Trinity River Restoration Program Objectives and Targets Summary

August 2024

Preface

The content of this document was completed in June of 2022 and circulated as a "TMC Review Draft". The Program's needs at that time were sufficiently covered with the draft. On June 16, 2023, the TMC passed a series of motions to support the inclusion of the objectives in the Science Plan and that TMC members vet the targets with their technical staff prior to the Science Plan. Discussion during the meeting, as captured in the minutes, distinguished targets as:

> The targets, however, are technical assessments on how to achieve the objectives. They are not regulatory or binding and are not meant to be fixed as they can change as new information comes in.

On March 30, 2023, the TMC moved to approve the Science Plan portion of the Program Document and use it to guide the TRRP's science process. The Science Plan (Pickard et al. 2023) incorporated Objectives and Targets by reference to the TMC Review Draft. Therefore, those Objectives and Targets were adopted without further change.

The Science Plan describes the Objectives and Targets [draft] report as a living document. By 2024, several revisions to the Targets have been proposed, and several Objectives are currently under discussion by workgroups (a process for revision of Targets is outlined in the Science Plan, Appendix C, and does not specify TMC approval; revision of Objectives is not addressed but presumably does require approval since the existing set was approved by the TMC). To maintain clear documentation of both the original Objectives and Targets, and subsequent revisions, this suite of the original Objectives and Targets is now finalized with a 2024 publication date. The only changes to this document are (1) this preface, (2) addition of references for this preface, and (3) the list of appendices was moved to the front material of the document.

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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>
</table>

<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>
</table>

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 ≥ 2.4 m (8 ft) and with a surface area ≥ 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 ≥ 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 1 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.

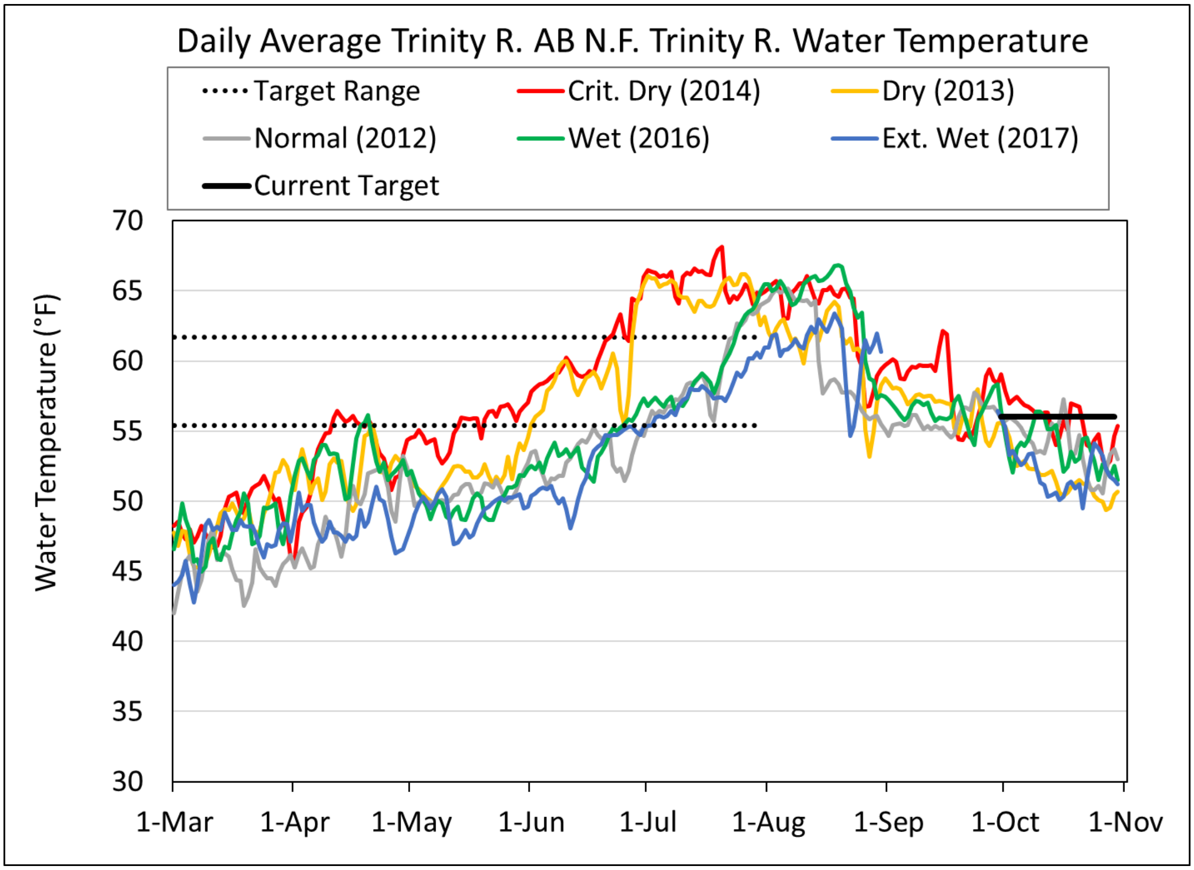

Figure 1. Water temperatures for one of each of the five water year types in the Trinity River above the North Fork Trinity River. Note the 5°F to 7°F reduction in temperature that occurs in all water year types in the end of April coincident with the onset of TRRP restoration flow releases from Lewiston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

Date	New Temp Objective (°F)	Existing Temp Objective (°F)	
	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 ($D_{50,\text{surface}}$) and the average subsurface median grain size ($D_{50,\text{subsurface}}$) both to the median bed load diameter ($D_{50,BL}$) to respectively produce values of D^*_{surface} and $D^*_{\text{subsurface}}$ that target >1.0. After Paola and Seal (1995), D^*_{surface} and $D^*_{\text{subsurface}}$ ≤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 $D^*_{\text{subsurface}}$ 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 $D_{50,\text{surface}}$ 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 $D_{50,\text{subsurface}}$ 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.

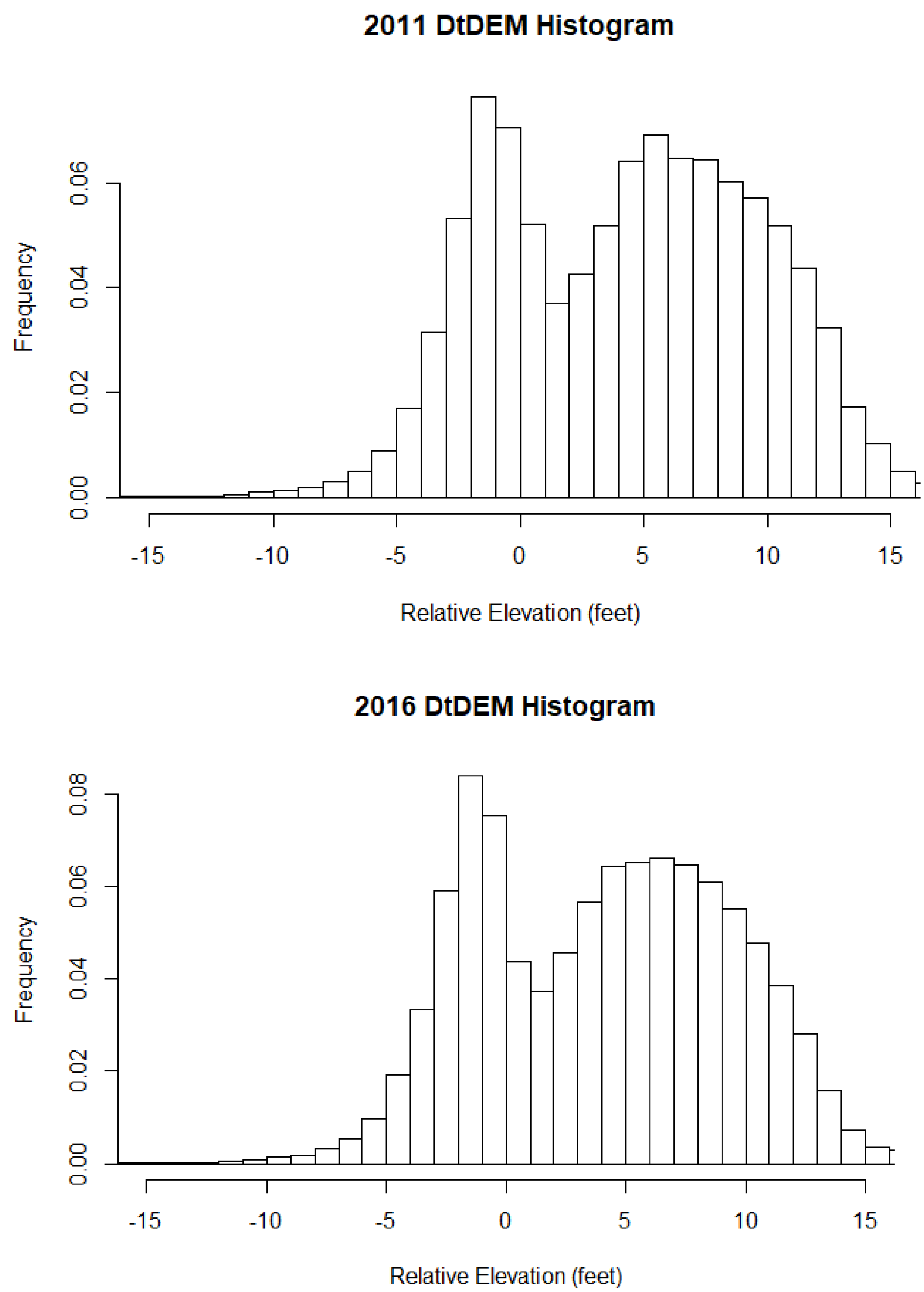

Figure 2. An example of an analysis used to determine the height of selected surfaces above baseflow conditions. These graphs are used to describe the change of the relative frequency of elevations within the restoration reach.

<u>Objective</u>: 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.

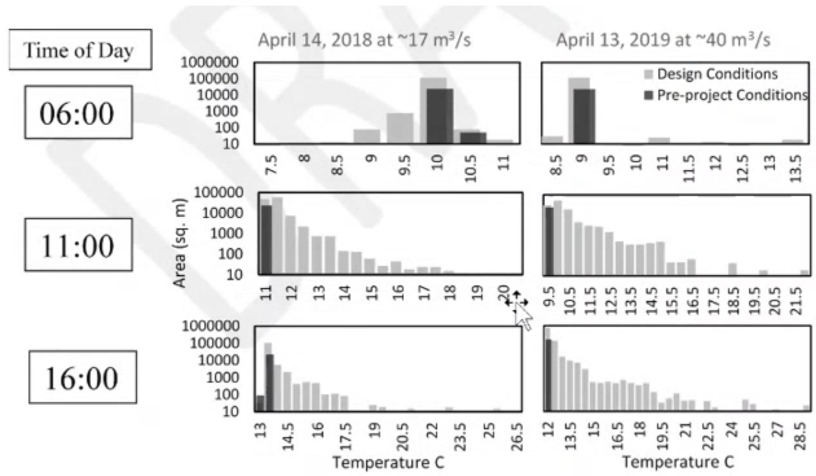

Figure Xc: Summary of SRH 2-D temperature results for 3 times of day at the Oregon Gulch Rehabilitation site for design and pre-project conditions in April prior to spring releases under dry hydrology (left; 2018) and wet hydrology (right; 2019).

