ANNUAL REPORT 2015

TRINITY RIVER RESTORATION PROGRAM

Thank you

to the Trinity River Restoration Program partners for your contributions to this report.

Yurok Tribe

Cover photo: Side channel constructed at Upper Douglas City channel rehabilitation project.

Contents

Introduction

The Trinity River Restoration Program (TRRP or Program) is a partnership of federal, state, tribal, and Trinity County entities that share responsibility for restoring the Trinity River between Lewiston Dam and the confluence of the North Fork Trinity River. The TRRP is administered by two U.S. Department of the Interior (DOI) agencies, the Bureau of Reclamation (Reclamation) and the U.S. Fish and Wildlife Service (USFWS). Other partner agencies share in the decision-making process through their contributions to the Trinity Management Council (TMC). These partner agencies are the Hoopa Valley Tribe (HVT), the Yurok Tribe (YT), Trinity County, the California Resources Agency (which includes the State of California's Department of Water Resources (CDWR) and Department of Fish and Wildlife (CDFW)), the U.S. Forest Service (USFS), and the National Marine Fisheries Service (NMFS).

This 2015 annual report celebrates two significant anniversaries for the TRRP:

- the 15th anniversary of the signing of the decision that mandated increased flows in the Trinity River and channel rehabilitation projects downstream of Lewiston Dam, and
- the 10th anniversary of the first channel rehabilitation project (Hocker Flat).

We are using the occasion of these two anniversaries to celebrate work that has been done to achieve the vision of a healthier Trinity River and a restored and more productive fishery. This 2015 annual report is dedicated to our agency and tribal partners, members of our working groups, and our many other stakeholders and supporters.

TRRP's Mission

The mission of the TRRP is to restore the fisheries and wildlife of the Trinity River between Lewiston Dam and the confluence of the North Fork Trinity River. The defined goal set out in the legislation and federal decision documents that were instrumental in creating the TRRP is to restore the Trinity River's fishery resources in a managed river that has the characteristics of a healthy alluvial river.

TRRP Background

As early as 1955, Congress passed legislation authorizing the Trinity River Division (TRD) as an integral component of the Central Valley Project. The legislation directed the Secretary of the Interior to ensure the preservation and propagation of fish and wildlife in the Trinity Basin through adoption of appropriate measures.

Completion in 1964 of Trinity and Lewiston dams restricted anadromous fish to habitat below Lewiston Dam. (See *Important Terms* on next page for the definition of "anadromous" and other technical terms.) The dams also inundated more than 20,000 acres of the former Trinity River Valley and eliminated the sediment supply below the dams from more than 700 square miles of the upper watershed.

Water diversions from Lewiston Reservoir to Whiskeytown reservoir via the Clear Creek tunnels and, ultimately, to the Sacramento River diminished the annual flows in the Trinity River by up to 90 percent of the flows before construction of the two dams. The diminished flows resulted in encroachment of riparian (streamside) vegetation onto the former floodplain, establishment of riparian berms, and fossilization of point bars as far downstream as the North Fork Trinity River. The ages and species of riparian vegetation became less diverse and the floodplain was less frequently inundated, leading to reductions in both the quantity and quality of fish habitat.

In 1981, in response to the declines in the Trinity River's salmon and steelhead populations, the Secretary of the Interior directed the USFWS to

Important Terms

Anadromous Fish. Fish, such as salmon and steelhead, that spawn in fresh water, migrate to the ocean to grow, and then return to fresh water to spawn.

Fossilization. The process of stabilization and "hardening" of gravel bars by rooted riparian vegetation, which also contributes to increased deposition of alluvial silts on the bars, promoting establishment of yet more vegetation and so on.

Geomorphology. The science of landforms, with an emphasis on their origin, evolution, form, and distribution across the physical landscape.

Hydraulic. Hydraulic action is the movement or wearing down of material by flowing water. In geographic processes, hydraulic action is also known as erosion.

Hydrograph. A chart that displays the change of a hydrologic variable over time. A discharge hydrograph, for example, shows the rate of flow (discharge) versus time past a specific point in a river.

Hyporheic zone. A region beneath and alongside a streambed where there is mixing of shallow groundwater and surface water.

LiDAR—Light Detection and Ranging. An optical remote-sensing technique that uses laser light to densely sample the surface of the earth, producing highly accurate x,y,z measurements

Morphodynamic. The study of landscape changes due to erosion and sedimentation.

Point bars. Point bars are features of alluvial river channels formed by the deposition of sediment on the convex bank of a curve in the channel as erosion of the opposite concave bank occurs.

Point cloud. A set of three-dimensional point locations that provide a digital representation of an object or surface. Point clouds for natural resource sciences are typically derived from laser scanning methods, including aerial LiDAR and ground-based scanners, sonar methods for bathymetry (underwater topography), and recent methods for processing photographs with computer vision techniques. Point clouds often include thousands to millions of points.

Programmatic environmental document. A programmatic environmental impact statement (PEIS) evaluates the effects of broad proposals or planning-level decisions that may include any or all of the following: a wide range of individual projects; implementation over a long timeframe; and implementation across a large geographic area.

Record of Decision (ROD). A legally binding document that identifies a federal agency's decision on how it will proceed with the proposed action identified in an environmental document prepared to comply with the National Environmental Policy Act.

Restoration flow. All ROD-mandated flows, including summer and winter base flows and peak flows in the spring.

Riparian. (1) Located on the bank of a river or other water body; (2) The Riparian Zone is the area of direct two-way interactions between aquatic and terrestrial systems.

begin a 12-year flow study to determine the effectiveness of flow restoration and other measures to mitigate for the impacts of the two dams. In 1984, Congress enacted the Trinity River Fish and Wildlife Program to further promote and support wildlife management and fishery restoration actions in the Trinity River basin. Under this program, nine pilot bank rehabilitation projects between Lewiston Dam and the North Fork Trinity River were implemented between 1991 and 1993.

In 1992, Congress enacted the Central Valley Project Improvement Act. One purpose of the act was to protect, restore, and enhance fish, wildlife, and associated habitats in the Trinity River basin. The act also directed the Secretary of the Interior to complete the 12-year Trinity River Flow Evaluation Study (Flow Study) and to develop recommendations "regarding permanent instream fishery flow requirements, TRD (Trinity River Division) operating criteria, and procedures for the restoration and maintenance of the Trinity River fishery." The Trinity River Flow Evaluation Final Report (Flow Evaluation Report) was ultimately published in 1999, providing a framework for restoration activities below Lewiston Dam (USFWS and HVT 1999).

In 1994, the USFWS and Trinity County began the public process for developing the Trinity River Mainstem Fishery Restoration Environmental Impact Statement/Environmental Impact Report (TREIS/EIR). This process was completed with the signing of the Record of Decision (ROD) for the Final EIS/EIR in December 2000. The ROD directed DOI agencies to implement the Flow Evaluation Alternative and elements of the Mechanical Restoration Alternative (U.S. DOI 2000) analyzed in the TREIS/EIR.

The ROD set forth Trinity River flows for five water-year types: extremely wet (815,200 acre-feet annually (afa)), wet (701,000 afa), normal (646,900 afa), dry (452,600 afa), and critically dry (368,600 afa).

In 2002, Reclamation's TRRP office opened in Weaverville. The office was established to guide TRRP implementation of the ROD based on the Flow Study and the TREIS/EIR. TRRP's focus encompasses seven activities outlined in the ROD: flow management, mechanical channel rehabilitation, sediment management, watershed restoration, infrastructure improvement, adaptive environmental assessment and monitoring, and environmental compliance and mitigation. The

Laws and Guiding Documents

1955. Congress authorized Trinity River Division of the Central Valley Project.

1963. Trinity and Lewiston Dams are completed.

1981. Interior Secretary increased flows to ~300 cfs (8.5 m^3/s) and initiated Flow Study.

1984. Congress enacted Trinity River Basin Fish and Wildlife Management Act to implement salmon restoration.

1992. Congress enacted Central Valley Project Improvement Act with 340,000 acre-feet (0.42 km^3) of water available to the Trinity River

1999. Flow Study is completed and is used as preferred alternative in TREIS/EIR.

2000. ROD signed, establishing modern TRRP with minimum water volume allocations determined annually by the water year type.

active rehabilitation work of the Program began in 2004 with the first restoration flows, and 2005 saw the first in-channel rehabilitation project.

TRRP Restoration Strategy

In accordance with the ROD, TRRP's restoration strategy consists of the following elements:

- *Flow management*—a variable flow regime based on five water year types to mimic natural flows.
- *Mechanical channel rehabilitation*—treatment of 44 channel rehabilitation sites and three side channel sites along the Trinity River to reshape the channel form to promote physical processes that will create and maintain riparian and fish habitat.
- *Sediment management*—augmentation of gravels below Lewiston Dam and reduction in fine sediments, which degrade fish habitats.
- *Watershed restoration*—a program to reduce fine sediment input to the Trinity River and to improve fish habitat connectivity within the tributaries and between the tributaries and the mainstem river.

Robin inspects an upland meadow at Lowden Ranch rehabilitation site.

Robin Schrock
Former Executive Director

Robin Schrock retired last December after serving as the TRRP's executive director for nearly 5 years. She is now living on the Olympic Peninsula in Washington.

Robin directed the TRRP's science and restoration branches staff in the TRRP's Weaverville office. Under the oversight of the TMC, she developed the budget that funds program activities by all program partners. She also ensured accountability to the TMC, TAMWG, the public, the Bureau of Reclamation's Central Valley Project, and Congress. Robin said that what she enjoyed most at the TRRP was working with a dedicated staff with diverse areas of expertise.

Before working for the TRRP, Robin was an Associate Program Coordinator for the USGS Fisheries and Aquatic Resources Program. Prior to that, she was a USFWS Fishery Resource Scientist specializing in juvenile salmonid physiology for 4 years on the Olympic Peninsula and 12 years on the Columbia River.

Robin has a B.A. in both Biology and German from Portland State University in Portland, Oregon, and an M.S. in Fisheries from the University of Wisconsin at Stevens Point.

- *Infrastructure improvements*—modification of structures in the floodplain to allow peak flows.
- *Adaptive environmental assessment and monitoring*—a rigorous program to monitor and improve restoration activities.
- *Environmental compliance and mitigation*—measures to minimize or eliminate short-term impacts.

This strategy does not strive to recreate pre-dam conditions. Rather, the goal is to create a dynamic alluvial channel that exhibits all the characteristics of the pre-dam river but at a smaller scale.

2015 Highlights

TRRP broke ground on its first project in 2005. Restoration activities in the past 10 years have focused on the first five management elements outlined in the ROD, supported by compliance and infrastructure work in the context of environmental mitigation and adaptive management. The five elements place a priority on physical restoration of the river to create the attributes of an alluvial river system that are known to enhance habitat for anadromous fish species. The ROD describes expected physical and biological outcomes from flow, channel rehabilitation, gravel, and watershed restoration activities. Monitoring and evaluation activities show progress toward these desired states.

Through 2015, the Program has completed 33 of the 47 projects described in the Flow Evaluation Report. The year 2015 provided the opportunity to build two projects: the Upper Douglas City channel rehabilitation project, a unique project that had site-specific objectives as well as features that enhanced the work done previously at the Indian Creek Project, and the Limekiln Gulch channel rehabilitation project.

TRRP partners continued development of a fish production model known as the Stream Salmonid Simulator (S3). The S3 model is being developed by the USFWS in collaboration with the U.S. Geological Survey (USGS) Columbia River Research Laboratory, Dr. Thomas Hardy from Watershed Systems Group, Inc., and Texas State University. The S3 model will enable evaluation of the effects of TRRP management actions and restoration scenarios on juvenile Chinook salmon production.

Clair contributed to the TRRP for more than 20 years.

Clair Stalnaker, Ph.D.
Former Science Advisory Board Member

Clair Stalnaker, Ph.D., was deeply involved in the work to rehabilitate the Trinity River and restore the fish populations for more than two decades. As a member of the intergovernmental Cooperative Instream Flow Service Group, he was one of the authors of the landmark Flow Evaluation Study (USFWS and HVT 1999) that provided the framework for TRRP activities and was a key negotiator for promoting and testing the rehabilitation strategy among the USFWS, HVT, CDFW, and DOI. He served on TRRP's Scientific Advisory Board beginning in 2002, stepping down at the end of his third term in April 2016.

Now retired, Clair held numerous high-level positions at the USGS and the USFWS. Most recently, he was a Senior Scientist for the USGS in its Fort Collins, Colorado, office and an adjunct professor in the Department of Environmental Engineering at Utah State University and in the Department of Fisheries and Wildlife at Colorado State University. He has authored or co-authored nearly 75 scientific papers. His areas of expertise include aquatic ecology, riverine species, and instream flow policy.

Clair has a B.S. in Forestry and Wildlife Management from West Virginia University and a Ph.D. in Animal Ecology and Fisheries from North Carolina State University.

Although Clair is no longer a member of the Scientific Advisory Board, he maintains a keen interest in the success of the TRRP. He is particularly supportive of the Program's emphasis on hypothesis testing and prediction followed by targeted monitoring to validate (or refute) predictions as part of the TRRP's adaptive management mandate.

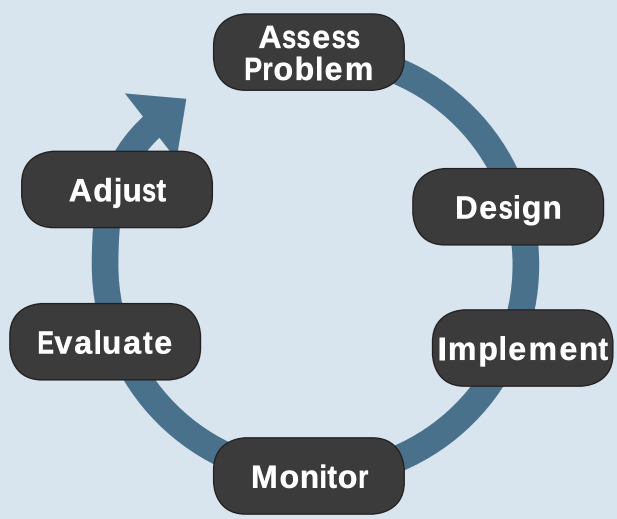
The S3 model is composed of coordinated sub-models that reflect an array of physical and biological processes that affect the growth, movement, and survival of juvenile salmonids. The S3 model is constructed to (1) link habitat and flow to population dynamics; (2) operate on spatial scales that capture habitat quality gradients in the basin; and (3) run on temporal scales that capture variability in river discharge that can result from flow management actions. A benefit of the S3 model is its ability to update sub-models as new data and analyses become available. Sub-models currently being developed include a module to incorporate salmon-rearing conditions in the lower Klamath River and the Pacific Ocean and an upstream adult migration module that will enable the S3 model to function as a full life-cycle model. Future development of the S3 model will include predictions of fish dynamics for coho salmon and steelhead, as requested by NMFS and the Bureau of Reclamation, and modules for foothill yellow-legged frogs and cottonwood recruitment.

In addition to implementing restoration flows and mechanical rehabilitation projects, the TRRP continued sediment management, monitoring, and assessments and environmental compliance activities in 2015. Sections of this annual report are dedicated to each of these topics.

This report provides concise summaries of major program activities with our partners, as well as citations, references, and contacts for readers who desire more information.

Adaptive Management

The Trinity River Restoration Program was established by the ROD as an adaptive management program. The Adaptive Environmental Assessment and Management (AEAM) component of the Program assesses changes in the river, providing interdisciplinary information that allows development of hypotheses about how the river has changed under past natural and man-made conditions. Teams of scientists, managers, stakeholders, and policy makers use this information to develop future management actions based on quantifiable knowledge gained from the assessments. The adaptive management process is repeated in a systematic way as management actions gradually result in the rehabilitation of the Trinity River and restoration of its fishery resources.



Funding and Expenditures

Funding for the TRRP has varied between $10 million and $16.66 million per year. In 2015, the Program received a total of $15.151 million, as shown in the Table 1.

Most of the funding supported physical modifications to the river and the associated watershed and monitoring of physical and biological responses. Other partner agencies contributed in-kind services to support Program activities.

The Program budget allocations for administration, implementation, and science were about $2.6 million, $7.8 million, and $4.7 million, respectively.

Table 1. Fiscal Year 2015 Funding (in millions of dollars)

BUREAU OF RECLAMATION	
Water and Water-Related Fund	$11.911
Central Valley Project Improvement Act Restoration Fund	$1.5
FISH & WILDLIFE SERVICE	
FY 2015 Appropriations	$1.74
TOTAL	**$15.151**

Activities and Accomplishments

Flow Management

The water volume for restoration releases into the Trinity River below Lewiston Dam is based on the forecasted inflow to Trinity and Lewiston reservoirs grouped into five water year types. Forecasts are used because the actual water year type is not known at the time that annual release schedules are developed. The forecasted water year type for 2015 was "Dry."

