area
Delta Smelt (*Hypomesus transpacificus*) **Critical Habitat Designated**	T	Endemic to the Sacramento-San Joaquin River Delta Estuary. Primarily located in the freshwater-saltwater mixing zone of the estuary, except during spawning season when it migrates upstream to freshwater.	**Absent from Action Area.** Known range of the species is outside of the action area and does not include the Klamath-Trinity River basin. Species is endemic to the Sacramento-San Joaquin Delta.
Sacramento River Winter-Run ESU Chinook Salmon *(Oncorhynchus tshawytscha)* **Critical Habitat Designated**	E	Spawn and rear in the Sacramento River below Keswick Dam. Requires cool water temperature for embryo incubation (typically during hottest part of the year).	**Absent from Action Area.** Known range of the species is outside of the action area and does not include the Klamath-Trinity River basin. Species range includes the Pacific Ocean and freshwater and estuarine areas of the Sacramento River.
Upper Klamath-Trinity Rivers ESU Chinook Salmon *(Oncorhynchus tshawytscha)*	NW	Freshwater rivers and streams, including the Trinity and Klamath Rivers and their tributaries. Chinook salmon require cool streams with deep pools and riffles, and gravel or cobble substrate. Trinity River is designated EFH for the species.	**Present in Action Area.** Known to occur in the mainstem Klamath River, Trinity River and perennial tributary streams. Consists of both spring- and fall-run races. Suitable over-summering, spawning, rearing, and migration corridor habitats exist throughout the action area.
Klamath Mountains Province ESU Steelhead *(Oncorhynchus mykiss irideus)*	NW	Freshwater rivers and streams, including the Trinity and Klamath Rivers and their tributaries. Steelhead require cool, swift, shallow water; clean loose gravel for spawning; and suitable large pools in which to spend the summers (CNDDB, CDFW 2002a).	**Present in Action Area.** Known to occur in the mainstem Klamath River, Trinity River and perennial tributary streams. Consists of both late-summer/fall- and winter-run races. Suitable spawning, rearing, and migration corridor habitats exist throughout the action area.

Table 10. Species included on the list generated by query of the US Fish and Wildlife Service's endangered and threatened species database, and augmented by the National Marine Fisheries Service website, for the Trinity River Restoration Program action area from Lewiston Dam to the confluence of the Klamath River and the Lower Klamath River.

Common Name[1] (Scientific Name)	Federal Status[2]	General Habitat	Potential to Occur in the Action Area
Southern Resident DPS Killer Whale *(Orcinus orca)* **Critical Habitat Designated**	E	Inhabit the inland coastal waters of Washington and British Columbia. Specifically, they occur in the Puget Sound, Strait of Juan de Fuca, southern Georgia Straight and to a lesser extent have been reported to be seen in the coastal waters of Oregon and central California, and the Queen Charlotte Islands (NMFS 2014). Sightings in central California coastal waters are infrequent, and southern resident DPS killer whales are likely to occur as transient individuals or in small pods. Threats to southern residents include decreased prey availability (NMFS 2011a), which may explain sightings in the coastal waters of California, as they travel in search of more abundant resources.	**Absent from Action Area.** Known range of species is outside the action area and does not include the Klamath-Trinity River basin. However, species have been occasionally sighted off the northern California coast. SR killer whales feed primarily on fish, with a preference for Chinook salmon. Designated critical habitat for the SR killer whale does not include the near-coastal ocean in vicinity of the mouth of the Klamath River. Interactions between resident killer whales and salmon produced in the Trinity River may occur well outside of immediate action area, throughout the overlapping oceanic ranges of the resident killer whale and their salmon prey.
Southern DPS Pacific Eulachon *(Thaleichthys pacificus)* **Critical Habitat Designated**	T	Occur in nearshore ocean waters, except for brief spawning runs into natal streams. Spawning grounds are typically in the lower reaches of larger snowmelt fed rivers. Spawning occurs over sand and pea gravel substrates. Eulachon run up and spawn in the lower Klamath River during the early spring months, rarely ascending the river more than 10 to 12 kilometers.	**Present in Action Area.** Known range of the species in lower Klamath River but does not extend upstream to the Trinity River. Interactions between eulachon and salmon produced in the Trinity River may occur outside of immediate action area, throughout the overlapping estuarine and oceanic ranges of eulachon and their salmon predators.

Notes:
1 "DPS" – Distinct Population Segment; "ESU" – Evolutionarily Significant Unit
2 Status: Federal Endangered (E); Federal Threatened (T); NMFS Species of Concern (SC); Not Warranted (NW).

The NMFS website indicated that the action area is within the current known range of the SONCC ESU Coho Salmon, Klamath Mountains Province ESU Steelhead, and the upper Klamath-Trinity Rivers ESU Chinook Salmon. The

NMFS website search was compared to both the CNDDB and Cal-Fish database results and the USWFS special-status fish species list, with support from literature searches and conversations with local experts. Federally listed species that do not occur in the action area, but that may be ultimately affected by the overall goal of the TRRP, to increase anadromous salmonid production in the action area, are also briefly considered in this BA. Species that occur in the Lower Klamath River are also included, even though no construction activities will occur in this watershed, only research activities. In consultation with NMFS, the southern resident DPS Killer Whale, Southern DPS Pacific Eulachon, and Southern DPS Green Sturgeon were identified for inclusion in this BA.

The upper Klamath-Trinity Rivers ESU Chinook Salmon, while not a federally listed species under the ESA, is a stock covered under the Pacific Salmon Fishery Management Plan (FMP), for which EFH occurs in the action area. As such, effects of the action on EFH for upper Klamath-Trinity Rivers ESU Chinook and SONCC ESU Coho Salmon require analysis as part of the EFHA, which follows the BA portion of this document.

This BA/EFHA has been prepared by Reclamation to identify and describe potential impacts of the action upon species listed under the federal ESA, their critical habitat, and EFH for Pacific salmon. This analysis includes SONCC ESU Coho Salmon, southern resident DPS Killer Whale, and Southern DPS Pacific Eulachon; and their designated critical habitat. The EFHA portion of this document will identify and describe potential impacts of the action on EFH for Pacific salmon, including Chinook and Coho Salmon.

The narratives that follow focus on attributes of the listed species' life histories and distributions that influence the manner and likelihood that a particular species may be exposed to effects of the ongoing TRRP action, as well as the potential responses of these listed species, when exposures may occur.

Southern Resident DPS Killer Whale

The southern resident Distinct Population Segment (DPS) Killer Whale (killer whale) was listed as endangered under the ESA in 2005 (70 FR 69903; November 18, 2005). Following the listing of the Killer Whale as an endangered species in 2005, NMFS designated critical habitat in November 2006 (71 FR 69054; November 29, 2006).

Killer Whales occupy coastal habitats in the northern Pacific Ocean, and there is no evidence that they travel more than 50 km offshore (Ford et al. 2005). The Southern Resident Killer Whale population consists of 86 individuals in three separate pods: 26 in J pod, 19 in K pod, and 41 in L pod (NMFS 2011a). Southern Resident Killer Whales primarily consume fish, with the majority being Chinook Salmon (Ford and Ellis 2006; NMFS and USFWS 2012). Members of L pod are most consistently recorded off the northern coast of California, with 11 sightings between 2000 and 2011; K pod had been observed

5 times, and there have been no recorded sightings of J pod in coastal areas of northern California (NMFS 2009 and 2011a).

Recorded sightings do not necessarily include all members of each pod, and NMFS considers the relatively low number of sightings a realistic reflection of the number of Killer Whales in the area during the study years (NMFS and USFWS 2012). Therefore, this migration of Killer Whales to Oregon and northern California is likely reflective of more transient individual or smaller group movements rather than large-scale group movements for long durations (NMFS and USFWS 2012).

Because the ongoing implementation of the TRRP has the potential to affect salmon abundance in the Pacific Ocean, and Killer Whale has been observed off the northern California coast, the environmental baseline for Killer Whales considers the interactions of salmon in the coastal area where they might encounter and prey upon salmon. The availability of Chinook Salmon to Killer Whales in coastal waters is affected by a number of natural and human actions.

Threats to the killer whale include a decreased prey availability, accumulation of high concentrations of contaminants (through bioaccumulation in prey), and vulnerability to ship strike or exposure to high amplitude sound (70 FR 69903; November 18, 2005). Other activities that may affect Killer Whale include NMFS authorized research activities, including attachment of satellite tags and other methods intended to understand their ecology in coastal waters (NMFS 2011a).

Human activities that cause negative impacts to include land use activities that result in freshwater habitat loss and degradation, hatchery practices, harvest and hydropower systems (NMFS 2008a). Recently, climate change and ocean conditions have been linked to growth and survival rates of salmonids (Wells et al. 2006). Generally, when the Pacific Ocean is cold and has abundant food resources, as a result of recurrent upwelling, salmon grow rapidly and are more likely to survive. The opposite is true when spring upwelling does not develop and ocean conditions are warmer (Wells et al. 2006, Lindley et al. 2009). Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fishes, birds, and marine mammals (including Killer Whale).

Although Killer Whales have not been documented in the coastal waters near the Klamath River, they may encounter and prey upon Klamath-Trinity River basin produced salmonids, particularly Chinook Salmon, that migrate along the coast as far north as the mouth of the Columbia River. Additionally, Killer Whales that leave the inland waters of British Columbia, and migrate towards the coastal waters of northern California, may be present in the vicinity of the mouth of the Klamath River as they travel south, at any time between October and March. Therefore, adult fall-run Chinook Salmon migrating into the

Klamath-Trinity River basin between September and November may serve as a prey base for passing Killer Whales.

Based on the beneficial effects of the action to upper Klamath-Trinity Rivers ESU Chinook and SONCC ESU Coho Salmon, it is anticipated that the action will not adversely affect killer whale but is expected to have a beneficial effect by increasing local populations of salmonids over the long term, which are important food sources for killer whale. Because the action is NLAA the killer whale, they will not be further considered in this BA/EFHA.

Southern DPS of Pacific Eulachon

The Southern DPS of Pacific Eulachon (eulachon) was listed as threatened under the ESA in 2010 (75 FR 13012; March 18, 2010). Following the listing of Eulachon as a threatened species in 2010, NMFS designated critical habitat in October 2011 (76 FR 65324; October 20, 2011). Eulachon are endemic to the eastern Pacific Ocean and primarily occur in near shore ocean waters, close to large snowmelt-fed rivers, which are used for spawning grounds. Historically, large aggregations of Eulachon were reported to have consistently spawned in the Klamath River. Allen et al. (2006) indicated that Eulachon usually spawn no further south than the Lower Klamath River and Humboldt Bay tributaries. The California Academy of Sciences ichthyology collection database lists Eulachon specimens collected from the Klamath River in February 1916, March of 1947, and 1963, and in Redwood Creek in February 1955. During spawning, fish were regularly caught from the mouth of the river upstream to Brooks Riffle, near the confluence with Omogar Creek (Larson and Belchik 1998), indicating that this area contains essential spawning and incubation, and migratory corridor features.

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

Based on the beneficial effects of the TRRP to upper Klamath-Trinity Rivers ESU Chinook and SONCC ESU Coho Salmon, it is anticipated that the ongoing action will increase salmon populations. Salmonids prey upon Eulachon and, as a consequence of the TRRP goal of increasing anadromous salmonid populations over the long-term, predation on Eulachon may also increase. However, salmon and Eulachon historically co-existed in the Klamath River basin, both at much higher population levels. Therefore, the amount by which predation by salmon may increase on Eulachon as a result of the ongoing implementation of the TRRP is expected to be within historical levels. The ongoing action is not expected to significantly alter the ecological relationship between salmon and Eulachon or the physical, chemical, and biological features in the Klamath River and estuary. Research activities occurring in the lower Klamath will not impact habitat and with the low numbers of Eulachon, incidental catch is not expected. Because TRRP is NLAA Eulachon and its designated CH, they will not be considered further in this BA/EFHA.

Southern DPS of Green Sturgeon

NMFS published a final rule listing the Southern DPS of Green Sturgeon as threatened in 2006 (71 FR 17757). Two Green Sturgeon DPSs are defined– a Southern DPS that spawns in the Sacramento River and a Northern DPS with spawning populations in the Klamath and Rogue rivers. The Southern DPS includes all spawning populations of Green Sturgeon south of the Eel River in California, of which only the Sacramento River currently contains a spawning population. The Southern DPS of Green Sturgeon has been listed as threatened under the ESA (71 FR 17757), whereas the Northern DPS is only a Species of Concern. McLain (2006) noted that Southern DPS Green Sturgeon were first determined to occur in Oregon and Washington waters in the late 1950s when tagged San Pablo Bay Green Sturgeon were recovered in the Columbia River estuary (CDFG 2002a). Northern DPS Green Sturgeon have been documented up to Gray Falls (RM 43) in the mainstem Trinity River. The distribution of northern and southern DPS Green Sturgeon overlaps outside of their spawning streams in coastal estuaries and marine waters from southern California to Alaska.

Critical habitat for Southern DPS Green Sturgeon was designated by NMFS in 2009 (74 FR 52300). Critical habitat includes specific physical and biological factors (PBFs) essential for the conservation of Southern DPS Green Sturgeon. PBFs for freshwater riverine systems include abundant food sources, suitable substrate for spawning and egg development, adequate flow regime, and suitable water quality. While Southern DPS Green Sturgeon have not been documented in the Action Area, according to NMFS, the presence of Southern DPS Green Sturgeon is likely (based on limited records of confirmed Northern DPS fish or Green Sturgeon of unknown DPS), but not confirmed within the Klamath/Trinity River estuary (74 FR 52300). According to Wiseman (personal communication 2018) in 2011, he observed a Green Sturgeon (50 inches) coming down over Gray's Falls, the supposed Green Sturgeon barrier, located at RM 43.5. Based on the beneficial effects of the action to upper Klamath-Trinity Rivers ESU Chinook and SONCC ESU Coho Salmon, it is anticipated that the action will not adversely affect Southern DPS Green Sturgeon but is expected to have a beneficial effect by increasing local populations of salmonids over the long term, which be a potential food base for Green Sturgeon. Research activities in the Lower Klamath will not impact habitat and because of low numbers of Green Sturgeon, incidental catch is not anticipated. Because the action is not likely to adversely affect the Green Sturgeon, they will not be further considered in this BA/EFHA.

Southern Oregon-Northern California Coasts ESU Coho Salmon listing designation

The SONCC ESU Coho Salmon was first listed as a threatened species on May 6, 1997 (62 FR 24588). "Threatened" status means the species is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (federal ESA Section 3 (20)). The SONCC ESU Coho Salmon includes all populations of Coho Salmon in coastal streams from the Elk River near Cape Blanco, Oregon southward to, and including, the Mattole River, near Punta Gorda, California. CH for this species was designated on May 5, 1999 (64 FR 24049). The mainstem Trinity River and accessible tributary reaches in the action area is occupied by all freshwater life stages of Coho Salmon and includes one or more of these physical and biological features essential to the conservation of the SONCC ESU Coho Salmon and has been designated as critical habitat.

Life History

Most Coho Salmon spawning streams flow directly into the ocean or are tributaries of large rivers. Females tend to prepare their redds (gravel nests) and spawn soon after arriving on spawning grounds between November and January with timing varying by watershed within the ESU (Weitkamp et al. 1995). Most adult Coho Salmon begin their freshwater spawning migration as three-year-olds in the late summer and fall, spawn by mid-winter, and then die (Shapovalov and Taft 1954; Leidy and Leidy 1984; Moyle 2002). Klamath-Trinity River basin populations of SONCC ESU Coho Salmon generally migrate upstream from September through late-December with arrival in the upper reaches peaking in November and December (Leidy and Leidy 1984; NMFS 1997; NMFS 2012). In the Trinity River, spawning mainly occurs in November and December (Leidy and Leidy 1984; Shaw et al. 1997; CDFG 2004; Figure 11). Prime spawning habitat conditions generally occur near the head of a riffle, just below a pool, where there is abundant small to medium gravel (Shapovalov and Taft 1954) and suitable water depths and velocity.

The number of fertilized eggs deposited in each redd is based on the fecundity of the female and their individual fertilization success, with fecundity ranging between 1,400 to 3,000 eggs and these eggs are dispersed among pockets within the redd (Sandercock 1991). Migration distance can also influence egg production, with longer migrations inhibiting egg size and/or quantity (Kinnison et al. 2001). Once spawning is complete the female will cover the redd with gravel and guard it until she dies (approximately 4 to 15 days) (Weitkamp et al. 1995). Ultimately, the success of reproduction depends on a number of environmental and biological factors that occur within the redd, the spawning site, and within the watershed, and many of these factors are linked to the timing of reproduction, one of the most critical adaptations Coho Salmon make to their spawning environment (NMFS 2014). Embryonic development begins when the egg is fertilized, and developmental rate and incubation period are inversely related to water temperature.

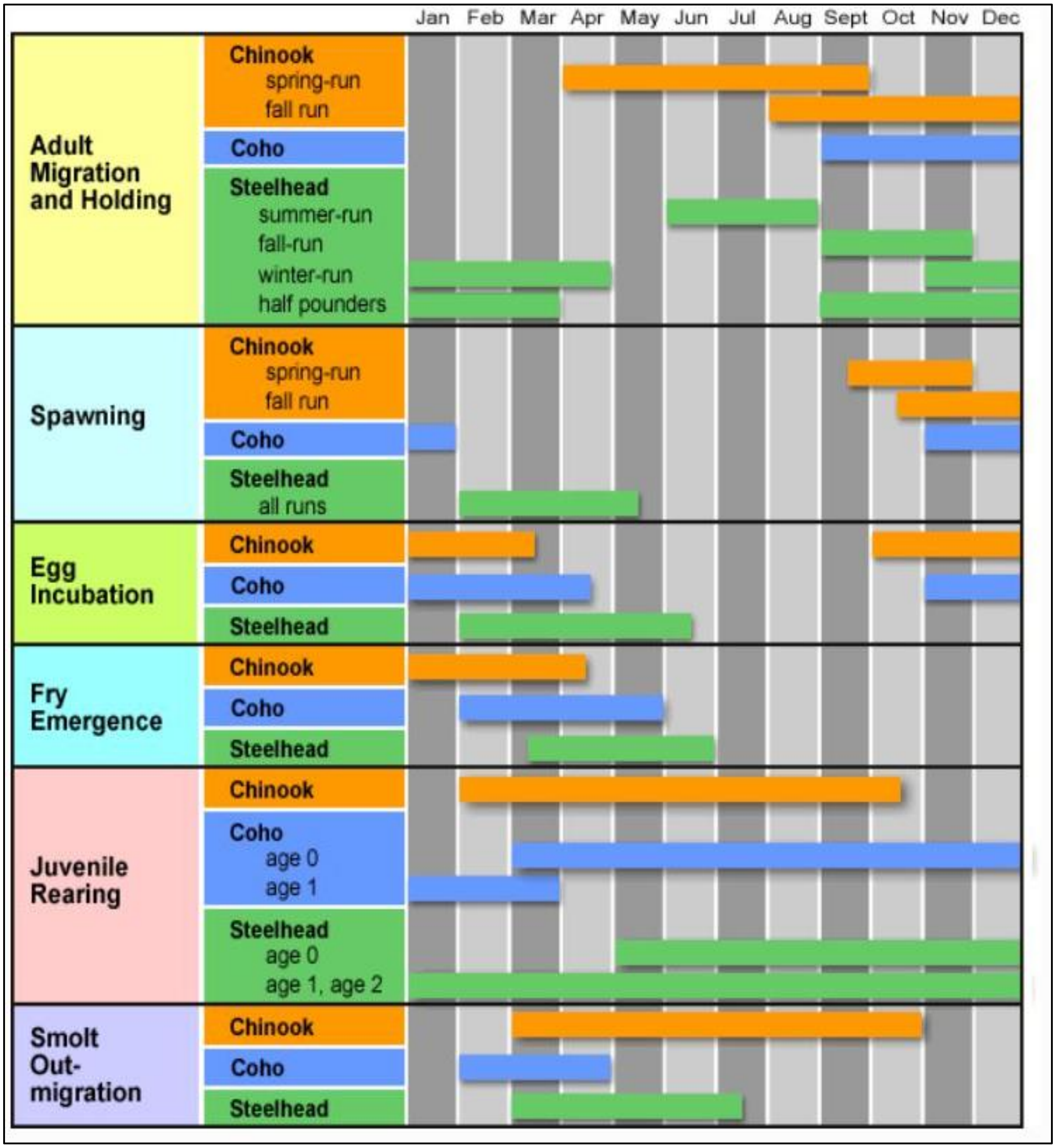

Figure 11. Life history timing of Trinity River Coho and Chinook Salmon and Steelhead (reproduced from Trinity River Restoration Program Website).

Depending on river temperatures, eggs incubate in redds (gravel nests excavated by spawning females) for 1.5 to 4 months before hatching as alevins (a larval life stage dependent on food stored in a yolk sac). The time between hatching and fry emergence is also dependent on temperature and dissolved oxygen levels in the redd and can last between 4 to 10 weeks. The percentage of eggs and alevins that survive to emergence is dependent on stream and riverbed conditions with winter flooding, with its associated scour and gravel movement accounting for a high proportion of losses (NMFS 2014). Following yolk sac absorption, alevins emerge from the gravel as fry and begin actively feeding. In the Trinity River and other Klamath River tributaries, fry emergence typically occurs two to three weeks after hatching, beginning from about February and continuing through mid-May (Leidy and Leidy 1984; Hassler 1987). Following emergence, fry move into shallow areas near stream banks. As Coho Salmon fry grow, they disperse upstream and downstream, usually remaining in, or moving into, small tributary streams, and establish and defend territories (Leidy and Leidy 1984; Hassler 1987).

The dominant life history pattern is for juvenile Coho Salmon to feed and rear within streams of their natal watershed for a year before migrating to the ocean. However, they may spend up to two years rearing in freshwater (Bell and Duffy 2007) or emigrate to an estuary shortly after emerging from spawning gravels (Tschaplinski 1988). Coho Salmon have also been shown to utilize non-natal streams for rearing and to redistribute into riverine ponds following fall rains (Peterson 1982). The extent to which fish utilizing these alternate life history patterns contribute to adult returns is not known, however, they demonstrate the diversity of strategies that are potentially used by juvenile Coho Salmon in the ESU (NMFS 2014). Depending on the size of the stream in which it emerged, Coho Salmon fry may move upstream or downstream to rear after emergence. The most productive Coho areas tend to be small streams, but other rearing areas include lakes, sloughs, side channels, estuaries, beaver ponds, low-gradient tributaries to large rivers, and large areas of slack water (PFMC 1999). The abundance of Coho Salmon in streams is limited by the number of suitable territories available and streams with more complex habitat support larger numbers of fry (Scrivener and Andersen 1982, Larkin 1977).

During the summer, Coho Salmon fry prefer shallow pools and riffles with wood cover, undercut banks, boulders, and overhanging vegetation (Shapovalov and Taft 1954). During summer, juvenile Coho may also move into deep pools and areas with dense shade and LWD for refuge from high summertime temperatures (Nickelson et al, 1992, Brown et al. 1994). Most mortality takes place in the first summer and fry-to-smolt survival rates average between 1.27 and 1.71 percent (Godfrey 1965).

During the winter, Coho Salmon fry prefer to rear in large mainstem pools, backwater areas and secondary pools with LWD, and undercut bank areas (Hassler 1987). Coho Salmon rear in fresh water for up to 15 months, then migrate to the sea as smolts generally from February through mid-June, peaking in April and May throughout their range in California, including the Trinity River (Shapovalov and Taft 1954; Leidy and Leidy 1984; Petros et al. 2015). Recent Klamath-Trinity monitoring data show the average length of out-migrating Coho smolts is approximately 128 mm, with the largest smolts originating from the Trinity River (mean length= 147 mm) and the smallest originating from Blue Creek on the Klamath River (mean length= 104 mm; NMFS 2014; Petros et al. 2015). The large average size of smolts produced from the Trinity River is likely a result of hatchery operations, which generally produce larger smolts when compared to naturally produced smolts (NMFS 2014; Petros et al. 2015).

Temperature is an important physical factor affecting the freshwater residency and survival of Coho Salmon. However, the effect of temperature on anadromous salmonids is not a simple relationship. Temperature is interrelated with other ecological factors, such as prey availability, predator and competitor species present, thermal refugia, life stage, and the acclimation and exposure history of individual fish, in its ultimate effect on salmon (Marine 1997, Ligon et al. 1999; McCullough 1999). In general, juvenile Coho can tolerate a range of temperatures from about 2°C to 22.5°C, however, their preference for 12°C to 14°C approximates the range where optimum growth occurs (Brett 1952). Temperatures from 6°C to 12°C appear to be optimal for the period of smoltification, which is generally the winter through early-summer seasons (Zaugg and McLain 1972; Clarke et al. 1981; Zedonis and Newcomb 1997). Temperatures exceeding about 15°C result in reversal of the physiological transformation associated with smoltification (Zaugg and McLain 1972).

A Coho juvenile’s downstream migration to the ocean is accompanied by a series of internal changes in morphology, physiology, and behavior needed for transition to saltwater (NMFS 2014). Once fry reach the estuary, they will spend a variable amount of time, anywhere from a few days to a few weeks (Miller and Sadro 2003), completing the fry-to-smolt transformation. While living in the ocean, Coho Salmon remain closer to their river of origin than do Chinook Salmon (Sandercock 1991; Pearcy 1992). Compared to other Coho Salmon populations, the SONCC Coho Salmon ESU has a comparatively small marine distribution (NMFS 2014) and occur in the upper part of the water column in the open ocean, at observed depths of from about 10 to 25 m (Quinn 2005). When they first enter coastal areas, Coho Salmon feed primarily on marine invertebrates; as they grow larger, they shift to more piscivorous diets (Shapovalov and Taft 1954). Studies of smolt-to-adult survival place estimates between 1% and 10% with the greatest mortality during the first year at sea (NMFS 2014). The growth and survival of adult Coho Salmon is closely linked to marine productivity, which is controlled by complex physical and biological processes that are highly dynamic and vary greatly over space and time (NMFS 2014). The age composition and size of Coho at maturity is influenced by a number of factors including growth rate, sex, origin (hatchery or wild and population) and genetics (Quinn 2005).

Coho Salmon typically spend two growing seasons in the ocean before returning to their natal stream to spawn as three-year-olds. Some precocious males, called jacks, return to spawn at 2 years old, only after spending 6 months in the ocean.

Population Trends

The following summary is primarily taken and modified from the NMFS Final Recovery Plan for the SONCC ESU Coho Salmon (NMFS 2014). Additional information in this section, obtained from other sources, is cited where appropriate.

The status and viability of the SONCC ESU Coho Salmon was evaluated in the most recent 5-Year Status Review (NMFS 2011b) and described in the Final Recovery Plan (NMFS 2014), using the concept of Viable Salmonid Populations (VSP) and the population viability criteria described by McElhany et al. (2000) and expanded upon by Williams et al. (2008). VSPs are described in terms of four parameters: population abundance, population productivity, spatial structure, and diversity, which are predictors of extinction risk and reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany et al. 2000). To be considered viable, a salmonid population must have a negligible risk for extinction over 100 years.

Long-term population estimates for SONCC ESU Coho Salmon are scarce; however, available monitoring data indicates that many populations have declined, and that the ESU does not appear to support a single viable population (one at low risk of extinction). Most of the 30 independent populations are a high risk of extinction for abundance because they are below or likely below their depensation threshold (NMFS 2014).

To compensate for these declines, hatcheries supplement naturally spawning SONCC ESU Coho Salmon (CDFG and NMFS 2001). Supplementation of hatchery salmon into depressed naturally occurring SONCC ESU coho salmon populations, with low productivity, has subsequently led to further reduced population diversity. Additionally, recent information indicates that distribution within the range of the SONCC ESU has also been reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which they are now absent (NMFS 2001).

Therefore, given the recent trends in population abundance, productivity, spatial structure, and diversity across the ESU, the SONCC ESU Coho Salmon is considered not viable and is at high risk of extinction, with a likelihood to become endangered in the foreseeable future (Williams et al. 2011).

Critical Habitat

Section 7(a)(2) of the ESA requires federal agencies, in consultation with and with the assistance of the Secretaries of the Interior and Commerce, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of CH of such species (50 CFR 402.02). "Destruction or adverse modification" was recently clarified to mean "… a direct or indirect alteration that appreciably diminishes the value of CH for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214, February 11, 2016).

CH for SONCC ESU Coho Salmon was designated in 1999 by NMFS and is identified as "the water, substrate, and adjacent riparian zone [within the range of an ESU] . . . [below] longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years)" (64 FR 24049, May 5, 1999). The NMFS has excluded from the SONCC ESU Coho Salmon CH designation all tribal lands in northern California and areas that are above certain dams which block access to historic habitats of listed salmonids. This includes a portion of the Lower Klamath River sub-basin, which lies within the Yurok Tribe Reservation.

Biological and physical features (PBFs) of the CH for SONCC ESU Coho Salmon corresponds to all the water, riverbed and bank areas, and riparian areas within the ESU boundaries except as noted above. Waterways include estuarine areas and tributaries. Adjacent riparian area is defined as "the area adjacent to a stream that provides the following functions: shade, sediment, nutrient, or chemical regulation, stream bank stability, and input of large woody debris or organic matter" (64 FR 24049, May 5, 1999). In other words, riparian areas are those that produce physical, biological, and chemical features that help to create biologically productive stream habitat for salmonids. PBFs essential to the conservation of the SONCC ESU Coho Salmon include juvenile summer and winter rearing areas, juvenile migration corridors, areas for growth and development to adulthood, adult migration corridors, and spawning areas (64 FR 24049, May 5, 1999).

Chapter 5
Environmental Baseline

The environmental baseline includes the effects of past and ongoing human and natural factors leading to the status of the species, its habitat, and the ecosystem in the action area. Specifically, the environmental baseline includes 1) the past and present impacts of all federal, state, or private actions and other human activities, 2) the anticipated impacts of all federal projects in the action area that have already undergone formal or early section 7 consultation, and 3) the impacts of state or private actions that are contemporaneous with the consultation process (50 CFR 402.02).

For environmental baseline analysis the Trinity River watershed was divided into three sub-watersheds: 1) Upper Trinity River defined as from Lewiston dam (RM 112.2) to the North Fork Trinity River (RM 72.5; Figure 12), 2) Lower Trinity River (Figure 13), and 3) South Fork Trinity River (Figure 14). TRRP research activities occurring in the Lower Klamath River watershed will not impact habitat, so an abbreviated discussion of the baseline conditions is included.

Regional Setting

The Trinity River originates in the rugged Salmon-Trinity Mountains of northern California in the northeast corner of Trinity County, California. The Trinity River watershed is approximately 2,861 square miles in size and is the largest Klamath River tributary. From Lewiston Dam, the Trinity River flows westward for 112 miles until it enters the Klamath River near the town of Weitchpec on the Yurok Reservation. The Trinity River passes through Trinity and Humboldt counties and the Hoopa Valley (Hoopa Tribe) and Yurok Indian Reservations. The Klamath River flows northwesterly for approximately 40 miles from its confluence with the Trinity River before entering the Pacific Ocean.

About 65% of the Lower Klamath River sub-basin is private land; the majority of which is owned by Green Diamond Resource Company which has an Aquatic Habitat Conservation Plan, finalized in 2006 and valid through 2056 (NMFS 2014). The rest of the LKR consists of public lands managed by the Redwood National Park, Redwood State Park, U.S Forest Service, U.S BLM, and a few smaller private land holdings (Gale and Randolph 2000).

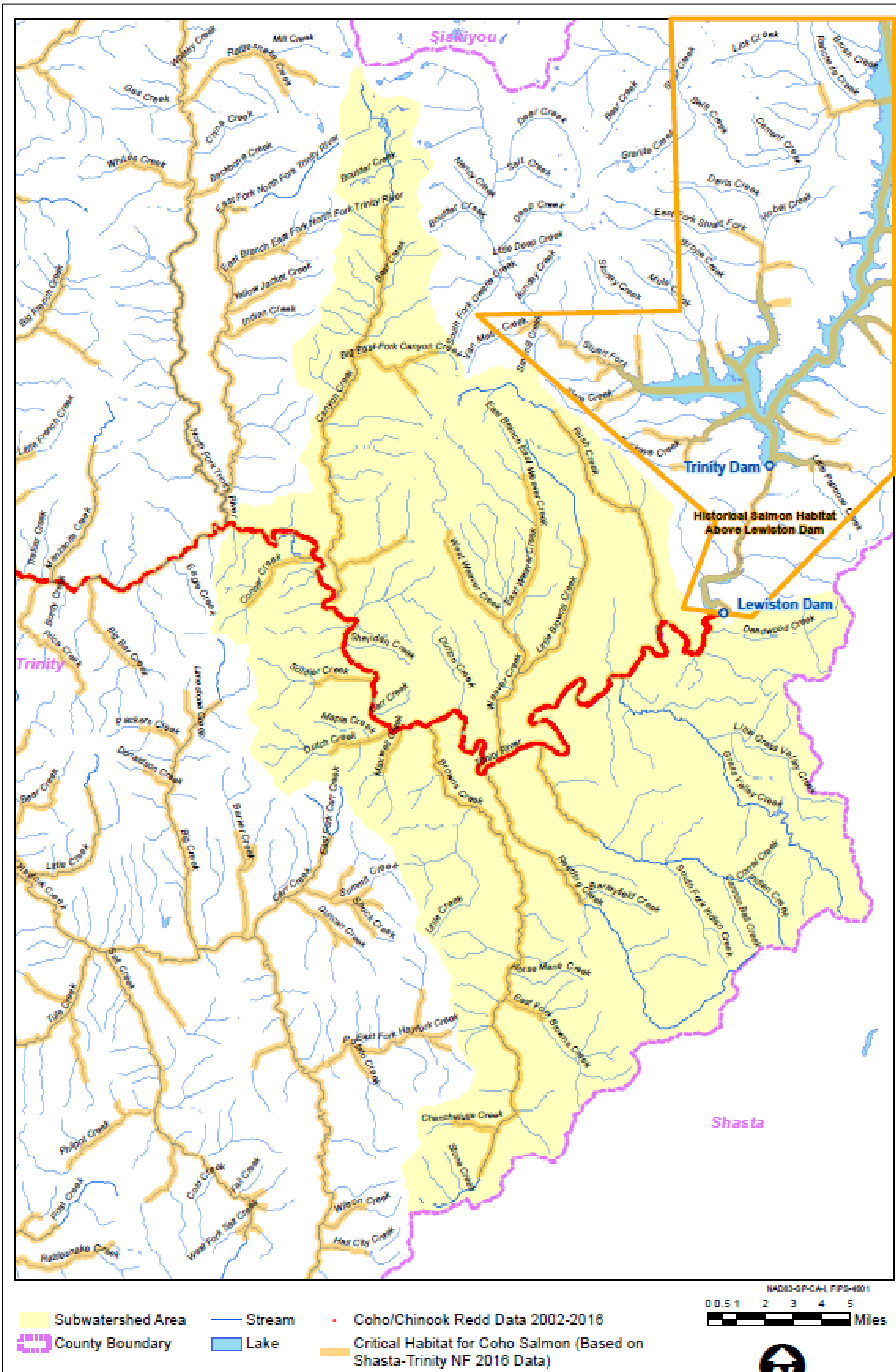

Figure 12. Upper Trinity River Watershed from RM 72.5 Upstream to Lewiston Dam.

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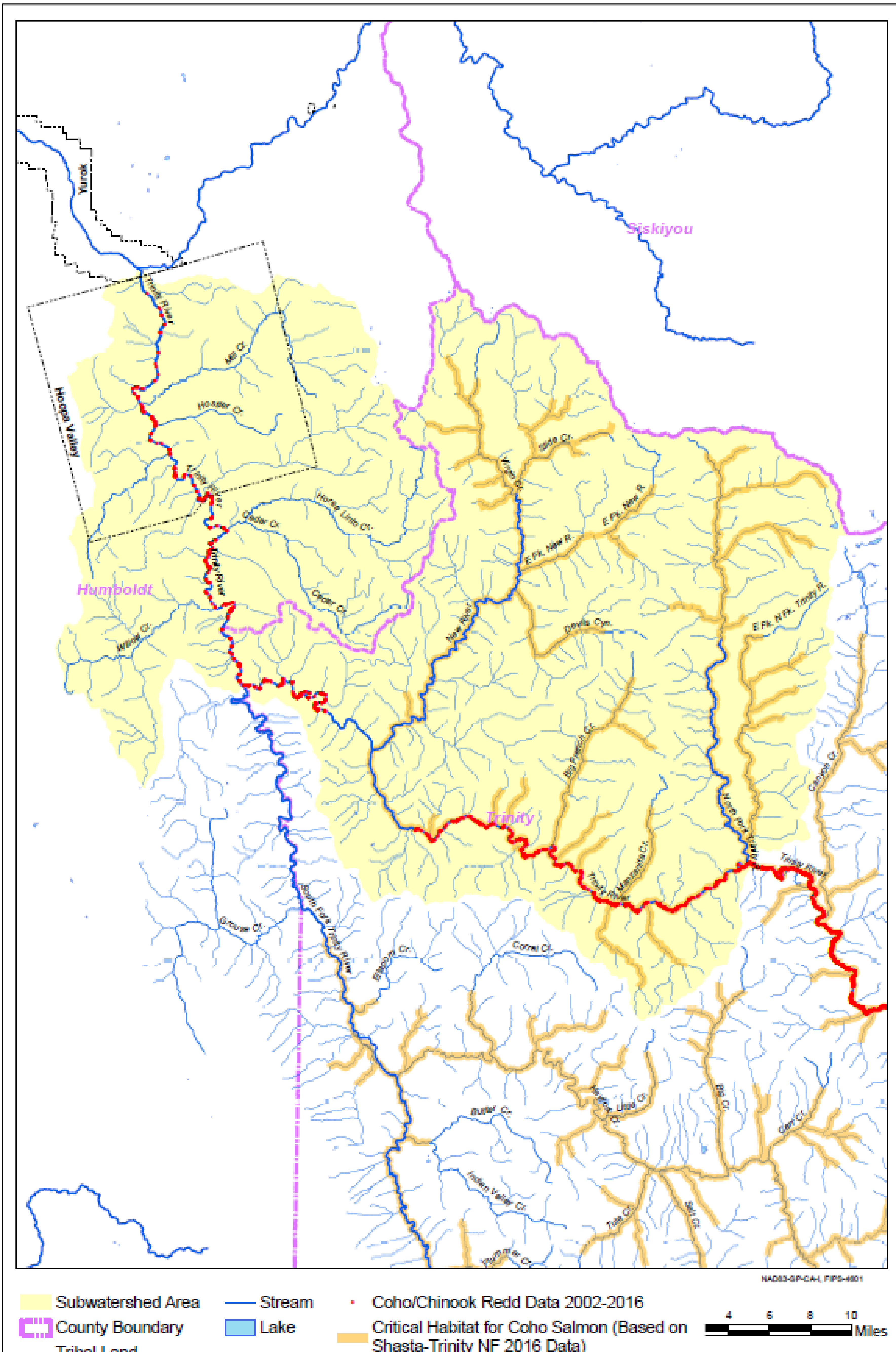

Figure 13. Lower Trinity River Watershed from the Klamath River confluence to RM 72.5.