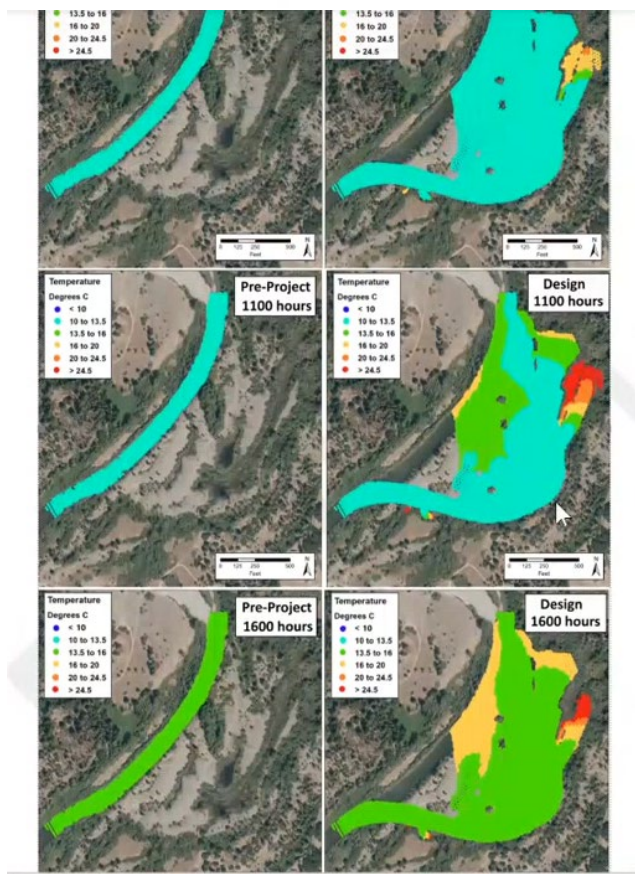

Figure 3. An example of an analysis using the SRH2D model for temperature. These graphs show the distribution of water temperatures over time and space.

***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

Meeting Summary

Trinity River Restoration Program (TRRP) Objectives Workshop

Trinity County Library, Weaverville, CA
May 22, 2013

Participants

U.S. Bureau of Reclamation (USBR): Robin Schrock (TRRP Executive Director), DJ Bandrowski (TRRP Implementation Branch Chief), Andreas Krause (TRRP), Rod Wittler (via teleconference)

U.S. Fish and Wildlife Service (FWS): Ernie Clarke (TRRP Science Coordinator), Joe Polos, Nicole Athearn, Charles Chamberlain

Hoopa Valley Tribe (HVT): George Kautsky, Robert Franklin, James Lee

Trinity County: Judy Pflueger

Yurok Tribe: Tim Hayden, Aaron Martin

California Department of Fish and Wildlife (CDFW): Andrew Jensen, Wade Sinnen, Steve Cannata (via teleconference)

California Department of Water Resources (DWR): Scott Kennedy

U.S. Forest Service: Bill Brock

National Oceanic and Atmospheric Administration (NOAA) – National Marine Fisheries Service (NMFS): Seth Naman, Ann Garrett, Wes Smith

Atkins: Tom St Clair (facilitator), Rebecca Burns (note taker)

Pre-Workshop Preparation

The email announcement for the workshop (Appendix A)invited attendees to two webinars on the Integrated Assessment Program (IAP) objectives and the structured decision making (SDM) process. These webinars were held on May 8 and May 10, 2013, respectively, and the presentations are included as Appendix B. The email announcement also included a pre-workshop assignment for attendees to identify the purpose of each of the IAP objectives in order to identify any redundancies and separate fundamental and means objectives. The pre-workshop assignment is included as Appendix C.

Desired Outcome

A refined, consolidated list of objectives that distinguishes between fundamental and means objectives.

Summaries for Agenda Items

1. **Introductions, Meeting Objectives, Ground Rules and Agenda Review**

Ernie Clarke opened the workshop by welcoming everyone and introducing Nicole Athearn, Tom St. Clair and Rebecca Burns, the workshop facilitators.

Tom St. Clair asked everyone to introduce themselves, then presented the workshop objectives, and ground rules and expectations (Appendix D) and reviewed the workshop agenda (Appendix E).

2. Lessons Learned from other Adaptive Management Applications

The purpose of this agenda item was to present lessons learned from other natural resource management programs on defining and specifying objectives, including explicitly stating stakeholder objectives.

Tom St. Clair presented a brief example from the Comprehensive Everglades Restoration Program (CERP) where the purpose of an established restoration project was modified, resulting in the need to reevaluate the project's objectives.

Rebecca Burns presented lessons learned from four case studies that were included in the Decision Support System (DSS) Literature Review Atkins recently prepared for the TRRP. The presentation is included as Appendix D.

Robert Franklin and Wade Sinnen questioned the purpose and relevance of presenting these examples, given that the TRRP has already defined its objectives. Tom St. Clair responded that these examples were presented so that attendees could recognize the challenges that other programs have faced in specifying and reevaluating objectives. Robert Franklin pointed out that stakeholders were not represented at the workshop to define stakeholder objectives. Robin Schrock responded that the Trinity Adaptive Management Working Group (TAMWG) was invited to the workshop, but they opted to leave this process to the technical staff and are more concerned with implementation (i.e., the way projects are built to meet objectives). Stakeholder concurrence and involvement was added to the "Parking Lot" of topics to be addressed later.

3. Brief Introduction to Structured Decision Making

Nicole Athearn presented an overview of structured decision making and adaptive management, including the characteristics of fundamental objectives, the difference between fundamental and means objectives and the role of monitoring in restoration programs (Appendix F).

Wade Sinnen asked how ambiguous objectives could be grouped and evaluated to determine sensitivity to management alternatives. Nicole Athearn explained that subjective and less tangible objectives can still be measured by asking the proponent to develop a scale (e.g., a teenage boy developing a "coolness" scale to evaluate car options). She added that collaborative processes involving stakeholders, as well as legal mandates and other factors determine which objectives are fundamental depending on the values of the decision maker. George Kautsky asked about the process to assign weights to objectives. Nicole Athearn said the weighting process is absolutely necessary and there are many ways to do this, which all involve discussions with decision makers to obtain concurrence. This topic was added to the "Parking Lot."

4. Review Results of Pre-Workshop Assignment and Determine Fundamental Objectives

Tom St. Clair began by asking attendees for their observations on the pre-workshop assignment. James Lee noted that there are other purposes not reflected in the existing objective lists, some which were alluded to but not captured completely. Robin Schrock pointed out the many redundancies resulting from multiple versions of the same objective depending on the author and their discipline. Judy Pflueger agreed and said many of the objectives could have been consolidated, but were split due to wording preferences. Tim Hayden explained that the IAP was written by many authors and its very structure lent itself to organizing the objectives in this manner.

After receiving the completed pre-workshop assignments from a majority of attendees (completed by staff from HVT, FWS, NOAA-NMFS, CDFW, Yurok Tribe, USBR and DWR), Nicole Athearn compiled all of the responses and developed a spreadsheet to summarize the results (Appendix G). Nicole explained the process by which she summarized the information as follows:

a. Consolidated the objectives provided as the purposes for each objective and also included a tally row above each one to indicate how many people gave that as a response. If it is blank, then only one person did.
b. Summarized objectives by how many other objectives had it listed as a purpose, and sorted those from high to low to identify the most popular objectives (i.e., those that were chosen most often).
c. Picked the top 15 objectives (by considering what was a good natural break, which was those with 20 or more objectives citing them), and highlighted those in yellow to consider as higher-level objectives.

Nicole then reorganized the objectives into a new hierarchy, organized by the primary (i.e., most popular) "purpose" objectives identified in the responses (Appendix H). This hierarchy includes Nicole's notes (in purple) to explain her rationale, but no objectives were deleted or reworded. The results of this assignment, as organized by Nicole, identified two fundamental objectives that can be loosely summarized as (1) Facilitate harvest and (2) Restore an ecologically functioning river system, as well as one major group of means objectives related to physical habitat.

Nicole noted that the following objective, which is summarized as the "Facilitate harvest" fundamental objective, had the highest degree of consistency among the respondents:

> Restore adult anadromous fish numbers to pre-Trinity River Dam levels in order to facilitate dependent tribal, commercial and sport fisheries full participation in the benefits of restoration via enhanced harvest opportunities

Wes Smith noted the wording implies that restoring fish numbers is a means objective to facilitate harvest; however, this may not have been the intention of the original authors since the goal of the program is to restore fish numbers. Tim Hayden said the IAP authors recognized that harvest can be facilitated in many different ways so they worded the objective to be specific about how that should be accomplished. There was discussion among the attendees on whether facilitating harvest is a fundamental objective of the TRRP. Andreas Krause summarized a statement from Jim Peterson's presentation at a symposium held in February regarding how to separate a fundamental from a means objective. He asked the question: if the Program was successful in restoring all of the qualities of a functioning river system, including increased fish numbers, but did not facilitate harvest, would it be successful? In his mind the answer is no and thus harvest is the fundamental objective. Nicole Athearn reminded attendees that there can be multiple fundamental objectives, some of which can be secondary to the primary goal of the Program. Judy Pflueger stated that harvest is a result of the fundamental objective to restore the fish in the river.

5. **Lessons from Klamath Objectives Hierarchy**

The agenda was modified to skip this item and allow more time for discussion of the TRRP fundamental and means objectives. Nicole Athearn's presentation on the Klamath objectives hierarchy is included as Appendix I.

6. **Revise Objectives: Sessions 1, 2 and 3**

Identify Fundamental Objectives

For the remainder of the workshop attendees discussed the fundamental objectives of the Program. George Kautsky asked how the hierarchy created from the pre-workshop assignment differs from the hierarchy in the IAP. Nicole Athearn explained that the exercise identified that some of the six level 1 objectives in the IAP are actually means objective, so there are differences at the highest level of the hierarchy, but the lower levels remained intact.

There was significant discussion among the attendees on whether there are one (restore fish populations) or two (restore fish populations and a healthy river system) fundamental objectives of the Program or whether restoring a healthy river system is a means to restoring fish populations. With a single fundamental objective to restore fish populations, the wildlife/riparian means objectives in the IAP do not fit into the hierarchy; however, they would be encompassed in a healthy river system objective. Robert Franklin explained that the fundamental objective from the Hoopa Valley Tribe perspective is to restore the health of the river which produces fish. Tim Hayden agreed with two fundamental objectives and said there is still ambiguity in defining "harvest."

Joe Polos pointed to Figure 2.1 of the IAP which shows how the objectives link to one another and suggested that the highest level box in the figure is the fundamental objective or overarching goal of the Program:

> Restore and sustain natural production of adult 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. The TRRP strategy for accomplishing this goal restores and perpetually maintains fish and wildlife

resources (including T&E species) by restoring the processes that produce a healthy alluvial river system.

DJ Bandrowski agreed that this is the fundamental objective and the six level 1 objectives in the IAP are means objectives. Nicole Athearn noted that this includes multiple fundamental objectives and when a decision needs to be made based on how well alternatives meet the fundamental objective, it is unclear how important one objective is versus another. Wes Smith noted that fundamental objectives can be separated from the overarching goal and metrics can be developed as needed, but otherwise the goal can be left as is. Ernie Clarke agreed with this idea and emphasized the importance of portraying a consistent picture of the Program's objectives.

George Kautsky and Robert Franklin questioned how these objectives will be used as part of a potential DSS. George noted that the complexity of modeling and analysis increases exponentially with the number of objectives. He also raised the issue of the consequences of the DSS on the monitoring program. These topics were added to the "Parking Lot" and will be discussed within the context of the DSS.

Andreas Krause advocated for two objectives: one focused on fish production, one related to inherent value of healthy ecosystem, which includes other objectives, such as wildlife, that are not as important to the Program as fish. There was discussion of a single overarching goal with two fundamental objectives, as stated below:

- **Overarching Goal:** Restore and sustain natural production of adult 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. The TRRP strategy for accomplishing this goal restores and perpetually maintains fish and wildlife resources (including T&E species) by restoring the processes that produce a healthy alluvial river system.
- **Fundamental Objectives:**
    - Restore and sustain natural production of anadromous fish populations downstream of Lewiston dam to pre-dam levels.
    - Restore the processes and attributes of a healthy alluvial river system.