The 2015 water year (WY2015) began with Trinity Reservoir at 603,500 acre-feet (0.744 cubic kilometers (km^3)), which is roughly 24.7 percent of capacity, and ended with Trinity Reservoir at 545,000 acre-feet (0.672 km^3), which is roughly 22.3 percent of capacity.

Because it was a Dry water year, the TMC recommended a restoration release of 452,600 acre-feet based on the B120 April 1st 50-percent inflow forecast from the CDWR. Reclamation implemented a modified ROD hydrograph known as the Dry Joint Physical Riparian Alternative 1 Peak (D-JPR-1p) to meet programmatic objectives for a Dry year, increase geomorphic work, and meet riparian objectives.

Each year, the TRRP's Flow Workgroup, the Trinity Adaptive Management Working Group (TAMWG), and the TMC recommend to Reclamation a schedule for releasing restoration flows. The selection criteria used for determining each year's hydrograph include providing suitable temperatures for all salmonid life stages, reducing the travel time for outmigrating smolts, managing riparian seed germination, reducing fine sediment storage, and providing monitoring opportunities to support learning and adaptive management strategies.

FLOW RELEASE RATES FROM LEWISTON DAM

Figure 1 shows the actual WY2015 flow releases from Lewiston Dam to the Trinity River. Reclamation released flows higher than 450 cubic feet per second (cfs) (12.7 m^3/s) in August and September to supplement flows in the lower Klamath River and for the HVT's Boat Dance ceremony. All other flow releases were conducted for river restoration purposes (i.e., the TMC flow). Figure 1 also shows the "full natural flow" (FNF) at Lewiston. The FNF is the quantity of water that would have passed the gage at Lewiston if Trinity and Lewiston dams or other diversions or impedances had not been in place.

IMPLEMENTATION OF RESTORATION FLOW SCHEDULE

Outcome of Hydrograph Implementation

In addition to showing actual water releases and the FNF, Figure 1 illustrates the releases from Lewiston Dam relative to the TMC-specified release schedule and compared to the FNF, as measured by the Lewiston gage located below Lewiston Dam (USGS #11525500). Apparent deviations from the planned releases within the elevated flow period from April through July were small relative to stream gage accuracy. Actual deviations were due to the operational constraints of the gates at Lewiston Reservoir and are within the measurement accuracy of the gage.

Temperature Targets and Compliance

To protect all life stages of Trinity River salmonids, regulatory compliance mandates and scientifically based temperature targets have been established for multiple time periods at multiple locations along the Trinity River. River temperature is measured at Douglas City and above the confluence with the North Fork Trinity River to meet regulatory compliance targets specified in State Water Resources Control Board (SWRCB) Order WR 90-5 (SWRCB 1990). Additional targets for Douglas City and Weitchpec were added by the TREIS/EIR (USFWS et al. 2000). Temperature targets and dates are shown in Table 2.

During Dry or Critically Dry years, temperature targets adjust to "Marginal" values (see Table 2). Figure 2 shows the flow rate, measured water temperature, and temperature targets at Weitchpec during the spring outmigration period along with the average air temperature measured at Douglas City (DGC) <*http://cdec.water.ca.gov/wquality/*>. As the graph shows, the water temperature this far downstream of the dams closely follows the air temperature. Marginal temperature targets were met 21 days out of the 62-day target period, which is approximately 34 percent of the time. The average water temperature above the marginal target was 2.1°F, with the peak exceedance of 5.1°F occurring on June 13.

In WY2015, the Trinity River temperatures at Douglas City remained near the temperature target during the summer holding period while flows remained at baseflow (Figure 3). Discharges above baseflow (450 cfs) released for the HVT Boat Dance ceremony and in response to concerns about fish health in the lower Klamath River caused a sharp decline in water temperatures on August 16. The decrease in water temperature on September 16 resulted from a cold front that occurred during this time period.

The temperature sensor at Douglas City malfunctioned and was not repaired until July 23. Therefore, temperatures were monitored only 55 of the 76 days in the compliance period. During that time, the targets were met 44 out of the 55 days, with exceedances limited to the first half of the summer holding target period. The average exceedance above summer holding targets was 0.44 °F, with maximum of 1.1 °F on August 1. The compliance mandates (September 15 to September 30) were satisfied for 11 of the 16 days during the spawning period. Exceedances occurred on 5 days of the compliance period after the river returned to baseflow. During the spawning temperature compliance period, exceedances averaged 0.58 °F above the mandate, with a maximum of 1.2 °F occurring on September 21.

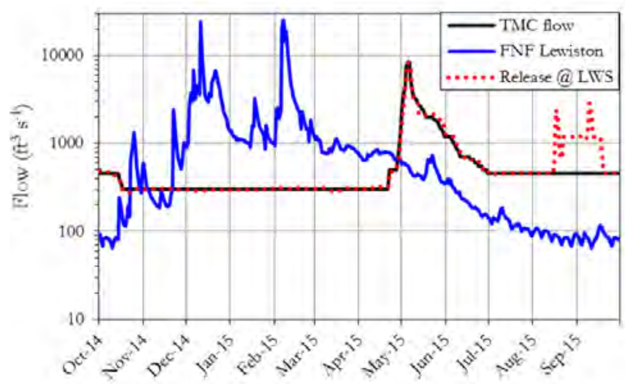


Figure 1.
Actual releases from Lewiston Dam to the Trinity River in Water Year 2015, based on the average daily stream flow record from the Lewiston gage (USGS #11525500). Full natural flow is the estimated flow at Lewiston if no dams had been in place.

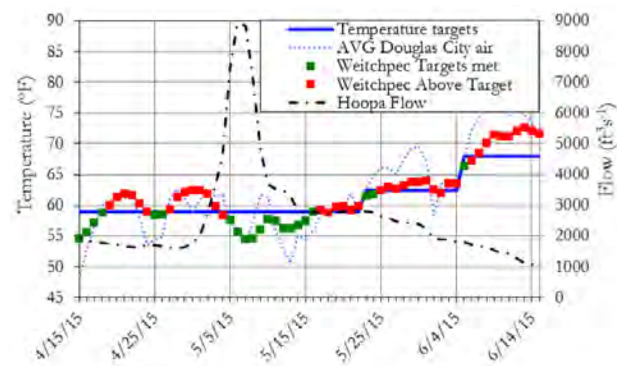


Figure 2.
2015 Trinity River spring and summer temperatures at Weitchpec. Temperature targets are shown as a solid blue line indicating the highest temperatures for "marginal" conditions.

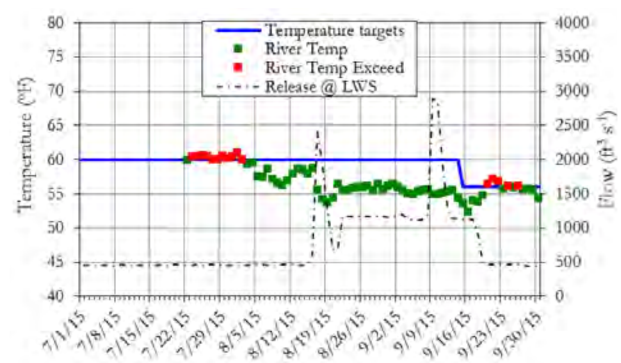


Figure 3.
Trinity River summer and fall temperatures at Douglas City (DGC). The solid red line shows the temperature compliance target at Douglas City. The dashed line shows discharge at the Lewiston Gage, LWS (USGS#11525500).

Table 2. Trinity River Temperature Targets by Reach and Date

Source	Target Reach	Dates	Target
		All Years	
Basin Plan for the North Coast Region (North Coast RWQCB 2011) and WR 90-5	Lewiston to Douglas City	July 1–September 15	≤60 °F (15.5 °C)
	Lewiston to Douglas City	September 15–30	≤56 °F (13.3 °C)[a]
	Lewiston to North Fork	October 1–December 31	≤56 °F (13.3 °C)[a]
Springtime Objectives of the ROD for the TREIS/EIR (USFWS et al. 2000)	Lewiston to Weitchpec	**Normal & Wetter Water Years — Optimum**	
		April 15–May 22	≤55.0 °F (12.8 °C)
		May 23–June 4	≤59.0 °F (15.0 °C)
		June 5–July 9	≤62.5 °F (17.0 °C)
		Dry & Critically Dry Water Years — Marginal	
		April 15–May 22	≤59.0 °F (15.0 °C)
		May 23–June 4	≤62.5 °F (17.0 °C)
		June 5–June 15	≤68.0 °F (20.0 °C)

[a]Mandated temperature requirements for operation of dams permits.

WATER VOLUME ACCOUNTING

The total volume of water released from Lewiston Dam to the Trinity River in WY2015 was 508,000 acre-feet. Of that total, restoration releases accounted for 450,700 acre-feet. The difference between the restoration water volume (452,600 acre-feet) and measured restoration releases (450,700 acre-feet) is roughly 0.5 percent, and is less than the ±10 percent accuracy of the stream gage record. Therefore, the water volume of the restoration releases equals the volume recommended when measurement error is accounted for. Additional releases to address lower Klamath River fish health concerns accounted for 47,900 acre-feet and the HVT Boat Dance ceremony required 9,300 acre-feet, which cumulatively resulted in 57,300 acre-feet released to the Trinity River in excess of the ROD volume.

BASIN EXPORT VOLUME

Reclamation exported a total of 450,500 acre-feet of water from the Trinity River to the Sacramento River in WY2015, as reported by the California Data Exchange Center for the Judge Carr Power Plant. Exports in WY2015 to the Carr Power Plant were approximately 50 percent of the inflow to Trinity and Lewiston reservoirs.

RESERVOIR CONDITIONS

The water year began October 1, 2014, with Trinity Reservoir holding a total volume of 603,500 acre-feet (0.744 km^3), roughly 24.7 percent capacity; the volume had declined to 545,000 acre-feet (0.672 km^3), roughly 22.3 percent capacity, by the water year's end on September 30, 2015. Releases totaled 68.4 percent of the long-term average annual inflow for Trinity reservoir, or approximately 106.5 percent of WY2015 FNF.

Mechanical Channel Rehabilitation

The year 2015 saw the successful construction of the Limekiln Gulch and the Upper Douglas City channel rehabilitation projects.

LIMEKILN GULCH

The Limekiln Gulch site is one of the original 44 channel rehabilitation sites identified in the Flow

Evaluation Report (USFWS and HVT 1999). The site is located between Poker Bar Road and Steel Bridge Road, 3 miles upstream from the intersection of California State Routes (SR) 3 and 299 (see Figure 4). The site spans 0.8 mile of the Trinity River from River Mile (RM) 99.7 to RM 100.5 and consists entirely of public land managed by the Bureau of Land Management (BLM). Access to the site is via a gravel road extending from Union Hill Road 4.5 miles south of Weaverville.

The Limekiln Gulch channel rehabilitation project was designed to increase aquatic habitat for salmonids over a range of flow conditions by creating hydraulic and ecological complexity in the form of in-channel and riverine elements. The design elements for the project included mid-channel islands, split flows, side channels, off-channel ponds, alcoves, floodplain, large wood/boulder habitat structures, and riparian revegetation. Like for the earlier channel rehabilitation projects on the Trinity River, the site-specific design features are intended to evolve over time under the Congressionally mandated flow releases described in the ROD.

The Limekiln Gulch project was designed by the Federal Design Group using a multi-disciplinary and multi-organizational approach that focused on including stakeholder input early in the design phase. The TRRP Design Team reached out to local landowners and the riverine community during the planning process to discuss and evaluate design elements and measures that best met the project goals and objectives. Through this collaborative process, several alternatives were formally evaluated using objective and quantitative metrics before an agreement was reached on the best alternative to implement. This more structured design process helped to foster better communication and transparency and created an environment that allowed for new ideas and recommendations.

Site Characteristics

The Limekiln Gulch rehabilitation site is located in a relatively narrow bedrock-controlled gorge downstream of the Poker Bar residential subdivision. The upstream three-quarters of the site consists of a long, straight, bedrock-controlled channel bounded by narrow bedrock benches mantled with a few feet of fine sediment and dense riparian vegetation. The benches have well-developed natural levees or berms adjacent to the channel along much of their length, but at flows of 6,000 cfs, the benches are 2 to 3 feet below the water surface near the valley walls. Two constructed side channels totaling about 0.75 mile in length provide high-quality rearing habitat along the right bank in this straight stretch.

In the downstream quarter of the site, the channel curves to the right, the width of the valley bottom increases slightly, and the river flow splits into a third side channel that defines a narrow island near the apex of the bend.

The Limekiln Gulch project area includes a large historic hydraulic mine site on the left side of the river. Referred to as the Premier Hydraulic Mine Site, the site consists of a large terrace bench that contains numerous mine features such as drains, tailings, sorted fines or slickens, and a large hydraulic cut, as well as a residential area associated with the mine that contains numerous artifacts such as bottles, stove parts, tools, and square-cut nails.

Initial Design and Redesign

The Limekiln Gulch project was originally designed in 2010. The project was then put on hold because the location for the placement of excavated materials would have had an adverse effect on cultural resources associated with the Premier Hydraulic Mine site. In 2014, an interdisciplinary team, including BLM archaeologists and forestry personnel, identified a suitable location for the spoils pile, allowing the project to move forward.

As described above, the initial design featured two side channels on the left side of the river and a minor modification to the side channel on the right side at the downstream end of the site. Several Design Team meetings and site visits in 2014 led to relatively minor modifications to the proposed left-side side channels, more aggressive manipulation of the downstream side channel on the right side, and the addition of new design elements adjacent to an old feather-edge project site at the upstream end of the reach.

The Design Team considered about 2,000 cubic yards of gravel augmentation adjacent to the feather edge at the upstream end of the site and excavation a short distance upstream from the side channels on the right side of the river, but both design elements were rejected following exploratory morphodynamic modeling that suggested neither measure would be likely to perform as intended.

Rehabilitation Activities

Figure 4 shows the activity areas for the Limekiln Gulch channel rehabilitation site. For a description of all the activity areas, refer to the Final Environmental Assessment/Initial study (EA/IS) for the Limekiln Gulch site (North Coast RWQCB et al. 2015)

Excavation in the R-3 area lowered an existing, relatively barren floodplain surface by up to 3 feet to an elevation of 1,689 feet, which is slightly higher than the summer baseflow water-surface elevation. The area, which is expected to become inundated at flows between 600 and 700 cfs, was stocked with woody debris and planted with riparian vegetation.

In-channel feature IC-1 consists of large trees keyed into the left bank and extending 60 feet into the stream at an upstream diagonal angle, with the root wad extending furthest into the stream. The structure will increase the existing river bed elevation in the area by about 3 feet. The trees will be ballasted with coarse sediment and pinned with smaller logs.

Feature R-1 is a base-flow side channel extending about 1,250 feet through the left overbank area in the upstream half of the site. The side channel has pool/riffle topography featuring side slopes varying from nearly vertical to about 4:1, variable widths averaging about 10 feet at the bottom of the cut, and two sloughs. Surface flow enters at two locations, both of which were over-excavated and backfilled with coarse gravel and cobbles capable of transmitting hyporheic flow.

Wood jams IC-2, IC-3, and IC-4 are located on the left bank immediately downstream from the entrances to the R-1 and R-2 side channels. The three jams are of similar dimensions, with the top elevations approximately equal to the existing riparian berm and horizontal spans extending up to 15 feet into the channel. The jams are composed of large wood keyed into the bank and ballasted with boulders. The adjacent side channels were over-excavated to bedrock in the immediate vicinity of the jams to prevent material from being scoured at those locations and deposited in the side channel immediately downstream.

