Trinity River Restoration Program Objectives and Targets Summary

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Introduction

Trinity River Restoration Program Objectives and Targets Summary

The Trinity River Restoration Program's main science, monitoring, and evaluation planning document, the Integrated Assessment Plan (TRRP and ESSA 2009) was completed over a decade ago. This document contained an extensive list of ecological objectives and associated assessments and was used by the Program for over a decade to guide the science program. In the years since its completion, the Program identified a need to refine, reduce, and reorganize its objectives. The Program began this process with a workshop held in 2013 (Appendix 1). The process stalled in the years after the workshop, but the need remained. The TRRP Interdisciplinary Team (IDT) provided fresh guidance to the technical workgroups in 2018 (Appendix 2), and for the next two years four TRRP workgroups (Fish, Flow, Physical, and Riparian and Aquatic Ecology) worked diligently to complete the exercise. The workgroups provided their recommendations to the IDT in January 2021, and this document summarizes the new set of objectives and associated targets. The purpose of this document is to provide information needed to support a recommendation from the IDT to the TMC to adopt the list of objectives and targets presented in Table 1. Some objectives and targets are still at a conceptual stage and are not yet complete, as TRRP scientists have expected. Therefore, this document is intended to be updated as objectives and targets are improved.

The summary is presented in five sections that follow this introduction. Four sections contain reports from the four workgroups in a consistent format. Each workgroup recommended a set of objectives and associated targets, and describe how the pre-existing set of objectives were reviewed, how the new list of objectives and targets were developed, and then described the new list of objectives and targets (definitions associated with this exercise are contained in Appendix 2). The last section describes "next steps"- how and when to prioritize the objectives and targets; how and when to update objectives and targets; and how to handle questions that come up during the review process, particularly the objectives and targets that are incomplete.

Table 1: All objectives and targets, with their associated management actions, recommended by TRRP technical workgroups. Detailed descriptions are in the workgroup sections.

Objective	Target	Management Action
Fish 1: Increase naturally produced fall-run Chinook Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced fall-run Chinook Salmon to 62,000 adults.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
	Harvest of 131,750 adult fall Chinook Salmon across all tribal, recreational, and commercial fisheries in ocean and in-river sectors	
Fish 2: Increase naturally produced spring-run Chinook Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced spring-run Chinook Salmon to 6,000 adults.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
	Harvest of 12,750 adult spring Chinook Salmon across all tribal, recreational, and commercial fisheries in ocean and in-river sectors	
Fish 3: Increase naturally produced Coho Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced Coho Salmon to 1,400 adults.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
	Harvest target is undefined.	
Fish 4: Increase naturally produced steelhead adult production to the extent	Increase escapement of naturally produced steelhead to 40,000 adults.	Channel rehabilitation, flow management, gravel

Objective	Target	Management Action
necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Harvest target is undefined.	augmentation, watershed restoration
Fish 5: Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Not quantified to measure program success. No target.	Flow management
Fish 6: Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Not quantified to measure program success. No target.	Channel rehabilitation, flow management, sediment management
Fish 7: Reduce brown trout population to decrease predation on and competition with native naturally produced fish	No more than 5 individuals over 35 cm per day at Junction City weir and carcass surveys combined.	Non-native species management in TRRP-funded projects, e.g., weirs and juvenile outmigrant traps
	No more than 200 1+ brown trout (approx. 10 cm) at the North Fork screw trap between 1 January and 31 August.	Non-native species management in TRRP-funded projects, e.g., weirs and juvenile outmigrant traps

Objective	Target	Management Action
Fish 8: Increase the amount and improve the quality of rearing habitat available to native juvenile salmonids	Restoration sites will maintain at least 80% of the gain in area-under-the-curve (AUC) of the flow-to-Capacity relationship estimated for the design condition compared to the pre-construction condition for at least ten years post-construction. Current and future site designs should estimate gains in AUC from 300-3,500 cfs.	Channel rehabilitation, gravel augmentation, watershed restoration
Fish 9: Link the phenology of prey species and salmonid species to disturbance caused by management actions to enhance production of BMI assemblage with species of appropriate size and vulnerability	Annual streambed disturbance event (>6,000 cfs) between 6 and 12 weeks prior to peak Chinook Salmon fry emergence in ≥90% of the restoration reach to reset BMI succession and promote the production of abundant vulnerable prey. Streambed disturbance events which occur 3-18 months prior to peak emergence are desirable in the absence of more recent disturbance.	Flow management
Fish 10: Increase/maintain the amount and improve the quality of spawning habitat available to native salmonids	Not quantified to measure program success. No target.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
Fish 11: Maintain or increase adult holding habitat from baseline conditions	Target remains undefined	Channel rehabilitation, flow management, watershed restoration

<table>
<tr><th>Objective</th><th>Target</th><th>Management Action</th></tr>
<tr><td>Fish 12: Provide thermal regimes that promote growth and survival throughout the rearing and outmigration periods for native juvenile salmonids</td><td>Rearing: 7-day average of the daily average (7DADA) of 13.0-16.5 C upstream of NF Trinity from 1 April to 31 July</td><td>Flow management</td></tr>
<tr><td>Fish 13: Provide thermal regimes to promote spawning success of spring and fall Chinook Salmon</td><td>Maintain existing temperature objectives at Douglas City (60F 1 July-14 Sept; 56F 15 Sept-30 Sept) and North Fork (56 F Oct 10 Dec 31). Added Lewiston Dam release objectives of 53.5 F 15 Sept-31 Oct, 50 F 1 Nov-31 Dec, and 48 F 1 Jan – 1 March.</td><td>Flow management</td></tr>
<tr><td>Fish 14: Minimize competition and predation by hatchery smolts on wild fry and juveniles</td><td>Target remains undefined</td><td></td></tr>
<tr><td>Flow 1: Provide suitable ramp up rates by time of year for target species by water year class</td><td>EIS ramp up rates (CFS):
<table>
<tr><td>≥6,000</td><td>1,000 cfs/2 hrs</td></tr>
<tr><td>4,000 to 5,999</td><td>1,000 cfs/2 hrs</td></tr>
<tr><td>2,000 to 3,999</td><td>500 cfs/2 hrs</td></tr>
<tr><td>500 to 1,999</td><td>250 cfs/2 hrs</td></tr>
<tr><td>300 to 500</td><td>100 cfs/2 hrs</td></tr>
</table></td><td>Flow management (rate of change)</td></tr>
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<table>
<tr><th>Objective</th><th>Target</th><th>Management Action</th></tr>
<tr><td>Flow 2: Provide suitable ramp down rates by time of year for target species by water year class</td><td>EIS ramp down rates (CFS):
<table><tr><td>≥6,000</td><td>500 cfs/4 hrs</td></tr><tr><td>4,000 to 5,999</td><td>400 cfs/4 hrs</td></tr><tr><td>2,000 to 3,999</td><td>200 cfs/4 hrs</td></tr><tr><td>500 to 1,999</td><td>100 cfs/4 hrs</td></tr><tr><td>300 to 500</td><td>50 cfs/4 hrs</td></tr></table></td><td>Flow management (rate of change)</td></tr>
<tr><td>Flow 3: Release allocated flow volumes by water year class and implement prescribed hydrographs</td><td>• Extremely Wet WY 815.2k AF
• Wet WY 701.0k AF
• Normal WY 646.9k AF
• Dry WY 452.6k AF
Critically Dry WY 368.6k AF</td><td>Flow management (total water volume)</td></tr>
<tr><td>Flow 4: Provide flows that inundate ephemeral surfaces above the winter baseflow channel for variable durations to meet ecological needs</td><td>Inundate ephemeral habitats for 35 to 84 days between January 1 and May 1 for fish prey food production and groundwater recharge; inundate floodplain surfaces <4,500 cfs for ≥21 days to facilitate natural riparian regeneration between May 1 and June 20.</td><td>Flow management (provide suitable annual hydrographs)</td></tr>
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Objective	Target	Management Action
Physical 1: Increase topographic variability of active channel as measured by R*	$R*$ targets are applied at the reach scale dependent on local geomorphic controls. Target values of $R*$ have not yet been defined but can be determined by adopting a value representative of reaches that are deemed to be satisfactorily complex. Increases in $R*$ generally indicate an increase in channel complexity.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Physical 2: Inundation effectiveness as measured by A_w*	A_w* targets are applied at the reach scale dependent on local geomorphic controls. Target values are under development. Increases in A_w* are perceived as indication that availability of habitat is increased.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Physical 3: Increase rates of bed mobility and scour	Mobilization of matrix surface particles (D_{84}) on alternate bar surfaces during Normal and wetter water years >6,000 cfs) Mobilization of subsurface particles (≥ 1D_{84} depth) during Wet and Extremely Wet years Mobilization of subsurface particles (≥2D_{84} depth) during Extremely Wet years	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Physical 4: Increase area of active bars	Target values set at reach scale based on local controls. Target trends are to increase number of active bars and spatial extent of active bars	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Physical 5: Maintain sediment mobility at thresholds that aide physical and biological processes	Maintain observed critical Shields stress at Lewiston, Limekiln Gulch, and Douglas City sediment monitoring transects for the median grain size (τ^*_{c50}) between 0.025 and 0.085.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.

Objective	Target	Management Action
Physical 6: Maintain fine sediment storage at levels that promote healthy river functioning	Maintain storage of fine sediment in substrate at level where mobility is not limited by sheltering effects of coarse grains.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Physical 7: Promote channel migration	Targets set at reach scale based on channel design guide (Hoopa Valley Tribe et.al, 2011).	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
RAE 1: Increase the width of the aquatic-terrestrial interface within the restoration reach that are colonized by native wetland and riparian plants	Increase area less than 6 feet above summer baseflow water surface elevation within the margins of the maximum fishery flow	Flow releases, gravel augmentation, channel rehabilitation
RAE 2: Maintain a range of temperatures over various flow regimes needed by native species	Increase the diversity of water temperature (residence time of water) at rehabilitation sites	Flow releases, gravel augmentation, channel rehabilitation
	Achieve daily average water temp of 10 C at the gage above NF (USGS 11526400) on or before May 1 during critically dry and dry water years; and maintain or increase for 14 days	
	Promote timely oviposition and reduce scour of FYLF egg masses by limiting magnitude of discharge increases once water temperature of 10C has been achieved and water stage has been stable (less than 0.05 m/d change for 7 days) at the USGS gauge above the North Fork. After which, discharge increases should be limited to less than 1000 cfs for 24 hours and 500 cfs for longer periods prior to July 1.	
RAE 3: Promote dominance of native flora and fauna species in the ecological community structure	Increase richness, abundance, and diversity of native cover types	Flow releases, channel rehabilitation
	Increase richness, abundance, and diversity of native species of fish, wildlife, invertebrates, and algae	

Objective	Target	Management Action
RAE-4: Maintain flow variability over a broad temporal range to promote scour and inundation to promote habitat complexity	Ensure sufficient mortality of riparian vegetation along the margins of the low-water channel and on the floodplain by ensuring only one surviving cohort of narrowleaf/dusky willow every decade.	Flow Releases
	Ensure recession limb falls at a rate conducive for black cottonwood recruitment every 3-5 years.	
	Reduce desiccation of FYLF egg masses by limiting recession rate to 0.03 m/d for 35 days after achieving 10 C for 10 days at the gage above NF (USGS 11526400).	

Fish Workgroup

Following the TRRP Objectives Workshop on 22 May 2013, the Fish Work Group began the task of refining objectives presented in the IAP to a manageable set. Details of this work are presented in a Fish Work Group document dated 5 May 2014 (Appendix 3). The set of 54 fish-related objectives from the IAP were subjected to several iterations of evaluation for redundancy with other objectives and for their connection to management actions, which resulted in a set of just 20 objectives to be further evaluated. The effort in 2014 appears to have ended there.

The Fish Work Group reinitiated refinement of fish-related objectives and their associated targets at their 25 June 2018 meeting after a hiatus beginning in 2014. The 20 objectives identified by the previous Fish Work Group effort provided the starting point for this renewed effort. Over the course of the 11 meetings held since June 2018 work group members further distilled this set and their associated targets to the 14 objectives described herein.

IAP Objectives Considered

The Fish Work Group effort in 2014 evaluated all fish-centric objectives in the IAP. For the most part IAP objectives were either kept as-is, deleted because of redundancy with other objectives, or deleted all together for various reasons. The language and numeric values were modified in a few instances. Documentation on this process is limited, but we have indicated the fate of all IAP objectives to the best of our ability in Table 2. At the end of this effort in 2014, the work group compiled a consolidated list of objectives they wished to move forward (Table 3). This consolidated list provided the starting point for the effort reinitiated in 2018. Table 2 Objectives were listed in the IAP. Results of the Fish Work Group effort in 2014 are provided.