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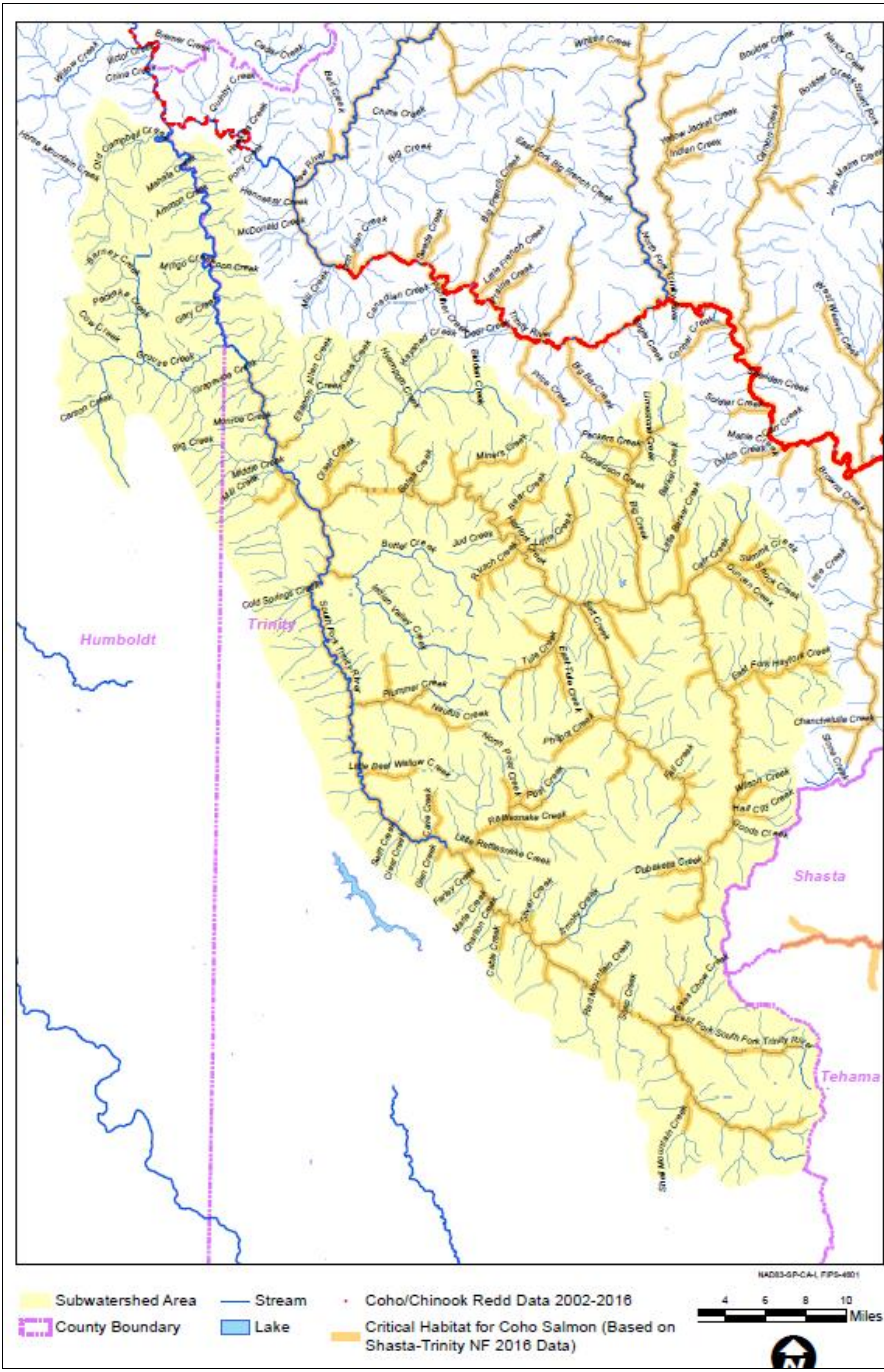

Figure 14. South Fork Trinity River Watershed.

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Approximately 80% of the lands within the Trinity River basin are federally managed, and of these, the Forest Service administers approximately 95%. The BLM, however, which administers only 5% of the total Trinity County public lands acreage, manages approximately 41% of the Trinity River floodplain acreage along the channel rehabilitation reach from Lewiston dam to the North Fork Trinity River. Of the remaining 20% privately-owned land in the basin, approximately half (10% of the total) are industrial timberlands, with the other 10% being small private holdings (TRRP 2018). According to TRRP (2018) this land ownership mix provides good opportunities to improve Trinity River watersheds and its fisheries.

Historically, the Trinity River functioned as a dynamic river reach that provided quality spawning and rearing habitat for anadromous fish. Construction of Lewiston Dam, part of the CVP, in 1963 near Lewiston is now the upper limit of anadromous fish migration on the Trinity River as no fish passage facilities were built. At times, 90% of the Trinity River flow was diverted into the Sacramento Basin, contributing to the decline of Chinook Salmon, Coho Salmon and Steelhead (NMFS 2014). These water withdrawals caused severe degradation of fish habitat of the Trinity River. The minimal flows released were insufficient to maintain the Upper Trinity River and, as a consequence, much of the river channel between Lewiston and the North Fork Trinity River confluence became confined within a narrow channel bordered by dense riparian berms.

Located at the base of Lewiston Dam, the 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 (USFWS and HVT 1999). CDFW is contracted to operate and maintain the hatchery, the Hoopa Valley Tribe assists with propagation of Coho Salmon at TRH, and the Hoopa Valley and Yurok tribes assist in evaluation of the performance and operations of the TRH (CDFW 2017). The Trinity River Fish Hatchery has not been effective in sustaining fish populations (NCRWQB 2005). Approximately 5,000 wild adult Coho Salmon migrated past the town of Lewiston annually prior to the construction of the TRD (USFWS and CDFG 1956; USFWS and HJVT 1999).

Reclamation is funding development of a Hatchery and Genetic Management Plan (HGMP) for Coho Salmon reared at the TRH (CDFW 2017). The primary goal of the HGMP is to devise biologically based hatchery management strategies that ensure the conservation and recovery of salmon and Steelhead populations (CDFW 2017).

Logging practices, road construction, mining, and floodplain development within the Trinity River watershed also contributed significantly to habitat degradation (USFWS and HVT 1999). Clear-cut logging, along with hundreds of miles of unpaved roads and skid trails, promoted increased sediment loading in the Trinity River and its tributaries and removal of streamside vegetation increased water temperatures. Within the mainstem Trinity River, the distribution of Coho Salmon can likely be explained, at least in part, by water temperature (Reclamation 2018). Virtually all tributaries have been subjected to hydraulic mining activities. This has reduced the biological productivity and fish carrying capacity of much of the Trinity River basin (USFWS and HVT 1999; EPA 2001). In addition, degradation of freshwater habitat has been pervasive in the Lower Klamath River contributing to declines in native fish runs (Gale and Randolph 2000).

Congress enacted a number of legislative actions to restore Trinity River fisheries resources. In 2000, the Secretary of the Interior signed the ROD for the Trinity River Mainstem Fishery Restoration EIS/EIR which required Reclamation to implement a suite of actions. These actions included a variable annual flow regime, mechanical channel rehabilitation, sediment management, watershed restoration, and adaptive management. Reclamation has been and continues to implement the flows described in the Trinity ROD.

Southern Oregon-Northern California Coasts ESU Coho Salmon Populations in Action Area

The SONCC ESU Coho Salmon inhabiting the Klamath-Trinity Rivers basin is thought to be comprised of nine metapopulations (population units) exhibiting varying levels of interrelationship (Williams et al. 2006). Three of these population units occur in the Trinity River sub-basin and one within the Lower Klamath River sub-basin within the Action Area (Figure 15). The following summary on SONCC ESU Coho Salmon population units is primarily taken and modified from the NMFS Recovery Plan for SONCC ESU Coho Salmon (NMFS 2014). Additional information in this section, obtained from other sources, is cited where appropriate.

The Upper Trinity River and Lower Trinity River Population Units are “core” population units and need to achieve a robust level of adult spawners for recovery of the ESU. The South Fork Trinity River Population Unit is not considered a core population unit and needs to achieve only the amount of adult spawners required to be functionally independent for the recovery of the ESU (NMFS 2018).

The Interior-Trinity diversity stratum, the Upper Trinity River population unit and the Lower Trinity River population unit, capture both the coastal winter returning run timing and the inland fall returning run timing. These run timings aid in protecting the diversity stratum from both drought and flood by extending the time which adults enter the Trinity River. The Upper Trinity River population unit may serve as an important “source” population for the Lower Trinity and South Fork Trinity populations which may act as a “sink.” The Upper Trinity River population unit also protects the ESU against range shrinkage by maintaining an inland population that is one of the furthest east migrating population units in the ESU (NMFS 2018).

The Upper Trinity River Coho Salmon population is a core “Functionally Independent” population within the Trinity diversity stratum, meaning that it was sufficiently large to be historically viable-in-isolation and historically had demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005; Williams et al. 2006). As a core population, the recovery target for the Upper Trinity population is for the population to be viable, to have a low risk of extinction, and sufficient spawner densities to maintain connectivity and diversity within the ESU (NMFS 2014).

According to NMFS (2014) the South Fork Trinity River Coho Salmon population is considered to be a non-core “Functionally Independent” population within the Trinity diversity stratum. This population was likely once sufficiently large to be historically viable-in-isolation and had demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005; Williams et al. 2006).

The Lower Klamath River population is a “core,” “Functionally Independent” population within the Central Coastal diversity stratum, meaning that it was sufficiently large to be historically viable-in-isolation and has demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005; Williams et al. 2006). The Lower Klamath River Coho population is not viable, at high risk of extinction, and the estimated average spawner abundance, from the three lowest consecutive years within the past twelve years, is likely less than the depensation threshold of 205 spawners, assuming marine survival of less than 1% (NMFS 2014).

The Action Area (AA) is very important to the survival and recovery of the ESU because the ESU cannot recover without these three core population units in the AA being recovered. The run timing of the Upper Trinity River population unit is earlier (September and October) than those fish in the Lower Trinity Population Unit (November through January). The discharge of the Lower Trinity River is more dominated by rain while discharge of the Upper Trinity River is more of a rain-snow mix and these populations have developed different life history strategies to take advantage of this difference. The Lower Klamath population is important for connectivity between populations to the north and south along the California and Oregon coasts in the Central Coastal Basins Diversity Stratum (NMFS 2018).

Ackerman et al. (2006) developed run size estimates of naturally produced Coho Salmon in the Trinity River (Lower, Middle, and Upper Populations combined) to be between 500 and 9,000 adults for the years 2001 through 2004. The current Trinity River Coho Salmon population is largely comprised of hatchery-origin fish and the natural population growth rate is considered to be negative (NMFS 2014).

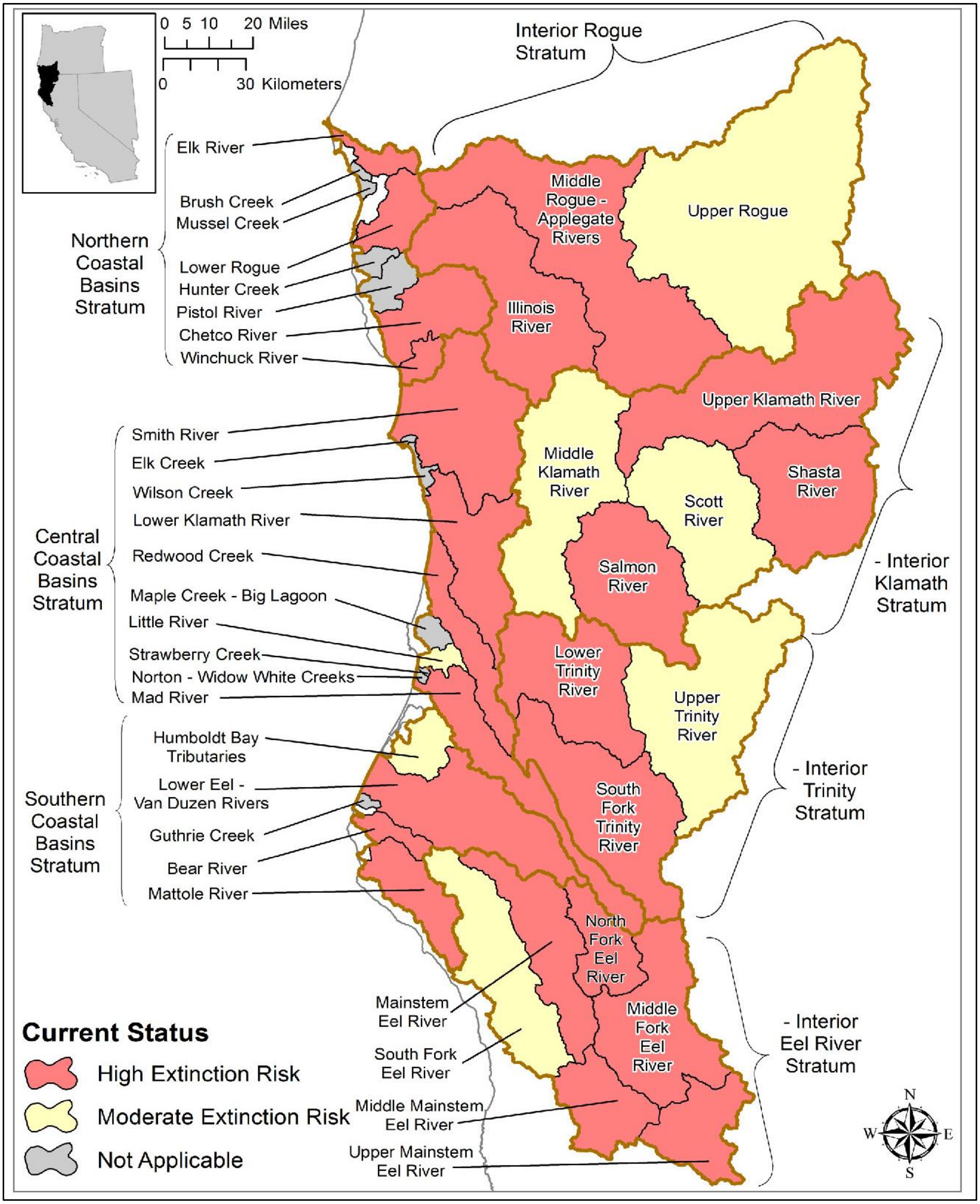

Figure 15. Southern Oregon/Northern California Coasts Evolutionarily Significant Unit Coho Salmon Geographic Distribution and Extinction Risks (NMFS 2014).

Upper Trinity River Coho Population

The Upper Trinity River population of SONCC Coho Salmon occurs in the mainstem and tributaries from the North Fork Trinity River upstream to Lewiston Dam (Figure 12) and is limited to a fraction of habitat that was historically available. CDFW (2017) indicates that the Upper Trinity River Population Unit extends upstream from the North Fork Trinity River to Ramshorn Creek, the reported historical upstream extent of Coho Salmon in the basin (Williams et al. 2008).

Several factors have and continue to affect the productivity of the Upper Trinity River population of SONCC ESU Coho Salmon by acting on various freshwater life stages and impacting habitat requirements. The single most important factor stems from the effects of large-scale dams, reservoirs, and diversions (e.g. the TRD) on the hydrologic and geomorphic functions of fluvial channel and riparian habitat processes, water quality, and blocking access to habitats upstream of Lewiston Dam. The TRD not only decreases the amount of water in the Trinity River downstream and creates a temperature elevation problem but disrupts physical cues for Salmon migration and spawning (NMFS 2014).

Problems facing the Upper Trinity River Coho Salmon population include barriers, disconnected floodplains, degraded riparian habitat, degradation of spawning and rearing habitat, sparse spawning gravel recruitment, lack of deep pools, stressful late summer water temperatures, water diversions, channelization and confinement, irregular timing of flows, fragmentation of populations, and unscreened diversions (NMFS 2014).

Limited high-quality Coho Salmon habitat exists throughout the Upper Trinity River recovery area. The intrinsic Potential (IP) data show the greatest amount of high value IP (IP>0.66) habitat is upstream of Trinity Dam. Coho Salmon are thought to have inhabited many of the smaller creeks and tributaries to the Trinity River in the area upstream of where the Trinity Dam is now located (NMFS 2014). Between the time when the TRD was completed and 1977, only two Coho Salmon escapements were estimated for the area upstream of the North Fork Trinity River and between 1970 and 1999, Coho spawner escapement ranged from 558 to 33,373 with an average of 10,192. Based on population estimates from 1991-1995, 1998, and 1999, the average in-river escapement of naturally produced Coho Salmon was approximately 400 fish (USFWS and HVT 1999). Coho Salmon are found in only a fraction of their historic habitat areas in the Upper Trinity River sub-basin, due mainly to the loss of access to habitat resulting from the erection of the dams and loss of 36% of the historic IP-kilometer (km) habitat (Williams et al. 2008). In addition to the physical reduction of habitat, water temperatures often rise above 60°F downstream of the first 12 km below Lewiston Dam, which effectively restricts rearing Coho Salmon in this upper reach (CDFG 2004).

The Upper Trinity River is about 1,183 sq. mi. in size (Fig. 11). Table 11 shows the major tributaries to the Upper Trinity River below Lewiston Dam. Many tributaries presently, or historically, contained salmonid habitat, particularly in the lower gradient reaches. Tributaries, such as Rush, Reading, Brown's and Canyon creeks have been subjected to some form of habitat modification, including historic hydraulic mining, current water diversions, road construction and timber harvesting (EPA 2001). EPA (2001) determined that Weaver and Rush creeks are impaired based on an analysis of the stream and watershed condition indicators and that water quality and channel conditions were rated as functioning at risk. Watershed hazard condition was considered high in Weaver and Rush Creek and Browns' Creek was in a moderate condition. The Weaver and Helena areas appear to have fair riparian conditions, while portions of the Helena and Upper Trinity areas have very good riparian conditions.

Table 11. Upper Trinity River Watersheds (*Based on USFS 2016 Critical Habitat map)

River/Stream	Length (~Mi.)*	Coho Critical Habitat (~Mi.)	Agency/Group/ Tribe
Upper Trinity River	40	40	USFS US Reclamation
Deadwood Creek	6	0	unknown
Rush Creek	20	18	USFS
Grass Valley Creek	18	0	USFS
Indian Creek	20	6	unknown
East Fork Weaver Creek	10	6	USFS
West Fork Weaver Creek	**8**	4	USFS
Little Browns Creek	10	6	USFS
Sidney Gulch	8	2	private/unknown
Reading Creek	16	8	unknown
Browns Creek	16	14	USFS
Dutch Creek	6	4	USFS
Soldier Creek	8	2	USFS
Canyon Creek	16	10	USFS
Conner Creek	6	4	USFS
North Fork Trinity River	20	16	USFS
East Fork of North Fork Trinity River	16	12	USFS

NMFS (2014) identified the following tributaries in the Upper Trinity River as having high IP reaches based on Williams et al. (2006): Deadwood, Rush, Brown's, Little Brown's, Indian, Grass Valley, Little Grass Valley and Weaver creeks (and tributaries). In addition, Coho Salmon presence has been confirmed in a variety of streams in the Upper Trinity River sub-basin including Grass Valley Creek, Sydney Gulch, Deadwood Creek, Rush Creek, Weaver Creek, Little Brown's Creek, Dutch Creek, Indian Creek, Canadian Creek, Soldier Creek, Canyon Creek, North Fork Trinity River, and East Fork North Fork

Trinity River (Everest 2008). However, most of these streams do not have a substantial amount of high IP reaches when compared to the Trinity River upstream of Lewiston Dam (NMFS 2014).

The North Fork Trinity River is a largely undeveloped, 10,145-acre forested watershed, that drains into the mainstem Trinity River near the community of Helena. Most of the area is designated as wilderness, managed by the Forest Service, with little timber harvest. Some mining still takes place in the lower part of the watershed and the NCRWQB (2005) recommends that an assessment of the old and current mining sites on public lands be conducted. Wildfires also occur in this sub-watershed. The North Fork Trinity and East Fork North Fork Trinity rivers remain accessible to Coho Salmon; however, these accessible streams are higher gradient rivers that currently support populations of Steelhead with minimal Coho Salmon production and may not have historically supported robust population of Coho Salmon (Everest 2008).

Currently, suitable habitat and small spawning populations of Upper Trinity River Coho Salmon have been reported to occur in numerous tributaries to the mainstem Trinity River. Spawner surveys in 1995 indicate substantial usage in many of the tributaries from the North Fork Trinity River upstream to Deadwood Creek. Coho Salmon redd surveys conducted from 2002 to 2015 in the mainstem Trinity River, and upstream of the North Fork Trinity River, indicate that, on average 97% of the redds were found upstream of the North Fork Trinity River (CDFW 2017).

There appears to be some diversity of life history strategies in the Upper Trinity River as data on run timing and outmigration indicate that there is some variation in life history characteristics of the population (NMFS 2014). Coho Salmon enter the Trinity River between September and November and spawning in the river continues into January (CDFG 2009b) and both young-of-the-year and yearling Coho Salmon are captured at downstream migrant traps located in the Trinity River near Willow Creek (Pinnix et al. 2007).

Coho Salmon population estimates for individual tributaries are not available, although limited presence/absence observation data are available from the Forest Service (NMFS 2014). Given land use changes and activities such as logging and mining, Coho Salmon abundance in smaller tributaries like Weaver and Reading Creeks is probably much less than it was historically.

Although there may be robust numbers of spawners occasionally in some years, the overall number of naturally produced Coho Salmon in the Upper Trinity River watershed is low compared to historic conditions, and hatchery fish dominate the run (NMFS 2014). In some years, it appears that naturally produced spawners returned to the Trinity River in sufficient numbers to meet the low population threshold specified by Williams et al. (2008); however, a small proportion (generally less than 1%) of the Coho Salmon that are judged to be of natural origin. Based on the criteria set forth by Williams et al (2008) the

Upper Trinity River population is at a moderate risk of extinction because the number of spawners exceeds the depensation threshold (NMFS 2014; Figure 15).

Data from the Willow Creek Weir, collected between 1997-2008 (CDFG 2009), indicate the number of recruits produced per female spawner in Upper Trinity River is substantially less than two, meaning the population is failing to replace itself (NMFS 2014). Due to the low natural population abundance and a negative population growth rate, the Upper Trinity River population does not meet the minimum standards of a viable salmonid population (NMFS 2014).

Hatchery influences on the Upper Trinity River Coho Salmon population are substantial (NMFS 2014). Based on the recent returns at Willow Creek, the Trinity River population is between 5,800 and 39,000 adults, with the majority being hatchery-origin (>90 percent most years) (Table 12). Coho Salmon escapement dropped significantly between 2014 and 2017, due to a combination of factors, with low stream flows considered a major factor. Escapement to the Trinity River is counted by the CDFW at Willow Creek weir on the lower Trinity River, and most of the Coho Salmon counted there are thought to spawn in the Upper Trinity River.

Chilcote et al. (2011) found that the number of recruits (as smolts) per Coho Salmon spawner decreases as the mean proportion of hatchery fish in the spawning population increases, a finding similar to that of Buhle et al. (2009), as cited in NMFS (2014). This finding is particularly important given that a high percentage of SONCC ESU Coho Salmon spawners in the Upper Trinity River are of hatchery origin.

Table 12. Estimated spawning escapement of Coho Salmon to the Trinity River above Willow Creek, 1997– 2017

Year	Natural Origin	Hatchery Origin	Total Escapement	% Natural	% Hatchery
1997	651	7,284	7,935	8.2	91.8
1998	1,132	11,348	12,480	9.1	90.9
1999	586	4,949	5,535	10.6	89.4
2000	539	14,993	15,532	3.5	96.5
2001	3,372	28,768	32,140	10.5	89.5
2002	596	15,420	16,016	3.7	96.3
2003	4,093	24,059	28,152	14.5	85.5
2004	9,055	29,827	38,882	23.3	76.7
2005	2,729	28,690	31,419	8.7	91.3
2006	1,624	18,454	20,078	8.1	91.9
2007	1,199	4,551	5,750	20.9	79.1
2008	1,312	8,671	9,983	13.1	86.9
2009	645	5,697	6,342	10.2	89.8
2010	861	7,085	7,946	10.8	89.2
2011	1,413	13,627	15,040	9.4	90.6
2012	1,966	16,692	18,658	10.5	89.5
2013	4,457	17,448	21,905	20.3	79.7
2014	1,001	12,536	13,537	7.4	92.6
2015	814	3,805	4619	17.6	82.3
2016	798	527	1325	60.2	39.8
2017	65	590	655	9.9	90.1

Sources: CDFG (2009), CDFW (2018)

Lower Trinity River Population

The Lower Trinity River is approximately 746 square miles in size and includes the mainstem Trinity River, from the North Fork Trinity River confluence (RM 73) near Helena, downstream to mouth at Klamath River confluence, near Weitchpec (RM 0) (Figure 13). The Lower Trinity River population of SONCC ESU Coho Salmon spawns in accessible tributaries to the Trinity River downstream of the North Fork Trinity River, excluding the South Fork Trinity River. Coho Salmon that escape to the Trinity River, counted at Willow Creek weir, are thought mostly to spawn in the Upper Trinity River. Population estimates for individual tributaries in the Lower Trinity River are not available but are thought to be dominated by hatchery-origin Coho Salmon. The proportion of the Lower Trinity River population of SONCC ESU Coho Salmon that naturally spawns is not known. As a result, the natural population abundance of the Lower Trinity River Coho Salmon population is thought to be low and exhibit a negative population growth rate (NMFS 2014).

USFWS and CDFG (1956) noted that "Silver [Coho] Salmon enter most lower Trinity River tributaries to spawn" and Moffet and Smith (1950) stated that "silver [Coho] salmon enter the lower Trinity River to spawn" and reported that Coho Salmon were usually observed in the Hoopa Valley by October. Coho Salmon on the Hoopa Valley Indian Reservation (HVIR) are rare and seemingly missing cohorts based on monitoring conducted by the HVT. The limited data available from the Forest Service, and the HVT for the Lower Trinity River Coho Salmon population, suggests that much of the IP habitat in the Lower Trinity River is currently unoccupied or only sporadically occupied (NMFS 2014).

Prior to 1944, the Lower Trinity River was occupied by Native Americans and turn-of-the century miners and their use of these lands probably had relatively minor impacts (USFS 2000b). Forest Service road construction and timber harvest did not begin until the 1950's (USFS 2000c). Land use activities in the Lower Trinity River watershed include mining, timber harvesting, agriculture, road construction, recreation and a limited degree of residential development (USEPA 2001).

Table 13 shows the major tributaries to the Lower Trinity River. NMFS (2014) indicates that there is little information on the historic abundance of Coho Salmon in the Lower Trinity River; however, the presence of Coho Salmon has been confirmed in Manzanita Creek, Big French Creek, New River and East Fork New River (Everest 2008).

Table 13. Lower Trinity River Watersheds (*Based on USFS 2016 Critical Habitat map

River/Stream	Length (~Mi.)*	Coho Critical Habitat (~Mi.)	Agency/Group/ Tribe
Price Creek	10	5	USFS
Manzanita Creek	10	8	USFS
Big French Creek	14	12	USFS
New River	36	32	USFS
East Fork New River	12	10	USFS
Sharber (AKA Unnamed) Creek	4	4	USFS
Willow Creek	10	unknown	unknown
Horse Linto Creek	20	unknown	USFS
Tish Tang Creek*	15	unknown	YT
Supply Creek	10	unknown	YT
Hostler Creek	10	unknown	YT

Table 13. Lower Trinity River Watersheds (*Based on USFS 2016 Critical Habitat map

River/Stream	Length (~Mi.)*	Coho Critical Habitat (~Mi.)	Agency/Group/ Tribe
Soctish Creek	8	unknown	YT
Mill Creek	15	unknown	YT
Trinity River Mainstem Below NF& above SF	36	36	USFS
Trinity River Mainstem below SF Confluence	32	32	USFS, Yurok Tribe

*Also known as "Tish Tang a Tang"

Given that several tributary streams in Lower Trinity River provide spawning habitat NMFS (2014) infers that Coho Salmon were historically widely distributed throughout the Lower Trinity River sub-basin and that it was probably rare for Coho Salmon to spawn in the mainstem Lower Trinity River. The steep nature of the surrounding terrain likely limited the amount of high-quality habitat available to Coho Salmon and the majority of IP habitat is of moderate value (0.33-0.66) with only a few scattered areas of high IP habitat (>0.66). The combination of the relatively steep nature of the area and the lack of high IP habitat suggest that this population never supported large runs of Coho Salmon but may have supported a moderately-sized population that was spread throughout most major tributaries (e.g., Big French Creek, New River, Willow Creek, Horse Linto Creek, Tish Tang Creek, Mill Creek, and Cedar Creek) (NMFS 2014). An unnamed tributary (known as Sharber-Peckham Creek) has one of the strongest populations of Coho Salmon in the Lower Trinity River and is the single greatest Coho Salmon producer between the Hoopa Tribe Reservation and the North Fork Trinity River (Cyr 2008; Boberg 2008).

Good spawning habitat exists in a few tributaries in the Lower Trinity River and the Burnt Ranch and New River HAS's have some of the best-known spawning habitat in the population area. Tributaries known to support Coho Salmon spawning and/or rearing include Mill Creek, Horse Linto Creek, Tish Tang Creek, and Sharber-Peckham Creek. The presence of juvenile Coho Salmon has also been confirmed within recent years in Manzanita Creek, Big French Creek, East Fork New River, Cedar Creek, Supply Creek, Campbell Creek and Hostler Creek, as well as Willow Creek as far upstream as the Boise Creek confluence (Boberg 2008, Everest 2008) with Sharber-Peckman Creek supporting the highest number of spawning Coho Salmon (USFS 2001). Based on spawner surveys by the USFS, run sizes in Sharber Creek between 1996 and 2001 ranged from 0 fish in 1999 to almost 150 fish in 2001 (USFS 2003b). The SRNF indicated that populations in the lower portions of Mill and Horse Linto Creeks are extremely low, particularly in Horse Linto Creek since 1995 (USFS 2001). Horse Linto Creek is a designated Tier-1 watershed by the NWFP, meaning the creek is intended to serve as refugia for maintaining and recovering habitat for at-risk salmonid stocks (USFS and USDI 1994).

Effects to Coho Salmon habitat in the Lower Trinity River include degradation of spawning and rearing habitat, lack of deep pools, sedimentation, channelization and channel confinement, and high-water temperatures. Some streams with moderate IP value are relatively intact with regards to their historic condition and a few have federally designated Wilderness protection (NMFS 2014). Fish habitat, especially anadromous fish habitat, was greatly degraded in the 1964 flood, which affected the Lower Trinity River and most anadromous fish habitat in northern California (USFS 2000c). Substantial habitat recovery has occurred since the 1964 flood; however, wild anadromous fish populations and salmon habitat have generally not recovered in the Klamath River Basin (USFS 2000c).

NMFS (2014) indicates that it is likely that many watersheds within the Burnt Ranch and New River hydrologic subarea (HAS) are properly functioning with regard to aquatic habitat and watershed conditions. These streams have a large portion of their watersheds in the Trinity Alps Wilderness and remain in a relatively undisturbed state. Most of these streams remain accessible to Coho Salmon, currently supporting small populations of Steelhead and some Coho Salmon, but may not have historically supported robust populations of Coho Salmon due to their high gradient (NMFS 2014).

Hatchery influences on the genetic diversity of the Coho Salmon population are substantial in the Lower Trinity River sub-basin (NMFS 2014). The estimated escapement of naturally produced Coho Salmon adults and jacks upstream of the Willow Creek Weir from 1997 to 2010, ranged from 539 to 9,055, with an average of 2,028; however, unknown is the proportion of these Coho Salmon that spawn in the Lower Trinity River, as many are likely migrating to the Upper Trinity River (NMFS 2014). Spawning surveys conducted by the USFS (2003b) in the mid to late 1990’s have found scattered use of tributaries in the Lower Trinity by Coho Salmon, with between 0 and 100 spawners found during any given year in the few surveyed streams. Population growth rate is likely to be negative, and the population relies on the heavy influence of hatchery fish to maintain current abundance levels (NMFS 2014). NMFS indicates that the Lower Trinity Coho Salmon population is at high risk of extinction based on criteria described by Williams et al. (2008; Figure 15).

Although not well documented, there appears to be some diversity of life history strategies in the Lower Trinity River as data on run timing and outmigration indicates for this Coho Salmon population (NMFS 2014).

South Fork Trinity River Population

The South Fork Trinity River is the largest undammed river in California and is designated a wild and scenic river managed by the Forest Service and a Key Watershed by the Forest Service's NWFP. The South Fork Trinity River originates in the North Yolla Bolly Mountains about 50 miles southwest of Redding and runs northwest for approximately 90 miles before reaching its confluence with the mainstem Trinity River (RM 31). A large portion of the watershed is publicly owned and managed by the STNF (US Reclamation 2018).

The South Fork Trinity River is approximately 932 square miles (596,480 acres) in size (Fig. 13) and contains 167 square miles of private land (18% of total watershed) with population trends that indicate that the Trinity County human population could double (NMFS 2014). The geology of the South Fork Trinity River watershed is complex. In general, the west side of the river is more prone to erosion compared to the east of the river, thus the mainstem South Fork Trinity River has much higher sediment loads than its main tributary, Hayfork Creek. West of the South Fork Trinity River mainstem, tributaries are short and high gradient, originating on the unstable and steep slopes of South Fork Mountain, while east of the mainstem, the tributaries are longer, more stable and more complex, flowing through steep mountains and wide valleys (WRTC 2016).

According to NMFS (NMFS 2014) several factors limit the viability of the South Fork Trinity River Coho Salmon population. The most dominant of these factors stem from the effects of agricultural practices on private land and legacy sediment-related impacts from past floods, fire, and forest management.

The South Fork Trinity River population of SONCC ESU Coho Salmon occurs upstream to about Butter Creek (although there are no known migration barriers at Butter Creek) (NMFS 2014). Coho Salmon are limited in their distribution, occurring in Hayfork Creek up to Corral Creek, Eltapom Creek, Olsen Creek, and Madden Creek (Everest 2008; Boberg 2008). Rattlesnake Creek has moderate and high IP reaches, yet no Coho Salmon are known to inhabit these stream reaches. Coho Salmon have not been found in Hayfork Creek near, or upstream of the town of Hayfork, and yet the area has the greatest concentration of high IP values of any stream in the basin (NMFS 2014). It is not clear if Coho Salmon are currently able to migrate past Corral Creek; however, it is likely that habitat conditions, such as high summer water temperatures and low dissolved oxygen, arising from land use, water utilization, climate change and channel aggradation are currently limiting the spatial structure of Coho Salmon (NMFS 2018). In the lower SFTR (Garwood in WRTC 2016), Coho Salmon have been documented in Madden/Old Campbell and Eltapom creeks in the past few decades and were also observed in Pelletreau Creek in 1951. In lower Hayfork Creek, Garwood (in WRTC 2016) reported that Coho Salmon have been documented in Corral and Olsen creeks.

Table 14 shows the major tributaries to the South Fork Trinity River. The 604,000-acre South Fork Trinity River sub-watershed, the largest of the four tributary watersheds of the Trinity River basin (Wiseman and Brock 2018), is primarily mountainous, forested land, with two broad agricultural valleys occupied by the towns of Hayfork and Hyampom. Elevations range from more than 7,800 feet in the headwaters, to less than 400 feet at the confluence with the Trinity River, and land is a mix of private and Forest Service, and BLM administered land that had extensive timber harvesting in the past that caused erosion and sedimentation to streams and the Trinity River.

Hayfork Creek (South Fork River confluence at RM 30) is the largest tributary to the South Fork Trinity River and includes approximately 191,000 acres of public land and 52,000 acres of private land (SFCRMP 2008). The majority of high IP habitat exists on private land in the Hayfork Valley and is characterized by poor water quality, a lack of hydrologic function, sedimentation and high-water temperatures (Lisle 1981). Hayfork Creek historically has been a spawning area for Steelhead, spring-run and fall-run Chinook Salmon, and spring-run Chinook Salmon populations that have declined by 90% (NCRWQCB 2005). The Hayfork Creek sub-basin is a relatively geologically stable basin in comparison to the rest of the South Fork Trinity River Basin. However, the majority of water diversions and water quality issues (high water temperatures, high nutrient loads, low dissolved oxygen) in the South Fork River basin occur in the Hayfork sub-basin, where depleted summer flows and lack of riparian shading have adversely affected salmonid production (PWA 1994). The upper reaches of Hayfork Creek are too warm for rearing Coho Salmon, making it uninhabitable without thermal refugia from cold water springs or ground water. The loss of riparian canopy (from grazing and timber harvest) contributes significantly to increased water temperatures, which can exceed 80°F in Hayfork Creek (PWA 1994). Flow depletion, lack of riparian cover, and water pollution all affect the ability of Hayfork Creek, and its major tributaries, to produce Salmon and Steelhead.

Table 14. South Fork Trinity River Watersheds (*Based on USFS 2016 Critical Habitat map)

River/Stream	Length (~Mi.)*	Coho Critical Habitat (~Mi.)	Agency/Group/ Tribe
South Fork Trinity River	60	60	USFS, YT, private
East Fork of SF Trinity River	10	8	USFS
Rattlesnake Creek	16	12	USFS
Plummer Creek	12	10	USFS
Butter Creek	10	3	USFS
Indian Valley Creek	10	Redds only	USFS
Hayfork Creek	60	55	USFS, private

Table 14. South Fork Trinity River Watersheds (*Based on USFS 2016 Critical Habitat map)

River/Stream	Length (~Mi.)*	Coho Critical Habitat (~Mi.)	Agency/Group/ Tribe
East Fork Hayfork Creek	10	8	USFS
Summit Creek	12	5	USFS
Big Creek	14	10	USFS
Salt Creek	20	18	USFS
Eltapom Creek	10	3	USFS

Because of its high-water temperatures, Hayfork Creek increases temperature downstream in the South Fork Trinity River in some years, whereas it formerly provided a moderate influence (PWA 1994). The Hayfork Creek watershed has abandoned mines and small placer sluicing and hard rock milling operations that need to be investigated and assessed for release of toxic pollutants. The Kelly Mine, on McCovey Gulch in Hayfork, has drainage discharges containing chromium and arsenic affecting domestic diversions downstream and the Trinity County Health Department has notified homeowners not to drink the water (NCRWQCB 2005).

Little information is available on the historic distribution and abundance of Coho Salmon in the South Fork Trinity River basin (NMFS 2014). CDFG (now CDFW) operated a weir on the South Fork Trinity River at Sandy Bar, located about two kilometers upstream of the confluence with the mainstem Trinity River, between 1984 to 1990 (Jong and Mills 1992). In 1985 and 1990, years when enough adult and jack Coho Salmon returned to the river to make an escapement estimate possible, it was estimated that 127 and 99 adult and jack Coho Salmon returned to the river, however, 35.8% of the adult Coho Salmon captured in 1985 were of hatchery origin (Jong and Mills 1992). Further, the report found that straying of hatchery fish into tributaries, such as the South Fork Trinity River, presents a particular threat to the diversity of the population. Hatchery fish may reduce the reproductive success of the overall population (Mclean et al. 2003) through outbreeding depression (Reisenbichler and Rubin 1999). Continuing degradation of aquatic habitat, declining water quantity and quality, and influences of hatchery fish straying into the South Fork Trinity River are all thought to currently limit the viability of South Fork Trinity Coho Salmon (NMFS 2014).