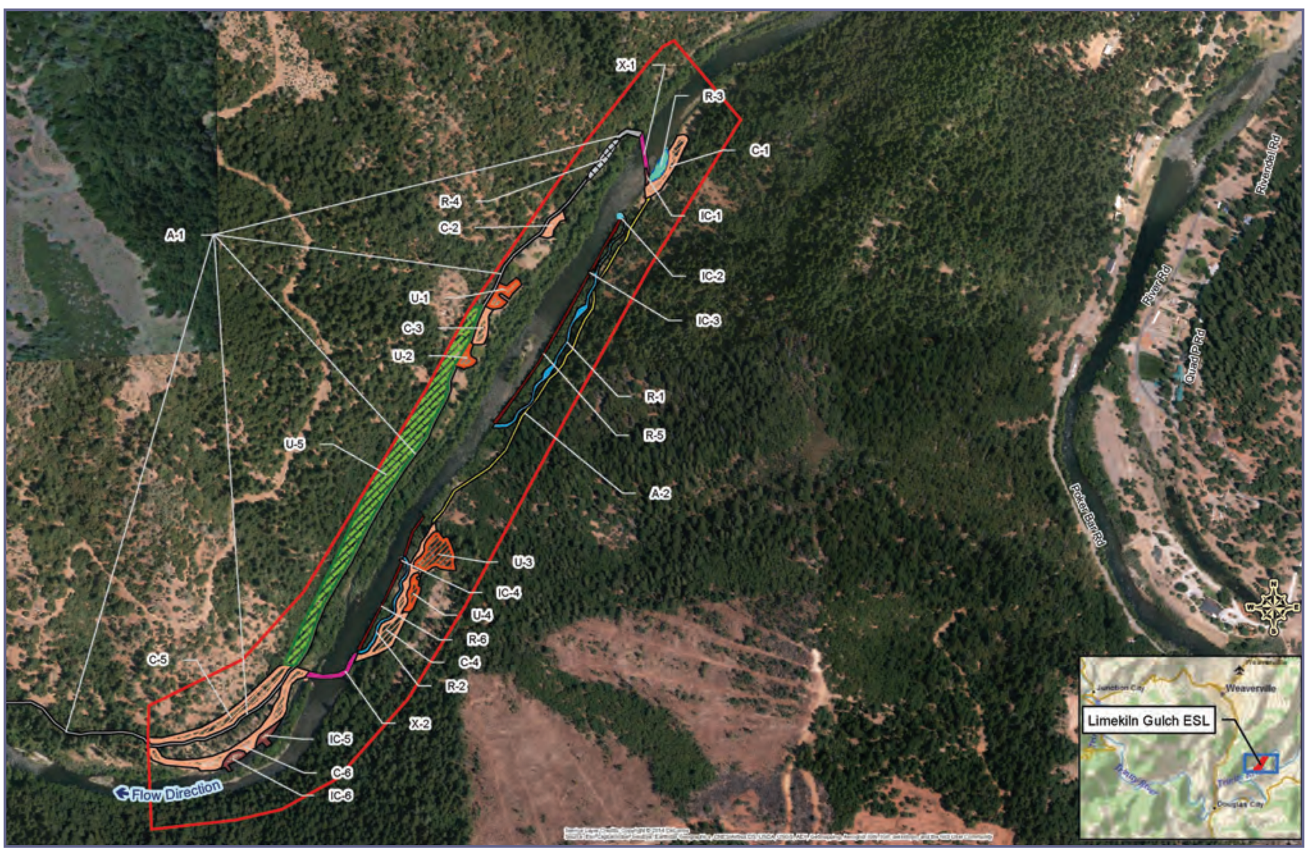


Figure 4.
Limekiln Gulch Activity Areas

Timeline of Management Actions

The following is a brief chronology of the most pertinent management actions related to restoration of the Trinity River basin.

2002

TRRP office established in Weaverville.

2003

First sediment augmentation effort at Cableway site.

2005

Trinity River Bridges Project completed.

Hocker Flat Project constructed.

First peak flow not constrained by litigation; peak flow release from Trinity Dam reached 6,970 cfs.

2006

Canyon Creek projects (Conner Creek, Valdor Gulch, Elkhorn, and Pear Tree Gulch) constructed.

Several infrastructure improvement projects completed, including relocation of “little yellow house” and realignment of roads in Poker Bar subdivision.

Peak flow release from Trinity Dam reached 10,100 cfs.

2007

Indian Creek Project constructed.

2008

Lewiston-Dark Gulch Project constructed.

2009

Master EIR-EA/EIR for the Remaining Phase 1 and Phase 2 Channel Rehabilitation and Sediment Management Activities released.

Sawmill Project, the first to include installation of a log jam, constructed.

2010

Reading Creek, Lowden Ranch, and Trinity House Gulch projects constructed.

2011

Wheel Gulch site constructed.

2012

Lower Steiner Flat and Upper Junction City projects constructed.

2013

Lower Douglas City and Lorenz Gulch projects constructed.

2014

Science Advisory Board completed Phase 1 review and Phase 2 recommendations.

Lower Junction City site constructed.

2015

Limekiln Gulch and Upper Douglas City projects constructed.


Robert Stewart (right) oversees gravel augmentation while Nate Bradley and Dave Gaeuman implement a gravel tracer study.

Robert Stewart
Hydraulic Engineer

Robert Stewart has been the TRRP's hydraulic engineer since 2014. Robert is responsible for determining whether it is possible to implement the flow recommendations made by the Flow Workgroup and the TMC and that the flows are not ramped up or down too quickly. He is also responsible for tracking Trinity River flows and water temperatures and modeling water velocity.

Robert also participates in the design of channel rehabilitation projects. After the projects are constructed, he monitors the design before and after restoration flows. Robert was instrumental in a change made in 2015 to shorten the duration of the restoration flows but increase their magnitude to increase change to the river while using less water.

Robert has a Ph.D. in Water Resources Engineering and an M.S. in Civil Engineering from the University of Kentucky. He also has a B.S. in Civil Engineering from Tennessee Technical University.

Feature IC-5 consists of an excavation to widen an existing side channel located in the right overbank area near the downstream end of the site, combined with the installation of a log and rock structure to reduce flow velocities. The existing side channel, which was about 30 feet in width, was locally expanded to a maximum top width of about 60 feet. Logs, gravel, and small boulders were used to create a broad-crested, riffle-like grade control structure that spans the excavation at its widest point and attains an elevation 2 feet above the existing river bed near the channel center. Backwater effects from IC-5 extend about 200 feet upstream at baseflow, but have no effect on existing hydraulic conditions at the side channel inlet nor do they alter discharge through the side channel. The wetted area was stocked with large woody debris and the emergent areas planted with riparian vegetation.

UPPER DOUGLAS CITY

The Upper Douglas City project was initially intended to be part of a larger project known as the Douglas City channel rehabilitation project. The Douglas City site was one of the 44 original channel rehabilitation sites identified in the Flow Evaluation Report (USFWS and HVT 1999). The Douglas City site (RM 93.6 to 94.6) is along either side of the SR 299 bridge between Douglas City and SR 3 and adjacent to SR 299. The Weaver Creek delta is within the boundary of the Douglas City site, with Weaver Creek entering the Trinity River at RM 94.0.

The Douglas City project was analyzed in the May 2013 Douglas City/Lorenz Gulch EA/IS (North Coast RWQCB and TRRP 2103), and the lower portion of the Douglas City project was constructed in summer 2013. The upper portion of the Douglas City (upstream of the SR 299 bridge) site was later redesigned to improve the functioning of the lower portion by increasing the elevation and size of a forced meander. What became known as the Upper Douglas City (Figure 5) site was constructed in 2015.

Site Characteristics

A review of historic aerial photographs taken between 1944 and 2009 provides insight into changes to the channel in the Douglas City site over time. The photographs show a dramatic decrease in the width of the mainstem bankfull channel between 1944 and 2009. Reduced flows from Lewiston Dam combined with delta deposits from Weaver Creek narrowed the bankfull channel width of 250 to 300 feet to a bankfull width of 110 to 120 feet. Safety of Dam releases, tributary floods, and high flow releases mandated by the ROD have exacerbated the problem, depositing additional fine sediment along the right bank and scouring the channel into its current rectangular form with near vertical banks.

The mainstem river is mostly straight in this area, as is a constructed side channel. Little topographic diversity has developed within the side channel since it was built in 2007.

Upstream of SR 299, mature riparian vegetation is prevalent along the left bank as the mainstem follows the bedrock valley wall.

Significant geological/physical constraints exist at the Douglas City site: valley wall and bedrock confinement along the entire left bank channel through the project reach and bedrock control that limits vertical scour at the downstream end of the site. In addition to these constraints, FEMA requires that the 100-year flood water surface elevation at the site not be raised or lowered by more than 1 foot.

Initial Design and Redesign

The goals and objectives of the Upper Douglas City project were developed by the Trinity River Design Team. Construction activity areas within the full Douglas City site, including the upper site, were designed for the river to function and evolve in a way that will meet the project goals:

- increasing available habitat for all life stages of salmonids through construction of mainstem, tributary, and off-channel rearing and refugia habitat and adult spawning and holding habitat;
- maintaining and improving existing salmonid habitat for all life stages, including adult spawning and holding habitat and maintaining and improving juvenile rearing and refugia habitat;
- increasing and enhancing wildlife habitat by adding habitat for western pond turtles and yellow-legged frogs;
- increasing and enhancing riparian and upland habitat by promoting development of diverse riparian and upland vegetation, preserving the riparian corridor, preserving large trees, increasing the area for natural riparian regeneration, increasing the residence time for fine sediment on the project floodplain, avoiding impacts on previously revegetated areas, and reducing invasive plant species;

2015 saw the successful construction of the Limekiln Gulch and Upper Douglas City channel rehabilitation projects.

- promoting fluvial processes that create and maintain salmonid habitat through increases in channel and floodplain complexity to create a more dynamic river bed topography, reducing coarse sediment size, increasing coarse sediment storage and residence time, increasing stream sinuosity, increasing the supply, storage, and routing of large wood, reducing bank armoring, and enhancing and maintaining dynamic alluvial properties within the Weaver Creek delta;
- collaborating to enhance public lands by working with federal and state landowners to determine appropriate actions for access, recreation, education, and preservation; and
- collaborating to protect and improve existing infrastructure by reducing scour on the SR 299 bridge pier.

Rehabilitation Activities

The Upper Douglas City project realigned an approximately 700-foot-long reach of the Trinity River (Figure 5, Activity Area IC-2) by excavating a new river channel into the existing right-bank floodplain. When the excavation of the new alignment was completed, a skeletal bar (Figure 5, Activity Area IC-1) was constructed in the previous alignment to permanently divert flow through the new channel. Other features included side channel enhancements, an additional new high-flow channel, a second skeletal bar, alcoves, willow trenches, and large wood habitat structures.

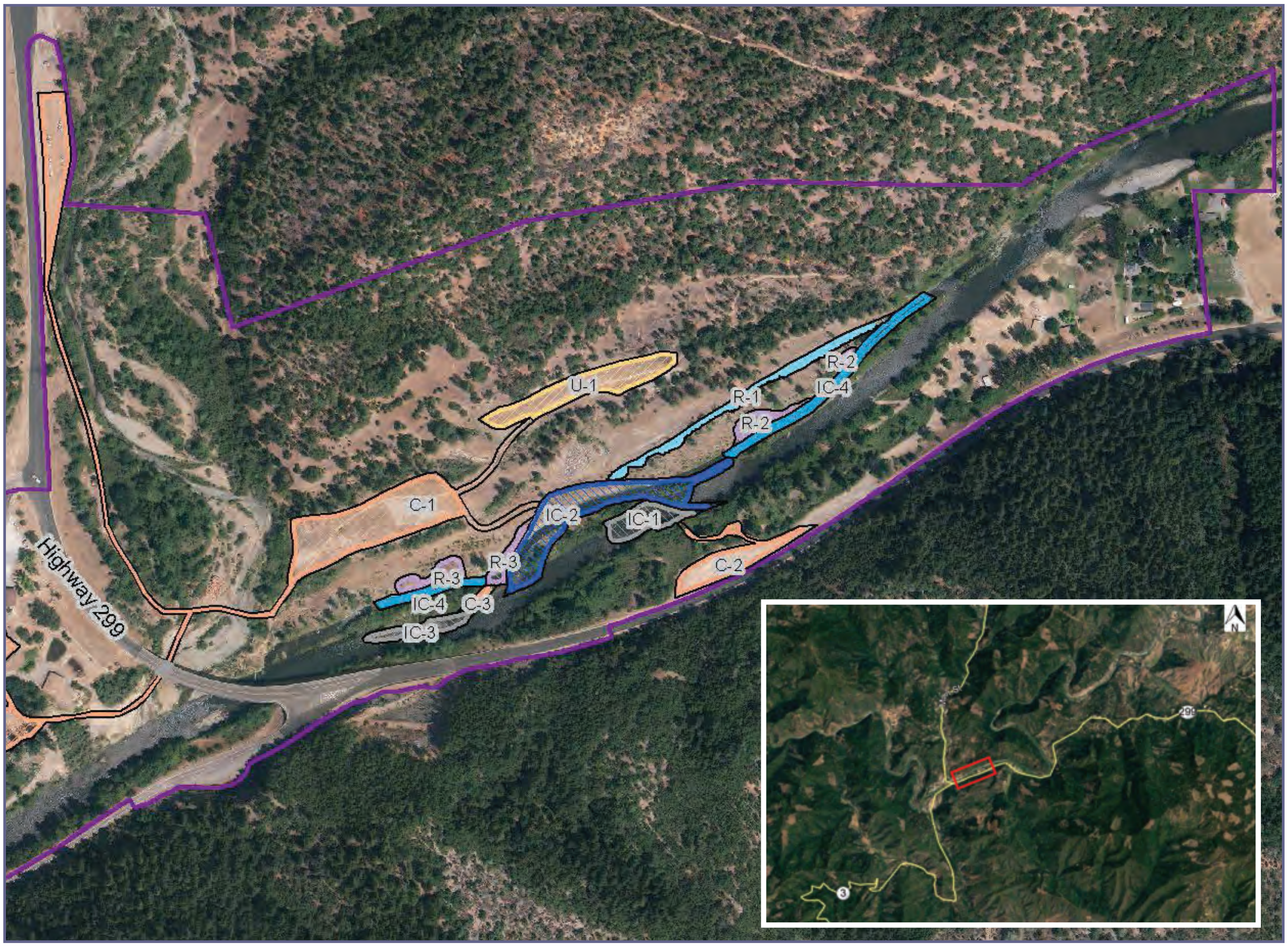


Figure 5.
Upper Douglas City activity areas.

The activity areas for the Upper Douglas City channel rehabilitation site are shown on Figure 5. The following are example features of the project:

Activity area IC-1 is a skeletal bar designed to force the mainstem channel into activity area IC-2, adding channel complexity, confining flows, initiating floodplain development by natural recruitment and distribution of fine sediments and wood material, enhancing floodplain connectivity, and increasing habitat.

IC-2 is a side channel enhancement. This left bank structure supports about 50 trees that will increase hydraulic diversity by creating a flow constriction that may stimulate bed scour and an eddy downstream.

IC-3 is a skeletal bar designed to promote left bank vertical scour along bedrock to deepen existing adult holding habitat, increase sinuosity and channel complexity, provide coarse sediment for future channel migration and recruitment, provide fry and pre-smolt habitat at flows up to 2000 cfs, increase yellow-legged frog and pond turtle habitat, increase large wood storage, capture wood material from high flows, and improve floodplain connectivity through the restoration flows mandated by the ROD.

IC-4 is a series of side channel enhancements designed to increase side-channel complexity and large wood storage, decrease the distance to cover for migrating fish, provide fry and pre-smolt habitat for flows up to 2,000 cfs, increase yellow-legged frog and pond turtle habitat, capture wood material from high flows, and improve floodplain connectivity through the restoration flows mandated by the ROD.

R-1 is a high-flow channel designed to increase the groundwater elevation, improve natural regeneration and planting success of riparian vegetation, increase floodplain complexity, provide off-channel rearing opportunities and refuge for salmonids at flows greater than 2,000 cfs, and increase long- and short-term storage of large wood.

R-2 consists of side channel enhancement and bank shaping to promote off-channel rearing areas for salmonids at flows greater than 2,000 cfs, provide areas for natural riparian recruitment, increase side channel and floodplain complexity, increase short- and long-term wood storage, and increase off-channel fine sediment deposition.

R-3 consists of side channel enhancement and bank shaping designed to promote off-channel rearing areas for salmonids at flows greater than 2,000 cfs, provide areas for natural riparian recruitment, increase side channel and floodplain complexity, and increase short- and long-term wood storage.

U-1 is an upland spoils site that will provide a long-term supply of coarse sediment for future coarse sediment augmentation.

Coarse Sediment Management

Trinity and Lewiston dams trap the supply of coarse sediment (gravel and small cobble). The ROD directs implementation of a coarse sediment augmentation program below Lewiston Dam to replace the coarse sediment trapped behind the dams and balance the coarse sediment transported during high-flow releases. The combination of the high-flow releases and coarse sediment augmentation is intended to increase the availability and quality of physical habitat by promoting the processes of scour and fill that maintain bars, pools, juvenile rearing habitat, spawning beds, and other elements of channel complexity. Progress toward these goals is assessed by measuring coarse sediment transport, estimating sediment fluxes, and tracking changes in channel topography.

Although WY2015 was a Dry year, a relatively large, but brief, peak flow was released from Lewiston Dam to facilitate gravel mobilization. Daily mean flows of 8,200 and 8,300 cfs were attained on May 5 and 6, 2015, making it possible to introduce a total of 1,700 cubic yards of coarse sediment into the river channel. About half of that total was introduced into the flow about 1 mile downstream of Lewiston Dam, and the remainder was introduced

Dave (front) and colleagues observing changes to the river channel caused by the 2016 high-flow release.