Table 2: Objectives listed in the IAP. Results of the Fish Work Group effort in 2014 are provided. [1]

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives	Fish Work Group decision 2014
2. Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals	2.1 Increase and maintain salmonid habitat availability for all freshwater (in-river and tributary) life stages *(linkage to Riparian Objectives 5.1.2 & 5.2)*	2.1.1 Increase/maintain salmonid fry and juvenile rearing habitat in the upper 40 miles of the mainstem Trinity River by a minimum of 400 % following rehabilitation of fluvial attributes	Kept
		2.1.2 Increase/maintain spawning habitat quantity and quality to 2,550,000 square feet in the upper 40 miles of the mainstem Trinity River	Kept
		2.1.3 Create channel form that reduces loss of fry to stranding in the upper 40 miles of the mainstem Trinity River following rehabilitation during high flows	Kept, combined with 3.2.5
		2.1.4 Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River	Kept
		2.1.5 Minimize physical impacts to lamprey habitat	Deleted, redundant with 4.5.1 and 4.5.2
		2.1.6 Minimize physical impacts to other native fish habitats	Deleted, too general
		2.1.7 Maintain or increase tributary habitat	Deleted, too general
	2.2 Improve riverine thermal conditions for growth and survival of natural anadromous salmonids	2.2.1 Provide optimal temperatures to improve spawning success of spring and fall-run Chinook salmon	Deleted, redundant with 3.1.3
		2.2.2 Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon	Kept
		2.2.3 Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	Kept
		2.2.4 Minimize temperature impacts to other native fish habitats	Deleted, too general
	2.3 Enhance or maintain food availability for fry and juvenile salmonids	2.3.1 Increase and maintain macroinvertebrate populations *(achieve Fish Production objective 3.1.1)*	Deleted, unknown

1. The numbers represent the same numbering system used in the IAP.

Table 2 (cont.)

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives	Fish WG decision 2014
3. Restore and maintain natural production of anadromous fish populations	3.1 Increase spawning, incubation and emergence success of anadromous spawners	3.1.1 Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes	Deleted, redundant with 2.1.1
		3.1.2 Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes	Deleted, redundant with 2.1.1
		3.1.3 Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River	Kept
	3.2 Increase freshwater production of anadromous fish	3.2.1 Increase fry abundance, growth, physical condition, and health from baseline conditions in the mainstem Trinity River within 3-4 brood cycles following rehabilitation of fluvial river processes	Combined with 3.2.2 and reworded
		3.2.2 Increase outmigrant juvenile life stage abundance, growth, physical condition and health from baseline conditions in the mainstem Trinity River within 3-4 brood cycles following rehabilitation of fluvial river processes	Combined with 3.2.1 and reworded
		3.2.3 Improve juvenile fish production as a function of water temperature and habitat flow relationships from baseline conditions in the mainstem Trinity River within 3-4 brood cycles following rehabilitation of fluvial river processes	Deleted, redundant with 2.2.2
		3.2.4 Reduce clinical disease incidence in Trinity River origin outmigrants in the Klamath River to less than 20% within 5 years	Deleted, unknown
		3.2.5. Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes	Kept, combined with 2.1.3
		3.2.6 Reduce non-native fish predation on naturally produced fish by 50% in the mainstem Trinity River within 3-4 brood cycles following rehabilitation of fluvial river processes *(linkage to Wildlife objective 6.3)*	Deleted, unknown
	3.3 Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish	3.3.1 Limit impacts of hatchery fish predation on naturally produced juvenile salmonids to less than 20% over the 40 miles	Kept, split into separate competition and predation objectives
		3.3.2 Increase proportion of Natural Influence (pNI) to 0.7 or greater	Kept and reworded

Table 2 (cont.)

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives	Fish Work Group decision 2014
4. Restore and sustain natural production of anadromous fish populations downstream of Lewiston Dam to pre dam levels, to facilitate dependent tribal, commercial, and sport fisheries' full participation in the benefits of restoration via enhanced harvest opportunities	4.1 Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	4.1.1 Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults	Kept
		4.1.2 Increase harvest of naturally produced fall-run Chinook salmon adults	Kept
	4.2 Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	4.2.1 Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults	Kept
		4.2.2 Increase harvest of naturally produced spring-run Chinook salmon adults	Kept
	4.3 Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	4.3.1 Increase escapement of naturally produced coho salmon to 1,400 adults	Kept
		4.3.2 Increase harvest of naturally produced coho adult salmon adults	Kept
	4.4 Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	4.4.1 Increase escapement of naturally produced steelhead to 40,000 adults	Kept
		4.4.2 Increase harvest of naturally produced steelhead adults	Kept
	4.5 Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	4.5.1 Increase escapement of Pacific lamprey adults	Kept
		4.5.2 Increase harvest of Pacific lamprey adults	Kept
	4.6 Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	4.6.1 Increase escapement of green sturgeon adults	Kept
		4.6.2 Increase harvest of green sturgeon adults	Kept

Table 3: Consolidated list of objectives derived from the IAP by the Fish Work Group effort in 2014.

Means objective type	Means objective	Metric
Fish Population/harvest	Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults. Harvest metric is undefined.
	Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults. Harvest metric is undefined.
	Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced coho salmon to 1,400 adults. Harvest metric is undefined.
	Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced steelhead to 40,000 adults. Harvest metric is undefined.
	Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Escapement and harvest metrics not yet defined
	Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Escapement and harvest metrics not yet defined
Fish production	Limit redd superimposition by increasing suitable spawning habitat areas	Metric not yet defined
	Minimize fry stranding	Do not exceed ramping rates in EIS (binary metric yes/no)
	Reduce brown trout population to decrease predation on and competition with native naturally produced fish	Negative trend in CDFW JC weir CPUE data (binary metric yes/no)
Fish Habitat	Increase/maintain salmonid fry and juvenile rearing habitat	Increase habitat by a minimum of 400 % following rehabilitation of fluvial attributes
	Increase/maintain spawning habitat quantity and quality	Increase to 2,550,000 square feet for upper mainstem. Increase available spawning habitat to XX proportion of available habitat in tributaries TBD
	Maintain or increase adult holding habitat from baseline conditions	pools $\geq$ 2.4 m (8 ft) and with a surface area $\geq$ 72 m^2 (775 ft^2) under baseflow conditions

Means objective type	Means objective	Metric
Water temperature	Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon	Preferred temperature-Steelhead: 50.0 to 55.4 F. Coho 53.6 to 57.3 F. Chinook 53.6 to 57.2 F.
	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	Steelhead (May 22), <55.4 F in EW,W, N water years @ Weitchpec, <55.4 F in D, CD water years @ Weitchpec
	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	Coho (June 4), <59 F in EW,W, N water years @ Weitchpec, <62.6 F in D, CD water years @ Weitchpec
	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	Chinook (July 9), <62.6 F in EW,W, N water years @ Weitchpec, <68 F in D, CD water years @ Weitchpec
	Provide optimal temperatures to minimize pre-spawning mortality, protect in-vivo egg viability, and improve spawning success of spring and fall-run Chinook salmon	60F to Douglas City July 1-Sept 14, 56F to Douglas City Sept 15-Sept 30, 56F to North Fork Trinity Oct. 1-Dec 31.
Hatchery	Increase proportion of Natural Influence (pNI) used as a surrogate for genetic interactions = mixing of hatchery and natural fish	pNI $\geq$ 0.5
	Minimize predation by hatchery smolts on wild fry and juveniles	< 0.05 fry/hatchery fish
	Minimize competition by hatchery smolts on wild fry and juveniles	Surrogate-Release date after April 15. (Yes or no binary metric)

New Objective and Target Development

The consolidated list of objectives resulting from the 2014 effort provided the starting point for the renewed effort in 2018. The work group first distilled the 2014 list of objectives down to a set that most closely supported fundamental goals of the Program, could be measured with a reasonable amount of effort, and could be affected by management actions within the scope of TRRP. Of the 20 objectives in that list, 17 were kept in whole or in part. The final list comprised 14 objectives that closely reflected the 2014 list, including a few combined closely related objectives and one new objective (Table 4).

Over the course of 11 meetings held since 2018, twelve targets were developed or carried over from targets in the 2014 list. Two additional targets have been carried forward but need revision, and development of four additional targets have been deferred until additional information necessary for their completion is available. Three objectives were kept but are not recommended to be quantified to measure program success. For each target that did not already have a clearly defined quantifiable target, a subgroup was formed to develop a new target and complete a written justification. Subgroup members developed targets, conveyed the proposed target to the work group in written documents and at work group meetings, adjusted targets in response to feedback, and finalized targets in written form. These written documents are provided as attachments to this report for targets that were newly defined or substantially revised. Further details on the objectives/targets refinement and discussions had at work group meetings can be found in meeting summaries found on the TRRP website.

Notably, three objectives were deemed no longer relevant to TRRP goals or outside the management control of the Program. Below is a list of these objectives and brief descriptions of why they were deemed no longer relevant. Further details are available in Fish Work Group meeting summaries.

Limit redd superimposition by increasing suitable spawning habitat areas

Work group members believed that management actions available to the Program have little effect on redd superimposition, and scientist do not have sufficient understanding of why fish superimpose redds when apparently suitable spawning habitat goes unused. Based on current understanding of suitable spawning habitat, a significant amount of apparently suitable habitat goes unused, even in high abundance years when rates of redd superimposition is high. We have little ability to control where they spawn. In addition, this objective was considered redundant with the objective to increase/maintain the amount and quality of spawning habitat.

Minimize fry stranding

Work group members agreed that the stranding issue identified in the Flow Study has largely been resolved in the 40-mile restoration reach. The riparian berms that were of most concern have been remediated via restoration efforts. In addition, some behaviors of habitat selection that could arguably be described as stranding may provide a benefit to juvenile salmonids. Explicitly noted by work group members was occupation of off-channel features that provide good habitat during winter and spring that may become disconnected from the mainstem between high flow events.

Increase the proportion of Natural Influence (pNI) used as a surrogate for genetic interactions - mixing of hatchery and natural fish

TRRP does not have any management authority of Trinity River hatchery, thus the Program's ability to control mixing of hatchery and natural fish is limited. However, recent discussion (6 January 2021 Fish Work Group meeting) on the effects of resuming gravel augmentation adjacent to the hatchery included some evidence and hypothesizing that Program management affecting the amount of spawning habitat available in that area has affected the distribution of spawning of hatchery-origin fish and may affect hatchery/natural interactions. Information in the adult synthesis report is likely to provide more insight on this topic.

Table 4: Objectives and Targets Proposed by the Fish Workgroup.

Objective	Target	Management Action
Increase naturally produced fall-run Chinook Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced fall-run Chinook Salmon to 62,000 adults.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
	Harvest of 131,750 adult fall Chinook Salmon across all tribal, recreational, and commercial fisheries in ocean and in-river sectors	
Increase naturally produced spring-run Chinook Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced spring-run Chinook Salmon to 6,000 adults.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
	Harvest of 12,750 adult spring Chinook Salmon across all tribal, recreational, and commercial fisheries in ocean and in-river sectors	
Increase naturally produced Coho Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced Coho Salmon to 1,400 adults.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
	Harvest target is undefined.	
Increase naturally produced steelhead adult production to the extent necessary to meet or	Increase escapement of naturally produced steelhead to 40,000 adults.	Channel rehabilitation, flow management, gravel

Objective	Target	Management Action
exceed escapement objectives and facilitate expanded harvest opportunity	Harvest target is undefined.	augmentation, watershed restoration
Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Not quantified to measure program success. No target.	Flow management
Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	Not quantified to measure program success. No target.	Channel rehabilitation, flow management, sediment management
Reduce brown trout population to decrease predation on and competition with native naturally produced fish	No more than 5 individuals over 35 cm per day at Junction City weir and carcass surveys combined.	Non-native species management in TRRP-funded projects, e.g., weirs and juvenile outmigrant traps
	No more than 200 1+ brown trout (approx. 10 cm) at the North Fork screw trap between 1 January and 31 August.	Non-native species management in TRRP-funded projects, e.g., weirs and juvenile outmigrant traps
Increase the amount and improve the quality of rearing habitat available to native juvenile salmonids	Restoration sites will maintain at least 80% of the gain in area-under-the-curve (AUC) of the flow-to-Capacity relationship estimated for the design condition compared to the pre-construction condition for at least ten years post-construction. Current and future site designs should estimate gains in AUC from 300-3,500 cfs.	Channel rehabilitation, gravel augmentation, watershed restoration

Objective	Target	Management Action
Link the phenology of prey species and salmonid species to disturbance caused by management actions to enhance production of BMI assemblage with species of appropriate size and vulnerability	Annual streambed disturbance event (>6,000 cfs) between 6 and 12 weeks prior to peak Chinook Salmon fry emergence in ≥90% of the restoration reach to reset BMI succession and promote the production of abundant vulnerable prey. Streambed disturbance events which occur 3-18 months prior to peak emergence are desirable in the absence of more recent disturbance.	Flow management
Increase/maintain the amount and improve the quality of spawning habitat available to native salmonids	Not quantified to measure program success. No target.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
Maintain or increase adult holding habitat from baseline conditions	Target remains undefined	Channel rehabilitation, flow management, watershed restoration
Provide thermal regimes that promote growth and survival throughout the rearing and outmigration periods for native juvenile salmonids	Rearing: 7-day average of the daily average (7DADA) of 13.0-16.5 C upstream of NF Trinity from 1 April to 31 July	Flow management
Provide thermal regimes to promote spawning success of spring and fall Chinook Salmon	Maintain existing temperature objectives at Douglas City (60F 1 July-14 Sept; 56F 15 Sept-30 Sept) and North Fork (56 F Oct 10 Dec 31). Added Lewiston Dam release objectives of 53.5 F 15 Sept-31 Oct, 50 F 1 Nov-31 Dec, and 48 F 1 Jan – 1 March.	Flow management
Minimize competition and predation by hatchery smolts on wild fry and juveniles	Target remains undefined	

Discussion of Objectives and Targets

Objective: Increase naturally produced fall-run Chinook Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity.