Several studies and habitat typing reports noted stream temperature as a major limiting factor for fisheries in the South Fork Trinity River (USFS 1990; PWA 1994). Stream temperatures in the mainstem, below Hyampom and in Hayfork Creek, often reach lethal levels during the summer and tributaries with the potential for thermal refugia often lack adequate flows during the summer

(PWA 1994). Riparian vegetation is reestablishing in some smaller tributaries and is expected to experience improved water quality in the future (e.g., Sulphur Glad Creek); however, many of these stream lack the flow and/or habitat requirements of juvenile Coho Salmon (NMFS 2014). Wiseman and Brock (2018) indicates that Hitchcock Creek is not properly functioning[16] for peak/base flow hydrology.

Based on the IP of the watershed, Williams et al. (2008) calculated the low risk spawner threshold for the South Fork Trinity River population is 6,400 Coho Salmon. Moderate IP reaches exist throughout the South Fork Trinity River basin, both in the mainstem, the East Fork of the South Fork, and tributaries such as Butter Creek and there are several streams that contain high IP reaches (IP>0.66), such as Hayfork Creek and Salt Creek; however, many of these high IP reaches are on private land and experience high temperatures during the summer (Williams et al. 2008). There are no historical accounts of Coho Salmon presence in the Hayfork Valley, and their prevalence in Hayfork Valley remains in question (NMFS 2014). There is a section in Hayfork Creek thought to inhibit salmon migration into Hayfork Valley because of its high gradient, particularly in dry water years.

Potential Coho Salmon refugia areas exist at many stream confluences within the South Fork Trinity River (NMFS 2014). According to Boberg (2008), Madden Creek provides excellent refugia for juvenile and adult Coho Salmon in the lower South Fork Trinity River and has cool, clean water that originates in the mountains of the SRNF and moderates the high temperature of the South Fork Trinity River. In the summer months, at times, near the confluence of the SFTR and Madden Creek hundreds of juvenile salmonids congregate in this area. Other potential refugia areas in the South Fork Trinity River listed by NMFS (2014) include Grouse Creek, Butter Creek, Rattlesnake Creek, Olsen Creek and Eltapom Creek.

Current aquatic habitat conditions within the South Fork Trinity River watershed remain affected by a legacy of historic land uses including logging and its associated road-building practices, water diversions and surface runoff from livestock grazing and other agricultural uses (NMFS 2014). More recently, significant reductions to summer base flow and degradation of water quality is caused by illegal marijuana cultivation in many northwestern California watersheds, including the Trinity River watershed (Bauer et al. 2015; Carah et al. 2015).

Little is known about Coho Salmon life history diversity in the South Fork Trinity River such as unique migration timing, redistribution of juveniles, or non-natal rearing. There does appear to be some diversity of life history strategies in the South Fork Trinity River based on data on run timing and

[16] Not properly functioning for base/peak flows-pronounced changes in peak flow, baseflow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography (NMFS 1996).

outmigration, as Coho Salmon enter the Trinity River between September and November and spawning in the river continues into December (CDFG 2009b). Also, both young-of-the-year and yearling Coho Salmon are captured at downstream migrant traps located in the Trinity River near Willow Creek (Phinnix et al. 2007).

Outmigration of age 0+ Coho Salmon occurs over a large time period between March and September as does outmigration of Age 1+. Outmigration of sub yearling Coho Salmon may be due to competition for rearing habitat or sub-optimal rearing conditions or it may be due to a unique life history type that may rear in natal or non-natal streams or both prior to emigrating to the ocean. It is unknown whether the South Fork Trinity River population has any of these unique life history characteristics because no juvenile salmonid trapping currently occurs in the basin (NMFS 2014).

The only population estimates for the South Fork Trinity River are based on work by Jong and Mills (1992) who estimated that 127 adult and jack Coho Salmon returned to the South Fork Trinity River in 1985 and 99 returned in 1990, with 35.8% (46) of the adult Coho Salmon captured in 1985 being of hatchery origin, and the total wild population was likely under 100 adults during these years. In 1985, several hundred Coho Salmon juveniles were trapped in the South Fork Trinity River below the mouth of Madden Creek (CDFG 1993). More recent data on population sizes, other than that of Jong and Mills (1992) are unavailable; however, Williams et al. (2008) determined that at least 242 spawners are needed each year in the South Fork Trinity River to avoid dispensatory effects of extremely low population sizes and, if we assume abundances are similar to those found in 1985 and 1990, the South Fork Trinity River population does not meet this depensation threshold. Based on current spawning densities and locations, the South Fork Trinity River population is at an elevated risk of extinction because its spatial structure and diversity are very limited compared to modeled IP (NMFS 2014).

Coho Salmon in the upper reaches of the South Fork Trinity River were likely dissimilar to those of the coast range and Lower Trinity River. In order to access spawning grounds in the Hayfork Valley, Salt Creek, and upper mainstem South Fork Trinity River, they would have begun their spawning migration in late September or October. These “long-run” Coho Salmon most likely had run timing similar to Coho Salmon in the Shasta River. This is unlike Coho Salmon in the coast range that enter rivers and streams to spawn in November and December following winter rains. The far distance that they travel, distinctive geology and ecology of the Yolla Bolly Mountains, and unregulated flow of the South Fork Trinity River, would have made this population of Coho Salmon unique among Trinity River Coho Salmon populations (NMFS 2014).

The USFS (USFS 2018) considers the Upper South Fork Trinity River a high priority due to several factors including 1) its function as a Key Watershed, 2) its location in the upper portion of the watershed, 3) its location in unstable geologic terrain west of the mainstem of the South Fork Trinity River, 4) its greater than average density of critical CH, and 5) the fact that nearly all of the land in the sub-watershed is owned by the Forest Service. The Forest Service (USFS 2018) summarized the known sediment sources that lie within the Headwaters-South Fork Trinity River drainage and identified 17 stream crossings (all undersized culverts) as the highest rated priorities for restoration of all the inventoried legacy sediment sites on the west side of the Shasta-Trinity National Forest.

WRTC (2016) priorities for the South Fork Trinity River watershed recommendations include: 1) Develop appropriate silvicultural prescriptions for benefit to Coho Salmon habitat in the South Fork Trinity River watershed to reduce water temperature and increase dissolved oxygen by thinning, or releasing conifers, guided by prescription, and planting vegetation in riparian areas to reduce delivery of sediment; 2) Revegetate the top 50 riparian listed sites (hottest and most degraded) out of 858 sites in the South Fork Trinity River watershed, having the highest restoration priority for revegetation; 3) Construct riparian fencing and riparian vegetation and conduct riparian vegetation education for local residents; 4) Assess fish passage at all major known stream diversions by a professional fish biologist and prescribe treatments to allow fish passage. Olsen Creek, Silver Creek and Big Creek Tule Creek, and West Tule Creek are the highest restoration priorities.

Lower Klamath River (below Trinity River Confluence) Coho Population

The Lower Klamath River (LKR) Sub-Basin downstream of the confluence of the Trinity River has a drainage area of about 493.3 square miles. The Lower Klamath River (LKR) SONCC Coho Salmon population occurs from the mouth of the Klamath upstream to the confluence with the Trinity River in the mainstem and accessible tributaries (NMFS 2014). Only a fraction of historic anadromous fish runs return to spawn in the LKR and its tributaries (Gale and Randolph 2000).

The declining health and productivity of the Klamath River's anadromous fisheries is of great economic and cultural concern to the Yurok Tribe so it initiated the Klamath Restoration Program Long Range Plan, a large-scale, coordinated watershed restoration effort in the LKR Sub-Basin, that includes all The goal of the Yurok Tribe is to restore aquatic habitat conditions within Lower Klamath River tributaries to a level that supports viable, self-sustaining populations of native salmonids and rely on sound scientific methods and principles to plan, implement, and monitor all watershed restoration activities within the LKR Sub-Basin (Gale and Randolph 2000).

In addition to providing connectivity to tributary watersheds for spawning and rearing, the mainstem LKR provides migratory and rearing habitat for adult and juvenile Coho Salmon for all Klamath River Coho Salmon populations. Coho Salmon Juveniles and smolts from upstream populations use the LKR Sub-

Basin during the summer and winter for rearing and acclimation, and adults use thermal refugia for holding prior to migrating upstream (Voight and Gale 1998; Yurok Tribal Fisheries Program 1999; Soto et al. 2008; YTFP 2009a, Hillemeier et al. 2009; Silloway 2010; Belchik and Turo 2002).

Williams et al. (2008) concluded, based on the model results to predict the IP Coho Salmon habitat, that the amount of Coho Salmon habitat included most LKR tributaries and that most of the high IP reaches are in the lower (downstream) tributaries with a total of Intrinsic Potential (IP) of 127 miles.

Habitat typing inventories were conducted throughout all anadromous fish-bearing LKR tributaries during 1996-1997, and LWD inventories during 1998, using methods in Flosi et al. (1998). The Blue Creek drainage contains the highest quality habitat and riparian conditions of all the LKR tributaries and the upper 2/3 of the drainage are all located within the Six Rivers National Forest with the majority protected as part of the Siskiyou Wilderness Area, while most of the remaining area is classified as LSR (FEMAT 1993). In contrast to conditions found in upper Blue Creek, the remainder of the LKR Sub-Basin has been subjected to extensive timber harvesting and related road construction over the last 60 years. These activities, in conjunction with naturally fragile hillslopes and large flood events, have resulted in substantial streambed sedimentation, reduced channel and streambank stability, and an overall reduction in quality and quantity of instream fish habitat (Gale and Randolph 2000).

According to Gale and Randolph (2000), while conditions vary between tributaries due to geologic and geomorphic differences, most LKR tributaries suffer from low habitat diversity, reduced quantity and complexity of fish cover, excessive sedimentation and substrate embeddedness, and reduced channel stability. These deficiencies likely hinder successful spawning and emergence, limit the quality and quantity of rearing habitat for juvenile salmonids, increase competition and predation, alter composition of available food organisms, and in general reduce overall survival of salmonids from spawning to emigration.

Very little is known about the life history and genetic diversity of the LKR Coho Salmon population, but based on survey data the population has been affected by out-of-basin stock planting and hatchery influences and the reduced population abundance has likely led to depensation effects some years (e.g. inbreeding) and reduced genetic diversity. However, compared to other Klamath populations, tributaries in the LKR sub-basin may support some of the healthiest wild Coho Salmon in the Klamath River Basin (NMFS 2014).

There is little information on the historic size of the LKR Coho Salmon population. The commercial gill-net fishery in the LKR caught 11,162 Coho Salmon (83,836 pounds) between late September and late October 1919 (Snyder 1931). The estimated annual sport fishery catch in the LKR was 1,187 Coho salmon in 1951 (Gibbs and Ramsey 1955) and 4,000 Coho Salmon in 1954

(McCormick 1958). The proportion of Coho Salmon caught in these fisheries that originated from the LKR Coho salmon population is unknown (NMFS 2014). The California Department of Fish and Game (CDFG 2004b) reported that in the 1960's, approximately 8,000 Coho Salmon returned to the mainstem Klamath River and tributaries (excluding the Shasta, Scott, Salmon, and Trinity rivers). The percentage of these fish that originated from the LKR Coho Salmon population is also unknown.

Data concerning historic fish rescue in a number of LKR tributaries provide some additional information about Coho Salmon in the population area (NMFS 2014). Historical CDFG (now California Department of Fish and Wildlife) and U.S. Fish and Wildlife Service (USFWS) records (1945 to 1993) note the presence of Coho salmon in Hunter, Hoppaw, Saugep, Terwer, McGarvey, Tarup, Blue, Bear, Tectah, and Roach creeks (Voight and Gale 1998). Presence and abundance in these streams varied among years and was largely dependent on plantings of Coho Salmon fingerlings by CDFG. Although most of these plantings were of fish originating from within the sub-basin, 20,000 out-of-basin Coho Salmon from the Alsea River in Oregon were planted in McGarvey Creek between 1962 to 1963. About 150,000 Coho Salmon fingerlings were planted in Tarup, McGarvey, Hunter, Surpur, and Tectah creeks between 1962 and 1990 (NMFS 2014). Planting of Coho Salmon peaked in the late 1960's and some stocked sub-basins were more successful than others (Voight and Gale 1998). The current population of LKR Coho Salmon may be partial descendants of these planted fish.

The Yurok Tribe, CDFG, and GDRC conducted multiple fish surveys over the past several decades and from these data we can assess, to some degree, the spatial structure of the LKR Coho Salmon population (NMFS 2014). Coho Salmon have been observed in more tributaries than Chinook but were typically found in very low densities relative to other salmonids and were only observed in the lower reaches of most tributaries, and in at least a few cases their presence appeared to be attributable to non-natal rearing (Voight and Gale 1998). Crescent City Fork Blue Creek was the only tributary where sizeable numbers of juvenile Coho were consistently observed and large numbers of young-of-the-year Coho were observed rearing throughout the creek. In the middle and upper tributary reaches juvenile Coho have been observed outnumbering other salmonid species. Relatively large numbers of young-of-the-year Coho were also observed in lower South Fork Ah Pah Creek during 1997, but abundance during subsequent years has been variable (Gale and Randolph 2000).

Spawning Coho Salmon have been found in Blue Creek (mainstem), Crescent City Fork Blue Creek, Hunter, Waukell, McGarvey, Terwer, Ah Pah, Tectah, and Pine creeks (Gale 2009a, 2009b, Beesley 2010). Consistent LKR Coho Salmon spawner survey data are only available from Blue Creek but these data provide a relatively long period of productivity and abundance information for the population (Gale et al.1998, Gale 2009c). Adult Coho salmon population abundance, estimated by Ackerman et al. (2006), ranged from 15 to 1,500 spawners between 2001 and 2006, based on juvenile Coho Salmon abundance in the LKR.

Limiting Factors Affecting SONCC Coho Salmon and Critical Habitat in the Action Area

This section further describes limiting factors that historically and currently affect the SONCC ESU Coho Salmon population and their critical habitat in the action area and is primarily adopted from the Final Recovery Plan for SONCC ESU Coho salmon (NMFS 2014). Limiting factors were analyzed for the Upper Trinity River, Lower Trinity River, and South Fork Trinity River watersheds. Additional information, obtained from other sources, is cited where appropriate.

There are a variety of factors affecting SONCC Coho Salmon in the action area, most of which have a negative effect on SONCC Coho Salmon and their critical habitat. The California drought combined with the warm water “Blob” in the northeast Pacific Ocean took its toll on the SONCC Coho Salmon in the action area. These limiting factors contribute to low returns of adult Coho Salmon. Those Coho Salmon that do return are found to be limited as well as contain disease. They have also lacked forage in the ocean environment for multiple years in a row and this appears to have pushed adult returns to their lowest levels throughout the region (NMFS 2018).

The five primary factors considered for listing a species as endangered or threatened based include: 1) the present or threatened destruction, modification, or curtailment of its habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) the inadequacy of existing regulatory mechanisms; and 5) other natural or human-made factors affecting its continued existence (50 CFR Part 424).

Stresses contributing to the threatened status of the SONCC ESU Coho Salmon include: adverse hatchery-related effects, impaired water quality, degraded riparian forest conditions, increased disease/predation/competition, altered sediment supply, lack of floodplain and channel structure, altered hydrologic function, barriers, impaired estuary/mainstem function, and adverse fishing-related effects. Continuing threats include: climate change, roads, channelization and diking, agricultural practices, timber harvest, urban/residential/industrial development, high intensity fire, mining and gravel extraction, dams and diversions, invasive/non-native species, hatcheries, fishing and collecting, inadequate regulatory mechanisms, ocean conditions, and stochastic pressure from small population size (NMFS 2011b; NMFS 2014).

The dominant land uses in the Upper Trinity River are recreation and timber harvest, with key limiting stresses on Coho Salmon identified as “altered hydrologic function,” “barriers,” and adverse hatchery related effects” and key limiting threats as "Hatcheries" and "dams/diversions" (NMFS 2014; Table 15). Other land use activities include mining, road construction, and a limited degree of residential development in certain locations.

Dominant land uses in the Lower Trinity River include forestry and agriculture. The key limiting stresses to Coho Salmon being identified as "lack of floodplain and channel structure" and altered hydrologic function" and key limiting threats as "channelization/diking" and "hatcheries" (NMFS 2014; Table 15).

Dominant land uses in the South Fork Trinity River include agriculture and forestry. Key limiting stresses are "Altered hydrologic function" and "impaired water quality" and Key Limiting threats are identified as "dams/diversion" and "roads.". Juveniles are the most likely limited life stage due to poor summer rearing conditions (NMFS 2014; Table 15).

Dominant land use in the Lower Klamath River is timber harvest with key limiting stresses on Coho Salmon being "altered sediment supply" and "lack of floodplain and channel Structure," and key limiting threats as "roads" and "timber harvest" (NMFS 2014; Table 15).

Table 15. Key Limiting Stresses and Threats for Coho Salmon in the Trinity River and Lower Klamath River

Limiting Stresses	Overall Stress Rank				Limiting Threats	Overall Threat Rank			
	Upper Trinity	Lower Trinity	South Fork Trinity	Lower Klamath		Upper Trinity	Lower Trinity	South Fork Trinity	Lower Klamath
Adverse Hatchery-Related Effects	Very High[1]	Very High	Very High	Medium	Hatcheries[1]	Very High[1]	Very High[1]	Very High	Medium
Altered Hydrologic Function	Very High[1]	High	High[1]	High	Dams/ Diversions[1]	Very High[1]	High	High[1]	High
Barriers	Very High	Medium	High	Medium	Road-stream Crossing Barriers	High	Low	Low	Medium
Lack of Floodplain and Channel Structure	High	Very High[1]	High	Very High[1]	Climate Change	High	High	High	Medium
Increased Disease/ Predation/ Competition	High	Medium	Low	High	Invasive/ Non-native species	Medium	Low	Low	Medium
Impaired Water Quality	Medium	Medium	High[1]	Medium	High Severity Fire	Medium	Medium	Medium	Medium

Table 15. Key Limiting Stresses and Threats for Coho Salmon in the Trinity River and Lower Klamath River

Impaired Estuary/Mainstem Function	Medium	Medium	Medium	High	Roads	High	High	Very High[1]	High
Degraded Riparian Forest Conditions	Medium	Medium	High	High	Agricultural Practices	Medium	Medium	Medium	Very High[1]
Altered Sediment Supply	Medium	High	High	Very High[1]	Channeliza-tion/ Diking	Medium	Very High[1]	Low	Very High[1]
Adverse Fishery-Related Effects	Low	Low	Low	Low	Develop-ment	Medium	Medium	Low	Medium
					Timber Harvest	Medium	Medium	Low	High
					Fishing and Collecting	Low	Low	Low	Low
					Mining/ gravel Extraction	Low	Low	Low	Low

1. Key Limiting Stresses and Threats (NMFS 2014)

Trinity River Hatchery & Hatchery-Related Adverse Effects

TRH first began releasing Coho Salmon in 1960. Although substantial efforts were made to trap and haul Coho Salmon above the dam during the construction of Trinity Dam, adult returns fell to essentially zero during the 1962-63 run (0 females, 7 males, 9 jacks). Transfer of Coho Salmon eggs from outside of the Trinity River basin occurred, which imported Coho Salmon that were likely not as well adapted to the Trinity River Basin's habitat conditions as were the original stocks. The TRH facility originally used Trinity River fish for broodstock, though Coho Salmon from the Eel River (1965), Cascade River (1966, 1967, and 1969), Alsea River (1970), and Noyo River (1970) have also been reared and released at the hatchery as well as elsewhere in the Trinity River basin (NMFS 2003). Actual production averaged 496,813 from 1987 to 1991, decreased to 385,369 from 1992 to 1996, then increased again to 527,715 fish from 1997 to 2002, and then during the period 1991 to 2001, an average of 3,814 adult Coho Salmon were trapped and 562 females were spawned at TRH (NMFS 2003).

Between 1999 and 2012, hatchery-origin Coho Salmon constituted between 73 and 96.8 percent of the spawning run returning to the Willow Creek weir in the Lower Trinity River (Table 13). The population of native fish is considered at moderate risk of extinction if the fraction of naturally spawning hatchery fish exceeds 5% (Williams et al. 2008). Trinity River hatchery Coho Salmon stray into many of the tributaries on the Six River National Forest, such as Horse Linto Creek (Cyr 2008). Straying of hatchery fish into tributaries of the Trinity River presents a particular threat to the diversity viability parameter, as hatchery fish may reduce the reproductive success of the overall population (Mclean et al. 2003) through outbreeding depression (Reisenbichler and Rubin 1999).

In addition, roughly 30% of hatchery yearling Coho Salmon smolts have been found to die within 10 km of the TRH and disease and predation are possible explanations for this smolt mortality (Beeman 2009).

Hatchery influences are substantial in the Trinity River basin, as each year, the Trinity River Hatchery (TRH) releases approximately 500,000 Coho Salmon smolts, 800,000 Steelhead, and 4.3 million Chinook Salmon (NMFS 2014), and currently, returns are dominated by hatchery fish (USFWS and HVT 1999). NMFS (2014) ranked adverse hatchery-related effects as a very high limiting factor for Trinity River populations of SONCC ESU Coho Salmon (Table 15).

The TRH likely has played a role in the long-term productivity of the Trinity River population of SONCC ESU Coho Salmon through the well documented genetic and ecological interactions between hatchery- and natural-origin salmon (Nickelson 2003; Reisenbichler et al. 2003; Chilcote et al. 2011). Competition with, and predation by, hatchery-origin fish released from TRH may limit rearing and spawning capacity of natural-origin Coho Salmon in the Trinity River. Competition of hatchery fish with naturally produced fish has the potential to displace wild fish from portions of their habitat (Flagg et al. 2000; Chilcote et al. 2011). Competition may occur among hatchery and natural adults for spawning sites, and may lead to decreased production, especially for natural Coho Salmon. Hatchery fish, outnumbering natural fish, may overwhelm available spawning habitat, when first generation hatchery-origin fish spawn naturally in the river. The negative effect of such competition is magnified by naturally spawning hatchery stocks which have been found to exhibit lower reproductive success than natural-origin fish (Reisenbichler et al. 2003). This is especially true for anadromous salmonid stocks near carrying capacity, which may occur more often in river reaches near hatcheries (Lister 2014). Also important is predation on wild Coho Salmon fry by hatchery-reared salmonids (Naman 2008). Cumulatively, and in concert with other habitat-related stresses, adverse hatchery-related impacts are a key stressor for the population.

In recent years, hatcheries in California have stopped all inter-basin stock transfers, limited out planting (all TRH Coho Salmon smolts are released volitionally at the hatchery), marked outplants, and placed limits on production levels. Therefore, the current level of impact of hatchery fish on natural fish may be significantly less than in the past (CDFG 2002b).

No hatcheries or artificial propagation occur in the Lower Klamath River Coho Population area, but there are two hatcheries in the Klamath River Basin.

Hatcheries pose a medium threat to all life stages for LKR sub-basin Coho Salmon due to the presence of Iron Gate Hatchery and Trinity River Hatchery in the Klamath Basin (NMFS 2014; Table 15).

Altered Hydrologic Function

NMFS (2014) ranked altered hydrology as a very high limiting factor for the Upper Trinity River and a high limiting factor for the Lower Trinity and South Fork Trinity River populations of Coho Salmon (Table 15), because the overall annual flow and associated seasonal flow variability are reduced from that of the natural flow downstream of Lewiston Dam, negatively affecting Coho Salmon fry, juvenile, and smolt life stages (NMFS 2014).

Upper Trinity River

In the Upper Trinity River below the Dam, the reduction of peak flows in the mainstem contributed to accumulation of excessive fine sediment into spawning gravels and created conditions allowing sediment to deposit into channel constraining riparian berms, reduced the frequency of floodplain inundation and the corresponding seasonal riparian-riverine habitat connectivity, complexity, and riverine ecosystem function (USFWS and HVT 1999). This altered hydrology affects geomorphic processes and habitat linkages that contributed to the loss of open, shallow, low-velocity gravel bar habitats that are preferred by rearing salmonid fry and largely simplified the aquatic habitat available in the Upper Trinity River. Available fry and juvenile rearing habitat is reduced certain times of the year, particularly winter months, by reduced flow volumes, and habitat complexity and food supply are likely limited by reduced flow variability. Much of the TRRP's ongoing channel rehabilitation activity is focused on remediating this impact of the TRD.

Flow variability is an important component of river ecosystems that promotes the overall health and vitality of both rivers and the aquatic organisms that inhabit them (Poff et al. 1997; Bunn and Arthington 2002; Arthington et al. 2004), which is also being addressed for the mainstem Trinity River by the TRRP in concert with physical habitat restoration (McBain and Trush 1997; USDOI 2000). The reduction of dam controlled scouring flows in the mainstem has contributed to fine sediment infiltration into spawning gravels, with the impact being greatest just below the confluence of Grass Valley Creek (NMFS 2014). Downstream of the first tributaries, salmon egg survival to emergence appears to drop and is lowest below Grass Valley Creek (Poker Bar site), likely due to increased tributary derived fine sediment (GMA 2001).

Large flow events allow access to otherwise disconnected floodplain habitats (Bunn and Arthington 2002), which can increase the growth and survival of juvenile salmon (Sommer et al. 2001; Jeffres et al. 2008). In some streams, such as Weaver and Rush creeks, where water is withdrawn for residential purposes, summer and fall base flows may be decreased, affecting high water temperatures in these tributaries. Low, stable flows during the winter may also limit overwinter habitat for juvenile Coho Salmon in the upper Trinity River

(NMFS 2014). Additionally, water quality, particularly water temperature, in the Upper Trinity River is highly dependent on dam operations and releases.

Seaward migration of juvenile anadromous salmonids is often triggered by the seasonal increases in flow along with changes in temperature and other water quality factors (Tripp and McCart 1983). Upstream salmon and Steelhead spawning migrations are often triggered by flow variability in the fall (Groot and Margolis 1991); however, some concern exists that stable flows in the Upper Trinity River throughout the summer and fall may be adversely affecting adult migration.

Lower Trinity River

NMFS (2014) ranked altered hydrology as high limiting factor for the Lower Trinity River populations of SONCC ESU Coho Salmon (Table 15). The construction of the Trinity and Lewiston dams in the early 1960’s, and water diversions to the Sacramento Valley, has had major impacts on the flow and function of the mainstem Trinity River (USFS 2000c, USEPA 2001).

South Fork Trinity River

Altered hydrologic function presents a high stress for the South Fork Trinity River salmonid population (NMFS 2014; Table 18). This is a serious problem in parts of the South Fork Trinity River as flows are naturally low during the summer due to the low elevations in the basin, the bedrock geology and their low water holding capacity, and the summers are hot and dry for several months with little water flow (USFS 1996). Although no major dams exist on the South Fork Trinity River, numerous wells and diversions for domestic and agricultural uses occur throughout the watershed and reduce stream flows during critical low-flow periods (NMFS 2014). WRTC (2016) reports that the vast majority of the diversions in the South Fork Trinity River are pumps in streams, not constructed diversion infrastructure that needs fish passage structures. Exacerbating this issue is the substantial water utilization in the South Fork Trinity River, especially Hayfork Creek and its tributaries (PWA 1994), and Rattlesnake Creek (Wiseman and Brock 2018), which caused reductions in the amount of habitat available to rearing juvenile salmon in the summer and caused restricted access to spawning grounds in the fall. Hayfork Creek, below the East Fork, has been designated as a critical water shortage area (PWA 1994).

Missing groundwater connection to streams in the Hayfork Valley may be a major limiting factor in the current riparian vegetation condition. The Hayfork Valley has had a major loss of riparian vegetation from historic conditions (and has a majority of top priority restoration sites). A likely reason why riparian vegetation has been lost is due to the incision of Hayfork Creek and potential dewatering of the ground water table throughout the valley. Because of local geology, this incision has reduced the ability of surface water to connect with and recharge shallow groundwater aquifers and ultimately limits the area in which plants can establish and grow (WRTC 2016).

According to WRTC (2016), beaver populations have been rebounding significantly in the last 4-5 years in the South Fork Trinity River watershed and their activities have increased groundwater connectivity with Hayfork Creek, dramatically increased riparian vegetation, through raising the groundwater table and even potentially helping aggrade the incised streambed. However, while beavers seem to help overall vegetation growth, they also use riparian vegetation as a primary food source, so some vegetation needs protection from beavers, such as using fencing to protect riparian trees (WRTC 2016).

Recently, Van Kirk and Naman (2008), found that river discharge in the South Fork Trinity River was significantly lower from 1977 to 2005 than from 1966 to 1976. This decrease in flow is likely due to a combination of increasing water utilization, land use changes, and climate change, which has resulted in a decrease in snowpack in the region (Van Kirk and Naman 2008). This means that the increase in stream flows associated with fall and winter rains is often delayed as groundwater resources recharge (NMFS 2014).

Lower Klamath River

Altered hydrologic function is a high limiting stress for the LKR Coho Salmon population with greatest impacts to juveniles, smolts, and adults which are impacted by altered flows in LKR tributaries and altered hydrograph in the mainstem Klamath River (Table 15). The timing, magnitude and extent of flows in the LKR from the confluence of the Trinity River down to the estuary are altered compared to historic conditions as generally, spring and summer flows are lower than historical flows, while fall and winter flows in the LKR are generally similar top historical flows (NMFS 2014).

The hydrologic function of tributaries in the LKR has also been altered, evidenced by lower portions of tributaries going dry from late spring to fall. The removal of mature conifers from throughout the LKR has likely resulted in a change in the “wet season” stream hydrograph, in particular, this change in vegetative canopy and slope cover has likely resulted in peak discharge levels of an increased intensity and shorter duration following storm events (Beesley and Fiori 2007a).

Seasonal intermittent drying is the most common pattern observed in LKR tributaries (Gale and Randolph 2000; Beesley and Fiori 2007b). LKR tributaries such as Terwer and Hunter creeks, begin drying upstream of the mouth and subsurface conditions progress both upstream and downstream of this location as the dry season progresses. Watersheds in the LKR that appear most impacted by subsurface flow conditions and that are critically important to LKR Coho Salmon include Hunter, Terwer, Ah Pah, Tectah, and Johnsons (NMFS 2014). LKR tributaries such as Hunter, Mynot, Hoppaw, Tarup, Omagaar, Bear, and Johnsons creeks were usually the first to begin drying in the spring, and typically experienced period s of subsurface flow during winter and early spring months in the absence of continued, frequent rain events and all these creeks experienced a disruption or complete cessation of flow during critical juvenile Coho Salmon emigration periods for most if not all of the years monitored (Gale and Randolph 2000; Beesley and Fiori 2007a). Because of alterations in the hydrology of tributaries, the timing and magnitude of rains in autumn is critical for salmonid spawners attempting to gain access to spawning grounds (Voight and Gale 1998), and for juvenile fish seeking refuge in tributary habitats to overwinter (Soto et al. 2008; Hillemeir et al. 2009).

Barriers

Upper Trinity River

NMFS (2014) ranked barriers as a very high limiting factor for the Upper Trinity River populations of SONCC ESU Coho Salmon, primarily due to the adverse effects of the TRD (Table 15). These adverse effects on salmon habitat include: 1) blockage of migration to high-quality habitat above dams, 2) alteration of amount and timing of river flows, 3) flow-mediated, increased late-summer water temperatures, 4) reduction in coarse sediment recruitment from above TRD dams to the mainstem Trinity River, and 5) accumulation of fine sediment in the riverbed because of the disequilibrium between fine sediment inputs from the watershed (both natural and manmade increased sediment inputs) and reduced river discharges caused by TRD operation (USFWS and HVT 1999; USFWS 2000).

The effect of barriers is thought to be significant to all the migratory freshwater life stages of Upper Trinity River coho salmon. The Lewiston and Trinity dams block the Upper Trinity River population SONCC ESU Coho Salmon from high-quality habitat above the dams. The loss of this habitat has led to a restricted spatial structure and the reliance on a limited amount of spawning and rearing habitat downstream. The restricted amount and suitability of available habitat downstream of Lewiston Dam is a primary factor thought to limit the productivity of the Coho Salmon population (NMFS 2014).

At least seven total barriers block habitat on the North Fork Trinity, Canyon Creek, Browns Creek, Reading Creek, Weaver Creek, and Middle Weaver Creek (CalFish 2009, as cited in NMFS 2014). In addition, four partial barriers exist within the range of Coho Salmon on Weaver Creek, Browns Creek, and Canyon Creek. Other high priority total barriers exist on tributaries with the potential for providing Coho Salmon habitat. The California Fish Passage Assessment Database (CalFish 2009, as cited in NMFS 2014) Assessment Database lists 112 road stream crossing barriers in the Upper Trinity River and indicates that there are 30 road steam crossing structures that are total barriers to migration and 25 partial barriers. Additional barriers associated with road crossings on private land are thought to also exist. Thermal barriers are also a potential stress for the population because thermal refugia appear to be decreasing due to climate change and other factors. Migratory habitat in some tributaries may be limited and thermal barriers may prevent movement between habitats (NMFS 2014).

Lower Trinity River

Barriers pose a moderate stress to Coho Salmon in the Lower Trinity River and are especially detrimental to juveniles, smolts and adults. The extent of impact from barriers is largely unknown due to the number of private diversions in the Lower Trinity; however, the impact could be large (NMFS 2014). There are 25 road-stream crossing structures that are total barriers to salmonid migration in the Lower Trinity River population area and a total of 33 unscreened diversions with a remaining 30 diversions on private land that may also be unscreened (CalFish 2009). The location of most road crossings and diversions suggests that most of the watershed remains accessible to Coho Salmon and these barriers are not substantially restricting the availability of habitat, with the exception of a barrier on Sharber Creek, which is blocking access to approximately two miles of high quality rearing habitat on one of the last remaining productive streams (NMFS 2014). Low water barriers and thermal barriers (e.g., mainstem reaches) may seasonally limit Coho Salmon rearing and migratory habitat (NMFS 2014).

South Fork Trinity River

Although there are no large dams in the South Fork Trinity River basin, there are numerous small barriers scattered throughout the sub-basin that could block a significant amount of available habitat. Numerous wells and diversions, for domestic and agricultural uses, occur throughout the watershed that reduce stream flows during critical low-flow periods (NMFS 2014). Devastation Slide is an adult migration barrier on Grouse Creek. Hyampom (mainstem) and Hayfork (Hayfork Creek) valleys may be temperature barriers to rearing juvenile Coho Salmon. California Cooperative Anadromous Fish and Habitat Data Program (CalFish 2009, as cited in NMFS 2014) identified four small dams and 147 road-steam crossing potential barriers, and 11 have been identified as priorities for removal. Of the 147 road-stream crossing barriers in the South Fork Trinity River basin, 28 are partial barriers to fish migration, 64 are total barriers, and 42 are unknown. An assessment of county-owned roads identified 12 low priority stream crossings and 4 moderate to high priority stream crossings (Trinity County 2000). The crossing on Barker Creek is a barrier to 1.5 miles of fair-to-good habitat, and crossings in Kingsbury Gulch (Hayfork Creek) also pose a threat to Coho Salmon, due to the number of crossings. On public land, this threat is expected to decrease over time as roads are upgraded and culverts removed or upgraded (NMFS 2014).

Lower Klamath River

Barriers are a moderate limiting stress due to the prevalence of flow barriers in most LKR tributaries and the occurrence of road-related barriers (NMFS 2014). Most tributaries in the LKR have formed large, persistent gravel deltas at their mouths and these seasonal barriers interrupt successful juvenile emigration in the spring, block adult immigration in the fall, inhibit immigration of non-natal juvenile salmonids, limit the quality and quantity of rearing habitat, increase competition and predation, and alter composition of available food organisms (Payne and Associates 1989; Beesley and Fiori 2007b). There appears to be extensive mortality each year due to subsurface flows, and over-summer survival of natal Coho Salmon is reduced by the occurrence of these barriers (Beesley 2010). The dewatering of tributary reaches is primarily the result of excessive aggradation, and loss of fluvial deposited and recruited LWD, as well as deposition of sediment from the mainstem Klamath River and the altered hydrologic function. Large gravel bars and deltas at the LKR tributary mouths form barriers which require either high tributary or mainstem flows to allow fish passage (NMFS 2014).

Road-stream crossing barriers are a moderate limiting stress due to the occurrence of several fish passage barriers in the LKR sub-basin. Possible affected streams include McGarvey, Richardson, Saugep, Waukell, Junior, Blue and Terwer creeks and a Highway 101 grade control structure barrier on W.F. McGarvey Creek blocks access to high IP reaches. Another impassable highway grade control structure exists on Waukell Creek, and undersized culvert exists on Richardson Creek that is impassable most of the time except for when backwatering occurs from the mainstem Klamath River at higher flows (NMFS 2014). Several road crossings in the vicinity of the estuary have limited passage for Coho Salmon (Taylor 2007). The Highway 169 bridge over Terwer Creek and the GDRC bridge over Blue Creek also inhibit geomorphic function and limit floodplain connectivity in these creeks. Due to the importance of blocked tributary and estuary habitat to the LKR Coho Salmon population and other Klamath River population, the impact of these barriers is significant (NMFS 2014).

Lack of Floodplain and Channel Structure

NMFS (2014) ranked the lack of sufficient floodplain connection and simplified channel structure as a high limiting factor for the Upper Trinity and South Fork Trinity River populations and a very high limiting factor for the Lower Trinity River and Lower Klamath River populations (Table 15).

Upper Trinity River

The riverine habitat of the Upper Trinity River from Lewiston Dam, to the North Fork Trinity River confluence, has been most affected by the TRD and the Trinity River does not approach a pre-dam channel morphology until the confluence with the North Fork. Restricted channel-floodplain connectivity and simplification of channel structure of the mainstem Trinity River is largely a result of the TRD’s effect on hydrology of the sub-basin. Changes in sediment supply, storage, and transport, in combination with altered mainstem flow following construction of the TRD, altered the channel geomorphology. Riffle-pool sequences associated with point bars were replaced with monotypic runs after dam construction, which reduced the quantity, quality, and diversity of aquatic habitats. Important habitat types that have been adversely affected by these hydrologic changes include the frequency and depth of pools that provide cover from predators and refugia for Coho Salmon juveniles and adults; frequency and quality of gravel riffles for spawning; frequency of open gravel/cobble bars that create shallow, low-velocity zones important for emerging fry; and availability of slack water habitats for rearing juveniles (USFWS and HVT 1999). Remediation of these habitat alterations caused by the TRD is the main focus of the TRRP.

Mainstem reaches are generally disconnected from floodplain habitat and many tributaries experience simplified instream structure and habitat diversity and pool depths and frequencies are thought to be poor to fair, but data are limited (NMFS 2014). Moffett and Smith (1950) found a direct link between the filling of pools and thermal impacts on water quality in the Upper Trinity River and found that the deepest pools prior to the TRD, were as much as 7°F cooler than the shallow pools, provided important thermal refugia for juvenile Coho Salmon, and that the change in channel geomorphology has eliminated much of the temperature stratification in pools, particularly in the summer and early fall months.

