Trinity River Restoration Program 2013 Annual Report

Trinity River Restoration Program

Restore • Adapt • Improve

Weaverville, California
June 2014

Thank You

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

ON COVER: Collage representing TRRP activities. From top: Snorkelers enumerating juvenile salmonids, the river at the Lorenz Gulch site following rehabilitation, an egg mass of the foothills yellow-legged frog, adult Chinook salmon coming upstream to spawn, several juvenile Chinook, and an aerial view of the Upper Junction City site following rehabilitation.

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Introduction

Background

The Trinity River Restoration Program (TRRP or the Program) is a partnership of Federal, State, Tribal, and Trinity County entities that share in the responsibility to restore the Trinity River between Lewiston Dam and the confluence of the North Fork Trinity River. The Program was formed to mitigate for effects of the dams built on the Trinity River in the 1960s, Trinity Dam and Lewiston Dam. Greatly reduced flows led to a steep decline in anadromous fish in the river. The restoration of these fishery resources requires a collaborative effort with other Federal, State, and local entities to develop projects beneficial to the fish, the river, and the watershed, and to meet tribal and public trusts. TRRP was founded in 2000, based on three comprehensive foundational documents:

1. The landmark Trinity River Flow Evaluation Final Report (TRFES) prepared by the U.S. Fish and Wildlife Service and the Hoopa Valley Tribe (USFWS and HVT 1999) with technical support from the U.S. Geological Survey, Bureau of Reclamation, the National Marine Fisheries Service, and the California Department of Fish and Game;
2. The Trinity River Environmental Impact Statement Final Report (TREIS/R; USFWS et al. 2000);
3. The Record of Decision (ROD; U.S. Department of the Interior 2000), which summarized the concepts found in the originating documents.

The active rehabilitation work of the Program began in 2004 with the first restoration flows and the first in-channel project in 2005. It 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 Program is administered by two bureaus of the U.S. Department of the Interior as co-leads: the Bureau of Reclamation (Reclamation) and the U.S. Fish and Wildlife Service (USFWS). Other partner agencies share in the decision-making process through the Trinity Management Council (TMC): the Hoopa Valley Tribe (HVT), the Yurok Tribe (YT), Trinity County, the California Resources Agency

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 Evaluation Study

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

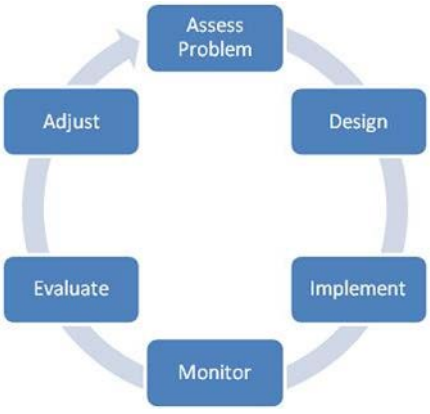
1992: Congress enacted Central Valley Project Improvement Act with 340,000 acre-feet (0.42 km^3) of water available to the Trinity River

1999: Flow Study is completed and is used as Preferred Alternative in EIS/EIR

2000: Record of Decision (ROD) signed, establishing modern TRRP with minimum water volume allocations determined annually by the water year type

Adaptive Management

The Trinity River Restoration Program was established by the Record of Decision 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.



The steps of the adaptive management process.

(which includes the State of California's Department of Water Resources (CDWR) and its Department of Fish and Wildlife (CDFW)), the U.S. Forest Service (USFS), and the National Marine Fisheries Service (NMFS). All activities of the Program are guided by the Federal laws that authorize the Trinity River Restoration Program and by documents that outline the Program function and available alternatives for implementing restoration activities.

The ROD summarized the guidance found in the TRFES, the TREIS/R, and the Implementation Plan for the Preferred Alternative of the TREIS/R (Stalnaker and Wittler 2000). The ROD describes the permanent flow allocation for the Trinity River based on five different water-year types, varying from "critically dry" to "extremely wet" years.

The ROD also established the Trinity Management Council, the decision-making body made up of entities with management responsibilities in and along the river. The ROD stated that the TMC will establish and guide Adaptive Environmental Assessment and Management (AEAM), an adaptive management program to monitor and evaluate the physical and biological responses to restoration activities.

One part of the AEAM organization is a federally appointed advisory committee under the oversight of the USFWS, the Trinity Adaptive Management Working Group (TAMWG — http://www.fws.gov/arcata/fisheries/tamwg.html). The TAMWG provides advice to the TMC; its members represent interest groups of local citizens, landowners, recreation, water users, environmental organizations, agriculture, utilities, business, and other agencies.

The Program is staffed by physical, environmental, and biological scientists, technicians, and administrative specialists drawn from its partner agencies and organizations (www.trrp.net) to carry out the interdisciplinary rehabilitation and science activities specified in the preferred alternative of the TREIS/R. Each partner agency designates its own technical experts to participate in the work groups and teams funded by the Program that plan, design, implement, monitor, and assess TRRP restoration efforts. The technical work groups and teams provide scientific information and recommendations to the TAMWG, stakeholders, and the public, for approval by the TMC. Based on the technical recommendations, the TMC provides direction to the Program

regarding monitoring and evaluation, and management action implementation.

Mission

The mission of the Program is to restore fisheries and wildlife to the Trinity River using a set of procedures outlined in the Program's foundational documents and conceptual plans (http://www.trrp.net/background/foundations/) while still providing beneficial flows to the Central Valley. The river was dammed and most of the flow was diverted to the Sacramento Valley beginning in 1963, as part of the Trinity River Division of the Central Valley Project, a Federal water development program for California, managed by Reclamation. The diverted water enters the Sacramento River near Redding, California, and provides for a variety of uses such as agriculture, industry, drinking water, recreation, electrical power generation, and habitat. By 1970, it became apparent that the diversion of an average of 75 percent of the water to the Sacramento River was a cause of the declining fisheries in the Trinity River (USFWS and HVT 1999). Federal legislation at that time and in subsequent years has called for a variety of protections to the river, including Native American tribal rights for access to Trinity River fish and protection of pre-dam levels of fisheries among other benefits for river users.

Congressional Authorization

As early as 1955, Congress passed legislation authorizing the Trinity River Division (Public Law No. 84-386) as an integrated component of the Central Valley Project, specifically directing the Secretary of the Interior to ensure the preservation and propagation of fish and wildlife in the Trinity Basin through the adoption of appropriate measures.

Studies of the river, culminating in the Record of Decision, concluded that the best option to both continue water deliveries to the Central Valley Project and recover fisheries in the Trinity would require (1) the commitment of approximately one-half the inflow to Trinity Reservoir for instream flows in the Trinity River, and (2) a set of physical restoration projects to increase habitat for fish. The Trinity River receives its flow through Lewiston Dam, which receives water from Trinity Dam. Flows released to the Trinity River as described in the ROD are referred to as restoration flows.

Goals

The founding documents define the goal of restoring the Trinity River fishery resources in a managed river that has the characteristics of a healthy *alluvial river*, and TRRP's actions are designed to support this goal. The physical restoration efforts on the river, such as the Lorenz Gulch site completed in 2013, are designed to implement this goal. Environmental assessment and monitoring activities provide periodic scientific

evaluations of the success of the Program in meeting habitat and fishery restoration goals. Partner agencies and collaborating natural resource management agencies work together to implement river and watershed projects and to improve management of the river and restoration of the fishery resources. These agencies include, among others:

- Hoopa Valley Tribe (HVT)
- Yurok Tribe (YT)
- U.S. Fish and Wildlife Service (USFWS)
- National Marine Fisheries Service (NMFS)
- U.S. Forest Service (USFS)
- California Department of Fish and Wildlife (CDFW)
- California Department of Water Resources (CDWR)
- Trinity County
- Bureau of Land Management (BLM)
- Trinity County Resource Conservation District
- Natural Resources Conservation Service
- Various nongovernmental organizations involved in watershed and fisheries restoration funded through the Program.

More information on the Trinity River, the TRRP, and the Central Valley Project is available through links provided in the References section at the end of this annual report.

The Program in 2013

TRRP broke ground on its first project in 2005, and in the past 9 years has focused on the first five management action goals outlined in the ROD, within the context of environmental compliance and adaptive management. The five goals place a priority on physical restoration of the river to create 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 rehabilitation and restoration activities. Monitoring and evaluation activities mark progress toward these desired states. Through 2013 the Program completed 30 of the 47 projects described in the Flow Evaluation Study. 2013 provided a unique opportunity to construct a project in cooperation with the local water district, the Weaverville Community Service District, to meet the mutual objectives of creating more juvenile fish habitat and reducing the district's dependence on a local creek that cannot meet demand in drier years.

The TRRP Scientific Advisory Board (SAB) continued its work on a broad, wide-ranging review of previous channel rehabilitation projects. (See Phase I Channel Rehabilitation Project Review sidebar.) The review addresses Phase 1 projects (2005–2010) and presents both data review and analyses compiled from information provided to the SAB by the TRRP. During 2013, the SAB submitted eight draft reports to the TRRP for technical review. These reports form the basis of the Phase I Review. The review was also the topic of the January 2013 Science Symposium, an event that allowed SAB members to share draft review findings with the TMC, TAMWG, TRRP technical staff, and the public.

Two mechanical channel rehabilitation projects were constructed in 2013: Lorenz Gulch and Lower Douglas City. As in previous years, the projects were designed by a multi-disciplinary, multi-agency team of experts and informed by interested stakeholders. Unique characteristics of each site were incorporated into the designs, which are intended to increase aquatic habitat for salmonids over a range of flow conditions by creating hydraulic and ecological complexity. They are further described in the "Mechanical Channel Rehabilitation" section of this report. Revegetation was a key element at the Lorenz Gulch site, where more than 7 acres (2.8 hectares) of native riparian species have been planted. Development of the Lower Douglas City project included collaboration with the Weaverville Community Services District to replace an aging infiltration gallery, improving the District's ability to deliver water from this site to Weaverville and surrounding communities.

Calendar year 2013 was the driest year on record in the Trinity region. Water year 2013 (October 2012 – September 2013) was classified as Dry, corresponding to a restoration release volume of 453,000 acre-feet (0.559 km^3). The Trinity Management Council adopted a flow schedule designed to provide improved rearing conditions for fry and juvenile Chinook salmon given the previous year's exceptionally high natural Chinook salmon escapement and subsequent high emergence success and fry abundance. Additional information about water year 2013 is reported in the Flow Management section of this report.

In addition to implementing restoration flows and mechanical rehabilitation projects, TRRP implemented sediment management activities, monitoring studies, and environmental

Phase I Channel Rehabilitation Project Review

The Program's Science Advisory Board (SAB) has been charged with overseeing a comprehensive evaluation of the first half of the planned channel rehabilitation projects (referred to as Phase I). Emphasis is to be placed on learning from past management actions, understanding ecosystem processes, development of guidance for hypothesis testing, and advancing adaptive management by the TRRP. Findings from the review will be used to plan future rehabilitation actions and to adjust the TRRP's adaptive management process. One of the emerging recommendations is that the Program should incorporate a Decision Support System to focus TRRP resources on desired outcomes.

compliance activities in 2013. Sections of the 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.

Funding and Expenditures

Fiscal Year 2013 Funding (in millions of dollars)	
BUREAU OF RECLAMATION	
Water & Water-Related Fund	11.38
CVPIA* Restoration Fund	2.00
U.S. FISH & WILDLIFE SERVICE	
FY 2013 Appropriations	1.98
TOTAL	15.36

*Central Valley Project Improvement Act

Program funding has mostly varied between $10 million and $16.66 million per year since 2002. In 2013 the Program received a total of $15.36 million, as shown in the table at left.

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

The Program budget allocations for administration, implementation, and science and monitoring were about $2.9 million, $7.4 million and $5.0 million, respectively.

Activities and Accomplishments

Flow Management

Conditions

Water Year 2013 was a DRY water year for the Trinity River Restoration Program. Conditions during the fall of 2012 (the beginning of water year 2013) were typical from a rainfall and reservoir storage perspective. The Trinity watershed received several large storms between Thanksgiving and Christmas setting hopes high for the upcoming runoff. From January 2013 on, the watershed received practically no additional precipitation.

Record drought conditions settled on the Trinity watershed in January 2013, and persisted throughout the remainder of the year.

According to the California Department of Water Resources, “Water year 2013, which ended on September 30, 2013, began

with above-average precipitation, but then turned dry. Sacramento Valley and San Joaquin Valley watersheds experienced record dry conditions in January through May. Although the water year's wet early start helped replenish storage in many reservoirs, subsequent ongoing dry conditions especially affected non-irrigated agriculture and contributed to an increased wildfire risk."

Water year 2012 ranked as the 25th driest year in terms of statewide runoff, based on a measured record of 112 years. Calendar year 2013 closed as the driest year in recorded history for many areas of California (Figure 1).

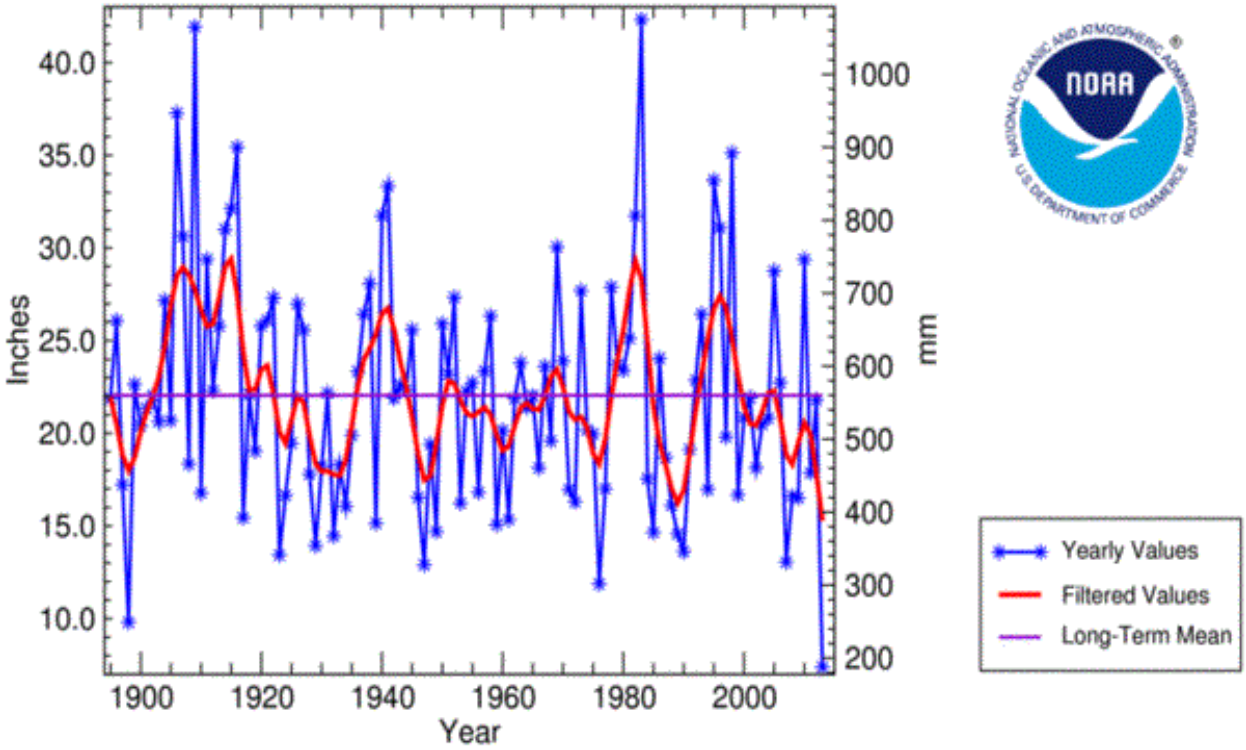


Figure 1. California statewide precipitation, January-December, 1895–2013 (Source: National Climatic Data Center, http://www.ncdc.noaa.gov/sotc/drought/2013/13).

Controlling flow releases is one of the primary management actions taken to restore the Trinity River fishery resources. TRRP's Flow Workgroup, the TAMWG, and the TMC invest a significant amount of effort and coordination each winter and spring to designing the annual restoration flow release schedule for implementation by Reclamation.

As of September 4, 2013, the U.S. Department of Agriculture included all but one of California's counties (San Francisco) in

its list of 2013 drought-related agricultural disaster designations.

Inflow Forecast and Water Year Classification

TRRP tracks two forecasts of basin inflow, one from the National Weather Service's California-Nevada River Forecast Center, and the second from the CDWR. The CDWR forecast (also known as the B120 Report) is the official forecast for determining the water year classification. Figure 2 shows both forecasts and their history during the forecast period (December-May).