David Gaeuman
Geomorphologist

Dave Gaeuman has served as the TRRP's geomorphologist for the past 10 years. His responsibilities include coarse sediment management, including developing gravel budgets and planning and overseeing gravel augmentation projects. Dave does most of the data analysis concerning sediment transport and changes in the morphology of the Trinity River.

Because Lewiston and Trinity dams block the supply of gravel from the upper Trinity River watershed, gravel augmentation is critical for maintaining spawning habitat for salmon and steelhead. Dave determines how much gravel to add to the river at several long-term augmentation sites located downstream from Lewiston Dam. He also develops conceptual designs and performs hydraulic and geomorphic modeling for rehabilitation projects designed by TRRP's Federal Design Group.

Dave has a Ph.D. in Geomorphology from Utah State University, an M.S. in Geography from the University of Montana, a B.A. in Geology from Colorado College, and a B.A. in Journalism from the University of Colorado, Boulder. He held a post-doctoral position with the U.S. Geological Survey, working on a geomorphology-related study of the Missouri River. Dave has written many peer-reviewed scientific papers.

about 6 miles downstream of the dam. The quantity of coarse sediment added to the river in 2015 was determined using methods described in a recent technical report (Gaeuman 2014) and was found to closely match the quantity of coarse sediment transported in more downstream reaches of the river where natural sediment supplies exist.

Sediment Transport Monitoring

Sediment transport monitoring in the mainstem Trinity River resumed in 2015 after a 1-year hiatus due to California's recent drought.

Sediment monitoring data are used to assess gravel augmentation needs and to determine whether management objectives of increasing coarse sediment transport rates and coarse sediment storage are being met.

In addition to collecting physical samples of suspended and bedload sediment discharge, some new experimental means for assessing sediment transport rates were explored in 2015. In particular, a TRRP scientist collaborated with USGS researchers to investigate the use of hydrophones to detect acoustic vibrations that can potentially be used to generate a continuous record of coarse sediment transport rates. A published report (Marineau et al. 2016) describes the acoustic methods and suggests that acoustic monitoring can provide useful estimates of bedload transport rates at a significantly lower cost than traditional sediment sampling.

High flows from Lewiston Dam.

Physical and Biological Responses to Restoration Flows

RIPARIAN MONITORING

The TRRP intends to indirectly restore the Trinity River fishery through restoring natural processes. An important suite of natural processes includes riparian vegetation establishment, growth, and mortality.

Riparian vegetation provides numerous benefits to fish as a source of cover and shade and a source of food for the insects that fish eat; it also provides a source of large woody debris around which the river can scour or deposit sediment. Riparian vegetation also provides habitat elements for songbirds and other species the TRRP is interested in.

The TRRP sets the timing of spring floods to promote the natural recruitment of important riparian species, such as black cottonwoods. In order for recruitment to be successful, the flood peak needs to occur before the seed dispersal period, the seeds need to fall on suitable surfaces, and the water surface needs to recede slowly enough that the seedling roots can track the water table as it sinks to its late-summer level. In addition, the flows need to interact with the right surfaces for riparian vegetation to become established; the TRRP creates those surfaces through moving sediment around with excavators, bulldozers, and dump trucks during channel rehabilitation projects.

An important question the TRRP has been investigating is "What makes a good surface for natural riparian vegetation establishment?" To answer this question, TRRP biologists mapped areas where cottonwood seedlings were found at recently constructed channel rehabilitation sites and determined the year when the seedlings started growing. They then compared this information to two datasets. The first was a map showing all of the features that TRRP had created through moving sediment around with heavy equipment. The second was a map showing the height-above-river of the area. The height-above-river is important because the water table is highly correlated with the water surface elevation of the river, and the roots of riparian tree seedlings need to stay close to the water table as it drops; if it drops too quickly or becomes too deep, the seedlings will dry up. By overlaying maps of the areas where riparian seedlings were observed over maps of the construction features and height-above-river, the biologists were able to describe the areas where cottonwood seedlings became established. By looking at the year when the cottonwoods were established, they were able to confirm which streamflow patterns were capable of encouraging riparian plant establishment.

Figure 6 shows the areas, by construction feature, where black cottonwood recruitment was observed. The feature type that represented the most recruitment area (1.8 hectare) was constructed floodplains. This was good news because floodplains are constructed with the intention of supporting black cottonwood recruitment.

The real take-home message came when the analysis was changed to include height-above-river. Figure 7 shows that within floodplains, 75 percent of all recruitment occurred below about 1.5 meters above the water surface and the median recruitment height was less than 1 meter above the water surface. This is important information because it shows that TRRP needs to construct floodplains so that they are very low—within a few feet of the baseflow water surface elevation.

This information also helps guide objectives. Although the Trinity River valley looks fairly natural in many areas, it is actually filled in with several (or more) feet of tailings from all the years of hydraulic mining that occurred in the watershed during and after the Gold Rush. This debris makes the valley bottom higher than it naturally would be, and it represents an important limitation on where TRRP can expect flows to promote the natural establishment of black cottonwoods. Knowing where cottonwoods are unlikely to become naturally established helps determine which areas should be directly planted instead.

TRRP was also able to determine which of the recent flow releases were better able to promote black cottonwood establishment. The vast majority of the seedlings were established in 2011 and 2012.

James holding a juvenile western pond turtle from a constructed wetland at the Lorenz Gulch channel rehabilitation project site.

James Lee
Riparian Ecologist

James Lee has served as the TRRP's riparian ecologist for the past four years. James participates in vegetation- and wildlife-related projects that support TRRP's goal of restoring anadromous fish populations in the Trinity River. A major objective of his work involves reestablishing cottonwoods and willows along the river.

James prepares wildlife and vegetation studies that assess the effects of TRRP's management actions. He designs and implements revegetation projects and guides the crews who plant and maintain native vegetation. He has recently been involved in helping to develop the TRRP's Decision Support System, emphasizing the attributes of a healthy river. When asked what most interests him in his work for the TRRP, James responded that he is interested in how components of the riparian zone interact with the river and lead to healthier and more abundant fish and wildlife populations.

James is an employee of the Hoopa Valley Tribe; funding for his position is provided by the DOI. One of James' roles is to ensure that the Tribe remains closely connected to the TRRP office.

James has a B.S. in Wildlife and Fisheries Biology from the University of California, Davis, and an M.S. in Forest Resources with a concentration in Wildlife from the University of Georgia. Before coming to the TRRP, he worked in private consulting and for the Kansas Department of Wildlife and Parks and Arizona State University.

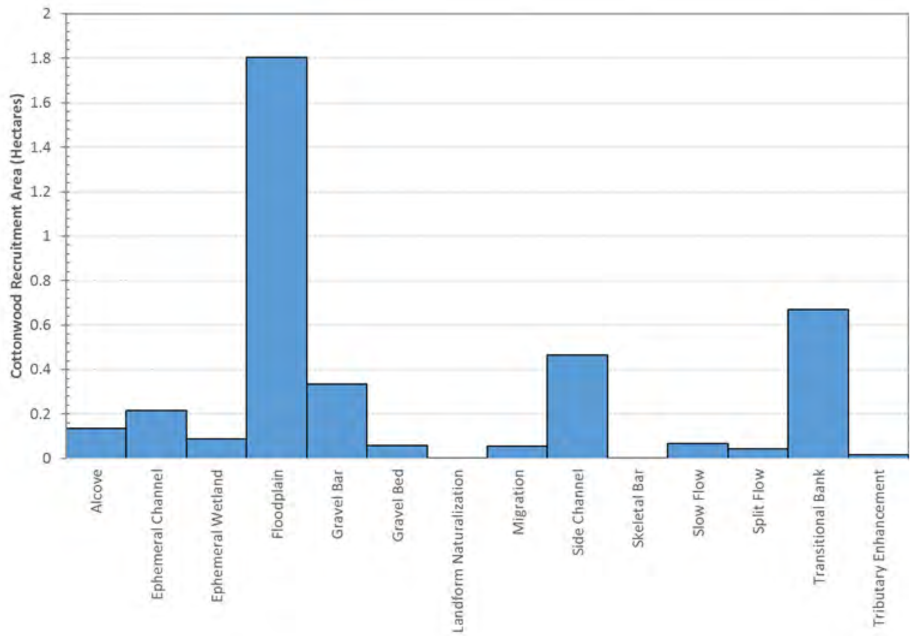


Figure 6
The area of cottonwood recruitment mapped at different constructed design surfaces.

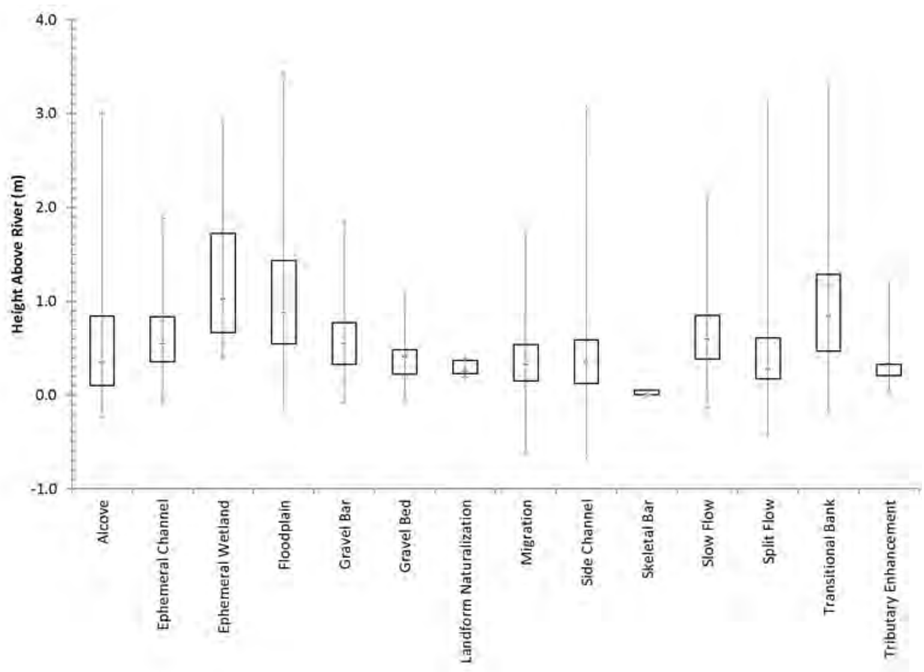


Figure 7
Box plots illustrating the median and range of cottonwood recruitment heights above the baseflow water surface elevation. The red dot is the median recruitment area height-above-river elevation. The lower box limits represent the 25th data percentile, and the upper box limits represent the 75th data percentile. The grey lines indicate the data range between minimum and maximum heights observed.

These years had peak flows in early May, and the river receded very slowly after that peak.

The recommendations that resulted from this analysis included: (1) constructed floodplains need to be lowered to an elevation that is within about 1.5 meters of the adjacent river baseflow water-surface elevation to promote the natural establishment of black cottonwoods, and (2) hydrographs similar to the 2011 and 2012 releases should be used to promote the natural establishment of black cottonwoods.

FISHERIES MONITORING

Fish Habitat Assessment

LOWER JUNCTION CITY. The Lower Junction City channel rehabilitation site was completed in 2014. Salmon-rearing habitat was evaluated before construction between 2011 and 2013 and after construction in 2015, with both surveys occurring during summer base streamflow. The total presmolt rearing habitat area after construction increased by 51 percent. The greatest improvements resulted from building a bar and forced meander in the upstream portion of the site and expanding the channel at the downstream end of the site. After construction, a new bar also formed on river left near the downstream channel expansion, which has resulted in substantial areas of suitable habitat.

UPPER DOUGLAS CITY. The Upper Douglas City channel rehabilitation site was completed in 2015. The site is located within the construction boundaries of the Indian Creek channel rehabilitation site, which was completed in 2007. Rearing habitat was surveyed before construction in 2014 and after construction in 2015, with both surveys completed during summer base streamflow. The surveyed area included a constructed forced meander, an alcove, and the downstream portion of the Indian Creek side channel. The total presmolt rearing habitat increased by 92 percent as a result of the construction; most of this improvement can be attributed to the forced meander and alcove features (Figure 8).

RESTORATION REACH EVALUATION. Flow and channel rehabilitation actions are anticipated

Figure 8.
Salmonid presmolt rearing habitat area before (left) and after (right) construction of a forced meander and alcove at the Upper Douglas City rehabilitation site. Red areas indicate total rearing habitat. Blue areas indicate low-quality habitat in the wetted channel. The representation of habitat in this figure is simplified. A full report and description can be found at <*http://odp.trrp.net/Data/Documents/Details.aspx?document=2292*>.

Adaptive Management in Action: Hocker Flat Rehabilitation Site

Constructed in 2005, Hocker Flat was the TRRP's first channel rehabilitation project. The original plan for the Hocker Flat site had a revegetation component intended to provide habitat for wildlife and shade and cover for fish. The revegetation component used cottonwood and willow pole cuttings that were collected during the winter and planted deep enough to root into the groundwater supplied by the river. Some native plants grown in containers were also used. Overall, the revegetation project was simple and inexpensive, which made sense considering that it was the first revegetation project the TRRP attempted.

Several years later, monitoring surveys found that few of the container plants had survived and that only about 20 to 30 percent of the pole cuttings had taken root and become established. The TRRP decided to revisit Hocker Flat and incorporate lessons learned not only from the original project but also from other revegetation projects that had been implemented since 2005. Some of these lessons were:

- Pole cuttings can sometimes work well, but can only be done with a few species (willows and cottonwoods).
- Consistent irrigation for 1 to 3 years is needed to ensure the establishment of container plants.
- Simple overhead irrigation systems are more reliable and efficient than hand watering or drip irrigation in the rough environments along the Trinity River.
- Larger container plants have a better chance of survival.
- Adding fine-textured soil and mulch to planting areas enhances plant survival and growth.
- Deer browsing limits plant growth and must be controlled or prevented.

In spring 2015, Hocker Flat was replanted. A local nursery provided the largest container plants that could be commercially grown. These were planted in holes dug with a mini-excavator, and the holes were back-filled with light-textured soil and wood grindings salvaged from a nearby channel rehabilitation project. The plants were protected from deer browsing with biodegradable mesh cages. The planted areas were outfitted with a simple overhead irrigation system that was designed to mimic a period of heavy precipitation. Irrigation began as soon as the plants went in the ground and continued through the first summer of growth. The intent of the irrigation plan was to simply allow the plants to survive until they develop deep tap roots all the way down to the water table.

Even though this area was planted during the third year of one of the most extreme droughts that California has experienced, the planted areas performed very well the first year, with negligible plant mortality (<5 percent). Plant growth rates were among the highest that TRRP has observed at its channel rehabilitation sites, with some cottonwood trees approaching sizes comparable to 3- to 5-year-old trees at other sites. Even though the site was disturbed by several floods during winter and spring 2016, growth was rapid at the beginning of the second year.

Hocker Flat is emerging as a very successful revegetation project as well as an example of adaptive management in action.

Spring planting 2015

Summer 2016

to create increases in the availability of rearing habitat through the 40-mile (64-kilometer) restoration reach.

Rearing habitat availability was mapped at 32 randomly selected sites in 2010, and these sites were revisited in 2015 as part of a multiyear study. The sample included TRRP channel rehabilitation sites surveyed in 2010 and 2015 both before and after construction, sites surveyed only after construction for sites constructed before 2010, and sites with no channel rehabilitation actions. Between 2010 and 2015, the restoration reach experienced five high-streamflow releases from Lewiston Dam, peaking at 12,300 cfs (350 cubic meters per second), the largest release since initiation of the TRRP. Overall, the median total presmolt habitat area increased from 22,335 square feet (2,075 square meters) to 24,283 square feet (2,256 square meters), and 22 of the 32 sites showed higher habitat values in the 2015 survey. All sites with channel rehabilitation actions completed since the 2010 survey showed improvements in habitat availability, demonstrating the benefits of the channel rehabilitation sites (Figure 9). However, the rearing habitat area increased at only two of the seven sites constructed before 2010, while it increased at 13 of the 18 sites with no channel rehabilitation actions.

Juvenile Chinook Salmon Abundance

Juvenile salmonid outmigrant monitoring occurred at two sampling sites along the Trinity River in 2015: the Willow Creek rotary screw trap site (WCT) on the lower Trinity River and the Pear Tree Gulch rotary screw trap site (PT) immediately above the confluence with the North Fork Trinity River. Sampling at WCT typically occurs from March through August and at PT from January through August, capturing the bulk of the emigrating, naturally produced juvenile Chinook salmon. It is important to note that a portion of the population is not sampled (from September through December). In addition, WCT captures juvenile salmon that originate from the entire basin above the trap site, while PT captures juvenile salmon that originate from the restoration reach of the Trinity River.