Lower Trinity River

In the Lower Trinity River, rearing opportunities and capacity are low due to disconnection of the floodplain, a lack of LWD inputs, poor riparian conditions, and sediment accretion. Low-lying areas of streams such as Supply, Mill and Willow creeks have been channelized, diked, and disconnected from the floodplain and there exists very little off-channel habitat that can be used for rearing and refugia. The mainstem river also lacks side channel, backwater, and wetland habitat where juvenile Coho Salmon can find over-wintering habitat. Lower reaches of tributaries such as Supply and Mill creeks in the Hoopa HAS have been straightened and diked, reducing the complexity and natural meandering tendency that produces complex habitat, diversity in foraging opportunities, and high-quality rearing habitat (NMFS 2014).

Creeks in the Lower Trinity River with the potential for floodplain connectivity include Supply, Mill, Tish Tang a Tang and Willow creeks and NMFS (2014) states that recovery of the Lower Trinity River Coho Salmon population will not be possible without significant restoration efforts to reconnect and expand the floodplain habitat in these, and other creeks, that are currently diked and channelized reaches. Diking and channelization in many streams has reduced habitat complexity and simplified, especially lower portions of Supply and Mill creeks, on the Hoopa Valley Tribe Reservation (NMFS 2014).

South Fork Trinity River

Lack of floodplain and channel structure in the South Fork Trinity River is primarily the result of the 1964 flood, with many stream reaches still not recovered (NMFS 2014). Past and present activities such as mining, road construction, stream diversion, and timber harvest have modified streamflow and natural erosion processes and altered the dynamic equilibrium of stream channels in areas of the South Fork Trinity River watershed such as the Hayfork Valley (USFS 1996). Piles of mining tailings still line the channels of streams such as Hayfork Creek, constricting flows in places, producing sediment sources, and reducing the proper functioning condition of the stream and associated riparian zone (NMFS 2014). Wiseman (2018) indicates that the South Fork Trinity River is functioning at risk for channel conditions (width/depth and streambank condition).

Lower Klamath River

The lack of floodplain and channel structure in the LKR Coho Salmon population is a very high stress for Coho Salmon (NMFS 2014). Most stream reaches are unstable, have simplified instream structure and habitat diversity, excessive erosion and aggradation, and lack suitable spawning gravels, resulting in reduced quality and complexity of instream habitat (Gale and Randolph 2000; Beesley and Fiori 2004, 2007a, 2007b, 2008a).

Recruitment of high quality LWD to fluvial habitats is critical to channel formation, floodplain connectivity, spawning gravel sorting, retention dynamics, and instream structure (NMFS 2014). Active removal of fluvial deposited wood and decades of no to low LWD recruitment has simplified stream and riparian forest complexity, reduced floodplain connectivity and productivity, and reduced the amount of off-channel habitat in the LKR. The distribution and abundance of LWD in LKR tributaries has been surveyed by the Yurok Tribal Fisheries Program and GDRC. The Yurok Tribal Fisheries Program found that LWD in LKR tributaries ranged from 34 to 537 pieces/mile (average=230). They found LWD as the primary cover type in only about 25% of the LKR tributaries and the lowest densities of LWD (<100 pieces/mile) occurred in Morek, Cappell, and Slide creeks. Conifers comprise between 1 and 19% of the riparian canopy in LKR tributaries and the riparian forest is dominated almost exclusively by deciduous tree species (Gale and Randolph 2000), such as red alders, which are substantially inferior to conifers for maintain channel stability and floodplain connectivity, and for creating and maintaining productive fluvial habitats for fish and wildlife (NMFS 2014).

The lack of functional instream and floodplain habitat hinders successful spawning and emergence, limits rearing capacity for juveniles, increase competition and predation, alters food webs, and leads to an overall decrease in growth and survival of Coho Salmon in the LKR population (Gale and Randolph 2000; Beesley and Fiori 2004, 2007a, 2007b, 2008a).

Channelization and diking pose a very high threat to the LKR Coho Salmon population due to the associated loss of habitat in the estuary and along many important tributaries ((NMFS 2014). Salt, High Prairie, Hunter, Mynot, Hoppaw, Waukell, Terwer, Saugep, Spruce, and Johnsons creeks have all been impacted by the activities (Gale and Randolph 2000; Beesley and Fiori 2004, 2008b).

Levee construction has eliminated estuarine slough habitat near the confluence of Salt and Hunter creeks and both creeks have been channelized through present day pastureland. These levees continue to reduce or eliminate hydrologic connectivity of floodplains, wetlands, and estuarine sloughs that provide essential ecosystem functions and productive juvenile rearing areas and numerous historic off-channel areas and tributaries are inaccessible permanently or seasonally due to inadequate flows and sediment accretion (NMFS 2014).

Increased Disease/Predation/Competition

Disease, predation, and competition can be locally significant for SONCC ESU Coho Salmon and are ranked, collectively, as a high limiting stress factor for the Upper Trinity River and Lower Klamath River and a medium limiting factor for the Lower Trinity River Coho Salmon population (NMFS 2014; Table 15). Roughly 30 percent of hatchery yearling Coho Salmon smolts have been found to die within 6 miles downstream of the TRH (Beeman et al. 2009). Disease and predation are possible explanations for this smolt mortality (Beeman et al. 2009), as are tagging and handling hatchery Coho Salmon. Competition and predation by non-native Brown trout and hatchery-released salmon and Steelhead is also a source of stress and mortality for Coho Salmon fry, juveniles, and smolts (NMFS 2014). Bacterial kidney disease infection rates at TRH can occasionally be significant (S. Foott, USFWS CA-NV Fish Health Center, personal communication). SONCC ESU Coho Salmon smolts may be exposed to diseases like Ceratomyxosis once they reach the Klamath River. Ceratomyxosis, which is caused by *Ceratonova shasta*, has been identified as one of the most significant diseases for juvenile salmon due to its prevalence and impacts in the Klamath Basin (Nichols et al., 2003; Nichols et al., 2008; True et al., 2012). Since areas with the highest rates of infection in the Klamath Basin are in the Klamath River upstream of the Trinity River confluence (Bartholomew 2008), the level of this stressor for Trinity River smolts is likely lower than for Coho Salmon populations located farther upstream in the Klamath River.

Predation has been listed as a minor factor contributing to the decline and listing of the SONCC ESU Coho Salmon (60 FR 38011; July 25, 1995). Competition and predation by non-native Brown Trout (*Salmo trutta*) and hatchery-released salmon and Steelhead may contribute to this stressor for Coho Salmon fry, juvenile, and smolts. In the Trinity River, Brown Trout are abundant enough to account for a large number of juvenile fish observations during habitat surveys (Martin 2009, as cited in NMFS 2014) and it is likely that they prey on fry and juvenile Coho Salmon (NSR 2012). Coho salmon eggs are consumed by juvenile hatchery Steelhead and returning adult hatchery Steelhead (Naman 2008). Naman (2008) also found that residualized Steelhead can consume large quantities of Coho Salmon fry. One mechanism thought to contribute to this observation is that the release of large numbers of hatchery-raised fish may increase mortality rate of wild fish by 1) attracting predators and/or 2) increasing their exposure to predators, both natural predators and the oftentimes larger hatchery-raised fish themselves (Nickelson 2003).

Lower Klamath River

Increased disease, predation, and competition constitute a high stress for Coho Salmon in the LKR sub-basin and can have a localized or seasonal impact on both juvenile and adult life stages (NMFS 2014). Generally, disease exposure is much lower below the Trinity River confluence but is exacerbated by poor mainstem water quality and stressful conditions in the LKR (Bartholomew 2008). Disease effects become most evident as water temperatures rise above 14°F, and as with the impacts of poor water quality in the mainstem, some life history strategies may be eliminated due to disease impacts, thereby reducing the viability of the fish population (NMFS 2014).

Rearing habitat is generally limited in the LKR tributaries and competition within these habitats likely results from high seasonal concentrations of juveniles and off-channel winter pond habitat, and instream summer habitat. Competition for thermal refugia in mainstem reaches may also be an issue in this population, as some juveniles may rear in the mainstem and estuary and be limited in their distribution due to scarcity of rearing habitat with adequate water quality. Also, adults may need to hold in the mainstem in refugial areas prior to upstream migration due to hydrologic conditions that inhibit access to tributary spawning area in the LKR (NMFS 2014).

Predation can have localized impacts, but is generally a natural process, unless facilitated by anthropogenic alterations to habitat or predator populations. A few non-native invasive species may be affecting the LKR sub-basin Coho Salmon population. Bullfrog and Brown Trout predation potentially have an effect on juvenile populations of Coho Salmon in certain areas of the LKR population area. Pinniped predation rates offshore and in open ocean may add to this predation. Also important may be increased seasonal predation rates on juveniles in streams due to lack of cover and high densities of juveniles in some habitats and it is likely that predation rates are not unnaturally high but do contribute to a reduction in the number of adults returning to the Klamath River Basin and the number of juveniles that survive (NMFS 2014).

Dams/Diversions

Upper Trinity River

NMFS (2014) ranks dams and diversions as a very high limiting factor for Upper Trinity River populations of SONCC ESU Coho Salmon (Table 15). Numerous small-scale wells and diversions for domestic uses, stock watering, and small agricultural operations occur throughout the watershed and reduce stream flows during critical low-flow periods in the late summer and fall. The Fish Passage Assessment Database lists 154 diversions in the upper Trinity River population, many of which are unscreened. A ten-foot defunct concrete diversion dam on Garden Gulch prevents access to high quality low gradient habitat. East Weaver Creek supplies the town of Weaverville with its water and the municipal diversion dam creates a barrier to salmon migration and gravel movement in the creek (NMFS 2014). Developments, like the housing development along Rush Creek, as well as the town of Weaverville (Weaver Creek), draw water from important tributaries used by Coho Salmon, resulting in reduced baseflow and habitat, and elevating water temperatures in some areas (NMFS 2014).

Lower Trinity River

NMFS (2014) ranked dams/diversions as high limiting factor for the Lower Trinity River populations of SONCC ESU Coho Salmon (Table 15). Numerous wells and diversions varying from single domestic spring boxes to community water systems occur throughout the watershed. The towns of Willow Creek, Burnt Ranch, Hawkins Bar, and Hoopa obtain water from streams in the Lower Trinity River and there are vineyards and small farms that utilize water in the watershed but their effects on stream flows has not been studied (NMFS 2014). There were 381 diversions listed in CDFG’s Fish Passage Assessment Database (CalFish 2009, as cited in NMFS 2014), and this does not include unpermitted or illegal diversions or groundwater use (NMFS 2014). There are no large dams on the Lower Trinity River, except on McDonald Creek, where the town of Burnt Ranch gets its water; however, the dam is located upstream of Coho Salmon habitat.

South Fork Trinity River

Numerous vineyards, small farms, and marijuana plantations use water from the South Fork Trinity River and its tributaries, including but not limited to, Rattlesnake Creek and Post Creek, and it has been estimated that only 13% of water currently diverted from Hayfork Creek, and its tributaries, have permits (Trinity County 1987; PWA 1994). The effects of water diversions are particularly acute in the Hyampom and Hayfork valleys, as well as the Forest Glenn area, where summer low flows lead to elevated water temperatures and a constriction of summer rearing habitat (NMFS 2014). It is likely that many, if not all of the illegal diversions in the watershed, are unscreened. Although there is a need for more recent assessments, the need for fish screens has already been identified on diversions in Barker, Big, East Fork Hayfork, Upper Hayfork, Little, Olsen, Salt, and Tule creeks (PWA 1994). Because of the impacts on summer rearing, diversions pose a very high threat to the juvenile life stage of Coho Salmon and other salmonids (NMFS 2014).

Lower Klamath River

Dams and diversions pose a high threat to the LKR Coho salmon population (NMFS 2014). Although there are no large dams or major diversions in the LKR, the large upstream diversion of water and the existence of numerous large dams perpetuate impacts on the mainstem Klamath River. Iron Gate, Copco 2 and 1, JC Boyle and Keno dams create significant stresses in the mainstem river (NMFS 2007). Low dissolved oxygen, elevated summer/fall water temperatures, and high nutrients are some of the water quality issues exacerbated by the four mainstem dams and poor water quality and changes in hydrology in the mainstem has been shown to affect disease incidence and mortality as well (NMFS 2014).

There are only a few diversions in the LKR sub-basin (NMFS 2014). Diversions to the Klamath Project in the Upper Klamath sub-basin, the TRD (53% of the LKR sub-basin), and the diversions from the Scott and Shasta rivers, decrease the total volume of water that otherwise would have naturally flowed down the LKR reach. Together, these major diversions cumulatively decrease the mainstem flows of the LKR by an average of 915,000 to 1,020,000 acre-feet per year and these reductions in flow, and changes in the shape of the hydrograph, can exacerbate water quality issues in the mainstem and increase the occurrence and severity of sediment barriers at many tributary mouths. These diversions decrease the quantity of mainstem flows on the Klamath River mostly during the spring and summer months, when juvenile access to cooler tributaries and cooler mainstem water temperature is essential. Generally, spring and summer flows are lower than historical flows, while fall and winter flows in the LKR are generally similar to historical flows and the hydrologic function of tributaries has also been altered, as evidences by downstream portions of tributaries going dry late spring and summer (NMFS 2014).

According to Gale and Randolph (2000), established domestic water systems are currently withdrawing water from the following fish-bearing tributaries in the LKR Sub-Basin: Salt, High Prairie, Hunter, and Cappell Creeks.

Roads

Upper Trinity River

NMFS (2014) ranked impaired roads and road-related barriers as a high limiting factor for the Upper Trinity River populations of SONCC ESU Coho Salmon (Table 15). NMFS (2014) indicates that road density varies from very high to low across the watershed and that most of the habitat with the greatest potential to support Coho Salmon occurs in areas with road densities greater than 2.5 miles/sq. mi. Of particular importance are the many roads in the Weaverville and Douglas City areas, where small tributary streams with high or medium IP value reaches are accessible to Coho Salmon (NMFS 2014). In total, 636 high and high/moderate priority sites have been identified for treatment on Trinity County Roads including 149 high priority road-stream crossing sites (Trinity County 2000).

The Five Counties Salmonid Conservation Program (2017) inventoried private roads within the Weaver Creek watershed for existing and future sediment sources (FCSCP 2017). Road inventories conducted in the Upper Trinity River tributaries (North State Resources 2012) found the Weaver Creek sub-watershed had the greatest road mileage and road density with 108.8 miles of road and 5.5 miles of road per square mile. Weaver Creek also had 82% of the total number of high-risk features and 80% of the total miles of high-risk gullies.

Lower Trinity River
NMFS (2014) ranked roads as high limiting factor for the Lower Trinity River populations of SONCC ESU Coho Salmon (Table 15). About one third of the area with high potential to support Lower Trinity River Coho Salmon juveniles occurs in areas with high or very high road densities and data indicates that road density is very high (>3 mi./sq. mi.) in the Hoopa and Willow Creek HAS's, where small tributary streams with high or medium IP stream reaches are accessible to Coho Salmon (NMFS 2014). Approximately 45% of sedimentation in the Lower Trinity River originates from roads, especially road-related landslides (USEPA 2001). Highway 299 significantly affects Willow Creek, as it runs along much of the creek's mainstem. USFS (2003a) ranked the area from the New River, to the South Fork Trinity River, as having a high road hazard potential while the area from the South Fork Trinity River, downstream to Tish Tang Creek, was given a moderate hazard rating.

South Fork Trinity River
Road density is very high throughout the South Fork Trinity River watershed with 1,946 miles of roads not including skid trails (Tetra Tech 2000). Road density ranges from a high of 5.1 mi./sq. mi. in Rattlesnake Creek to a low of 1.7 mi./sq. mi. in Happy Camp and the Upper South Fork Trinity sub-basins (Tetra Tech 2000). The East Fork of Hayfork Creek also has a dense road network on private land in the upper sub watersheds (USFS 1996). Impacts associated with roads and tractor skid trails included increased peak flows and increased rates of fine sediment production and mass failures (Tetra Tech 2000). Sedimentation associated with roads continues to alter natural river processes and salmonid habitat by filling in pools and reducing the quality of spawning gravels (NMFS 2014). High rates of aggradation, resulting in decreased channel complexity and pool depth, can be found throughout the South Fork Trinity (Dresser et al. 2001).

The Upper Hayfork Creek sub-watershed has 683.9 miles of roads with a road density of 4.1 miles of road per square mile of watershed, while Lower Hayfork Creek sub basin has 790.6 miles of road with a road density of 3.6 miles of road per square mile of watershed (North State Resources Inc. 2012). The Lower South Fork Trinity River sub watershed below Hayfork Creek has 201.8 miles of road, with a road density of 2.1 miles of road per square mile of watershed (North State Resources Inc. 2012). Wiseman and Brock (2018) indicates that the South Fork Trinity River is not properly functioning[17] for road density and location.

Lower Klamath River
As timber harvest increased within the LKR sub-basin, so did road construction and by 1994 the road density in the sub-basin was 5.3 miles of road per square mile of land, with an associate 7,249 road-stream crossings (NMFS 2014). The density of unpaved roads (.3 mi./sq. mi.) in the LKR creates a high threat to the

[17] Not properly functioning for road density >3 mi/mi², many valley bottom roads (NMFS 1996).

Coho salmon population with the highest densities (>9.6 mi./sq. mi.) in Ah Pah, Surpur, and Waukell Creeks (Gale and Randolph 2000). Many streams have over 12 road crossings per square mile and the South Fork Ah Pah watershed has over 25 road crossings per square mile. The cumulative sedimentation has occurred over the last 50 years of road-building and intensive logging has caused significant impacts to stream habitat. GDRC owns and manages approximately 169,000 square miles of lands below the Trinity River confluence for timber production and a majority of roads in the LKR sub-basin exist on these lands (NMFS 2014). As part of the GDRC HCP (2006), the company has prioritized road upgrades and decommissioning for 30 sub-basins across its LKR holdings and implementation of these measures will contribute to an overall improvement of ecosystem function, habitat quality and quality (NMFS 2014). Although the impacts from some existing roads may decrease through implementation of the HCP, the dominant land use within the LKR sub-basin is still timber harvest so a majority of these roads will continue to be used and deliver sediment to streams (NMFS 2014).

Another major impact from roads is the impact that Highway 101 and rural roads have on estuary and tributary habitat in the LKR. Highway 101 passes through or borders approximately 3 miles of estuary wetland habitat and in addition to the direct loss caused by the road footprint, the hydrologic connectivity of off-estuary wetlands located in the vicinity of the highway has been altered by the road and associated infrastructure, dikes, and levees along this route (Beesley and Fiori 2008b). This altered hydrology affects estuarine function, especially during storms and much of the estuary's ability to convey or store high flows without damage to mainstem and tributary channels has been lost (NMFS 2014). Smaller highways and roads in the LKR sub-basin have a similar effect.

Impaired Water Quality

The Trinity River Watershed Management Area, in concert with the Regional Water Quality Board, is subject to superior powers of 1) Secretary of Interior, 2) Central Valley Project, 3) the Tribal trust powers,4) State of California's appropriative water rights via the SWRCB and the Hoopa Tribe's sovereign status. NCRWQB (2005) recognized seven sub-basins for the Trinity River Watershed Management Area. These are arranged into the three main sub watersheds: 1) Upper Trinity River, 2) Lower Trinity River, and 3) South Fork Trinity River.

The North Coast Regional Water Quality Board (NCRWQB) (2005) identified the following primary water quality issues in the Trinity River watershed: 1) sedimentation of streams, 2) high water temperatures, 3) mercury contamination in fish, and 4) historic wood treatment facility contamination. In 1971, Congress created the Trinity River Task Force (TRTF) with a mandate to formulate and implement a management program to restore fish and wildlife populations in the Trinity River Basin and achieve temperature objectives that meet the life cycle needs of the fish (NCRWQB 2005). Both the Trinity River mainstem, and the

South Fork Trinity River, have been declared as impaired by sediment and placed on the CWA section 303(d) list for impaired waters. The USEPA developed and adopted a TMDL for sediment in the South Fork Trinity River in 1998.

In 1981, the State Water Resources Control, Board (SWRCB) established a Management Agency Agreement (MAA) with the Forest Service and certified the plan "Water Quality Management for National Forest System Lands in California." This plan designated the Forest Service as the management agency and executed the MAA with the Forest Service. This Water Quality Management (WQM) plan sets forth process standards as BMP's and addresses timber management, road and building site construction, mining, recreation, vegetative manipulation, fire suppression and fuels management, watershed management, and range management which was subsequently approved by USEPA. Under this agreement the Regional Board waives direct regulation on Forest Service maintained land except under special conditions and the Regional Board maintains the responsibility of oversight for implementation of the WQM plan, while the Forest Service evaluates and monitors BMP implementation (NCRWQB 2005).

Additionally, the USACE regulates removal and fill activities under CWA Section 404. At the time of listing, the USACE did not have a process to address the additive effects of the continued development of waterfront, riverine, coastal, and wetland properties on SONCC Coho Salmon (62 FR 24588, May 6, 1997). Activities in the action area most subject to Section 404 regulation are limited bank protection projects and private and public road and transportation projects.

Upper Trinity River

NMFS (2014) ranked impaired water quality as a medium limiting factor for the Upper Trinity River populations of SONCC ESU Coho Salmon (Table 15). According to NMFS (2014) the mainstem Upper Trinity River has an oversupply of sediments (landslides and erosion) because of hydraulic mining, dredging, logging, timber harvest, and road building and limited substrates that Coho Salmon require for particular life stages. Below Lewiston Dam, the already coarse channel bed coarsened even more without significant channel down-cutting and larger particles that were commonly transported during pre-dam floods were no longer mobilized, such that only finer gravels and sands were transported downstream and caused the riverbed to become armored, which inhibited redd construction (USFWS and HVT 1999).

Fine sediment input was high in the Upper Trinity River and consequently the Trinity River watershed in Trinity County was listed as sediment impaired in California's 1995 CWA 303 (d) list (NMFS 2014). At the time of listing, implementation of the CWA was found to have not been effective in adequately protecting SONCC Coho Salmon, especially with respect to non-point sources of pollution (62 FR 24588, May 6, 10 1997) and a TMDL was established in

2001. The ability of TMDLs to protect SONCC ESU Coho Salmon is expected to be significant in the long-term, provided implementation and performance is consistent throughout its range.

According to NMFS (2014) water quality in the Upper Trinity River is primarily impacted on a localized basis by fine sediment loading and temperature impairments and stress to Coho Salmon from water quality ranges from low to high across life history stages. Water temperature in the upper Trinity River can periodically exceed temperature objectives (Table 17). Downstream of Douglas City, daily average water temperatures during the summer months are higher than the preferred range for juvenile Coho Salmon (12-14°C [54-59°F]; Brett 1952; Bjornn and Reiser 1991). CDFG (2008c) documented the majority of observations of juvenile Coho Salmon in the Upper Trinity River were at water temperatures of 48.2 to 53 °F, with the highest water temperature where they were observed being 60.8 F. Although mainstem water temperatures during summer months in the Upper Trinity River are generally cool, downstream to roughly Douglas City, temperatures can be problematic during years when storage in Trinity Reservoir is low, tributary runoff is low, or air temperatures are high for long durations. Downstream of Douglas City, daily average mainstem water temperatures during the summer months are higher than the published range for juvenile Coho Salmon rearing (NMFS 2014). In some smaller tributaries, water temperatures can increase to levels considered stressful for rearing Coho Salmon in the summer. Coldwater refugia for juvenile Coho during the summer may be limited by intra- and inter-specific competition and the emerging effects of climate change on water management and water temperatures.

Table 16. North Coast Regional Water Quality Control Board Temperature Objectives for the Trinity River

Temperature	Dates	Trinity River Reach
60°F (15.6°C)	July 1- September 14	Lewiston Dam to Douglas City Bridge
56°F (13.3°C)	September 15- October 1	Lewiston Dam to Douglas City Bridge
56°F (13.3°C)	October 1- December 31	Lewiston Dam to the Confluence with the North Fork Trinity River

Source: Modified from NCRWQCB (2011)

In the Weaverville area, logging operations and road building and use have caused erosion, sedimentation and elevated turbidity in streams and the Trinity River. The NCRWQB (2005) recommends that access roads need to be inspected for maintenance and erosion control measures for ongoing roadside and upslope slumping. Twenty-one sites are being investigated in this area for known releases (gasoline, MtBE (Methyl tert-butyl ether), PCB's, wood treatment chemicals, etc.) from underground storage tanks and an abandoned mill site (heavy metals, fuels, wood treatment chemicals) near Douglas City and the NCRWQB (2005) recommends that septic tanks systems and old burn dumps need to be assessed for hazardous materials and impacts to water quality.

Lower Trinity River

Impaired water quality poses a moderate stress to the Lower Trinity population. In some smaller tributary streams, water temperatures can increase to levels stressful for rearing Coho Salmon in the summer months (>16 °C). Water temperature in the mainstem often reaches >20º C. There are several contaminated sites (including a USEPA Superfund Site) in the area and twelve underground storage sites are being investigated in the Hoopa/Willow Creek area for toxins (acids, PCB's, pentachlorophenol, etc.) and assessed for hazardous materials and impacts to water quality. In the Canyon area of the Lower Trinity River, some mining takes place and the NCRWQCB (2005) recommends that an assessment of the old and current mining sites on public lands, needs to be conducted and that a burnt dump (near Denny) needs to be assessed for hazardous materials and impacts on water quality.

Recent large algae blooms in the Lower Trinity River are likely associated with high levels of nutrients in runoff from various agricultural operations, particularly near the town of Willow Creek (NMFS 2014).

Some streams such as Coon, Bremmer, China, Soctish, McDonald and Kirkland creeks do not provide much anadromous fish habitat, however, they are generally well shaded and provide high quality thermal refugia and cool clean water for the Lower Trinity River in July, August, and September underscoring the importance of these cool water tributaries for fish species (NMFS 2014). Horse Linto Creek has cool, clean water that originates in the Trinity Alps Wilderness, and provides an excellent refugia area for juvenile and adult Coho Salmon and moderates the high temperature of the Lower Trinity River in the summer months at the confluence (NMFS 2014).

South Fork Trinity River

Impaired water quality is a key limiting stress for the South Fork Trinity River populations of SONCC ESU Coho Salmon (Table 15). The South Fork Trinity River was 303(d) listed as impaired from sediment and temperature in 1992 and a TMDL for sediment has been approved for the mainstem and Hayfork Creek USEPA 1998). Water temperature has long been identified as the primary factor limiting production of salmon and Steelhead in the SFTR watershed (WRTC 2016). In addition, the 2014 and 2015 droughts resulted in numerous tributaries to the South Fork Trinity River running dry in July-September, many associated with human water withdrawals (WRTC 2016).

Stream channels in the South Fork Trinity River with the greatest fine sediment accumulations in pools and associated low juvenile fish densities include lower Salt Creek, Hayfork Creek above 9-Mile Bridge, the entire mainstem, East Fork

South Fork and Grouse Creek. Sediment loading is greatest in the Hyampom Valley, with most of the sediment being delivered from South Fork Mountain tributaries. The Grouse Creek and Pelletreau Creek sub watersheds, both of which have been heavily logged since the 1940's, are major sediment contributors (PWA 1994). Federally managed watersheds in the South Fork Trinity River watershed, which cumulative erosion and sedimentation effects are likely to be problems, include Butter Creek, Rattlesnake Creek, Plummer Creek, South Fork Mountain tributaries, East Fork South Fork, Upper South Fork, Hidden Valley, Upper Hayfork Creek, Hyampom and Gulch watersheds (NMFS 2014). Wiseman and Brock (2018) indicate that the South Fork Trinity River is not properly functioning for sediment and for water temperature[18], and functioning at risk[19] for chemical contaminants and nutrients.

High levels of fine sediment may also be a major limiting factor in some tributaries and mainstem reaches of the South Fork Trinity River, for example the mainstem near Hyampom and Hayfork Creek (Dresser et al. 2001). Many streams exhibiting higher channel gradients have flushed substantial amounts of introduced coarse sediment, similar to a pattern of recovery described by Lisle (1981) and Hagans (1986). The mainstem South Fork Trinity River, downstream of Hyampom to the confluence with the Trinity River, has flushed a substantial portion of the sediment deposited in the 1964 flood. However, reaches of the mainstem upstream of lower Hyampom Valley, and lower Hayfork Creek, seem to be lagging in recovery both in terms of flushing recently introduced sediment and lowering water temperature. Water quality and water yield appear to be the main limiting factors to fisheries recovery in the potentially productive Hayfork Creek watershed (NMFS 2014).

Water temperature in Hayfork Creek and the mainstem South Fork Trinity River can reach levels stressful, or even lethal (>17 °C), for rearing Coho Salmon in the summer months (PWA 1994' USFS 1990). In addition to temperature, turbidity effects have been found in more erodible portions of the basin in the Upper and Lower South Fork sub-basins, particularly west of the mainstem, and in areas where land management practices are most intense (PWA 1994). Other tributaries including, but not limited to, Salt Creek, Rattlesnake Creek, Post Creek, Rush Creek, Tule Creek, also suffer from high stream temperatures and associated low dissolved oxygen in the summer months. Many of these streams are adversely affected by illegal water withdrawals, and nutrient and pesticide loading associated with outdoor marijuana cultivation and associated road building and land clearing.

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[18] Not properly functioning condition for sediment and water quality includes:1) sediment >17% fines (<0.85mm) in gravels, >20% fines at surface or depth in spawning habitat. 2) water quality: > 60ºF (spawning) > 64ºF (migration & rearing) (NMFS 1996).

[19] Functioning at risk for chemical contaminants/nutrients defined as moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one CWA 303d designated reach (NMFS 1996).

Industrial pollution from lumber mills, domestic pollution from poorly functioning septic systems, and pollution from agricultural non-point sources have also contributed to the declines of salmonids in the South Fork Trinity River (PWA 1994). Fourteen sites where known releases from underground storage tanks are being investigated in the SFTR area. In the Hyampom area, several domestic wells were contaminated with MtBE from underground fuel tanks and several former mill sites remain open in the area and need to be assessed to verify that threats to water quality have been abated (NCRWQCB 2005).

Lower Klamath River

Impaired water quality is a medium limiting stress for the LKR Coho Salmon population and is especially detrimental to juveniles, smolts and adults (Table 15). Seasonally high-water temperatures in the LKR, the estuary, and in lower reaches of some LKR tributaries are a primary limitation for this and other Klamath Basin Coho salmon populations (NMFS 2014). Generally, temperatures near the headwaters of LKR tributaries are mostly very good or good, but water quality decreases in the lower reaches (Bjornn and Reiser 1991). Tributaries such as Roaches, Blue, Pine, and Terwer Creeks have localized areas of seasonally high-water temperatures in their lower reaches.

The Yurok Tribal Fisheries Program and GRDC have conducted a water temperature monitoring program in LKR tributaries since 1995 (YTFP 2009b). They found that from 1995 to 2000, tributary water temperature consistently remained within acceptable tolerances identified for salmonid species present, including Coho Salmon, and that annual variation in average daily water temperature is less than 10 °F in the majority of the LKR tributaries, with the summer maximum temperature never exceeding 60 °F in most watersheds (Bell 1991).

Once emigrating salmonids exited LKR tributaries, however, they must contend with water temperatures in the mainstem Klamath River that often exceeds upper tolerance thresholds for salmonids and dissolved oxygen levels may fall below those considered acceptable for juvenile salmonids (Gale and Randolph 2000). In the LKR mainstem, maximum water temperatures at three LKR gauging stations exceeded 24 °C at times and regularly report temperatures above the critical 22 °C threshold for most of July and August (Hiner 2006; Beesley and Fiori 2004, 2008b). Temperatures in the estuary have also been recorded as being above lethal thresholds; however, thermal refugia in tidal areas may exist (Bartholow 2005).

In general, water temperatures in the LKR mainstem are below 17°C in the fall when adults typically migrate upstream, and temperatures do not increase in the spring until most juveniles have out-migrated. However, early adult migrations and late spring and summer juvenile migrations have likely been eliminated as fish are likely forced to leave the mainstem and estuary early, thereby reducing the life history diversity of the population (NMFS 2014).

Based on current stream and river sedimentation conditions, it is likely that seasonally high turbidity levels in the LKR, and in a majority of its tributaries, is a moderate stressor to most life stages of Coho Salmon. Dissolved oxygen concentrations and pH within the mainstem, estuary, and in some of the off-estuary tributaries are generally adequate but can reach levels which are stressful to Coho Salmon during late summer (NMFS 2014).

Degraded Riparian and Forest Conditions

Upper Trinity River

According to NMFS (2014) riparian forest condition in the Upper Trinity River present medium stresses across all Coho Salmon life history stages and where data exist, the assessment of streamside canopy cover ranges from fair to very good throughout the watershed (Table 15). The dynamics of the Trinity River riparian forest have changed dramatically as a result of historic mining in the river channel and floodplain and flow regulation. Whereas the natural flow regime historically supported a diverse and dynamic riparian forest that supplied nutrients, invertebrates, and LWD contributing to a complex of aquatic habitat for Coho Salmon, the contemporary flow regime tends to result in less diverse and dynamic riparian forests. Tree harvesting and removal of riparian canopy in some tributaries has increased solar radiation reaching streams and elevated water temperatures in portions of the watershed (NMFS 2014).

At the time of listing in 1997, NMFS determined California’s forest practice rules (CFPRs) contained provisions that can be protective of SONCC ESU Coho Salmon if fully implemented but found the ability of these rules to protect Coho Salmon could be improved (62 FR 24588, May 6, 1997). In particular, the CFPRs did not adequately address LWD recruitment, streamside tree retention to maintain bank stability, and canopy retention standards that assure stream temperatures are properly functioning for all life stages of Coho Salmon. In 2009, the CFPRs were updated, revised, and renamed the Anadromous Salmonid Protection Rules.

Lower Trinity River

According to NMFS (2014) degraded riparian forest conditions pose a medium stress to Coho Salmon in the Lower Trinity River, and evaluations of streamside canopy cover range from fair to very good throughout the watershed, based on existing survey data. The Willow Creek HAS has fair riparian conditions, while Burnt Ranch and New River HAS’s have very good riparian conditions; however, many of the riparian areas in the Lower Trinity River watershed have been disturbed through timber harvesting, natural storm events, landslides, and wildfires (NMFS 2014).

Timber harvest practices and developments on floodplains within the Lower Trinity River watershed have also contributed significantly to riparian and forest habitat degradation (USDI 1981). A total of 28% of the Lower Trinity River was harvested between 1940 and 1990 (USEPA 2001) on private land (especially Willow Creek and Sharber Creek) (USFS 2003b). Clearcutting increased sediment loading; removal of streamside vegetation increased water temperatures; and log jams at the mouths of tributaries. In addition, timber harvest within the sub-basin has necessitated the construction of hundreds of miles of unpaved timber management roads (USDI 1981). Road networks in the Lower Trinity River are a significant source of sediment input to anadromous fish habitats, often exceeding all other combined sources from forest activities (USFS 2003b). Timber harvest makes up approximately 5% of all sedimentation in the Lower Trinity River (USEPA 2001).

The HVT owns 15% of the Lower Trinity River Coho Salmon population area, and timber harvest is ongoing on these lands, and the extent of its environmental impacts are unknown but presumed to be low given Tribal timber management practices (NMFS 2014).

Data on instream LWD in Lower Trinity River is limited, but it is assumed to be low given the extent of timber harvest in the area and current lack of late seral stage riparian forest (e.g. Willow and Sharber Creeks)(USFS 2003b). Lack of LWD has resulted in loss of pool habitat and a reduction in overall habitat and hydraulic complexity in Coho Salmon streams (CDFG 2002).

South Fork Trinity River
Degraded riparian forest conditions present a high stress to the South Fork Trinity River salmonid population (NMFS 2014; Table 15). Decades of intensive grazing, logging, and intense fire impacted the riparian and forest communities throughout the basin. Overgrazing in the late 1800's and early 1900's damaged riparian vegetation and led to significant erosion (Tetra Tech 2000). By 1977, 52% of the forested areas within the basin had been logged and an additional 4% of the old growth forest had been lost to fire and at that time, total road length was 3,456 miles, 92% of which were associated with timber harvests (CDWR 1979, PWA 1994).

Habitat impairments have been identified in Hayfork Creek and its tributaries related to the lack of riparian vegetation. Loss of riparian vegetation can cause a stream to erode its bed, leading to subsequent streambank erosion problems. Forest Service (USFS 1999) surveys assessed riparian areas and identified watersheds that have more than 15% of their riparian zone acreage with low LWD recruitment potential and low shade. From the least (17%) to greatest (30%) were Butter, Corral, Upper South Fork Trinity River, Plummer, Lower Hayfork, Eltapom, Rattlesnake, Hidden Valley, Upper Hayfork, and Salt creeks. Grouse Creek and Eltapom Creek in the Grouse Creek HAS, Naufus, Indian Valley, Dobbins, Rattlesnake, and Salt creeks also show signs of low LWD recruitment. The upper South Fork, by comparison, has a riparian forest composed largely of Douglas Fir and White Fir, with canopy closures ranging between 70% and 80%, and LWD recruitment in these stands is excellent, with some of the highest recorded volume measurements in the Trinity River basin

(USFS 1999). Wiseman (2018) indicates that the South Fork Trinity River is functioning at risk[20] for riparian reserves.

Timber harvest is a low overall threat in the South Fork Trinity River drainage, but certain local factors amplify the level of threat to moderate-high levels (NMFS 2014; Table 15). Timber harvest on public land is highly regulated and current and future timber harvesting on USFS land is projected to be relatively small in scale and conducted under strict guidelines designated to protect aquatic resources. However, several extensive vegetation management projects on Forest Service lands in the watershed are planned in the next decade (Rattlesnake, Smoky, East Fork) which will have some effects on hydrologic response despite strict application of BMP's (NMFS 2014).

Lower Klamath River

Degraded riparian forest conditions are a high stress for all life stages of Coho Salmon in the LKR population. Past LKR logging practices have resulted in the removal of virtually all mature conifers from tributary areas. Riparian forests of LKR tributaries have not recovered from these activities, and in many cases, succession from deciduous (e.g. red alder) dominated riparian stands to conifer stands is not occurring. Inventories conducted by the Yurok Tribal fisheries Program indicate found that conifers comprise less than 1/3 of the riparian canopy in LKR tributaries (excluding portions of Blue Creek), with conifers constituting <15% of the riparian canopy in the majority of these tributaries, and tributary riparian areas are composed almost exclusively of deciduous trees species (predominantly red alder- *Alnus rubra*) (Gale and Randolph 2000). In addition, these LKR tributary inventories indicate that LWD identified as potentially recruitable to stream channels consist predominantly of live deciduous trees less than two feet in diameter while live conifers comprise less than 25% of the potentially recruitable LWD. In contrast, USFS portions of Blue Creek contain riparian canopies where live conifers comprise between 27-77% of the total canopy and represent 40-70% of the potentially recruitable LWD.