Two concerns were raised with the proposed fundamental objectives. Steve Cannata raised concern about including the phrase "pre-dam levels," given that historically most of the spring Chinook and coho salmon production occurred upstream of the dam. His understanding of the TRRP goal is to restore habitat for anadromous fish downstream of the dam, but it may not be to pre-dam levels. Several attendees noted that the goal of the mitigation hatcheries is to produce salmonids upstream of the dam. Robin Schrock noted that the targets for spring Chinook and coho salmon numbers are established pre-dam levels for the entire Trinity River that included the area above the dam.

Ann Garrett raised concern about removing harvest from the fundamental objectives, stating that since it is a goal of the Program it should be explicitly stated. Robin Schrock responded that the fundamental objectives are things that the Program can influence and since the TRRP does not manage fisheries (e.g., set quotas for harvest), harvest should not be included as a fundamental objective. Nicole Athearn added that, in a DSS, the fundamental objectives include all stakeholder objectives that are considered during decision making and harvest could be included in that category. Attendees agreed to keep the two fundamental objectives as is and include a placeholder for stakeholder objectives (to be determined at a later date) that includes facilitating harvest/fishing.

Eliminate Redundancies

Nicole Athearn quickly summarized her observations on redundancies among the IAP objectives. Different work groups developed the level 2 and 3 objectives in the IAP, resulting in objectives that are related but slightly different from one another. For example, the Fish Work Group established objectives for minimizing impacts to various species, whereas the Physical WG developed related objectives for sinuosity, substrate patch diversity, etc. There are opportunities to consolidate these objectives by specifying fish needs, which then become targets for the Physical Work Group. Nicole also noted that the Conceptual Models Report identifies objectives that were not included in the IAP.

7. <u>Post-Workshop Activities</u>

This portion of the agenda was reserved for developing plans to identify linkages between objectives and management actions, and develop quantitative metrics for each objective, the third and fourth objectives of the workshop. The work groups will be responsible for completing these activities, with coordination by the Interdisciplinary Team (IDT). Ernie Clarke said he will work with the Work Group Coordinators to develop a realistic schedule for completion.

8. <u>Wrap-Up, Review Outcomes and Next Steps</u>

The four action items for the work groups that emerged from the discussion were:

1. Reduce redundancies among means objectives;
2. Review the Conceptual Models Report to identify any missing objectives;
3. Identify linkages between objectives and management actions; and
4. Develop quantitative metrics for each objective.

Robin Schrock noted that many objectives are simply to increase a particular species' population or an attribute of the river. These objectives should be revised to specify the meaning of "increase," including whether it applies to the project or system scale (i.e., future ideal conditions).

<u>Adjourn</u>

The meeting was adjourned at 4:30pm.

Appendices

Appendix A: Workshop Email Announcement

Appendix B: Pre-Workshop Webinars on the IAP Objectives and SDM Process

Appendix C: Pre-Workshop Assignment

Appendix D: Workshop Introduction Presentation

Appendix E: Workshop Agenda

Appendix F: Workshop SDM Presentation

Appendix G: Pre-Workshop Assignment Summary Spreadsheet

Appendix H: Revised Objective Hierarchy based on Pre-Workshop Assignment

Appendix I: Klamath Objectives Hierarchy Presentation

Appendix A: Workshop Email Announcement

Burns, Rebecca E

From:	Clarke, Ernest [ernest_clarke@fws.gov]
Sent:	Wednesday, May 01, 2013 5:28 PM
To:	idt@trrp.net; Ann Garrett - NOAA Federal; Brock, William -FS; cmilliro@dfg.ca.gov; Hadley,Elizabeth; gilsaliba@aol.com; Dave Hillemeier; jpflueger@trinitycounty.org; Mike Orcutt; BRIANPERSON; Joe Polos; Robin Schrock; sheywood@fs.fed.us; Ed Duggan; Kelli Gant; Tom Stokely; Emelia Berol; Dave Steinhauser; Joe McCarthy; Liam Gogan; Paul Hauser; Rich Lorenz; Sandy Denn; Travis Michel; CarrieNichols; Ernie Clarke
Cc:	St Clair, G Tom; Burns, Rebecca E; Nicole Athearn
Subject:	May 22 TRRP Workshop
Attachments:	Objective Hierarchy Assignment.xlsx

Hello all,

This email provides additional information on the upcoming **TRRP Objectives for Decision Support System (DSS) Development workshop,** as well as pre-workshop materials and an assignment. **RSVP to Ernie Clarke by May 7, 2013.** Space is limited, thus we will determine the right mix of attendees to ensure broad participation across the program.

Logistics: The workshop will be held on **May 22, 2013 from 9:30am to 4:30pm** at the Trinity County Library located at 351 Main Street in Weaverville. A detailed agenda will be distributed by May 20. From 12 to 12:30pm we will break for lunch, which will be ordered from Trinideli (http://www.trinideli.com/Lunch_menu.html). We will place the lunch order in the morning, so **please come to the workshop with your order and cash (preferably exact change) to pay for your lunch.**

Expectations:

- Because this is limited to a one-day workshop, please come prepared, having read the pre-workshop materials and completed the assignment (see below).

- This workshop is intended to assist in the development of a DSS for the TRRP and is not an academic exercise. This step is necessary because:

    - The adaptive management process requires restoration objectives periodically be reviewed to ensure new learning of Trinity River ecosystem functionality is captured in both fundamental and means objectives.

    - Reducing the overall number of objectives (by eliminating redundancy) to clearly distinguish between fundamental and means objectives is necessary to design a DSS that captures the relationships between them (i.e., means objectives as potential ways (hypotheses) to achieve fundamental objectives).

- The desired outcome of this workshop is: A refined, consolidated list of objectives that distinguishes between fundamental and means objectives.

- Given the workshop purpose and limited time available, we will not be revisiting past exercises or decisions in great detail.

- Workshop attendees will have expertise in both policy and technical arenas and we will ensure equal representation.

Pre-Workshop Webinars:

Two webinars will be held in advance of the workshop to provide background on the structured decision-making (SDM) process, as well as the Integrated Assessment Program (IAP) objectives for the TRRP:

- IAP Objectives Webinar (hosted by Ernie Clarke): May 8 at 3pm PT
- SDM Webinar (hosted by Nicole Athearn): May 10 at 3pm PT

There will be time for questions during the live webinars, and the recordings will be made available for those who cannot participate at those times. Also, the Structured Decision Making for Recurrent Decisions presentation by Mike Runge (http://nctc.fws.gov/courses/SDM/courses/adaptive_management.html) is a good resource.

Pre-Workshop Materials:

Necessary:

This workshop was recommended by the TRRP's Scientific Advisory Board (SAB) and the following sections of the DSS Framework provide essential background on the role of objectives in a DSS for the TRRP.

1) DRAFT Decision Support System Framework (Appendix H of Phase I Report) (**This is a draft and is not for distribution**)

    a. Section 2.2: Stakeholder Objectives

    b. Section 2.3: Example of a DSS

    c. Section 3: Structure of the Trinity River DSS

Optional:

Everyone should be familiar with these documents, but refreshing your memory of the specific sections below would be helpful for establishing an overall context.

2) Integrated Assessment Plan (IAP) http://odp.trrp.net/Data/Documents/Details.aspx?document=400

    a. Section 1.3: Program management actions

    b. Section 1.4: Adaptive Environmental Assessment and Management (AEAM)

    c. Chapter 2: Overview of assessment needs

    d. Chapter 3: Why is each assessment required and what does it involve?

3) Conceptual Models Report http://odp.trrp.net/Data/Documents/Details.aspx?document=1203

4) Trinity River Flow Evaluation Report http://odp.trrp.net/Data/Documents/Details.aspx?document=226

    a. Chapter 7: Restoration Strategy

b. Chapter 8: Recommendations

In addition, familiarizing yourself with the applicability of adaptive management to natural resource conservation, as described in the US Department of the Interior Adaptive Management Applications Guide (http://www.usgs.gov/sdc/doc/DOI-Adaptive-Management-Applications-Guide-27.pdf), would be beneficial.

Pre-Workshop Assignment

Lastly, we have developed a pre-workshop assignment, the results of which will be used to guide workshop discussions. The goal of the assignment is for attendees to identify the purpose of each of the TRRP objectives. This will assist in reducing redundancy among objectives and distinguishing between fundamental and means objectives. The assignment and instructions are included in the attached spreadsheet. We do not expect you to spend more than 2 hours at the most on this assignment. **Please send your completed assignment to Ernie Clarke by May 15.**

Post-Workshop Assignment

This workshop is the first phase of a two-phased approach. The third and fourth objectives of the workshop will be accomplished in the second phase; however, there will be post-workshop assignments to facilitate Phase 2. A plan for the second phase will be developed during the workshop.

Regards,

Ernie

Ernie Clarke
Science Program Coordinator
Trinity River Restoration Program
1313 South Main Street
Weaverville, California 96093
Desk: 530-623-1815
Fax: 530-623-5944
Email: ernest_clarke@fws.gov

Appendix B: Pre-Workshop Webinars on the IAP Objectives and SDM Process

Pre-Workshop Webinar Participants

Integrated Assessment Plan Objectives Webinar (hosted by Ernie Clarke, FWS)*:*
Nicole Athearn (FWS)
Joe Polos (FWS)
Steve Cannata (CDFW)
Scott Kennedy (DWR)
Teresa Connor (DWR)
Ann Garrett (NOAA – NMFS)
Justin Day (Redding Electric)

Structured Decision Making Webinar (hosted by Nicole Athearn, FWS)*:*
Ernie Clarke (FWS)
Charlie Chamberlain (FWS)
Steve Cannata (CDFW)
Teresa Connor (DWR)
Robin Schrock (USBR)
Justin Day (Redding Electric)

IAP Objectives Webinar

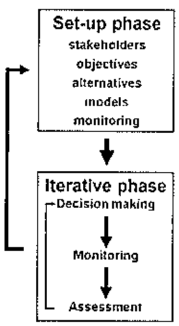
Ernie Clarke

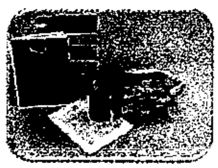
May 8, 2013

Goals of May 22 Workshop

- Primary Goals of Workshop
  - Review the three levels of objectives listed in Table 2.1 of the IAP
  - Minimize redundancy and the potential total number of objectives
  - Separate fundamental and means objectives
- Secondary Goals (to be accomplished following workshop)
  - Identify linkages between objectives and management actions to support development of the TRRP DSS
  - Develop quantitative metrics for each objective

Adaptive Management Framework





Goal / Strategy / Foundational Documents

Goal: Restore and sustain natural production of anadromous fish populations to facilitate enhanced harvest opportunities by dependent tribal, commercial, and sport fisheries'.

Strategy: Restore riverine habitats by restoring the processes that produce a healthy alluvial river ecosystem.

The above restoration strategy will be achieved by implementing management actions in a science-based adaptive management program (source TRFE and ROD).