One of the fundamental objectives of the Program is to restore anadromous fish populations. This objective provides specific guidance toward that fundamental objective for fall Chinook Salmon. Harvest is included because the population of any fishery resource would not be considered fully restored if full participation in fisheries cannot be supported by the population.

Target (*There are two targets for this objective****):***

1. **Escapement: increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults.**
2. **Harvest: harvest of 131,750 adult fall Chinook Salmon across all tribal, recreational, and commercial fisheries in ocean and in-river sectors.**

The justification for the harvest target is presented in Appendix 3. Using the escapement targets of 62,000 natural-origin and 9,000 hatchery-origin adults returning to the Trinity River, the harvest target was calculated based on the harvest control rule used by the Pacific Fishery Management Council to manage Klamath River fall Chinook Salmon. The fundamental goal of the program to “facilitate full participation by dependent tribal, commercial, and sport fisheries through enhanced harvest opportunities” was interpreted as the maximum spawner reduction rate defined by the control rule as 68%. Stock abundance levels that would support both the adult escapement target and the maximum spawner reduction rate were used to calculate the harvest target.

Management actions that increase adult abundance of anadromous fish in the Trinity River make progress toward achieving this objective, which is the intention of nearly all actions implemented by the Program. Examples include channel rehabilitation to improve adult spawning and juvenile rearing habitat, gravel augmentation to improve geomorphic function of the river and enhance spawning habitat, flow management to rehabilitate the channel through geomorphic work and to increase juvenile rearing and outmigrating habitat, and watershed restoration.

Escapement and harvest are monitored annually in the Trinity River with a combination of mark-recapture population estimates, monitoring of returns to Trinity River hatchery, carcass/redd surveys, and harvest monitoring surveys. All methods excluding carcass/redd surveys have been implemented annually since at least 1978. Estimates needed to measure progress toward the harvest target are the product of a cohort reconstruction model that accounts for harvest in ocean commercial and sport harvest sectors, in addition to freshwater tribal and sport harvest sectors. A cohort reconstruction model for natural-origin fall Chinook Salmon is in development by Program scientists.

***Objective*: Increase naturally produced spring-run Chinook Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity.**

One of the fundamental objectives of the Program is to restore anadromous fish populations. This objective provides specific guidance toward that fundamental objective for spring Chinook Salmon. Harvest is included because the population of any fishery resource would not be considered fully restored if full participation in fisheries cannot be supported by the population.

Target (*There are two targets for this objective)***:**

1. **Escapement: increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults.**
2. **Harvest: harvest of 12,750 adult spring Chinook Salmon across all tribal, recreational, and commercial fisheries in ocean and in-river sectors.**

The justification for the harvest target is presented in Appendix 3. Essentially the same logic used for developing the fall Chinook Salmon harvest target was used for spring Chinook. Using the escapement targets of 6,000 natural-origin and 3,000 hatchery-origin adults returning to the Trinity River, the harvest target was calculated based on the harvest control rule used by the Pacific Fishery Management Council to manage Klamath River fall Chinook Salmon. Spring Chinook Salmon are not managed by the Council, so no control rule exists for this stock. The control rule for fall Chinook Salmon was used as a surrogate for spring Chinook Salmon. The fundamental goal of the program to "facilitate full participation by dependent tribal, commercial, and sport fisheries through enhanced harvest opportunities" was interpreted as the maximum spawner reduction rate defined by the control rule as 68%. Stock abundance levels that would support both the adult escapement target and the maximum spawner reduction rate were used to calculate the harvest target.

Management actions that increase adult abundance of anadromous fish in the Trinity River make progress toward achieving this objective, which is the intention of nearly all actions implemented by the Program. Examples include channel rehabilitation to improve adult spawning and juvenile rearing habitat, gravel augmentation to improve geomorphic function of the river and enhance spawning habitat, flow management to rehabilitate the channel through geomorphic work and to increase juvenile rearing and outmigrating habitat, and watershed restoration.

Escapement and harvest are monitored annually in the Trinity River with a combination of mark-recapture population estimates, monitoring of returns to Trinity River hatchery, carcass/redd surveys, tributary dive surveys, and harvest monitoring. All methods excluding carcass/redd and tributary dive surveys have been implemented annually since at least 1980, except 1983 and 1995. Estimates needed to measure progress toward the harvest target are the product of a cohort reconstruction model that accounts for harvest in ocean commercial and sport harvest sectors, in addition to freshwater tribal and sport harvest sectors. A cohort reconstruction model for spring Chinook has not been proposed by the Program.

***Objective**: Increase naturally produced Coho Salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity.*

One of the fundamental objectives of the Program is to restore anadromous fish populations. This objective provides specific guidance toward that fundamental objective for Coho Salmon. Harvest is included because the population of any fishery resource would not be considered fully restored if full participation in fisheries cannot be supported by the population.

Target** (There are two targets for this objective)**:

1. **Escapement** (target remains unchanged)**: increase escapement of naturally produced Coho Salmon to 1,400 adults.**
2. **Harvest: undefined** (development of target has been deferred to a later time but has been recognized as necessary by the Fish Work Group).

Management actions that increase adult abundance of anadromous fish in the Trinity River make progress toward achieving this objective, which is the intention of nearly all actions implemented by the Program. Examples include channel rehabilitation to improve adult spawning and juvenile rearing habitat, gravel augmentation to improve geomorphic function of the river and enhance spawning habitat, flow management to rehabilitate the channel through geomorphic work and to increase juvenile rearing and outmigrating habitat, and watershed restoration.

Escapement and harvest are monitored annually in the Trinity River with a combination of mark-recapture population estimates, monitoring of returns to Trinity River hatchery, and harvest monitoring surveys. All methods have been implemented annually since at least 1978. Estimates needed to measure progress toward a harvest target are the product of a cohort reconstruction model that accounts for harvest in ocean commercial and sport harvest sectors, in addition to freshwater tribal and sport harvest sectors. A cohort reconstruction model for Coho Salmon has not been proposed by the Program.

***Objective*: Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity.**

One of the fundamental objectives of the Program is to restore anadromous fish populations. This objective provides specific guidance toward that fundamental objective for Coho Salmon. Harvest is included because the population of any fishery resource would not be considered fully restored if full participation in fisheries cannot be supported by the population.

***Target* (*There are two targets for this objective*):**

1. **Escapement** (target remains unchanged)**: increase escapement of naturally produced steelhead to 40,000 adults.**
2. **Harvest: undefined** (development of target has been deferred to a later time but has been recognized as necessary by the Fish Work Group).

Management actions that increase adult abundance of anadromous fish in the Trinity River make progress toward achieving this objective, which is the intention of nearly all actions implemented by the Program. Examples include channel rehabilitation to improve adult spawning and juvenile rearing habitat, gravel augmentation to improve geomorphic function of the river and enhance spawning habitat, flow management to rehabilitate the channel through geomorphic work and to increase juvenile rearing and outmigrating habitat, and watershed restoration.

Escapement and harvest are monitored annually in the Trinity River with a combination of mark-recapture population estimates, monitoring of returns to Trinity River hatchery, and harvest monitoring surveys. All methods have been implemented annually since at least 1980, except for 1981, and 1985-87. Three runs of steelhead occur in the Trinity River (summer, fall and winter). Population estimates developed since 1978 are referred to as fall steelhead, but the estimates comprise some unknown proportion of at least fall and winter, and possibly summer runs (CDFW 2020). Estimates needed to measure progress toward a harvest target are the product of a cohort reconstruction model that accounts for harvest in ocean commercial and sport harvest sectors, in addition to freshwater tribal and sport harvest sectors. A cohort reconstruction model for steelhead has not been proposed by the Program. Notably, ocean harvest of steelhead is trivial when compared to salmon, so future development of a cohort reconstruction for steelhead may only require estimates of freshwater harvest. Due to uncertainty of escapement estimates and the lack of a cohort reconstruction model, the data needed to evaluate escapement or harvest targets for steelhead are unavailable.

***Objective*: Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity.**

The group agreed that protecting and enhancing the green sturgeon population in the Trinity River should remain an objective of the TRRP, but it is unnecessary for the Program to monitor the population or habitat, or infer Program success based on a quantifiable target.

***Target*:** *Undefined*

***Objective*: Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity.**

The group agreed that protecting and enhancing the Pacific lamprey population in the Trinity River should remain an objective of the TRRP, but it is unnecessary for the Program to monitor the population or habitat, or infer Program success based on a quantifiable target.

***Target*:** *Undefined*

***Objective*: Reduce brown trout population to decrease predation on and competition with native naturally produced fish.**

Target *(There are two targets for this objective)***:**

1. **Predation: no more than 5 individuals over 35 cm captured at Junction City weir or found on carcass/redd surveys combined.**
2. **Competition: no more than 200 age 1+ brown trout (>8 cm and <15 cm) captured at the Pear Tree screw trap between January 1 and August 31.**

Justifications for these targets are provided in Appendix 3. The 35 cm break for the predation target is derived from isotopic diet analysis within the Trinity River basin and literature on Brown Trout from other drainages. At 35 cm most Brown Trout switch from a primarily invertebrate diet to a more piscivorous diet (Alvarez and Ward 2019, Jensen et al. 2012, Jonsson et al. 1999). While there are no Trinity specific studies looking at competition between Brown Trout and native fishes, the negative effects have been documented in both lab and field studies in other river systems (Li and Brocksen 1977; Fausch and White 1986). The number of age 1+ Brown Trout captured at the Pear Tree screw trap fluctuates from 200 to over 2000 each year. As suppression progresses the desire is to keep the number of juveniles competing with native fish to the low end of that range.

Management actions that will directly address this means objective are included in the 2020 Trinity River recreational fishing regulations as well as management actions being adopted by California Department of Fish and Wildlife in collaboration with the Hoopa Valley Tribe. As of April 2020, the quota for Trinity River Brown Trout will increase from 5 to 10 fish per person per day and the possession limit will increase from 10 to 20. Beginning in the 2020 sampling season, the Hoopa Valley Tribe will begin actively culling Brown Trout caught at the Junction City weir. Lastly, any Brown Trout captured in the outmigrant trapping projects will also be culled. The TRRP funds Junction City weir and the Pear Tree rotary screw trap where these invasive species management actions occur.

Counts of adult brown trout captured at Junction City weir, carcasses found during carcass/redd surveys, and age 1+ juvenile brown trout captured at Pear Tree screw trap are provided in annual reports for each project.

<u>Objective</u>: Increase the amount and improve the quality of rearing habitat available to native juvenile salmonids.

One of the most important actions implemented by the TRRP is instream construction to restore geomorphic and ecological function, which is largely focused on creating, maintaining, and improving juvenile salmonid habitat. Research has demonstrated that a lack of juvenile rearing habitat limits population growth (e.g., USFWS and HVT 1999), so increasing the amount and quality of rearing habitat is a critical means to achieve our fundamental objectives. An objective explicitly for juvenile salmonid habitat first appeared in TRRP and ESSA (2009): "increase the amount and improve the quality of rearing habitat available to native juvenile salmonids."

<u>Target</u>: *There is one target proposed for this objective, which is focused on the restoration site scale. A separate target for total juvenile salmonid rearing habitat within the 40-mile restoration reach is in the preliminary stages of development and is awaiting completion of an analysis and report of Capacity (Som et al. 2017) estimates at the 40-mile scale.*

Restoration sites will maintain at least 80% of the gain in AUC of the flow-to-Capacity relationship estimated for the design condition compared to the pre-construction condition for at least 10 years post-construction. Current and future site designs should estimate gains in AUC from 300-3,500 cfs.

The justification for the harvest target is presented in Appendix 3. An integrated fish habitat metric (i.e., one that addresses water velocity, water depth, water temperature, food availability, and distance to cover) is not available to directly evaluate fish habitat at all spatial and temporal scales of interest. Therefore, AUC derived from manually mapping habitat according to suitable (for rearing salmonids) water velocity, water depth, and distance to cover is done at several flows, and then plotted. The AUC at a particular channel rehabilitation site is generally very high immediately after the site is restored, and either increases or decreases depending on how features within the site respond to subsequent flows and sediment loads (De Juilio et al. 2014, Boyce et al. 2018, Boyce et al. in prep.). We assume sites are designed to provide the most physical habitat gain that can be reasonably achieved given site-specific constraints such as geomorphology, hydrology, legacy anthropogenic effects, land owner agreements, consideration of other aquatic and terrestrial species, and contemporary methods of ecosystem restoration. Recognizing some reasonable amount of decrease in habitat following construction and assuming sites are designed to maximize habitat potential given constraints, this target emphasizes the long-term performance of features within a restoration site and whether they increase or maintain the amount of salmonid rearing habitat.

Channel rehabilitation activities done by TRRP create rearing habitat for salmonids. TRRP-prescribed releases from Lewiston Dam inundate this habitat as appropriate. These flows also interact with the sediment supply (either natural, or augmented gravel) to create geomorphic changes that are intended to maintain or even increase rearing habitat.

The study design (how, when, and how frequently to monitor) still needs to be determined. Existing datasets need to be identified, and the Trinity River Restoration Program needs to prioritize this objective and target in the context of other objectives and targets.