Riparian forests comprised of mature native conifers, especially coastal redwoods, are critically important for LKR Coho Salmon populations. The lack of mature, confer dominated riparian forests and fluvial LWD recruitment in LKR tributaries and the mainstem has resulted in increased water temperatures, poor, sediment sorting, storage, and delivery dynamics, simplified stream reaches and floodplain areas with low habitat quality (NMFS 2014). The poorest channel and riparian conditions have been noted in Waukell, Saugep, Surpur, and Little Surpur creeks (Gale and Randolph 2000); however, these

[20] Functioning at risk for riparian reserves is defined as moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian conservation areas, or incomplete protection of habitats and refugia for sensitive aquatic species (70-80% intact), and adequately buffer impacts on rangelands : percent similarity of riparian vegetation to the potential natural community/composition 25-50% or better (NMFS 1996).

conditions persist in virtually every LKR tributary, including Blue Creek (Beesley and Fiori 2008a).

Altered Sediment Supply

Upper Trinity River

NMFS (2014) ranked altered sediment supply as a medium limiting factor for the Upper Trinity River populations of SONCC ESU Coho Salmon (Table 15). In recent history, the mainstem Trinity River has had oversupply of fine sediment because of a historic legacy of hydraulic mining, dredging, logging, and road building (USFWS and HVT 1999). At the same time, an undersupply of coarse sediment, including gravels preferred by spawning salmon, was created by the Trinity Dam. Inadequate spawning gravel availability in the mainstem has likely led to density dependent reductions in salmon populations and effects to the wild genome that have progressed through time (Ligon et al. 1995, as cited in NMFS 2014).

Prior to implementation of the TRRP ROD, fine sediment input was high in the Upper Trinity River, which prompted adding the Trinity River to the CWA 303(d) list, as impaired for sediment in 1995 and was still listed as sediment impaired on the 2014/2016 303(d) list. The majority of fine sediment in the mainstem Trinity River originates from roads, timber harvest, and natural sediment loading from landslides and erosion (EPA 2001). Excessive fine sediment in tributaries and the mainstem have limited SONCC Coho Salmon habitat by infiltrating riverbed gravels in spawning habitat, reducing salmon egg and alevin survival; depositing in rearing habitat, reducing invertebrate prey production and cover for juveniles; and filling pools and off-channel habitat, limiting juvenile summer rearing habitat. Downstream of Grass Valley Creek, which transported large volumes of fine decomposed granite to the Trinity River, GMA (2001) reported that gravel mixtures indicated very low salmon egg and alevin survival. Similarly, intergravel permeability rates[21] in several of the tributaries has been quite low (98cm/hr in Reading Creek; 258 centimeters per hour (cm/hr) in Indian Creek; 363 cm/hr in Rush Creek; 521 cm/hr in Canyon Creek) and may indicate low survival rates in early life-stages of salmon (GMA 2001). Grass Valley Creek drainage is a major sediment contributor to the Trinity River; it has the highest annual sediment delivery rates within the upper section (below Lewiston dam) of the Trinity River basin (North State Resources Inc. 2012).

The TRRP is focused on restoring a dynamic functional balance between a scaled-down hydrograph and fine and coarse sediment supplies to create conditions that will support restoration of anadromous salmonid populations, including recovery of SONCC ESU Coho Salmon, in the Trinity River basin. Since 2001, more than 50,000 tons of coarse sediment has been placed in the

[21] A measure of water movement through the streambed substrate.

river and more than 30 fine sediment source control projects in the watershed have been completed by the TRRP.

Lower Trinity River

Water quality of the Lower Trinity River is listed as impaired for sediment throughout its length, and in the Willow Creek and Hoopa HAS's, sediment loading is especially high and likely limits the potential for Coho Salmon spawning and rearing in these areas (NMFS 2014). Campbell, Supply, and Willow creeks have experienced intensive land management and suffer from high sediment loading and are highly impaired (NMFS 2014). Mill and Tish Tang creeks are also considered impaired due to sedimentation as a result of timber harvest and roadbuilding (USEPA 2001).

South Fork Trinity River

NMFS (2014) ranked altered sediment supply as a high limiting factor for the South Fork Trinity River populations of SONCC ESU Coho Salmon (Table 15). According to NCRWQCB (2005), a sediment source analysis determined that sediment delivery to the South Fork Trinity River averaged 1,053 tons/sq. mi. /yr. over the period 1944-1990. Sixty-four percent of that sediment was from mass wasting. There is a history of wildfires and subsequent erosion and salvage logging issues in the South Fork Trinity River sub-basin.

Salmon in the South Fork Trinity River have been affected by a number of large floods over the past several decades, especially by the flood of December 1964 (USEPA 1998). The 1964 flood caused tremendous soil loss in tributaries, especially those that had been logged (MacCleery 1974). Sedimentation from road failures, and mass wasting associated with roads and clear-cut logged areas, choked the channels of many of these tributaries. As these streams delivered sediment into the South Fork Trinity River, additional streamside landslides were triggered (PWA 1994). USEPA (USEPA 1998) stated that "Unstable geology, along with erosion-producing land use practices, have been blamed for the many mass wasting events triggered by the 1964 flood, which resulted in dramatic instream changes, including channel widening, aggradation, and loss of pool depth, all of which adversely affected salmonids." The Sayler reach (RM 1.5 to 6.2) showed about 20 feet of aggradation after the 1964 flood (Dresser et al. 2001). Hyampom Valley (as of 1982) still had 25 feet of aggradation and the channel has widened 66 feet due to the 1964 flood (PWA 1994). Since that time, further changes suggest improvement in some locations, while continued, chronic sediment inputs may be hindering a more complete or faster recovery (USEPA 1998).

Lower Klamath River

Past and ongoing increased sediment supply in the LKR sub-basin reduced quantity and quality of Coho Salmon habitat for all life stages; therefore, NMFS considers altered sediment supply to have an overall stress ranking of "very high." Timber harvest, removal of riparian and instream LWD, and road building (when combined with the naturally erodible geology of the area and large floods), have resulted in substantial streambed sedimentation, excessive channel widening, loss of riparian forest, and an overall reduction in the quality and quantity of instream fish habitat (NMFS 2014). Mass wasting is common in the region and causes more downslope movement of material than any other geologic process (Harris and Tuttle 1984). Such a high degree of sedimentation combined with the loss of fluvial stored LWD and resilient riparian forest, hinders successful spawning of adult Coho salmon and emergence of fry, limits access to rearing habitats, increases competition and predation, and reduces macroinvertebrate densities (Gale and Randolph 2000; Beesley and Fiori 2007b). In over ½ of stream pool tailouts surveyed, embeddedness (as a % occurrence) exceeded 50% and often reached 100% (Gale and Randolph 2000; GDRC 2006, 2009). Of stream surveyed (in the 1990's) in the LKR sub-basin, the highest embeddedness (50%) were in Roaches, Pecwan, Cappell, WF McGarvey, SF Mettah, Johnsons, and Mynot creeks (GRDC 2006). Some reaches within these creeks experience high sedimentation and may have unsuitable gravel for egg incubation and fry emergence (NMFS 20914). In addition to reduced quality and quantity of spawning gravels, excessive sedimentation also results in loss of Coho Salmon spawning habitat and the loss of connectivity within LKR tributaries due to intermittent periods of subsurface flow during the summer. Sediment from upstream watersheds not only deposited in LKR tributaries, but also downstream in the mainstem and estuary, forming point bars (where sloughs historically were present) and filling pools where Coho salmon were once able to hold in the LKR (Beesley and Fiori 2007b).

Adverse Fishery-Related Effects

NMFS (2014) ranked adverse fishery-related effects as a low limiting factor for the Upper Trinity, Lower Trinity, and South Fork Trinity River populations of SONCC ESU Coho Salmon (Table 15). Historically, salmon and Steelhead were an abundant resource that supported substantial commercial, sport, and tribal fisheries, contributing millions of dollars to numerous local economies. Over-fishing in the early days of the European settlement led to the depletion of many stocks of salmon and Steelhead even before extensive habitat degradation (Snyder 1931). At the time of listing in 1997, overfishing was thought to have compromised spawning escapement of Coho Salmon between 1950 and 1990. Currently, fishing has decreased as a factor affecting the SONCC ESU Coho Salmon due to prohibitions on commercial and sport harvest. Since the 1993 season, retention of Coho Salmon has been prohibited in commercial fisheries south of Cape Falcon, Oregon. California's inland Coho Salmon fisheries have remained closed since 1998. However, fishery impacts to Coho Salmon may still occur as a result of hook-and-release mortality in Chinook salmon-directed fisheries and mark-selective fisheries for Coho Salmon off the Oregon coast and tribal harvest under federal reserved fishing rights in the Klamath River (NMFS 2014).

Coho Salmon are harvested by Native American tribes, but it is primarily incidental to larger Chinook Salmon subsistence fisheries in the Klamath and

Trinity rivers. The Yurok fishery has been monitored since 1992. The median annual catch of Coho Salmon in the Yurok's fishery was 418 fish from 1992-2008 (about 4% of the total Klamath-Trinity Basin run). Coho Salmon harvested in the Hoopa Valley Tribe's fishery account for a median annual catch of about 210 fish from 1997-2008 (about 2% of total Trinity River run).

High Severity Fire

Upper Trinity River

Areas prone to fire risk are spread throughout the Trinity Basin and fires have swept through regions of the Upper Trinity River in the recent past and altered vegetation characteristics throughout the watershed. Future high intensity fires present a medium threat in the Trinity Basin, altering sedimentation processes as well as riparian vegetation characteristics (NMFS 2014; Table 15)

Lower Trinity River

Fire has been a source of catastrophic disturbance, as several high severity fires have burned through the Lower Trinity River since fire suppression activities on National Forest lands began in the mid-1900's (USFS 2000c). The 1999 Megram Fire burned 125,000 acres, and the Big Bar Complex Fire burned close to 80,000 acres, (53%) of the New River watershed in August 1999. Both fires impacted the riparian communities of some streams and accelerated the delivery of sediment to several streams in the Lower Trinity River drainage (USFS 2000c). Also, a complex of fires in 2008, swept through regions of Lower Trinity River more recently (NMFS 2014).

South Fork Trinity River

Fire is a significant disturbance factor within the South Fork Trinity River basin. Prior to the organized fire suppression in the early 1900s, low intensity, surface fires of relatively short intervals of 5 to 30 years, were typical in the basin. The suppression of fire, along with unnatural fuel loading, has initiated a transition to a fire regime characterized by more frequent, high intensity fires and vegetative community changes, such as greater abundance of White Fir (USFS 2008). Several intense wildland fires have burned in the South Fork Trinity basin since fire suppression commenced. High intensity, widespread fire has swept through regions of the South Fork Trinity River, such as the complex of fires in 2008 (NMFS 2014). Continued accelerated sediment production is found in many of the areas where large-scale forest fires have burned (USEPA 1998).

Lower Klamath River

The threat of high intensity fire in the LKR is minimal because climatic conditions do not favor frequent or high-intensity fires in the area and what fire risks are the result of past timber harvest activities, fire suppression, and climate change (NMFS 2014).

Mining

Much of the mainstem Trinity River, and virtually all tributaries, have been subjected to hydraulic mining activities (USFWS and HVT 1999, USEPA 2001). Hydraulic mining destabilized streambanks changed the channel structure and caused large amounts of sediment to be washed into tributary streams; however, the form and function of streams in areas where hydraulic mining occurred seem to have persisted despite this disturbance (USFWS and HVT 1999). Suction dredge gold mining was common in the Trinity River until it was stopped by a court order in 2009 and will remain prohibited until CDFG completes a court-ordered environmental review of its permitting program (NMFS 2014). Gravel extraction and mining is currently a low threat throughout the Trinity River basin (Table 15).

Upper Trinity River

Currently, very little in-stream gravel mining occurs in the Upper Trinity River (NMFS 2014) and the underlying bedrock supports natural pool and riffle formation and maintenance, providing a buffer against detrimental effect of mining on Coho Salmon habitat (Wolff 2009).

Lower Trinity River

A number of gravel mining operations occur on private land and on tribal land in the Lower Trinity River and a total of nine sites are mined on an annual, rotational or intermittent basis (NMFS 2014). Current mining practices consist of small placer sluicing and hard rock milling operations and that an assessment of abandoned mines and, past and present, mining activities need to be conducted. The Canyon area has experienced placer and hydraulic mining in the past NCRWQB (2005) needs to be assessed for impacts on water quality.

South Fork Trinity River

The mid-1850's saw the beginning of placer mining on several tributaries of the South Fork Trinity River, followed later by dragline mining and hard rock mining (PWA 1994). Smaller tributaries generally have been affected less severely than mainstem lower gradient reaches. Past placer mining in upper Hayfork Creek, and the East Fork of Hayfork Creek, has contributed to channel instability. Broad, shallow channels, a lack of pools and poorly established riparian vegetation and grazing have contributed to channel instability in Hayfork Valley, Salt Creek, Carr Creek and Barker Creek, and water drafting in Tule, Salt, Big and Hayfork creeks, has contributed to seasonal low flows and warming in these streams (PWA 1994). Mining activities in the region have decreased significantly from historic levels and there are no known gravel mining operations in the South Fork Trinity River basin (NMFS 2014).

Lower Klamath River

Gravel extraction poses a medium threat to juvenile and smolt Coho salmon and a low threat to other life stages in the LKR sub-basin (NMFS 2014). According to Gale and Randolph (2000), there is only one commercial gravel mining operation within the Lower Klamath River tributaries, located in lower Hunter

Creek, that extracts 5000-15,000 cubic yards of gravel from multiple sites on an annual basis. Similar plans have been proposed in the past on lower Terwer Creek (McBride 1990). The Green Diamond Resource Company (formerly Simpson Timber Company) routinely extracts gravel from lower Hoppaw Creek during summer months in an attempt to address channel aggradation and flood risk in the channelized lower reaches of this tributary. The majority of past and proposed gravel mining projects have involved extraction of gravel from mainstem LKR gravel bars.

Gravel extraction has also been proposed to address the delta barriers at the mouths of LKR tributaries, but no such activities have been undertaken to date, and would not be a long-term solution to the issue (NMFS 2014).

Timber Harvest

Upper Trinity River

A low amount of timber harvest presently occurs in the Upper Trinity River as much of the area is in public ownership (USFS and BLM), including a substantial portion of federally designated Wilderness (NMFS 2014). Under current management the Forest Service and BLM are unlikely to implement large timber sales which are governed by rigorous protective measures for water quality (NW Forest Plan ACS and S&G's).

Timber harvest in the Upper Trinity River has been on the decline over that past 50 years (GMA 2001). Almost all recently harvested land in the Upper Trinity watershed is privately owned and the extent of its environmental impacts are unknown (USEPA 2001). Most timber harvest on private land will occur in the Douglas City, Weaver Creek, and Upper Trinity Hydrologic Subareas (HSA's) of the Trinity River and based on the extent and restrictions on future timber harvest it is considered a medium threat to the Upper Trinity River Coho Salmon population (NMFS 2014; Table 15).

Lower Trinity River

In the Lower Trinity River, timber harvest is limited but there are chronic landslides that create soil deposition problems. Logging and roads create erosion hazards and potential sedimentation to area streams and timber harvest it is considered a medium threat to the Lower Trinity River Coho Salmon population (NMFS 2014; Table 15).

South Fork Trinity River

Major eastern tributaries which drain directly into the mainstem South Fork Trinity River, such as the East Fork of the South Fork, Rattlesnake Creek and Butter creek, have significant problems related to cumulative effects of intensive timber management over wide portions of these watersheds (PWA 1994).

Lower Klamath River

Timber harvest is a high threat for Coho Salmon because of the extent of harvest in the LKR tributaries and the existing poor habitat conditions (NMFS 2014). The majority of private timber land in the LKR population area is owned by GDRC and will continue to be harvested for timber at a moderate to high level and under the direction of the company's HCP (GDRC 2006). The HCP lays out goals and objectives to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities (NMFS 2014). However, timber harvest is still the dominant land use within the LKR sub-basin and the impacts of these activities, even when carried out under HCP guidelines, include the loss of pool habitat, loss of LWD and stream complexity, altered hydrology and nutrient cycling, and increased sediment loads (NMFS 2014).

Erosion within the LKR Basin has been greatly accelerated by road building to support logging and has connected thousands of miles of drainage ditches to LKR tributaries and significantly increased the overall amount of surface erosion (Gale and Randolph 2000). Timber harvest activities currently account for the greatest percentage of erosion-related problems within the LKR sub-basin and according to Balance Hydrologics, Inc. (1995), "erosion related to poorly designed, abandoned or poorly maintained logging roads, may be equal to or greater than all sum of natural erosion processes occurring elsewhere in the basin."

For over a century, timber harvest has been the dominant land use within the LKR sub-basin (NMFS 2014). Commercial timber harvest began in the LKR sub-basin in the mid-to late-1890's with clear cut logging starting in the 1940's. Stemming from this period of timber harvest and road building was an increased frequency in landslides and debris torrents (NMFS 2014). Between 1948 and 1997 there were: 1) about 1,729 landslides, 760 of which could be linked to anthropogenic activities, and 2) approximately 255 debris torrents, with 131 linked to anthropogenic activities (Gale and Randolph 2000). According to Balance Hydrologics, Inc. (1995), much of the remaining second- and third-growth is not expected to be harvested for many years, as it was cut during the 1950's through the 1980's.

Climate Change

Climate change poses a high threat to the Trinity River Coho Salmon populations and average temperature could increase by up to 3 °C in the summer and by 1.2 °C in the winter (NMFS 2014; Table 15). Also, all adult Coho Salmon populations in the SONCC ESU will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007; Portner and Knust 2007; Feely et al. 2008). Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function and could impact the duration of barriers at the mouths of tributaries and factors such as timing, intensity, and extent of rainfall could either improve accessibility to tributaries or make it more difficult for fish to immigrate and emigrate from tributaries (NMFS 2014).

Climate change will be an especially important factor for the South Fork Trinity River watershed as the trend towards less snowpack, earlier onset of spring snowmelt, and reductions in summertime surface flow are expected to continue into the future (Zhu et al. 2005; Vicuna et al. 2007). Juvenile and smolt salmonid rearing and migratory habitat in the South Fork Trinity River, and mainstem Klamath River, is most at risk to climate change (NMFS 2014). According to McCarthy et al. (2009) climate change scenarios in the South Fork Trinity River basin, estimated temperature increases will range from 1.4 °C to 5.5 °C during summer, and from 1.5 °C to 2.9 °C during winter. They concluded that feeding rate and temperature during the summer currently limit growth and productivity of salmonids (Steelhead and Rainbow Trout) in low-order streams and predicted that climate change will have detrimental effects on fish growth, as well as on macroinvertebrate communities, and stream ecosystems in general.

Lower Klamath River

Climate change poses a medium threat to the LKR Coho Salmon population with the greatest impact on juveniles, smolts, and adults (Table 15). Although the current climate is generally cool in the LKR, modeled regional average temperature show a moderate increase over the next 50 years and average temperature could increase by up to 1.8 °C in summer and by 1°C in winter (NMFS 2014). Recent studies have already shown that water temperatures in the LKR mainstem have already been increasing at a rate of 0.4°C /decade since the early 1960-‘s. The season of high temperatures that are potentially stressful to salmon has lengthened by about 1 month (Bartholow 2005). Snowpack in the Klamath Basin will likely decrease with changes in temperature and precipitation and will likely impact mainstem and tributary hydrology (CNRA 2009).

The vulnerability of the estuary and coast to changes in seas levels is moderate in this region due to projected sea level rise and local rates of subsidence. Juvenile and smolt rearing and migratory habitat are most at risk to climate change as is adult access to tributary spawning habitat. Rising sea level may also impact quality and extent of wetland rearing habitat in the estuary and wetlands would naturally migrate inland with rising sea level but there are few places that are unarmored that would allow for this migration. Overall, the range and degree of variability in temperature and precipitation are likely to increase in all LKR populations (NMFS 2014). Adults will also be negatively impacted by changes in ocean conditions such as ocean acidification, and prey vulnerability (ISAB 2007; Portner and Knust 2007).

Impaired Estuary/Mainstem Function

Trinity River

NMFS (2014) ranked functional impairment of Klamath River estuary and lower mainstem Klamath River as a medium limiting factor for the Trinity River Coho Salmon (Table 15). All salmon and Steelhead that originate from the Upper Trinity River migrate to and from the ocean through the Lower Trinity River, lower Klamath River, and the Klamath River estuary. The Klamath River estuary plays an important role in providing staging habitat for migrating adult and juvenile Coho Salmon. The Lower Trinity River and lower Klamath River and estuary may also provide foraging, rearing and refuge opportunities for emigrating juvenile Coho Salmon from the Upper Trinity River, especially since a significant number of sub-yearling Coho Salmon leave the Upper Trinity River and presumably rear downstream in non-natal habitat (NMFS 2014). Although the estuary is relatively small in area compared to the large size of the watershed, it does provide habitat and conditions for juvenile growth and smoltification prior to entering the ocean. The estuary, although relatively intact, suffers from periodically poor water quality and sedimentation (NMFS 2014; USDOI and CDFG 2012).

Lower Klamath River

Estuary and Mainstem function is a high stress limiting factor for the LKR Coho Salmon population due to the conditions encountered when migrating to and from the ocean and while staging and rearing prior to ocean entry (Table 15; NMFS 2014). Water quality in the mainstem Klamath River is generally poor (e.g., high turbidity and stream velocities during winter and high-water temperatures in summer/fall), and sedimentation from past and ongoing land use have led to substantial reductions in fluvial habitat complexity and loss of refugia (NMFS 2014). Water temperatures during summer and fall in the lower mainstem Klamath River often exceed upper tolerable thresholds for salmonids and in addition, to water quality, water withdrawals from the Klamath River and its major tributaries (e.g., Trinity, Shasta, and Scott rivers) have altered the hydrologic regime and resulted in a lowered water table during summer and fall months (NMFS 2014). Connectivity with most tributaries in the LKR is impaired during the late summer and fall, and a substantial precipitation event is usually necessary before access is reestablished in the LKR tributaries for migrating adult salmonids (Beesley and Fiori 2007b).

Agricultural Practices

There are agricultural operations across the Trinity River Basin, consisting of several small farms, vineyards and small cattle grazing operations which are thought to be a medium threat to Coho Salmon. However, in the area of Willow Creek in the Lower Trinity River sub-basin, where much of the agriculture occurs, localized impacts of reduction in thermal refugia areas and excessive nutrient loads could cause substantial impacts and may increase in the future as demand for high quality fruits and vegetables in the area grows (NMFS 2014).

Lower Klamath River

Only a small portion of the LKR sub-basin is suitable for agriculture but agricultural impacts affect some of the most important tributaries and off-estuary habitats for Coho Salmon and is considered a very high limiting threat to this population (Table 15). These tributaries include Salt, Hunter, Mynot, Spruce, Hoppaw, Terwer, Tarup, Panther, and Blue creeks. Portions of the estuary have also been diked and filled for agriculture, especially near the Salt Creek and Hunter Creek confluences and near Rekwoi with the loss of estuarine and tributary habitat on the order of hundreds of acres of floodplain and wetland habitat (NMFS 2014).

Only a small portion of the LKR sub-basin contains suitable terrain for livestock grazing. However, cattle are actively grazed on privately owned pastures in Salt, lower Hunter/Mynot/Spruce, Hoppaw, Panther, and lower Terwer creeks, all located within the floodplain of the Klamath River. The Hunter, Mynot, Spruce, and Salt Creek pastures were established through diking and conversion of the Hunter Creek Slough and the Terwer Creek pastures were established on a large floodplain terrace near the confluence with the Klamath River. Cattle are also grazed on the Klamath River bar at the confluence of Tarup, Pecwan, and Johnsons creeks (NMFS 2014).

In addition to these grazing operations, populations of feral cattle have become established in Terwer, lower Blue and Bear creeks. Grazing by these feral cattle has degraded riparian function and has created highly unstable banks and high rates of sedimentation and aggradation. Although cattle on Slat, lower Hunter and Mynot creeks have been excluded from the stream channel, cattle operations in these areas remain a significant limitation and threat to Coho Salmon (NMFS 2014).

Trinity River Restoration Program Activities that Address Limiting Factors for Coho

Restoration activities in the Trinity River basin are expected to benefit Coho Salmon populations by reducing several stressors in the action area like sedimentation and loss of wood (NMFS 2018). Since the listing of the SONCC ESU Coho Salmon as threatened in 1997, and its re-evaluation in 2005, the extent to which some of the stressors and threats are affecting Coho Salmon population units has changed. For example, the TRRP ROD, and subsequent implementation of the TRRP since 2000, has improved habitat conditions, and aided in the restoration of the anadromous fishery of the Trinity River through the provision of a variable instream flow schedule, physical channel rehabilitation and sediment management, and an AEAM process. Reclamation focuses substantial resources on physical channel rehabilitation and sediment management activities in the Upper Trinity River, particularly the mainstem Trinity River between Lewiston Dam and the North Fork Trinity River, as part of the TRRP.

From 2005 to 2018, 29 physical channel rehabilitation, and 3 side channel sites, have been fully implemented in the Upper Trinity River. The purpose of physical channel rehabilitation activities is to recreate complex fish habitat that was reduced as a result of the construction of the TRD and altered flow regime. Channel rehabilitation activities are intended to work with flows, over time, to restore the Trinity River and anadromous fisheries. The combination of channel rehabilitation and flow management is creating alternate bar sequences and meanders, low-velocity habitat for salmonid fry (i.e., floodplain, side channels, alcoves), and increased habitat complexity by placing wood and wood habitat structures for Chinook and Coho Salmon. An inventory of large wood placed at 27 channel rehabilitation sites constructed from 2005-2016, totaled 7,591 large wood pieces and 1,919 large wood structures (Boyce and Goodman 2018).

Recent review and evaluation of the first phase of physical channel rehabilitation projects showed that the initial projects produced little immediate geomorphic responses. Consequently, the degree of channel augmentation and complexity of subsequent rehabilitation projects increased for remaining sites, with hopes of achieving more immediate responses. In addition, the TRRP began using predictive, numerical models to assess salmon rearing habitat availability and potential geomorphic responses for a given project designs. The intent of these more elaborately designed projects was, in part, to create immediate habitat and to construct large-scale channel features that would interact with flood flows and drive more rapid channel changes (TRRP SAB 2014). This change in design strategy was based on lessons learned and, in general terms, is a type of adaptive management, but represents a shift from the foundational notion that a more dynamic river could be created with minimal bank reconstruction (HVT et al. 2011). The TRRP continues to improve and implement channel rehabilitation activities and an associated monitoring program to assess habitat and fish population response.

Additionally, the TRRP adds spawning gravel downstream of Lewiston dam to compensate for the lack of recruitment from the Upper Trinity River watershed. Spawning gravel augmentation under the TRRP takes place below the TRH, at the cableway site near Lewiston, and at various other rehabilitation sites above Indian Creek. Below Indian Creek, it is believed that tributaries to the mainstem Trinity River provide adequate spawning gravels (USFWS and HVT 1999; Gaeuman 2014). Fine sediment management is primarily located at the Hamilton Ponds, situated at the mouth of Grass Valley Creek. The Hamilton Ponds function as a settling basin for sediment in Grass Valley Creek and require periodic maintenance dredging to restore their sediment storage capacity.

The TRRP also has an active watershed program that performs sediment reduction and restoration work in tributaries, including fish passage, in-stream habitat enhancement, low flow restoration, and floodplain connectivity projects (TRRP Watershed Work Group 2015). In addition, many watershed restoration projects have been implemented, or are being planned by other agencies (USFS, BLM, Trinity County, etc.) and groups (Yurok Tribe, etc.) to increase fish populations in the tributaries. For example, the TCRCD, supported by the TRRP, recently completed the West Weaver Creek Salmonid Habitat Rehabilitation Project, which includes channel and floodplain rehabilitation on a degraded reach of West Weaver Creek, near Weaverville (ESA 2017).

The TRRP watershed restoration program includes upslope actions related to road maintenance, road rehabilitation and road decommissioning on private and public lands within the Trinity River basin below Lewiston Dam, for the reduction of sediment into the mainstem Trinity River. By improving land use practices and removing unused logging roads, fine sediment supply to the Trinity River decreases, improving water and habitat quality for salmonids and increasing production potential.

These combined rehabilitation activities are intended to aid in the restoration of aquatic habitat and anadromous fisheries in the Trinity River. Although some rehabilitation activities may have transient, localized adverse effects on listed species, the adaptive management process has allowed for the evolution and refinement of project activities and the overall improvement of habitat conditions. The long-term improvement of aquatic habitat conditions will provide benefits to listed species that far outweigh the potential short-term impacts to listed species or designated critical habitat.

Matrix of Pathways and Indicators for TRRP actions

The Matrix of Pathways and Indicators (NMFS 1996) is a tool for characterizing environmental baselines for anadromous fish habitat and can be used to predict the effect of human activities on these conditions. The Matrix of Pathways and Indicators provides generalized ranges of functional values for aquatic, riparian and watershed elements that collectively describe properly functioning condition for aquatic habitat essential to the long-term survival of anadromous fish. Key limiting factors related to relevant baseline pathways and indicators affected by TRRP activities in the Trinity River watershed are summarized by watershed (Table 17).[22] Limiting factors outside the scope of TRRP activities covered in this BA include adverse hatchery-related/hatchery effects, and to some extent altered hydrology (regulated dam flows) and barriers (i.e. TRD and Lewiston Dam). Since fisheries research and monitoring activities in the lower Klamath are not expected to affect baseline indicators, the Lower Klamath is not included in Table 17.

[22] The indicator metrics used for this effects analysis are consistent with the guidance provided by NMFS (1996) for making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale and with current use of this approach for Trinity Basin streams by the Shasta-Trinity National Forest (USFS 2006).

Table 17. Summary of relevant limiting factors related to the matrix of pathways and indicators for the Trinity River Watershed.

High to Very High Limiting Factors in Trinity River watershed	Affected Pathways and indicators	Upper Trinity River	Lower Trinity River	South Fork Trinity River
Impaired Water Quality, altered sediment supply, degraded riparian and forest conditions, roads, climate change	Water Quality			
	Temperature	NPF	NPF	NPF
	Turbidity	AR (303d listed for sediment)	AR	AR
	Chemical Concentration/Nutrients	AR (legacy tanks/dumps/mining)	AR	AR
Barriers, dams/diversions	Habitat Access			
	Physical Barriers	NPF (TRD and Lewiston Dams); barriers on tributaries	NPR – Known fish migration/ thermal barriers	AR –some barriers on tributaries/ thermal barriers
Impaired mainstem function, degraded riparian and forest conditions, altered sediment supply, lack of floodplain and channel structure, competition/disease/predation	Habitat Element			
	Substrate/Sediment	NPR	NPR	NPF
	Large Wood	AR	AR	NPF
	Pool Frequency and Quality	AR	AR	AR
	Off-Channel Habitat	AR	AR	AR
	Refugia	AR	AR	AR
Impaired mainstem function, lack of floodplain and channel structure, degraded riparian and forest conditions, altered sediment supply	Channel Condition and Dynamics			
	Width/Depth Ratio	AR	AR	AR
	Streambank Condition	AR	AR	AR
	Floodplain Connectivity	NPR	NPR	NPR
Altered hydrologic function, roads, dams/diversions, climate change	Flow/Hydrology			
	Changes in Peak/Base Flows	NPF	NPF	NPF
	Increase in Drainage Network	AR	AR	AR
Degraded riparian and forest conditions, roads, altered sediment supply	Watershed Condition			
	Road Density and Location	NPR	NPR	NPR

Table 17. Summary of relevant limiting factors related to the matrix of pathways and indicators for the Trinity River Watershed.

High to Very High Limiting Factors in Trinity River watershed	Affected Pathways and indicators	Upper Trinity River	Lower Trinity River	South Fork Trinity River
	Riparian Reserves	AR	AR	AR
	Disturbance History	AR	AR	AR

PF = Properly Functioning; AR = At Risk; NPF = Not Properly Functioning

Chapter 6
Effects of the TRRP Proposed Action

All freshwater life stages of the SONCC ESU Coho Salmon and other anadromous salmonids inhabit and migrate through the TRRP action area. The PBFs (Federal Register 2016) of critical habitat applicable to the project action area and activities are freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors. Water quality, riverbed and floodplain substrates, vegetation and other natural cover, and in-channel large wood are the critical habitat features most likely to be affected by ongoing TRRP activities and are the focus of this Effects analysis.

Collectively, the activities comprising the TRRP action, described in Chapter 3 of this BA/EFHA, are beneficial and intended to improve fluvial geomorphic processes of the Trinity River to restore aquatic and riparian habitat, enhance Trinity River watershed conditions compared to the environmental baseline, and lead to increased and sustainable anadromous fish production over the long-term. The project design process and construction/implementation criteria, along with conservation measures, described in Chapter 3, are intended to minimize potential adverse direct and indirect effects to the SONCC ESU Coho Salmon and its designated critical habitat and EFH for Pacific salmon. However, each activity comprising the action may have varying degrees of short-term, adverse, direct and indirect effects to Coho Salmon, CH, and EFH for Pacific salmon. “Direct effects” cause an immediate impact to a listed species that is concurrent with the action. “Indirect effects” are those effects that are caused by the action and occur later in time (i.e. following project completion), but still are reasonably certain to occur.

The TRRP activities associated with 1) mainstem Trinity River channel rehabilitation, 2) fine and coarse sediment management, 3) infrastructure modifications, 4) watershed restoration projects, and 5) fisheries monitoring activities range from No Effect (NE), May Affect, Not Likely to Adversely Affect (MANLAA) or May Affect, Likely to Adversely Affect (LAA) SONCC Coho Salmon, depending on project specifics, and May Adversely Affect (MAA) EFH for Pacific salmon.

The effects that are of most concern for this programmatic ESA Section 7 consultation are those resulting from in-water or near water construction activities, fish handling from both salvage operations and monitoring activities, short-term habitat alterations or degradation, and any associated impacts that cause changes in Coho Salmon behavior, growth, and reproduction, and may, consequently, affect their survival.

Methodology

Information used in this analytical approach for assessing potential impacts of the action on the ESA-listed SONCC Coho Salmon included a comprehensive data and literature search and reviewing environmental documents and technical studies pertinent to Trinity River Coho Salmon populations, evaluations of previous project implementation and performance, and the TRRP's current assessment, planning, and design guidance for its restoration projects. The effects analysis is organized around the limiting factors and stressors that affected declines in populations of the SONCC ESU Coho Salmon and that continue to affect the environmental baseline conditions for this species, as detailed in the 2014 Recovery Plan (NMFS 2014) and summarized in the environmental baseline, Chapter 5.

Key indicators[23] selected to represent the limiting factors relevant to this analysis are shown in Table 18. The short-term and long-term effects of the TRRP activities on key indicators relevant to the limiting factors are described and compared to the baseline condition for each factor in the following sections.

Table 18. Matrix of Limiting Factors Affecting Coho Salmon in the Trinity River, Primary Pathways and Indicators, and Project Effects (Adapted from NMFS 1996; USFS 2006; USFS et al. 2013)

Limiting Factors		Primary Pathway	Indicators	TRRP Activities and Effects
1	Adverse Hatchery-Related Effects	Fishery Management	1) Harvest management; 2) Hatchery practices	NA
		Fish Population	1) Fish population characteristics	NA
2	Altered Hydrologic Function	Flow/Hydrology	1) Changes in peak/base flows; 2) Increase in drainage network	Flows addressed in ROD to improve hydrologic function. Beneficial effects of activities aimed at removing roads decrease associated drainage network, sediment removal/reduction, and restoration of in-stream flows in tributaries.
3	Barriers	Habitat Access	1) Physical barriers	Beneficial effects of watershed restoration activities that remove fish passage barriers/dams/diversions blocking habitat. Temporary construction effects include in-channel work impacting streambed/banks, fish handling, potential sediment/turbidity during

[23] The indicator metrics used for this effects analysis are consistent with the guidance provided by NMFS (1996) for making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale and with current use of this approach for Trinity Basin streams by the Shasta-Trinity National Forest (USFS 2006).

Table 18. Matrix of Limiting Factors Affecting Coho Salmon in the Trinity River, Primary Pathways and Indicators, and Project Effects (Adapted from NMFS 1996; USFS 2006; USFS et al. 2013)

Limiting Factors		Primary Pathway	Indicators	TRRP Activities and Effects
				construction, temporal loss of habitat access during construction and temporary riparian vegetation loss.
4	Lack of Floodplain and Channel Structure	Channel Condition & Dynamics	1) Width: Depth ratio; 2) Streambank condition; 3) Floodplain connectivity	Beneficial effects of channel rehabilitation projects, coarse and fine sediment actions, infrastructure improvements, and watershed activities aimed at channel and floodplain restoration. Temporary construction effects include in-channel work impacting streambed/banks, fish handling, potential sediment/turbidity during construction, temporal loss of riparian vegetation
5	Increased Disease/Predation/ Competition	Fish Population	1) Fish population characteristics	Habitat restoration may also benefit competitor/predator species.
6	Impaired Water Quality	Water Quality	1) Temperature; 2) Sediment/Turbidity; 3) Contaminants; 4) Nutrients	Beneficial effects of TRRP channel rehabilitation projects that improve in-stream habitat (pools), cover with LWD, riparian vegetation restoration. Fine sediment removal and watershed restoration projects are aimed at in-stream and riparian restoration, sediment reduction, stormwater treatment, increased flows to improve water quality. Temporary negative effects during and immediately after construction due in water work (sediment/turbidity), riparian removal (loss of shading) until vegetation becomes re-established.

Table 18. Matrix of Limiting Factors Affecting Coho Salmon in the Trinity River, Primary Pathways and Indicators, and Project Effects (Adapted from NMFS 1996; USFS 2006; USFS et al. 2013)

Limiting Factors		Primary Pathway	Indicators	TRRP Activities and Effects
7	Impaired Estuary/Mainstem Function	Channel Condition & Dynamics	1) Width: Depth ratio; 2) Streambank condition; 3) Floodplain connectivity	Beneficial effects of TRRP channel rehabilitation projects that improve channel, bank, and floodplain conditions in upper mainstem and tributary sites. Sediment reduction improves width: depth ratio. Watershed restoration projects improve channel, streambank, floodplain conditions for certain projects. Temporary negative effects during and immediately after construction due in water work (sediment/turbidity), fish handling, temporal loss of vegetation until reestablished.
		Habitat Elements	1) Substrate/sediment; 2) Large wood; 3) Pool frequency & quality; 4) Off-channel habitat; 5) Refugia	Beneficial effects-TRRP channel rehabilitation projects add habitat elements (i.e. LWD, spawning gravel), improve off-channel habitat and refugia in upper mainstem. Sediment reduction improves pool conditions. Certain watershed restoration projects add habitat elements (i.e. LWD), improve refugia in tributaries. Temporary negative effects during and immediately after construction due to in water work (sediment/turbidity, bed and bank impacts), fish handling, temporal loss of vegetation until reestablished.
8	Degraded Riparian Forest Conditions	Watershed Condition	1) Road density & locations; 2) Riparian reserves; 3) Disturbance history	Beneficial for projects that target road removal, include riparian restoration, and revegetate upslope areas disturbed by land use activities and/or fire.
		Habitat Elements	1) Substrate/sediment; 2) Large wood; 3) Pool frequency & quality; 4) Off-channel habitat; 5) Refugia	Beneficial effects-TRRP channel rehabilitation projects add habitat elements (i.e. LWD, spawning gravel), improve off-channel habitat (side channels and alcoves) and refugia in upper mainstem. Sediment reduction improves pool conditions. Watershed restoration projects that add habitat elements (i.e. LWD),

Table 18. Matrix of Limiting Factors Affecting Coho Salmon in the Trinity River, Primary Pathways and Indicators, and Project Effects (Adapted from NMFS 1996; USFS 2006; USFS et al. 2013)

Limiting Factors		Primary Pathway	Indicators	TRRP Activities and Effects
				improve off-channel habitat and improve refugia.
9	Altered Sediment Supply	Habitat Elements	1) Substrate/sediment; 2) Large wood; 3) Pool frequency & quality; 4) Off-channel habitat; 5) Refugia	Coarse gravel placement and fine sediment reduction activities and channel rehabilitation and watershed activities benefit these indicators. Temporary negative effects on sediment/ turbidity during construction and/or after first flush.
10	Adverse Fishery-Related Effects	Fishery Management	1) Harvest management; 2) Hatchery practices	NA
		Fish Population	1) Fish population characteristics	Habitat restoration projects are to benefit fish populations.