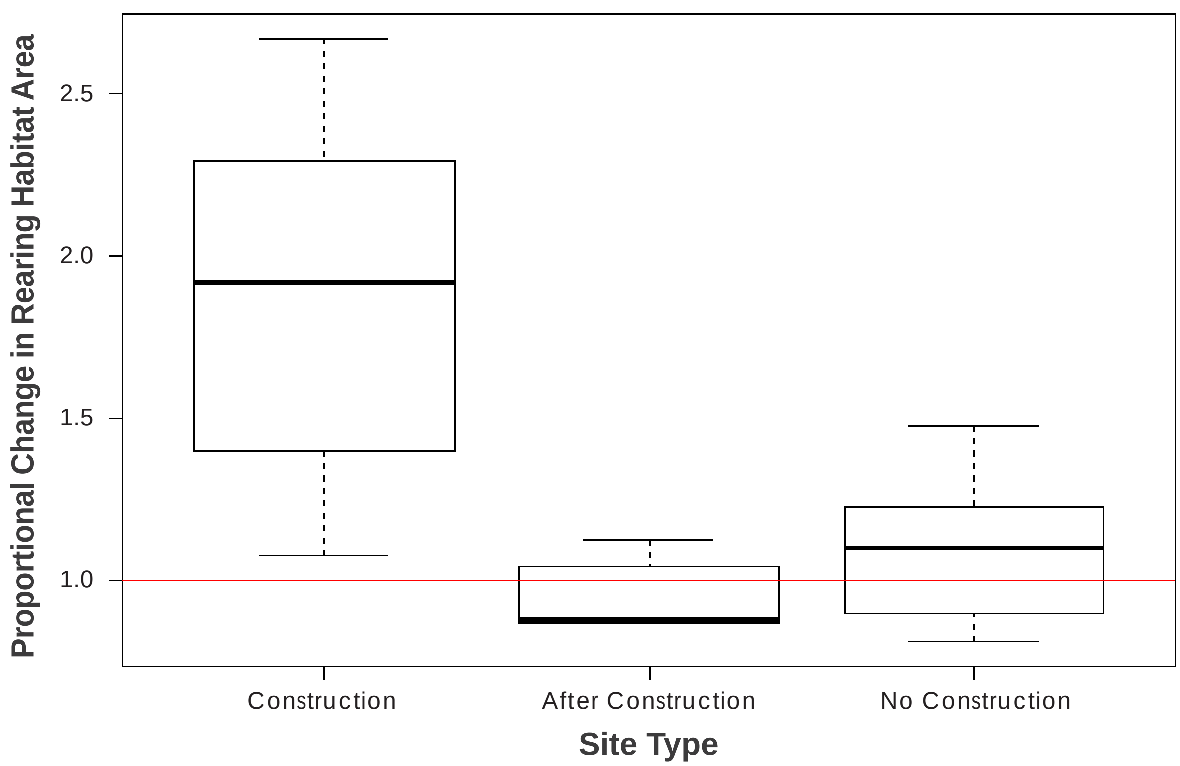


Figure 9.

Proportional change in total presmolt rearing habitat area at sites surveyed in 2010 and again in 2015. Site type indicates construction status: "Const." indicates areas that were surveyed before and after construction (n=7), "After Const." indicates sites where both surveys occurred after construction (n=7), and "No Const." indicates sites with no channel rehabilitation (n=18). Values greater than 1 indicate improvements in habitat, and values less than 1 indicate reductions.

The annual population estimates of naturally produced juvenile Chinook salmon (spring- and fall-run combined) in 2015 were 0.9 million fish at WCT and 1.9 million fish at PT (Figure 10). This is the lowest estimate at WTC and the second lowest at PT since 2009, with both estimates being similar to those in 2007 and 2008. These lower values in 2015 likely reflect the relatively low spawning population size during 2014 and are possibly related to increased mortality during egg incubation and fry emergence. Analyses to determine cause and effect are planned for 2016 and will include analyses relating the size of the spawning population to the number of juveniles produced as well as to habitat availability and temperature regimes to assess factors that influence juvenile population sizes. It is natural for salmon populations to vary dramatically from year to year, reflecting variations in freshwater and marine conditions and the level of harvest of adults.

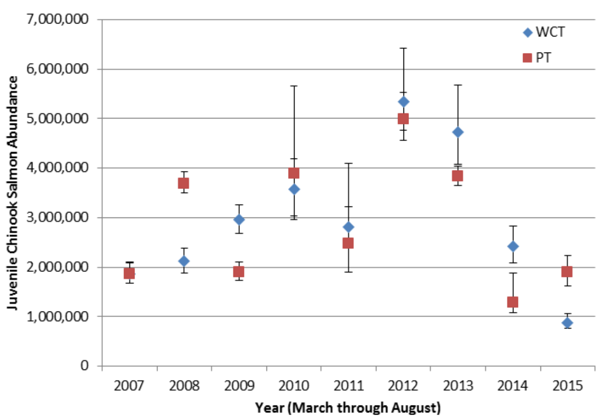


Figure 10.
Abundance of naturally produced juvenile Chinook salmon at the Willow Creek (WCT) and Pear Tree (PT) trap sites, 2007-2015. Error bars represent 95% credible limits for the annual estimates.

Salmon Redd Distribution and Abundance

Salmon spawning surveys were completed on the mainstem Trinity River to evaluate the distribution and abundance of Chinook salmon spawning activity. During the 2015 surveys, 2,162 salmon redds were located and 1,568 salmon carcasses were examined. An estimated 1,772 redds were built by natural-origin Chinook salmon, 331 were

Todd is one of the TRRP's fish biologists.

Todd Buxton
Fish Biologist

An employee of the USFWS, Todd is a fish biologist who has worked for the TRRP for about a year. He coordinates the TRRP's Fish Workgroup and is investigating the status of fine sediment storage and transport in the Trinity River and its effects on aquatic macroinvertebrates, nutrient retention, shallow groundwater flow, and other processes and biologic populations in the river. He is also investigating the effects of salmon spawning location on redd scour and flow to eggs in salmon nests for predicting egg to fry survival. Todd has worked for 25 years on river restoration and research projects with government, non-profit, and private entities. In addition to his current work for the TRRP, Todd is an independent consultant on fish habitat restoration projects in Alaska. When asked what is most interesting about his position with the TRRP, Todd said, "The opportunity to discern biophysical interactions in the Trinity River and their relationship to river restoration performed by the TRRP."

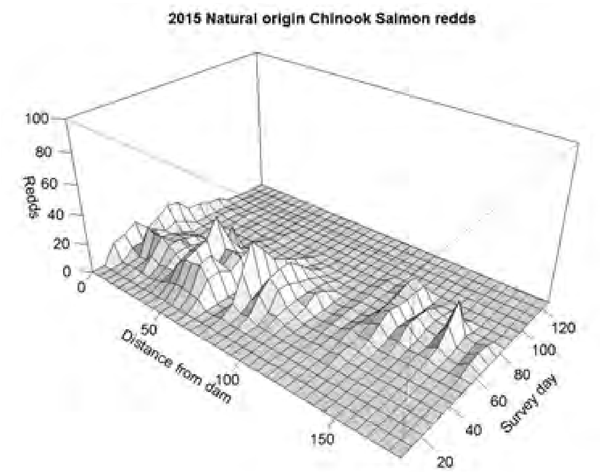
Todd has a Ph.D. in Water Resources from the University of Idaho and an M.S. in Watershed Management and a B.S. in Water Restoration and Analysis from Humboldt State University.

built by hatchery-origin Chinook salmon, and the remaining 59 were built by coho salmon (Table 3). The number of redds observed in 2015 was the lowest since the survey was initiated in 2002 (Figure 11).

Hatchery-origin Chinook salmon tended to spawn in relative proximity to Lewiston Dam, the location of the Trinity River Hatchery, while natural-origin Chinook salmon spawned throughout the mainstem (Figure 12).

Table 3.
Numbers of Chinook salmon and coho salmon redds observed in the mainstem Trinity River in 2015. Bootstrap-generated 95% confidence intervals (c.i.) are in parentheses.

	Chinook Salmon		Coho Salmon	
Type	Est.	(95% c.i.)	Est.	(95% c.i.)
Natural Origin	1,772	(1,632–1,948)	NA	—
Hatchery Origin	331	(155–471)	NA	—
Total	**2,103**	**(1,994–2,162**	**59**	**(0–168)**



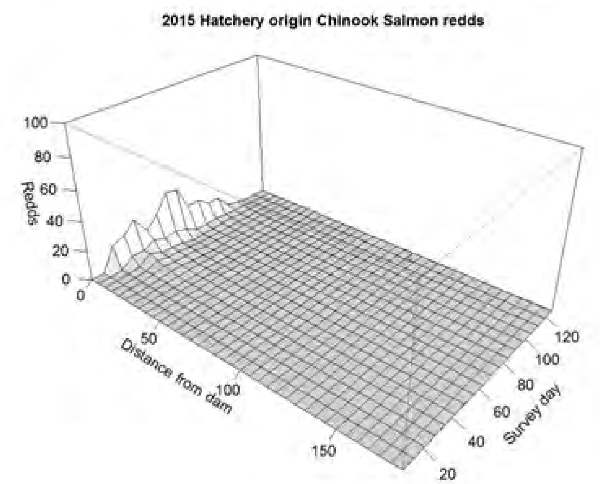


Figure 12
Spatiotemporal distribution of mainstem natural origin and hatchery origin Trinity River Chinook salmon redds observed in 2015. Pigeon Point and Burnt Ranch whitewater reaches were not surveyed. Survey Day 1 = September 1, Survey Day 120 = December 29. Distance from Lewiston Dam is in kilometers.

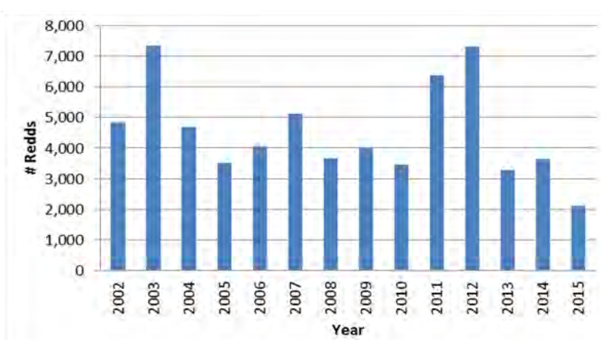


Figure 11.
Numbers of mainstem Trinity River Chinook salmon redds, 2002–2015. The Pigeon Point and Burnt Ranch whitewater reaches were not surveyed.

Derek holding a large male Chinook salmon carcass collected during the mainstem Trinity River spawning surveys.

Derek Rupert
Fish Biologist

Derek Rupert is a USFWS employee who has served as one of the TRRP's fish biologists since 2012. His responsibilities at the TRRP include participating in and coordinating field work involving Trinity River salmonids. His largest ongoing project is conducting the mainstem Chinook salmon spawning surveys and distributing the data to TRRP scientists and other interested parties.

Derek is particularly interested in wild (non-hatchery) fish: steelhead and Chinook and coho salmon. He describes himself as gratified by looking at photographs of the Trinity River in the 70s, 80s, and 90s and seeing the progress that has been made in restoring the river.

Before going to work for the USFWS in its Arcata office, Derek was a fisheries technician in Yellowstone National Park for the National Park Service. He has a B.S. in Fisheries Biology from Mansfield University in Mansfield, Pennsylvania, and an M.S. in Biology from Western Kentucky University in Bowling Green, Kentucky.

Density of Juvenile Salmon

Snorkel surveys were conducted in 2013 and 2014 to collect data for informing the salmon life cycle model Stream Salmonid Simulator (SSS). Pairs of divers simultaneously observed juvenile salmon in small, homogenous habitat units over the full range of habitat values, such as depth, velocity, and distance to cover.

Data from the snorkel survey were analyzed in 2015 to inform the SSS model and establish the link between the physical properties of the river and the capacity to hold juvenile salmon. A model was developed with physical parameters as inputs and juvenile Chinook capacity as the output. This model was applied to the underlying spatial structure of the SSS model. The model allows for simulated fish to distribute across space in a biologically meaningful way since it was developed from actual fish observations.

Divers conducting fish surveys during the juvenile salmonid density study.

Juvenile Chinook and coho salmon rearing in cover habitat.

RIPARIAN SPECIES MONITORING

The U.S. Congress passed an act in 1984 (Public Law 98-541) that acknowledged the loss of habitat for deer and other wildlife species caused by the inundation of large riparian and upland areas behind Lewiston and Trinity dams. Congress directed the Secretary of the Interior to take appropriate actions to maintain and propagate such wildlife. Much of the TRRP's wildlife management and monitoring respond to this mandate.

The 2000 ROD requires the TRRP to consider potential impacts on federally and state-listed plant and wildlife species (U.S. DOI 2000). The mitigation and monitoring program for the 2009 Master EIR (North Coast RWQCB and TRRP 2009) requires that adverse impacts, including impacts on fish and wildlife, be mitigated both during and after construction. TRRP's monitoring of species listed under the federal and California Endangered Species Acts (ESAs) and other sensitive species helps to ensure that their conservation and restoration needs are met. Two additional documents, Conceptual Models and Hypotheses for the Trinity River Restoration Program (TRRP 2009) and Integrated Assessment Plan (IAP), Version 1.0 (TRRP and ESSA Technologies 2009), provide further clarification and guidance on the development of fish and wildlife monitoring for the Program.

The purpose of the conceptual models is to clearly illustrate the physical-biological linkages by which the TRRP expects management actions to achieve the stated goals for valued ecosystem components, thus providing a foundation for developing detailed monitoring plans both to assess overall impacts and to resolve key questions affecting management decisions. The Flow Evaluation Report (USFWS and HVT 1999) and the ROD (U.S. DOI 2000) provided a restoration strategy for the TRRP but did not specify methods for assessing the effectiveness of the management actions in achieving Program goals or management targets. To fill this need, the IAP identifies key assessments that evaluate long-term progress toward achieving Program goals and objectives and that provide short-term feedback to improve Program management actions by testing key hypotheses and reducing management uncertainties.

Continued fish and wildlife monitoring will not only help to assess the overall effectiveness of the Program in meeting its goals and objectives but can also provide reliable data on longer term trends that provide feedback on the overall effectiveness of the Program over the next few decades (TRRP and ESSA 2009).

AVIAN MONITORING

The ROD mandated that the TRRP consider potential impacts on federally and state-listed plant and wildlife species (U.S. DOI 2000). Birds are excellent indicators of ecological status because of their habitat specificity, sensitivity to pollutants, ease of detection, territorial behaviors, and mobility. All environmental documentation and compliance processes (e.g., Biological Assessments (BAs), Environmental Impact Statements (EISs), Environmental Impact Reports (EIRs)) that are required for construction activities in or along the Trinity River (e.g., bridges, mainstem rehabilitation sites, gravel injections sites, watershed restoration) require consideration of special-status bird species and their important habitats in accordance with numerous federal and state environmental laws such as the National Environmental Policy Act (NEPA), the federal and state ESAs, the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and California Environmental Quality Act (CEQA). Moreover, TRRP and its partner agencies have a responsibility to prevent undue losses of birds and other wildlife species across the Trinity River basin and to maintain a healthy riparian corridor essential for ensuring the survival of bird species of concern (TRRP 2009).

Management actions could have both positive and negative effects on birds at different times and locations. For example, increased flows may increase available food while at the same time reducing the amount of nesting habitat. The long-term, overall effects are, however, expected to be positive. Examining the cumulative impacts on birds throughout the Trinity River watershed will provide the most reliable measure of overall system-level effects. While this requires a more comprehensive and larger scale monitoring program than would be mandated by NEPA/CEQA and licensing processes, it also ensures that inferences about the impacts of restoration actions are not biased by site-specific observations (TRRP 2009).

In 2011, the Klamath Bird Observatory (KBO) initiated its bird monitoring program along the 40-mile Trinity River reach below Lewiston Dam and at selected rehabilitation sites, building on research by the Redwood Sciences Laboratory from 2002 through 2009. In addition to evaluating bird use of constructed floodplain features and revegetated areas and maintaining a 40-mile monitoring program, KBO in 2012 began several new scientific inquiries that continue today.