***Objective*: Link the phenology of prey species and salmonid species to disturbance caused by management actions, to enhance production of BMI assemblage with species of appropriate size and vulnerability.**

Freshwater habitat was identified in the Trinity River Flow Evaluation Study (USFWS and HVT 1999) as limiting to juvenile production, which provided the primary motivation for implementation of channel rehabilitation and flow management prescribed in the ROD. This was further elaborated on in the IAP (TRRP and ESSA 2009), recognizing three critical components of juvenile salmonid habitat: physical habitat (e.g., water depth, velocity, and distance to cover), temperature, and food availability.

Target *(There is one target proposed for this objective)***:**

Annual streambed disturbance event (>6,000 cfs) between 6 and 12 weeks prior to peak Chinook Salmon fry emergence in ≥90% of the restoration reach, to reset benthic macroinvertebrate succession and promote the production of abundant vulnerable prey. Streambed disturbance events which occur between 3 and 18 months prior to peak juvenile salmonid abundance are desirable in the absence of more recent disturbance.

A ranking system was proposed that addresses the desirability of the two timeframes, 6-12 weeks vs. 3-18 months prior to peak emergence.

Table 5: Example of possible metric for matching scour disturbance to biota phenology. Time periods in first two columns are prior to 1 April or estimated peak juvenile salmonid abundance date of management year. Last column would be calculated using gage data.

Scouring Flow 6-12 Weeks Prior	Souring Flow 3-18 Months Prior	Ranking	Proportion of Restoration Reach (longitudinal)
Y	Y/N		100% (example)
N	Y		100% (example)
N	N		0%

Justification for the target is described in Appendix 3. The first scouring flow of an annual cycle generally scours more of the channel bed surface than subsequent events of the same or lower magnitude, due to both clockwise hysteresis and stabilization making it more resistant to subsequent flows (Mao 2012; Kirchner et al. 1990; Paphitis and Collins 2005). The timing of this disturbance is important for the natural phenology of the benthic macroinvertebrate (BMI) community since it causes significant mortality of longer lived less vulnerable species and provides opportunity for short lived pioneer species. These pioneer species are more vulnerable to predation by salmonids due to both behavioral and physical traits (Power et al. 2008; Wootton et al. 1997).

Linking the annual phenology of prey species with the phenology of predators requires an understanding of how species compositions and abundance of predator and prey shift seasonally and in relation to management actions. Benthic macroinvertebrate and salmonid life histories are influenced by hydrology. Changes to runoff patterns since the implementation of the TRD have disrupted the annual cycles of scour and inundation disturbance on the Trinity River below Lewiston Dam (USFWS and HVT 1999). Environmental flows prescribed in the ROD have re-introduced those disturbance cycles but may not reflect the timing or frequency that was present over evolutionary time. This proposed target is intended to realign the timing of disturbance events and relevant biotic factors.

Flow management is a primary tool of TRRP to improve the quantity and quality of juvenile salmonid habitat, and the Program recommends flow schedules to water managers annually, including the timing and magnitude of geomorphic flow releases. This objective and target may offer guidance for the timing and frequency of geomorphic events, even though they may be implemented for a different purpose. For example, scouring flow events have many purposes within the Program, such as geomorphic work and riparian scour.

Exact details on the frequency and timing of monitoring of this target have not been worked out by the Fish Work Group, but the Program has models that could be used to inform achievement of the target on an annual basis. A date for peak juvenile abundance within the Restoration Reach could be predicted using the S3 fish production model (Perry et al. 2018) or assumed to be April 1. A scoring system based on a magnitude threshold (6,000 cfs) and timing of the scouring event within two windows (6-12 weeks or 3-18 months) prior to peak juvenile salmonid abundance is proposed above. A proportion of the longitudinal extent of the restoration reach applicable to each ranking would be used to evaluate effectiveness of management at meeting the quantifiable target for longitudinal disturbance (e.g., >90%) within 6-12 weeks prior to emergence. Greater than 90% is suggested because recent studies indicated that species composition near Lewiston Dam may already be shifted as a result of tail water impacts (Starkey-Owens et al. 2020).

***Objective*: Increase/maintain the amount and improve the quality of spawning habitat available to native salmonids.**

The group agreed that increasing/maintaining the amount and improving the quality of spawning habitat in the Trinity River should remain an objective of the TRRP, but it is unnecessary for the Program to monitor, or infer Program success based on a quantifiable target. The Fish Work Group noted that the Program has little control over where native salmonids choose to spawn and apparently suitable spawning habitat is unused even in high abundance years.

***Target*:** *Undefined*

***Objective*: Maintain or increase adult holding habitat from baseline conditions.**

This objective was deemed necessary and in need of a target. The work group agreed that target development should be delayed until the pool thermal stratification study is complete.

***Target*:** *Undefined*

<u>Objective</u>: Provide thermal regimes that promote growth and survival throughout the rearing and outmigration periods for native juvenile salmonids.

This objective is necessary because one of the Program's fundamental objectives is to restore anadromous fish populations. Temperature is a critical component of juvenile salmonid habitat, along with physical habitat (e.g., water depth, velocity, and cover) and food availability. Providing appropriate thermal regimes to maximize growth and survival during the rearing and outmigration periods support the Program's fundamental objective to restore anadromous fish populations by increasing juvenile production. Temperature targets for outmigrants should account for survival through the lower Klamath River.

<u>Target</u> *The proposed target for juvenile rearing temperatures is as follows:*

7-day average of the daily average (7DADA) of 13.0-16.5° C upstream of the North Fork Trinity River from 1 April to 31 July.

Justification for the rearing temperature target is described in Appendix 3. The Program has never had a temperature target specific to rearing juvenile salmonids. Existing targets for adults and outmigrant juveniles are upper thresholds, implying that anything below the threshold is "good" even though cold suboptimal temperatures also suppress growth and reduce survival. Water temperatures outside of the target range would be considered an impairment to growth of juvenile salmonids during the rearing period. The 7DADA would allow for daily tracking of the target but it would not be overly sensitive to small violations in water temperatures that occur using a single daily average threshold, which may or may not be biologically meaningful. Also using a range of values rather than a single upper threshold captures the true nature of optimal salmonid growth, which occurs in a range of temperatures. Falling above or below this optimal range impairs growth at a given ration level.

Recent Trinity River water temperatures at the North Fork Trinity River are shown in Figure 3 along with our recommended target range. Note that for most water year types, just as the Trinity River begins to achieve the recommended target range for optimal juvenile salmonid growth, there is a large reduction in temperatures of 5°F to 7°F that begins near the end of April. This is due to the large volume of water that is released annually from Lewiston Dam in accordance with the TRRP restoration flow releases. In some cases, water temperatures are nearly 10°C less than our recommended temperature range. It has been widely hypothesized in

TRRP work groups that this has led to impaired juvenile salmonid growth, and possibly contributed to poor survival in the lower Trinity River, lower Klamath River, and Ocean.

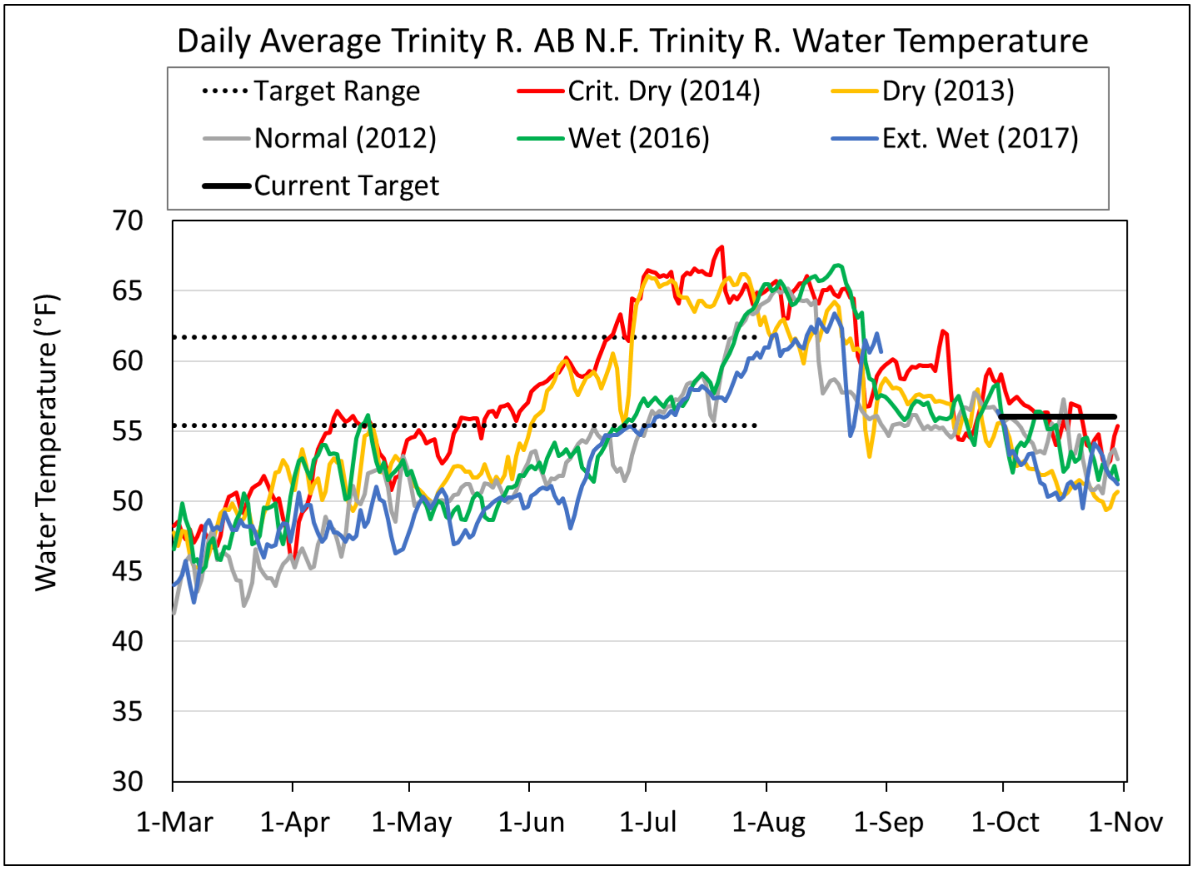

Figure 1. Water temperatures for one of each of the five water year types in the Trinity River above the North Fork Trinity River. Note the 5°F to 7°F reduction in temperature that occurs in all water year types in the end of April coincident with the onset of TRRP restoration flow releases from Lewiston Dam.

To evaluate the effectiveness of implemented and proposed hydrographs at achieving this target we propose a measure of cumulative thermal deviation (CTD) from the target range over the time period the target is intended. This would be accomplished by summation of the absolute differences between the observed or predicted 7DADA from each day, between April 1 and July 31. Daily average temperature data from the mainstem Trinity River at the North Fork Trinity River would provide the raw data to calculate 7DADA and CTD.

<u>Objective</u>: Provide thermal regimes to promote spawning success of spring and fall Chinook Salmon.

This objective is intended to reduce pre-spawn mortality of holding and spawning Chinook Salmon and improve in-vivo egg survival. Both of these objectives support the Program's fundamental objective to restore anadromous fish populations.

<u>Target</u>: *Table 6 provides the temperature targets for promoting spawning success of salmon in the upper Trinity River.*

Justification for these targets are documented in a memorandum that is included in Appendix 3.

Table 6: Recommended objectives for daily average water temperature (°F) for the Trinity River, at Lewiston Dam, Douglas City, and at the confluence with the North Fork Trinity River, CA.

	New Temp Objective (°F)	Existing Temp Objective (°F)	
Date	Lewiston Dam (RM 112.1)	Douglas City (RM 93.8)	North Fork Trinity River (RM 72.4)
July 1 through Sept 14	-	60[a]	-
Sept 15 through Sept 30	53.5[a]	56	-
Oct 1 through Oct 31	53.5[a]	-	56
Nov 1 through Dec 31	50[a]	-	56
Jan 1 through Mar 1	48[a]	-	-

[a]Not included in Water Order 90-05

Current temperature thresholds for the upper Trinity River can be found in the draft 1999 Trinity River Mainstem Fishery Restoration EIS, based on the recommendations provided in USFWS and HVT (1999). Additionally, State Water Resources Control Board Water Order 90-5 mandates Reclamation meet the temperature thresholds in Table 6 (excluding the July 1 - September 14 threshold). The temperature thresholds in Table 6 were also adopted by the California Regional Water Quality Control Board, North Coast Region (CRWQCB-NCR 2011). These thresholds were developed and implemented to meet the needs of adult salmonids, particularly Chinook Salmon in the Sacramento River Basin.

Management actions within control of TRRP that affect these targets are almost entirely limited to scheduled flow releases. The current summer baseflow of 450 cfs is intended to address this objective.

Water temperatures measured in the mainstem Trinity River at Douglas City and at the North Fork Trinity River are used to monitor progress toward meeting these targets on an annual basis. Proposed hydrographs are evaluated for violation of these temperature targets using the RBM10 predictive temperature model. Implemented hydrographs are evaluated based on empirical water temperatures measured at Douglas City and the North Fork.

Objective: Minimize competition and predation by hatchery smolts on wild fry and juveniles.

This objective was deemed necessary and in need of a target. Restoring natural-origin salmonid populations is a fundamental goal of TRRP. Any impacts hatchery fish may have on natural-origin populations limit the Program’s success toward achieving that fundamental goal and should be considered where management actions may affect the outcome.