Long-term Benefits of the TRRP Action on SONCC Coho Salmon

The ongoing TRRP action is expected to result in both immediate and long-term improvements to the environmental baseline conditions for Coho Salmon. It is anticipated that the TRRP's mainstem channel rehabilitation and fine and coarse sediment management, along with the ongoing TRRP fishery flow management regime, will increase floodplain connectivity, reactivate channel migration across floodplains, especially within rehabilitation sites, and improve riparian and aquatic habitat diversity and quality for anadromous salmonids and riparian-dependent species throughout the action area. The purpose of bioengineering a more dynamic fluvial channel is to create a net increase in salmon habitat quantity and its quality throughout the TRRP action area (HVT et al. 2011; Beechie et al. 2014). Particularly, increases in shallow water habitats at point bars and along floodplains, including side channels and alcoves, will benefit juvenile salmon rearing habitat and increases in point bar surface areas will increase salmon spawning habitat within the boundaries of the rehabilitation sites (Goodman et al. 2012; Beechie et al. 2014).

Current projections of improved habitat quantity and quality potentially achievable by the TRRP range up to 107% to 112% increases for Steelhead and Chinook Salmon rearing capacities[24], respectively (Beechie et al. 2014). An estimate for potential improvement of Coho Salmon rearing capacity, though not specifically provided by Beechie et al. (2014), is assumed to be similar to the range for Chinook Salmon and Steelhead, based on the observations

[24] Capacity, in this case, refers to relative levels of juvenile salmon production based on empirical observation of differential habitat use and salmon densities in the Trinity River, supplemented by additional data from other Pacific Northwest rivers (see Beechie et al. 2014).

reported by Goodman et al. (2014) and Alvarez et al. (2015) that habitat preferences of juvenile Coho Salmon in the mainstem Trinity River are similar to Chinook Salmon.

The ongoing annual additions of coarse sediment (including spawning gravels) at select sites, in accordance with recent gravel augmentation analysis, schedules, and recommendations (McBain and Trush, Inc. 2007; Gaeuman 2014), will continue to restore a balance between sediment transport and storage capacity of the mainstem Trinity River channel.

Addition of large wood, including SLJs, following recent national guidance (Reclamation and ERDC 2016), at watershed restoration sites and most of the remaining channel rehabilitation sites is expected to provide immediate physical habitat for spawning and rearing Coho and other salmonids and improve the long-term performance of fluvial geomorphic process design features in achieving the TRRP's habitat improvement goals.

Woody material is a natural and important ecological component of healthy rivers (Bilby and Bisson 1998). Placement of LWD increases physical habitat complexity for juvenile and adult salmonids by creating spawning and rearing habitat, increasing nutrient and organic matter retention (which increases food production in the system), and providing refuge from predators and cover during high winter flows (Bustard and Narver 1975; Lestelle 1978; Lestelle and Cederholm 1982; Hicks et al., (1991), as cited in Cederholm et al., 1997; Bilby and Bisson 1998).

The addition of trees and wood creates desired geomorphic effects within reaches, promotes channel migration and avulsion, causes local bed mobilization and scour that helps reduce risk of future detrimental riparian encroachment, retains coarse sediment and promotes island or medial bar formation, and provides a source of LWD for future recruitment to downstream reaches. Sediment deposits in low velocity areas surrounding large wood often times creating suitable salmon spawning conditions, especially by near channel-spanning wood accumulations in medium to large streams (Bilby and Bisson 1998). The fine and coarse organic materials comprising woody debris is a food source for aquatic invertebrates, which, in turn, are food for juvenile anadromous salmonids. Large wood contributes to creating and maintaining beneficial habitat features such as pools, islands, and gravel bars, and fish populations (particularly Coho Salmon) are typically larger in streams with plenty of LWD than in streams with little wood (Fausch and Northcote 1992).

Channel rehabilitation, fine sediment management, and watershed restoration activities will provide long-term benefits to water quality conditions for Coho Salmon in the mainstem Trinity River and its tributaries by improving and restoring channel structure and habitat complexity, floodplain connectivity, riparian vegetation structure and diversity, and by reducing excess accumulations of fine sediment in the river channel and sediment loads entering the river from tributaries. TRRP activities will promote conditions that:

- reduce fine sediment loads and turbidity (e.g., reduced fine sediment inputs from the watershed from upslope actions related to road maintenance, road rehabilitation and road decommissioning; maintaining sediment retention capacity in Hamilton Ponds; improved sediment retention through increased channel structural complexity, diverse riparian areas and floodplains);

- improve nutrient input and retention (e.g., increased riparian diversity and structure and associated allochthonous material and nutrient sources, retention through increased channel structural complexity, sinuosity, and frequency of inundation of floodplains);

- and maintain or reduce water temperatures (e.g., increased hyporheic flow patterns in key aquatic habitats such as riffles and alcoves, vegetation shading).

Specific Effects of TRRP Activities on SONCC Coho Salmon

The ongoing TRRP project implementation activities described in this BA/EFHA will result in NE, MANLAA, and LAA determinations for SONCC Coho Salmon and CH, depending on specific project circumstances. Certain project activities will result in a May Adversely Affect determination for EFH for Pacific Salmon. TRRP activities that are LAA Coho Salmon are those that a) will cause more than negligible disturbances to riparian soil and vegetation, streambanks, and channels; or b) will be completed in or adjacent to riparian areas (including USFS/BLM Riparian Reserves [NWFP]) such that the intensity and duration of the disturbance is likely to temporarily increase total suspended sediment and turbidity and impair function of aquatic habitats or fish behavior; or c) include pursuit or capture of Coho Salmon.

The TRRP implementation activities will result in short-term, adverse, impacts to the baseline condition of several SONCC ESU Coho Salmon limiting factors and EFH for Pacific salmon in the Trinity River action area, namely: 1) Impaired Water Quality, 2) Degraded Riparian Forest Conditions, 3) Lack of Floodplain and Channel Structure, 4) Barriers, and 5) Altered Sediment Supply. These limiting factors will be impacted because the TRRP restoration implementation activities will occur in the stream channel, up to the bankfull channel, and/or throughout the adjacent floodplain, which can result in increased water turbidity, sediment discharges, removal or disturbance of riparian vegetation and streambank and stream channel, creation of temporary passage barriers, and indirect disturbance of Coho Salmon. The following summary analysis in Table 19 examines Implementation Activities from Chapter 3, the stress factors that may result from those activities, how listed

Coho Salmon respond to the stress factors, how that response is minimized, and the potential effect to the species.

Direct harm or harassment of SONCC ESU Coho Salmon may occur from in-stream construction and gravel augmentation activities; pursuit, capture, transport, and release of fish during fish salvage and fisheries monitoring activities; and by hydroacoustic energy caused by pile-driving of wood piles for SJL construction. Indirect harm or harassment will occur by displacement of Coho Salmon from available habitat during implementation of project implementation activities. Indirect effects can also include changes in food web interactions and habitat conditions. Turbidity effects, and fish handling (direct mortality), may also occur to resident fish (prey species), indirectly affecting food web interactions for listed species. Such impacts will be minimized by design and construction approaches and implementing conservation measures and BMP's described in Chapter 3 of this BA/EFHA.

Table 19. Activity and Effects Matrix for TRRP Implementation Activities

Activity	Stressors	Potential Response to Stressor	Conservation/ minimization Measures	Effects
1. Heavy equipment operation in or adjacent to water (in-channel activities)	Elevated turbidity from machine movement, potential spills of fuel and solvents to surface waters, aquatic habitat disturbance/ degradation.	In-water work equipment can elicit responses from avoidance to rare cases of mortality. Temporary habitat displacement is the most common effect with in-water work. There can be sublethal behavioral effects from elevated sediment levels and reduced foraging opportunities.	Almost all general conservation measures and measures specific to in-water work relate to how, where, when, and how long heavy equipment can operate in-water. Fuel and lubricant spills are prevented or minimized by fueling equipment away from surface waters and inspecting equipment daily. The use of rubber-tired equipment or spider excavators minimizes disturbance to sediments. Vegetable-based hydraulic fluid used for in-water machines.	Effects vary from no effect to rare cases of mortality. In most cases minimization measures reduce impacts to sub-lethal changes in behavior or physiology or temporary impacts to habitat.
2. In-Water Excavation or Dredging (Hamilton Ponds)	Can cause elevated turbidity, disturbance to stream substrate and habitat loss, and hydraulic fluid spills.	Habitat displacement from in-water work activity/turbidity; temporary loss of benthic invertebrate habitat/disturbance to fish habitat features.	Activities are done in the in-water work window, in isolation, or in the dry to the extent possible. Dewatering and approved fish handling methods will be used. Rubber tired equipment or spider excavators minimize streambed footprint. Vegetable-based hydraulic	Temporary increased turbidity can alter physiology and behavior, leading to loss of fitness. Rare cases of mortality. Potential temporary habitat displacement. Increased sediment and loss of benthic invertebrates can reduce foraging opportunities and increase competition. Effects to habitat could include loss of prey habitat, infilling of pools and reduction (or burial) of interstitial spaces in spawning gravels. Excavation can be beneficial for stream

Table 19. Activity and Effects Matrix for TRRP Implementation Activities

Activity	Stressors	Potential Response to Stressor	Conservation/ minimization Measures	Effects
			fluid used for in-water machines.	restoration. Fish handling is covered under Activity/Effect 7.
3. In-channel or floodplain grading/alteration	Soil disturbance can lead to elevated sediment delivery to surface waters and increased turbidity. Substrate effects covered under in-water excavation. Altered contours can change local drainage patterns. Fill can reduce wetland areas. Potential loss of riparian habitat from vegetation removal.	Habitat avoidance of areas with elevated turbidity. Reduced rearing or sheltering habitat from wetland and other habitat loss; habitat may be disconnected from floodplain.	Activities are done in the in-water work window, in isolation, or in the dry to the extent possible. Minimization measures are used to contain sediment and reduce turbidity, reduce vegetation loss and impact areas. Cut and fill balanced in floodplains so no net loss of floodplain storage.	Effects to aquatic resources from terrestrial activities are greatly reduced with erosion control minimization measures, but can include temporary exposure to elevated turbidity, leading to negative physiological/behavioral effects. Habitat displacement from sediment delivery can lead to temporary loss of spawning habitat, increased competition, and greater exposure to predators. Effects from loss of riparian vegetation are covered in Activity/Effect 5. In-water excavation is covered in Activity/Effect 2.
4. Gravel augmentation	Elevated sediment and turbidity, disturbance to streambanks and potential loss of in-stream habitat.	Habitat avoidance of areas with elevated turbidity. Reduced rearing or sheltering habitat in-stream habitat loss.	Minimization measures are used to contain sediment and reduce turbidity, reduce vegetation loss and impact areas. Gravels will be clean. Gravel injection occurs during high spring flows so gravel is more readily transported and at strategic injection sites where flows are too high for salmon holding, staging, or	Effects to aquatic resources are reduced with sediment control minimization measures and timing, but can include temporary exposure to elevated turbidity, leading to negative physiological/behavioral effects. Rare cases of mortality could occur. Habitat displacement from sediment delivery can lead to temporary loss of spawning habitat, increased competition, and greater exposure to predators. Effects from loss of riparian vegetation are covered in Activity/Effect 5.

Table 19. Activity and Effects Matrix for TRRP Implementation Activities

Activity	Stressors	Potential Response to Stressor	Conservation/ minimization Measures	Effects
			spawning. Gravel can also be placed during low flows along the bank for later incorporation into the river at high flows.	
5. Riparian vegetation removal and management	Temporary or permanent riparian vegetation loss can lead to elevated sediment delivery to surface waters until the site is stabilized; reduced streambank stability; reduced shade and elevated surface water temperature; reduced terrestrial invertebrate populations and food chain effects; and lower aquatic habitat complexity from reduced LWD contribution to surface waters.	Foraging, rearing and spawning habitat displacement from warmer water, reduced prey base and loss of habitat complexity associated with less LWD and behavioral effects from temporarily elevated turbidity levels.	Riparian vegetation areas recognized as highly sensitive. Minimize impact areas, protect below-ground root systems for faster site recovery. Revegetate with native species. Prevent spills in these areas. Control sediment mobilization with erosion control measures.	This work can often be accomplished without in-water work, and with sediment control minimization measures. Temporary increased turbidity can have physiological and behavioral effects, with elevated stress levels, gill trauma, changes in predator avoidance behavior, and reduced territorial behavior. These factors can have various effects on fitness, depending on intensity and duration of exposure to elevated turbidity. Effects to habitat could include loss of prey habitat, infilling of pools, habitat simplification from reduction in LWD, and reduction (or burial) of interstitial spaces in spawning gravels. Temporary habitat displacement could occur. Actual effects vary depending on duration (temporary/permanent) and area of vegetation removed.
6. Work Area Exclusion and Dewatering	Exclusion techniques in-water can elevate turbidity and disturb bottom sediments. Potential temporary	Temporary habitat displacement during de-watering results in fish relocation with possible increased	Activities are done in the in-water work window, in isolation, or in the dry to the extent possible; attempt to provide passage during	A small number of fish may be stranded and have elevated physiological stress or die. Temporary loss of habitat would not typically affect spawning or migration because of timing windows. Fish handling covered in Effect 7.

Table 19. Activity and Effects Matrix for TRRP Implementation Activities

Activity	Stressors	Potential Response to Stressor	Conservation/ minimization Measures	Effects
	blockage of habitat for migration or normal up or downstream movements. Fish may be stranded or affected when moved.	competition with adjacent fish populations. Behavioral and physiological effects from elevated turbidity. Loss of foraging habitat when benthic invertebrate habitat unavailable.	exclusion; limit turbidity via by-pass system methods; turbid work area water pumped to upland site; appropriate screens on intake pumps; use NMFS fish handling protocol.	
7. Fish Salvage and Handling	Elevated turbidity levels from exclusion placement (i.e. block nets); electroshocking, fish handling and potential mortality	Evasive movements to elude capture; short-term exposure to elevated turbidity until captured; stress during capture; stress from electroshocking; entraining on nets; stress in new release site.	Minimization measures for work area isolation and approved fish handling protocol; multiple checks of block nets each day and only qualified biologists for electroshocking. Research activities will follow prescribed NOAA take limits and handling protocols by qualified biologists.	Elevated stress during handling and holding can reduce fitness; electrofishing can cause rare mortality or injury (up to 5% of fish handled). Competitive effects from movement to new habitat can lead to greater predator exposure and reduced feeding opportunities. Research activities (handling, anesthetizing, acoustic and PIT tag insertion) can lead to direct mortality and/or reduced fitness.
8. In-Water and Adjacent Pile Driving	In-water peak and cumulative sound exposure effects from impact pile driving. Temporary elevated sediment levels and potential re-suspension	Noise effects may include temporary threshold shift in hearing, changes in behavior, or injury. Response may depend on fish size,	Vibratory pile driving is used when possible. Wooden piles may be driven below OHW mark for SLJ structures. NMFS behavioral injury and sound thresholds have been adopted. In-water work	Neither the number of strikes on the wood piles nor the acoustic acute injury threshold for mortality is expected to be reached with wood piles. Behavioral effects are expected and fish may be displaced by pile driving noise. Effects will depend on pile size/pile number/substrate characteristics.

Table 19. Activity and Effects Matrix for TRRP Implementation Activities

Activity	Stressors	Potential Response to Stressor	Conservation/ minimization Measures	Effects
	of contaminated sediments.	with smaller fish often more susceptible to effects. Fish may or may not avoid areas with pile driving noise and elevated sediment levels.	windows minimize fish exposure.	
9. Fish Passage Barrier removal or retrofit (culvert/ dam)	Elevated turbidity from in-water excavation; possible vegetation removal and riprap placement; temporary blockage of habitat during de-watering.	Habitat displacement from areas with elevated turbidity and in-water work; changes in movement or migration.	Work done in dry if possible; work area exclusion to minimize effects on movement/migration; construction methods minimize sediment mobilization. Fish passage design will meet NMFS (2011) criteria.	Temporary habitat loss and exposure to elevated turbidity minimized by work timing; habitat displacement during in-water work can lead to competitive effects and reduced fitness. Habitat benefits possible if culvert replaced and made fish-passage friendly - results in additional spawning/rearing habitat upstream.
10. Bank stabilization	Bank hardening adjacent to or within surface water can lead to loss of riparian vegetation; disconnects channel or basin from surrounding floodplain and prevents channel migration; leads to temporary elevated turbidity; alters or eliminates bank habitat;	Habitat displacement for rearing and spawning; habitat displacement during floods with lowered access to side channels; behavioral and physiological effects from elevated turbidity; long-term reduction in habitat quality; reduced prey	Bioengineering techniques (i.e. revegetation, LWD, will be used to mitigate impacts and help to reform habitat such as scour pools, aid in LWD racking, sediment retention, provide shade/cover, benthic invertebrate prey base. Clean riprap used. Dewatering may be used for work in channels or basins. Construction	Temporary habitat displacement can lead to lost foraging opportunities and elevated exposure to predators. Long-term effects lead to habitat simplification and lower quality factors for rearing and spawning, lowered productivity. Habitat benefits include stabilizing erosion-prone areas, reducing fine sediment input to streams, and providing LWD cover in wood-poor streams.

Table 19. Activity and Effects Matrix for TRRP Implementation Activities

Activity	Stressors	Potential Response to Stressor	Conservation/ minimization Measures	Effects
	changes sediment deposition dynamics; covers benthic invertebrate habitat.	base and loss of foraging opportunities.	buffers and water quality protection measures prevent fuel spills.	

Direct Harm or Harassment

Contact injury and mortality

Suitable SONCC Coho Salmon spawning and rearing habitat exists within the TRRP action area, and juvenile Coho Salmon may be expected to rear within the action area year-round. Adult Coho Salmon migrate through the boundaries and use suitable spawning habitat throughout the 40-mile reach below Lewiston Dam. Coho Salmon could be incidentally injured or killed during in-channel rehabilitation construction activities (e.g., use of temporary, shallow-water river crossings; in-water channel excavations; pile-driving; and fish salvage prior to certain construction activities), fine sediment removal in Hamilton Ponds (i.e., dredging), and coarse sediment addition, including grading. In-channel construction activities would be conducted only during the summer-to-early fall, low-flow conditions (July 15 – October 15), avoiding the potential for direct effects on spawning Coho, since this period avoids the adult migration and spawning and egg incubation season in the action area (see Leidy and Leidy 1984 and Shaw et al. 1997; Figure 10). This in-river work window also corresponds to the season when the fewest number of juvenile Coho Salmon are known to occur in the action area, after age-0 pre-smolt emigration, but before active yearling smolt migration (Leidy and Leidy 1984; Glase 1994; Petros et al. 2015; Figure 10).

Direct injury, through collision with or crushing by heavy equipment working in the water (e.g., excavators and dredges), may result in mortality of juvenile Coho Salmon. However, construction practices, as described in Chapter 3, will employ slow, deliberate operations of equipment, which will allow most fish, especially active fish like salmon, to move and disperse from the immediate work area. It is expected that all juvenile fish, including Coho Salmon, that are displaced by in-water construction activities will find other suitable habitat in the vicinity, but away from, the construction activities, since juvenile rearing habitat in the mainstem Trinity River is not likely to be limiting Coho Salmon during summer and fall months (NMFS 2006). In addition, pre-construction surveys by TRRP biologists and fish salvage in dewatered area, when necessary, will further reduce the potential for direct contact injuries to juvenile salmon. The construction period identified above would completely avoid the spawning period for Coho Salmon; therefore, direct impacts to adult Coho Salmon or their embryos/alevins would not occur.

In Channel Crossings

Some channel rehabilitation project sites may require temporary use and placement of low flow channel crossings, which would consist of gravel fill materials or temporary bridges. The crossings will be constructed, as described in Chapter 3 of this BA/EFHA, to maintain adequate water depths (i.e., $\geq$ 1 foot deep) and water velocities ($\leq$ 2 feet per second) over as much of the length of the crossing as possible to provide suitable conditions for adult and juvenile salmonid upstream and downstream passage (Powers and Orsborn1985; Bell 1990). A clean cobbly gravel mixture, with a high ratio of cobbles, would be used to create any in-channel crossing surface. The high cobble ratio will be used to avoid attracting spawning salmon to the crossing area.

The low water crossings would be used to move heavy equipment across the low-flow channels to access activity areas on opposite banks of the Trinity River or its tributaries throughout the summer and fall and into winter (July – December), while the river discharge remains near base flow. In-channel construction activities from July 15 to October 15 could require service vehicles to cross up to several times per week; otherwise, vehicle crossing traffic would be kept to a minimum outside this period. Temporary gravel fill work ramps and low-flow channel crossings would be constructed to extend across the width of the base-flow channel and are expected to be in-place long enough to complete work in activity areas. In-channel construction activities will be conducted only between July 15 and October 15. However, construction and revegetation activities on adjacent floodplains and riparian zones may occur during from the summer through the autumn months (between July and December). Access in and out of the sites could be required during other low-flow times as well. Upon completion of work in riverine areas requiring use of low-flow channel crossings (usually within one construction season), these crossings would be dismantled and materials would be contoured to the original or restoration design river bottom during in-water work period (July 15-October 15).

Although use of low-water crossings by construction vehicles could extend into the fall, Coho Salmon smolt emigration and adult immigration and spawning seasons, the effect of the low-water crossings on fish passage is expected to be temporary and non-lethal. Undue exertion or delay due to unsuccessful passage attempts at inadequate passage (blocking) structures can lead to reduced spawning success and pre-spawning mortality of adult salmonids (Robison et al. 1999). Vehicles using the low-water crossings may disturb both juvenile and adult Coho Salmon in the vicinity; however, adequate water depths and velocities over the low-water crossings will allow both juveniles and adults to readily pass either up and/or downstream when displaced by passing construction vehicles.

Coffer dams and water bypass systems associated with channel rehabilitation activities may temporarily (on the order of a few weeks) block fish movement up and/or downstream through portions of channel rehabilitation areas (usually side-channels). In these cases, sufficient bypass areas will be left open in the main Trinity River channel to allow for free up and downstream passage with minimal or no adverse effects on adult and juvenile salmonids.

Gravel Augmentation

Direct impacts to juvenile Coho Salmon could also occur during augmentation of coarse sediment at selected sites identified in Chapter 3. Gravel augmentation methods may vary by site and river flow levels. Methods include gravel injection by placing the material along the margin of the channel for distribution by the high winter-spring river flows, or by delivering the material to locations within the channel via mechanized equipment. In these cases, heavy equipment works on the streambank, near the water's edge, and dumping of gravel could disturb juvenile salmon or entomb and crush them, when gravel is placed along these sites. However, the probability of such an effect is low because the selected sites for regular gravel augmentation are high velocity areas which do not contain the shallow vegetated edges, preferred by salmon fry during the winter and early spring, when gravel addition is scheduled to occur. Gravel augmentation sites, both mid- channel and streambank sites, exhibit deeper channel cross-sections, with steeper banks and higher water velocities, than that preferred by juvenile salmon.

Gravel augmentation during high flows is not expected to have adverse effects on redds or juvenile salmonids because the coarse sediment injection sites exhibit high water velocities, where Coho spawning and rearing would not be expected. Additionally, sediment transport and scour in the Trinity River during these high flow events, when gravel addition is scheduled to occur, would likely already be within the natural range of variation experienced by fish in the action area.

A small, but uncertain, level of stranding of Coho Salmon fry could occur on restored floodplain surfaces (e.g., constructed wetlands) and side channels during the first few inundation and flood recession cycles after construction (an indirect effect). Constructed side-channel features may result in stranding conditions as flows recede, particularly, if the downstream end of the channel fills with fine sediments, potentially stranding Coho Salmon fry. Although some stranding of salmon fry occurs naturally on shallow floodplains during receding flood flows (Sommer 2001), the constructed floodplain may contain residual features (e.g., equipment tracks, tilling rills) that could exacerbate this occurrence slightly. Generally, the floodplain, alcove, and side-channel surface designs incorporate a downstream slope similar to that of the river channel, as well as, high flow scour channels (chutes). Though the primary design objective is functionality (e.g., wetland function) most features drain in a downstream direction toward the river channel guided by earthwork contours to minimize the potential for fish stranding. Within one or two inundation cycles, floodplain surfaces and side-channels will naturalize and the river channel will migrate across constructed floodplains, and any fry stranding potential is expected to equilibrate to a natural stranding risk.

Pile-driving

Pile driving within or adjacent to the Trinity River channel may be used for securing SLJs, which may affect Coho Salmon in the vicinity through hydroacoustic disturbance. In-channel construction activities would be restricted to the July 15-October 15 period to avoid exposure of adult Coho Salmon and incubating eggs/alevins but includes the risk of exposure of rearing juveniles in the action area.

Impact pile driving that is conducted in or near waterways can generate high levels of underwater sound pressure that has the potential to injure or kill fish (Caltrans 2015). Percussion shock waves may damage the sensory cells of juvenile fish if sustained high-intensity exposures occur. Low-frequency sounds have been found to repel salmonids, while high-frequency sounds may result in internal physiological damage. Startling of juvenile salmonids may cause harm by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, evading predators, and migrating. Harm can occur when normal behaviors are disrupted that result in increased competition for food and space among individual fish, with subsequent reduction in growth rates or weight loss. Temporary elevated sediment levels and/or re-suspension of contaminated sediments can also occur during in-water pile driving.

Acoustic criteria intended to protect fish from harm and mortality from pile driving activities were adopted by several state agencies, CDFW, USFWS, and NMFS in 2008 (Caltrans 2015). These "interim injury criteria" are now routinely used to evaluate the effects of impact pile driving sound on fish (Table 20).

Table 20. Interim hydroacoustic injury criteria for fish (from Caltrans 2015)

Acoustic Metric	Interim Injury Criteria
Peak	206 decibels (dB)
Cumulative Sound Energy Level (SEL $_{cumulative}$)	183 dB – for fish less than two grams 187 dB – for fish two grams or greater

Note: An additional assessment threshold that has been identified by NMFS is that a level of 150 dB RMS [Root Mean Square] should be used to assess if a pile driving project will have behavioral effects on fish.

Assessment of pile-driving impacts to fishes uses information on project layout, material and type of piles, daily number of piles to be driven, daily number of impact-hammer strikes, and type of impact hammer to be used. Because of the programmatic nature of this consultation, specific restoration designs are not available for all remaining channel rehabilitation sites. However, it is anticipated that wooden timber piles will be used to construct and stabilize some SLJs, as was included in the Wheel Gulch (2011), Upper Junction City (2012), and Lorenz Gulch (2013) channel rehabilitation sites. Typical wood piles used were 12- to 13-inches in diameter. Based on a review of the Caltrans pile-driving screening tool (Table 21), an underwater acoustic impact zone for the behavioral threshold of > 150 dB (decibels) RMS (root mean square), can be expected within 100 feet of a 12-inch wood pile driven in the water, but this impact zone reduces to 20 feet or less from shore for wood piles driven on land in the vicinity of a waterbody (e.g., on the bank or in the floodplain).

Table 21. Distance from pile driving at which fish may experience physical or behavioral effects

dB	Effects to fish	Zone of potential effects (ft)
150 dBRMS	Avoidance	20-100
183 dB SEL	Harm to fish less than 2 g	30-60
187 dB SEL	Harm to fish greater than 2 g	30-60
206 dBpeak	Harm to all fish	NA for wooden piles

When 750 or more pile strikes per day occurs on wood piles in the water, the acoustic thresholds for physical injury to juvenile salmon fry and smolts (≥ 183 dB SEL (sound exposure level $_{\text{cumulative}}$) can be expected to occur within 30 to 60 feet of the piles being driven (Table 21). Wooden piles driven on land in the vicinity of water would not be expected to reach this acoustic threshold for physical injury to juvenile salmon. In no case, would the peak acoustic acute injury threshold (206 dB for a single strike) occur during driving of wooden piles; therefore, no instances of acute acoustic pressure-shock mortality would be expected.

Accordingly, it is anticipated that a small, but uncertain number, of juvenile Coho Salmon may be exposed to underwater sound levels (150-183 dB) that could cause a behavioral response such as startle or disorientation during the initial phases of pile driving, but fish would likely flee the area of disturbance and relocate in other suitable habitat in the vicinity of channel rehabilitation sites before the number of pile strikes and sound levels accumulated to a level that can cause physical harm (> 183 dB). There would be no restrictions on juvenile salmon moving out of the acoustic impact zones because fish passage in the main river channel would not be impaired at any of the work sites.

Fish Salvage and Handling

Fish salvage may be conducted as part of certain projects that include blocking or dewatering of portions of the Trinity River and tributary streams. Fish salvage includes isolation, capture, handling, transport, and relocation. Fish handling has the potential to result in fish injury or death. Mortality may be immediate or delayed. Handling of fish can cause physical injury and increases stress, which may contribute to reduced disease resistance, reduced ability to avoid predators, decreased growth, decreased reproductive capacity, and increased latent mortality. Fish salvage protocols, described in Chapter 3 of this BA/EFHA, minimize the potential for injury and death of fish. Removal of fish from dewatered natural streambeds may not be complete due to fish avoiding detection under vegetation, cobbles, and rocks. Similar to that reported by the USFS et al. (2013) for similar efforts, it is anticipated that up to five percent of juvenile salmonids may not be recovered during any one fish salvage effort during dewatering at the scale of mainstem Trinity River channel rehabilitation projects.

Current need for fish salvage in channel rehabilitation projects by the TRRP has been limited with low numbers of Coho Salmon encountered to date. At the Lower Steiner Flat site two juvenile Coho were moved via dip net. Dip net/seining occurred at the Wheel and Lorenz Gulch sites (B. Gutermuth, personal communication). At the upper Douglas City Rehabilitation site, approximately 150 feet (46 meters) of lower Weaver Creek, which had severely reduced flows due to drought, and approximately 1000 ft of a 2007 TRRP constructed side channel (from the Indian Creek project) on the Trinity River, were salvaged prior to construction activities. No juvenile Coho Salmon were captured, although one juvenile Chinook Salmon and several hundred juvenile Steelhead and Brown Trout among other fish species and herpetofauna were successfully captured and released in the main river channel. No handling mortality of salmonids occurred in this case, with water temperatures ranging from 20°C in the creek and 15°C in the river; therefore, under typical water temperature conditions along the upper Trinity River, it is expected that, conservatively, no more than one percent handling mortality would occur during fish salvage efforts, similar to mortality rates reported for other stream restoration projects in Northwestern California (NMFS 2012b). Fish salvage is not required at all of the channel rehabilitation sites and it is expected that no more than 5-10 (approximately 50%) of the total remaining channel rehabilitation sites would require fish salvage efforts in the future and that no more than two channel rehabilitation sites per year would be implemented.

Fish salvage and relocation are expected to minimize impacts to juvenile Coho Salmon by removing them from in-water work sites, where they could experience high rates of injury and mortality, if not removed. Fish relocation activities are anticipated to only affect a small number of juvenile Coho Salmon rearing within restricted portions of channel rehabilitation sites and the relocation release site (s). The effect of fish salvage is anticipated to mostly be non-lethal, however, a few rearing juvenile Coho Salmon captured may become injured or die. In addition, the number of fish affected by increased competition at relocation release sites is not expected to be significant at most fish relocation sites, based upon the anticipated low number of Coho Salmon likely to inhabit any one channel rehabilitation site.

Fish handling and take will occur with the implementation of fisheries research and monitoring activities described in Chapter 3 and Appendix D. Actual take and mortality numbers for research conducted in 2016 and 2017 are considerably lower (less than 20% at the highest) than the authorized take for the activities that were implemented. At the Willow Creek trapping site, the actual take of SONCC Coho Salmon from handling was 301 in 2016 and 161 in 2017 with actual mortality at 6 and 7 Coho Salmon in 2016 and 2017, respectively. At the Pear Tree trapping site, actual take numbers of SONCC Coho Salmon from handling was 292 fish in 2016 and 289 fish in 2017 with actual mortality of SONCC Coho Salmon at one in both 2016 and 2017. Tissue sampling (carcasses) in selected tributaries and the mainstem from the Lewiston Dam to the confluence with the Klamath yielded actual take of 7 and 6 SONCC Coho Salmon on 2016 and 2017, respectively (Appendix D).

Turbidity and sediment

In-water activities may cause localized, temporary increases in turbidity and sedimentation during and immediately after construction. Short-term inputs of sediment and increases in turbidity can result from instream activities associated with equipment crossings, instream structure and coarse sediment placements, and opening of side-channels. Other sources of sediment can arise from disturbed and exposed ground adjacent to stream channels and in floodplains created by heavy equipment use and riparian vegetation restoration, mitigation and management (e.g., grubbing, vegetation removal, planting, weed control). Sediment and turbidity plumes will be most concentrated in the immediate vicinity of projects and typically dissipate within less than 12-24 hours, based on TRRP monitoring of past restoration projects (TRRP 2011a, b; 2012a, b; 2013). It is also anticipated that all project-related sediment will be flushed out during the first fall/winter/spring high flows after completion of individual projects, and site restoration and riparian mitigation plantings are expected to prevent future project-related sediment inputs.

According to best available science, suspended sediment may impact adult and juvenile salmonids in various ways. Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments (DeVore et al. 1980; Birtwell et al. 1984). Scientists have observed fish moving laterally and downstream to avoid turbid plumes (McLeay et al. 1984). Reported positive effects include sediment-providing refuge and cover from predation (Gregory and Levings 1988). Salmonids have evolved in systems with periodic short-term pulses (days to weeks) of high-suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. The duration of turbidity exposure is the critical determinant of the occurrence and magnitude of physical and behavioral effects (Newcombe and McDonald 1991). Chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Redding et al. 1987, Lloyd et al. 1987, Servizi and Martens 1991).

Turbidity generally does not cause acute adverse effects to aquatic organisms unless the concentrations are extremely high (Lloyd 1985). Noggle (1978) estimated an acute lethal concentration, causing 50 percent mortality of juvenile Coho Salmon, at 1,200 mg per liter (mg/L) during summer (approximately 900 NTU). At relatively high levels, suspended solids can adversely affect the physiology and behavior of aquatic organisms and may suppress photosynthetic activity at the base of food webs, affecting aquatic organisms either directly (e.g. ability to feed) or indirectly (e.g. impact to food supply and spawning substrate) (Alabaster and Lloyd 1980). At lower levels, the effects of turbidity may last as long as the perturbation in water clarity lasts and are limited to reducing a fish's reactive distance to prey, as well as, reducing predation risk to small fish. In the laboratory, benthic feeding success of Coho Salmon in water with turbidity levels as high as 100 NTU has been found to be at least 70 percent of their feeding success in clear water (Harvey and White 2008).

The Trinity River is typically very clear with natural background turbidity levels in the range of 0 to 1 NTU during summer low flow conditions. Due to the very low background concentrations during the summer, turbidity levels immediately downstream of rehabilitation sites, where in-channel activities are proposed, can be very noticeable. Current CWA Section 401 water quality certification for the TRRP requires meeting turbidity thresholds during project construction (i.e., >20 NTU at 500 feet downstream of in-river construction, when background turbidity is ≤20 NTU; and > 20 percent increase in turbidity at 500 feet downstream, when background is > 20 NTU). If standards are not met, construction activities will cease until such a time that erosion and turbidity controls and operations can be adjusted to ensure compliance with water quality standards. Erosion and turbidity controls described in Chapter 3 of this BA/EFHA will be maintained to comply with water quality standards, which restrict changes in turbidity to levels that will not impair biological and ecological functions.

Dredging of fine sediment from Hamilton Ponds will increase turbidity of water in the immediate area of the ponds; however, use of silt control curtains to isolate the work area and bypass of Grass Valley Creek flows around the sediment retention ponds during dredging will minimize any increase in turbidity of the Trinity River to that allowed under the TRRP's CWA Section 401 water quality certification. Use of pre-cleaned equipment and screened or washed coarse sediment to be placed in the river will minimize the introduction of fine sediment to the stream.

In-channel construction activities would occur during low-flow conditions between July 15 and October 15, minimizing the potential for adverse effects on Coho Salmon spawning and egg incubation. Additionally, it is anticipated that all project-related sediment will be flushed out during the first fall/winter/spring high flows after each project is completed, and site restoration conservation measures are expected to prevent future project-related sediment inputs to stream channels. Some fine-textured materials may settle near or on known spawning habitats located downstream of riverine rehabilitation areas, but these materials are not expected to impair redd excavation or spawning due to remobilization of this material and deposition on upper margins of the channel. Therefore, long-term impacts to water turbidity and sediment inputs on spawning gravels within designated critical habitat are not expected.

Accidental spills, contaminants

Construction activities will typically involve the refueling of construction equipment on location. As a result, minor fuel and oil spills could occur. Without rapid containment and clean up, these materials could be toxic, depending on the location of the spill in relation to surface water features, including the Trinity River. Oils, fuels, and other contaminants could have deleterious effects on all salmonid life stages in close proximity to construction activities. Project-specific water pollution control plans and emergency spill control measures and other BMPs will be implemented to reduce the risk of a potentially adverse effect on water quality, protecting SONCC Coho Salmon and its designated CH within the action area, and is, therefore, discountable.

Indirect Effects

In Channel or Floodplain Alteration/Grading

As described above, all TRRP activities are expected to improve floodplain connectivity and channel structure. A key objective of the TRRP is to restore functionally dynamic alluvial river channel processes and attributes within the action area that provide abundant, complex, instream habitat for salmonids.

Displacement of salmonids from preferred habitat may result in an increased predation risk or reduced feeding efficiency through the loss of the cover function provided by the shaded riverine aquatic (SRA) habitat (Michney and Hampton 1984; Michney and Deibel 1986). However, all in-channel work would be conducted only during late-summer to early-fall (during the in-water work window) low-flow conditions to avoid impacts to spawning Coho Salmon and would not interfere with spawning, egg development, and alevin life stages.

In addition, streambank stabilization activities can reduce sediment yield from the protected bank and prevent the establishment of riparian vegetation and associated shading and cover for resting adults and juveniles. Therefore, the proposed designs incorporate woody debris and plantings to provide cover and shade adjacent to the pools and encourage natural sediment build up next to the wood structures, intending to allow the bank to fill in and recruit more vegetation for long-term streambank functions and development of habitat features.