KBO continues to collect data on five focal bird species along the Trinity River. The target riparian species—black-headed grosbeak, song sparrow, tree swallow, yellow-breasted chat, and yellow warbler—were selected based on their strong association with riparian habitat in the western United States and their diversity of ecological requirements, their status as riparian focal species by California Partners in Flight (RHJV 2004), and their high frequency of occurrence on the Trinity River. While the strategy includes continuing to monitor temporal variations in avian performance metrics at the Program-area and river-reach scales, the strategy is also designed to link changes in riparian bird performance metrics to specific restoration actions at the scale of the rehabilitation site, a key component of the adaptive management process. Because the revegetation of constructed floodplains through mechanical and natural processes is a primary restoration approach being implemented by the TRRP (Sullivan and Bair 2004, TRRP 2008), the bird monitoring strategy attempts to explicitly identify mechanistic linkages between avian metrics and restoration-associated changes in the complexity of riparian microhabitat at rehabilitation sites. Monitoring efforts continue to assess programmatic compliance, with the goal of increasing the precision of management activities (e.g., flow releases, revegetation efforts, excavation and floodplain management) to directly benefit targeted avian species.

The year 2015 also saw the completion of KBO's report on bird population trends in the Program area from 2002 through 2014 (Rockwell and Stephens 2016). The monitoring described in this report was designed to assess whether birds are substantially affected by TRRP implementation activities at the scale of the entire Program area. The results suggest that the TRRP has been largely successful in maintaining riparian and riverine bird abundance and diversity. Overall, two-thirds of the species studied exhibited either increasing trends or stable populations at this scale. Results from all survey locations indicate that five of 16 riparian bird species significantly increased during the study period while seven decreased significantly and four showed no significant trend. Of the populations of the five riparian focal species, three increased significantly: black-headed grosbeak, tree swallow, and yellow warbler. The song sparrow population remained stable, and the yellow-breasted chat population decreased.

TRRP has been largely successful in maintaining riparian and riverine bird abundance and diversity.

The declining trend of the yellow-breasted chat, as well as that of other shrub-associated species, suggests that the reduction in dense, well-developed shrub habitat may be limiting their populations. As restored habitat continues to mature, populations of shrub-associated species are expected to stabilize.

The trend for seven of the eight species with evidence for population declines matches the direction of the regional trend measured by National Breeding Bird Survey data (Sauer et al. 2014, cited in Rockwell and Stephens 2016); these data suggest that factors operating at a larger geographic scale than the Program area are responsible for the declines. Although substantial variation existed by reach, overall avian diversity within the Program area remained relatively stable (Rockwell and Stephens 2016).

HERPETOFAUNA MONITORING

TRRP management actions affect several species of reptiles and amphibians both directly and indirectly. Reptiles and amphibian populations require a full range of properly functioning riverine conditions to support the various stages of their life histories; consequently, these species provide indicators of habitat conditions both in the Trinity River and within the larger floodplain (TRRP 2009).

A comprehensive monitoring program for the river's varied wildlife is required to evaluate management impacts on wildlife. Foothill yellow-legged frogs (*Rana boylii*) and western pond turtles (*Actinemys marmorata*) have been identified as important herpetological species on which to focus monitoring efforts because of their status as California species of special concern and BLM and USFS sensitive species. (In addition, the USFWS is reviewing a petition to list the frog under the federal ESA.) These two species have been focal species of study on the Trinity River for many years. Adverse impacts to both species documented since construction of Trinity and Lewiston dams have been attributed to changes in channel morphology and flow dynamics (Reese and Welsh 1998, Lind et al. 1996) as well as water temperature (Wheeler et al. 2014). Restoring pre-dam functions to the Trinity River system should benefit these and most other native herpetological species (TRRP 2009).

In 2012, the TRRP enlisted the help of the USGS to develop and implement a Trinity River–specific monitoring strategy for these species, with the objectives of establishing baseline values such as the probabilities of the presence of animals at restoration sites (site occupancy) and estimating overall trends in the number of animals within the 40-mile reach (abundance). An initial 3-year study suggests that the probability of site occupancy by foothill yellow-legged frogs declined. Conversely, the results of the study suggest that western pond turtles increased in both abundance and the probability of site occupancy.

Long-term monitoring efforts would provide the information required to establish the response of foothill yellow-legged frogs and western pond turtles to restoration efforts and offer insight into the growth trends of other aquatic vertebrates in managed systems. Along with the preliminary results, the monitoring protocols presented in the USGS report (Snover and Adams 2016) provide a means of tracking trends in the probability of site occupancy and abundance for foothill yellow-legged frogs and western pond turtles. With continued efforts, the protocols can also provide information on how habitat changes correlate with the probability of local extinction. This information is invaluable to understanding the status of these populations over the long-term and can provide insights into how dam operation and restoration decisions might affect demographic processes. The next logical step in synthesizing this information will be the development of decision support tools to predict population responses to management actions (e.g., flow releases or channel rehabilitation projects) (Snover and Adams 2016).

DATA MANAGEMENT

The ultimate products of the TRRP will be twofold: a more functional river and the information we gather about it. The Program's online data portal (ODP) at <*http://odp.trrp.net*> is a key resource for managing TRRP information and coordinating data across the partnership.

The ODP is a data storage and access system that provides equal access to Program information to partners, stakeholders, and the public. The ODP includes online maps <*http://odp.trrp.net/Map/*>, with convenient and intuitive access to 14 data overlays and 6 aerial photography datasets dating as far back as 1944. The ODP now also provides convenient access to over 1,400 reports and other documents; over a hundred meeting agendas and summaries; 61 data packages; and millions of data points on stream flow, water temperature, and reservoir operations. Many of the reports and documents are scanned items dating as far back as 1900. Using web services to automatically provide up-to-date information on data and document holdings, the ODP interacts with the Program's general website at <*http://www.trrp.net*>.

REMOTE SENSING

Aerial Photography, Aerial LIDAR, and Terrestrial Laser Scanning

High-resolution aerial photography may be the most widely used type of data by the Program partnership since it provides the context for documenting changes in the river channel, designing restoration actions, planning scientific investigations, and communicating both within the Program and with the public. The annual collection of aerial photography from Lewiston Dam to the North Fork Trinity River provides a reliable census of the visual form of the river from a standardized point of view, enabling a variety of analyses of the changes in the river over time. Historic aerial photography datasets going as far back as 1944 provide context for current river conditions. The most recent aerial photography was collected on July 27, 2015; it spanned the Trinity River from Lewiston Dam to the North Fork.

Detailed topographic data have similarly widespread utility and can be collected over large areas by aerial LIDAR (light detection and ranging). Because LIDAR costs are significantly greater than for aerial photography, annual data collection is limited to documentation of the rehabilitation sites completed each year while reach-wide collection occurs less frequently.

Eric (right) monitoring and discussing river conditions with Brandt Gutermuth during a restoration flow release.

Eric Peterson
Data Steward

Eric Peterson has been TRRP's data steward since 2009. Eric manages about 2 terabytes—equal to 2,000 gigabytes—of Trinity River-related data and is responsible for making sure that TRRP's partners, work groups, and contractors have access to the data they need. He also designs the way information is displayed in TRRP maps and maintains TRRP's website.

Eric is responsible for managing TRRP's cache of documents, aerial photography, LIDAR data, and photogrammetry data. These are foundational datasets used extensively for the TRRP's implementation actions and various scientific projects.

Before joining the TRRP, Eric worked for the State of Nevada as a vegetation ecologist. He received a Ph.D. in Plant Ecology from Oregon State University and a B.S. in Botany from Humboldt State University. His research for the Ph.D. involved distribution modeling of lichens and the impacts of forest management on lichen communities.

On November 18, 2014, LIDAR was collected for the as-built condition of the Lower Junction City site. On December 15, 2015, LIDAR data were collected for the as-built condition of the Upper Douglas City and Limekiln Gulch rehabilitation sites.

TRRP works with two additional technologies to supplement aerial LIDAR for local 3D point cloud documentation and analysis: terrestrial laser scanning (TLS) and structure from motion photogrammetry (SfM). Both of these technologies provide survey-grade data collection (accuracy within +/- 0.5 feet). TLS has advantages for collecting ground surface data through some vegetation. SfM, however, provides more points of view, allowing all sides of the subject to be seen, as well as more flexibility in the ways data are collected, including from a raft on the river. The two technologies can be used interchangeably to analyze changes to individual features, as in the example of Lorenz Gulch (Figures 13 and 14) before and after restoration flows. Figures 13 and 14 show the recruitment of large wood, the loss of brush and rocks, and the removal of a single piece of large woody debris from a constructed wood jam during the 2015 restoration flow. Figure 15 shows a side channel at Upper Douglas City, another site expected to change with future flows. This side channel is also shown on the cover of this annual report.

Figure 16 shows aerial photographs of the Limekiln Gulch reach of the Trinity River taken over approximately 70 years. In 1944, the year the first photo was taken, the channel was highly complex, with bars and alcoves. By 1960, the channel had been reworked, presumably by the 1955 flood, though bars and alcoves remained in similar locations, likely due to bedrock controls. In the 1965 photo, vegetation is already evident on bars and other channel margins due to a lack of scouring flows after Lewiston and Trinity dams began holding back water. By 1980, vegetation growth had become quite thick, simplifying the channel form. The 1997 photos show little change from the New Year's Day 1997 flood; most of the visible changes are due to preliminary restoration efforts, including some of the first side channels and floodplains constructed on the Trinity River. The 2014 image shows the site prior to the channel rehabilitation project, with densely vegetated banks (largely left in the 2015 restoration) and a very simple channel, except where some side channels that were constructed earlier remained.

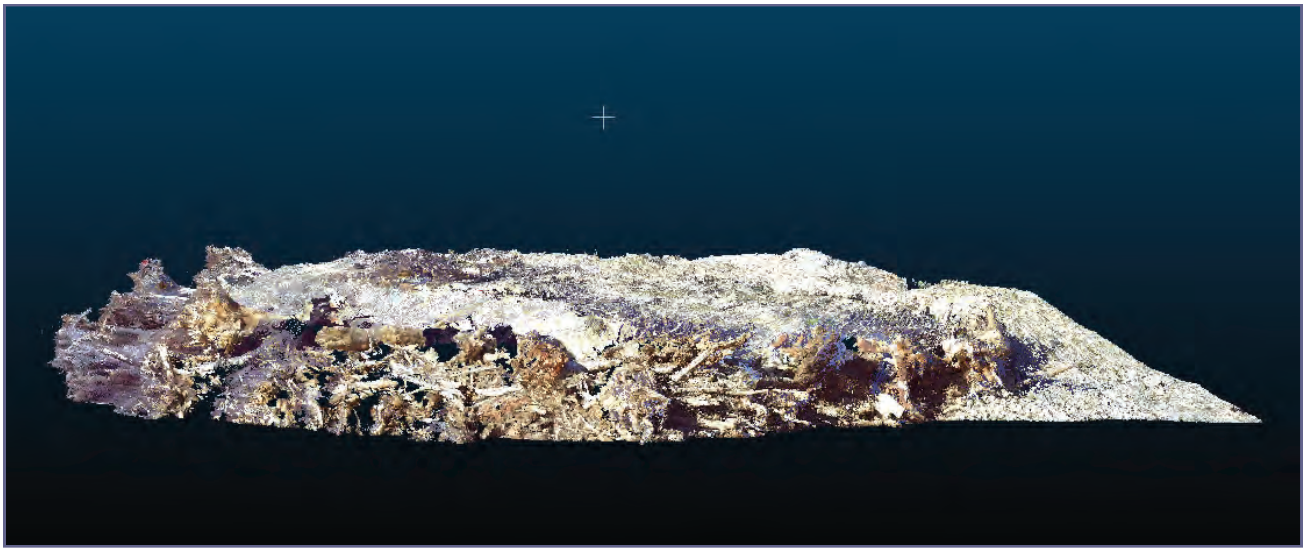


Figure 13
TLS scans of Lorenz Gulch wood jam, as-built. This shows an oblique, 2D view of the 3D point cloud developed after site construction in 2013 from approximately 10 laser scans.

Figure 14
SfM photogrammetry of Lorenz Gulch wood jam after 8,500 cfs restoration flow release in 2015. This shows the same oblique, 2D view as in Figure 1, but from a 3D point cloud developed from 42 ordinary photographs after the 2015 restoration flow release.

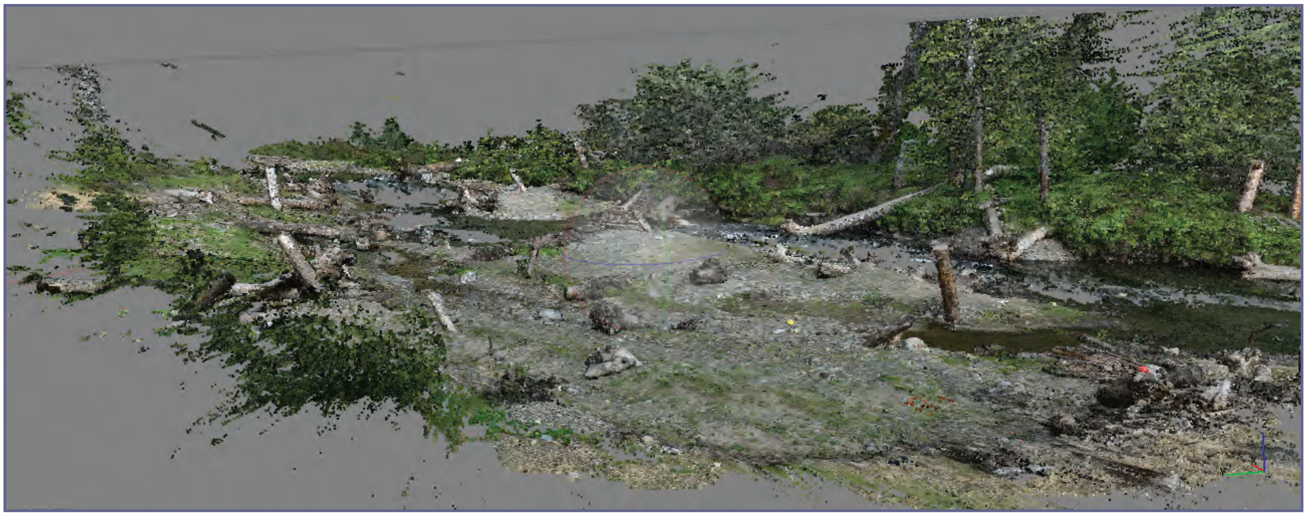


Figure 15

SfM photogrammetry of complex side channel area at the Upper Douglas City site, as-built. This location is expected to undergo significant geomorphic change and possible accumulation of large woody debris (due to upright logs) in subsequent restoration flows.

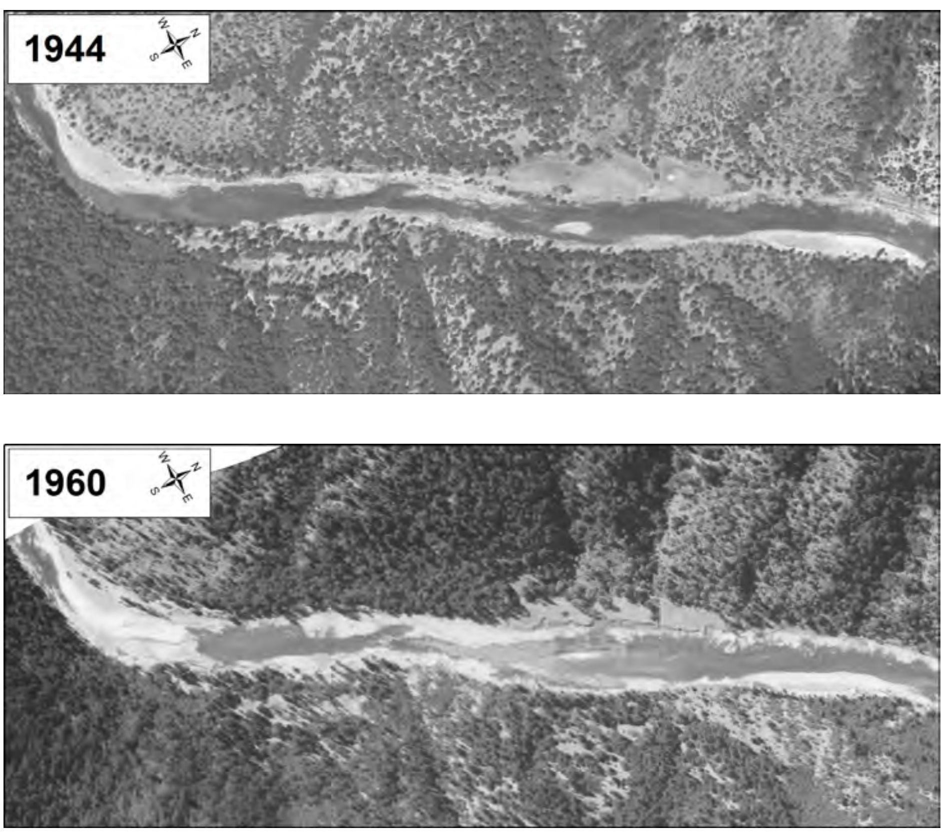


Figure 16.

Comparative aerial photographs of the Limekiln Gulch reach of the Trinity River.