Foundational Documents continued

IAP Structure

Executive summary

Recommendations of the IAP steering committee concerning the next steps for the IAP

1. Overview
2. → Overview of assessment needs
3. Why is each assessment required and what does it involve?
4. Sampling framework for the program area

IAP Structure continued

- 16 Appendices
- Appendix E. Nested objectives for the Trinity River Integrated Assessment Plan
- Appendix F. Looking outward matrix
- Appendix H. Table of assessments

Table 2.1 - IAP Objectives

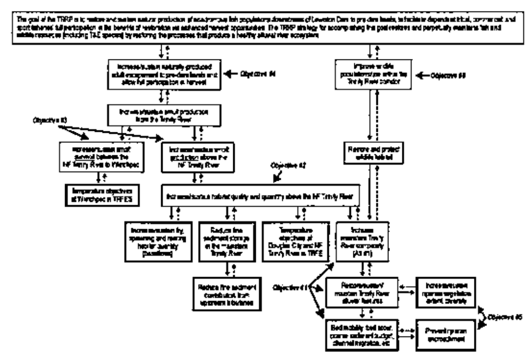
- Provides 3 levels of objectives (Appendix E lists 5 levels)
- Includes relative within Level 1 Objective (Appendix H includes cross domain prioritization)
- Documents linkages between objectives
- Listing objectives leads to delineation of performance measures and quantitative thresholds

Level 1 Objectives

1. Create and maintain spatially complex channel morphology
2. Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals
3. Restore and maintain natural production of anadromous fish populations
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
5. Establish and maintain riparian vegetation that supports fish and wildlife
6. Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation

IAP Moving Beyond Part 1

Conceptual Model for the TRRP with Physical and Biological Objectives



Example of Objective Levels

- Objectives expressed in levels of complexity as illustrated below:
  - *Level 1*: Create and maintain spatially complex channel morphology
  - *Level 2*: Reduce fine sediment storage in the mainstem Trinity River
  - *Level 3:* Transport fine sediment through mainstem at a rate greater than tributary input

Objective 1: Physical Features and Processes

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

Objective 2: Fish Habitat

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives
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
		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
		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
		2.1.4 Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River
		2.1.5 Minimize physical impacts to lamprey habitat
		2.1.6 Minimize physical impacts to other native fish habitats
		2.1.7 Maintain or increase tributary habitat
	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
		2.2.2 Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon
		2.2.3 Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)
		2.2.4 Minimize temperature impacts to other native fish habitats
	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)*

Objective 3: Fish Production

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives
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
		3.1.2 Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes
		3.1.3 Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River
	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
		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
		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
		3.2.4 Reduce clinical disease incidence in Trinity River origin outmigrants in the Klamath River to less than 20% within 5 years
		3.2.5. Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes
		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)*
	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
		3.3.2 Increase proportion of Natural Influence (pNI) to 0.7 or greater

Objective 4: Harvest and Escapement

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives
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
		4.1.2 Increase harvest of naturally produced fall-run Chinook salmon adults
	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
		4.2.2 Increase harvest of naturally produced spring-run Chinook salmon adults
	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
		4.3.2 Increase harvest of naturally produced coho adult salmon adults
	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
		4.4.2 Increase harvest of naturally produced steelhead adults
	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
		4.5.2 Increase harvest of Pacific lamprey adults
	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
		4.6.2 Increase harvest of green sturgeon adults

Objective 5: Riparian

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*

Objective 6: Wildlife Habitats and Populations

Level 1 Objectives	Level 2 Objectives	Level 3 Objectives
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	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)*
	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

TRRP Adaptive Management - Challenges

Initial confusion and disagreement on the goals of the program:

Implement channel rehabilitation projects, coarse sediment augmentation, and release flows

Restore the fishery resources of the Trinity River impacted by the construction and operation of the TRD.

TRRP Adaptive Management - Challenges

Confusion and disagreement on the role of channel rehabilitation:

Construct features that will allow the fluvial processes to create and maintain habitat

Build habitat for immediate benefit

A combination of the above

Structured Decision Making and Adaptive Management

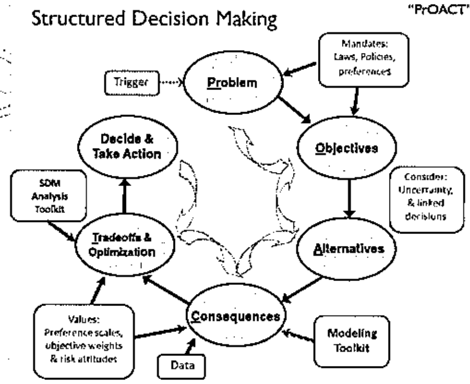
Reducing Uncertainty and Clarifying Linkages

Structured Decision Making

- Carefully organized problem analysis used to reach decisions that are focused clearly on achieving fundamental objectives
- Explicitly integrates science and policy
- Decisions are transparent with respect to legal mandates and public preferences or values
- Uncertainty is dealt with explicitly

Structured Decision Making

"PrOACT"



Problem Definition

- The way you state your problem frames your decision.
- Every decision has a trigger – it is important to consider the trigger in defining your problem.

Objectives …

- Form the basis for evaluating the alternatives available to you
- Keep you on the right track
- A full set of objectives can help us identify more and better alternatives than the ones that seem obvious
- Help you determine what information to seek
- Help you explain your choice to others
- Determine a decision's importance and, consequently, how much time and effort it deserves

Cautions

- Must identify ALL objectives to avoid making an unbalanced decision.
  - If a prospective decisions sits uncomfortably in your mind, you may have overlooked an important objective
- Pitfalls include taking too narrow a focus
  - Focus too much on tangibles without enough attention to intangibles
  - In science, this can be looking too hard for a science-based decision without adequately considering social and cultural issues
- Need to look beyond "obvious" objectives – so this will be an iterative process
- Don't eliminate an objective because of the perception that it is not measurable

But, well thought out fundamental objectives for similar problems should remain relatively stable over time (which is why prior work that involved objective-setting will be helpful).

A Good Set of Fundamental Objectives is…

- Complete. No essential objectives are missing.
- Concise. Nothing unnecessary or ambiguous. Similar objectives grouped together; no double accounting.
- Sensitive. The objectives are influenced by the alternatives under consideration.
- Understandable. Use commonly understood terms. May need to be defined by sub-objectives and performance measures.
- Independent. "Preferentially independent" -- contribute independently to the overall performance of an alternative, you don't need to know what is happening in one objective to evaluate performance in another

Steps in Developing Objectives

1. Brainstorm what matters
2. Separate means from ends
3. Separate "process" and "strategic" objectives from "fundamental" objectives
4. Build a hierarchy of objectives
5. Test to make sure they are useful

Fundamental vs. Means Objectives

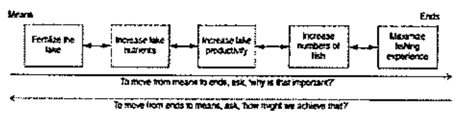


Figure 4.1 A simple means-ends diagram.

- Means to an end vs. ends in themselves (Fundamental objectives)
- Keep asking "Why?" until you can't go any farther
- Means objectives represent way stations in the progress towards a fundamental objective, the point where you can say "I want this for its own sake"
- Fundamental objectives constitute the broadest objectives directly influenced by your decision alternatives

A Typical Objective Hierarchy

Maximize safety
Maximize operator safety
Maximize public safety

Maximize net revenue
Maximize revenue from ore sales
Minimize capital costs
Minimize operating costs

Minimize impacts on First Nations traditional use activities
Minimize impacts to ceremonial sites
Minimize access impediments to traditional food gathering areas

Minimize adverse environmental impacts
Minimize soil contamination from tailings
Minimize material waste
Minimize air emissions
Minimize impacts on groundwater

Minimize disturbances to recreational activities
Minimize disturbance to viewscapes
Minimize trail access blockages
Minimize noise from construction /operations

Fundamental Objective

For the U.S. Fish and Wildlife Service

To characterize and maintain functional landscapes capable of supporting self-sustaining fish, wildlife, and plant populations.

Functional landscapes *are defined as lands and waters with the properties and elements required to support desirable populations of fish and wildlife, while also providing human society with desired goods and services, including food, fiber, water, energy, and living space.*

TRRP: "to restore and maintain the Trinity River's anadromous fishery resources"

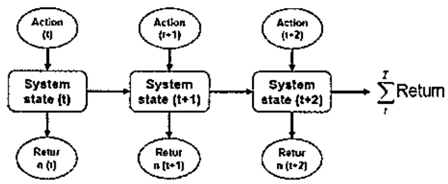
Objective Hierarchy

	Biologically-based Conservation Objective	Sub-Objective Level 2
Biological component of achieving functional landscapes in the Klamath Basin	Restore natural hydrologic processes and conditions	Restore natural hydrologic connectivity
		Restore natural stream flow
		Achieve naturally functioning riverine communities within the Basin
		Achieve naturally functioning riparian communities within the Basin
		Improve the quantity, quality, and distribution of wetland communities within the Basin
		Reduce the hypereutrophic state of lentic systems in the upper Basin
	Restore natural upland processes and conditions	Improve the quantity, quality, and distribution of forested upland communities within the Basin
		Improve the quantity, quality, and distribution of non-forested upland communities within the Basin
		3. Improve connectivity and distribution of habitats within the Basin
	Achieve stable populations of priority species by reducing the impacts of threats	Maintain genetic and life history diversity (representation)
		Improve population resiliency
		Improve priority populations' ability to resist perturbation
		Achieve sufficient population redundancy
	Improve community resistance and resilience to long-term perturbations, particularly climate change, (or we could just say "disturbance") within identified priority habitats	Increase native biological diversity
		Achieve appropriate levels of habitat heterogeneity
		Preserve the roles of strongly-interacting species that influence community structure
Non-biological component	Non-biological objectives	Sub-Objective Level 1
	Decision Maker weights	**Subject Matter Expert weights**

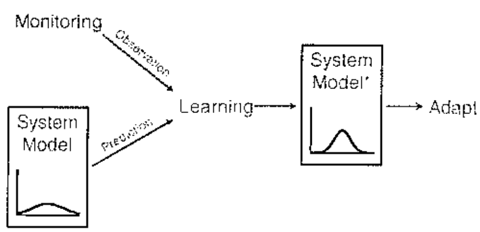
Adaptive Management as a Special Case of SDM

- Some decisions are repeated over time, at regular (or irregular) intervals
- How it is different
  - Added complexity
    - Current decisions influence future state(s) and, therefore, future actions
  - Opportunity to learn
    - Comparison of model-based predictions with monitoring data permit learning

Added Complexity



Opportunity to Learn



Elements of an Informed Decision Process (SDM for Recurrent Decisions)

1. Objective(s): what do you want to achieve
2. Restoration alternatives: stuff you can do
3. Model(s) of system response to restoration actions (for prediction)
4. Measures of model credibility
5. Monitoring program to estimate system state and other relevant variables
6. Solution algorithm (e.g., optimization)

- 1-2: based on societal values, law, politics, stakeholders
- 3-6: scientists and managers

Objectives in ARM

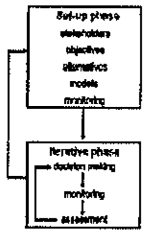
- Objectives drive the development of other aspects of the ARM framework (DSS)
- May be significant input from stakeholders
  - Balance regulatory responsibilities of agencies with stakeholder input

Actions

- Need to consider how the set of alternative actions may change over time for recurrent decisions
- Potential scenarios
  - Fixed set of alternatives
  - Time-dependent set of alternatives (linked decisions)
  - Dynamic set of alternatives
    - Decision today affects options tomorrow in a known way
  - Adaptive set of alternatives

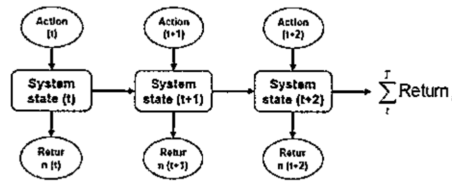
Evolution of Objectives and Actions

- "Double loop learning"
- Revisit objectives due to new information, experience, or change in values
- Alternative management actions may also evolve



Models for Recurrent Decisions

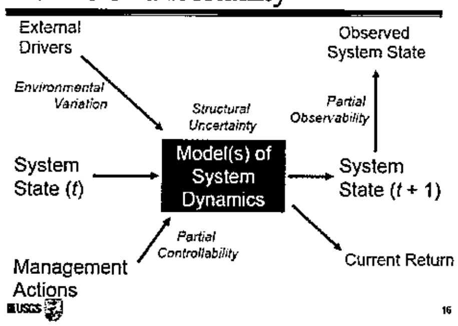
- What is the expected current return (value) of an action?
- How will resource conditions change as a result of an action?