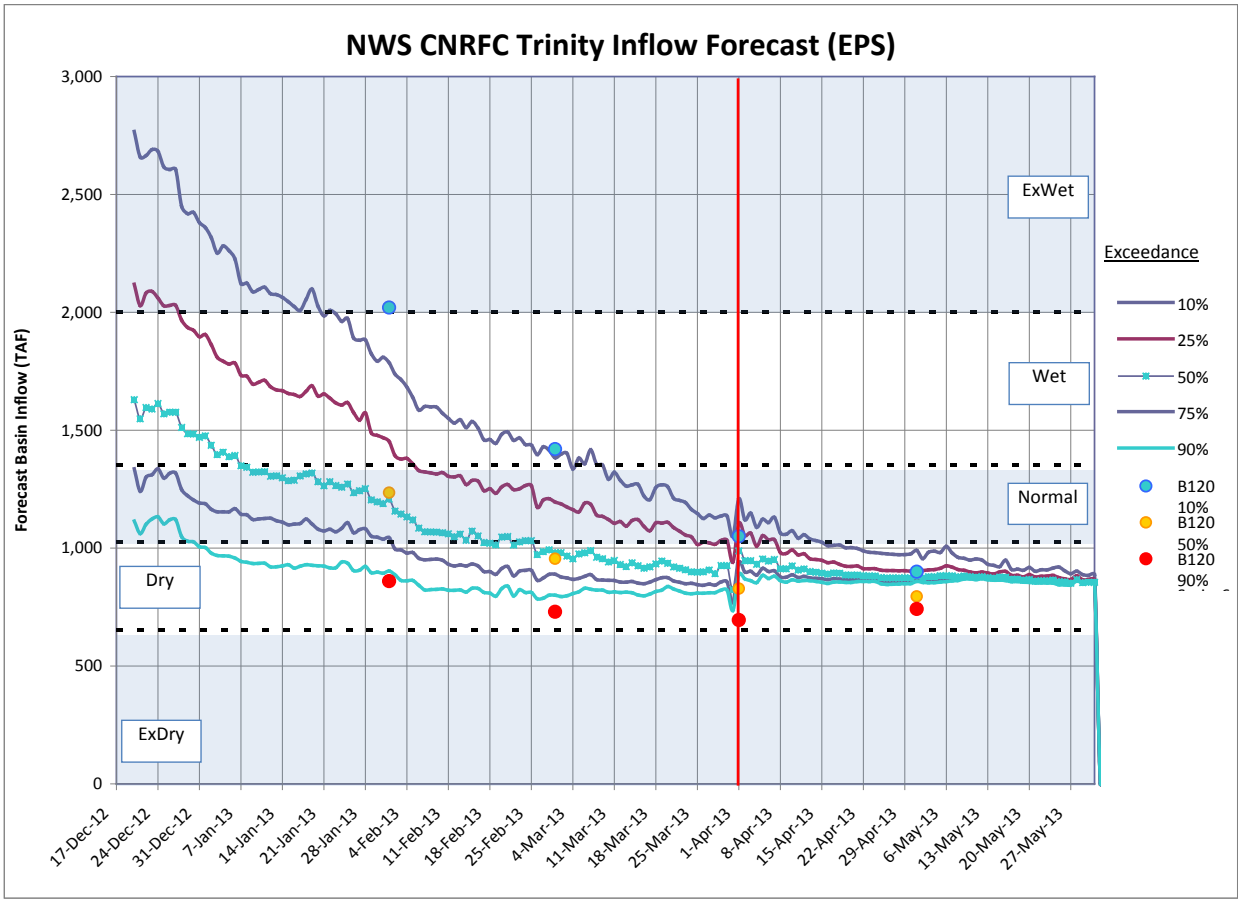


Figure 2. Daily and monthly inflow forecasts for WY 2013 (data from California-Nevada River Forecast Center and from CDWR 2013).

On April 9, 2013, CDWR published the 50-percent exceedance forecast for the annual inflow into Trinity Reservoir (CDWR 2013). The forecast volume was 828,000 acre-feet (1.021 km^3). As shown in Table 1, this volume corresponds to a Dry water year, and to a prescribed restoration release volume of 453,000 acre-feet (0.559 km^3). At the end of the water year,

TRRP used provisional U.S. Geological Survey (USGS) flow measurement data to estimate the actual annual inflow for WY 2013 to have been 859,000 acre-feet (1.060 km^3).

Table 1. Annual water volumes for in-stream flow releases, probability of occurrence, and annual basin runoff thresholds

Forecast Annual Inflow[1]	Predicted Water Year Type	Restoration Water Allocation[1]	Annual Probability of Occurrence[2] (percent)
>2,000	Extremely Wet	815	12
1,350 to 2,000	Wet	701	28
1,025 to 1,350	Normal	647	20
650 to 1,025	Dry	453	28
<650	Critically Dry	369	12

[1] In thousands of acre-feet (1,000 acre-feet ≈ 1.23 million cubic meters).
[2] Probability based on data from years 1912 to 1994.

Flow Schedule and Operational Performance

The TMC adopted a flow schedule that modified the ROD Dry-year hydrograph. The adopted flow schedule is a proactive management approach to provide improved rearing conditions for fry and juvenile Chinook salmon during a Dry water year that had been preceded by exceptionally high natural Chinook salmon escapement and subsequent high emergence success and fry abundance. The Flow Workgroup members conducted supporting analyses including sediment transport, temperature, and riparian establishment. Figure 3 shows the recommended hydrograph (Dry Alt 3) along with the ROD Dry-year hydrograph for comparison.

The ascending limb began April 21st with increases to 2,000 cubic feet per second (cfs) (57 m^3/s). Following an eight-day "bench" at that level, it then ascended to the two-day 4,500-cfs (127-m^3/s) peak (May 3–4). This was followed by a descending limb that included three short-duration benches at 2,000, 1,200, and 700 cfs (57, 34, and 20 m^3/s) for monitoring purposes.

The TRRP monitored Reclamation operations throughout the water year to verify performance of the adopted flow schedule. Figure 4 demonstrates that Reclamation accomplished the flow schedule very precisely. The increased releases from Lewiston Dam in August and September correspond to Ceremonial flows for downstream Tribes and releases by Reclamation to support fisheries in the lower Klamath River.

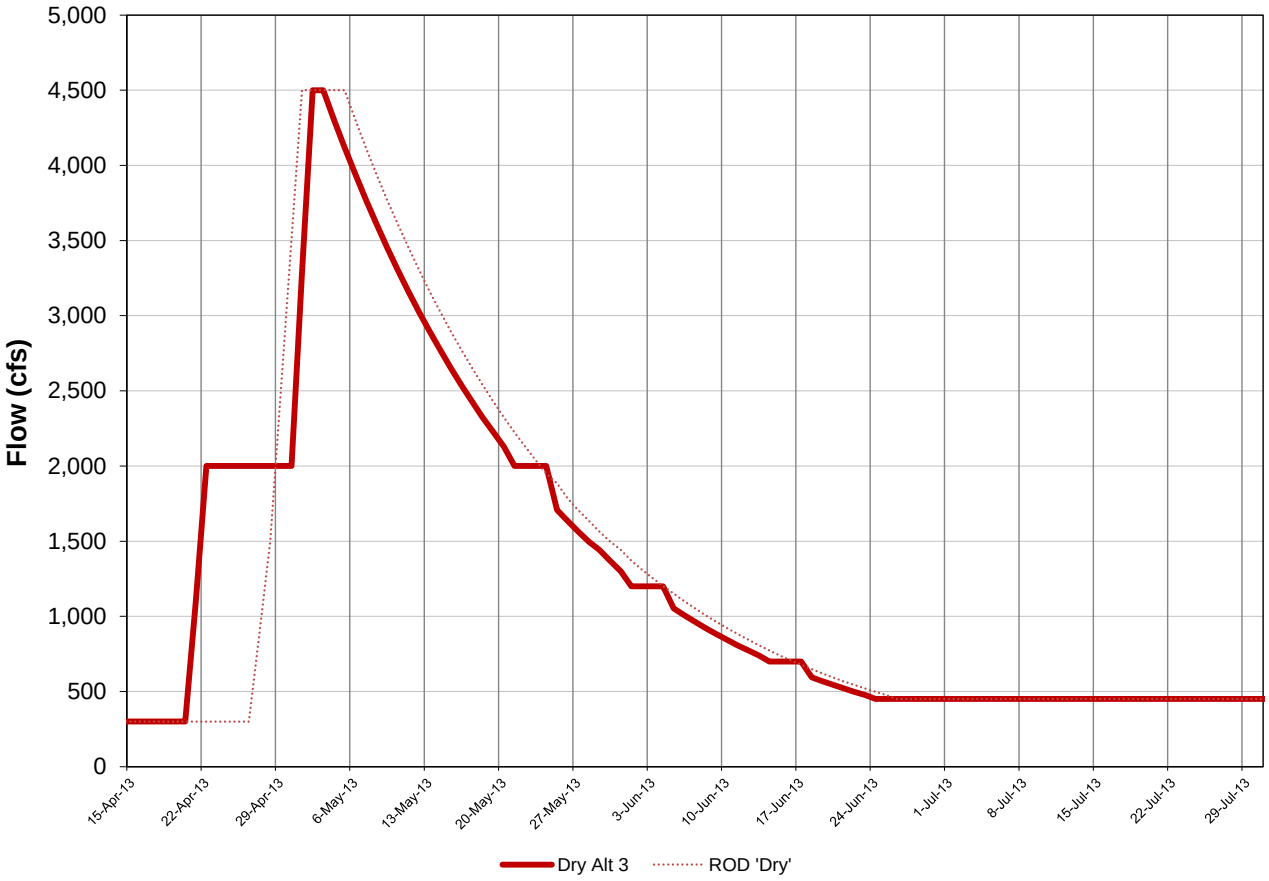


Figure 3. Water year 2013 restoration flow hydrograph.

Mechanical Channel Rehabilitation

Two successful projects were completed during the 2013 construction period: Lorenz Gulch and Lower Douglas City. Both of these projects are part what is called Phase II of the channel rehabilitation actions (the second half of the 47 ROD projects). Restoration features were designed to increase aquatic habitat for salmonid fish over a range of flow conditions by creating hydraulic and ecological complexity in the form of in-channel and riparian elements. These design elements, including mid-channel islands, split flows, side channels, off-channel ponds, alcoves, floodplain enhancements, large wood/boulder habitat structures, and riparian revegetation, provide a range of functional riverine elements. Channel rehabilitation projects and the site-specific design features are intended to function and evolve over time when combined with the ROD flow releases, which then contribute to the restoration of the Trinity River mainstem fishery.

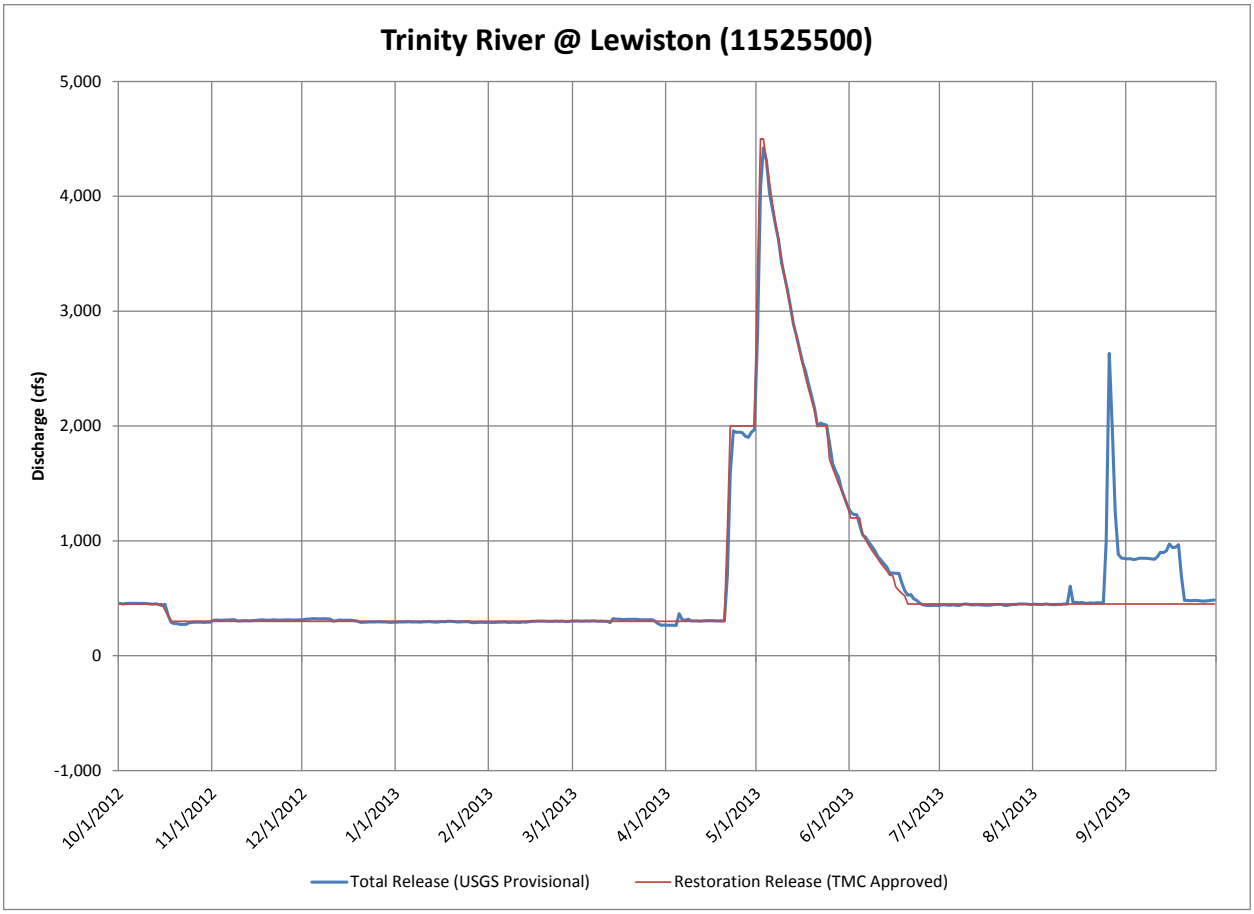


Figure 4. TMC-approved restoration flow release schedule (red) and provisional USGS flow data (blue) for all releases to the Trinity River in WY 2013.

The Lorenz Gulch and Douglas City channel rehabilitation projects were designed using a multidisciplinary and multi-organizational collaborative approach, which focused on including stakeholder input early in the design phase. The TRRP Design Team reached out to local landowners and the river community during the planning process to discuss and evaluate design elements and the measures that best met the project goals and objectives. Through this comprehensive process, four different alternatives were formally evaluated using objective and quantitative metrics to determine the best alternative to implement. Using this more structured design process helped to foster better communication and transparency, and created an environment that allowed for new ideas and recommendations to be considered.

The Lorenz Gulch Rehabilitation Site (Figure 5) is on the Trinity River near Douglas City, California. The site is located 22 miles (35 km) downstream of Lewiston Dam and 5 miles (8

km) downstream of the Douglas City Bridge on Steiner Flat Road. The project boundary is entirely on public lands managed by the BLM and encompasses approximately a 1-mile (1.6-km) reach of the Trinity River. Lorenz Gulch was designed by the Federal Design Group, a multi-agency team that includes Reclamation, USFWS, NMFS, and USFS. The original design was completed in 2011, but it was subsequently revised based on new emerging science and stakeholder input through the adaptive management process. The revised design was completed in January 2013, and on-site implementation began in July 2013.

The Lorenz Gulch project incorporated several diverse design elements including two large wood structures, a split flow channel complex, a low-flow side channel, berm removal, a high-flow bench, and a large floodplain complex with a low-flow side channel and an off-channel rearing pond. Constructing all of these features required the excavation of approximately 45,000 cubic yards (34,400 m^3) of material, which was then strategically distributed in key locations for upland enhancement. In addition, 4,000 cubic yards (3,060 m^3) of cobble/gravel fill was used to construct the split-flow island complex.

Inspection of plant container stock to be used at Lorenz Gulch channel rehabilitation project.

Revegetation was a key element at the Lorenz Gulch. Planting took place on over 7 acres (2.8 hectares), utilizing a variety of more than 10,000 riparian and upland plants. Almost all the plants were derived from container stock which had been grown and supplied by local nurseries. One of the most significant changes at Lorenz Gulch, compared to past projects, was the development and integration of solar irrigation to support revegetation success. Irrigation is a prime example of the adaptive management process in action, with applied modifications resulting from a range of past project monitoring. The irrigation system at Lorenz is a state-of-the-art application for automatic, remote watering of plants, using solar technology with low pressure/volume micro-spray heads. Independent solar panel/pump systems water all riparian and upland plant communities, and will continue to do so for three years to establish positive root growth. The efficiency of the irrigation system will increase survival of the plants at Lorenz Gulch and contribute to the overall ecological success of this project.

Figure 5. Aerial view of the Lorenz Gulch Channel Rehabilitation Project Site, looking southeast. The design incorporated multiple features, including a low-flow side channel and an off-channel rearing pond, shown here.

The other project implemented during the 2013 construction season was the Douglas City Channel Rehabilitation Project. This project is located within the residential zone of Douglas City proper (Figure 6). It extends approximately a half-mile (0.8 km) upstream and downstream from the Highway 299 Bridge, and it encompasses both private and public lands. Only the lower half of the project—the area downstream of the 299 bridge—was implemented and completed in 2013.