Target: *undefined.*

Flow Workgroup

The Flow Workgroup met in 2018 and 2019, developing a refined list of flow management objectives and metrics that can easily be monitored and evaluated. Flow releases from Lewiston Dam are a means to meet other biological (fish production) or physical (sediment mobilization) restoration objectives but are not necessarily restoration objectives themselves. Therefore, the Flow work group's decision was to focus on the flow management actions themselves, rather than the outcome or result that the flow management actions were intended to attain.

IAP Objectives Considered

The nested objectives listed in Table 2.1 of the IAP (TRRP 2009) do not specifically address flow management actions. Instead, the objectives in Table 2.1 are biological (e.g. increased natural fish production) and physical (e.g. fine sediment management) objectives that could be met by utilizing flow management actions. As such, the Flow Workgroup largely did not develop objectives from existing documents such as the IAP that would be appropriate from which to develop metrics. Four final objectives were chosen for the Flow Workgroup, and metrics were developed for these objectives.

New Objective and Target Development

Four final objectives were developed for flow management that will aid in accomplishing the TRRP's overarching goals; 1) providing suitable Lewiston Dam flow ramp up rates, 2) flow ramp down rates, 3) total water volume, and 4) floodplain inundation (Table 7). The ramping rates and total water volumes were adopted from the Trinity River Mainstem Fishery Restoration EIS. One floodplain inundation objective was developed that serves to blend and capture some of the objectives listed in Table 2.1 of the IAP.

Table 7: Objectives and Targets Proposed by the Flow Workgroup.

<table>
<tr><th>Objective</th><th>Target</th><th>Management Action</th></tr>
<tr><td>Provide suitable ramp up rates by time of year for target species by water year class</td><td>EIS ramp up rates (CFS):<table><tr><td>≥6,000</td><td>1,000 cfs/2 hrs</td></tr><tr><td>4,000 to 5,999</td><td>1,000 cfs/2 hrs</td></tr><tr><td>2,000 to 3,999</td><td>500 cfs/2 hrs</td></tr><tr><td>500 to 1,999</td><td>250 cfs/2 hrs</td></tr><tr><td>300 to 500</td><td>100 cfs/2 hrs</td></tr></table></td><td>Flow management (rate of change)</td></tr>
<tr><td>Provide suitable ramp down rates by time of year for target species by water year class</td><td>EIS ramp down rates (CFS):<table><tr><td>≥6,000</td><td>500 cfs/4 hrs</td></tr><tr><td>4,000 to 5,999</td><td>400 cfs/4 hrs</td></tr><tr><td>2,000 to 3,999</td><td>200 cfs/4 hrs</td></tr><tr><td>500 to 1,999</td><td>100 cfs/4 hrs</td></tr><tr><td>300 to 500</td><td>50 cfs/4 hrs</td></tr></table></td><td>Flow management (rate of change)</td></tr>
<tr><td>Release allocated flow volumes by water year class and implement prescribed hydrographs</td><td>• Extremely Wet WY 815.2k AF
• Wet WY 701.0k AF
• Normal WY 646.9k AF
• Dry WY 452.6k AF
• Critically Dry WY 368.6k AF</td><td>Flow management (total water volume)</td></tr>
<tr><td>Provide flows that inundate ephemeral surfaces above the winter baseflow channel for variable durations to meet ecological needs</td><td>Inundate ephemeral habitats for 35 to 84 days between January 1 and May 1 for fish prey food production and groundwater recharge; inundate floodplain surfaces <4,500 cfs for ≥21 days to facilitate natural riparian regeneration between May 1 and June 20.</td><td>Flow management (provide suitable annual hydrographs)</td></tr>
</table>

Discussion of Objectives and Targets

The Flow Workgroup developed four objectives and targets to monitor along with these objectives. In large part, flow is a means to meet other TRRP restoration objectives and the TRRP's overarching goals, but not in itself a restoration objective.

The Flow Workgroup does not believe the ramp rates for Lewiston Dam were set for biological purposes, but rather public safety. The flow WG recommends that up ramp rates remain as published in the EIS, but that ramp rates for discharge above 6,000 cfs be increased to more closely replicate flow patterns on regional, unregulated rivers. Data for verifying implementation of ramp rates should be 15-minute discharges for Trinity River at Lewiston averaged in running 2-hour timeframes. Successful implementation is defined as ramp rates always being met. The Flow Workgroup believes this is the most conservative averaging for accommodating public safety, while also more closely replicating natural flow patterns on unregulated streams in the region.

Given lessened concern for salmonid fry stranding (see page 18, "Minimize fry stranding"), the Flow Workgroup believes that ramp down rates for all discharges should be revised to mirror rates observed on undammed rivers in the region. Ramp rates should be variable depending on time of year, discharge, and other factors, to meet requirements for inundation duration for ecological needs, peak magnitude of flow events, and species requirements.

Flow release volumes by water-year class should be released from Lewiston dam to within ±5% of the allocated volume. The Flow Workgroup also recommends that sub-daily flows should be implemented to within ±5% of the recommended hydrograph values. Floodplain inundation during the correct time of year is a critical component of riverine processes. Currently, restrictions on flow releases from Lewiston Dam during the winter months do not allow for proper floodplain inundation during times of the year when biological resources are adapted to take advantage of them. This will limit the ability of the flow management actions recommended by the Flow Workgroup to accomplish the TRRP biological and physical objectives, as well as the TRRP's overarching goals.

Physical Workgroup

IAP Objectives Considered

The IAP was developed to articulate methods for assessing system response of the Trinity River to TRRP management actions. The IAP was completed in 2009 and identified six primary restoration objectives. The focus of the Physical Workgroup (PWG) is on the hydraulic and geomorphic processes that create and maintain river form and aquatic and riparian habitat. Given this focus, the PWG is primarily concerned with developing methods for assessing IAP Objective 1: create and maintain spatially complex channel morphology. The IAP recognized that physical processes are also partial or indirect drivers for achieving other IAP Objectives and referenced the role of achieving IAP Objective 1 in supporting IAP Objective 2 (improve aquatic habitat), IAP Objective 5 (establish riparian habitat) and IAP Objective 6 (protect wildlife habitats).

IAP Objective 1 level 1, 2, and 3 objectives are listed in Table 8. There are four level 2 objectives. Review by the Physical Workgroup members indicates that the first three Level 2 objectives are still valid and appropriate objectives. Results from the fine sediment synthesis report indicate that the objective to reduce fine sediment storage (1.4) is no longer valid. At the start of the 1990's, fine sediment levels in the project area were at levels that significantly impacted aquatic habitat. Flow management actions initiated in the 1990's, followed by implementation of the ROD flow regime greatly reduced excess fine sediment in the project reach and fine sediment levels are no longer a significant cause of habitat impairment.

Table 8: Physical process objectives listed in the IAP. Objectives highlighted in light gray were incorporated into new targets and objectives. Objectives in dark gray were not.

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives
1. Create and maintain spatially complex channel morphology	1.1. Increase physical habitat diversity and availability (to achieve Fish Habitat objective 2.1, Riparian objectives 5.1 & 5.2, and Wildlife objectives 6.4.1 & 6.5.1)	1.1.1. Increase the size, frequency and topographic relief of bar/pool sequences
		1.1.2 Increase channel/thalweg sinuosity
		1.1.3 Increase geomorphic unit and substrate patch diversity
	1.2 Increase coarse sediment transport and channel dynamics	1.2.1 Increase and maintain target coarse sediment transport rates
		1.2.2 Frequently exceed channel migration, bed mobilization, and bed scour thresholds
		1.2.3. Encourage bed-level fluctuations on annual to multi-year time scales
		1.2.4 Route coarse sediment through all reaches
	1.3 Increase and maintain coarse sediment storage	1.3.1 Increase bars, side-channels, alcoves, and other complex alluvial features
	1.4 Reduce fine sediment storage in the mainstem Trinity River	1.4.1 Transport fine sediment through mainstem at a rate greater than tributary input
		1.4.2 Reduce fine sediment supply from tributary watersheds
		1.4.3 Encourage fine sediment deposition on floodplains

New Objective and Target Development

The PWG was directed by the Trinity Management Council (TMC) to develop targets that assess progress towards achieving Trinity River Restoration Program physical objectives. One challenge that the PWG encountered was developing targets that define channel complexity. The term channel complexity is an amalgamation of several aspects of physical channel properties used as an indicator of channel conditions that promote beneficial aquatic habitat. It is a fuzzy term that requires evaluation and subjective integration of several physical channel processes. The PWG found it difficult to define optimal targets describing complexity attributes because physical processes operate at different levels through the system in response to local controls.

The PWG held discussions to identify targets that would properly characterize IAP **Objective 1**. Several individuals developed initial target definitions based on their areas of expertise. The definitions were discussed at PWG meetings and through email discussions. The PWG consensus was to proceed with development of targets listed in Table 9. Additional tasks that need to be completed include development of implementation plans.

Table 9: Objectives and Targets Proposed by the Physical Workgroup.

Objective	Target	Management Actions
Topographic variability	Target is to increase R^* through time. Increases in R^* generally indicate an increase in channel complexity. A specific target value has not been defined because that requires formal study not yet undertaken.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Inundation effectiveness	Target is to locally increase A_w* through time. Increases in A_w* are perceived as indication that availability of habitat is increased. Specific target values of I_W cannot be defined because maximum possible values depend on local valley width and similar constraints.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Increase bed mobility and scour	Mobilize D_{84} on alternate bar surfaces at flows >6,000 cfs. Metric is the percent of point bar area mobilized.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Increase active bars	Reach 1: 2,700-3,600 m^3/1000m Reach 2: N/A Reach 3: 3,600-6,500 m^3/1000m Reach 4: 1,100-2,700 m^3/1000m Reach 5: N/A Reach 6: 1,300-2,700 m^3/1000m Reach 7: 1,300-2,700 m^3/1000m Reach 8: 3,600-6,500 m^3/1000m Reach 9: 3,600-6,500 m^3/1000m	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Maintain sediment mobility at thresholds that aide physical and biological processes	Maintain observed critical Shields stress at Lewiston, Limekiln Gulch, and Douglas City sediment monitoring transects for the median grain size (τ^*_{c50}) between 0.025 and 0.085.	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Fine sediment storage	Maintain exponent in hiding function by Parker et al. (1982) > -0.9	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.
Promote channel migration	Increase amplitude of meanders through time	Global: Flow management Reach Scale: Channel rehabilitation, gravel augmentation.

Discussion of Objectives and Targets

Appendix 4 includes detailed definitions of the PWG objectives and targets listed in Table 8. Each objective and the metric used to measure the objective are described briefly below.

Topographic Variability (R*)

Means Objective: Topographic variability

Hypothesis for Fundamental Objective: Topographic variability is the primary attribute defining spatially complex channel morphology (IAP objective 1).

Target: Increase the value of the metric R^*. A target value of R^* has not yet been defined, but such a target could be determined by adopting a value representative of reaches that are deemed to be satisfactorily complex. That work has yet to be formally undertaken.

Locations: Throughout the TRRP restoration domain.

Spatial Scale: R^* is best applied at the reach scale to river segment when comparing different locations, as small samples of geomorphic units within short reaches can lead to biased results. However, smaller reaches with consistent boundaries can be used when comparing the same reach at different times or under different condition (i.e., design and pre-construction). Analysis should never be used on areas smaller than a complete geomorphic unit (riffle crest to riffle crest) and it is preferred that boundaries coincide with geomorphic controls.

Frequency: Whenever updated bathymetry and topography are available for an area. R^* would be computed throughout the project domain approximately every 5 years when full topography is updated, and more often in connection with site-scale survey such as project as-builts or design alternatives.

Reporting: R^* will be used to identify both trends and the magnitude of changes toward increased complexity.

Methods: R^* is defined in terms of the frequency distribution of flow depths at a reference discharge according to:

$$R^* = [(h_{75} - h_{25}) + (h_{90} - h_{10})] / (h_{90} + h_{10}) \qquad (1)$$

where all depth percentiles are based on the reference discharge of 2000 ft^3/s. Depths are derived as the difference between the modeled water surface elevation (WSE) at the reference discharge and the terrain models being evaluated. Modeling is performed with SRH-2d. A reference discharge of 2000 ft^3/s was selected because that discharge fully inundates the active channel bed. The resulting depths are processed with a Perl script that computes a variety of depth statistics, including the 90th, 75th, 25th, and 10th depth quantiles used in the computation of R^*.

Depth percentiles are a better choice for assessing topographic relief than ground elevations because the continuous downstream slope of the river means ground elevations would require detrending before use. Depths, on the other hand, are automatically detrended. In addition, the wetted area associated with a reference water surface automatically defines the spatial extent of the "channel" that the metric represents.

Inundation effectiveness (A_w*)

Means Objective: Valley/floodplain inundation.

Hypothesis for Fundamental Objective: Wetted area is a key driver of habitat availability at moderate discharges, of fish production, and of riparian health (IAP objectives 2, 3, and 5).

Target: Rehabilitation actions should increase the value of I_W. Specific target values of I_W cannot be defined because maximum possible values depend on local valley width and similar constraints. Normalization that would support the development of numeric targets are possible, but not complete at this time.

Locations: Throughout the TRRP restoration domain.

Spatial Scale: I_W is best applied at the river segment scale when comparing different locations. Ambiguity in the locations of boundaries between reaches become increasingly influential as reach length decreases. However, smaller reaches with consistent boundaries can be used when comparing the same reach at different times or under different condition (i.e., design and pre-construction). Analysis should never be used on areas smaller than a complete geomorphic unit (riffle crest to riffle crest) and it is preferred that boundaries coincide with geomorphic controls.