Types of Uncertainty

- Environmental variation
- Partial controllability
- Partial observability
- Structural uncertainty
  - Competing ideas about effects of management actions
  - Focus of adaptive management
  - Focus on effects of alternative actions -- uncertainty that matters to your ability to achieve your objectives
  - May be expressed as competing (alternative) system models
  - What uncertainty makes the decision difficult?

Forms of uncertainty



Why Monitor?

- Science
  - Understand ecological systems
  - Learn
- Management, Conservation, Restoration
  - Apply decision-theoretic approaches
  - Make smart decisions

Purpose of Monitoring

- To assess the state of the system for the purpose of making state-dependent decisions
- To determine if the objectives are being met
  - Estimate system state for comparison with model-based predictions to learn about system dynamics
- To resolve uncertainty
  - Estimate parameters needed for model development
- The development of the monitoring system should be tailored to these needs & driven by the decision context

Monitoring and Restoration

- It is not efficient to simply collect information about physical conditions or a population of conservation concern
  - There is a very large number of quantities that we could potentially estimate
- Instead, we need to ask:
  - What information is most useful for making conservation and restoration decisions?
  - What explicit, measurable parameters can be used to assess restoration effectiveness?
    - Address multiple scales

All Information is Not Equally Useful for Science or Decisions

"Biology, with its vast informational detail and complexity, is a 'high-information' field, where years and decades can easily be wasted on the usual type of 'low-information' observations and experiments if one does not think carefully in advance about what the most important and conclusive experiments would be." (Platt 1964)

Value of Information

- Formal concept from decision theory
- How much management is expected to improve if uncertainty is reduced
- VOI is high when:
  - Different actions would be chosen under different hypotheses
  - The predicted outcomes are very different under different hypotheses
- Types: expected value of perfect information, partial information

EVPI and Model Discrimination

Quantifies the importance of model discrimination

- Basic idea: how much better is it to know which model is "best" than to base decisions on average (across models) model performance

Compares:

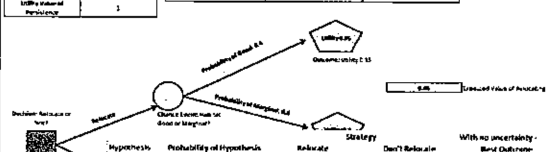
- weighted average of model-specific maximum values, across models
- maximum of an average of values (based on average model performance; value under best nonadaptive decision)

EVPI Example

Relocate to West Creek	Probability of West Creek Habitat Type	Probability Persistence Habitat Type	Probability Extinction Habitat Type
Marginal	0.6	0.2	0.8
Good	0.4	0.85	0.15

Utility value of extinction	0
Utility value of Persistence	1

Do Not Relocate	Probability of Persistence	Probability of Extinction
East Creek	0.4	0.6

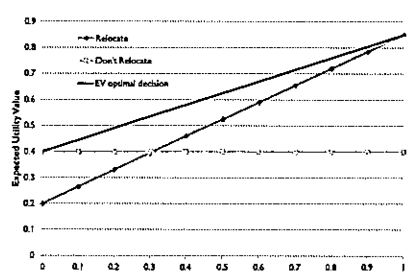


Hypothesis	Probability of Hypothesis	Relocate (Strategy)	Don't Relocate	With no uncertainty - Best Outcome
Habitat Good	0.4	0.85	0.4	0.85
Habitat Marginal	0.6	0.2	0.4	0.4
EV under uncertainty		0.46	0.4	0.58

EVPI	0.120

26.1%
Increase in performance

Role of Information in Decisions



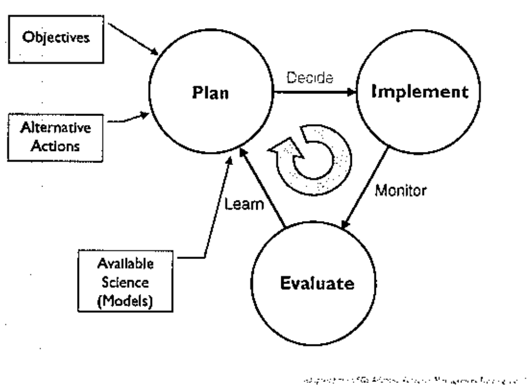
Conceptual model approach

- A **graphical or verbal representation** of the **relationships** between:
  - human activities, watershed processes, potential impacts or sources of stress and the effects on ecological function/endpoints
  - Physical and biological processes (e.g., TRRP components)
- Makes explicit statements about hypothesized **functional relationships** underlying management decisions
- Process descriptions are based on various conceptualizations of the components of process of interest – here, fish recovery
- Use to explore need for quantitative models and additional mechanistic relationships

Objectives and TRRP
Comments from Peter Wilcox

"… the exercise of defining objectives and hypotheses has been done, particularly in the IAP. The IAP has some issues – it is overly detailed and repetitive, it places the overarching 'restore fish' objective at the same level as some means objectives – but the hard work has been done."

- What is needed is NOT to start over but to revisit and perhaps reorganize the objectives to form a clear hierarchy



Climate Change and Adaptive Management

- Climate change as a special case of system change
- Focus on external system change that is outside of the control of management
  - That is, we're not focusing on how to adaptively manage the system change itself, but how to manage in the face of it
  - Re-evaluate objectives and alternatives considering the potential system change
  - Incorporate system change into models
- Both spatial and temporal aspects to the system change
  - Do our management scales need to change?

Summary

- Conceptual models can be used to make explicit our understanding of system and program component linkages, and associated uncertainties
- System uncertainties can be expressed as alternative models, which can be evaluated with monitoring data
- Models can help identify high priority data needs for decision-making
- An SDM-based DSS will increase decision-making transparency and enhance learning and communications

Appendix C: Pre-Workshop Assignment

Instructions for pre-workshop assignment:

Background:
For this assignment, the IAP objectives have been randomized and grouped into two groups (A and B).
We would like you to think creatively about the *purpose* of each objective instead of reverting back to the IAP structure, so please deliberately disassociate these objectives from those listed hierarchically in the IAP.
Identifying the purpose of each objective will help distinguish between fundamental and means objectives.
We do not expect you to spend more than 2 hours at the most on this assignment.

Steps:
1) Start with the objectives in the Group A tab. What is the purpose of this objective? Fill in the purpose in Column C, which should be one or more of the objectives from the Group B list (copied to the right). Insert the number(s) of the corresponding objective(s) in Column C. In some cases, the objective may not have a higher purpose. If so, leave this blank.
2) Next, move to the objectives in the Group B tab and repeat step 1 above.In this case use the Group A OR Group B objectives as the purpose and insert the number(s) in Column C. Leave any objectives without a higher purpose blank.

Number	Objective	Purpose (enter Group B objective number(s) from list to the right)
A1	Frequently exceed channel migration, bed mobilization, and bed scour thresholds	
A2	Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River	
A3	Transport fine sediment through mainstem at a rate greater than tributary input	
A4	Encourage bed-level fluctuations on annual to multi-year time scales	
A5	Increase/maintain spawning habitat quantity and quality to 2,550,000 square feet in the upper 40 miles of the mainstem Trinity River	
A6	Minimize temperature impacts to other native fish habitats	
A7	Increase channel/thalweg sinuosity	
A8	Increase harvest of naturally produced spring-run Chinook salmon adults	
A9	Route coarse sediment through all reaches	
A10	Reduce fine sediment supply from tributary watersheds	
A11	Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults	
A12	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	
A13	Increase escapement of Pacific lamprey adults	
A14	Increase structural and thermal diversity of aquatic habitats used by various age classes of Western Pond Turtles	
A15	Minimize physical impacts to other native fish habitats	
A16	Increase and maintain macroinvertebrate populations	
A17	Limit impacts of hatchery fish predation on naturally produced juvenile salmonids to less than 20% over the 40 miles	
A18	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs	

Number	Objective
B1	Increase freshwater production of anadromous fish
B2	Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish
B3	Increase physical habitat diversity and availability
B4	Increase and maintain coarse sediment storage
B5	Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity
B6	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (FYLF)
B7	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
B8	Create and maintain spatially complex channel morphology
B9	Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity
B10	Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation
B11	Restore and maintain natural production of anadromous fish populations
B12	Increase population size, survival, distribution, and recruitment success of Western Pond Turtle (WPT)
B13	Restore adult anadromous fish numbers to pre-Trinity River Dam levels in order to facilitate dependent tribal, commercial, and sport fisheries full participation in the benefits of restoration via enhanced harvest opportunities
B14	Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality
B15	Maintain Trinity River riverine bird populations and species diversity in the Program area
B16	Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity
B17	Reduce fine sediment storage in the mainstem Trinity River
B18	Maintain Trinity populations and species diversity of birds using the riparian zone in the Program area

A19	Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD	
A20	Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults	
A21	Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River	
A22	Increase geomorphic unit and substrate patch diversity	
A23	Increase harvest of naturally produced coho adult salmon adults	
A24	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	
A25	Increase harvest of naturally produced steelhead adults	
A26	Discourage invasive species	
A27	Increase and maintain target coarse sediment transport rates	
A28	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	
A29	Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat	
A30	Increase proportion of Natural Influence (pNI) to 0.7 or greater	
A31	Increase bars, side-channels, alcoves, and other complex alluvial features	
A32	Increase recruitment of younger age classes of Western Pond Turtles	
A33	Adapt timing of hatchery release to alter distribution of avian predators and minimize predation on natural fry and smolts	
A34	Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon	
A35	Provide optimal temperatures to improve spawning success of spring and fall-run Chinook salmon	
A36	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	
A37	Increase escapement of naturally produced coho salmon to 1,400 adults	

B19	Establish and maintain riparian vegetation that supports fish and wildlife
B20	Increase and maintain salmonid habitat availability for all freshwater (in-river and tributary) life stages
B21	Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals
B22	Enhance or maintain food availability for fry and juvenile salmonids
B23	Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity
B24	Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity
B25	Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation
B26	Improve riverine thermal conditions for growth and survival of natural anadromous salmonids
B27	Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity
B28	Increase coarse sediment transport and channel dynamics
B29	Minimize impacts of riverine bird predation on fry and smolts
B30	Increase spawning, incubation and emergence success of anadromous spawners
B31	Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high quality aquatic and terrestrial habitat

A38	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	
A39	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	
A40	Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes	
A41	Enhance quality and maintain quantity of riparian bird nesting and foraging habitats	
A42	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	
A43	Maintain or increase tributary habitat	
A44	Minimize physical impacts to lamprey habitat	
A45	Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife	
A46	Increase harvest of green sturgeon adults	
A47	Enhance quality and maintain quantity of riverine bird nesting and foraging habitats	
A48	Increase escapement of naturally produced steelhead to 40,000 adults	
A49	Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes	
A50	Reduce clinical disease incidence in Trinity River origin outmigrants in	
A51	Encourage fine sediment deposition on floodplains	
A52	Create channel form that reduces loss of fry to stranding in the upper 40	
A53	Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes	
A54	Increase escapement of green sturgeon adults	
A55	Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs	
A56	Increase harvest of naturally produced fall-run Chinook salmon adults	
A57	Increase harvest of Pacific lamprey adults	
A58	Increase the size, frequency and topographic relief of bar/pool sequences	
A59	Increase population size, survival, distribution, and recruitment success of Western Pond Turtles	