Figure 6. The first phase of the Douglas City Channel Rehabilitation Project, completed in 2013, was done almost entirely on or adjacent to private land. (Note the residence in the background.) The restoration activities take place through voluntary agreements with the landowners.

The Douglas City project was designed by the Hoopa Valley Design Group and featured four main design elements: (1) mid-channel gravel bar and wood placement at the upstream end of the project; (2) infiltration gallery development, wood revetment, and infrastructure removal complex; (3) a mid-channel island and split-flow complex; and (4) large boulder habitat placements at the downstream end of the project. The total project included approximately 2,000 cubic yards (1,530 m^3) of cobble/gravel fill and 3,000 cubic yards (2,290 m^3) of

excavated soil, which was used primarily to construct the split-flow island complex.

The infiltration gallery design was a collaborative effort between the TRRP and the Weaverville Community Services District. Tests showed that the existing infiltration system, installed in 1996 and consisting of 367 feet of infiltration pipe, was not effective in collecting the amount of water it was designed to convey. This jeopardized the district's ability to pump enough water to meet demand when the flows in Weaver Creek are too low to service the gravity flow system. During the construction of the Lower Douglas City project, the TRRP and the Community Services District reconfigured the existing gallery to provide a more efficient and fish-friendly infiltration system. The rehabilitation project created new juvenile fish habitat features and also placed boulders for adult fish holding. In-channel activities involved removal of existing infrastructure along the Trinity River and reconfiguring it, improving the district's ability to deliver water from the Trinity mainstem to Weaverville and surrounding communities.

Sediment Management and Watershed Restoration

The third and fourth elements of the Program's restoration strategy relate to management of coarse and fine sediments. As these sediments compose both the bed and banks of the river channel, as well as upslope areas, managing their supply is key to developing complex channel topography and diverse physical aquatic habitat. Reduction of fine sediment input into the river is an important component of watershed restoration, along with activities such as improving fish passage and habitat.

ROD Sediment Actions

"Sediment management includes the supplementation of spawning gravels below the Trinity River Division and reduction in fine sediments which degrade fish habitats."

Coarse Sediment

Trinity and Lewiston Dams trap the supply of coarse sediment (gravel and cobble) upstream. The Record of Decision directs implementation of a coarse sediment augmentation program below Lewiston Dam to replace the coarse sediment trapped behind the dams and to 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, 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.

Water year 2013 was a Dry year in which a spring high flow with a maximum daily mean discharge of 4,420 cfs (125 m^3/s) was released from Lewiston Dam. As flows of this magnitude cannot transport significant quantities of coarse sediment, relatively little coarse sediment was added to the river in 2013. About 1,500 cubic yards (1,150 m^3) of coarse sediment was added to reconstruct a gravel bar originally built as part of the 2009 Sawmill rehabilitation project, and 200 cubic yards (153 m^3) of coarse sediment was injected directly into the flow at the Diversion Pool site during the peak of the 2013 flow release. As no coarse sediment was added to the river in 2012, additions over the last 2 years are just less than one-fifth of the annual additions recommended in the ROD. TRRP scientists are currently in the process of revising recommendations for long-term annual coarse sediment augmentation quantities.

Fine Sediment

The Program teamed with the Trinity County Resource Conservation District (TCRCD) and local stakeholders to implement five priority watershed projects in 2013 using $496,000 from the Program and $121,527 in matching funds.

These projects reduced fine sediment inputs to the Trinity River by reducing sediment production from roads and other controllable sediment sources and limiting their delivery to tributary streams and to the mainstem (Figure 7).

Figure 7 (on facing page). Before and after culvert replacement at China Gulch on Blue Rock Road. Culvert replacement reestablishes tributary flows and access to fish habitat in the tributaries. An undersized 30-inch mining pipe was replaced with 48-inch pipe arch; both inlet and outlet were armored and a critical dip was constructed, as some storm flows may exceed the new culvert capacity.

Project work implemented in 2013 included two feasibility studies to look at costs versus benefits of improving fish passage and habitat quality at the mouth of Conner Creek and in Sidney Gulch in the Forest Service Compound. One project was a sediment reduction project located on BLM roads. Another project was to improve habitat and infrastructure on Lower East Weaver Creek. The final project was a data acquisition project to collect high-resolution LIDAR (light detection and ranging) data for both Weaver Creek and Browns Creek watersheds. LIDAR was used to establish baseline monitoring and current surface topography data for the development of future projects and associated monitoring needs within the watershed.

ROD Watershed Actions

"Watershed restoration efforts, addressing negative impacts which have resulted from land use practices in the Basin."

The program also approved funding for five watershed projects to be implemented in 2014, using $501,018 from the Program and $215,029 in matching funds. Four of these projects are road-related sediment reduction projects in Browns Creek, Grass Valley Creek, Schofield Gulch, and on USFS lands. One small project is to fund research into the effects of agricultural practices on sediment and nutrient deliveries in the Trinity River watershed.

Infrastructure Modification and Improvements

Well Grant Program

The Trinity River restoration strategy includes assistance to landowners whose potable water systems are affected by the higher ROD flows associated with river restoration. Initially, infrastructure modification and improvements involved upgrades to bridges and other publicly owned structures. However, some riverfront landowners experienced adverse impacts to their private wells and septic systems from the fishery restoration flows. In response, the TRRP initiated the Potable Water and Sewage Disposal System Assistance Program, or 'Well Grant' program, to provide eligible landowners with financial assistance to relocate, replace, upgrade, or otherwise improve their private potable water and sewage disposal systems.

This program is limited to potable water systems that are adjacent to the Trinity River and/or that divert surface or subsurface waters of the river between the Lewiston Dam and the confluence with the North Fork Trinity River. To be

eligible for potable water system financial assistance, applicants must be U.S. Citizens or legal residents, must own land in Trinity County upon which they operate an existing potable water system (water suitable for drinking and cooking) that utilizes surface or subsurface waters of the Trinity River, and must have legal access to the water source. The Assistance Program does not apply to irrigation systems, fire suppression systems, non-potable water systems, or unimproved parcels of land.

Applicants submit a conceptual design and cost estimate signed by a licensed contractor or licensed engineer. Designs and cost estimates are reviewed by the TRRP for conformance with the intent of the program and to ensure funding availability. Applicants determined to be qualified are reimbursed on a "first come-first served" basis up to $10,000 per parcel for potable water systems and up to $5,000 for sewage disposal systems. Applicants may receive assistance only one time per system/parcel for capital improvements.

In 2013, 16 applicants who applied to the program were deemed eligible and qualified. All of the 16 completed the improvements and were reimbursed from Well Grant funding. More than $125,000 was dispersed to Trinity County residents.

The Potable Water and Sewage Disposal System Assistance Program was discontinued after the end of the 2013 fiscal year. The Program provided assistance to approximately 180 Trinity River landowners since its inception in 2006, mitigating damages to their water systems which were in place prior to the 2006 initiation of ROD flows, and it was believed that all homeowners that wished to submit applications for assistance had done so. The Program provided over $900,000 to Trinity County residents between 2006 and 2013.

Bucktail Bridge

In addition to well and septic system replacement, the restoration strategy also includes improvements to existing public infrastructure. The TRRP and Trinity County identified a need to replace the Bucktail Bridge, located on the Trinity River near Lewiston, California. Although the CalTrans Office of Structure Investigations gave the bridge a 96.6 sufficiency rating in September 2013 and did not consider the bridge at risk of failure (Caltrans 2013, p. 931), the County and TRRP determined that the bridge would not allow passage of the 100-year flow event (14,910 cfs or 422 m^3/s).

Browns Mountain Road serves a small community via the Bucktail Bridge, a 73-foot (22.3-m)-long single-span steel girder bridge approximately 6.5 miles (10.5 km) downstream of the Lewiston Dam, owned and maintained by Trinity County. Residents use the bridge as their primary access point. Analysis showed that the Bucktail Bridge and its associated concrete box culvert create a hydraulic flow restriction when higher velocity flows are released during "wet" water years. Erosion at existing abutments, potential bridge overtopping, and salmonid habitat limitations caused by hydraulic pressures all indicate the need for a replacement bridge.

The TRRP worked closely with Trinity County's Department of Transportation and with a contracting firm to complete the cost-benefit analysis, geotechnical exploration, hydraulic studies, HEC-RAS design, and related plans and engineering specifications for replacement of the Bucktail Bridge. The environmental studies are now evaluating the existing conditions and forming alternatives for replacement, working within the constraints of the project site and stakeholder concerns. A draft report will be provided to the Trinity Adaptive Management Working Group and the Trinity Management Council and will be released to the public for review when completed.

The proposed design recommends a 155-foot (47.2-m) single-span, weathering-steel truss bridge over the existing channel, with an overflow control structure constructed immediately upstream. The longer span will alleviate the hydraulic constriction. Additionally, the bridge replacement project will provide an opportunity to develop beneficial fisheries habitat by regrading the river channel and side channel and removing the existing overflow structure.

The partners will continue to review project status, design standards, and environmental considerations with Trinity County and associated agencies, and will continue to involve stakeholders in restoration planning phases until the new bridge and project are approved.

Physical and Biological Responses to Restoration Flows

The Trinity River, like other alluvial river systems, is complex and dynamic. Our understanding of the Trinity River and how it will respond to restoration actions is continually improving. AEAM, the sixth element of the Trinity River restoration

strategy, is a systematic approach for improving future management decisions by learning from outcomes of past actions.

Sediment Monitoring

Annual sediment transport monitoring in the mainstem Trinity River continued for the 10th consecutive year in 2013 with measurements at four sampling locations during the spring flow release. Water year 2013 was a Dry year in which a spring high flow with a maximum daily mean discharge of 4,420 cfs (125 m^3/s) was released from Lewiston Dam. This peak magnitude is insufficient to generate significant sediment transport rates, and the duration of the peak was curtailed from 5 days, as recommended in the ROD, to just 2 days. Sediment monitoring results for the 2013 release are not yet available, but the data are expected to confirm that very little geomorphic change was accomplished in 2013.

Bed Mobility and Scour Monitoring

Bed mobility and bed scour were monitored to evaluate core Fiscal Year 2013 geomorphic features and processes described in three proposals submitted to the TRRP in spring 2012: Geomorphic Monitoring, Assessment of Bed Scour and Mobility, and Map and Quantify Riparian Vegetation. Specific core geomorphic tasks included the following:

1. Develop a census of exposed bars between Lewiston Dam and the North Fork Trinity River, and define a subsample of 24 exposed bars from the census using the GRTS[1] method.
2. Establish one monitoring cross section at each of the 24 exposed bars.
3. Quantify topographic changes, bed mobility, and bed scour at the 24 exposed bar cross sections in response to WY 2013 winter and ROD streamflows, with emphasis on providing a basis from which WY 2013 riparian seedling demographic response can be correlated.

The exposed bar census and cross section selection were performed in late summer 2012. Exposed bars were defined as all point bars and medial bars larger than 1,500 square feet (140 m^2) that are exposed at 460 cfs (13 m^3/s), as visible on

[1] Sampling was conducted using a generalized random-tessellation stratified (GRTS) sampling design, as described in Stevens and Olsen (2004).

WY 2012 aerial photographs. Additional attributes include: (1) vegetation (bars must be "open," meaning they have <2% total cover by any plant species), (2) location (bars located in the mainstem only, bars in side channels are excluded, as are tributary deltas), and (3) particle size (minimum particle size must be gravel, as visible on the 2012 aerial photographs). Bars meeting these criteria were identified and then measured in the field to confirm their elevation exceeded at least the 2,000-cfs (57-m^3/s) stage, such that monitoring could be conducted across the range from 460 to 2,000 cfs (13 to 57 m^3/s). Of all exposed bars identified on the WY 2012 aerial photographs, 69 met these criteria. A subsample of these 69 exposed bars was selected using the GRTS sampling method, from which 24 were identified for WY 2013 monitoring. The distribution of monitoring sites spanned 62.1 river kilometers (38.6 river miles), from river kilometer 117.5 to 179.6 (river mile 73.0 to 111.6).

Once the population of 24 GRTS exposed bar sites was determined, landowner access was secured and cross section locations were selected. In some locations, the bar had been monitored as a part of previous years' geomorphic and/or riparian investigations; in these cases, existing monumented cross sections were used rather than establishing new cross sections. In fall 2012 (prior to the high flow season), all cross sections were surveyed, and bed mobility and bed scour experiments were installed. Bed mobility and scour were monitored using a combination of painted tracer rocks and scour chains, which were placed with particular emphasis in the riparian encroachment risk zone (i.e., the 460–2,000 cfs [13–57 m^3/s] inundation zone). Bed mobility and bed scour experiments were monitored following winter storms in early spring 2013, and were monitored again in summer 2013 following the spring ROD release. Cross sections were resurveyed in late summer 2013, capturing net topographic changes (from winter floods and ROD releases) since their first survey in fall 2012.

The Trinity River winter peak flow event occurred on December 2, 2012; due to tributary accretion, instantaneous peak flows ranged from 317 cfs (9 m^3/s) at Lewiston to approximately 9,400 cfs (266 m^3/s) below Canyon Creek. Despite this relatively large winter peak, Water Year 2013 was classified as Dry, with a corresponding spring ROD peak magnitude of approximately 4,500 cfs (127 m^3/s) that lasted for approximately two days (May 3–4, 2013). Unlike the winter floods, which are tributary driven, the spring ROD release

produced very little accretion; the instantaneous peak ROD release ranged from 4,600 cfs (130 m^3/s) at Lewiston Dam to 4,870 cfs (138 m^3/s) at our farthest downstream site at river kilometer 117.5 (river mile 73.0).

Data review and analyses from the spring 2013 ROD release are not yet completed, but preliminary results relative to TRFE Dry water year objectives are summarized below:

- The TRFE Dry water year bed mobility objective is to mobilize the surface of bar flank features. Of the 24 exposed bar sites, two were disturbed and, hence, results from them could not be used: the Lower Bell Gulch tracer rocks were driven over several times, and the entire Lorenz Gulch tracer rock set was vandalized. Of the remaining 22 sites, 13 sites recorded no mobility (< 20% of the tracer rocks in the 460- to 2,000-cfs [13- to 57-m^3/s] zone were mobilized) and 9 sites recorded partial mobility (20% – 80% of the tracer rocks in the 460- to 2,000-cfs zone were mobilized). Complete mobility (> 80%) was not observed at any of the sites.
- The TRFE does not provide a bed scour objective, but scour results are used to support riparian vegetation study objectives. For WY 2013, almost all sites recorded scour depths in the 460- to 2,000-cfs zone that were less than 1.0 D_{84}. (D_{84} = particle diameter that exceeds the diameter of 84 percent of the sampled particles; scour and redeposition are normalized to the site-specific D_{84} diameter.) Each of the 24 exposed bar sites had, on average, between 2 and 4 scour chains, for a total of 73 scour chains installed. Of the 73 total scour chains, 47 were located within the 460- to 2,000-cfs zone; each monitoring site had between one and four scour chains installed in the 460- to 2,000-cfs zone. For the spring ROD release, 1 chain recorded scour > 2.0 D_{84}, 3 recorded scour between 1.0 and 2.0 D_{84}, 40 recorded scour < 1.0 D_{84} (22 of which recorded no scour at all), and 3 chains were not found, presumably vandalized. Results show that the Dry water year release generated little to no scour across exposed bar surfaces. Individual results will be explored in more detail in the riparian vegetation monitoring component of the WY 2013 reporting.
- Deposition recorded by the scour chains showed similar results to scour: 1 chain recorded deposition > 2.0 D_{84}, 4 recorded deposition between 1.0 and 2.0 D_{84}, and the

remaining 39 chains recorded deposition < 1.0 D_{84} (13 of which recorded no deposition at all).

- Cross-section surveys captured the net WY 2013 topographic change from all flow events between fall 2012 and summer 2013. All cross sections but one showed very little to no topographic change in WY 2013. The one exception, Hocker Flat XS 358+89, showed a surprising amount of change. It included one approximately 50-foot (15-m) segment of net bed lowering (maximum lowering = 4.3 feet [1.3 m]) and an approximately 100-foot (30-m) segment of net deposition (maximum deposition = 2 feet [0.6 m]). All of these topographic changes occurred below the 460-cfs (13-m^3/s) water surface elevation. Downstream cross sections did not show anywhere near this degree of change, and we infer that this site is more dynamic than the others because it is affected by the sediment supply from Canyon Creek. (The site is located immediately downstream of the Canyon Creek delta.)

Based on preliminary results described above, the WY 2013 spring ROD flow release resulted in no bed surface mobility at a little more than half of the exposed bar monitoring sites, and the remaining sites experienced only partial bed surface mobility. Most sites recorded little to no bed scour or redeposition, with very few sites recording isolated scour depths or deposition thickness greater than 1.0 D_{84}. As supported by the cross section surveys, the exchange of bed material via scour and redeposition did not occur in sufficient quantity to create large geomorphic changes. (The changes on Hocker Flat XS 358+89 are assumed to have resulted from the winter peak flow event, which was approximately 9,400 cfs [266 m^3/s]).