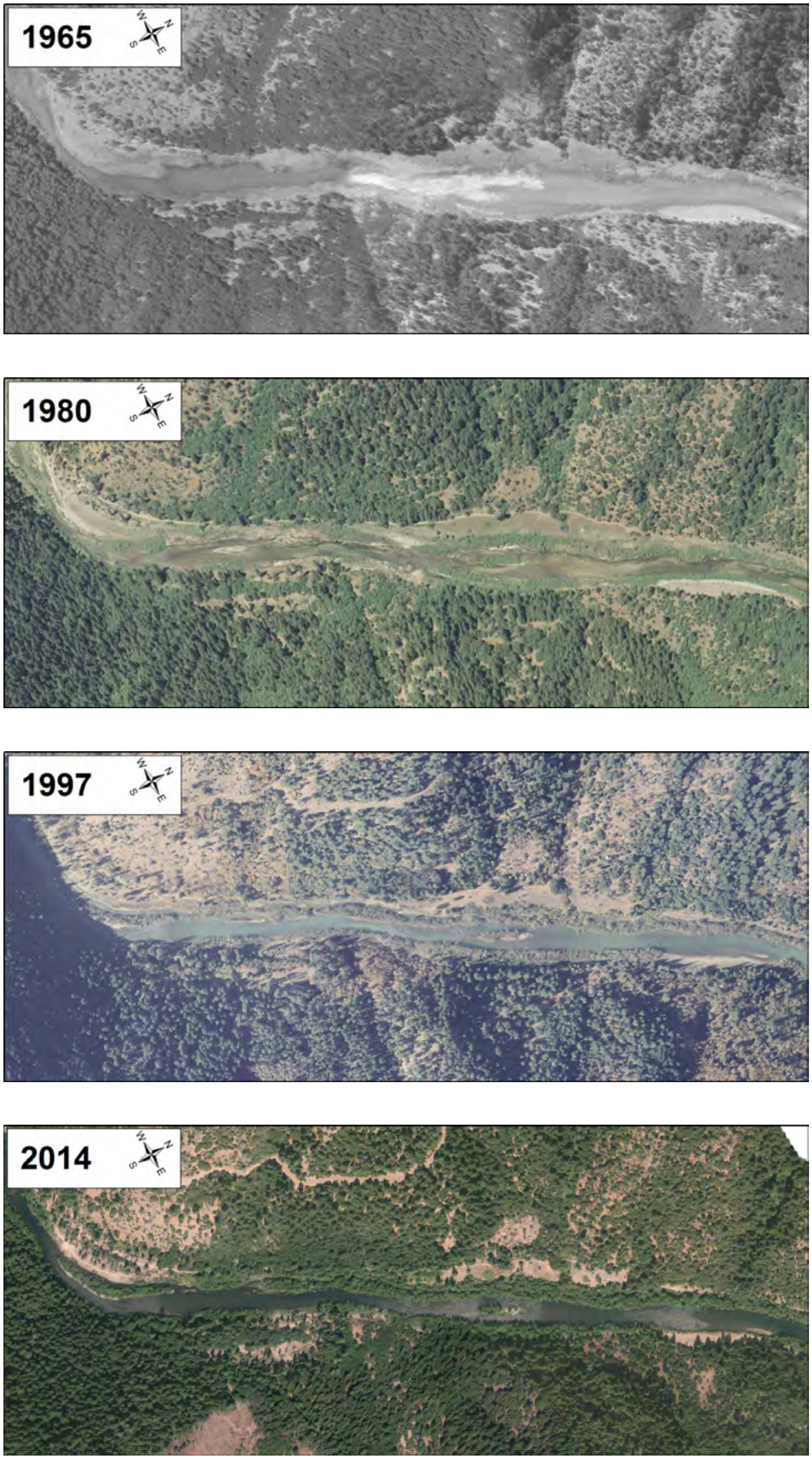


Figure 16 (continued).
Comparative aerial photographs of the Limekiln Gulch reach of the Trinity River.

Environmental Compliance and Mitigation

NEPA, CEQA, AND OTHER MANDATES

On January 1, 1970, President Richard Nixon signed NEPA into law. In California, Governor Ronald Reagan followed suit by signing CEQA into law on September 18 of the same year. These laws compel federal, state, and local agencies to analyze and disclose to the public the potential environmental effects of their proposed actions. NEPA applies specifically to actions proposed by federal agencies, and CEQA applies to actions proposed by California state agencies and local governments. CEQA requires that, to the extent feasible, the effects of the proposed actions be mitigated to minimize significant adverse environmental effects.

To meet NEPA and CEQA requirements, the TRRP continues its efforts to inform the northern California community, including partners, collaborators, and public and private stakeholders, about its proposals. Public meetings are held during the early stages of project site design and gravel augmentation planning. Subsequent meetings also help keep the public informed about any modifications made to the designs based on public or agency input and associated monitoring and evaluation before, during, and after in-channel project construction and revegetation.

Bear Island near Lewiston. The bar is growing in response to upstream gravel augmentation and high flow releases.

To carry out planned 2015 activities, the TRRP continued to prepare detailed site-specific environmental assessments and initial studies based on programmatic NEPA and CEQA documents for environmental compliance. The Trinity River Mainstem Fishery Restoration Final Environmental Impact Statement (USFWS et al. 2000) serves as the programmatic document under NEPA, and the Master Environmental Impact Report for Channel Rehabilitation and Sediment Management for Remaining Phase 1 and Phase 2 Sites (Master EIR; NCRWQCB and TRRP 2009) serves as the programmatic document under CEQA.

In addition to NEPA and CEQA, the following statutes, Acts, and Executive Orders (EOs) provide regulatory guidance concerning the type and intensity of actions that the TRRP may perform to benefit the health of the Trinity River fishery:

- Endangered Species Act of 1973
- Clean Water Act
- Wild and Scenic Rivers Act
- National Historic Preservation Act
- Archaeological Resources Protection Act of 1979
- EO 11988 for floodplain management
- EO 11990 for the protection of wetlands
- EO 13112 for invasive species
- EO 12898 for environmental justice

CHANNEL REHABILITATION COMPLIANCE

Activities associated with channel rehabilitation projects have the potential to result in short- and long-term impacts on protected Trinity River resources. Monitoring and mitigation help ensure long-term beneficial results.

Channel rehabilitation projects are designed to reestablish the physical and hydrological attributes that existed before the dams were built more than 50 years ago. The natural state of the Trinity River system and the particular processes that sustained a healthy fishery were severely altered not only by the effects of decades of restricted flows but also by early mining and logging operations.

Stakeholders request assurances that changes resulting from the channel rehabilitation projects will maintain fishery resources, river health, and tribal and public trust resources. Program partners also work to minimize and monitor impacts to non-target species (e.g., birds and other wildlife) and to cultural resources.

The EA/IS for the Limekiln Gulch channel rehabilitation project (North Coast RWQCB et al. 2015) was completed in May 2015. The EA/IS provides site-specific details about the project, which was first proposed in 2010. Project activities included constructing two side channels, lowering part of a barren floodplain and stocking it with woody material, installing wood jams ballasted with boulders, and slowing an existing side channel with gravel and a wood grade-control structure. Post-construction riparian improvement included revegetating wetland, upland, and riparian areas. A variety of native sedges, rushes, and willows were planted in the wetland/slope areas after the construction was completed.

OTHER COMPLIANCE ACTIVITIES

In 2015, the TRRP worked with the North Coast RWQCB (CEQA lead agency for the 2009 Master EIR and EA/EIR for the Remaining Phase I and Phase 2 Channel Rehabilitation and Sediment Management Activities (Master EIR and EA/EIR)) to review Program actions that are authorized under the Board's water certifications for sediment management and general channel rehabilitation activities. The impacts of these management actions were originally analyzed in the Master EIR and EA/EIR. The TRRP reviewed activities that, by design, evolved under adaptive management practices to learn whether these activities have changed in a manner that could have potentially significant adverse impacts. Based on the analysis, the North Coast RWQCB determined that Program actions and impacts are the same as or very similar to those that were previously evaluated. After the review, the Board issued General Water Quality Certification R1-2015-0028 for activities associated with the TRRP under section 401 of the federal Clean Water Act with essentially the same mitigation requirements as those for the 2009 Master EIR. The TRRP also received authorization from the U.S. Army Corps of Engineers to perform these activities under section 404 of the Clean Water Act.

The TRRP continued preparing Biological Assessments to address any possible new effects of Program activities on species listed as threatened or endangered under the federal ESA since the 2000 Biological Opinions were issued (NMFS 2000, USFWS 2000). In addition, some species that potentially have habitat in the Program area have been listed under the ESA since the original Biological Opinion was issued, and one species—the bald eagle—has been delisted. Furthermore, any activities or methods that have been modified through adaptive management decisions need to be analyzed for their continued benefits to the Trinity River ecosystem. It is anticipated that the Biological Assessments will be completed in 2016.

Projects performed on public lands managed by the USFS or the BLM must also meet the guidelines of the Northwest Forest Plan and the related Aquatic Conservation Strategy. In the same way that TRRP works with private landowners to implement mutually beneficial projects on their lands, the TRRP works with federal partners to ensure that their environmental compliance needs are met for each project.

ENVIRONMENTAL MITIGATION

Specific measures are required to avoid, minimize, and mitigate for short-term adverse effects, such as the removal of riparian and wetland vegetation, in order to support the goal of long-term benefits to the Trinity River fishery and associated habitats. The TRRP uses performance monitoring to determine the success of mitigation efforts. Environmental permits require no net loss of riparian lands and wetlands. Contractors provide healthy, native container stock or dormant cuttings; perform weeding, mulching, fertilizing, and irrigating; and install browse protection. Data collection includes performing field surveys pre- and post-project, obtaining aerial imagery and GIS documentation, and detailed reporting.

The TRRP uses performance monitoring to determine the success of mitigation efforts.

Other important work involves removing invasive species such as Dyer's woad, star-thistle, and tree-of-heaven as well as non-native species, both of which can out-compete native vegetation. Since using herbicides is discouraged on public lands in Trinity County, invasive and non-native species have been manually removed, a labor-intensive process. After removal, re-infestation must be prevented until native species can become established. The TRRP contracts with local agencies to maintain revegetated sites, but success is hard-won. Drought and high temperatures can reduce the survival rate of native plants to less than half of what is planted. This means that crews must return to the project sites annually to counter vegetation losses and keep survival at or above replacement requirements.

Cultural Resources

The Program works with BLM, the Forest Service, and Reclamation archaeologists to evaluate the status of cultural resources, such as old homesteads, apple orchards, and tailings piles, at proposed channel rehabilitation sites. The archaeologists also evaluate whether these resources might make a significant contribution to our understanding of history and might be eligible for inclusion in the National Register of Historic Places (NRHP).

Federal land managers along the Trinity River are also subject to guidelines of the Archaeological Resources Protection Act of 1979.

As implementation of the ROD was considered, the potential impact to cultural resources in the restoration reach was recognized. To ensure preservation of historic resources, a programmatic agreement between the federal agencies, the HVT, and the California State Historic Preservation Office was developed.

Much of the Program's work is confined to the floodplain, where historic resources have lost much of their integrity during flood events. However, the large scope of the channel rehabilitation projects and the interrelatedness of the remaining historic sites along the river (e.g., Trinity Historical Mining District) have continued to impress researchers, suggesting the need for a comprehensive analysis of historic resources throughout the restoration reach. To date, cultural resources studies have included archaeological surveys within the project areas and evaluations of any identified cultural resources for inclusion in the NRHP.

In 2013, the Program developed a map-based historic context report to determine which areas within the proposed project sites might be eligible for NRHP listing (AECOM 2013). The report is now being used to facilitate site-specific surveys as each new site is evaluated. Two historic context documents are available for reading about historic conditions and events along the Trinity River: *The Other California Gold—: Trinity County Placer Mining, 1848-1962* (Bailey 2008), and *Historic Context for Mining along the Trinity River* (AECOM 2013).

As a site-specific example, investigations were conducted at the Limekiln Gulch project site where the Premier Hydraulic Mine Site was documented and quantified. This historic complex was determined to contain significant cultural character with evidence that suggested activities pre-dating 1880; part of the complex was determined to be eligible and the remainder was determined to be ineligible for the NRHP. The project was redesigned to avoid the area containing historic character. Reclamation committed to provide funding assistance in support of a historic preservation and protection program in this area.

Turbidity

Turbidity is a measure of light scattering in water. Waters that measure high in nephelometric turbidity units (NTU), the common turbidity unit, appear cloudy to the human eye.

Turbidity in the Trinity River is typically low in the summer but, like in most rivers, occurs naturally during storms or other runoff events. Turbidity may also be caused by construction or other human activities in the river. The permits needed for restoration projects such as gravel augmentation or mechanical channel rehabilitation require that TRRP construction contractors ensure that Trinity River water does not become excessively turbid.

Figure 17 shows flow and turbidity in the Trinity River above the North Fork for water year 2015. The highest turbidity values are measured during high tributary flows from winter storm events, and the lowest values occur during minimum river and tributary flows.

As the CEQA lead agency for the 2009 Master EIR, the North Coast RWQCB worked with the TRRP to develop water quality mitigation measures

Brandt is observing gravel augmentation during high flows across from the weir hole augmentation site.

Brandt Gutermuth
Environmental Scientist

Brandt Gutermuth has been with the TRRP since the office first opened in 2002. As an environmental scientist in the TRRP's Implementation Branch, Brandt is responsible for ensuring that the program complies with environmental laws and regulations, including NEPA and CEQA.

Brandt's contributions go beyond environmental compliance. He describes his job as "doing whatever it takes to implement high-quality restoration," which means he is involved in numerous other aspects of the TRRP. He works with the TRRP's various partner agencies to support native flora and fauna. He has been a champion for creation of wetlands, native grass seeding, weed management, and population monitoring of frogs and turtles. In addition, Brandt works with local landowners and state and federal managers to make sure that mutually beneficial projects are constructed.

Before joining the TRRP, Brandt worked for various federal and state agencies in data management and monitoring/planning for recovery of threatened habitats and aquatic species. He also worked for 5 years in private industry to measure and mitigate the company's environmental impacts.

Brandt has an M.S. in Fisheries from the University of Washington and a B.S. in Biology from the University of Michigan.

for TRRP activities; these measures were also included in the initial (2010) 5-year water quality certifications (permits) for channel rehabilitation, fine sediment reduction, and coarse sediment management activities. Because of the nature of the proposed restoration activities and the clarity of the Trinity River during low flow conditions, the North Coast RWQCB determined that an allowable zone of turbidity dilution is appropriate and necessary for Trinity River restoration activities to be accomplished in a meaningful, timely, and cost-effective manner that fully protects beneficial uses without resulting in a violation of the North Coast RWQCB Basin Plan objective for turbidity.

The 2010 permits state: "[W]hen naturally occurring background levels are less than or equal to 20 NTUs, turbidity levels immediately downstream of the allowable zone of turbidity dilution shall not exceed 20 NTUs. When naturally occurring background levels are greater than 20 NTUs, turbidity levels downstream of the 500 linear foot zone of dilution shall not be increased by more than 20 percent above the naturally occurring background level."

After the 2010 permits were issued, TRRP turbidity monitoring demonstrated that when background turbidity levels in the river were relatively high (e.g., >15 NTU), permitted turbidity values for sediment augmentation projects could be exceeded while still protecting beneficial uses. The North Coast RWQCB has interpreted the language in the 2010 Water Quality Certification for Coarse Sediment Augmentation to apply when background turbidity values are approaching 20 NTU, thereby allowing a 20 percent (i.e., 4 NTU) increase in turbidity at the point of compliance 500 feet downstream. The flexibility developed under the 2010 Water Quality Certification for Coarse Sediment Management enabled the TRRP to help ensure that gravel augmentation would remain protective of beneficial river uses.

The North Coast RWQCB reissued all three of its water quality permits in 2015 with the following turbidity condition: "Turbidity levels downstream of the 500 linear foot zone of dilution shall not be increased to greater than 20 NTUs or 20% above background, whichever is greater." This clarification resulting from the North Coast RWQCB interpretation of the 2010 permits ensures that the TRRP actions are consistent with the permit language, are protective of the river, and allow for lawful restoration activities (e.g., gravel augmentation) under nearly all monitored turbidity conditions to date.