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B3	Increase physical habitat diversity and availability	
B4	Increase and maintain coarse sediment storage	
B5	Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	
B6	Increase population size, survival, distribution, and recruitment	
B7	Minimize adverse impacts to additional native riparian or aquatic	
B8	Create and maintain spatially complex channel morphology	
B9	Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	
B10	Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation	
B11	Restore and maintain natural production of anadromous fish populations	
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B15	Maintain Trinity River riverine bird populations and species diversity in the Program area	
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A9	Route coarse sediment through all reaches
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A37	Increase escapement of naturally produced coho salmon to 1,400 adults
A38	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
A39	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
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A41	Enhance quality and maintain quantity of riparian bird nesting and foraging habitats
A42	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
A43	Maintain or increase tributary habitat
A44	Minimize physical impacts to lamprey habitat
A45	Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife
A46	Increase harvest of green sturgeon adults
A47	Enhance quality and maintain quantity of riverine bird nesting and foraging habitats
A48	Increase escapement of naturally produced steelhead to 40,000 adults
A49	Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes
A50	Reduce clinical disease incidence in Trinity River origin outmigrants in the Klamath River to less than 20% within 5 years
A51	Encourage fine sediment deposition on floodplains
A52	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
A53	Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes
A54	Increase escapement of green sturgeon adults

A55	Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs
A56	Increase harvest of naturally produced fall-run Chinook salmon adults
A57	Increase harvest of Pacific lamprey adults
A58	Increase the size, frequency and topographic relief of bar/pool sequences
A59	Increase population size, survival, distribution, and recruitment success of Western Pond Turtles

Appendix D: Workshop Introduction Presentation

Trinity River Restoration Program
Objectives Workshop

May 22, 2013

Ground Rules and Expectations

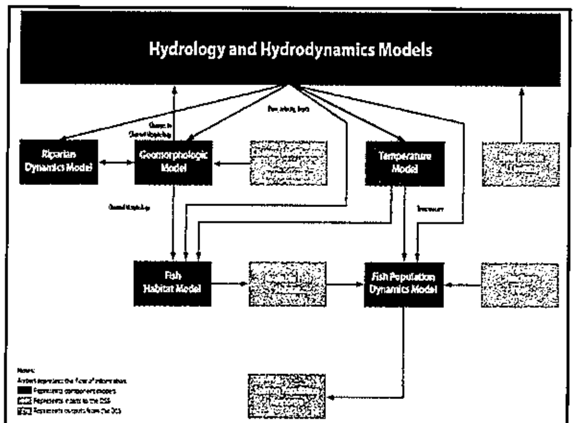
- Arrive on time; stay until the end of the meeting
- Be present, focused and prepared
- Avoid interruptions (we will use a queue)
- Listen before responding
- Be future orientated; avoid rehashing past exercises/decisions
- Stay on agenda (we will use a "parking lot"); avoid policy debates
- Keep an open mind as there will be differing perspectives
- Avoid assumptions; ask for clarification

Workshop Goals

- Primary Goals of Workshop
  - Review the three levels of objectives listed in Table 2.1 of the IAP
  - Minimize redundancy and potentially the total number of objectives
  - Separate fundamental and means objectives
- Secondary Goals (to be accomplished following workshop)
  - Identify linkages between objectives and management actions
  - Develop quantitative metrics for each objective

Why is this necessary?

- The adaptive management process requires restoration objectives periodically be reviewed to ensure new learning of Trinity River ecosystem functionality is captured in both fundamental and means objectives.
- Reducing the overall number of objectives (by eliminating redundancy) to clearly distinguish between fundamental and means objectives is necessary to design a DSS that captures the relationships between them (i.e., means objectives as potential ways (hypotheses) to achieve fundamental objectives).



Lessons Learned from other AM Applications

- DSS Case Studies
  - Horseshoe Crab-Red Knot Management
  - Adaptive Harvest Management of Waterfowl
  - Tallapoosa River
  - Cultus Lake Salmon
- Everglades Restoration

Horseshoe Crab-Red Knot and Adaptive Harvest Management (Waterfowl)

- Link species population models to inform harvest management decisions
- Collaborative effort with stakeholders
- First steps in developing DSS were defining problem statement and establishing objectives
- These steps, along with concurrence on models, were most time-intensive
- As new information is gained, objectives and underlying hypotheses will be reevaluated

Tallapoosa River Flow Management

- Establishes flow regimes to meet multiple objectives: hydropower production, recreational boater weekends and protection of ecological resources (spawning windows)
- Workshop to identify stakeholder values and objectives
- Established fundamental and means objectives and a flow regime that was the product of a series of compromises
- Structured decision making process allowed trust to be established among stakeholders

Cultus Lake Salmon

- Structured decision making process on sockeye salmon management alternatives
- Formed consultative stakeholder committee
- Held three workshops to develop objectives, performance measures and management options
  - Four objective categories: conservation, cost, catch and employment
- Process introduced rigor into development of objectives and management options, and recognition of tradeoffs

Appendix E: Workshop Agenda

Trinity River Restoration Program (TRRP) Objectives Workshop
Agenda

May 22, 2013 9:30am to 4:30pm

Workshop Location: Trinity County Library
351 Main Street
Weaverville, CA

WebEx Online Meeting:
https://trrp.webex.com/trrp/j.php?ED=229138717&UID=487141902&PW=NNDMyNTU2NmFi&RT=MiM0

Meeting Number and Access Code (for online meeting and audio conference): 577 665 038
Meeting Password (for online meeting): Abc123
Call-In Number: 1-408-792-6300

Workshop Objectives:

1) Review the three levels of objectives listed in Table 2.1 of the IAP to determine if the total number of objectives can be reduced to minimize redundancy
2) Separate fundamental and means objectives
3) Develop a plan to identify linkages between objectives and management actions
4) Develop a plan to develop quantitative metrics for each objective

Desired Outcome: A refined, consolidated list of objectives that distinguishes between fundamental and means objectives.

Meeting Facilitators: Nicole Athearn (USFWS); Tom St. Clair, Rebecca Burns (Atkins)	
9:30am – 10:00am	Introductions, Workshop Objectives, Ground Rules and Agenda Review
10:00am – 10:15am	Lessons Learned from other Adaptive Management Applications
10:15am – 10:30am	Brief Introduction to Structured Decision Making
10:30am – 10:40am	Break
10:40am – 11:30am	Review Results of Pre-Workshop Assignment • Determine fundamental objectives
11:30am – 12:00pm	Revise Objectives: Session 1
12:00pm – 12:30pm	Catered Lunch
12:30pm – 1:00pm	Lessons from Klamath Objectives Hierarchy
1:00pm – 2:15pm	Revise Objectives: Session 2
2:15pm – 2:30pm	Break
2:30pm – 3:45pm	Revise Objectives: Session 3
3:45pm – 4:15pm	Post-Workshop Activities
4:15pm – 4:30pm	Wrap-Up, Review Outcomes and Next Steps
4:30pm	***Adjourn***

Appendix F: Workshop SDM Presentation

Structured Decision Making and Adaptive Management

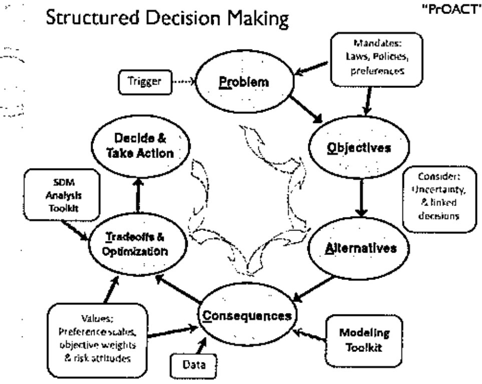
Reducing Uncertainty and Clarifying Linkages

Structured Decision Making

- Carefully organized problem analysis used to reach decisions that are focused clearly on achieving fundamental objectives
- Explicitly integrates science and policy
- Decisions are transparent with respect to legal mandates and public preferences or values
- Uncertainty is dealt with explicitly

Structured Decision Making

"PrOACT"



Problem Definition

- The way you state your problem frames your decision.
- Every decision has a trigger – it is important to consider the trigger in defining your problem.

Objectives …

- Form the basis for evaluating the alternatives available to you
- Keep you on the right track
- A full set of objectives can help us identify more and better alternatives than the ones that seem obvious
- Help you determine what information to seek
- Help you explain your choice to others
- Determine a decision's importance and, consequently, how much time and effort it deserves

Cautions

- Must identify ALL objectives to avoid making an unbalanced decision.
  - If a prospective decisions sits uncomfortably in your mind, you may have overlooked an important objective
- Pitfalls include taking too narrow a focus
  - Focus too much on tangibles without enough attention to intangibles
  - In science, this can be looking too hard for a science-based decision without adequately considering social and cultural issues
- Need to look beyond "obvious" objectives – so this will be an iterative process
- Don't eliminate an objective because of the perception that it is not measurable

A Good Set of Fundamental Objectives is…

- Complete. No essential objectives are missing.
- Concise. Nothing unnecessary or ambiguous. Similar objectives grouped together; no double accounting.
- Sensitive. The objectives are influenced by the alternatives under consideration.
- Understandable. Use commonly understood terms. May need to be defined by sub-objectives and performance measures.
- Independent. "Preferentially independent" -- contribute independently to the overall performance of an alternative, you don't need to know what is happening in one objective to evaluate performance in another

Fundamental vs. Means Objectives

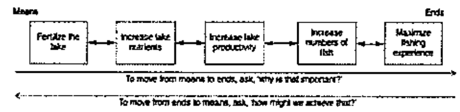


Figure 4.1 A simple means-ends diagram.

- Means to an end vs. ends in themselves (Fundamental objectives)
- Keep asking "Why?" until you can't go any farther
- Means objectives represent way stations in the progress towards a fundamental objective, the point where you can say "I want this for its own sake"
- Fundamental objectives constitute the broadest objectives directly influenced by your decision alternatives
  - A Fundamental objective is not necessarily an "important" objective

A Typical Objective Hierarchy

Maximize safety
Maximize operator safety
Maximize public safety

Maximize net revenue
Maximize revenue from ore sales
Minimize capital costs
Minimize operating costs

Minimize impacts on First Nations traditional use activities
Minimize impacts to ceremonial sites
Minimize access impediments to traditional food gathering areas

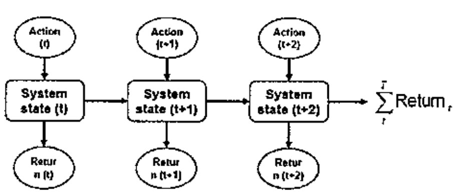
Minimize adverse environmental impacts
Minimize soil contamination from tailings
Minimize material waste
Minimize air emissions
Minimize impacts on groundwater

Minimize disturbances to recreational activities
Minimize disturbance to viewscapes
Minimize trail access blockages
Minimize noise from construction /operations

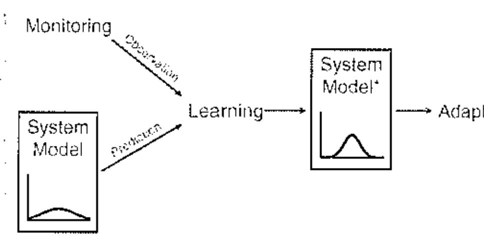
Adaptive Management as a Special Case of SDM

- Some decisions are repeated over time, at regular (or irregular) intervals
- How it is different
  - Added complexity
    - Current decisions influence future state(s) and, therefore, future actions
  - Opportunity to learn
    - Comparison of model-based predictions with monitoring data permit learning

Added Complexity



Opportunity to Learn



Elements of an Informed Decision Process (SDM for Recurrent Decisions)

1. Objective(s): what do you want to achieve
2. Restoration alternatives: stuff you can do
3. Model(s) of system response to restoration actions (for prediction)
4. Measures of model credibility
5. Monitoring program to estimate system state and other relevant variables
6. Solution algorithm (e.g., optimization)