Riparian Vegetation Monitoring

During WY 2013, riparian vegetation was monitored at the same sites used for with fish habitat and geomorphic assessments. Specific riparian monitoring tasks included: vegetation and large wood mapping and band transect sampling. In the fall of 2012 before winter storms, and again in summer 2013 after the 4,420-cfs (125-m^3/s) spring ROD release, the monitoring team:

- Surveyed recruitment of target riparian woody plant seedlings at channel rehabilitation sites constructed between 2005 and 2012,
- Mapped large wood at eight GRTS Panel 5 sites, and eight Panel 1 sites (16 GRTS sites total), and
- Conducted combined riparian and geomorphic assessments at 24 exposed gravel bars.

WY 2013 was classified as a Dry water year. The TMC-adopted hydrograph had flows increasing from 300 to 1,060 cfs (8.5 to 30 m^3/s) on April 21 then a 9-day 2,000-cfs (57-m^3/s) bench, and then a 4,500-cfs (127-m^3/s) peak on May 3 and 4. Flows then receded to 460 cfs (13 m^3/s) on June 24. During the late summer, streamflows were increased to above 850 cfs (24 m^3/s) for 20 days, with a one-day peak above 2,650 cfs (75 m^3/s). There are no specific ROD-related riparian vegetation scour or recruitment objectives in a Dry water year. Riparian vegetation monitoring did not document the effect of the late summer streamflow increases on fine sediment deposition or seedling mortality.

A band transect was sampled along one cross section at each of the 24 GRTS selected gravel bars. Vegetation measures included structural complexity, extent, species richness, age diversity, and riparian woody regeneration within different inundation zones. The riparian recruitment survey included visiting channel rehabilitation sites, mapping woody riparian tree species, and estimating density of these species on side-channel margins and floodplains. Large wood greater than 20 cm and occurring below the 2,000-cfs (57-m^3/s) inundation zone was mapped. Data gathered during riparian monitoring was related to hydrology and to changes in channel morphology, channel bed and bank mobility, and channel bed scour. Riparian vegetation monitoring in 2013 followed the strategy identified in the Integrated Assessment Plan (TRRP and ESSA 2009). The data were used to evaluate the hypothesized linkages in the current riparian vegetation conceptual model. Results of the 2013 spring ROD flows included the following findings:

- The richness of regenerating riparian woody plant seedling species continues to increase within the 460- to 2,000-cfs and 2,000- to 4,500-cfs (13- to 57-m^3/s and 57- to 127-m^3/s) inundation zones.

- The 2011 and 2012 cottonwood, ash, red willow, and shiny willow cohorts were more frequent, covered more area, and had greater density than in any previous years.

Due to the lack of scouring flows in 2013, seedling density continued to increase in the 460- to 2,000-cfs zone. Plants that had regenerated and survived the previous high flows continued to grow in all inundation zones. Overall, however, the number and density of new seedlings continued to be lower. The continued reduction in regenerating seedlings documented in 2013 may be a result of less available fine sediment substrate on surface deposits across bars and on floodplain surfaces.

Riparian woody plant species richness resulting from spring 2011 and 2012 ROD releases continued to be more apparent systemically. Narrowleaf willow was still the most frequently sampled woody plant, and most sampled woody plants were growing within the 460- to 2,000-cfs inundation zone. However, cottonwoods, shiny willow, and red willow successfully regenerated in higher numbers than previously documented, and many were sampled above the 2,000-cfs (57-m^3/s) level on naturally formed bars and some constructed floodplain surfaces. The modification to the receding limb of the ROD hydrograph in Normal and wetter years is apparently successful in promoting broader woody plant richness in the riparian corridor.

Large wood was mapped at 16 GRTS sites. Similar to previous years, large wood loading was estimated to be approximately seven pieces of wood greater than 20 cm (8 in) in diameter per 100 m (305 feet). White alder was the most abundant type of wood among those pieces that could be identified, making up 34 percent of the sample. Conifer wood (including Douglas fir, ponderosa pine, and incense cedar) made up 8 percent of the sample, and willow wood made up 10 percent. Cottonwoods made up 2 percent of the mapped large wood. Unidentified wood made up 46 percent of the sample. Overall, large wood storage increased 21 percent at GRTS Panel 5 sites between 2012 and 2013.

Fisheries

Juvenile Salmonid Outmigrant Abundance

To estimate the abundance of naturally produced age-0 Chinook salmon outmigrating from the upper Trinity River, the HVT Fisheries Department conducted sampling at Pear Tree

Bar, located approximately 39 miles (63 km) downstream of Lewiston Dam. A second site located near Willow Creek, operated by the YT Fisheries Program, was used to monitor basin-wide annual age-0 Chinook salmon production, and to assess program performance objectives for outmigrating juvenile Chinook salmon, juvenile coho salmon, and steelhead smolts.

For both sites, an extensive mark-recapture effort was employed with partners conducting the fish marking and CDFW providing juvenile Chinook salmon from the Trinity River Hatchery. From January through August, 2013, abundance estimates of natural age-0 Chinook salmon were: 3,624,757 (±189,428) at the upriver site and 4,828,842 (±186,074) at the lower river site. The mean migration rate between the two sites was 6.9±4.1 miles per day (11.1±6.6 km per day). The 80-percent population outmigration date for juvenile Chinook salmon at the lower river site was June 10, which met the outmigrant objective of July 9. The 80-percent population outmigration date objectives for juvenile coho salmon (June 4) and steelhead (May 22) at the Willow Creek trap were also met in 2013. While earlier outmigration timing may enhance fish survival, as it allows them to pass through the lower Trinity River and lower Klamath River before the temperature increases later in the season, additional rearing time and the associated growth may also have a positive effect on survival.

Salmonid Spawning Escapement and Harvest

The TRRP supports monitoring run size and escapement of naturally produced and Trinity River Hatchery produced spring and fall-run Chinook and coho salmon, and of adult fall-run steelhead. The total 2013 adult fall Chinook salmon spawning escapement estimate for the Trinity Basin is 31,382 fish. Naturally produced adult spawner escapement is considered a high-level indicator to evaluate progress toward achieving TRRP salmonid restoration goals. Preliminary estimates for 2013 indicate 18,510 naturally produced fall-run Chinook escaped to the mainstem Trinity River and its tributaries, and 12,872 hatchery-produced fall-run Chinook returned to the hatchery or escaped to natural river areas. Details on the 2013 escapement monitoring for Trinity River salmonids are provided in Table 2, and a recent perspective of naturally produced fall-run Chinook escapement is presented in Figure 8.

Table 2. Preliminary 2013 adult escapement estimates for Trinity River salmonids (preliminary data provided by CDFW)

Species	Natural Produced Escapement		Hatchery Produced Escapement	
	2013 Run	Program Goal	2013 Run	Program Goal
Spring Chinook Salmon	3,024	6,000[a]	5,840	3,000
Fall Chinook Salmon	18,510	62,000	12,872	9,000
Coho Salmon	4,313	1,400	14,809	2,100
Fall Steelhead Adults	9,764	40,000	7,394	10,000

[a] The natural spring Chinook salmon spawning escapement goal is for the entire Trinity Basin, but the run-size estimate only accounts for the population above the Junction City Weir and does not include spawning escapement into the South Fork of the Trinity, the North Fork of the Trinity, the New River, or Canyon Creek.

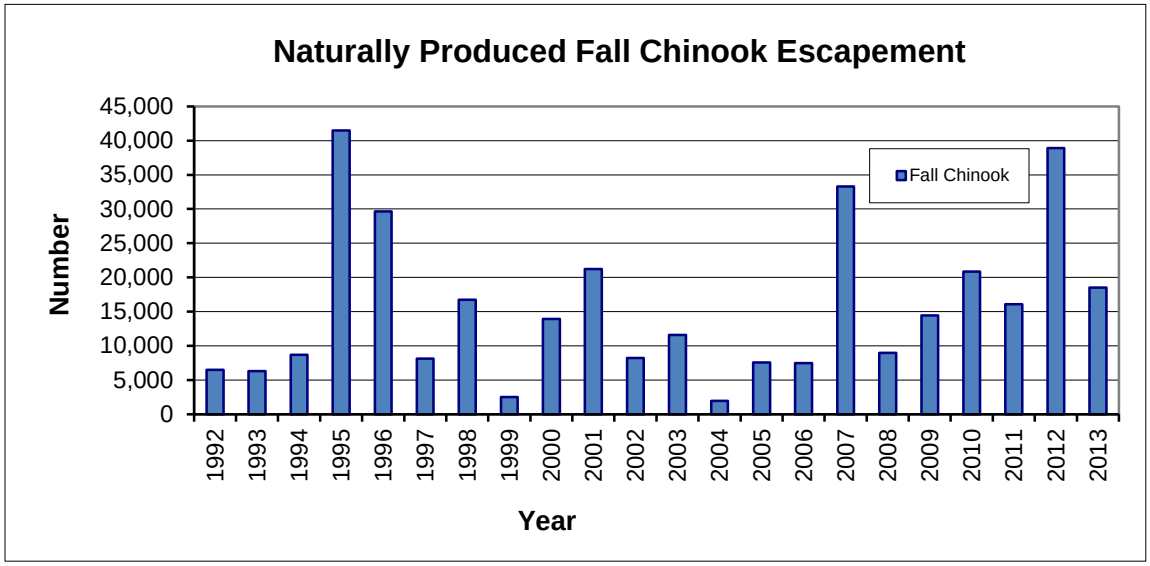


Figure 8. Adult natural fall Chinook salmon spawning escapement above the Willow Creek Weir, 1992–2013.

Adult Fall Run Chinook Salmon Harvest

A component of the TRRP's goal to restore anadromous fish populations is to support dependent ocean fisheries, as well as in-river recreational and tribal fisheries. Natural and hatchery-produced fall Chinook salmon from the Trinity River support the recreational fishery and the Hoopa Valley Tribal fishery on the Trinity River and contribute to the recreational fishery and Yurok Tribal fishery in the Klamath River below its confluence with the Trinity.

In 2013, the estimated adult fall Chinook salmon harvest for the recreational fishery was 1,148 fish on the Trinity River and 14,166 fish on the lower Klamath River. The estimated tribal harvest of adult fall Chinook salmon was 3,019 fish by the Hoopa fishery and 59,750 fish by the Yurok fishery.

Redd Distribution and Abundance

The mainstem Trinity River is surveyed each fall to determine the geographic distribution of spawning salmon. Improved fry-rearing habitat created through Program activities are anticipated to lead to changes in both the distribution of natural-origin Chinook salmon spawning and the relative run size of natural versus Trinity River Hatchery origin fish. From September 5 to December 19, the fall 2013 survey mapped a total of 4,303 redds (Chinook and coho salmon), from Lewiston Dam to Weitchpec (excluding Pigeon Point to Big Flat River Access, and Cedar Flat to Hawkins Bar). Based on the distribution of 1,026 spawned female carcasses recovered over the same survey, an estimated 2,643 of these redds were constructed by natural-origin Chinook salmon females and 572 were constructed by hatchery-origin Chinook salmon females (Figure 9). The remainder of redds mapped (1,088) were estimated to be constructed by coho salmon of mixed hatchery and natural origin, although it should be noted that the survey period does not envelop the entire coho salmon spawning period.

Fish Habitat Assessment

Restoration Reach Evaluation — Flow and channel rehabilitation actions are anticipated to affect rearing habitat availability through the 40-mile (64-km) restoration reach. Rearing habitat availability was mapped at 32 randomly selected sites annually between 2009 and 2013 as part of a multiyear study. The total area of rearing habitat within the

restoration reach in 2013 was about 4.22 million square feet (390,000 m^2) for fry, and 5.22 million square feet (485,000 m^2) for presmolt (Figure 10). This represents the highest estimate recorded in the study. In addition, 16 of this year's study sites had been sampled in 2009. Of the resampled sites, 14 had a higher total habitat area for fry and 11 had higher habitat values for presmolt, further supporting restoration-reach-scale increases in rearing habitat availability.

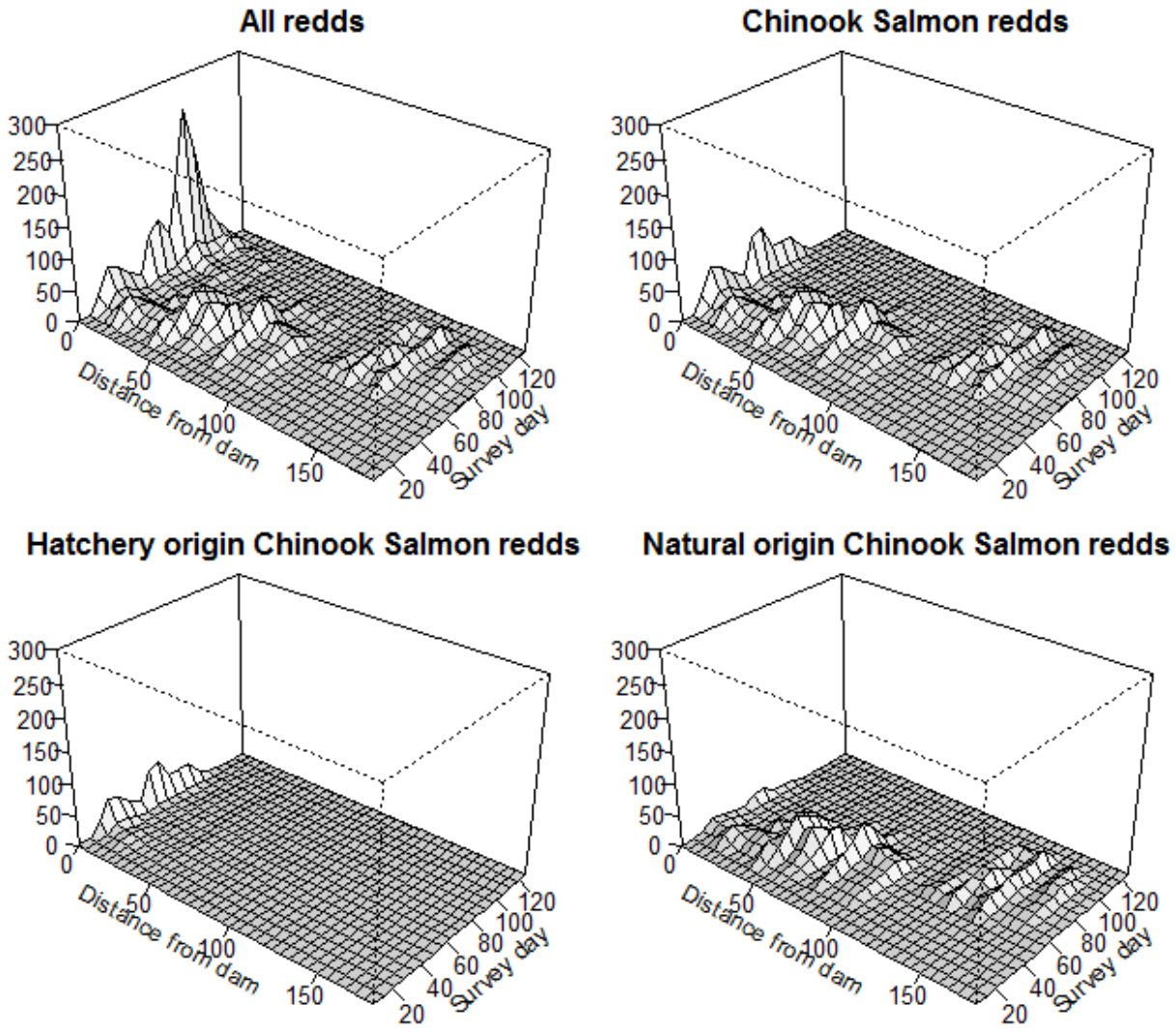


Figure 9. Spatiotemporal distributions, Lewiston Dam to Weitchpec, of mainstem Trinity River redds, fall 2013. Pigeon Point to Big Flat River Access and Cedar Flat to Hawkins Bar not surveyed. Survey day 1 = September 1, survey day 120 = December 29.

Juvenile Salmonid Density Monitoring – Juvenile Snorkel Surveys

In 2013 the focus of the Juvenile Salmonid Density project was to provide detailed information on juvenile Chinook salmon density to habitat relationships to inform development of a salmon life cycle computer model. Snorkel surveys were conducted from January through April of 2013 to document the spatial and temporal variation in juvenile salmonid density and to document juvenile Chinook salmon density over the full range of depth, velocity, and distance to cover throughout the restoration reach. Snorkel survey sites were located at 2-D hydrodynamic model sites to facilitate linking the biological

model (fish presence/density) to the physical river model (habitat conditions). Results from the 2013 study have been used to develop statistical functions that link the distribution of juvenile salmonids across the TRRP restoration reach to habitat parameters that are collected by the Integrated Habitat Mapping Project. Figure 11 shows two divers simultaneously enumerating juvenile salmonids in optimal fry habitat. These simultaneous counts allow for a development of a robust statistical function between fish density and measures of habitat.