Frequency: Whenever updated bathymetry and topography area available. I_W would be computed throughout the project domain approximately every 5 years when full topography is updated, and perhaps more often in connection with site-scale survey such as project as-builts or design alternatives.

Reporting: I_W will be used to assess the success of rehabilitation actions at project sites and temporal trends throughout the Program's focal area.

Methods: I_W is defined in terms of the mean width of inundation integrated over a range of flows, as determined by hydraulic modeling with SRH-2d. Mean wetted width (W) for a given stream reach at a given discharge (Q) is computed as the wetted area at that Q divided by the valley length through the reach. As applied in the habitat synthesis report, wetted width is considered over discharges ranging from 150 to 6000 ft^3/s and I_W is integrated over discharges ranging from 150 to 2000 ft^3/s. As numerically integrated, the general definition of I_{WR} is for a given reach is:

$$Aw *= \sum_{i=1}^{n}[W_i \, \Delta Q_i] \qquad (2)$$

where W_i is the mean wetted width at discharge Q_i, ΔQ_i is $(Q_{i+1} - Q_{i-1})/2$, $Q_0 = 0$, and n is the number of discrete values of Q_i considered. I_W can easily be re-computed over alternative discharge ranges as needed to address specific questions. For example, $Q_n = 3500$ ft^3/s may be well suited for assessing juvenile rearing habitat availability, whereas $Q_n = 11000$ ft^3/s or more might be selected for assessing valley or riparian restoration objectives.

Increase bed mobility and scour

Fundamental Objective: increase rates of bed mobility and scour in order to increase coarse sediment transport, increase channel complexity, increase aquatic habitat quantity, quality, and complexity.

Hypothesis for Fundamental Objective: Increasing bed mobility and scour is an index for improving a suite of coarse sediment-related physical and ecological attributes as defined as impaired in the TRFER.

Means Objective: Increase coarse sediment (and sub-surface fine sediment) mobility and transport rate.

Target – Quantifiable targets from TRFE Objectives:

Mobilize D_{84} on alternate bar surfaces during flows >6,000 cfs

Spatial Extent: The 40-mile TRRP reach, divided into geomorphic sub-reaches.

Frequency: All years with Normal or wetter hydrographs.

Algorithm: Three methods to evaluate bed mobility and scour, along with the pros, cons and relative costs of each are presented below.

1. Empirical measurements of bed mobility and scour using tracer rocks, scour cores and scour chains.
    a. Pros
        i. High degree of certainty from results of direct measurements.
        ii. Simple methodology, highly repeatable.
    b. Cons
        i. Spatially limited.

        ii. Extrapolation to un-measured areas results in higher levels of uncertainty.
    c. Relative Cost
        i. Medium.
2. Predictive statistical model developed from 2009-2014 empirical measurements.
    a. Pros
        i. Provides estimates of uncertainty
        ii. Simple, the fieldwork and the model have been completed
        iii. Facilitates predictions of different peak flow alternatives.
    b. Cons
        i. The data are dated (2009-2014), may require updating (more fieldwork)
        ii. Results are limited to areas where monitoring has occurred.
        iii. Results are sub-divided by reaches and inundation zones but are not spatially explicit beyond reaches and inundation zones.
    c. Relative Cost
        i. Low (unless mobility and scour data require updating, then Medium)
3. Deterministic Model using the SRH2D Hydraulic Model
    a. Pros
        i. Uses existing data sets
        ii. Covers a very large area (40 miles), providing systemic predictions of bed mobility and scour.
        iii. Generates predictions of *area* mobilized by peak flows, not just along cross sections.
        iv. Can be overlain with other spatial analyses (e.g. spawning area) to predict ecological impact (e.g. redd scour).
        v. Facilitates predictions of different peak flow alternatives.
        vi. Easy sensitivity analyses of assumptions (critical Shields parameter)
        vii. Predictions can be analyzed by:
            1. Geomorphic reaches (e.g., Lewiston Dam to Rush Creek backwater)
            2. Geomorphic feature (e.g., pool tails, point bars, mid-channel bars)
            3. Inundation zone (e.g., 450 cfs-2,000 cfs inundation zone on active bars)
            4. Mesohabitat boundaries (e.g., pool tails, riffles)
            5. Fish habitat suitability boundaries (e.g., Chinook spawning habitat)
            6. Riparian vegetation patches (e.g., initiating seedlings along low flow channel margins)
            7. Groupings of all the above
    b. Cons
        i. If physical conditions (grain size, topography) change, the model needs to be updated.
    c. Relative Cost
        i. Low, unless input data require updating, then High.

Increase active bars

Fundamental Objective: increase active bar coarse sediment storage, increase channel complexity, increase aquatic habitat quantity, quality, and complexity.

Hypothesis for Fundamental Objective: Increasing active bar area is an index for improving a suite of physical and ecological attributes as defined as impaired in the TRFER.

Means Objective: Increase coarse sediment supply and transport rate.

Target – Quantifiable targets will differ by reach and can be developed by evaluating:

Reach 1: 2,700-3,600 m^3/1000m

Reach 2: N/A

Reach 3: 3,600-6,500 m^3/1000m

Reach 4: 1,100-2,700 m^3/1000m

Reach 5: N/A

Reach 6: 1,300-2,700 m^3/1000m

Reach 7: 1,300-2,700 m^3/1000m

Reach 8: 3,600-6,500 m^3/1000m

Reach 9: 3,600-6,500 m^3/1000m

Spatial Extent: The 40-mile TRRP reach, divided into geomorphic sub-reaches.

Frequency: Every five years.

Algorithm: The methodology for evaluating the active bar area metric will follow the methods described in "McBain Associates 2015. *Trinity River Active Bar Mapping, Lewiston Dam to the North Fork Trinity River Confluence, Summer 2014*. Prepared for Hoopa Valley Tribal Fisheries, Hoopa, CA 44 pp." This report also identifies the locations of reaches 1-9. The field-based mapping methods could potentially be modified to utilize aerial photograph analysis, or a hybrid approach could be developed (office-based air photo mapping followed by field verification). The 2015 report suggests field-based professional judgement is necessary to ensure data accuracy regarding: bar areas covered with overhanging vegetation, grain size criteria, and limiting measurements to bars formed and maintained by post-ROD flows.

Other Items to Consider:

4. The merits of the bar area metric are:
    a. While some sources of uncertainty must be carefully considered (flow magnitude as "datum" and professional judgement criteria), the method is reasonably repeatable.

b. It requires relatively minimal additional data collection (2 weeks every 5 years).
c. The results are easily interpreted, and the implications are easily understood by a broad audience.

5. Active bar area may be an index of coarse sediment storage volume, but more importantly, it provides a stand-alone measure of progress from an impaired state toward a more functional state. It is important to note this is not a direct measure of coarse sediment storage volume, and to acknowledge that local geomorphic/hydraulic changes (incision/aggradation at riffle control) might generate variability. We assume that this variability is small compared to reach totals.
6. Active bar area monitoring evaluates a measurable attribute of a scaled-down alluvial river. For example, in response reaches (where bars were historically present) with abundant coarse sediment supply (such as downstream of an augmentation site), bar area might be expected to evolve to a magnitude approximating a maximum post-dam active-bar-area potential. This value might then be used to develop targets for other similar sub-reaches.
7. If mapping is conducted during late summer 450 cfs base flow (when tributary accretion is minimal), then the "datum" will be very consistent and will not be a source of year-to-year variability. Flow by reach will be documented per survey." We have to make the assumption that this will have minimal effect on the results. Perhaps some sort of sensitivity analysis is required – or at least an error estimate from changes in cumulative flow magnitude between survey years.
8. Active bars provide fry and juvenile rearing habitat over a range of flows as shown in the TRFEFR (to reverse the "dip in the flow-habitat curve" characteristic of an encroached channel).
9. Active bars provide numerous ecological, physical and biological functions aside from providing juvenile salmon habitat (e.g. FYLF breeding habitat).
10. Gravel storage can occupy some fish habitat (such as when a holding pool gets filled), but this phenomenon is (1) often short lived (pools tend to re-scour), and/or (2) when scour potential is limited (such as near a dam), a certain amount of coarse sediment may be required to overcome local post-dam deficits and promote ongoing coarse sediment transport. In such cases (as on Clear Creek), the gravel that goes into storage and changes the channel type for short distances, is considered a negligible impact on the overall health and habitat potential of the river.

Maintain sediment mobility at thresholds that aide physical and biological processes

Fundamental Objective: Promote channel complexity, intergravel flow, and river meandering.

Target: Maintain critical Shields stress for the median grain size (τ^*_{c50}) between 0.025 and 0.085.

Localities: Sediment monitoring transects at Lewiston, Limekiln Gulch, and Douglas City.

Frequency and Timing: During water years designated as dry and wetter with ROD releases >4,000 cfs.

Methodology: With shear stress partitioned for the granular bed, extrapolate physically sampled mass transport rates of bed load size fractions, D_i, ≥0.5 mm to a dimensionless reference value of 0.002 for each D_i. Compute fractional Shields stresses, τ_{ci}^*, for D_i and plot against D_i/D_{50}, where D_{50} is sampled on the bed surface near the respective sediment monitoring stations prior to the spring high flow release. Use the hiding function of Parker et al. (1982; $\tau_{ci}^* = \tau_{c50}^* \, (D_i/D_{50})^b$) to estimate τ_{c50}^* with power functions of τ_{ci}^* on the ordinate versus D_i/D_{50} on the abscissa.

Fine sediment storage

Means Objective: Promote coarse sediment mobility, riparian vegetation recruitment, lamprey populations, and groundwater storage.

Fundamental Objective: Maintain fine sediment storage at levels that promote healthy river functioning.

Targets: (1) Maintain the exponent (b) in the hiding function of Parker et al. (1982; $\tau_{ci}^* = \tau_{c50}^* \, (D_i/D_{50})^b)\tau_{c50}^*$) at >-0.9, which indicates that fines are more mobile than coarse grains because they are sufficiently present on the bed to not be sheltered from flow by coarse grains. (2) Maintain ratios of the median surface grain diameter before spring flow releases ($D_{50,\mathrm{surface}}$) and the average subsurface median grain size ($D_{50,\mathrm{subsurface}}$) both to the median bed load diameter ($D_{50,BL}$) to respectively produce values of D^*_{surface} and $D^*_{\mathrm{subsurface}}$ that target >1.0. After Paola and Seal (1995), D^*_{surface} and $D^*_{\mathrm{subsurface}}$ ≤1 infer bed load is dominated by surface particles and bar and riffle material and ratios >1 indicate dominance of fine sediment entrained by local scour exposing subsurface sediments and mobilization of fines from channel banks, lee areas, and patches in the channel.

Localities: Sediment monitoring stations at Lewiston, Limekiln Gulch, and Douglas City.

Frequency and Timing: In years that sediment mobility is measured, compute b, D^*_{surface}, and $D^*_{\mathrm{subsurface}}$ with bed load and bed material samples and cross section surveys and measured water surface slopes.

Methodology: For b, see methodology for sediment mobility target. Values of $D_{50,BL}$ are determined by physically sampling bed load at the sediment monitoring stations and dry sieving the material in half-phi size intervals for computing the median bed load diameter by mass for each discharge that samples are taken. Values of $D_{50,\mathrm{surface}}$ are measured with a Wolman (1954) sample of 300 grains in the upstream vicinity of the monitoring stations before the spring flow release. Values of $D_{50,\mathrm{subsurface}}$ are measured with three or more bulk samples of subsurface sediment in the near upstream vicinity of monitoring stations following criterion in Church et al. (1987) for requisite sample size. The sampling domain for subsurface sediments extends below the depth of the local surface D_{84}.

Channel Migration

Means Objective: Promote channel migration to increase channel complexity and floodplain development and shift the channel to reset riparian forests by eroding banks and surfaces fossilized by vegetation and course material.

Fundamental Objective: Increase extent of laterally mobile channel to create new alluvial features, new floodplains, and woody riparian recruitment.

Targets: "Naturally" construct or further develop meanders with flows and sediment management that have wavelengths, amplitudes, and radius of curvatures predicted with information in the TRRP channel design guide (HVT et al., 2011). Also, laterally shift the Trinity River channel outside meander bends by statistically significant distances every 5 years.

Localities: Throughout the Trinity River restoration reach.

Frequency: Every 5 years at any time of year.

Methodology: Utilize geo-rectified aerial photographs to map the channel and determine its change in location since the previous survey. Use continuous lines traced at the wetted summer baseflow to determine vectors of magnitude and direction of change in set increments that are determined through trial and error to best represent the observed shifts in channel position. Estimate error in estimates of shifts in channel position with estimates of horizontal accuracy provided by the contractor for aerial photography. Bin the vectors and their associated error by river miles representing geomorphic provinces in the river and perform t-test to determine whether the observed shifts ±error in channel position are statistically significant. Additionally, use CAD or GIS software to estimate changes in meander properties mentioned and t-tests to determine if the changes are significant or within the range of error. From these analyses, effectiveness meeting targets for channel migration can be evaluated.

Riparian and Aquatic Ecology Workgroup

The Riparian and Aquatic Ecology Workgroup (RAEWG) has been working on refining and developing objectives since its inception in November 2018. The goal of this effort was to refine objectives to a manageable set that can be monitored by the Program to measure success. Results from these discussions can be found in the meeting minutes listed on the TRRP website and in Appendix 6.