Riparian Habitat Impacts

TRRP activities are expected to improving floodplain connectivity, benefitting the associated riparian vegetation and other riparian-dependent species and important ecological linkages to stream habitat. The TRRP revegetates restoration project sites to ensure compliance with permitting requirements and to meet TRRP ecological objectives. Permits require no net loss of riparian vegetation coverage and acreage. The ecological objectives are more complex and are focused on improving ecological function of riverine-riparian ecosystem linkages within the action area. Ecological objectives include establishing self-sustaining stands of native vegetation in the riparian zone, providing habitat elements for selected species of wildlife, and providing a long-term source of large wood to enhance geomorphic processes of the adjacent river channel (TRRP and ESSA 2009). The design of channel rehabilitation sites includes consideration of creating conditions within the riparian zone that will support a more natural disturbance regime to which native riparian vegetation are adapted and will be sustained in concert with the TRRP's channel rehabilitation, sediment management, and variable annual instream flows.

TRRP channel rehabilitation designs generally preserve large riparian trees or reuse them to create instream large wood structures; however, occasional removal of riparian tree canopy could result in reduction cover and water temperature regulation created by tree stream shading, reduced nutrient cycling (water quality and primary/secondary productivity), and reduced terrestrial invertebrate (potential prey) production functions provided by the riparian vegetation (Michney and Hampton 1984; Michney and Deibel 1986).

Highly suitable rearing habitat for early life stage juvenile Coho Salmon and other anadromous salmonids occurs along the shallower river margins, especially in proximity to riparian vegetation (Goodman et al. 2010, 2012, 2014; Alvarez et al. 2015). Temporary adverse effects to the quality of juvenile salmonid rearing habitat through removal of riparian vegetation will occur during streambank and upland construction activities adjacent to the river channel. The primary adverse effects of riparian vegetation removal include the direct displacement of rearing salmonid fishes from their habitat and a reduction in habitat quality. Although, the influence of riparian vegetation generally diminishes as streams get larger (Murphy and Meehan 1991), riparian vegetation along the Trinity River and its tributaries in the action area is thought to play an important role in providing high quality fish habitat (TRRP and ESSA 2009; Beechie et al. 2014). The reduction in habitat quality from removal of riparian vegetation is likely to affect Coho Salmon through the loss of cover, organic inputs, and LWD input which increases predation risk and reduced feeding efficiency. To address the loss of riparian vegetation in the project action areas, the project includes replanting disturbed areas with native plantings, and often adding LWD (immediate shade and cover).

Effects on Coho Salmon Critical Habitat

Critical Habitat (CH) (50 CFR 223 and 226) includes the physical and biological features (PBFs) or Primary Constituent Elements (PCEs) essential to the conservation of SONCC Coho Salmon. The PBFs of critical habitat applicable to this project include those sites and habitat components that support one or more life-history stages:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
- Freshwater rearing sites with:

a. Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;

b. Water quality and forage supporting juvenile development; and

c. Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

  Project effects on the features and functions of CH and EFH are summarized in Table 22. Overall, negative effects are short-term with a higher benefit to CH and EFH with the implementation of TRRP activities.

Table 22. Potential Effects to SONCC Coho Salmon Critical Habitat (PBFs) from TRRP Activities

Potential Effects	Freshwater Spawning: water quality/quantity, substrate	Freshwater Rearing: water quality/quantity, habitat features	Freshwater Migration, adults and juveniles
Elevated Pollutant Delivery-minor and temporary from construction impacts. Projects that remove and/or improve roads and provide stormwater treatment improve this element.	X	X	
Elevated Sediment/Turbidity in Surface Waters- minor and temporary from construction impacts. Not expected to fill pools or impact spawning gravels. Activities overall reduce fine sediment in watershed.	X	X	X
Elevated Surface Water Temperature- minor and temporary from construction impacts. Restoration actions restore flows, riparian vegetation, provide shade and cover to reduce stream temperatures.	X	X	X
Substrate Disturbance – Contaminant Mobilization- minor and temporary from construction impacts. Projects add spawning gravel in action area	X	X	X
Loss of Invertebrate Habitat-Food Web Effects. Impacts are minor and temporary, TRRP revegetates disturbed areas, adds LWD		X	X

Table 22. Potential Effects to SONCC Coho Salmon Critical Habitat (PBFs) from TRRP Activities

Potential Effects	Freshwater Spawning: water quality/quantity, substrate	Freshwater Rearing: water quality/quantity, habitat features	Freshwater Migration, adults and juveniles
Effects on Fish Migration. Impacts are minor and temporary, projects include barrier removal (culverts, dams, in-channel barriers) and restore of low flows for connectivity			X
Permanent and Temporary Habitat Displacement. Impacts are temporary during (work area isolation) and immediately after construction until habitat reforms.	X	X	X
Altered Water Quantity Delivery-temporary construction impacts but overall improvement of flows from restoration activities such as diversion/low flow restoration projects/removal of roads (impervious surfaces).	X	X	X
Streambank/Shoreline Habitat Loss/Modification and Reduced Habitat Connectivity-Select streambank stabilization projects will harden banks to protect property or infrastructure, but mitigation measures (LWD, planting) will be implemented. Overall improvement as in-stream projects aimed at restoration of streambanks, floodplains, and habitat connectivity throughout watershed.	X	X	X
Altering Natural Stream Processes and Floodplains. Temporary impacts during and immediately after construction until habitat reforms.	X	X	X
Beneficial Effects-TRRP activities aimed at overall restoration of spawning, rearing, and migratory habitat for SONCC	X	X	X

Interrelated and Interdependent Effects

Section 7(a)(2) of the ESA, and its implementing regulations (50 CFR Part 402), requires federal agencies, when consulting with the Services, to consider the direct and indirect effects of any actions that are interrelated or interdependent to the action on species listed or proposed for listing under the ESA and designated critical habitat. Interrelated actions are those actions that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action (50 CFR Part 402.02).

The ongoing TRRP channel rehabilitation, fine and coarse sediment management, limited infrastructure, watershed restoration, and fisheries monitoring activities analyzed in this BA/EFHA are part of the larger preferred alternative specified in the 2000 ROD for the Trinity River Mainstem Fishery Restoration FEIS/EIR. The TRRP's variable annual flow regime[25] is the only component of the TRRP preferred alternative that is not further analyzed in this BA/EFHA. The TRRP's variable annual flow schedule has not changed over the course of the program and remains the same operationally in its interrelationship with the TRRP mainstem Trinity River restoration activities analyzed in this BA/EFHA, as was described in the ROD (USDOI 2000). Furthermore, the effects of the interrelationship of the Coordinated Long-term Operation of the Central Valley Project (CVP) and State Water Project (SWP) and the TRRP variable instream flow regime on SONCC ESU Coho Salmon and its designated CH in the action area, and on other species listed or proposed for listing under the ESA within the action area, were addressed by a 2008 USFWS BiOp and a 2009 NMFS BiOp and recent 2015 Final EIS for the Coordinated Long-term Operation of the CVP and SWP (US Reclamation 2015). These analyses concluded that, with implementation of the Reasonable and Prudent Alternatives specified in the 2008 USFWS and 2009 NMFS BiOps, the Coordinated Long-term Operation of the CVP and SWP would not functionally affect ongoing implementation of the TRRP preferred alternative or significantly alter environmental baseline conditions of designated critical habitat for SONCC ESU Coho Salmon.

Cumulative Effects

Cumulative effects for the purposes of the ESA encompass those impacts of future state, local, private, and tribal actions that are reasonably certain to occur within the action area and may affect endangered and threatened species considered in this BA/EFHA. For purposes of this BA/EFHA, cumulative effects are generic to the area of consideration and not related to the ongoing TRRP action. Future projects not covered under this consultation that have a federal nexus (i.e., implementation, permitting, funding) will be subject to separate ESA Section 7 consultation. This discussion addresses cumulative effects on SONCC ESU Coho Salmon and its designated critical habitat in the context of general trends in land uses, human population, and fishery and natural resource management activities on the primary limiting factors affecting Coho Salmon in the Trinity River watershed.

Trinity County (comprises 86% of the Trinity River watershed) is located in the northwestern portion of the state of California. As of the 2010 federal census, the population was 13,786, making it the fourth-least populous county in California. The population declined to 13,069 by 2015, reflective of a relatively stable, if not somewhat declining resident population (U.S. Census Bureau; www.census.gov/quickfacts/table/PST045215/06105). This population trend indicates the development and associated effects on the environment will occur at a low to modest rate for, at least, the near-term future.

[25] The TRRP's variable annual instream flows for the Trinity River from the TRD, ranging from 369,000 acre-feet (af) in critically dry years to 815,000 af in extremely wet years, are based on forecasted hydrology for the Trinity River Basin as of April 1st of each year.

Residential, urban, and industrial development is relatively low density and concentrated around the towns of Weaverville (Weaver Creek – Upper Trinity River watershed) and Hayfork (Hayfork Creek – South Fork Trinity watershed); otherwise, development is sparsely distributed throughout the county and limited to low-density rural residential uses. Transportation and utility infrastructure (e.g., highways and other roadways, pipelines, and power transmission lines) tracks closely with residential and commercial development and is expected to occur into the future at a modest rate.

Primary limiting factors that may be potentially affected by these development activities include degradation and loss of riparian and aquatic habitat, reduced water quality, adverse alteration of watershed hydrologic function, and altered sediment supplies. Residential, commercial, and associated infrastructure developments are subject to local ordinances and state and federal regulations to protect soil and water resources and threatened and endangered species. Actions taken to mitigate for potential impacts of development will help to minimize habitat degradation and cumulative effects to the environmental baseline for SONCC ESU Coho Salmon. Because most of the TRRP channel rehabilitation sites occur within the federally designated 100-year flood plain, where residential, transportation, and most commercial development is restricted, the potential for further population growth and development in a majority of the action area is minimal.

Federal, state, and private forest lands dominate the land use of Trinity County in the action area. Agriculture (e.g., ranching and grazing, viticulture), forestry, manufacturing (sawmills), mining, and leisure and recreation are conducted in the county and contribute to the economy of the region. Logging continues to be conducted primarily on private lands throughout the tributary watersheds of the Trinity River, except in Canyon Creek (BLM 1995). Some mining for gravel and aggregate and minor precious metals occurs on the Trinity River floodplain and a few tributary watersheds.

Agriculture can affect Coho Salmon habitat through irrigation diversions, agrochemical applications, land clearing, and sediment runoff into streams, if provisions and BMPs to protect habitats and water quality are not enforced and properly implemented. Mining operations can affect coarse sediment supplies and impair water quality via contaminated and sediment-laden runoff from operations. Similarly, forestry and timber harvest can impact riparian and aquatic habitat through clear-cutting and road building and contribute to collective impacts of past forestry practices.

Currently, state timber harvest planning rules include practices and enforcement procedures to protect water quality, riparian areas, and threatened and endangered species, which provide some protection to SONCC ESU Coho Salmon and its critical habitat, but forestry activities may result in future periodic localized degradation of aquatic habitats.

Additionally, a TMDL for sediment was completed in 2001 for the mainstem Trinity River and a TMDL for sediment and water temperature was completed for the South Fork Trinity River in 1998. Protective measures to meet the TMDL criteria are implemented, monitored, and enforced by the State of California through the NCRWQCB through permitting processes for local development, commercial, industrial, and infrastructure activities. Although commercial and industrial activities are required to comply with regulatory antidegradation measures intended to protect soil resources, water quality, and other natural resources, including threatened and endangered species, these activities are likely to continue to have short-term and long-term effects of varying degrees on the environmental baseline for SONCC ESU Coho Salmon.

Numerous watershed restoration projects are planned and are being implemented throughout the Trinity River Basin. The Yurok and Hoopa tribes, Trinity County Resource Conservation District (TCRCD) and the STNF, in coordination with funding provided by the CDFW, NOAA Northwest California Restoration Center, and the TRRP, are implementing numerous watershed and tributary restoration projects throughout the basin. These projects focus on removing fish passage impairments and reducing drainage network and soil erosion impacts, reducing impacts of these specific limiting factors for Coho Salmon and other anadromous salmonids and resident fish species.

Current state fishery management practices regulate sport and commercial fisheries for Coho Salmon by prohibiting in-river and ocean harvests in California waters. Hatchery culture and release practices for Coho Salmon at Trinity River Hatchery have been reviewed and amended to reduce impacts on naturally produced fish and better serve in the recovery of SONCC ESU Coho Salmon (CDFG & NMFS 2001; CDFG 2004; California HSRG 2012; NMFS 2014).

The effect of the proposed TRRP aquatic habitat and watershed restoration activities on SONCC Coho Salmon is largely beneficial over the long-term. The adverse effects would be minor in comparison to other factors reasonably certain to occur in the vicinity of the action area described above. Reclamation also complies with conditions of the Trinity River TMDL for sediment that was established in 2001 by the USEPA in accordance with Section 303(d) of the CWA. Annual project limits are expected to prevent cumulative impacts to water quality (sediment, turbidity, and water temperatures) in the watershed.

Chapter 7 Determinations

Southern Oregon/Northern California Coasts ESU Coho Salmon

Although the ongoing implementation of the TRRP action is designed to result in overwhelmingly significant, long-term benefits for anadromous salmonids in the Trinity River basin, short-term, localized adverse impacts to the SONCC ESU Coho Salmon would occur and are considered significant under the implementing regulations of the ESA. Therefore, the overall determination for the action is ***"May Affect, is Likely to Adversely Affect"*** **the federally threatened SONCC ESU** Coho Salmon.

Southern Oregon/Northern California Coasts ESU Coho Salmon Designated Critical Habitat

The ongoing Implementation of the TRRP action ***"May Affect, is Likely to Adversely Affect"*** **designated critical habitat for the SONCC ESU** Coho Salmon.

Adverse impacts to SONCC Coho Salmon and their CH by the ongoing activities of the TRRP action would be temporary and localized. However, these temporary adverse effects are expected to be offset in the long-term by substantially more significant beneficial long-term increases in, and improved suitability of, physical rearing habitat associated with implementing the action. These benefits will accrue from (1) the engineered floodplain habitat improvements, (2) overall reconnection of the floodplain to the river at a broader range of river flows, (3) improvements in alluvial channel functions such as periodic channel migration through floodplains, (4) reduced fine sediment loads in tributaries and the mainstem Trinity River, (5) improved balance between coarse sediment storage and transport in the upper Trinity River, (6) improved hydrologic and ecologic connectivity of the mainstem Trinity River and watershed tributaries, and (7) revegetation of the rehabilitated floodplain with native plant species that will contribute shade and large wood to the river channel. Improved river connection with floodplains during high flows is expected to increase areas of slow, shallow-water habitat preferred by salmonid fry. The process of channel migration through the floodplain may also create alternate point bars, further increasing the availability of this preferred habitat. Within the action area, the channel migration process and engineered side channel and alcove habitats will collectively increase the relative abundance of this preferred salmon rearing habitat compared to the existing condition. Ultimately, the collective changes as a result of the action are intended to improve habitat diversity for all life-stages of anadromous salmonids.

Chapter 8
Essential Fish Habitat Assessment for Pacific Salmon

The MSA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297), established requirements for EFH descriptions in federal fishery management plans and requires federal agencies to consult with the NMFS on activities that may adversely affect EFH. EFH for Pacific Coast salmon has been described in Appendix A, Amendment 14 and updated by Amendment 18 (79 FR 75449, December 18, 2014) to the Pacific Coast Salmon Fishery Management Plan (50 CFR Part 660). The Trinity River up to Lewiston Dam and all tributaries accessible to anadromous fish is identified to contain freshwater EFH for Chinook and Coho Salmon, including the entirety of the action area (79 FR 75449, December 18, 2014).

TRRP activities are expected to benefit designated critical habitat for SONCC ESU Coho Salmon. These habitat benefits are similar for all species of anadromous salmonids in the Trinity River Basin and include improving mainstem channel structure and diversity of habitats; spawning gravel distribution and quality; floodplain connectivity; riparian vegetation structure and diversity, along with important ecological linkages to stream habitat; reduction in fine sediment loads in tributaries and the mainstem river; and tributary connectivity and habitat quality. In acquiring these benefits, short-term adverse impacts to EFH within the action area are expected. Such impacts will be minimized by design and construction approaches and conservation measures described in Chapter 3 of this BA/EFHA.

Temporary effects on Pacific salmon EFH associated with construction of the action are expected to be limited to minor disturbances of rearing, migrating, and spawning fish during construction activities; short-term, localized increases in turbidity caused by bankside excavation or in-channel work activities; temporary placement of coarse gravel fills to create low-water crossings for construction vehicles, after which materials would be removed and/or the river bottom contoured to match pre-existing or restoration design grades; removal of riparian vegetation to restore dynamic alluvial channel processes and connect floodplains, with revegetation to create more functional riparian habitat; disturbances to stream channels during installation of coarse sediments and large wood for habitat enhancement; and installation of temporary barriers (coffer dams) in portions of stream channels during construction of channel features (side-channels, alcoves), and passage improvements such as culvert replacement/dam removal in tributaries.

These impacts on Pacific salmon EFH during TRRP restoration activities, though temporary and ultimately outweighed by long-term benefits to salmon freshwater habitat quantity and quality in the action area, are considered ***"Will Adversely Affect"*** **EFH for Pacific Salmon** for construction activities associated with habitat restoration.

Chapter 9
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Appendix A Key Provisions of the Aquatic Conservation Strategy of the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Related Species within the Range of the Northern Spotted Owl

Introduction

An important component of the Northwest Forest Plan (NWFP) is the Aquatic Conservation Strategy (ACS). The ACS was included as part of the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Related Species within the Range of the Northern Spotted Owl and Record of Decision (ROD). The ACS entails a set of goals and objectives and standards and guidelines for federal land managers to restore and maintain the ecological health of watersheds and their aquatic ecosystems on federally managed lands within the range of the northern spotted owl. The ACS was incorporated into the 1994 Shasta-Trinity National Forest's Land and Resource Management Plan (USFS 1995) and Bureau of Land Management's 1993 Redding Resource Management Plan (BLM 1993). The ACS was considered in two applicable watershed analyses covering the regional focus of the Trinity River Restoration Program (TRRP), upper 40 miles of the Trinity River from Lewiston Dam downstream to the North Fork Trinity River confluence [*Upper Trinity River Watershed Analysis* (Shasta-Trinity National Forest 2005) and the *Mainstem Trinity River Watershed Analysis* (Bureau of Land Management 1995)].

The ACS acknowledges that species-specific strategies aimed at defining explicit standards for habitat elements would be insufficient for protecting even the targeted species. The intent of the ACS is to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian-dependent species and resources and to restore currently degraded habitats. This approach seeks to prevent further habitat degradation and restore habitat over broad landscapes as opposed to implementing individual projects or focusing on small watersheds. Because the ACS is based on natural disturbance processes, the ROD recognized that it is a long-term strategy that may take decades, and possibly more than a century, to accomplish all of its objectives.

The ACS contains four components: riparian reserves, key watersheds, watershed analysis, and watershed restoration. Each component is integral to improving the health of the aquatic ecosystems encompassed by the ROD.

Components of the Aquatic Conservation Strategy

Riparian Reserves

The TRRP action area contains Riparian Reserves on federally managed lands, as defined in the STNF's 1994 LRMP and BLM's 1993 RMP. Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edge of the100 year flood plain, or to the outer edge of the riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest. The STNF nor the BLM designates Riparian Reserves consistent with the Standards and Guidelines described in the Northwest Forest Plan and in the STNF 1994 LRMP and BLM 1993 RMP (see Table A-1 of this appendix).

Key Watersheds

The STNF does manage key watersheds in the upper Trinity River watershed, primarily associated with the Salmon-Trinity Alps Wilderness Area and Canyon Creek, which confluences with the mainstem Trinity River, in the TRRP action area, near the town of Junction City.

Watershed Analysis

Watershed analysis has been conducted by the BLM and the STNF for the lands within and surrounding the TRRP action area. These analyses did not identify specific recommendations regarding the Riparian Reserve widths; therefore, the Standards and Guidelines established under the ACS are applicable and considered as criteria for design of the TRRP's mainstem river channel rehabilitation, coarse and fine sediment management, and watershed restoration activities.

Watershed Restoration

By its nature, the TRRP is a comprehensive ecosystem restoration program intended to restore the physical processes and biological resources of the mainstem Trinity River and tributaries. While some short-term impacts may occur to riparian-dependent species, the scale of the TRRP ensures that restoration of ecological processes and functions will be consistent with the ACS.

Aquatic Conservation Strategy Objectives

Nine ACS objectives and relationships with TRRP actions are as follows:

1. *Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.*

The TRRP restoration actions, by their nature, are intended to restore the landscape processes, specifically the alluvial and riparian functions that have been impaired by construction of the Trinity River Division of the Central Valley Project (TRD). The activities that are proposed on federal lands subject to the ACS are an integral part of the larger project and are intended to assist BLM and the STNF in attaining this ACS objective.

2. *Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide* chemically *and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.*

The TRRP program, including the BLM and STNF, have been involved in the identification and prioritization of channel rehabilitation sites since inception of the TRRP in 2000. Project design guidelines and criteria have been developed that acknowledge and address protection and functional improvement of ecological linkages between aquatic and riparian habitats that occur throughout the TRRP action area (HVT et al. 2011), consistent with assisting the BLM and STNF in attaining this ACS objective.

3. *Maintain and restore the physical integrity of the aquatic system, including shorelines, banks and bottom configurations.*

A fundamental objective TRRP activities and individual projects is the restoration of functional connectivity and long-term integrity of the bed, banks, and floodplain of the Trinity River, consistent with assisting the BLM and STNF in attaining this ACS objective. The modification of channel grade controls, expansion of functional floodplain habitat, and efforts to enhance the coarse sediment supply are examples of the activities intended to restore the physical integrity of the aquatic system. Collectively, these efforts are designed to restore the alluvial character of the Trinity River that was impaired by reductions in flow and alteration of sediment dynamics caused by the TRD.

4. *Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the*

system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

A number of channel rehabilitation treatments require removal of vegetation and extensive grading activities, including construction within the active channel of the Trinity River. The TRRP, in cooperation with BLM and the STNF, incorporate Best Management Practices in all activities, including those on federal lands, to ensure that effects on water quality are minimized. Additionally, mitigation measures are incorporated to further reduce potentially significant effects on water quality from construction activities. TRRP activities require the following discretionary approvals related to the Clean Water Act: Section 401 water quality certification and Section 404 permit and waste discharge requirements. These authorizations are intended to ensure that various habitat restoration activities meet the water quality standards established by the Regional Water Quality Control Board, North Coast Region (Regional Water Board), which are consistent with assisting the BLM and STNF in attaining this ACS objective.

5. *Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.*

A fundamental goal of the TRRP is restoration of the sediment regime in a manner that enhances the alluvial character and ecological function of the 40-mile reach of the Trinity River downstream of Lewiston Dam, which is consistent with assisting the BLM and STNF in attaining this ACS objective. Coarse and fine sediment management activities are designed to replenish course sediment on an ongoing basis consistent with the timing, volume, and rates appropriate for the scaled down river channel.

6. *Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.*

The TRRP channel rehabilitation, coarse and fine sediment management, and watershed upslope restoration activities are scientifically designed to integrate with the managed ecological flow regime component of the program in a manner to create and sustain functional and productive riverine and riparian habitat along the upper 40 miles of the Trinity River and contributing watersheds.

7. *Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.*

The activities to modify the bed, banks, and floodplains of the Trinity River within the TRRP action area are designed to maintain and/or restore the hydrologic connectivity of the river and adjacent wetland/riparian habitat. Current TRRP channel rehabilitation design guidelines and watershed restoration guidelines include specifications and criteria for modifying floodplain elevations to better interact with current flow regimes to establish functional, connected wetland habitat adjacent to the Trinity River, which is consistent with assisting the BLM and STNF in attaining this ACS objective.

8. *Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.*

A fundamental objective of the TRRP is to restore the species composition and structural diversity of native plant communities that occur along the mainstem Trinity River. Design criteria and guidelines for floodplain and upland activity areas will provide conditions that are receptive to re-introduction of a diverse assemblage of native riparian vegetation, and reduce the potential for non-native, invasive, and noxious plant species. Woody material removed as part of the rehabilitation activities will be incorporated into restoration projects, as appropriate, to enhance channel complexity and edge habitat. Overall, these criteria and guidelines support natural recruitment of riparian communities, supplemented by riparian planting efforts, which is consistent with assisting the BLM and STNF in attaining this ACS objective.

9. *Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.*

A fundamental objective of the TRRP is to restore the structure and function of aquatic, riparian, and upland habitat along the 40-mile reach of the mainstem Trinity River. TRRP design criteria and guidelines emphasize creation and/or rehabilitation of aquatic and riparian habitat within individual project boundaries. Collectively, these activities are intended to generate geomorphic responses downstream that will further the overall habitat enhancement objectives by reestablishing the alluvial processes that were impaired by the construction and operation of the TRD. The activities that are proposed on federal lands subject to the ACS are an integral part of the larger project and are intended to assist BLM and the STNF in attaining this ACS objective.

Table A-1. ACS Applicable Standards and Guidelines

		All Land Allocations
Survey and Manage	2	Survey prior to ground disturbing activities.
		Riparian Reserves
Timber Management	TM 1-c	Apply silvicultural practices for Riparian Reserves to control stocking, reestablish and manage stands, and acquired desired vegetation characteristics needed to attain ACS objectives.
Roads Management	RF-1	Federal, state, and county agencies should cooperate to achieve consistency in road design, operation, and maintenance necessary to attain Aquatic Conservation Strategy objectives.
	RF-2	For each existing or planned road, meet Aquatic Conservation Strategy objectives by:
	RF-2a	Minimizing road and landing locations in Riparian Reserves.
	RF-2b	Completing watershed analyses (including appropriate geotechnical analyses) prior to construction of new roads or landings in Riparian Reserves.
	RF-2c	Preparing road design criteria, elements, and standards that govern construction and reconstruction.
	RF-2d	Preparing operation and maintenance criteria that govern road operation, maintenance, and management.
	RF-2e	Minimizing disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flow.
	RF-2f	Restricting side casting as necessary to prevent the introduction of sediment to streams.
	RF-3	Determine the influence of each road on the Aquatic Conservation Strategy objectives through watershed analysis. Meet Aquatic Conservation Strategy objectives by:
	RF-3a	Reconstructing roads and associated drainage features that pose a substantial risk.
	RF-3b	Prioritizing reconstruction based on current and potential impact to riparian resources and the ecological value of the riparian resources affected.
	RF-3c	Closing and stabilizing or obliterating and stabilizing roads based on the ongoing and potential effects to Aquatic Conservation Strategy objectives and considering short-term and long-term transportation needs.
	RF-4	New culverts, bridges and other stream crossings shall be constructed, and existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associated bedload and debris. Priority for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure.

Table A-1. ACS Applicable Standards and Guidelines

	RF-5	Minimize sediment delivery to streams from roads. Out sloping of the roadway surface is preferred, except in cases where out sloping would increase sediment delivery to streams or where out sloping is unfeasible or unsafe. Route road drainage away from potentially unstable channels, fills, and hillslopes.
	RF-7	Develop and implement a Road Management Plan or a Transportation Management Plan that will meet the Aquatic Conservation Strategy objectives. As a minimum, this plan shall include provisions for the following activities:
	RF-7a	Inspections and maintenance during storm events.
	RF-7b	Inspections and maintenance after storm events.
	RF-7c	Road operation and maintenance, giving high priority to identifying and correcting road drainage problems that contribute to degrading riparian resources.
	RF-7d	Traffic regulation during wet periods to prevent damage to riparian resources.
	RF-7e	Establish the purpose of each road by developing the Road Management Objective.
Recreation Management	RM-1	New recreational facilities within Riparian Reserves, including trails and dispersed sites, should be designed to not prevent meeting Aquatic Conservation Strategy objectives. Construction of these facilities should not prevent future attainment of these objectives. For existing recreation facilities within Riparian Reserves, evaluate and mitigate impact to ensure that these do not prevent, and to the extent practicable contribute to, attainment of Aquatic Conservation Strategy objectives.
	LH-3	Locate new support facilities outside Riparian Reserves. For existing support facilities inside Riparian Reserves that are essential to proper management, provide recommendations to FERC that ensure Aquatic Conservation Strategy objectives are met. Where these objectives cannot be met, provide recommendations to FERC that such support facilities should be relocated. Existing support facilities that must be located in the Riparian Reserves will be located, operated, and maintained with an emphasis to eliminate adverse effects that retard or prevent attainment of Aquatic Conservation Strategy objectives.
	LH-4	For activities other than surface water developments, issue leases, permits, rights-of-way, and easements to avoid adverse effects that retard or prevent attainment of Aquatic Conservation Strategy objectives. Adjust existing leases, permits, rights-of-way, and easements to eliminate adverse effects that retard or prevent the attainment of Aquatic Conservation Strategy objectives. If adjustments are not effective, eliminate the activity. Priority for modifying existing leases, permits, rights-of-way and easements will be based on the actual or potential impact and the ecological value of the riparian resources affected.
General Riparian Area Management	RA-2	Fell trees in Riparian Reserves when they pose a safety risk. Keep felled trees on-site when needed to meet coarse woody debris objectives.
	RA-3	Herbicides, insecticides, and other toxicants, and other chemicals shall be applied only in a manner that avoids impacts that retard or prevent attainment of Aquatic Conservation Strategy objectives.

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Appendix B Summary of Channel Rehabilitation Construction Activities and Projects

The following summary of channel rehabilitation activities is primarily taken and modified from the Channel Rehabilitation Design Guidelines for the Mainstem Trinity River (Channel Design Guidelines; HVT, et al. 2011), Version 1.0 of the TRRP: IAP (TRRP and ESSA 2009), and the Master EIR (NCRWQCB and Reclamation 2009).

Activities A through G are intended to increase the potential for the river to meander (migrate) within the floodplain, in which it has been confined by historic dredging activities and by the effects of construction and operation of the TRD. In addition to the immediate changes to the channel (e.g., side channel construction and berm removal), the action would increase the likelihood that the Trinity River would reflect more of the "healthy river" attributes of an alluvial river (see USFWS and HVT 1999). Activities E, F, and G are intended to create aquatic habitat that would provide refuge for salmonids and other aquatic wildlife during inundation and that would evolve over time. The side channels, alcoves, and floodplain enhancements would also provide additional complexity to the riverine environment and areas of riparian habitat diversity and juvenile salmonid rearing habitat during periods of floodplain inundation. All of these activities are consistent with the "healthy river" attributes of the TRFES.

Activities H and I are intended to increase channel complexity and usable spawning habitat through the removal of grade control structures and sediment management. Activity H is intended to promote channel migration, increase sinuosity, reduce in-channel fine sediment storage, increase coarse sediment transport, and restore gravel bars. Activity I is intended to remove fine sediment at key rehabilitation sites and place coarse sediment to encourage channel migration and the development of alternate bars.

Activities J through M are associated with practical construction needs, including transfer, placement, and stabilization of material excavated from the riverine areas. Activity N crossings are to provide a reasonable method to access activity areas on opposite sides of the river or tributaries. In conjunction with Activity J, various grading techniques would be used to direct drainage to create seasonal, off-channel riparian habitat available for Western Pond Turtle and other riparian-dependent species. Activity K includes the processing and storage of coarse sediment and boulder material for use in construction of in-river installations.

Table B-1. Proposed Channel Rehabilitation Implementation Activities

Identifier	Activity Type
A	Vegetation removal and recontouring of ground surfaces on flood plains, adjacent riparian and proximate upland vegetation
B	Construction of inundated surfaces (450 cfs)
C	Construction of inundated surfaces (1,000-4,500 cfs)
D	Construction of inundated surfaces (6,000 cfs)
E	Construction of low-flow side channels (300 cfs)
F	Construction of medium-flow side channels (1,000 cfs)
G	Construction of Alcoves (300 cfs)
H	Grade control removal
I	Site-specific sediment management (coarse and fine)
J	Placement of excavated materials
K	Staging/use areas (includes gravel processing and stockpiling, limited vegetation clearing.
L	Upgrade existing roads
M	Construct new access roads
N	Installation and use of temporary channel crossings (Trinity River and tributaries)
O	Revegetation
P	Construction of engineered log jams/hydraulic structures (wood and/or rock), habitat wood structures, skeletal bar or boulder habitat placement
Q	Construction of split flow channels (30 to 60% of river flow)
W	Construction of wetland complexes, including off-channel floodplain ponds

Note: Adapted from: NCRWQCB and Reclamation (2009); HVT, et al. (2011); CardnoEntrix and CH2M Hill (2011); NCRWQCB, et al. (2014)

Activity O includes revegetation of disturbed surfaces (e.g., access routes, staging areas, recontoured river terraces).

Activities P and Q are intended to create aquatic habitat diversity to provide cover refuge for salmonids and other aquatic wildlife and food web substrates during inundation, which would also evolve over time, similar to activities E, F, and G. Activities P and Q will use wood and rock structures to increase hydraulic complexity and geomorphic channel diversity, which will, in turn, create and maintain aquatic habitats. Activity P is intended to increase woody material, which is a natural part of rivers in north temperate coniferous forests, like the Trinity River, and provides important habitat for aquatic species, including cover from high flows and predators, aggradation of suitable spawning materials, and substrates for aquatic insects. It also creates and maintains beneficial channel habitat features such as pools, side channels, islands, and gravel bars.

Activity A (Vegetation Removal and Recontouring of Ground Surfaces)

The ground surface within floodplains at project sites will be modified, as needed, to reduce channel-confinement, attain functional riparian vegetation conditions, and minimize the risk of stranding of juvenile salmonids consistent with TRRP objectives. Vegetation will be cleared or thinned at some locations but, in most cases, designs will avoid or minimize the amount removed from activity areas. Activity A also includes grading to construct or enhance topographic features that promote development of functional riparian habitat; excavation and fill will be balanced to the extent practical within the activity area. Vegetation removal, when needed, will be designed to maintain or reestablish ecologically based tree stand densities and enhance wildlife habitat. Trees marked for selective removal will meet objectives for enhanced forest health, ensured site safety, and for meeting present and future large woody debris (LWD) needs for riparian and aquatic habitat. Vegetation removed will be used for in-river and riparian zone placement as LWD, chipped/masticated, or spread/tilled in revegetation areas in order to increase nutrients and water holding capability of the soils. Excavated alluvium may be processed to obtain clean gravel, boulders and fines for use in terrestrial and in-river construction and vegetation efforts. Excavated alluvium on private parcels will primarily be utilized on the lands under ownership from which they were removed. These activities will be accomplished using a variety of methods, including hand tools and heavy equipment, such as excavators, bulldozers, scrapers, and dump trucks.

Activities B, C, and D (Construction of Inundated Surfaces – 300 cfs, 1,000 to 4,500 cfs, and >6,000 cfs)

Activities associated with the construction of inundated surfaces will be designed to enhance the connection of these surfaces to the river channel at various flow levels. As a reference point, the ordinary high water (OHW) mark typically correlates to a post-ROD (since about 2005) 1.5-year recurrence flow level of 6,000 cfs, as measured below Rush Creek. Downstream of Canyon Creek the post-ROD flow OHW is approximately 7,935 cfs (this is calculated as the median peak flow for the period of 2005 to 2013 on the North Fork Trinity River near Helena gage). These activities are intended to expand the surface area of the channel that would be inundated at varying flows below the OHW mark causing more frequent inundation of these surfaces, and sometimes lowering floodplains to inundate them more frequently. Vegetation will be cleared, as necessary, and earth will be excavated to meet design elevations to allow for this periodic inundation.

These newly inundated surfaces are expected to provide important rearing and slow-water habitats for juvenile anadromous salmonids and other native fish. They also provide low points that may enhance channel sinuosity and thereby provide the habitat variability that was historically present and is required to support the levels of fish production sought through the TRRP.

These treatment areas will rely primarily on natural recruitment of native riparian vegetation, with supplemental strategic planting of native riparian plant species, consistent with fish habitat restoration objectives, to re-establish better functioning floodplain riparian vegetation along the river channel at rehabilitation sites. Design objectives and criteria for individual projects will be consistent with the CDFW policy of no net loss in riparian vegetation from pre-project levels.

Activities E and F (Construction of Side Channels – low flow (300 cfs); medium flow (1,000 cfs))

Modifications to historic side channels and construction of new side channels will reconnect the Trinity River with its floodplain at targeted flows. Side channels constructed for 300 cfs activation flows would provide off-channel, low-velocity habitat for a variety of aquatic organisms, including juvenile salmonids, at a wide range of flow. Side channels constructed for 1,000 cfs activation flows will be designed to provide habitat for salmonid rearing at the activation flow and higher flows. These side channels will be designed with positive drainage such that as flows recede the potential for aquatic organism, stranding is minimized. It is important to note that side channels do not necessarily flow year-round. Side channels are expected to evolve over time and partially vegetate. While the duration of side channel flow at any particular site will depend on fluvial evolution over time, and the river's water surface elevation, riparian and wildlife habitat diversity is expected to increase even when water is not flowing through these project features.

Side channel construction techniques may leave small berms, or portions of berms, at the upstream and downstream ends to control water exchange with the main river channel and protect water quality during construction. These berms will be removed at the end of construction if the water in the side channel meets required water quality criteria for discharge to the river; alternatively, berms and water in constructed side channels may be left in place to be naturally flushed by subsequent high river flows. Side channel waters may be pumped to uplands and dewatered during construction, or slowly metered into the mainstem after construction. These techniques reduce the amount of turbid water that ultimately reaches the Trinity River during side channel connection.

Activity G (Construction of Alcoves – 300 cfs)

Alcoves will be excavated to specific design elevations and positioned at the downstream end of side channels or other appropriate locations. These will be continuously inundated, with a design objective of variable depth (generally 1–2 feet deep during low flows of 300 cfs) and will provide year-round habitat through a range of flow levels for juvenile salmonids and other aquatic biota. Alcoves are also subject to morphological change as they may scour out during high flow events, or fill in with fines, promoting additional riparian vegetation development.

Activity H (Grade Control Removal)

Grade control structures, including bedrock and man-made features, will be removed to allow for increase channel complexity via promotion of channel migration, increased sinuosity, reduced fine sediment storage, increased coarse sediment transport, and restoration of bars.

Activity I (Site-specific Sediment Management)

In addition to site-specific creation and enhancement of alluvial features, riverbed and floodplain sediment may be removed or added at various rehabilitation sites. This activity is separate from, but related to, the long-term coarse sediment augmentation element of the program. Sediment management at channel rehabilitation sites may include low-flow placement of coarse sediment (e.g., spawning gravel ranging from 0.25 in. to 6 in. [6 mm to 153 mm] graded size fractions and a portion of skeletal bar cobbles ranging from 10 in. to 12 in. [254 mm to 300 mm], as appropriate) to create gravel bars and removal of excessive fine sediment (≤ 0.02-0.03 in. [0.5-0.8 mm]). Additionally, periodic coarse sediment placements may occur at select channel rehabilitation sites to augment the long-term coarse sediment augmentation program's use of several designated gravel injection sites within the upstream-most portion of the action area (Lewiston Reach). These periodic gravel placements at channel rehabilitation sites may be necessary to balance reach-to-reach sediment transport rates. Gravel routing promotes a number of channel morphodynamics (i.e.., replenishment of spawning riffles, development of point bars, development of medial bars, replenishment of scoured areas, etc.).