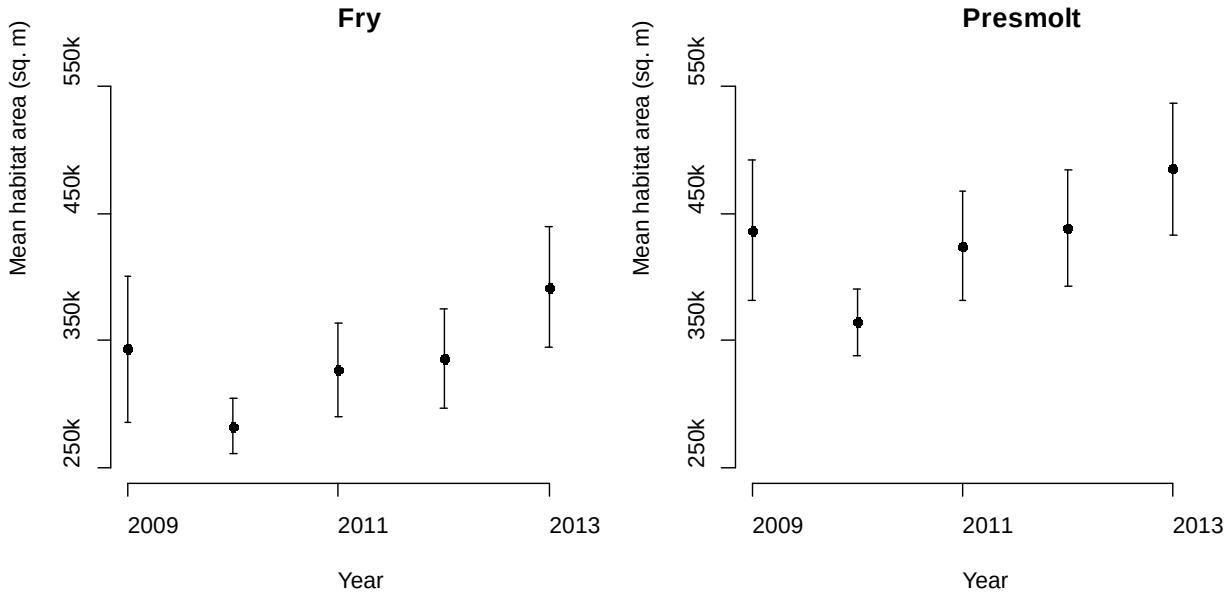


Figure 10. Total fry and presmolt rearing habitat area estimates between 2009 and 2013. Data presented is preliminary and subject to change. Error bars indicate a 95-percent confidence interval.

Remote Sensing: Aerial Photography, Aerial LIDAR, and Terrestrial Laser Scanning

High-resolution aerial photography may be the most widely used data across the Program partnership, as it provides 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 provides a reliable census of the visual form of the river from a standardized point of view, which enables a variety of analyses of change over time. Historic aerial photography datasets going as far back as 1944 provide context for current river conditions (Figure 12).

Figure 11. Snorkelers enumerating juvenile salmonids in optimum fry habitat in a restoration reach.

Detailed topographic data has similarly widespread utility and can be collected over large areas by aerial LIDAR (Light Detection And Ranging). LIDAR is significantly more expensive than aerial photography, so annual data collection is limited to documentation of the rehabilitation sites completed each year, and reach-wide collection occurs less frequently.

TRRP now has access to a terrestrial laser scanning (TLS) system. This system is being used to supplement aerial LIDAR collection in areas where additional detail is needed, such as areas that include large wood structures. While standard photography can provide a visual image of changes over time, TLS enables volumetric quantification of changes (Figure 13). The combination of aerial photography, aerial LIDAR, and TLS accurately portrays the evolution of sites and features over time and provides solid documentation of TRRP actions.

Aerial photography and LIDAR for the as-built condition of the Upper Junction City and Lower Steiner Flat rehabilitation sites were collected in February 2013, prior to the first release

of restoration flows for the newly constructed sites. New reach-wide orthorectified aerial photography was collected on July 28, 2013, after the river returned to its summer base flow, and included near-infrared imagery to improve vegetation analyses. TLS was used to document a wood structure at the Upper Junction City site as well as four wood structures and islands at the new Lorenz Gulch and Douglas City rehabilitation sites.

Implementation Monitoring and Analysis

Implementation monitoring informs a range of implementation actions, including rehabilitation site design and gravel augmentation. Recent implementation monitoring has concentrated on assessing the impacts of rehabilitation actions and gravel augmentation on pool habitats. In 2013, the results of a multi-year study addressing that issue were released (Gaeuman and Krause 2013). The report documents a tendency for pools to fill slightly in some river reaches and a tendency for them to deepen in other reaches. Instances of significant pool aggradation were found to be limited to a few local areas.

Data Management

The ultimate products of the Program 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 under development to provide equal access to Program information products for Program partners, stakeholders, and the public. During 2013 the mapping component of the ODP matured (http://odp.trrp.net/Map/), providing convenient and intuitive access to 11 data overlays and 6 aerial photography datasets dating as far back as 1944. The ODP now provides convenient access to more than 1,300 reports and other documents; more than a hundred meeting agendas and summaries; 38 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 back to 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.

Figure 12 (above and on facing page). Comparative aerial photographs of the Upper Junction City reach of the Trinity River. In 1944, multiple channels existed, with tailings from dredge mining evident throughout the reach. In 1960, the tailings had been reworked with a single channel cut, presumably by the 1955 flood, though alcoves and off-channel ponds remained. By 1980, flow regulation had enabled thick vegetation to grow over many of the banks.

Figure 12 (continued). The 2001 photo demonstrates how continuous low flow simplified the channel and encouraged growth of a uniform bank of riparian vegetation. The 2011 photo shows the site prior to construction, with a transverse bar already forming at the lower end due to restoration flows. The 2013 photo shows changes due to rehabilitation, with newly built side channels and off-channel ponds.

Figure 13. (Above) Upper Junction City IC-1 island photographed September 4, 2013, by Ken DeCamp. (Below) Same location and perspective rendered from a composite of 23 Terrestrial Laser Scans (TLS) collected in November 2013, showing changes to the split-flow channel, growth of a medial bar, and accumulation of wood.

Environmental Compliance and Mitigation

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

Through implementation the Program has the potential to create short-term impacts and to make long-term positive (or negative) impacts on protected Trinity River resources. Direct and cumulative effects of large-scale implementation need to be monitored, and mitigated if required, to ensure long-term beneficial results. Local landowners and agencies alike have seen the river change with Program activities, and stakeholders request assurances that the changes will create mutually beneficial results for the fishery resources, river health, and tribal and public trusts. Program partners cooperate in order to minimize and monitor impacts to non-target species (e.g., birds and other wildlife) and to cultural resources. What is more, full public disclosure is required under both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). In order to meet these requirements, the TRRP continues its outreach efforts to inform the Northern California community of restoration program intentions and to include all partners, collaborators, and public and private stakeholders. Public meetings are held repeatedly during the early stages of project site design and gravel augmentation planning. Subsequent meetings also help keep the public informed of associated monitoring and evaluation before, during, and after in-channel project construction and revegetation with native plant species.

In 2013 the Program continued to generate site-specific environmental assessments based on programmatic NEPA and CEQA documents for environmental compliance, for disclosure to the public, and for analysis of program impacts to resources. The *Trinity River Mainstem Fishery Restoration Final Environmental Impact Statement* (Trinity River FEIS/EIR; USFWS et al. 2000) serves as the programmatic document under NEPA and the *Master Environmental Impact Report for Channel Rehabilitation and Sediment Management*

Applicable Environmental Laws and Authorizations:

- The National Environmental Policy Act (NEPA)
- California Environmental Quality Act (CEQA)
- Endangered Species Act of 1973
- Clean Water Act
- Wild and Scenic Rivers Act
- National Historic Preservation Act
- Arch Resources Protection Act of 1979
- Executive Order (EO) 11988 for floodplain management
- EO 11990 for the protection of wetlands
- EO 13112 for invasive species
- EO 12898 for environmental justice

for Remaining Phase 1 and Phase 2 Sites (Master EIR; NCRWQCB and TRRP 2009) functions as the programmatic document under CEQA. The Environmental Assessment / Initial Study for the Douglas City and Lorenz Gulch channel rehabilitation sites (NCRWQCB et al. 2013) provides site-specific details concerning the projects that were proposed for 2013 construction. Though both projects were permitted for 2103 construction, only the Lorenz Gulch project was completely built. Just the downstream portion of the Douglas City project was constructed in 2013.

During 2013, the Program worked to increase opportunities for local stakeholder input and attempted to make the design process more transparent for observers. The TRRP used a stream restoration decision analysis and design guidance tool (Stream Project Tool) that was created to define an objectives-driven approach to evaluating and designing stream restoration projects. Using the Stream Project Tool, attendees at public meetings participated in the scoring of proposed alternative designs for proposed channel rehabilitation. Participants ranked their opinions of three Program objectives — increasing/enhancing habitat, restoring physical processes, and supporting more proper riparian function. The results helped the TRRP design team characterize stakeholder concerns and showed what design objectives caused a particular design alternative to rank higher. Based on this input, the team was able to add, modify, or eliminate design features earlier in the design process than had been possible on past rehabilitation site designs.

The team also endeavored to ensure stakeholders that channel rehabilitation site designs would function in the way described in the environmental documents and that planned projects would provide long-term benefits to river function and fisheries. The Program incorporates public input to designs at the conceptual and intermediate stages, and proposed designs are vetted through public meetings and public participation in technical work group meetings. Designers integrate physical models to predict how sites will perform and evolve under different flow regimes. With current models, the designers may choose alternative implementation scenarios to increase or enhance juvenile salmonid rearing habitat, restore fluvial processes, and restore proper riparian function.

As part of the public outreach and environmental review for the 2013 Lorenz Gulch Channel Rehabilitation Site, special attention was given to designing the river left side channel so

that it did not take stream power away from the main channel during high flows. Stream power is needed to maintain the existing deep pool habitat (Goat Hole) in the reach. In addition, outreach efforts allowed local fishermen to consult with TRRP biologists and construction staff. Among other things, they had input on the placement of habitat boulders in the river, the development of improved public access, and the installation of a new boat ramp (with BLM cooperation) at Lorenz Gulch (Figure 14). The Program is attempting to balance the concerns of recreational and commercial enterprises with those of private citizens and all other users of the river. The TRRP continues to work within the guidance of the North Coast Region Water Quality Control Plan (the Basin Plan) to protect the beneficial uses of water resources, including migration and spawning habitat for anadromous fish.

Figure 14. Newly constructed boat access at the Lorenz Gulch channel rehabilitation site.

The TRRP works closely with trustee agencies, who have jurisdiction by law over natural resources (including fish, wildlife, waters, and land) affected by implementation of the ROD. Guidance from these agencies and the Master EIR's mitigation and monitoring program require that negative impacts to the environment (air quality, vegetation, historic resources, etc.) and to fish and wildlife be mitigated during construction and for the long term. TRRP works with the public and private landowners of the restoration sites to facilitate monitoring of sensitive State and federally listed species to ensure that these species' conservation and restoration needs are met. These short and long-term monitoring requirements ensure that mitigation is completed for any cumulative negative impacts from ROD implementation. As an example, any riparian vegetation that the Program removes during project implementation must be replaced with native plant species, and the Program is required to monitor the success of replanted riparian vegetation for 10 years. Many migratory birds rely on riparian vegetation for shelter, food, and nesting. The Program monitors these birds to ensure that project implementation is not causing a long-term decline in key species throughout the restoration reach.

Revegetation Performance and Compliance Monitoring

As part of its environmental mitigation requirements, the Program has been charged with areal replacement of all impacted riparian vegetation disturbed during channel rehabilitation site construction. In November 2013, the Program assessed planting survival at seven sites along the Trinity River where it had conducted channel rehabilitation activities. These sites are:

1. Indian Creek Boat Launch,
2. Wheel Gulch,
3. Reading Creek,
4. Trinity House Gulch,
5. Lowden Meadows,
6. Upper Junction City, and
7. Lower Steiner Flat.

The rehabilitation (planted) areas within each site were visited and the number and health of the surviving plantings were documented by species. Post-construction plans were used to identify the location of each of the pods and identify the type of each planted pod (i.e., mixed willow, cottonwood, arroyo willow, or other). A Global Positioning System unit was used

to navigate to each of the planted pods. The total of surviving individuals within each pod was recorded on a field data form. Each planting was assessed to determine species of planting, height of individuals, vigor (based on a 0 to 5 ranking), and extent of browsing damage (also recorded on a 0 to 5 ranking). (See Table 3.)

Table 3. Vigor and Browsing Use Ranking Classifications

Health/Vigor		
Rating	**Description**	
0	Dead	Dead, no evidence of recovery
1	Dying	Plant apparently not growing
2	Poor	Low vitality with evidence of biomass loss
3	Fair	Main stem dead but basal sprouts emerging
4	Good	Vigorous, but not optimal growth
5	Optimal	Optimal growth (budding, new leaf growth, flowering, seeding, etc.)
Browsing		
Rating	**Range**	**Description**
0	0-5	None – Current year's leaders show little or no use
1	6-20	Slight – Available leaders show some use but 20% or less of current year's leaders have use
2	21-40	Light – Available leader appear browsed or cropped in patches but 60-79% of current year's leaders remain intact
3	41-60	Moderate – Browse appear rather uniformly used and 40-59% of current year's leaders remain intact
4	61-80	Heavy – Most available leaders are used and 20-39% of the terminal buds remain
5	81-100	Severe – Grazing on second and third year's leaders growth; plants show club-like appearance

The first five sites were planted in late 2010 or early 2011, and the survival metrics presented in this report represent the second year of post-construction revegetation success. The other two were planted in 2012 and thus the metrics for these sites represent a sampling of the first year survival success.

This assessment is used to determine the success of revegetation following site rehabilitation and to determine the likely success of achieving the recovery goal of no net loss of riparian vegetation within 10 years of construction. A total of 1,332 pods representing 7,992 plantings were assessed for survival at the first five sites, which were found to have the following percent survival: Indian Creek Boat Launch, 51.7; Wheel Gulch, 59.0; Reading Creek, 66.1; Trinity House Gulch, 44.5; and Lowden Meadows, 51.7. Additional plantings may

be necessary at all five sites to bring overall success back to at least 70 percent.

A subsampling (equaling at least 10 percent) of the container and pole plantings at Upper Junction City and Lower Steiner Flat was also conducted to get a quantitative estimate of survival of individuals. At Upper Junction City the planting layout presented in the *Draft Contract No. R12PC20204 TRRP Revegetation Project Post Implementation Report* was used to identify sampling areas. The as-built record drawings for the Lower Steiner Flat planting in the same report were used to determine sampling locations at Lower Steiner Flat. Areas identified as containing riparian clusters and upland clusters were selected as sampling locations. These areas cover the majority of the revegetated area.

The results of the 2013 field surveys are summarized in the following sections of this report. At the five older sites, 1,332 pods were visited to assess survival of plantings, and pod survival was determined based on individual plantings survival. Only a sampling of individual plantings was assessed at Upper Junction City (732 plantings) and at Lower Steiner Flat (841 plantings). Results based on this sampling are presented in Table 4.

Table 4. Site Assessment Summary

Site	Number of pods	Assessed plantings
Indian Creek Boat Launch	100	600
Wheel Gulch	118	708
Reading Creek	86	516
Trinity House Gulch	208	1,248
Lowden Meadows	820	4,920
Upper Junction City	--	732
Lower Steiner Flat	--	841
Total	1,332	9,565

During the survey certain trends were observed in the rehabilitation sites. These trends included the following:

- Survival rates for all species were less than those observed during the 2012 field survey.
- In many cases, surviving arroyo willows were more robust than other surviving species.

- Some plantings were broken off at ground level at all sites, apparently from human or wildlife trampling.
- Shining willows typically received heavier browsing than any other species, at least in the Year 1 and 2 plantings.
- Douglas fir plantings in the Upper Junction City site had a very low survival rate.
- Narrow-leaf willow recruitment was evident at all sites.
- Following the suspension of watering at the Lowden Meadows site the loss of individuals increased.
- 2013 has been an abnormally dry year in the area surrounding the TRRP project area. Precipitation in 2013 is a total of 1.07 inches (27 mm), fifth lowest reading since 1975, as reported by Weather Source, LLC.

Throughout all of the revegetation locations, some plantings appeared to have been lost as a result of human activity (i.e., foot traffic by fisherman and campers). Additional plantings are recommended for those surveyed locations that contain pole plantings. Plantings should occur in areas where the highest survival has been documented. At the Indian Creek Boat Launch site additional measures should be taken to control the infestation of Himalayan blackberry, which is invading the planting areas. Natural regrowth/recruitment and revegetation of cottonwood and narrow-leaf willows was observed at Indian Creek Boat Launch, Wheel Gulch, Reading Creek, and Lowden Meadows sites. Regeneration was limited to small areas within the revegetation limits. Regrowth/ recruitment is increasing and helping to compensate for the loss of riparian vegetation.

The revegetation areas at the Upper Junction City and Lower Steiner Flat sites are being tended under a maintenance contract with Restoration Resources. The contract requires the contractor to ensure a 70-percent survival of planted individuals at the end of year three of the contract. Most likely, they will meet this goal by replacing individuals that do not survive during the first couple of years.