IAP Objectives Considered

The RAEWG used relevant objectives described in the IAP as guidance for developing and refining objectives (Table 10). Level 1 objectives were considered too broad and were not subject to the refinement process. We incorporated several of the old Level 2 and 3 objectives into new means objectives and targets, removed objectives that we felt were redundant or were encapsulated by the new means objectives and targets, and others were removed entirely. Several IAP objectives were not incorporated because they were regulatory requirements for physical rehabilitation (IAP objective 5.3), not a TRRP management action (IAP objective 6.3), by being potentially listed species (IAP objective 6.4, 6.5), or were linked to other objectives (IAP objectives 6.1, 6.2).

Table 10: Wildlife and riparian objectives listed in the IAP. Objectives shaded in light grey were incorporated into new targets and objectives. Objectives in darker grey were not.

Level 1 Objectives	**Level 2 Objectives**	**Level 3 Objectives**
5. Establish and maintain riparian vegetation that supports fish and wildlife	5.1 Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high-quality aquatic and terrestrial habitat *(achieve Fish Habitat objective 2, Fish Production objective. 3.1, and Wildlife objective 6.1*	5.1.1 Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat
		5.1.2 Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD
		5.1.3 Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife
	5.2 Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality *(achieve Fish Habitat objective 2.1, Wildlife Objectives 6.2 & 6.4)*	5.2.1 Manage flows, coarse sediment augmentation, and channel rehabilitation that cause sufficient riparian plant mortality along low water margins to prevent channel simplification leading to degraded fish habitat.
	5.3 Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation (*achieve Wildlife Objective 6.1*)	*- no level 3 objective required, as level 2 objective is sufficiently specific*
6. Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation	6.1 Maintain Trinity populations and species diversity of birds using the riparian zone in the Program area *(linkage to Riparian Objectives 5.1.2 & 5.2)*	6.1.1 Enhance quality and maintain quantity of riparian bird nesting and foraging habitats *(linkage to Riparian objective. 5.1)*
	6.2 Maintain Trinity River riverine bird populations and species diversity in the Program area *(linkage to Riparian Objectives 5.1.2 & 5.2)*	6.2.1 Enhance quality and maintain quantity of riverine bird nesting and foraging habitats *(linkage to Physical objective 1.1, Fish Habitat objective 2.3.1, Fish Production objectives 3.2.1 & 3.2.2 and Riparian objectives 5.1 & 5.2)*
	6.3 Minimize impacts of riverine bird predation on fry and smolts	6.3.1 Adapt timing of hatchery release to alter distribution of avian predators and minimize predation on natural fry and smolts *(achieve Fish Production objective 3.3.3)*

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives
	6.4 Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (FYLF)	6.4.1 Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs
		6.4.2 Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs *(linkage to Riparian objectives 5.1 & 5.2)*
	6.5 Increase population size, survival, distribution, and recruitment success of Western Pond Turtle (WPT)	6.5.1 Increase population size, survival, distribution, and recruitment success of Western Pond Turtles
		6.5.2 Increase structural and thermal diversity of aquatic habitats used by various age classes of Western Pond Turtles
		6.5.3 Increase recruitment of younger age classes of Western Pond Turtles
	6.6 Minimize adverse impacts to additional native riparian or aquatic associated wildlife from Program activities. Focus on wildlife species associated with a healthy river ecosystem, not necessarily all species.	6.6.1 Discourage invasive species

New Objective and Target Development

The RAEWG has proposed four new means objectives with corresponding targets for each (Table 11). Rather than focus on species-specific objectives, the RAEWG opted to develop means objectives that were ecologically relevant. For instance, we believe that "Increas[ing]e the width of the aquatic-terrestrial interface within the restoration reach that are colonized by native wetland and riparian plants" will have cascading effects on not only the riparian community but also on bird, amphibian, and fish communities. We also have proposed targets that are based on already existing data sources or models. This will enable the rapid integration of targets and give a simple evaluation of success of the Program.

Table 11: Objectives and Targets Proposed by the Riparian and Aquatic Ecology Workgroup.

Means Objective	Target	Management Action	IAP Objective
RAE-1 Increase the width of the aquatic-terrestrial interface within the restoration reach that are colonized by native wetland and riparian plants	Increase area less than 6 feet above summer baseflow water surface elevation within the margins of the maximum fishery flow	Flow releases, gravel augmentation, channel rehabilitation	5.1
RAE-2 Maintain a range of temperatures over various flow regimes needed by native species	Increase the diversity of water temperature (residence time of water) at rehabilitation sites	Flow releases, gravel augmentation, channel rehabilitation	N/A
	Achieve daily average water temp of 10 C at the above gage above NF (USGS 11526400) on or before May 1 during critically dry and dry water years; and maintain or increase for 14 days		6.4
	Promote timely oviposition and reduce scour of FYLF egg masses by limiting magnitude of discharge increases once water temperature of 10C has been achieved and water stage has been stable (less than 0.05 m/d change for 7 days) at the USGS gauge above the North Fork. After which, discharge increases should be limited to less than 1000 cfs for 24 hours and 500 cfs for longer periods prior to July 1.		6.4
RAE-3 Promote dominance of native flora and fauna species in the ecological community structure	Increase richness, abundance, and diversity of native cover types	Flow releases, channel rehabilitation	6.6
	Increase richness, abundance, and diversity of native species of fish, wildlife, invertebrates, and algae		6.6

Means Objective	Target	Management Action	IAP Objective
RAE-4: Maintain flow variability over a broad temporal range to promote scour and inundation to promote habitat complexity	Ensure sufficient mortality of riparian vegetation along the margins of the low-water channel and on the floodplain by ensuring only one surviving cohort of narrowleaf/dusky willow every decade.	Flow releases	5.2
	Ensure recession limb falls at a rate conducive for black cottonwood recruitment every 3-5 years.		5.1
	Reduce desiccation of FYLF egg masses by limiting recession rate to 0.03 m/d for 35 days after achieving 10 C for 10 days at the gage above NF (USGS 11526400).		6.4.1

Discussion of Objectives and Targets.

<u>Objective</u>: Increase the width of the aquatic-terrestrial interface within the restoration reach that are colonized by native wetland and riparian plants

The objective is necessary because one of the Program's fundamental objectives is to "establish and maintain riparian vegetation that supports fish and wildlife (IAP objective 5)." The RAEWG hypothesizes that achieving this objective will increase habitat for fish and wildlife, increase supply of large woody debris, and promote a diverse assemblage of riparian plant species (HVTF & USFWS 1999; TRRP and ESSA 2009). This reasoning behind this objective is largely based off IAP objective 5.1.

Mechanical channel rehabilitation, ROD flows, and sediment augmentation are effective methods to achieve this target. Channel rehabilitation can be used to lower floodplains, remove riparian berms, and create high-flow and side-channels. ROD flows will promote inundation of low elevation surfaces, recharge groundwater, scour seedlings, and deposit seeds on floodplain surfaces. Sediment augmentation can be used to form river bars and low-elevation floodplains. Mechanical channel rehabilitation, in conjunction with sediment augmentation and ROD flows, will encourage natural alluvial processes which should promote riparian vegetation to expand laterally (TRRP and ESSA 2009).

***<u>Target</u>*:** **Increase area less than six feet above summer baseflow water surface elevation within the margins of the maximum fishery flow.**

The basis for this target is fully described in the memorandum “Increasing the width of the aquatic-terrestrial interface target recommendations” located in Appendix 6. The RAEWG hypothesizes that increasing area in the 0-6 feet above water surface elevation will allow the mainstem and groundwater to interact more frequently across the landscape. The RAEWG proposes using bathymetry and digital elevation models (DEMs) as a way to calculate elevations within the maximum fishery flow.

The study methodology still needs to be finalized; however, the RAEWG did develop a feasible methodology that uses previously collected bathymetry and DEM datasets. This target will not require any new data to be collected as bathymetry and DEMs are already collected by the Program (Table 12). Using these existing datasets will greatly reduce the cost and effort to implement this target. This methodology allows evaluation on the site, reach, and system scale. An example of the potential analysis can be seen in Figure 2.

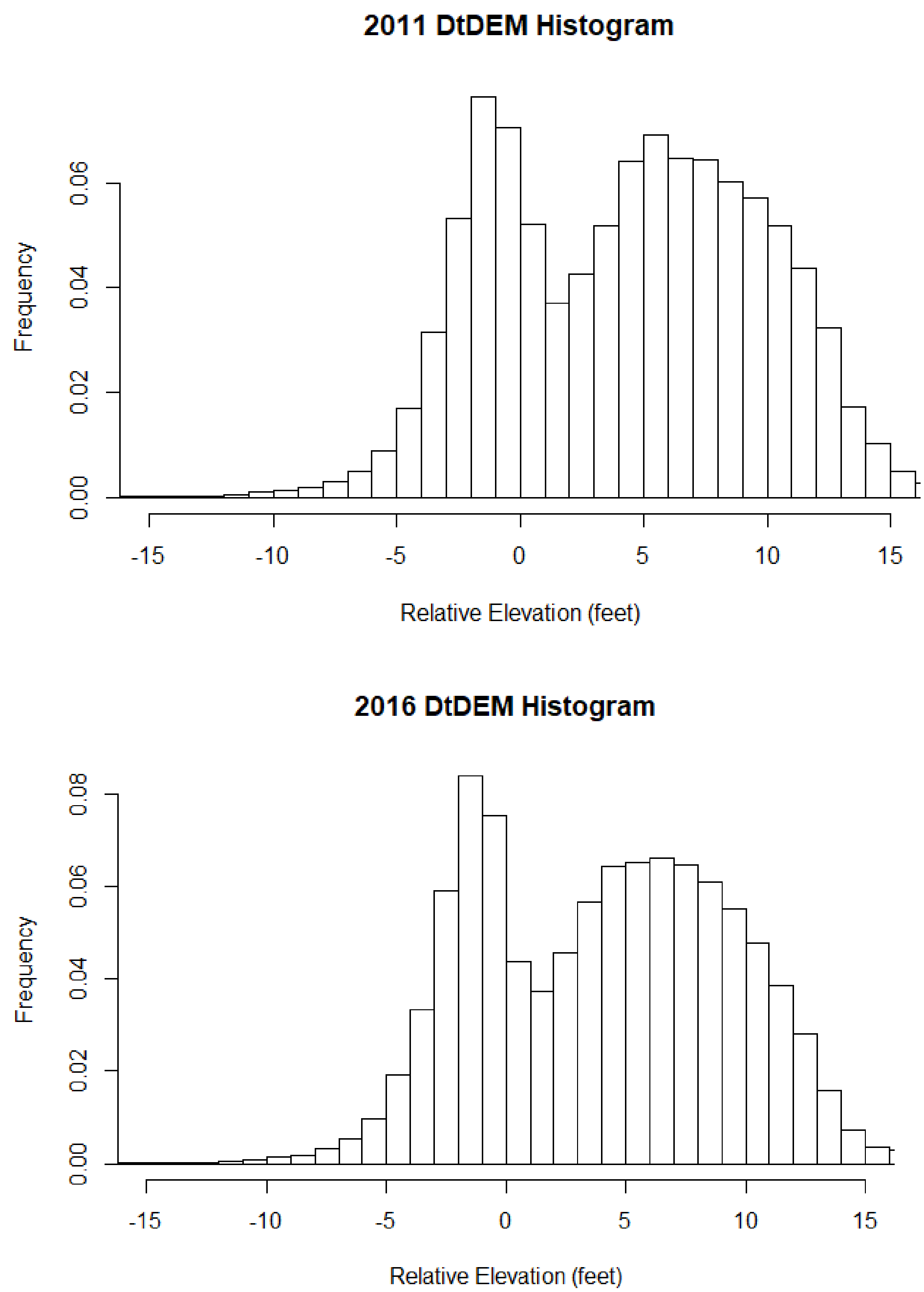

Figure 2. An example of an analysis used to determine the height of selected surfaces above baseflow conditions. These graphs are used to describe the change of the relative frequency of elevations within the restoration reach.

***Objective*: Maintain a range of temperatures over various flow regimes needed by native species**

The objective is necessary because one of the Program's fundamental objectives is to "rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation (IAP objective 6)." Temperature is a critical component to wildlife habitats, especially for amphibian and reptile species. A temperature regime that is suitable for wildlife is of vital importance for listed species and for the success of the Program. The RAEWG has developed three targets for this objective.

Channel rehabilitation, ROD flows, and sediment augmentation are all expected to promote a complex temperature regime. Channel rehabilitation can be used to create temperature variability by lowering floodplains, creating off-channel habitats, high-flow, and side-channels. ROD flows can further alter temperature variability by inundating areas that are shallow and low velocity, causing warming. Sediment augmentation also plays a role in temperature variability by supplying gravel that forms bars and floodplains which will create shallow, low-velocity areas during elevated flows.

Target (*There are three targets for this objective)**:*

1. Increase the diversity of water temperature (residence time of water) at rehabilitation sites.

The basis for this target is an attempt to diversify water temperatures for a variety of species. Currently temperature regimes in the mainstem are simple due to the flow regime and topography of the river (D. Gaeuman, personal communication). This simplified temperature regime can have a negative effect on several focal species such as Foothill Yellow-legged Frog and Western Pond Turtle (Lind *et al.* 1996; Reese and Welsh 1997, 1998a, 1998b). This target attempts to address this problem by increasing the residence time of water in certain areas of the river thereby creating temperature diversity for fish and wildlife.