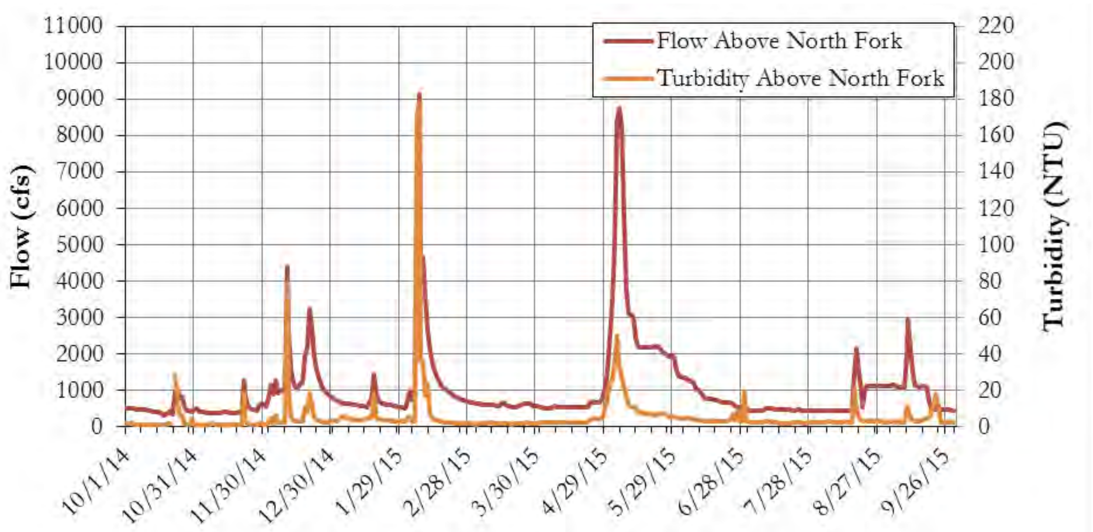


Figure 17

For water year 2015, the flow rate in the Trinity River above the North Fork is shown in red and turbidity is shown in orange.

TURBIDITY MONITORING AT 2015 CONSTRUCTION SITES

During 2015 construction, the contractor successfully employed best management practices (e.g., isolation of work areas, pumping of turbid water into upslope sediment ponds, and slowing of work during periods of increased turbidity) to ensure that turbidity consistently stayed within permit levels. The highest turbidity values at the Upper Douglas City project were measured on August 3, 2015, when the contractor was cleaning out and placing wood in location IC-2; work was stopped to allow the turbidity level to decrease. The highest turbidity values at Limekiln Gulch were measured on August 5, 2015, when the contractor was excavating in location IC-1; again, work was stopped to allow turbidity levels to decrease. While the contractor's attention to detail allowed the TRRP to minimize 2015 construction-related turbidity impacts, late summer flow releases from Lewiston dam intended to benefit Lower Klamath River water quality conditions caused short-term turbidity impacts that were measureable at the North Fork Trinity River monitoring site (Figure 17.)

Public Outreach in 2015

The TRRP completed an ambitious public outreach schedule in 2015, with both new and continuing efforts.

PUBLIC EVENTS

The TRRP's public events during 2015 included the second of the Phase II Lessons Learned Workshops: "The Evolution of Gravel and Fine Sediment Management on the Trinity River." This workshop offered an opportunity to learn about the science behind the Program's sediment management strategy, how methods for sediment management have changed, and what has been learned over the last 15 years through adaptive management.

Events like this workshop give the public the opportunity to learn about the physical processes important to restoring the Trinity River and how implementation of Program activities sets the stage for natural processes to take over, allowing the river to use the new "tools"—variable flows, gravel, wood, and more complex physical features—to form dynamic and more sustainable habitats for fish and riparian wildlife. The Program is continuously updating its conceptual models to better quantify the effects of these restoration tools on sediment transport, bed scour, gravel storage, and other types of geomorphic change.

Another public event, the 2015 Public Float, took place on June 26. Landowners, stakeholders, and people interested in the Trinity River were able to view completed projects and proposed project sites during the float down the river. The float began at the Evan's Bar boat launch and continued downstream through the Lower Valley Suite of channel rehabilitation sites near Junction City.

PUBLIC MEETINGS AND WORKSHOPS

Several formal and informal meetings were held in 2015 to describe projects proposed for implementation in 2015 and to gather public input about possible activities and mitigation measures related to these projects. A primary objective of the TRRP's public meetings is to increase the public's knowledge and understanding of the roles of Program partners and cooperators in implementing TRRP science activities, including monitoring and evaluation.

Formal public meetings required under NEPA and CEQA were held to receive scoping comments for the 2015 Limekiln Gulch channel rehabilitation project and to receive comments on the EA/IS prepared for the project. There was also a Gravel Recommendations informational meeting, providing a forum for local residents to hear about the upcoming flow release schedule based on the forecasted "Dry" year designation and the associated gravel augmentation recommendations.

In addition to the formal public meetings required by environmental compliance regulations, a meet-and-greet was held in the Lower Valley Suite neighborhood to inform local landowners about the planning process for proposed channel rehabilitation projects in their area. Similarly, a meet-and-greet was held with residents of the Limekiln Gulch neighborhood shortly before the Limekiln Gulch channel rehabilitation project began in July 2015. Neighborhood residents were invited to ask questions about project activities and the construction schedule.

The 2015 Public Float was held in early summer.

COMMUNITY EVENTS

TRRP provides financial support to the Trinity County Resource Conservation District for the Salmon Festival, Trinity County Fair, Children's Festival, Weaverville Summer Day Camp, and Environmental Camp. TRRP technical staff volunteered as science instructors for "Science in the Field" and "Day at the Wetlands" for local school students. The TRRP also continued its educational outreach at the Trinity River Salmon Festival and other community events.

FUNDING OF THE CONSERVATION ALMANAC

TRRP continued to fund the publishing and distribution of the Trinity County Resource Conservation District's quarterly newsletter, the *Conservation Almanac*. The Almanac featured several TRRP articles in 2015, including Enjoying the River—Why Do Flows Change in Summer?, Restoring the River—Why Add Gravel and Wood to the River?, and Drought Conditions on the Trinity River.

IN-PERSON CONTACT AND RESPONSE

Inquiries about the Program and its projects were welcomed from walk-ins, telephone calls, and email messages at the TRRP Weaverville office. We received a wide range of questions, often regarding spring restoration flow release schedules, duration, ramping rates, and maximum peaks. TRRP volunteers and private citizens continued to post the approved restoration hydrographs at

Educational outreach activities also included the Cub Scouts' White Oak seedling count outing, a turtle workshop for the Hoopa Valley Tribe after-school program, and a field visit with the Humboldt State University Public Lands Planning class.

approximately 40 sites along the river to update river users about coming changes in the river flows.

ONE-ON-ONE MEETINGS

Individual meetings with private landowners were held on their properties to arrange for rights of entry for upcoming projects and monitoring of revegetation at a previous project site.

INTERNET AND MEDIA PRESENCE

TRRP's official website, <*http://www.trrp.net/*>, is used to post announcements, scientific data, technical papers, and other information on the website. In 2015, the Program continued to review, improve, and update website content to provide pertinent, useful, and accessible information for the public.

A number of articles regarding TRRP's 2015 activities appeared in various regional media. TRRP also funds the outreach website <*www.trinityriver.org*>.

Michele served as the TRRP's Project Coordination Specialist for about 4 years.

Michele Gallagher
Former Project Coordination Specialist

Michele Gallagher served as Project Coordination Specialist for the TRRP from August 2012 to May 2016. At the TRRP, she was responsible for developing partnerships with local landowners, stakeholders, and other individuals and interest groups. She was also responsible for facilitating communication between the TRRP and the local community.

Michele's technical duties included preparing and administering realty contracts and construction and right-of-way permits. She also helped prepare environmental compliance documents and project-specific plans.

Michele has a B.S. in Biological Conservation from the University of Wisconsin at Milwaukee and a B.S. in Behavioral Science from the University of Wisconsin at Parkside.

Before coming to the TRRP, Michele was a Migratory Birds Permits Administrator in the Albuquerque, New Mexico office of the USFWS. Michele said that she loved working at the TRRP but that she missed the Southwest. In May, she transferred back to Albuquerque to become a Realty Specialist for Reclamation.

Looking Ahead: 2016 Program Activities

In 2016, the TRRP is continuing to execute the restoration strategy based on the ROD (U.S. DOI 2000), the Trinity River Mainstem Fishery Restoration EIS/EIR (USFWS et al. 2000), and the Trinity River Flow Evaluation Final Report (USFWS and HVT 1999). Activities proposed for the year include construction of a channel rehabilitation project at Bucktail; completion of design and compliance requirements for the Lower Dutch Creek, Deep Gulch, and Sheridan channel rehabilitation projects; WY2016 flow schedule planning and implementation; completion of identified priority watershed projects; coarse sediment augmentation depending on the water year type; the addition of gravel based on how much water is available to mobilize it; and continuation of monitoring and assessment projects. At the time this 2015 annual report was published, some of these activities were in progress.

FLOW MANAGEMENT

Preliminary modeling of the ecosystem response to Lewiston Dam releases indicates that flow management strategies should move toward a hydrology that more closely mimics that of regional streams by providing higher flow rates in the winter—higher and potentially more variable than a flat 300 cfs base—and earlier in the spring. A simple goal for TRRP scientists might be to have the Trinity mainstem reach peak spring flows at the same time that the tributaries do. TRRP scientists continue to develop methodologies consistent with the ROD to provide winter flows for the benefit of anadromous fisheries and to promote a healthy river.

ENVIRONMENTAL COMPLIANCE

TRRP's restoration activities continue to evolve as new information is collected and evaluated. This focus on adaptive management enables the TRRP to better achieve the goals set forth in the ROD.

Since the ROD and the associated Biological Opinions (NMFS 2000, USFWS 2000) were issued, the status of several species, or their designated critical habitats, that occur in the Trinity River watershed have been under review or have changed. Some species that are now listed or proposed for listing under the ESA and/or their designated critical habitats were not listed or designated when the TREIS/EIR, the ROD, and the 2000 Biological Opinions were prepared and were therefore not analyzed in these documents. New restoration techniques were also not analyzed. Because of these changes, we have reinitiated consultation with NMFS and the USFWS under Section 7 of the ESA. We are also working with our partners to develop a new programmatic Biological Assessment that will ensure that our actions to restore the Trinity River comply with the ESA.

FEMA FLOODPLAIN MAPPING AND COUNTY FLOODPLAIN DEVELOPMENT COMPLIANCE

The new FEMA Flood Hazard Zone maps are effective as of July 2016. TRRP staff are working with FEMA, CDWR, and Trinity County to update floodplain maps to include changes due to recent projects and to ensure that new project designs minimize changes to the 100-year base flood hazard zone.

FISH PRODUCTION MODEL

We are continuing to develop a salmonid production model for the Trinity River that will link to a Klamath River model. The model will be a component of the TRRP Decision Support System that can be used to evaluate (1) the response of fish production to different flow management alternatives; (2) the response of fish production to different proposed channel rehabilitation project designs; (3) fish growth and resulting production in response to water temperature; and (4) the growth/size and survival of fish in response to different flow/temperature alternatives. Figure 18 is a graphic of the fish production model.

STAKEHOLDER INVOLVEMENT

Outreach and other forms of stakeholder involvement continue through outreach materials, updates to the TRRP website <*www.trrp.net*>, public meetings and seminars, at least one public float per year, work with private landowners on rehabilitation projects, educational outreach to students through field days, and informational booths at fairs and festivals such as the Trinity County Fair, the Trinity River Salmon Festival in Weaverville, and the Return of the Salmon Festival in Anderson. The TAMWG continues to provide an opportunity for stakeholders to give policy and management advice about restoration efforts.

IMPLEMENTATION MONITORING

TRRP and its partners will be instituting new approaches to monitor gravel movement, physical habitat attributes, and juvenile rearing to track the effectiveness of sediment management and channel rehabilitation projects.

CHANNEL REHABILITATION

In 2016, the Bucktail channel rehabilitation project will be constructed in the vicinity of the Bucktail river access; features of this project include:

- constructing low-flow side channels and split-flow structures to provide juvenile salmon rearing habitat;
- connecting an existing seasonal wetland to surface and subsurface flows to provide juvenile salmon rearing and foraging habitat;
- shifting the main channel into a new meander to decrease slope and increase spawning area;
- lowering areas of the floodplain to increase connection to the river at a greater range of flows, thereby increasing shallow rearing habitat;
- installing engineered log jams and a beaver dam analog to increase juvenile fish-rearing area, provide habitat variablility, and enhance groundwater retention and riparian condition; and
- revegetating construction-disturbed upland and riparian areas.

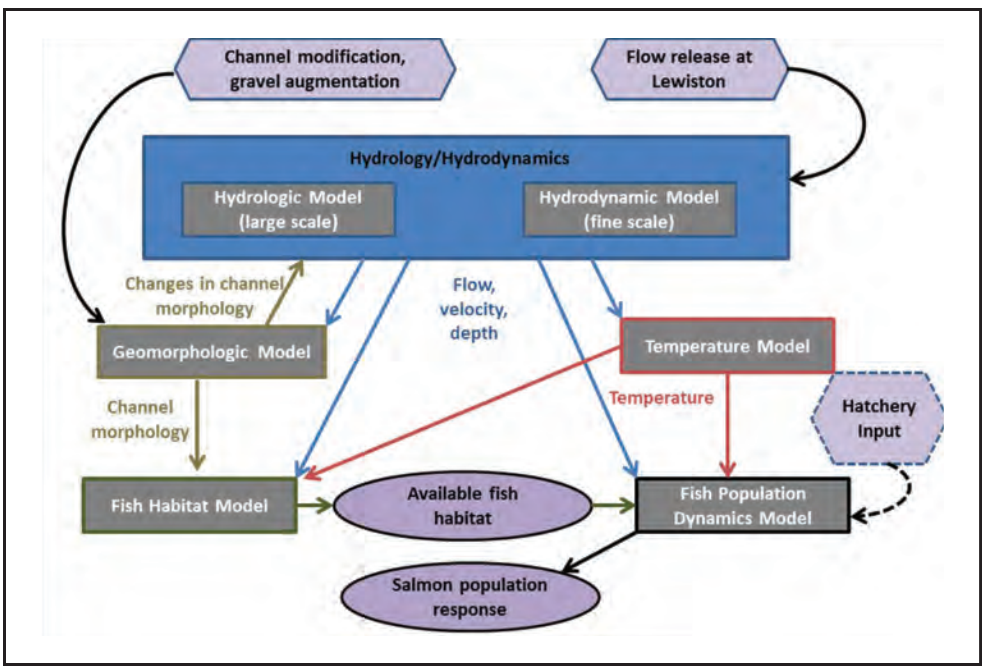


Figure 18. Decision Support System: TRRP Conceptual Integrated Model.
Source: James T. Peterson, 2013. Decision Support System framework for adaptive management. Presentation at TRRP 2013 Science Symposium TRRP's Scientific Advisory Board Review of Phase 1; January 8, 2013.

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Web Sources

- *<http://www.trrp.net/background/>*

  The TRRP website with information on the Trinity River and the Program.

- *<http://www.trrp.net/background/foundations/>*

  A chronological list with links to foundational and other pertinent documents.

- *<http://www.fws.gov/arcata/fisheries/activities/habRestoration/default.html>*

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- *<http://www.trrp.net/structure/tmc/>*

  TMC information including bylaws

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The 2015 Annual Report of the Trinity River Restoration Program is available electronically at www.trrp.net and includes web links to reference material and agencies.

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Acronyms

ºC	degrees Celsius
ºF	degrees Fahrenheit
AEAM	Adaptive Environmental Assessment and Management
afa	acre feet annually
BLM	Bureau of Land Management
CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CVPIA	Central Valley Project Improvement Act
DGC	Douglas City (rehabilitation site)
DOI	Department of the Interior
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Administration
Flow Study	Trinity River Flow Evaluation Study
FNF	full natural flow
FY	fiscal year
GRTS	generalized random-tessellation stratified (sampling design)
HVT	Hoopa Valley Tribe
km	kilometer(s)
LIDAR	light detection and ranging
LWS	Lewiston Gage
m	meter(s)
m^3/s	cubic meters per second
North Coast RWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRHP	National Register of Historical Places
NTU	nephelometric turbidity units
ODP	online data portal
Program	Trinity River Restoration Program
PT	Pear Tree Gulch rotary screw trap site
Reclamation	Bureau of Reclamation
RM	river mile
ROD	Record of Decision
SAB	Scientific Advisory Board
SfM	structure from motion photogrammetry
SWRCB	State Water Resources Control Board
TAMWG	Trinity Adaptive Management Working Group
TLS	terrestrial laser scanning
TMC	Trinity Management Council
TRD	Trinity River Division
TREIS/EIR	Trinity River Environmental Impact Statement/Environmental Impact Report
TRFES	Trinity River Flow Evaluation Study
TRRP	Trinity River Restoration Program
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCT	Willow Creek rotary screw trap site
WY	water year (October through September)
YT	Yurok Tribe

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Back cover photo: TRRP partners conducting redd and carcass surveys downstream of the 40-mile restoration reach.

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