Survival of individuals was compared for each species planted within the pods and on an overall survival basis (Table 5). In summary, there were two areas of increase observed between 2012 and 2013. The increase is largely the result of individuals resprouting from root systems that were not fully developed in 2012, although some of it is due to misidentification of individuals during the 2012 survey. Pod survival was assessed

Native Oregon ash (*Fraxinus latifolia*; above) and native mugwort (*Artemisia douglasiana*; below) growing at Lower Steiner Flat channel rehabilitation site in 2013.

by looking at the number of individuals which survived from one year to the next. Table 6 shows a comparison of pod survival based on the number of individuals that survived within each pod.

To ensure revegetation success of hardwood plantings (e.g., willows and cottonwoods) on the harsh (hot, dry, and mined) Trinity River floodplain, the Program continues to update its planting techniques. In 2013, more than 8 acres (3.2 hectares) were planted in the riparian corridor using appropriate species for local environmental conditions. Irrigation systems were also installed to provide water during the establishment phase. The plantings include a diverse assemblage of species, such as California wild rose (*Rosa californica*), American Dogwood (*Cornus sericea*), black cottonwood (*Populus trichocarpa*), mugwort (*Artemesia douglasiana*), Oregon ash (*Fraxinus latifolia*), and California coffeeberry (*Frangula californica*).

Before beginning channel rehabilitation work, the TRRP conducts botanical surveys to ensure that rare species would be located and protected if found, and to determine if any high-priority invasive species are present so that management options might be considered for their control. Construction activities may temporarily reduce the existing abundance of many of the Trinity River's non-native species (e.g., Himalayan blackberry and Dalmatian toadflax (*Linaria dalmatica*)).

Table 5. Comparison of Individual Survival Between 2012 and 2013

Site	Year	Arroyo Willow		Cottonwood		Shinning Willow		Red Willow		Planting Survival		Difference in Survival (%)
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	
Indian Creek Boat Launch	2012	126	--*	45	--*	144	--*	7	--*	322	53.7	2.0
	2013	137	--*	39	--*	128	--*	6	--*	310	51.7	
Wheel Gulch	2012	12	29	284	82	141	88	101	63	538	76.0	17.0
	2013	7	17	287	83	78	48	46	29	418	59.0	
Reading Creek	2012	75	82	138	78	85	68	78	63	376	72.9	6.8
	2013	75	82	106	60	85	68	75	61	341	66.1	
Trinity House Gulch	2012	183	--*	291	--*	185	--*	148	--*	807	64.6	20.1
	2013	138	--*	195	--*	116	--*	106	--*	555	44.5	
Lowden Meadows	2012	795	--*	1,184	--*	860	--*	707	--*	3,514	73.8	22.1
	2013	596	--*	850	--*	618	--*	479	--*	2,543	51.7	

* Due to the compilation of individuals in the other pods it is not possible to determine the exact percentage of survival for individuals.

Table 6. Comparison of Pod Survival Between 2012 and 2013

Site	Year	Number of Surviving Individuals Per Pod													
		Zero		One		Two		Three		Four		Five		Six	
		Pods	% of total	Pods	% of total	Pods	% of total	Pods	% of total	Pods	% of total	Pods	% of total	Pods	% of total
Indian Creek Boat Launch	2012	16	16.2	5	5.1	11	11.1	15	15.2	20	20.2	22	22.2	10	10.1
	2013	6	6.1	12	12.1	14	14.1	23	12.2	24	24.2	15	15.2	6	6.1
Wheel Gulch	2012	6	5.1	0	0.0	2	1.7	11	9.3	29	24.6	35	29.7	35	29.7
	2013	1	0.8	6	5.1	19	16.1	28	23.7	35	29.7	27	22.9	2	1.7
Reading Creek	2012	1	1.2	2	2.4	5	5.9	14	16.5	13	15.3	30	35.3	20	23.5
	2013	0	0.0	3	3.5	12	14.1	14	16.5	19	22.4	26	30.6	11	12.9
Trinity House Gulch	2012	11	5.3	7	3.4	22	10.7	28	13.6	55	26.7	46	22.3	37	18.0
	2013	36	17.2	26	12.4	37	17.7	37	17.7	33	15.8	28	13.4	12	5.7
Lowden Meadows	2012	12	1.5	15	1.9	64	7.9	99	12.3	178	22.1	234	29.0	204	25.3
	2013	85	10.4	92	11.2	134	16.3	138	16.8	153	18.7	151	18.4	67	8.2

The TCRCD visits sites several times to map and manually remove certain noxious weeds, such as dyer's woad (*Isatis tinctoria*). Due to the plant's noxious weed status, relatively low abundance in Trinity County, abundant seed production, and adaptability to thrive in disturbed areas, all necessary measures were implemented to eradicate the plant from the site and to prevent its spread. During construction, excavated floodplain material (free from dyer's woad) was placed on one of the largest areas from which dyer's woad had been manually removed.

Riparian Species

The Focal Birds

In 2011, the Klamath Bird Observatory (KBO) initiated its bird monitoring program along the 40-mile (64-km) Trinity River reach and at selected rehabilitation sites, building upon the earlier research done by the Redwood Sciences Lab from 2002-2009 (Figure 15). In addition to evaluating bird utilization of constructed floodplain features and revegetated areas, and maintaining its monitoring program, KBO initiated several new scientific inquiries in 2012, which it continued into 2013. These refined studies, which include productivity estimates (nest searches), spot mapping of bird territories, and intensive vegetation monitoring, are meant to provide results to link potential management with the health of focal bird populations. They also address several objectives identified in the Integrated Assessment Plan (TRRP and ESSA 2009) that attempt to measure population and diversity trends following project implementation.

The strategy includes continued monitoring of temporal variation in avian performance metrics at the program area and river reach scales, and 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 Program activity (Sullivan and Bair 2004, Bair 2008) the bird monitoring strategy attempts to explicitly identify mechanistic linkages between avian metrics and restoration-associated changes in riparian microhabitat complexity at rehabilitation sites. Monitoring efforts continue to meet and assess programmatic compliance, the goal being to increase the precision of management activities (e.g., flow releases, revegetation efforts, excavation and floodplain management) in order to directly benefit targeted avian species.

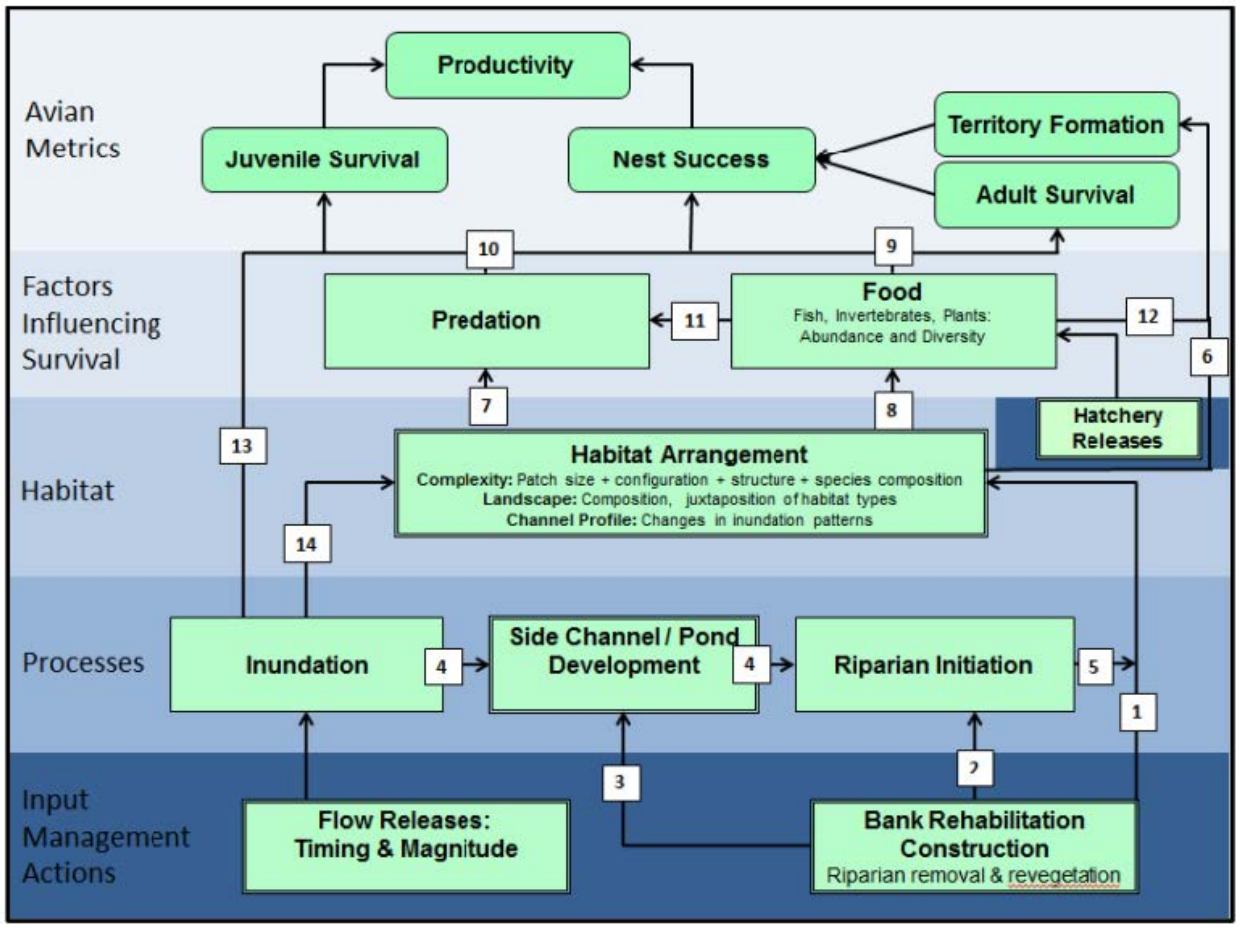


Figure 15. Conceptual model for interactions among programmatic restoration techniques and the riparian bird life cycle. Originally developed by Redwood Sciences Lab and revised by Klamath Bird Observatory.

TRRP continues to collect data on five bird species — one resident and four migrants — selected as riparian focal species for the Trinity River Restoration Program. The target riparian species — Black-headed Grosbeak, Song Sparrow, Tree Swallow, Yellow-breasted Chat, and Yellow Warbler — were selected due to their strong association with riparian habitat in the western United States, their status as riparian focal species by California Partners in Flight (RHJV 2004), and their high frequency of occurrence on the Trinity River. In combination, these species represent key structural components of a riparian ecosystem capable of supporting numerous other species.

Photo © Jim Livaudais

Song Sparrow (Resident)—
This heavily streaked russet, gray, and white bird is perhaps the most familiar native sparrow in the United States. It is also our most common focal species. Song sparrows keep relatively low to the ground as they utilize grasses and shrubs for nesting

Photos © Jim Livaudais

and foraging. They feed on seeds, berries, and a variety of invertebrates. As habitat generalists, song sparrows will inhabit both early successional and mature riparian habitat. They are our first focal species expected to inhabit restored riparian and our first indication that young habitat is on a successful trajectory.

Black-Headed Grosbeak (Migrant)—
A large bill combined with a black, white, and cinnamon pattern helps identify males of this species. Black-headed grosbeaks occur in a variety of habitats and show a preference for areas that contain a deciduous component. They are often most abundant in riparian zones, mixed conifer-hardwood forests, and at the interface between these two habitat types. They conceal their nests in the midstory and feed mainly on insects, seeds, and berries. On the Trinity, grosbeak abundance in the riparian zone is an indication of an intermediate successional stage containing deciduous shrub and lower tree layers.

Yellow Warbler (Migrant)—
This bird with rich yellow plumage sports a prominent black eye. Yellow warblers can be found in dense thickets of willow- or cottonwood-dominated riparian habitat. They nest in midstory vegetation, typically between 1 and 14 feet off the ground. They feed almost exclusively on insects. Yellow warblers are indicators of well-developed riparian habitat.

Yellow-Breasted Chat (Migrant)—
White “spectacles” adorn the grayish head of this vocal bird with a bright yellow chest. Yellow-breasted chats occur at thicket edges with an open canopy overstory. They nest in the understory, often fewer than 5 feet off the ground. Their diet includes both insects and berries. Similarly to the yellow warbler, this focal species prefers structural features that indicate a well-developed riparian habitat.

Tree Swallow (Migrant)—
Iridescent blue-green above and snow-white below, the tree swallow is often seen in flight. Tree swallows occur near mature riparian forests due to their dependence on standing dead trees for nesting cavities. They also require open areas with ready access to water. The bulk of their diet is formed from insects taken on the wing, but berries are eaten too. This focal species indicates mature riparian components retained within restoration areas.

In 2012 and 2013, the most abundant target species, the song sparrow, was the focus of a study by Rockwell and Stephens (2014) designed to detect changes in bird metrics attributable to restoration (Miller et al. 2010). The song sparrow was selected because there was a large enough sample to permit a preliminary analysis of habitat selection after two field seasons. The objective was to examine whether song sparrows place their nests and/or territories on patches of microhabitat that differ from what is generally available on study sites. This would provide evidence of habitat preferences for specific elements of vegetation structure that could be incorporated into the restoration design of future rehabilitation sites. No directional *a priori* hypotheses were specified regarding which vegetation characteristics song sparrows were expected to select for their territory or nest locations.

The song sparrow (top, © Jim Livaudais) favors a brushy or shrubby open habitat with few trees, as shown here.

Song sparrows were tested for departure from random use of available habitat by comparing vegetation characteristics sampled at nest sites, random territory points, and systematic sitewide points (Figure 16). In general (with some exceptions), song sparrows seemed to exhibit a preference for microhabitats with positive shrub characteristics and negative tree characteristics. This was evidenced by their trend towards selecting territory and/or nest locations with greater percent cover by shrubs, blackberry, forbs, and flood-deposited vegetation material than expected if placed at random.

In contrast, song sparrows appeared to choose areas of microhabitat with lower canopy heights and less diversity of tree species than was available on study plots. Sometimes important differences in habitat selection were revealed by examining patches of remnant riparian habitat and areas of constructed floodplain separately. For instance, on constructed floodplains, where the overall percent cover by blackberry shrubs was low, song sparrows chose territory locations with more blackberry cover than average. In remnant riparian patches, where the overall blackberry cover was higher, song sparrows selected territories that had blackberry cover similar to that of the whole area.

The Program is operating under an adaptive management philosophy, and identifying mechanisms that explain variation in bird performance metrics in relation to Program activities is important. This initial study appears to reveal a song sparrow preference for microhabitat with greater percent shrub cover, including willow shrubs and areas with more flood-deposited dead vegetation. It demonstrates the importance of returning

these natural processes to the riparian system. Spot-map and nest-search surveys continue to provide precise data regarding the locations of territories and nests of this and other riparian target species, and their associations with habitat structure on constructed floodplains vs. unmanipulated remnant riparian habitat. Territory and nest locations continue to be related to measures of microhabitat complexity and vegetation structure, and they are linked to restoration-associated revegetation of constructed floodplains. Such quantified relationships of bird habitat selection and preferred vegetation characteristics can be incorporated into restoration site design and management actions, in order to enhance the quality of rehabilitation sites for riparian birds and other wildlife. Reproductive success will be the ultimate test of the quality of restored riparian habitats and their ability to support healthy bird populations.

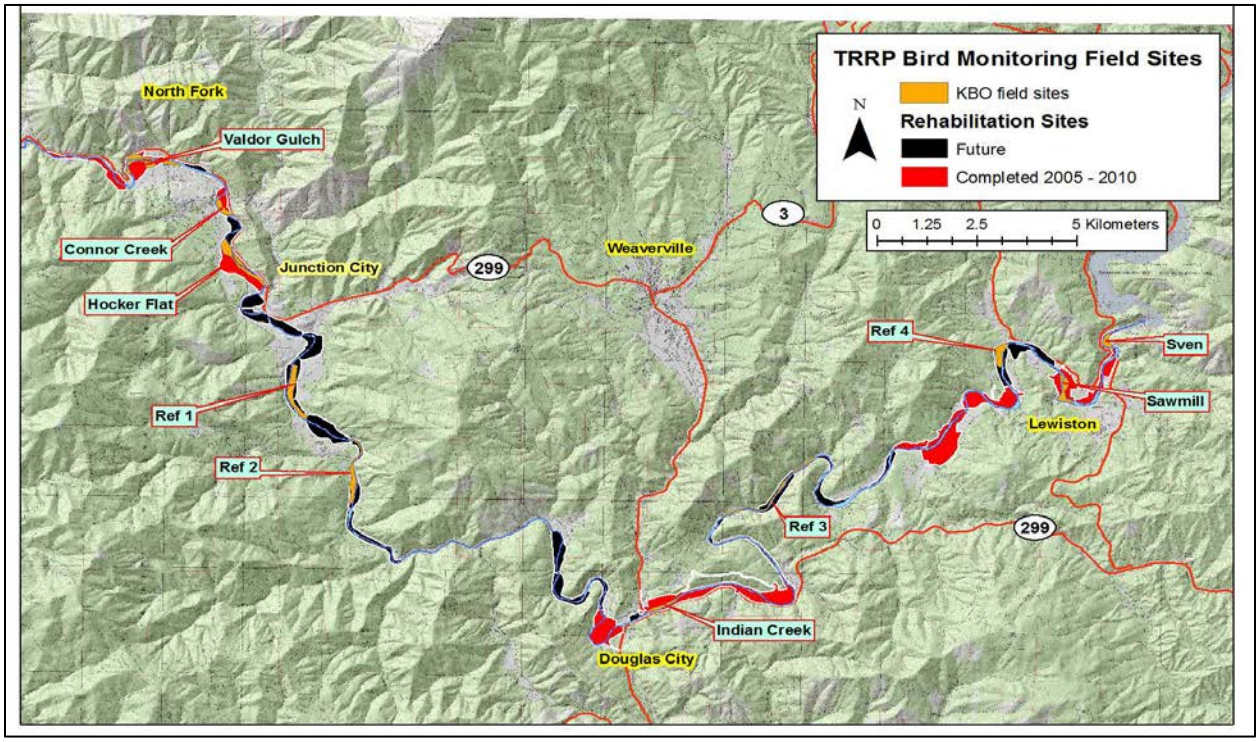


Figure 16. Map of the program area, comprising approximately 40 miles (64 km) of the Trinity River between Lewiston and North Fork. Orange polygons are study sites used for territory mapping and intensive vegetation sampling, including six sites that have been rehabilitated and four unmanipulated reference sites. Additionally, nests were monitored at the Connor Creek, Hocker Flat, Valdor Gulch, and Reference 1 sites.