The study design for this target still needs to be determined; although, the RAEWG does not believe any additional data sources are necessary. The RAEWG has consulted with Dave Gaeuman, geomorphologist for the Yurok Tribe, to develop a metric for this target using the SRH2D model. He was able to provide the RAEWG with model outputs for a channel rehabilitation design of how the model could be used to predict water temperature diversity (Figure 3). The model outputs clearly demonstrate the differences between pre- and post-construction conditions; however, creating a measurable "diversity" water temperature metric is needed. We expect the temperature synthesis report to be able to provide a metric for this target.

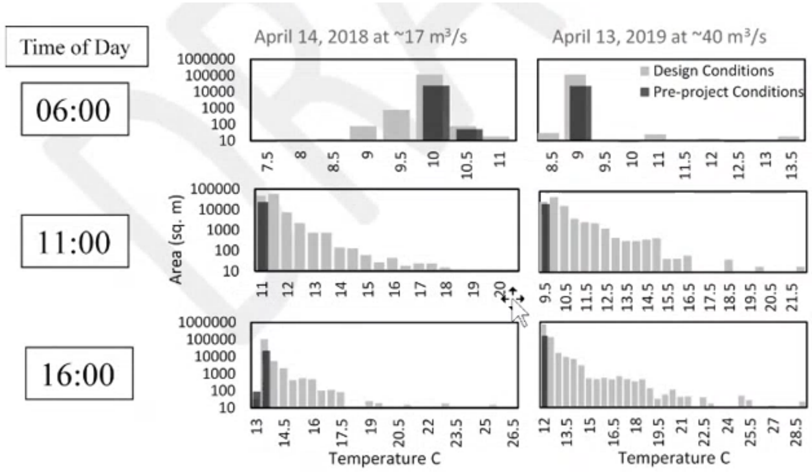

Figure Xc: Summary of SRH 2-D temperature results for 3 times of day at the Oregon Gulch Rehabilitation site for design and pre-project conditions in April prior to spring releases under dry hydrology (left; 2018) and wet hydrology (right; 2019).

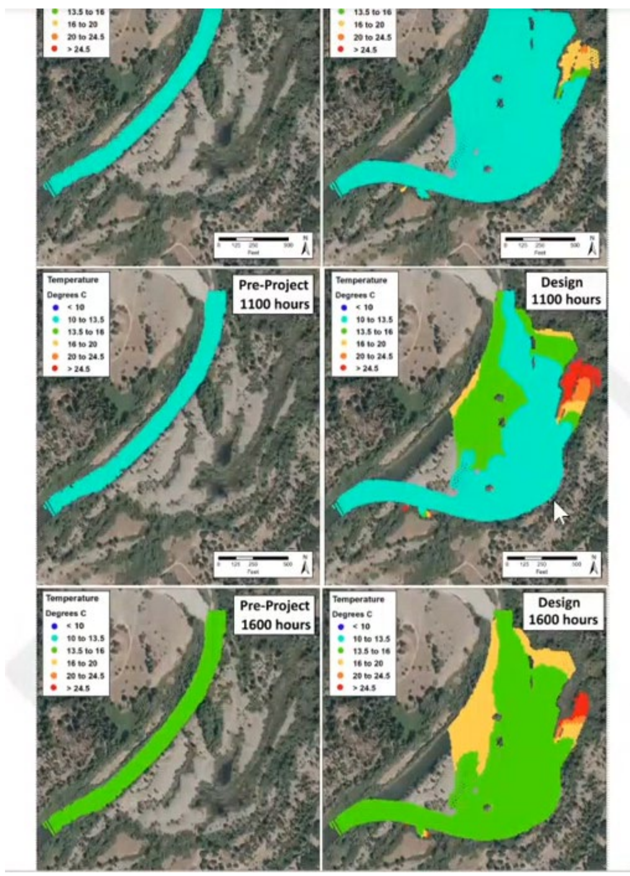

Figure 3. An example of an analysis using the SRH2D model for temperature. These graphs show the distribution of water temperatures over time and space.

Target (*temperature targets cont.)*:**

2. **Achieve daily average water temp of 10 C at the gage above NF (USGS 11526400) on or before May 1 during critically dry and dry water years; and maintain or increase for 14 days.**

3. **Promote timely oviposition and reduce scour of FYLF egg masses by limiting magnitude of discharge increase to less than 1000 cfs for 24 hrs and 500 cfs for longer, until July 1, after daily mean water temperature of 10 C has been achieved, AND water stage has been stable (less than 0.05 m/d change), at the gage above NF (USGS 11526400) for 7 days.**

The basis for these targets is fully described in the memorandum "Foothill Yellow-legged Frog reproduction target recommendations" located in Appendix 6. These targets are specifically designed to minimize cold-water pulses as flows increase in the spring which affects FYLF breeding and rearing. These targets aim to promote timely oviposition and reduce scour of egg masses. These targets should be prioritized in dry or critically dry years as those are years where high recruitment is expected; however, managers should also consider these targets in normal and wetter water years. This target is largely based on parameters derived for use in the Foothill Yellow-legged Frog Assessment Model (FYFAM) (Railsback and Harvey 2015).

This target already has an established study design as FYFAM is an accepted methodology used by the Program. This target can be quantified using data already collected by the Program. FYFAM has been used to assess hydrograph development for ROD flows over the past several years. For further information, please see the memorandum "Foothill Yellow-legged Frog reproduction target recommendations" located in Appendix 6.

Objective: Promote dominance of native flora and fauna species in the ecological community structure.

This objective is necessary because one of the Program's original objectives is to "rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation (IAP objective 6)." The IAP has level 2 and 3 objectives specifically addressing discouraging colonization of invasive species. The RAEWG felt it was important to use the spirit of the objective in the IAP for developing the new objective and targets. This objective has two targets related to native flora and fauna species.

Promotion of native flora and fauna species are not affected by management actions the same way other objectives listed in this document are. Native species evolved following natural processes and disturbing any one of those natural processes has the potential to disturb native species. The promotion of a more natural flow regime should benefit native species and management actions to promote this process should be incorporated by the Program.

Target (*There are two targets for this objective*)***:***

1. **Increase richness, abundance, and diversity of native cover types.**
2. **Increase richness, abundance, and diversity of native species of fish, wildlife, invertebrates, and algae.**

The basis of these targets can be found in chapter 3.6.6 in the IAP (TRRP and ESSA 2009). One major difference between the IAP objectives and the ones developed by the RAEWG are the discouragement of invasive species versus promotion of native species. The RAEWG hypothesize that promoting an environment that promotes native species will naturally discourage the colonization of invasive species. The RAEWG felt that separating the two targets into flora and fauna species was necessary because management of flora and fauna require different management actions.

A study design has not been finalized for these targets; however, multiple data sources to evaluate these targets are already collected by the Program (Table 12). Cover type mapping is the expected data source to quantify richness, abundance, and diversity of flora. There is no standardized data source collected by the Program to quantify richness, abundance, and diversity for fish, macroinvertebrate, wildlife, or algal species.

Objective: Maintain flow variability over a broad temporal range to promote scour and inundation to promote habitat complexity.

This objective is necessary because one of the Program's fundamental objectives is to "establish and maintain riparian vegetation that supports fish and wildlife (IAP objective 5)" and "rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation (IAP objective 6)." Historically, the Trinity River was reliant on disturbance events to riparian plant colonization and mortality (USFWS and HVT 1999; TRRP and ESSA 2009).

This objective attempts to address flow variability and how it affects flora and fauna within the Trinity River. There are three targets for this objective.

Mechanical channel rehabilitation, ROD flows, and sediment augmentation are methods the Program could use to achieve this objective. Channel rehabilitation allows the Program to design features that can address scour while still promoting habitat complexity. ROD flows can also promote scour by promoting bed mobility and causing riparian plant mortality on bars and floodplains. ROD flows will inundate areas such as off, high, and low flow channels to promote habitat complexity. Sediment augmentation is also important to achieving this objective by supplying the material for bed mobility to cause riparian plant mortality which can prevent encroachment.

Target (*There are three targets for this objective)****:***

1. **Ensure sufficient mortality of riparian vegetation along the margins of the low-water channel and on the floodplain by ensuring only one surviving cohort of narrowleaf/dusky willow every decade.**

The basis for this target can be found in the "Vegetation Encroachment Synthesis for the Trinity River. Report for the Trinity River Restoration Program (TRRP)" (Bair et al. 2018). Riparian encroachment is a serious issue in the Trinity River and has been addressed extensively in the TRFE (USFWS and HVT 1999). Narrowleaf and Dusky Willow are the primary species responsible for the initiation of the riparian encroachment process that the Program is trying to prevent (IAP 2009). This target is comparable to objective 5.2 in the IAP.

The study design for this target already exists and is in use by the Program. GRTS sampling has been conducted annually or biennially since 2013 (Table 12). These efforts include band transects, riparian mapping, large wood inventory, and riparian hardwood phenology monitoring. These monitoring efforts should continue in order to evaluate the effectiveness of the target. See "Trinity River Restoration Program Riparian Monitoring Reports" for more information about study design and methodology.

2. Ensure recession limb falls at a rate conducive for Black Cottonwood recruitment every 3-5 years.

The basis for this target can be found in "Draft Water Year 2019 Trinity River Hardwood Recruitment Monitoring (Hoopa Valley Tribe and McBain Associates 2021)." Black Cottonwood is the largest riparian hardwood growing along the Trinity River and is of critical importance for future large wood supply. Components of IAP target 5.1 were used to develop this target.

The study design for this target already exists and is in use by the Program. GRTS sampling has been conducted annually or biennially since 2013 (Table 12). These efforts include band transects, riparian mapping, large wood inventory, and riparian hardwood phenology monitoring. These monitoring efforts should continue in order to evaluate the effectiveness of the target. See "Trinity River Restoration Program Riparian Monitoring Reports" for more information about study design and methodology.

3. Reduce desiccation of FYLF egg masses by limiting recession rate to 0.03 m/d for 35 days after achieving 10 C for 10 days at the gage above NF (USGS 11526400).

The basis for this target is fully described in the memorandum "Foothill Yellow-legged Frog reproduction target recommendations" located in Appendix 6. This target is designed to address the negative effects of desiccation, resulting from rapidly receding water levels, on egg masses. Egg masses are likely vulnerable to desiccation when recession rates exceed 0.03 m/d. Recession rates were taken based on unpublished data (Welsh and Wheeler 2014) and personal knowledge and literature on the susceptibility of egg masses to scour. This target is best prioritized in critically dry, dry, and normal water year designations but should also be considered in wet and extremely wet water years.

Table 12: Metrics, frequencies, and data sources associated with targets.

Target	Metric	Monitoring Frequency	Data Sources
Increase area less than 6 feet above summer baseflow water surface elevation within the margins of the maximum fishery flow	Percent of selected surfaces (i.e., 0-2 ft, 2-4 ft, 4-6 ft, etc.) above 450 cfs baseline	Decadal or bi-decadal	LIDAR, DEM, and bathymetry data
Increase the diversity of water temperature (residence time of water) at rehabilitation sites	TBD	Pre/Post-construction	SRH2D
Achieve daily average water temp of 10 C at the above gage above NF (USGS 11526400) on or before May 1 during critically dry and dry water years; and maintain or increase for 14 days	See target	Annually	RBM10, hydrographs, temperature gauges, FYFAM
Promote timely oviposition and reduce scour of FYLF egg masses by limiting magnitude of discharge increase to less than 1000 cfs for 24 hrs and 500 cfs for longer, until July 1, after daily mean water temperature of 10 C has been achieved, AND water stage has been stable (less than 0.05 m/d change), at the gage above NF (USGS 11526400) for 7 days.	See target	Annually	RBM10, hydrographs, temperature gauges, FYFAM
Increase richness, abundance, and diversity of native cover types	richness, abundance, diversity	TBD	Cover type mapping
Increase richness, abundance, and diversity of native species of fish, wildlife, invertebrates, and algae	richness, abundance, diversity	TBD	Weir, rotary screw trap, TBD
Ensure sufficient mortality of riparian vegetation along the margins of the low-water channel and on the floodplain by ensuring only one surviving cohort of narrowleaf/dusky willow every decade.	TBD	Decadal	Hydrographs, cover-type mapping
Ensure recession limb falls at a rate conducive for black cottonwood recruitment every 3-5 years.	GRTS habitat sampling	Annually	Hydrographs, cover-type mapping
Reduce dessication of FYLF egg masses by limiting recession rate to 0.03 m/d for 35 days after achieving 10 C for 10 days at the gage above NF (USGS 11526400).	See target	Annually	RBM10, hydrographs, FYFAM

Recommendation and Next Steps

The purpose of this document is to describe the process of refining objectives and targets, and to present the objectives and targets that were recommended by the workgroups (Table 1) so that the TMC may consider their adoption.

We propose that revisions to this document are driven by information that becomes available through annual monitoring activities, focused scientific experiments and modeling exercises, and the peer-reviewed literature.

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Appendices

Appendices are contained in a separate file. There are six appendices:

Appendix 1- TRRP Objectives Workshop Summary and Appendices

Appendix 2- Objectives refinement guidance memo 20181025

Appendix 3- Fish Workgroup

Appendix 4- Physical Workgroup

Appendix 5- Flow Workgroup

Appendix 6- Riparian and Aquatic Ecology Workgroup