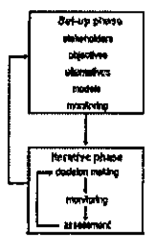
- 1-2: based on societal values, law, politics, stakeholders
- 3-6: scientists and managers

Objectives in ARM

- Objectives drive the development of other aspects of the ARM framework
- May be significant input from stakeholders
  - Balance regulatory responsibilities of agencies with stakeholder input

Evolution of Objectives and Actions

- "Double loop learning"
- Revisit objectives due to new information, experience, or change in values
- Alternative management actions may also evolve



Purpose of Monitoring

- To assess the state of the system for the purpose of making state-dependent decisions
- To determine if the objectives are being met
  - Estimate system state for comparison with model-based predictions to learn about system dynamics
- To resolve uncertainty
  - Estimate parameters needed for model development
- The development of the monitoring system should be tailored to these needs & driven by the decision context

Monitoring and Restoration

- It is not efficient to simply collect information about physical conditions or a population of conservation concern
  - There is a very large number of quantities that we could potentially estimate
- Instead, we need to ask:
  - What information is most useful for making conservation and restoration decisions?
  - What explicit, measurable parameters can be used to assess restoration effectiveness?
    - Address multiple scales

Value of Information

- Formal concept from decision theory
- How much management is expected to improve if uncertainty is reduced
- VOI is high when:
  - Different actions would be chosen under different hypotheses
  - The predicted outcomes are very different under different hypotheses
- Types: expected value of perfect information, partial information

Conceptual model approach

- A **graphical or verbal representation** of the **relationships** between:
  - human activities, watershed processes, potential impacts or sources of stress and the effects on ecological function/endpoints
  - Physical and biological processes (e.g., TRRP components)
- Makes explicit statements about hypothesized **functional relationships** underlying management decisions
- Process descriptions are based on various conceptualizations of the components of process of interest – here, fish recovery
- Use to explore need for quantitative models and additional mechanistic relationships

Summary

- Conceptual models can be used to make explicit our understanding of system and program component linkages, and associated uncertainties
- System uncertainties can be expressed as alternative models, which can be evaluated with monitoring data
- Models can help identify high priority data needs for decision-making
- An SDM-based DSS will increase decision-making transparency and enhance learning and communications

Appendix G: Pre-Workshop Assignment Summary Spreadsheet

Number	# purpose objectives	Objective	Purpose Objectives																														Number	Objective	# means objectives
			3	10		2	14			3	4	12	5	2	3	5	2		2	2	11	2	6												
A1	21	Frequently exceed channel migration, bed mobilization, and bed scour thresholds	B1	B3	B4	B5	B8	B9	B10	B11	B13	B14	B17	B19	B20	B21	B23	B25	B26	B27	B28	B30	B31										B1	Increase freshwater production of anadromous fish	48
			12	5	8	10	9		3	4	7	11	4	10																					
A2	12	Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River	B1	B5	B9	B11	B13	B17	B20	B21	B23	B26	B27	B30																			B2	Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish	9
			5	2	3	3	3	4	5	4	13	3	7	5	4		3		8																
A3	18	Transport fine sediment through mainstem at a rate greater than tributary input	B1	B3	B5	B8	B9	B11	B13	B14	B17	B20	B21	B22	B23	B24	B27	B28	B30	B31													B3	Increase physical habitat diversity and availability	34
			4	12	4	2	13		2	3	8	3		2	4	2	2	2	9	4	3														
A4	19	Encourage bed-level fluctuations on annual to multi-year time scales	B1	B3	B4	B5	B8	B9	B11	B13	B14	B17	B19	B20	B21	B23	B26	B27	B28	B30	B31												B4	Increase and maintain coarse sediment storage	27
			9		8		6	2	7	9	8		7	10		8		5		10															
A5	18	Increase/maintain spawning habitat quantity and quality to 2,550,000 square feet in the upper 40 miles of the mainstem Trinity River	B1	B2	B3	B4	B5	B8	B9	B11	B13	B17	B20	B21	B22	B23	B26	B27	B28	B30													B5	Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	28
					3				5					6	5		2																		
A6	16	Minimize temperature impacts to other native fish habitats	B1	B5	B7	B9	B11	B13	B16	B19	B20	B21	B23	B24	B26	B27	B30	B31															B6	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (FYLF)	5
			3	11	4	2	12			4	3	5	3		6	6	3			3	6	2	2												
A7	21	Increase channel/thalweg sinuosity	B1	B3	B4	B5	B8	B9	B10	B11	B13	B14	B17	B19	B20	B21	B23	B24	B26	B27	B28	B30	B31										B7	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	12
			6	5																															
A8	2	Increase harvest of naturally produced spring-run Chinook salmon adults	B13	B23																													B8	Create and maintain spatially complex channel morphology	25
			4	9	7	2	12	2	4	4	3	4		4	6		3			2	9	4													
A9	21	Route coarse sediment through all reaches	B1	B3	B4	B5	B8	B9	B11	B13	B14	B17	B19	B20	B21	B22	B23	B24	B26	B27	B28	B30	B31										B9	Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	23
			3	3		2	3	2	4	4	3	12	4	6	5	3		4		6	2														
A10	19	Reduce fine sediment supply from tributary watersheds	B1	B3	B4	B5	B8	B9	B11	B13	B14	B17	B20	B21	B22	B23	B24	B27	B28	B30	B31												B10	Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation	5
			4			7	4	10																											
A11	8	Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults	B1	B2	B3	B9	B11	B13	B23	B30																							B11	Restore and maintain natural production of anadromous fish populations	23
			11		6	6	11	9		4	5	5	2	7	6	4																			
A12	14	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	B1	B3	B5	B9	B11	B13	B16	B20	B21	B23	B24	B26	B27	B30																	B12	Increase population size, survival, distribution, and recruitment success of Western Pond Turtle (WPT)	7
			5	3	5			9																											
A13	6	Increase escapement of Pacific lamprey adults	B1	B11	B13	B14	B21	B24																									B13	Restore adult anadromous fish numbers to pre-Trinity River Dam levels in order to facilitate dependent tribal, commercial, and sport fisheries full participation in the benefits of restoration via enhanced harvest opportunities	32
			2	6		11	6	3																											
A14	6	Increase structural and thermal diversity of aquatic habitats used by various age classes of Western Pond Turtles	B3	B7	B8	B12	B25	B31																									B14	Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality	17
			3				2			2	2		4						4																
A15	21	Minimize physical impacts to other native fish habitats	B1	B3	B4	B5	B7	B8	B9	B11	B13	B14	B16	B17	B19	B20	B21	B23	B24	B26	B27	B30	B31										B15	Maintain Trinity River riverine bird populations and species diversity in the Program area	6
			7		5	4	5	6	2	4	2	2		3		2	9	2		4															
A16	18	Increase and maintain macroinvertebrate populations	B1	B2	B5	B6	B9	B11	B12	B13	B15	B16	B17	B18	B20	B21	B22	B23	B24	B27													B16	Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	23
			6	12	5	4	5	2			5	5																							
A17	10	Limit impacts of hatchery fish predation on naturally produced juvenile salmonids to less than 20% over the 40 miles	B1	B2	B5	B9	B11	B13	B20	B21	B23	B27																					B17	Reduce fine sediment storage in the mainstem Trinity River	12
			7	4		6																													
A18	5	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs	B6	B7	B19	B25	B31																										B18	Maintain Trinity populations and species diversity of birds using the riparian zone in the Program area	4
			2	9	2	2		7	3	2	3		4	3			8	4	5		3		2	3	2		9								
A19	25	Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD	B1	B3	B4	B5	B7	B8	B9	B10	B11	B12	B13	B14	B15	B18	B19	B20	B21	B22	B23	B25	B26	B27	B28	B29	B31						B19	Establish and maintain riparian vegetation that supports fish and wildlife	10
			4	5	8	7																													
A20	4	Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults	B1	B11	B13	B23																											B20	Increase and maintain salmonid habitat availability for all freshwater (in-river and tributary) life stages	25
			4	4	2	4	3	4	5	6	3	7	7	6		4																			

A21	14	Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B26	B27												B21	Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals	22
			2	8			9			2	2	3	2					2	2											
A22	17	Increase geomorphic unit and substrate patch diversity	B1	B3	B4	B5	B8	B9	B11	B13	B17	B20	B21	B22	B23	B26	B27	B28	B30									B22	Enhance or maintain food availability for fry and juvenile salmonids	5
			3		4																								
A23	3	Increase harvest of naturally produced coho adult salmon adults	B5	B11	B13																							B23	Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	21
			9		7	6	6	10		5		2	6																
A24	12	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	B1	B2	B5	B9	B11	B13	B20	B23	B24	B26	B27	B29														B24	Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	15
			5	4																									
A25	2	Increase harvest of naturally produced steelhead adults	B13	B27																								B25	Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation	9
			4		3	4	4		3		4	4	2	3	2	3	4	2	3	2	3	3	3		3		4			
A26	25	Discourage invasive species	B1	B3	B5	B6	B7	B8	B9	B10	B11	B13	B14	B15	B16	B18	B19	B20	B21	B22	B23	B24	B25	B26	B27	B30	B31	B26	Improve riverine thermal conditions for growth and survival of natural anadromous salmonids	14
			4	11	8	3	9	3	3	4				3	3		3		3	6	2								
A27	19	Increase and maintain target coarse sediment transport rates	B1	B3	B4	B5	B8	B9	B11	B13	B14	B16	B17	B20	B21	B22	B23	B26	B27	B28	B30							B27	Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	21
			9	2		6		6	7	9		3	3		5		5												
A28	16	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	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B22	B23	B26	B27	B30										B28	Increase coarse sediment transport and channel dynamics	14
			5		3	7		2	6	4	8	8			6														
A29	13	Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat	B3	B6	B7	B10	B12	B14	B15	B18	B19	B25	B26	B29	B31													B29	Minimize impacts of riverine bird predation on fry and smolts	4
			6	7	2		5		5	5	6		2		4	5													
A30	15	Increase proportion of Natural Influence (pNI) to 0.7 or greater	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B30											B30	Increase spawning, incubation and emergence success of anadromous spawners	23
			5	9	2	3		11	3	5		4		2	3	4		3			3	2							
A31	22	Increase bars, side-channels, alcoves, and other complex alluvial features	B1	B3	B4	B5	B6	B8	B9	B11	B12	B13	B14	B16	B20	B21	B22	B23	B25	B26	B27	B28	B30	B31				B31	Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high quality aquatic and terrestrial habitat	15
					3		8	5																					
A32	7	Increase recruitment of younger age classes of Western Pond Turtles	B3	B6	B7	B8	B12	B25	B31																					
			4	7			2		3	3	3				3	3	7												
A33	15	Adapt timing of hatchery release to alter distribution of avian predators and minimize predation on natural fry and smolts	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B29													
			8			7		6	6	7	2	3	4	6		7	5		3										
A34	17	Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B24	B26	B27	B28	B30											
			7	2	8	5	5	5	7	5		5																	
A35	9	Provide optimal temperatures to improve spawning success of spring and fall-run Chinook salmon	B1	B5	B9	B11	B13	B21	B23	B26	B27	B30																		
			3	6		2		8	2		2	4	7			2	2	3		2		2			6					
A36	23	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	B1	B3	B4	B5	B7	B8	B9	B10	B11	B13	B14	B16	B17	B19	B20	B21	B22	B23	B26	B27	B28	B30	B31					
			3	9		5																							
A37	4	Increase escapement of naturally produced coho salmon to 1,400 adults	B1	B5	B11	B13																								
			7	4			5		5	8	5		2	4	5	4													
A38	16	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	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B28	B30												
			10				6		6	8	7			2	6	5													
A39	15	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	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B30													
			7	3		6	2	6	6	8		3	3	6	5		4												