Herpetofauna

Trinity River riparian health impacts other species as well. In a newly released report, Wheeler et al. (2013) analyzed the effects of water temperature on the foothill yellow-legged frog

(*Rana boylii*) species' breeding phenology, growth, and timing of metamorphosis. The report showed potentially severe negative impacts from poor timing or incorrect magnitude of stream discharges, and the importance of reaching prolonged, optimal temperatures using the proper flow management.

The foothill yellow-legged frog (top) is most at home in a tributary with sloping banks dominated by cobbles and shallow, slow-moving water, as shown here. (Both photos © Gary Nafis, used under his posted grant of Free Use: http://www.californiaherps.com/info/photouse.html.)

Foothill yellow-legged frogs have experienced significant population declines across their range in California and Oregon. Studies have linked the presence of water impoundments to the species' decline, with ill-advised or uninformed management of dams identified as a major threat to the persistence of the species (Lind et al. 1996, Lind 2005, Kupferberg et al. 2012). Modified flow regimes resulting from such dam management (Leigh et al. 2012) can have both direct and indirect effects on these frogs (Kupferberg et al. 2011). Temperature is a critical driver of physiological processes in cold-blooded organisms. Abrupt and unpredictable changes are a potential threat to survival, and while numerous studies have suggested that water temperature influences breeding activity, the effects of different water temperatures on embryonic development, tadpole growth, and metamorphosis have only recently been examined (Kupferberg et al. 2013).

Water temperatures in the mainstem Trinity River during the late spring and summer months have been substantially colder (10–20°C [18–36°F] lower) since the construction of the dams compared to pre-dam conditions; water released into the mainstem Trinity River from the bottom of the Trinity Reservoir is much cooler than the surface water temperature.

Wheeler et al. (2013) predicted that frogs would be smaller at metamorphosis in the mainstem and in colder water tributaries (i.e., higher elevation snow-influenced streams) since breeding likely occurs later and the colder water temperatures would impede growth and differentiation. The objectives of their study were to: (1) examine and compare key aspects of the reproductive cycle of yellow-legged frogs in different Trinity River tributaries; (2) examine and compare the phenology of reproduction, including rates of differentiation, time to metamorphosis, and size at metamorphosis, by tributary; and (3) examine the differences as they relate to variation in water temperature regime, such that the influences of the hypolimnetic releases from the reservoir on the mainstem Trinity could be identified and potentially mitigated.

Wheeler et al.'s (2013) conclusions show that the foothill yellow-legged frog population on the mainstem is extremely small and that multiple factors, primarily related to unnatural

Egg mass of a foothill yellow-legged frog.

flow and temperature regimes (Olden and Naiman 2010), are negatively impacting this population. Negative effects of the flow regime on frogs in this river system previously documented include delayed breeding activity and stranding or scouring of egg masses (Lind et al. 1996). The results provide information regarding differences in populations suggesting that reduced water temperature resulting from the management of the mainstem Trinity River is an additional stressor impacting frog population survival and fitness.

Wheeler et al. (2013) suggest that low water temperatures may contribute to delays in breeding activity (Figure 17) and that persistent cold water temperatures result in decreased larval growth and smaller-sized metamorphs on the mainstem. Smaller size at metamorphosis likely has profound effects on both individual survival and population fitness. The water in the mainstem is maintained at a colder temperature than would occur naturally during the development period of foothill yellow-legged frog larvae, and the unseasonably low maximum summer temperatures may be nearing the species' lower thermal limit. These data indicate that late breeding activity, loss of egg masses, and inhibited larval growth, in addition to extremely low annual reproductive output, have all contributed to a greatly reduced population size on the mainstem.

Humboldt State University graduate student with two of her radio-tagged turtles at Lowden Ranch channel rehabilitation site.

Western Pond Turtle (*Actinemys marmorata*) populations have declined throughout much of their range as a result of habitat loss, overexploitation, introduced species, and watercourse alterations. Alterations to the Trinity River resulting from damming and flow regulations have decreased mainstem river quality for turtles. Therefore, alternative habitats, such as ponds and wetlands adjacent to the river, may be important in providing resources not supplied by the river. However, the use of such alternative habitats by turtles has only been briefly studied. Preliminary work by researchers at Humboldt State University revealed a highly adult-biased population of Western Pond Turtles in ponds at a single site along the Trinity River (Sloan and Marks 2012). Although adult turtles are currently abundant at that site, there is little recruitment of juveniles, compromising the ability of the population to sustain itself over the long term. To determine if this situation is typical for lentic habitats in this watershed, or simply a localized phenomenon, the Humboldt State researchers examined four population health parameters for Western Ponds in lentic habitats along the upper Trinity River and its tributaries: (1) age structure, (2) size structure, (3) body size, and (4) growth rate of young turtles.

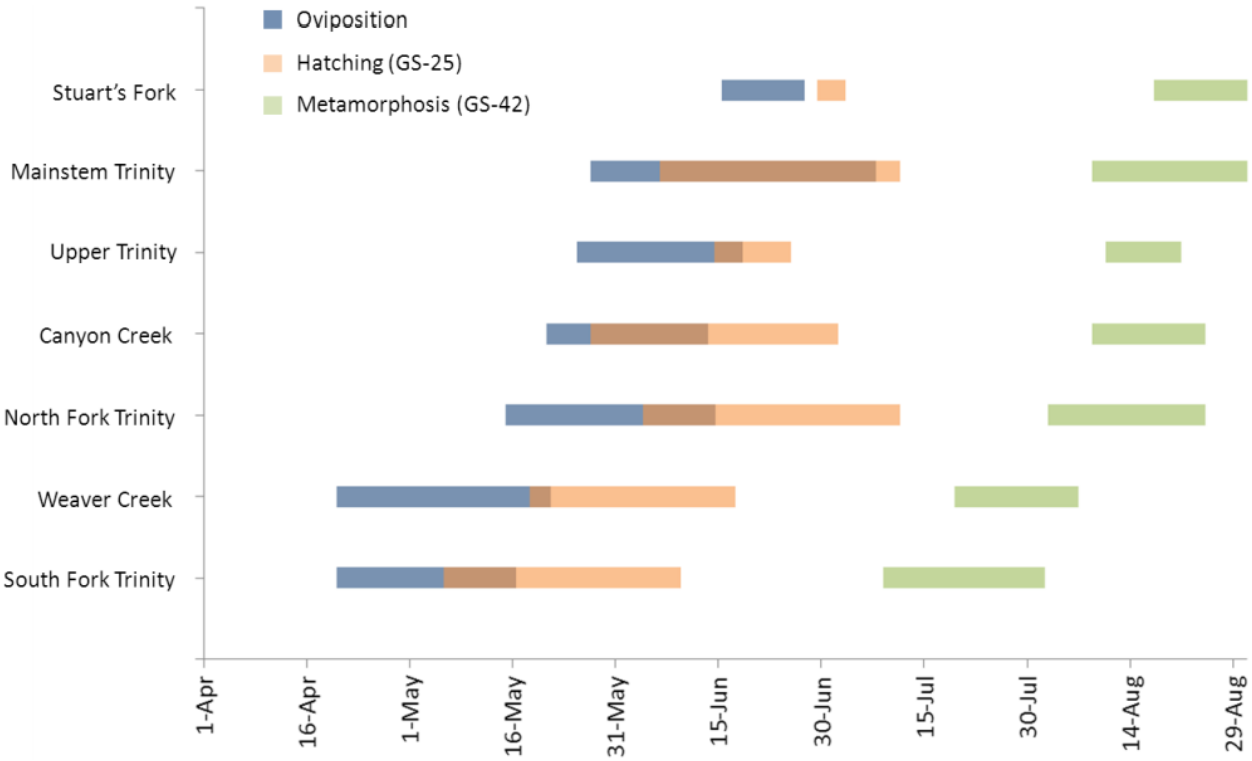


Figure 17. Annual variation in initial dates for detection of oviposition, hatching, and metamorphosis in foothill yellow-legged frogs (*Rana boylii*) on seven tributaries of the Trinity River, Trinity County, California. Areas in brown represent an overlap in oviposition and hatching dates. GS = Gosner stage. South Fork Trinity, North Fork Trinity, Mainstem Trinity and Canyon Creek were sampled from 2006 to 2009. Weaver Creek, Upper Trinity, and Stuarts Fork were sampled in 2008 and 2009.

Population health indicators and habitat variables varied substantially across lentic habitats; however, all populations had at least some characteristics that compromise long-term viability. Four of six lentic sites had populations that were heavily biased towards older turtles. There were prolific populations of non-native American bullfrogs (*Lithobates catesbeianus*) at these sites; these are voracious predators that will eat small turtles. Given that all sites with bullfrogs had few young turtles, it appears that bullfrogs are the principal factor in reducing turtle recruitment. By contrast, no bullfrogs were observed at the other two sites, and these had a high proportion of young turtles. However, turtles at these sites had a slow growth rate and small size, likely delaying reproductive maturity and decreasing clutch size. Cold water temperature likely played a role, since the ponds at these sites are at least partially spring fed.

Turbidity

Turbidity monitoring downstream of Lorenz Gulch during typical construction conditions.

Turbidity, a measure of the cloudiness of water, is typically low in the Trinity River during summer conditions but is a natural occurrence in rivers during storms or other runoff events. It 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 TRRP construction contractors to strictly adhere to permit requirements specified in the Program's general water quality certification.

In 2009, the Regional Water Board worked with TRRP to develop water quality mitigation measures that are included in the TRRP's general permit (Order Number R1-2010-0028) and that are followed on TRRP projects today. At that time, the agencies determined that an allowable zone of turbidity dilution is appropriate and necessary in order 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 Regional water quality objective for turbidity. The general permit limits allowable turbidity levels at 500 feet downstream of the work zone to no more than 20 nephelometric turbidity units (NTU). Compared to the Trinity River's usually excellent water clarity, turbidity levels between 10 and 20 NTUs appear cloudy, but these permitted levels allow construction of river restoration projects and are protective of beneficial river uses (NCRWQCB and TRRP 2009).

During 2013 construction, the contractor successfully employed best management practices (e.g., isolation of work areas, pumping of turbid water into upslope sediment ponds, and the slowing of equipment work during periods of increased turbidity) to ensure that turbidity consistently stayed within permit levels. Given the contractor's attention to detail and full-time awareness to keep the Trinity River as clear as possible, 2013 visual turbidity impacts were minimized. Not only did the contractor operate within permitted levels but they were usually well below the permit's 20-NTU limit (e.g., less than 10 NTU at the monitoring areas downstream of in-channel work).

Water Temperatures and Compliance

Table 7 lists the ROD Trinity River water temperature targets. Reclamation (Central Valley Operations), the Program, and the USFWS actively track water temperatures in the Trinity and

Lower Klamath Rivers (Scheiff and Zedonis 2011) to understand how dam releases meet those targets.

Table 7. Trinity River Temperature Targets by Reach and Date

Source	Target Reach	Dates	Target
Basin Plan for the North Coast Region (NCRWQCB 2011)		***All Years***	
	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)
	Lewiston to North Fork	October 1–December 31	≤56 °F (13.3 °C)
Springtime Objectives of the Record of Decision for the Trinity River EIS/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–July 9 *	≤68.0 °F (20.0 °C)

*For Dry and Critically Dry years, TRFES prescribes maintaining temperature <68° F "prior to July 9" in Table 8.3, but only "until mid-June" in Tables 8.8 and 8.9.

Water Temperature Compliance

The following figures show temperature compliance in WY 2013.

Confluence with North Fork – Fall 2012 (WY 2013)—
Fall temperatures in the Trinity River, measured at the confluence with the North Fork of the Trinity River, were below the target set by State Water Resources Control Board Order WR 90-5 (SWRCB 1990), as illustrated in Figure 18. There was one day of river temperature exceedance, October 16, 2012.

Hoopa – Spring 2013—
Figure 19 illustrates the river temperatures at Hoopa between 15 April and 9 July, 2013. The target temperatures were exceeded on numerous days as the river temperature tracked the weather patterns of the lower Trinity basin.

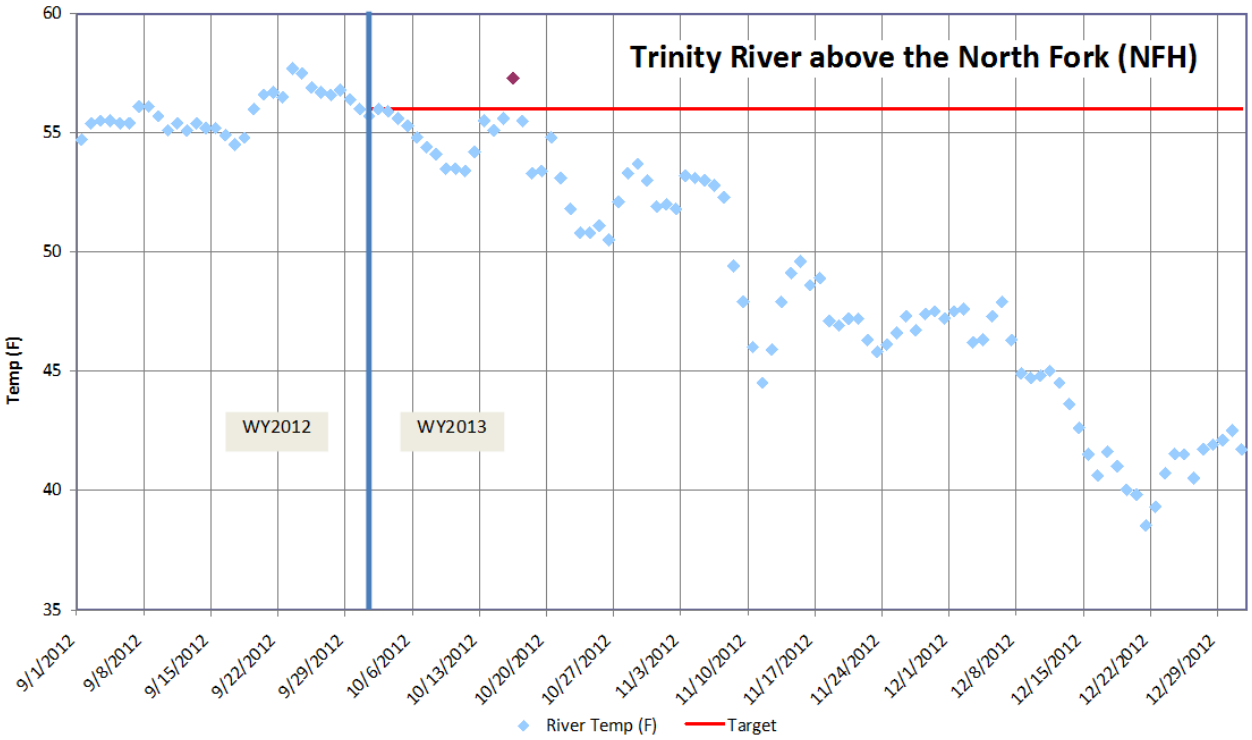


Figure 18. River temperatures, Fall 2012 in the Trinity River at the confluence with the North Fork.