Some vegetation may be removed to facilitate the placement of coarse sediment along channel margins forming longitudinal or transverse bars. As appropriate, large wood removed to accommodate gravel placement will be retained and incorporated as in-channel structure to provide additional habitat complexity at rehabilitation sites. Coarse sediment will be placed using mechanized equipment (e.g., conveyor belts, placement with a loader below the bankfull elevation) into the river channel under various high-flow conditions in a manner that facilitates the river's ability to incorporate it in the bedload transported during high-flow periods. In-channel gravel placements will occur during summer and early fall project construction using front-end loaders and excavators under seasonal low flow conditions.

Activity J (Placement of Excavated Materials)

Excavated materials will be placed in designated areas so there will be no increase in the elevation of the 100-year flood to comply with the requirements of Trinity County's Floodplain Ordinance. Spoiled materials will be spread in uniform layers to blend with the natural terrain. In general, revegetation of upland areas, including for erosion control, will be consistent with agency permit requirements and with authorization from land managers and owners. Refer to Activity O (Revegetation) for details. Placement of excavated and cleaned coarse sediment or cobbles may alternatively be used to create an infiltration gallery to allow sub-surface water flow. Placement of excavated material may occur to a limited extent within channels, legacy channels, floodplains and upland areas, such that there is no increase in the elevation of the 100-year flood.

Activity K (Staging Areas)

Staging areas are designated areas staging and storing material for construction. They are typically flattened areas within the floodplain or upland of a construction or activity site and may also be used as source areas of gravel processing.

Construction of staging areas is typically done with heavy equipment (bulldozers, excavators, etc.) to achieve a functional surface for staging, laydown and storage. Large wood and plant materials may be harvested incidental to the construction to be used in other functional design features. Staging areas are deconstructed by recontouring the surface to a natural slope, decompacting the surface soil, and planted and/or seeded and mulched.

Excavated materials will be transported across staging areas to stockpile areas. Water will be applied for construction purposes in staging areas, including dust abatement. Staging areas will be constructed using BMPs to protect downslope resources installed at staging areas and stockpiles, for example to protect existing water wells and other infrastructure. The staging areas may also be used for processing and storage of coarse sediment required for long-term sediment management activities or to obtain and store boulders for use in constructing hydraulic structures and boulder habitat placements. Tree thinning may occur in forested upslope areas adjacent to channel rehabilitation to upgrade access routes, and to create staging and equipment lay-down areas. If tree thinning is used for creating access and staging areas on lands owned by the USFS and the BLM, this activity will conform to all applicable policies, standards and guidelines of the respective federal land management agency's land and resource management plans, in order to be consistent with land and resource management plans. In such situations, thinned forest material may be used for large wood habitat installations at rehabilitation sites.

Activity L and M (Upgrade and Construction of Roads, Existing and New)

Existing roads will be used to access most of the Phase 2 rehabilitation areas. Individual road segments may be used for one or more activities (e.g., access for equipment and personnel, removal of material, revegetation efforts, and monitoring activities). Roads used for TRRP activities may be constrained by load limits or other stipulations of the landowner/manager and may require substantial improvements (e.g., widening, surfacing).

The location of some activity areas may require construction of new roads for specific project purposes. Site-specific locations will consider factors like topography, soils, existing vegetation, and the need for future vehicle access. Best management practices (BMPs) will be used to reduce the impacts of road-related sediment in the riparian and aquatic environments (see Chapter 3–

Conservation Measures). For projects on federal lands, BMPs will conform to those prescribed by the U.S. Forest Service's Water Quality Management on Forest System Lands in California (USFS 2000).

Activity N (Installation of Temporary Channel Crossings)

Temporary crossings to access across the mainstem Trinity River, existing and constructed side-channels, and tributaries, may be constructed at some project locations, where main road access is limited. Limited access to both sides of the river may require the use of temporary instream crossings. These temporary crossings may include constructed fords, temporary bridges, or other site improvements to facilitate access for construction-related traffic. Temporary bridges, if required, will be used for work performed outside of the summer season (i.e., July 15-September 15). All temporary crossings will be designed and constructed to meet the size and weight requirements for heavy equipment, such as trucks, excavators, and scrapers. Stream fords will be constructed using fill comprised of native alluvial materials excavated from the bed and bank of the Trinity River or adjacent sources. With the exception of riprap or other stabilizing materials, all fill material will be extracted from activity areas within identified TRRP sites or adjacent in basin sources. Use of fords to cross the river will be minimized.

To retain navigability and minimize impacts to aquatic resources, at least 1/3 of any stream ford crossing will be designed to be submerged to minimum depth of one foot under low-flow conditions. The construction of the temporary crossings usually requires some vegetation removal at entrances to the channel. If temporary bridges or other constructed crossings are used, abutment fill material may be extracted from activity areas. All temporary crossings will be constructed in a manner that does not impede navigability at the specific site.

Activity O (Revegetation)

Revegetation of riparian areas will occur to mitigate for necessary construction-related vegetation clearing and as part of purposeful restoration designs at various channel rehabilitation sites. This will rely on a combination of planting activities that promote natural plant recruitment. Revegetation of riparian areas will be conducted to mitigate for impacts from project activities and will be composed of a strategic planting of seeds, cuttings, plugs and container stock to promote natural recruitment and succession of native plant species.

Revegetation is expected to be necessary to address landowner requests, agency permit mitigation requirements, and fish and wildlife habitat restoration objectives. Native willows from the impact areas will be replanted as clumps and pole cuttings during construction to speed recovery of vegetation. Replanting of impacted native vegetation (e.g., willows and cottonwoods) after construction is also planned. In general, the TRRP objective is to ensure that riparian vegetation is minimally impacted by TRRP activities and is replaced at a 1:1 ratio (no net loss of riparian habitat area) within the Trinity River corridor. Revegetation is designed to provide aquatic refugia at discharges above the base flow, improve terrestrial habitat for birds and other wildlife, provide for future wood recruitment to the river channel and floodplain, and to provide future terrestrial nutrient input to the river. Additional planting, seeding and mulching is also planned to control or inhibit the reestablishment of noxious and invasive plant species. This activity includes post-planting irrigation, when necessary. Any irrigation water withdrawals from the Trinity River and its tributaries will be temporary (i.e., typically planned for 3 growing seasons) and will conform to all state and federal water withdrawal criteria for streams inhabited by anadromous salmonids (i.e., NMFS' 2001 Water Drafting Specifications).

Activity P (Construction of Structural Log Jams [Hydraulic and Habitat Structures], Skeletal Bars, and Boulder Habitat)

The TRRP uses appropriate wood and lithic materials to create and enhance hydraulic and geomorphic dynamics to achieve healthy alluvial river functions and provide immediate structural fish and wildlife habitat enhancement. Large cobble (> 6 inch [153 mm]) and boulders (> 10 inch [254 mm]), used in construction of skeletal bars[26], and rock/wood structures will be installed to generally remain in place and create localized hydraulic action, and to scour and maintain the deeper channel habitats preferred by adult salmonids for holding cover during the heat of the summer. Where appropriate, LWD will be salvaged and incorporated into wetted channel and floodplain structural features to provide additional hydraulic and habitat diversity. This may include LWD placement as individual pieces, small accumulations, and large structures (e.g., log jams). The addition of large wood contributes to topographical and hydraulic complexity and increases bank length to provide additional rearing habitat over a wide range of flows.

Activity P may also include the construction of SLJs to further interact with the river flow and act as a catalyst for natural processes of scour and channel migration. Alternatively, SLJs may be built to function together with downstream skeletal bars, forming habitat complexes that would grow by creating depositional areas.

Construction of larger habitat structures or SLJs may incorporate the use of rock and boulders as ballast to ensure that the structures do not get transported with high flows. Large logs may be anchored by excavating and burying in banks or the riverbed. Additionally, in some cases, where compatible with river navigation and public safety, pile-driving of logs and peeler cores may be used to create weir-like structures to support SLJs or accumulate woody debris (Reclamation and ERDC 2016).

Alluvial cobbles for construction material may be obtained by processing excavated material on site or by purchase from local rock and gravel suppliers. All LWD installations would be designed so that local velocities would be safe

[26] Bars created by channel rehabilitation efforts, where the lower portion of the bars is constructed of larger grains (small boulders) that are less mobile by the ROD flow regime in order to shoal high flows to the opposite bank. These bars may be covered with a layer of cobbles and gravels that are more mobile by the ROD flow regime.

for boat navigation during river flows used by fisherman and whitewater enthusiasts (typically less than about 2,000 cfs). Natural wood material will be placed in a manner that minimizes hazards for recreational river users.

Activity P also includes the placement of wood in alcoves to improve the habitat quality by providing cover for juvenile fish, enhancing roughness and complexity, and increasing shading. Trees and slash for use in constructing LWD structures will be obtained on-site (see Activity A) and/or opportunistically from other lawful sources (e.g., public or private construction areas where clearing has occurred) and delivered to the project site. The availability, types, shapes, and sizes of the wood are expected to vary on a site-by-site basis, which along with specific construction methods, will be determined by the TRRP Design Team, which includes NMFS technical staff.

Activity Q (Construction of Split Flow Channels – 30 to 60% of river flow)

Where compatible with habitat objectives, river navigation, and public safety, new channels may be included in site designs. Where this is a stand-alone activity (i.e.., UDC, Bucktail, Chapman and future Oregon Gulch) then construction will create forced meanders or new river channel alignments. These channels will be excavated to convey between 30 and 60 percent of the Trinity River flow during low flow conditions (approximately 300 cfs design flow). The constructed split flow channels will be excavated through existing floodplains, generally behind the existing riparian berms and vegetation. Construction methods for these features will be similar to those described for low flow side channels (Activity E).

Activity W (Construction of Wetland Complexes, Including Floodplain Ponds)

Channel rehabilitation designs may include construction of wetland ponds off the main channel of the Trinity River in adjacent floodplain depressions. Such ponds provide slow backwater refugia, at higher river flows, for juvenile salmonids (coho salmon prefer and exhibit greater growth in such conditions) and amphibians, and year-round habitat for other aquatic and wetland-dependent species. Groundwater infiltration and surface water in-flow from side channels will be the primary sources to supply the ponds with a cold-water environment. Existing tree/shrub canopy will be conserved during construction to provide food sources, shade, and cover structures. The ponds will be constructed with excavated elevations that allow a connection to hyporheic flow and groundwater to supply cold water. Existing vegetative cover and re-vegetation planting will be incorporated into wetland pond designs to support food productivity. Ponds will be constructed of sufficient depth to ensure that aquatic organisms stranded in them will not be dried out. The functional life span of these ponds is subject to a number of processes that are subject to change in this dynamic aquatic environment.

Table B-2. Channel Rehabilitation Activities for the Primary Phase 2 Project Locations

Identifier. Activity Type	Tom Lang Gulch (RM 103.1-103.9)	Poker Bar (RM 101.7-102.9)	China Gulch (RM 101.0-101.6)	Limekiln Gulch (RM 99.6-100.4)	McIntyre Gulch (RM 97.2-98.0)	Upper Steiner Flat (RM 91.8-92.2)	Middle Steiner Flat (RM 91.4-91.8)	Dutch Creek (RM 85.1-86.6)	Evans Bar (RM 84.4-85.1)	Soldier Creek (RM 83.6-84.2)	Chapman Ranch (RM 82.9-83.6)	Deep Gulch (RM 82.4-82.9)	Sheridan Creek (RM 81.6-82.4)	Oregon Gulch (RM 80.9-81.6)	Sky Ranch (RM 80.3-80.9)	Lower Junction City (RM 79.3-79.8)	Upper Conner Creek (RM 77.4-78.3)
A. Recontouring and vegetation removal	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
B. Inundated surfaces (450 cfs)	X	X				X		X	X	X	X	X	X	X	X	X	X
C. Inundated surfaces (1,000-4,500 cfs)	X	X				X		X	X	X	X	X	X	X	X	X	X
D. Inundated surfaces (6,000 cfs)	X	X				X		X	X	X	X	X	X	X	X	X	X
E. Low-flow side channels (300 cfs)		X				X		X		X				X	X		
F. Medium-flow side channels (1,000 cfs)		X				X				X							
G. Alcoves (450 cfs; 6,000 cfs)		X				X				X							
H. Grade control removal								X									
I. Sediment management																	
J. Placement of excavated material	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
K. Staging/use areas	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L. Roads, existing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
M. Roads, new	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
N. Temporary channel crossings	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table B-2. Channel Rehabilitation Activities for the Primary Phase 2 Project Locations

Identifier. Activity Type	Tom Lang Gulch (RM 103.1-103.9)	Poker Bar (RM 101.7-102.9)	China Gulch (RM 101.0-101.6)	Limekiln Gulch (RM 99.6-100.4)	McIntyre Gulch (RM 97.2-98.0)	Upper Steiner Flat (RM 91.8-92.2)	Middle Steiner Flat (RM 91.4-91.8)	Dutch Creek (RM 85.1-86.6)	Evans Bar (RM 84.4-85.1)	Soldier Creek (RM 83.6-84.2)	Chapman Ranch (RM 82.9-83.6)	Deep Gulch (RM 82.4-82.9)	Sheridan Creek (RM 81.6-82.4)	Oregon Gulch (RM 80.9-81.6)	Sky Ranch (RM 80.3-80.9)	Lower Junction City (RM 79.3-79.8)	Upper Conner Creek (RM 77.4-78.3)
O. Revegetation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P. Structured log jams, skeletal bars, boulders	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Q. Split flow channels (30-60% of flows)																	
W. Wetlands, floodplain ponds								X									

Source: Updated from NCRWQCB and Reclamation (2009); NCRWQCB et al. (2014)

Tom Lang Gulch Located between River Mile (RM) 103.1 and 103.9 in the Limekiln Reach, this channel rehabilitation site extends from a community boat launch on upstream river left to part way through the Poker Bar residential development on lower river right. At this project location, proposed activities include Activity A, B, C, D, E, F, G, J, K, L, M, N, and O. Tom Lang Gulch was combined into the Poker Bar Suite (4), a densely populated reach with major Federal Emergency Management Agency (FEMA) issues. Poker Bar Suite (4) is not likely to be constructed.

Poker Bar Located between RM 101.7 and 102.9 in the Limekiln Reach, this channel rehabilitation site extends from the upstream tip of an island associated with the bridges spanning the split channel at Poker Bar, through the Poker Bar area, to a mid-channel island. The mid-channel island is located downstream of the outlet of a potential side channel on the right bank. At this location, proposed activities include Activity A, B, C, D, J, K, L, M, N, and O. See above comment regarding FEMA issues. Site is not likely to be constructed.

China Gulch Located between RM 101.0 and 101.6 in the Limekiln Reach, this channel rehabilitation site includes the left bank side of a sharp left bend in the river at the downstream end of the Poker Bar residential area. The location is functioning fairly well and includes some alcoves and bars. At this location, proposed activities include Activity A, J, K, L, M, N, and O. China Gulch was combined into the Poker Bar Suite (4), a densely populated reach with major FEMA issues. Poker Bar Suite (4) is not likely to be constructed.

Limekiln Gulch Located between RM 99.6 and 100.4 in the Limekiln Reach, this channel rehabilitation site was selected because it is potentially the upstream-most point of feasible access between Steel Bridge Road and Lower Poker Bar Road. At this location, proposed activities include Activity A, J, K, L, M, N, and O.

McIntyre Gulch Located between RM 97.2 and 98.0 in the Limekiln Reach, this channel rehabilitation site is just downstream of the Steel Bridge Day Use Area along Steel Bridge Road and extends upstream and downstream of the Bigger's Road Bridge. At this location, proposed activities include Activity A, J, K, L, M, N, and O. Site is not in queue due to an uninterested landowner.

Douglas City Located between RM 93.6 and 94.6 in the Douglas City Reach, this channel rehabilitation occurs both upstream and downstream of the Douglas City Bridge. At this location, proposed activities include Activity A, B, C, E, G, K, L, M, N, O and P.

Upper Steiner Flat Located between RM 91.8 and 92.2 in the Douglas City Reach, this channel rehabilitation site includes the old Steiner Flat feathered edge restoration site and extends downstream 1,800 feet. The site is functioning fairly well but includes significant tailings on the floodplain and some small riparian berms. At this location, proposed activities include Activity A, B, C, D, E, F, G, J, K, L, M, N, and O.

Middle Steiner Flat Located between RM 91.4 and 91.8 in the Douglas City Reach, this channel rehabilitation site includes all of a confined, sharp (almost 180-degree) river bend. There are extensive bedrock outcrops throughout the site. At this location, proposed activities include Activity A, J, K, L, M, N, and O. Site is not in queue due to the extensive bedrock.

Lower Steiner Flat Located between RM 90.1 and 91.1 in the Douglas City Reach, this channel rehabilitation site includes two 90-degree river bends and is confined by narrow valley walls and adjacent steep topography. At this location, proposed activities include Activity A, E, F, G, J, K, M, N, and P.

Lorenz Gulch Located between RM 89.4 and 90.2 in the Douglas City Reach, this channel rehabilitation site includes private landowners, the Steiner Flat campground with the upper half of the site dominated by steep hill slope and bedrock on the left bank. At this location, proposed activities include Activity A, B, C, E, G, J, K, L, N, and O, P, W

Dutch Creek Located between RM 85.1 and 86.6 in the Junction City Reach, this channel rehabilitation site begins where Dutch Creek enters the Trinity River (across from Johnson Point) and extends to Evan's Bar. There are berms on the right and left banks, especially the upstream left and middle right banks. At this location, proposed activities include Activity A, B, C, D, J, K, L, M, N, and O.

Evans Bar Located between RM 84.4 and 85.1 in the Junction City Reach, this channel rehabilitation site is in the vicinity (upstream and downstream) of the current CDFW fish-counting weir near Junction City and includes the old Bell Gulch Rehabilitation site. There are berms on both banks and a high, flattened tailings terrace on the left bank. The reach is relatively linear and simple. At this location, proposed activities include Activity A, B, C, D, J, K, L, M, N, and O.

Soldier Creek Located between RM 83.6 and 84.2 in the Junction City Reach, this channel rehabilitation site is just upstream of Chapman Ranch. There is a berm on the left bank, and a steep slope confines the right bank. At this location, proposed activities include Activity A, B, C, D, E, F, G, J, K, L, M, N, and O.

Chapman Ranch Located between RM 82.9 and 83.6 in the Junction City Reach, this channel rehabilitation site is a relatively straight and simple reach, roughly 4,000 feet long, and shows signs of meander development. The channel is naturally confined within terraces, with significant tailings along the banks and on the terrace. At this location, proposed activities include Activity A, B, C, D, J, K, L, M, N, and O.

Deep Gulch Located between RM 82.4 and 82.9 in the Junction City Reach, this channel rehabilitation site is just downstream of the UCR site. A steep hillslope adjacent to the left bank confines this site while the right bank is bordered by various alluvial features. At this location, proposed activities include Activity A, B, C, D, J, K, L, M, N, and O.

Sheridan Creek Located between RM 81.6 and 82.4 in the Junction City Reach, this channel rehabilitation site is located upstream of Sheridan Creek and includes the old Deep Gulch feathered-edge project on the left bank and the old Sheridan Creek feathered edge work area on the downstream right bank. This reach is relatively straight and has a plane bed channel. At this location, proposed activities include Activity A, B, C, D, J, K, L, M, N, and O.

Oregon Gulch Located between RM 80.9 and 81.6 in the Junction City Reach, this channel rehabilitation site is located upstream and downstream from a sharp left bend in the river near the location where Oregon Gulch enters the Trinity River on the right bank. The project location is evolving, with multiple channels present at the bend and massive, high tailing piles at the upper right bank. At this location, proposed activities include Activity A, B, C, D, E, J, K, L, M, N, and O.

Sky Ranch Located between RM 80.3 and 80.9 in the Junction City Reach, this channel rehabilitation site is located near the junction of SR 299 and Sky Ranch Road. The location is mostly bounded by a naturally high terrace/valley wall on the left bank. The right bank includes riparian berms and is bounded by a massive terrace of flattened tailings. A large pile of LWD has been deposited near the channel on the upstream right bank, and there are several low-flow side channels. At this location, proposed activities include Activity A, B, C, D, E, J, K, L, M, N, and O.

Upper Junction City Located between RM 79.8 and RM 80.4 in the Junction City Reach this channel rehabilitation site is located immediately upstream from the Dutch Creek Bridge. The location largely consists of a narrow channel entrenched between terraces and barren tailings with little bedform development. Highway 299 borders the upstream eastern edge of the project. At this location, proposed activities include Activity A, B, C, D, E, F, G, J, K, L, M O, P, Q, W.

Lower Junction City Located between RM 79.3 and RM 79.8 in the Junction City Reach this channel rehabilitation site is located between the Dutch Creek Bridge and the confluence with Canyon Creek. The location largely consists of a narrow channel entrenched between terraces and barren tailings with little bedform development. At this location, proposed activities include Activity A, B, C, J, K, M O, P, Q, W.

Upper Conner Creek Located between RM 77.4 and 78.3 in the North Fork Reach, this channel rehabilitation site is immediately upstream of the original Conner Creek project constructed in 2006. At this location, proposed activities include Activity A, B, C, D, J, K, L, M, N, and O.

Wheel Gulch Located between RM 76.0 and 76.4, this channel rehabilitation site is confined by dredge tailings on the left and a valley wall to the right. At this location, proposed activities include Activity A, B, C, E, G, J, K, M, O, P, Q.

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Appendix C Streambank Stabilization Techniques

Table C-1 includes a list of proposed streambank stabilization designs, location of method (above or below the OHWM, with design references for each technique (ESA 2019).

Table C-1. Summary of Erosion Reduction and Streambank Stabilization Techniques.

Action	Description	Suggested professional resource	Reference	Location (relative to Ordinary High Water Mark)
Infrastructure removal/ relocation	Relocation of infrastructure away from eroding banks.	N/A	4, 6, 7	A
Exclusionary fencing	Livestock or human foot traffic exclusion fencing to prevent trampling to vegetation and minimize soil compaction.	N/A	1, 2, 4, 6	A
Flow spreading	Converting concentrated flow to sheet flow by filling rills and small gullies.	N/A	3, 4, 6	A
Rill and gully prevention and treatment	Filling of rills and gullies to spread flow of water and facilitate infiltration. This may include ripping of soil, on contour, to break flow patterns and reduce soil compaction.	N/A	2, 3, 4, 5, 6, 7	A
Floodplain roughness elements	Native plantings or live stakes on floodplain placed in a linear pattern; this practice slows flow of water across the floodplain and facilitates fine sediment deposition.	Botanist	3, 4, 5 6, 7	A
Revegetation and native vegetation management	Planting of native species on flood plain and banks to facilitate slowing of water, promote infiltration, and stabilize soils.	Botanist	1, 2, 3, 4, 5, 6, 7	A/B

Table C-1. Summary of Erosion Reduction and Streambank Stabilization Techniques.

Action	Description	Suggested professional resource	Reference	Location (relative to Ordinary High Water Mark)
	Vegetation management includes mowing and clearing of invasive non-native species which may compete with native species. For example, non-native annual grasses do not develop roots in the quantity and depth that native perennial grass species do.			
Erosion control blanket (ECB)	Placement of 100 percent biodegradable blanket or fabric on slopes to stabilize soils. This practice ideally also includes revegetation by seeding, planting of container stock, or live staking.	Professional Engineer or Hydrologist to estimate water surface elevations	3, 4, 5, 6, 7	A/B
Wattles	Placement of 100 percent biodegradable certified weed seed free wattles. Wattles may be composed of coir, excelsior, or straw with biodegradable fabric casing. Plastic netting or biodegradable plastic nettings are not recommended as these can trap, injure, and kill wildlife such as birds, snakes, and reptiles. Wattles promote soil stabilization and prevent rilling of slopes.	Professional Engineer or Hydrologist to estimate water surface elevations	3, 4, 5, 6, 7	A/B
Live pole planting	Planting live poles of riparian species (e.g., willows), typically during dormancy period, to facilitate revegetation of slopes.	Professional Engineer or Hydrologist to estimate water surface elevations	1, 3, 6, 7	A/B
Live pole fascines	Live pole fascines are long bundles of live poles which are placed in a shallow trench on contour. Live pole fascines	Professional Engineer or Hydrologist to estimate water	3, 7	A/B

Table C-1. Summary of Erosion Reduction and Streambank Stabilization Techniques.

Action	Description	Suggested professional resource	Reference	Location (relative to Ordinary High Water Mark)
	initially act like wattles and will eventually produce roots and shoots like live poles.	surface elevations		
Brush Mattress/ Brush Layering	Brush mats are constructed biotechnical features which involves excavation of perimeter trenches, placement of live poles in the trench at the toe of slope, anchoring the toe trench with gravels and cobbles, and anchoring the live poles with a biodegradable rope and stakes. Perimeter trenches are filled with gravels and cobbles. Gravels are placed over the live poles to provide cover and to provide a medium for rooting. Brush mats are capable of resisting higher velocities and shear stresses than live poles.	Professional Engineer or Hydrologist to estimate water surface elevations	2, 3, 5, 6, 7	A/B
Vegetated Soil Lifts (AKA VSLs), Fabric Encapsulated Soil, Structurally Engineered Wall, Vegetated Mechanically Stabilized Earth without Hard Toe, etc.)	This practice is utilized to reconstruct stream banks which are eroding or slumping. Reconstruction of banks using VSLs allows a steeper bank slope than a re-graded slope; this practice is commonly utilized in settings near infrastructure or in locations with a limited footprint. -Bank reconstruction with VSLs involves constructing steps (minimum five feet horizontal and one-foot vertical) by first laying down a double layer of 100 percent biodegradable fabrics, placing a form board at	Professional Engineer or Hydrologist to estimate water surface elevations Geotechnical engineer to provide guidance on slope stability	3, 5, 7	A/B

Table C-1. Summary of Erosion Reduction and Streambank Stabilization Techniques.

Action	Description	Suggested professional resource	Reference	Location (relative to Ordinary High Water Mark)
	the edge of the step, placing and lightly compacting soil, seeding the soil, laying the fabric course over the step, and keying the fabric into the bank. Live stakes or container stock of riparian species are placed between each successive step (or "lifts). The double fabric layers consist of an inner non-woven layer and an outer woven layer; this double layer system contains fine soils as well as provides resistance to erosion. -Placement of VSLs on the toe of the bank often requires construction of a rock toe revetment to protect against to scour and to provide a stable surface to construction upon.			
Bank grading with revegetation	Bank grading can be used to reduce bank slopes in areas where banks have become over steepened as a result of channel incision. Consultation with a geotechnical engineer can inform stable bank angles. Incorporation of revegetation into the newly graded bank can provide additional bank stability through soil reinforcement by roots.	-Professional Engineer or Hydrologist to estimate water surface elevations Geotechnical engineer to provide guidance on slope stability	1, 3, 4, 5, 6, 7	A/B
Bank grading with integrated toe treatments	Bank grading, as described above with rock toe treatment.	-Professional Engineer or Hydrologist to estimate water	3, 4, 6, 7	A/B

Table C-1. Summary of Erosion Reduction and Streambank Stabilization Techniques.

Action	Description	Suggested professional resource	Reference	Location (relative to Ordinary High Water Mark)
		surface elevations - Analysis of local hydraulic forces by a water resources engineer will inform toe scour potential, estimate scour depths, and develop rock revetment design. -Geotechnical engineer to provide guidance on slope stability		
Vegetated Rock Toe	In locations with evidence of or high potential for toe scour, a vegetated rock toe may be constructed to stabilize the bank toe. Vegetated rock toes may be constructed as a foundation for vegetated soil lifts or brush mattresses. Incorporation of vegetation (live poles or container stock) provides multiple benefits: mechanical stabilization of rock, reduction of stream velocities and shear stresses, velocity refuge for fish, and provides a source of food (e.g., insects and larva, leaf litter, etc.).	-Professional Engineer or Hydrologist to estimate water surface elevations - Analysis of local hydraulic forces by a water resources engineer will inform toe scour potential, estimate scour depths, and	3, 4, 5, 6, 7	A/B

Table C-1. Summary of Erosion Reduction and Streambank Stabilization Techniques.

Action	Description	Suggested professional resource	Reference	Location (relative to Ordinary High Water Mark)
		develop rock revetment design. Geotechnical engineer to provide guidance on slope stability.		
Large Wood Structures (LWS)	Large wood structures constructed in the toe of banks can re-direct flows and potentially provide a foundation for other bank stabilization practices. Large wood structures may induce localized scour which can be accounted for in the design and installation of the structure. Benefits for fish from LWS include creation of velocity and temperature refuge (scour pools) creation of habitat for benthic macroinvertebrates, providing cover from predators.	Professional Engineer or Hydrologist to estimate water surface elevations Water resources engineer to estimate countermeasures to resist lift and drag forces.	2, 3, 4, 6, 7	B
Large Wood Crib Wall with live staking or container stock	Large wood crib walls (LWCW) are constructed in locations where bank stabilization/ reconstruction is restricted by space availability. This practice may utilize a vegetated rock toe as a foundation and to protect against toe scour. Interstitial spaces of LWCW may provide cover and velocity refuge for fish.	-Professional Engineer or Hydrologist to estimate water surface elevations - Analysis of local hydraulic forces by a water resources engineer will inform toe	2, 3, 5, 7	A/B

Table C-1. Summary of Erosion Reduction and Streambank Stabilization Techniques.

Action	Description	Suggested professional resource	Reference	Location (relative to Ordinary High Water Mark)
		scour potential, estimate scour depths, and develop rock revetment design. -Geotechnical engineer to provide guidance on slope stability		
Stream alluvium augmentation	Stream alluvium augmentation (i.e., placement of river run gravels and cobbles) may be utilized for short-term protection against toe erosion. Care should be taken to properly determine the correct size of gravels and cobbles, and to preserve existing native vegetation during the placement of alluvium.	-Professional Engineer or Hydrologist to estimate water surface elevations and estimate sediment transport potential	5	B
Willow siltation baffles	This practice involves placing live poles in a shallow trench (i.e. 18 inches to two feet deep), anchoring with ballast cobbles, and backfilling with native soil. Willow baffles create zones of flow diversity on the edges flood benches. Willow baffles provide velocity refuge, encourage sediment deposition, and facilitate natural recruitment of vegetation through capture of seeds and propagules.	-Professional Engineer or Hydrologist to estimate water surface elevations and extent	5, 7	A/B

A-OHWM: Above Ordinary High-Water Mark; A/B-OHWM: Above and below Ordinary High-Water Mark, B-Below OHWM.

Note: Several of the practices listed above require sophisticated hydraulic and geotechnical analyses and should not be installed without consultation with a professional engineer. Consequences associated with failure of these structures should be considered during the design process and may limit applicability of practices.

Design reference guidelines for Table C-1 include:

1. California Department of Fish and Wildlife. 2003. California Salmonid Stream Habitat Restoration Manual, Part XI: Riparian Habitat Restoration

2. California Department of Fish and Wildlife. 2010. California Salmonid Stream Habitat Restoration Manual, Fourth Edition

3. USDA Natural Resources Conservation Service. 2007. National Engineering Handbook Part 654 Stream Restoration Design.

4. Technical Supplement 14I: Streambank Soil Bioengineering

5. United States Army Corps of Engineers. 2014. Revised Standard Local Operating Procedures for Endangered Species to Administer Maintenance or Improvement of Stormwater, Transportation, and Utility Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES for Stormwater, Transportation or Utilities). NMFS Consultation No. NWR-2013-10411.

6. National Academies of Sciences, Engineering, and Medicine 2005. NCHRP Report 544. Environmentally Sensitive Channel- and Bank-Protection Measures. Washington, DC: The National Academies Press. https://doi.org/10.17226/13556.

7. Washington Department of Fish and Wildlife. Washington State Aquatic Habitat Guidelines Program. 2003. Integrated Streambank Protection Guidelines.

8. Lagasse, P.F., Clopper, P.E., Thornton, C.I., Shields Jr, F.D., McCullah, J, and Spitz, W.J. 2016. NCHRP Report 822: Evaluation and Assessment of Environmentally Sensitive Stream Bank Protection Measures. Transportation Research Board of the National Academies, Washington, D.C

Appendix D Summary of Fish Research and Monitoring Allowable Take Limits and Actual Take Reported for 2016/2017

Take Descriptions and/or Levels

"Take" is defined in Section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect (a listed species] or to attempt to engage in any such conduct. For electrofishing activities, this means that if any fish is shocked, it is considered to have been taken and count it as such-even if it is allowed to swim away without any further interference. Annual take levels (listed below) are subject to an annual reporting process.

Table D-1: Study 1 - Authorized annual take levels by species, life stage, and origin. Research is authorized for the research period of January through December (emphasis February to August), annually, and in the research location: Trinity River, Willow Creek Trapping Site.

Listed Species	Life Stage	Origin	Take Activity	Procedure	Capture Method	# of Fish Authorized for Take	Authorized Unintentional Mortality	Actual Take (2016/ 2017)	Authorized Unintentional Mortality	Actual Mortality (2016/ 2017)
SONCC coho salmon	Juvenile	Natural	Capture/ Handle/ Release Fish	Anesthetize	Trap, Screw	500	5	88/15	5	0/0
SONCC coho salmon	Smolt	Natural	Capture/ Handle /Release Fish	Anesthetize	Trap, Screw	2000	20	32/32	20	2/2
SONCC coho salmon	Smolt	Listed Hatchery Intact Adipose	Capture/ Handle /Release Fish	Anesthetize	Trap, Screw	4000	40	181/114	40	4/5
SONCC coho salmon	Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/ Release Live Animal	Anesthetize Tag, PIT	Trap, Screw	1000	10	0/0	10	0/0
SONCC coho salmon	Juvenile	Listed Hatchery Intact Adipose	Capture/Mark, Tag, Sample Tissue/ Release Live Animal	Anesthetize Tag, PIT	Trap, Screw	1000	10	0/0	10	0/0
Totals						8500	85	301/161	85	6/7

Table D-2: Study 1 - Authorized annual take levels by species, life stage, and origin. Research is authorized for the research period of January through December (emphasis February to August), annually, and in the research location: Trinity River, Pear Tree Trapping Site.

Listed Species	Life Stage	Origin	Take Activity	Procedure	Capture Method	# of Fish Authorized for Take	Authorized Unintentional Mortality	Actual Take (2016/ 2017)	Authorized Unintentional Mortality	Actual Mortality (2016/ 2017)
SONCC coho salmon	Juvenile	Natural	Capture/ Handle/ Release Fish	Anesthetize	Trap, Screw	l000	10	159/92	10	1/0
SONCC coho salmon	Smolt	Listed Hatchery Intact Adipose	Capture/ Handle/ Release Fish	Anesthetize	Trap, Screw	1500	15	94/132	15	0/0
SONCC coho salmon	Smolt	Natural	Capture/ Handle/ Release Fish	Anesthetize	Trap, Screw	1500	15	39/65	15	0/1
Totals						4000	40	292/289	40	1/1

Table D-3: Study 2 - Authorized annual take levels by species, life stage, and origin. Research is authorized for the research period of January through December (emphasis February to July), annually, and in the research location: Restoration sites within the Trinity River Restoration Project area, between Lewiston Dam and the North Fork Trinity River. NOT IMPLEMENTED YET.

Listed Species	Life Stage	Origin	Take Activity	Capture Method	# of Fish Authorized for Take	Authorized Unintentional Mortality
SONCC coho salmon	Juvenile	Natural	Observe/ Harass	Snorkel/Dive surveys	3000	0
SONCC coho salmon	Smolt	Natural·	Observe/ Harass	Snorkel/Dive surveys	300	0
SONCC coho salmon	Smolt	Listed Hatchery Intact Adipose	Observe/ Harass	Snorkel/Dive surveys	300	0

Table D-4: Study 3 - Authorized annual take levels by species, life stage, and origin. Research is authorized for the research period of September through February, annually, and in the research location: Mainstem Trinity River and selected tributaries from Lewiston Dam to Klamath River confluence.

Listed Species	Life Stage	Origin	Take Activity	Capture Method	Procedure	# of Fish Authorized for Take	Authorized Unintentional Mortality	Actual Take (2016/2017)	Authorized Unintentional Mortality	Actual Mortality (2016/2017)
SONCC coho salmon	Spawned Adult/ Carcass	Natural	Observe/ Sample Tissue Dead Animal	Tissue Sample Fin or Opercle	Gaff	1500	0	7/6	0	0/0
SONCC coho salmon	Adult	Natural	Observe/Harass		Fish or a stream survey (where fish information is collected)	2000	0	0/0	0	0/0
Totals						3500		7/6	0	0

Table D-5: Study 4 - Authorized annual take levels by species, life stage, and origin. Research is authorized for the research period of February through April for electrofishing and January through December for other capture methods, annually, and in the research location: Trinity River from Lewiston Dam to Weitchpec. NOT IMPLEMENTED IN 2017.

Listed Species	Life Stage	Origin	Take Activity	Capture Method	# of Fish Authorized Take	Authorized Unintentional Mortality	Actual Take (2016)	Authorized Unintentional Mortality	Actual Mortality (2016)
SONCC coho salmon	Juvenile	Natural	Capture/Handle /Release Fish	Electrofishing, Boat	500	13	7	13	0
SONCC coho salmon	Adult	Natural	Capture/Handle/ Release Fish	Hook and line/angler/rod and reel	10	0	0	0	0
SONCC coho salmon	Adult	Natural	Observe/Harass	Snorkel/Dive surveys	10	0	0	0	0

Table D-6: Study 5 - Authorized annual take levels by species, life stage, and origin. Research is authorized for the research period of April through December, annually, and in the research location: Trinity River and tributaries from Lewiston Dam to Weitchpec. NOT IMPLEMENTED AT THIS LOCATION YET.

Listed Species	Life Stage	Origin	Take Activity .	Procedure	Capture Method	# of Fish Authorized for Take	Authorized Unintentional Mortality
SONCC coho salmon	Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Anesthetize; Tag, PIT	Net, Fyke	2500	25
SONCC coho salmon	Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Anesthetize; Tag, PIT	Trap, Minnow	500	5
SONCC coho salmon	Juvenile	Natural	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Anesthetize; Tag, PIT	Seine: Beach	500	5

Table D-7: Study 6 - Authorized annual take levels by species, life stage, and origin. Research is authorized for the research period of April through October, annually, and in the research location: Trinity River and tributaries between Lewiston dam and North Fork Trinity River. NOT IMPLEMENTED AT THIS LOCATION YET.

Listed Species	Life Stage	Origin	Take Activity	Capture Method	# of Fish Authorized for Take	Authorized Unintentional Mortality
SONCC coho salmon	Juvenile	Natural	Capture/Handle/ Release Fish	Seine, Beach	100	3
SONCC coho salmon	Juvenile	Natural	Capture/Handle/ Release Fish	Trap, Minnow	100	2
SONCC coho salmon	Juvenile	Natural	Observe/Harass	Snorkel/ Dive surveys	5000	0
SONCC coho salmon	Juvenile	Natural	Capture/Handle/ Release Fish	Net, Fyke	100	2