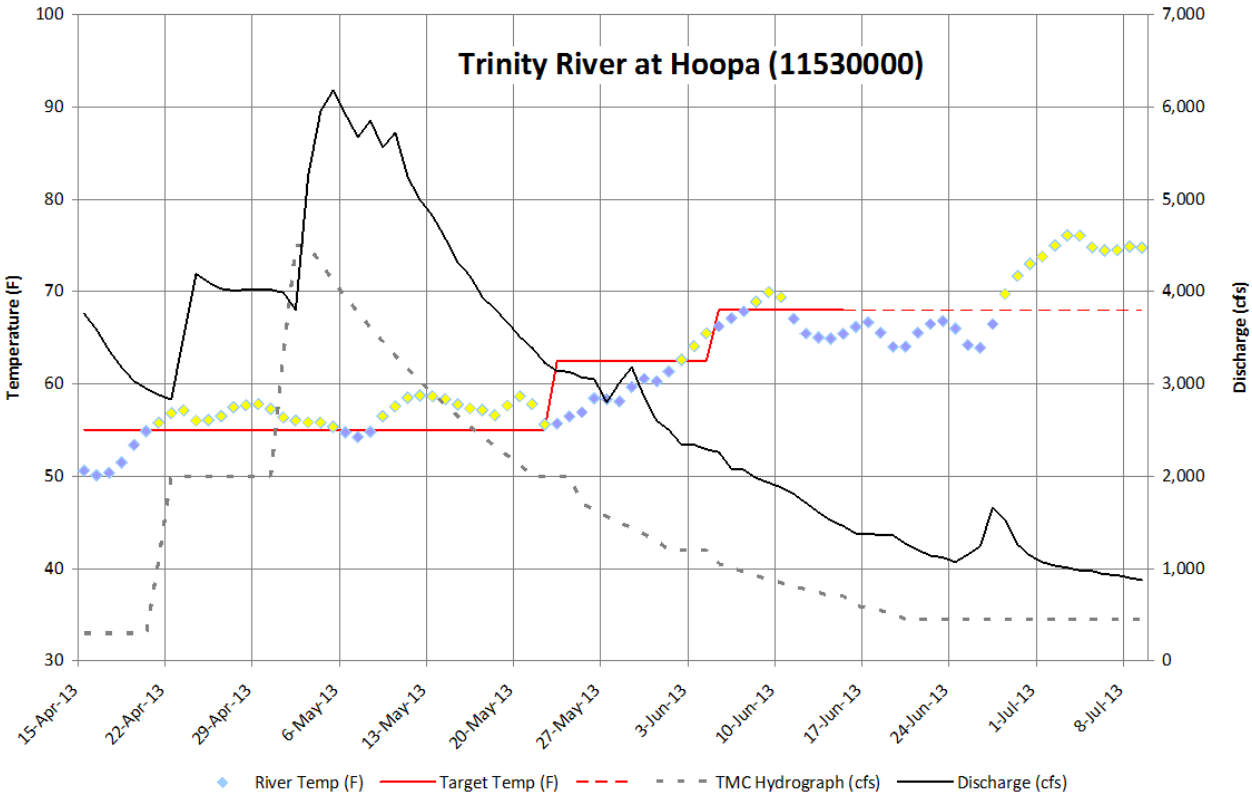


Figure 19. River temperatures Spring 2013 in the Trinity River at Hoopa (USGS 11530000).

Douglas City – Summer 2013—
Figure 20 illustrates the river temperatures at Douglas City during the summer of 2013. There were no days when the mean river temperature exceeded the target temperature of 60°F.

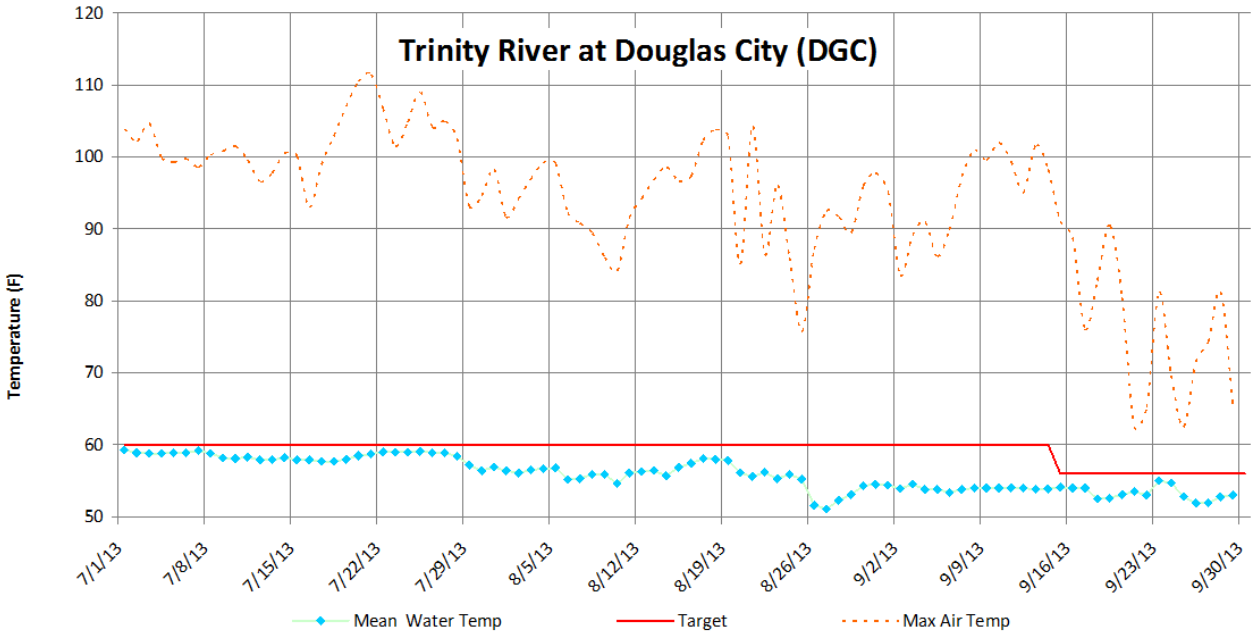


Figure 20. River temperatures Summer 2013 in the Trinity River at Douglas City.

Cultural Resources

The Program works with BLM, USFS, and Reclamation archaeologists to evaluate the status of cultural resources (e.g., old homesteads, apple orchards, tailings piles, etc.) at proposed rehabilitation sites and to determine whether any of 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.

In considering implementation of the ROD, TRRP researchers realized the potential impact to cultural resources in the restoration reach. To ensure preservation of historic resources, a programmatic agreement was developed between the Federal agencies, the HVT, and the California State Historic Preservation Office. Though much of the Program's work is confined to the floodplain where historic resources have been inundated and, hence, have lost much of their integrity, the

large scope of channel rehabilitation and the interrelatedness of historic sites along the river (e.g., mining operations) has continued to impress researchers and to suggest the need for a comprehensive analysis of historic resources throughout the restoration reach.

To date, cultural resource studies have included archaeological surveys within the project areas, plus significance evaluations of recorded properties within rehabilitation project site boundaries. However, as part of Phase II work, a historic context report and map have been developed to identify areas that might be eligible for NRHP listing within the Environmental Study Limits for all planned channel rehabilitation projects. The map-based mining context report helps facilitate site-specific surveys as each new site is evaluated; its historic background is already documented.

Two historic context documents are now available that describe historic conditions and events related to various types of mining operations, primarily hydraulic sluicing, and dredging. The first is *The Other California Gold: Trinity County Placer Mining, 1848-1962* (Bailey 2008), and the second (the map based context) is *Historic Context for Mining Along the Trinity River* (AECOM 2013).

As a site-specific example, on the left side of the river at the Lorenz Gulch site, the TRRP worked with BLM archaeologists to select degraded tailings piles for processing and development into clean gravel for placement in the river. Other tailings piles, which were more intact and representative of historic doodle bug mining operations on the river, were fenced with construction fencing and left undisturbed (Figure 21). These tailings now remain as a reminder of historic mining and may be marked by with interpretative signs in the future.

Public Outreach in 2013

The Program completed an ambitious public outreach schedule in 2013 with both new and continuing efforts, including:

- **Public Meetings and Workshops** – Public meetings included the TRRP Science Symposium. This event, described in the following section, provided presentations on the Phase I Review, the science behind the Phase I Review, and a brief overview of TRRP.

Figure 21. Construction fencing used at Lorenz Gulch channel rehabilitation site to protect archaeological historical mining features.

A primary objective of the public meetings is to enhance public knowledge and understanding of the roles of Program partners and cooperators in implementing TRRP science activities, including monitoring and evaluation. They provide an opportunity for TRRP staff to describe and discuss how in-channel projects are designed based on this information and how they are implemented in collaborative partnerships between public agencies, non-governmental organizations, and groups of landowners and other private citizens. Several public meetings and workshops were held to elicit input and answer questions about the Program in general and to preview designs for upcoming in-channel projects (Figure 22). In addition, public meetings are held to explain environmental compliance requirements and to gather public input about proposed approaches and mitigation measures related to site-specific projects. The meetings provide a public venue to discuss the biological and physical science behind project objectives, features, and approaches. Watershed project coordination and implementation were provided through TRRP funding to the TCRCD.

- **Expanded Presence at Community Events** – TRRP provides financial support to the Trinity County Resource Conservation District for the Salmon Festival, Trinity County Fair, Children's Festival, Wetlands and Salmon classes, the Weaverville Summer Day Camp, and the Environmental Camp. TRRP technical staff volunteered as science instructors at the Environmental Science Camp and

the "Day in the Wetlands" for local school students. The TRRP continues community participation as part of the Program's educational outreach at the Trinity River Salmon Festival, the Children's Festival, the Trinity County Fair, and other community events.

Figure 22. Post card invitations to two of the TRRP's public meetings in 2013.

- **Funding of the Conservation Almanac –** TRRP continued to fund the publishing and distribution of the *Conservation Almanac*. The Summer 2013 edition (http://tcrcd.net/almanac/pdf/nws-v22n3.pdf) includes an article about how the Program's structure facilitates public

input to the adaptive management approaches outlined for the Program in the Record of Decision.

- **Direct Solicitation of Community Feedback** – Community conversation meetings were held early in development of each future project at different locations in the county. Members of the public were encouraged to ask questions regarding any aspect of the Trinity River, the Program, or proposed site-specific projects. Answers were thoroughly researched, were provided to attendees, and were posted on the Program's website: http://www.trrp.net/.

- **Printed Brochures and Outreach Material** – The Program produced a video in 2013 providing a history of the need for river restoration and presenting an overview of the development of the modern Program. It describes the many partner and cooperative efforts that ensure Program success. The video, entitled *Restoring – Adapting – Improving/TRRP Overview*, is available on the Program's website: http://www.trrp.net/.

  A new tri-fold color brochure, *Native Species of the Trinity River: What to Look For and Where to Find Them*, was produced by a multidisciplinary group of technical staff funded through the TRRP at the Trinity County Resource Conservation District and throughout the TRRP partnership. The brochure was distributed regionally. It describes several native fish and other riverine species found in the river, cites the benefits of healthy native fish populations, and explains how restoration activities are designed to support these populations. It provides an overview of the Program partnership and the widespread, ongoing collaboration necessary for restoration of a healthy river with a diversity of native species. Based on community feedback, all of the materials produced in 2013 were written for public audiences with an emphasis on educational outreach.

- **In-Person Contact and Response** – Inquiries about the Program and its projects were welcomed from walk-ins, telephone calls, and email messages at the Weaverville TRRP 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 continue to post the approved restoration hydrographs at approximately 40 sites

along the river to update river users about the coming changes in the river flows. The program also assists private citizens in reaching the local, regional, or national agencies and organizations that have the responsibility for specific natural resource issues.

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

- **Internet Presence** – The official Program website is http://www.trrp.net/. Here, the Program posts announcements and makes available a broad spectrum of information for the public. In 2013, the Program continued to review, improve, and update website content to provide pertinent, useful, and accessible information for the public. The calendar lists scheduled quarterly meetings of the Trinity Management Council, the technical work groups, and, as a courtesy, the Trinity Adaptive Management Working Group.

- **Traditional Media Presence** – A number of articles regarding the TRRP appeared in various regional media outlets.

Science Symposium

The TRRP hosted a science symposium during the week of January 7, 2013. The emphasis of the symposium was the ongoing Phase 1 Review of past rehabilitation projects implemented from 2005 through 2010. SAB members Drs. Clair Stalnaker, John Buffington, Mike Merigliano, James T. Peterson, and Chris Jordan presented early draft findings during the week to TRRP decision makers, technical staff, and the public. The event began with a public presentation on the evening of January 7 that featured a TRRP overview by Executive Director Robin Schrock, a Phase 1 Review overview by SAB member Mike Merigliano, and a question and answer session. SAB members and their support contractors then made a series of public technical presentations on January 8. On January 9, SAB members met with TRRP technical staff to discuss technical details of their analyses, and potential adaptive management recommendations of the Phase 1 review that could be addressed before the final report was scheduled to be released. Finally, on January 10, SAB members briefed the TAMWG on initial analytical approaches and draft findings of

the Phase 1 Review. The need for a Decision Support System was emphasized.

Looking Ahead: 2014 Program Activities

The Program will continue to execute the restoration strategy in 2014, as described in the Record of Decision (U.S. Department of the Interior 2000), the Trinity River Environmental Impact Statement (USFWS et al. 2000), and the Trinity River Flow Evaluation Report (USFWS and HVT 1999). Proposed activities include the construction of two channel rehabilitation projects (Upper Douglas City, Lower Junction City), WY 2013 flow schedule planning and implementation, completion of five priority watershed projects, coarse sediment augmentation, and continuation of monitoring and assessment projects. Other noteworthy activities planned for 2014 include:

- Phase I Review of the Channel Rehabilitation Projects – The SAB has invested more than 2 years in an intensive evaluation of channel rehabilitation actions between 2005 and 2010. Their findings (Buffington et al. 2014) will serve as a foundation for the remaining rehabilitation projects and will facilitate full implementation of adaptive management. TRRP will focus on addressing the report's recommendations in 2014 and subsequent years.
- Fish Production Model – Also based on an SAB recommendation, the TRRP will develop a salmonid production model for the Trinity River that ties to a Klamath River model. The model will be a component of the TRRP Decision Support System, which 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 actions; (3) the effect of temperature on of fish growth and resulting production; and (4) the growth/size of fish resulting from different flow/temperature alternatives and how this relates to potential survival.
- Environmental Compliance – During 2014, the TRRP will re-initiate endangered species consultation with the NMFS and USFWS. In this consultation, TRRP partners will develop a Biological Assessment of TRRP effects on federally listed species based on new information learned

since the original consultation in 2000. The Biological Assessment will be partly programmatic in nature and will include information on the TRRP decision-making processes that provide for protection and support of the Trinity River ecosystem. It will also cover elements of the TRRP that may affect threatened, endangered, or sensitive species: channel rehabilitation, sediment management (fine and coarse), limited infrastructure, and watershed program elements. The TRRP will use current details to update the scope and techniques originally used to describe restoration actions, and will evaluate any new potential impacts to the status of listed species. Additionally, the TRRP will develop information to support the renewal of its general water quality permits for both channel rehabilitation and gravel augmentation. Renewing the gravel permit will require: (1) development of an updated project description based on information learned during the previous 5-year permitting period; (2) CEQA/NEPA documentation, public notification, and response to comments; and (3) a permit application.

- Phase II Plan – Based on draft Phase I review findings and in consultation with the SAB, the TRRP is developing a comprehensive plan for prioritizing the design and construction of future channel rehabilitation actions. The plan will use a quantitative approach to combine two-dimensional hydraulic modeling, biological factors, and a comprehensive logic model to evaluate temporal and spatial sequencing of remaining projects.
- Stakeholder involvement continues through the advisement of the Trinity Adaptive Management Working Group, frequent outreach updates and products, continuing improvements to the website (www.trrp.net), public meetings and seminars, and private landowner cooperation in rehabilitation projects.

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Web Sources

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  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.
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The 2013 Annual Report of the Trinity River Restoration Program is available electronically at www.trrp.net and includes web links to reference material and agencies.

Appendix A: Acronyms

AEAM	Adaptive Environmental Assessment and Management
BLM	Bureau of Land Management
°C	degrees Celsius
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
cfs	cubic feet per second
D_{84}	particle diameter that exceeds the diameter of 84 percent of the sampled particles
EIR	Environmental Impact Report (required under CEQA)
EIS	Environmental Impact Statement (required under NEPA)
°F	degrees Fahrenheit
GRTS	generalized random-tessellation stratified (sampling design) (Stevens and Olsen, 2004)
HVT	Hoopa Valley Tribe
KBO	Klamath Bird Observatory
km	kilometer(s)
LIDAR	light detection and ranging
m	meter(s)
m^3/s	cubic meters per second
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRHP	National Register of Historic Places
NTU	nephelometric turbidity units
ODP	online data portal
ROD	Record of Decision
SAB	Scientific Advisory Board
TAMWG	Trinity Adaptive Management Working Group
TCRCD	Trinity County Resource Conservation District
TLS	terrestrial laser scanning
TMC	Trinity Management Council
TREIS/R	Trinity River Environmental Impact Statement
TRFES	Trinity River Flow Evaluation Final Report
TRRP	Trinity River Restoration Program (also “the Program”)
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WY	water year (October through September)
YT	Yurok Tribe

On Back Cover:

An existing low-flow side channel with mature riparian vegetation was incorporated into the Lorenz Gulch site design and was improved during construction in 2013.