A40	15	Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B28	B30										
			2	4		5	7	2	7	3																	
A41	8	Enhance quality and maintain quantity of riparian bird nesting and foraging habitats	B3	B7	B12	B15	B18	B19	B25	B31																	
			9	4		6	3	6	7	8		4	5	6	5	2	2										
A42	15	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	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B28	B30										
			8		5		5	2	5	5	7			4	4		5				6		2				
A43	21	Maintain or increase tributary habitat	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B17	B20	B21	B22	B23	B24	B25	B26	B27	B28	B30				
			3			2			9																		
A44	7	Minimize physical impacts to lamprey habitat	B1	B3	B11	B13	B20	B21	B24																		
			7	5		3	5	4	3	4	4		5	2	3		3	8	2	5	2	3	5		3		9
A45	23	Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife	B1	B3	B4	B5	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B18	B19	B20	B21	B22	B23	B25	B26	B27	B30	B31
				2	4																						
A46	3	Increase harvest of green sturgeon adults	B1	B13	B16																						
					3	2	3			7	4	5	7	4													
A47	12	Enhance quality and maintain quantity of riverine bird nesting and foraging habitats	B1	B3	B7	B8	B10	B13	B14	B15	B18	B19	B25	B31													
			4	7					6																		
A48	7	Increase escapement of naturally produced steelhead to 40,000 adults	B1	B13	B15	B18	B19	B25	B27																		
			7	3		4		5	6	6		2	4	5	6	4											
A49	14	Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B30											
			11			4		4	9	6	2		3	4		3											
A50	15	Reduce clinical disease incidence in Trinity	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B24	B27	B30										
			2	3	2		4	2	9	2	2		5		7				2		2		7				
A51	21	Encourage fine sediment deposition on floodplains	B1	B3	B5	B7	B8	B9	B10	B11	B13	B15	B17	B18	B19	B20	B21	B22	B23	B25	B27	B28	B31				
			9	2		4		2	4	8	5			4	4	4	3										
A52	17	Create channel form that reduces loss of	B1	B3	B4	B5	B7	B8	B9	B11	B13	B14	B16	B20	B21	B23	B27	B29	B30								
			9	2		4		2	4	8	5			3	4	4	4										
A53	17	Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes	B1	B3	B4	B5	B7	B8	B9	B11	B13	B14	B16	B20	B21	B23	B27	B29	B30								
			2		5	8																					
A54	5	Increase escapement of green sturgeon adults	B1	B11	B13	B16	B24																				
			2	10	3			5																			
A55	5	Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs	B3	B6	B7	B15	B19	B25																			
				3	4																						
A56	3	Increase harvest of naturally produced fall-run Chinook salmon adults	B1	B9	B13																						
				4	4																						
A57	3	Increase harvest of Pacific lamprey adults	B1	B13	B24																						
			2	9	3		11		2	2	2	4	4			2		2	3								
A58	17	Increase the size, frequency and topographic relief of bar/pool sequences	B1	B3	B4	B5	B8	B9	B11	B13	B14	B20	B21	B22	B23	B26	B27	B28	B30								
				3	7	3																					
A59	5	Increase population size, survival, distribution, and recruitment success of Western Pond Turtles	B3	B7	B12	B25	B31																				

Number	# purpose objectives	Objective	Purpose Objectives																														Number	Objective	# means objectives
			3	10		2	14			3	4	12	5	2	3	5	2		2	2	11	2	6												
A1	21	Frequently exceed channel migration, bed mobilization, and bed scour thresholds	B1	B3	B4	B5	B8	B9	B10	B11	B13	B14	B17	B19	B20	B21	B23	B25	B26	B27	B28	B30	B31										B1	Increase freshwater production of anadromous fish	48
			12	5	8	10	9		3	4	7	11	4	10																					
A2	12	Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River	B1	B5	B9	B11	B13	B17	B20	B21	B23	B26	B27	B30																			B2	Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish	9
			5	2	3	3	3	4	5	4	13	3	7	5	4		3		8																
A3	18	Transport fine sediment through mainstem at a rate greater than tributary input	B1	B3	B5	B8	B9	B11	B13	B14	B17	B20	B21	B22	B23	B24	B27	B28	B30	B31													B3	Increase physical habitat diversity and availability	34
			4	12	4	2	13		2	3	8	3		2	4	2	2	2	9	4	3														
A4	19	Encourage bed-level fluctuations on annual to multi-year time scales	B1	B3	B4	B5	B8	B9	B11	B13	B14	B17	B19	B20	B21	B23	B26	B27	B28	B30	B31												B4	Increase and maintain coarse sediment storage	27
			9		8		6	2	7	9	8		7	10		8		5		10															
A5	18	Increase/maintain spawning habitat quantity and quality to 2,550,000 square feet in the upper 40 miles of the mainstem Trinity River	B1	B2	B3	B4	B5	B8	B9	B11	B13	B17	B20	B21	B22	B23	B26	B27	B28	B30													B5	Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	28
					3				5					6	5		2																		
A6	16	Minimize temperature impacts to other native fish habitats	B1	B5	B7	B9	B11	B13	B16	B19	B20	B21	B23	B24	B26	B27	B30	B31															B6	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (FYLF)	5
			3	11	4	2	12			4	3	5	3		6	6	3			3	6	2	2												
A7	21	Increase channel/thalweg sinuosity	B1	B3	B4	B5	B8	B9	B10	B11	B13	B14	B17	B19	B20	B21	B23	B24	B26	B27	B28	B30	B31										B7	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	12
			6	5																															
A8	2	Increase harvest of naturally produced spring-run Chinook salmon adults	B13	B23																											B8	Create and maintain spatially complex channel morphology	25
			4	9	7	2	12	2	4	4	3	4		4	6		3			2	9	4													
A9	21	Route coarse sediment through all reaches	B1	B3	B4	B5	B8	B9	B11	B13	B14	B17	B19	B20	B21	B22	B23	B24	B26	B27	B28	B30	B31										B9	Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	23
			3	3		2	3	2	4	4	3	12	4	6	5	3		4		6	2														
A10	19	Reduce fine sediment supply from tributary watersheds	B1	B3	B4	B5	B8	B9	B11	B13	B14	B17	B20	B21	B22	B23	B24	B27	B28	B30	B31												B10	Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation	5
			4			7	4	10																									
A11	8	Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults	B1	B2	B3	B9	B11	B13	B23	B30																							B11	Restore and maintain natural production of anadromous fish populations	23
			11		6	6	11	9		4	5	5	2	7	6	4																			
A12	14	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	B1	B3	B5	B9	B11	B13	B16	B20	B21	B23	B24	B26	B27	B30																	B12	Increase population size, survival, distribution, and recruitment success of Western Pond Turtle (WPT)	7
			5	3	5			9																									
A13	6	Increase escapement of Pacific lamprey adults	B1	B11	B13	B14	B21	B24																									B13	Restore adult anadromous fish numbers to pre-Trinity River Dam levels in order to facilitate dependent tribal, commercial, and sport fisheries full participation in the benefits of restoration via enhanced harvest opportunities	32
			2	6		11	6	3																									
A14	6	Increase structural and thermal diversity of aquatic habitats used by various age classes of Western Pond Turtles	B3	B7	B8	B12	B25	B31																									B14	Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality	17
			3				2			2	2		4						4																
A15	21	Minimize physical impacts to other native fish habitats	B1	B3	B4	B5	B7	B8	B9	B11	B13	B14	B16	B17	B19	B20	B21	B23	B24	B26	B27	B30	B31										B15	Maintain Trinity River riverine bird populations and species diversity in the Program area	6
			7		5	4	5	6	2	4	2	2		3		2	9	2		4															
A16	18	Increase and maintain macroinvertebrate populations	B1	B2	B5	B6	B9	B11	B12	B13	B15	B16	B17	B18	B20	B21	B22	B23	B24	B27													B16	Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	23
			6	12	5	4	5	2			5	5																					
A17	10	Limit impacts of hatchery fish predation on naturally produced juvenile salmonids to less than 20% over the 40 miles	B1	B2	B5	B9	B11	B13	B20	B21	B23	B27																					B17	Reduce fine sediment storage in the mainstem Trinity River	12
			7	4		6																											
A18	5	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs	B6	B7	B19	B25	B31																										B18	Maintain Trinity populations and species diversity of birds using the riparian zone in the Program area	4
			2	9	2	2		7	3	2	3		4	3			8	4	5		3		2	3	2		9								
A19	25	Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD	B1	B3	B4	B5	B7	B8	B9	B10	B11	B12	B13	B14	B15	B18	B19	B20	B21	B22	B23	B25	B26	B27	B28	B29	B31						B19	Establish and maintain riparian vegetation that supports fish and wildlife	10
			4	5	8	7																											
A20	4	Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults	B1	B11	B13	B23																											B20	Increase and maintain salmonid habitat availability for all freshwater (in-river and tributary) life stages	25
			4	4	2	4	3	4	5	6	3	7	7	6		4																			

A21	14	Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B26	B27																
			2	8			9			2	2	3	2					2	2													
A22	17	Increase geomorphic unit and substrate patch diversity	B1	B3	B4	B5	B8	B9	B11	B13	B17	B20	B21	B22	B23	B26	B27	B28	B30													
			3		4																									
A23	3	Increase harvest of naturally produced coho adult salmon adults	B5	B11	B13																									
			9		7	6	6	10		5		2	6																			
A24	12	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	B1	B2	B5	B9	B11	B13	B20	B23	B24	B26	B27	B29																		
			5	4																										
A25	2	Increase harvest of naturally produced steelhead adults	B13	B27																										
			4		3	4	4		3		4	4	2	3	2	3	4	2	3	2	3	3	3		3		4					
A26	25	Discourage invasive species	B1	B3	B5	B6	B7	B8	B9	B10	B11	B13	B14	B15	B16	B18	B19	B20	B21	B22	B23	B24	B25	B26	B27	B30	B31					
			4	11	8	3	9	3	3	4				3	3		3		3	6	2											
A27	19	Increase and maintain target coarse sediment transport rates	B1	B3	B4	B5	B8	B9	B11	B13	B14	B16	B17	B20	B21	B22	B23	B26	B27	B28	B30											
			9	2		6		6	7	9		3	3		5		5															
A28	16	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	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B22	B23	B26	B27	B30														
			5		3	7		2	6	4	8	8			6																	
A29	13	Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat	B3	B6	B7	B10	B12	B14	B15	B18	B19	B25	B26	B29	B31																	
			6	7	2		5		5	5	6		2		4	5																
A30	15	Increase proportion of Natural Influence (pNI) to 0.7 or greater	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B30															
			5	9	2	3		11	3	5		4		2	3	4		3			3	2										
A31	22	Increase bars, side-channels, alcoves, and other complex alluvial features	B1	B3	B4	B5	B6	B8	B9	B11	B12	B13	B14	B16	B20	B21	B22	B23	B25	B26	B27	B28	B30	B31								
					3		8	5																						
A32	7	Increase recruitment of younger age classes of Western Pond Turtles	B3	B6	B7	B8	B12	B25	B31																							
			4	7			2		3	3	3				3	3	7															
A33	15	Adapt timing of hatchery release to alter distribution of avian predators and minimize predation on natural fry and smolts	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B29															
			8			7		6	6	7	2	3	4	6		7	5		3													
A34	17	Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B24	B26	B27	B28	B30													
			7	2	8	5	5	5	7	5		5																				
A35	9	Provide optimal temperatures to improve spawning success of spring and fall-run Chinook salmon	B1	B5	B9	B11	B13	B21	B23	B26	B27	B30																				
			3	6		2		8	2		2	4	7			2	2	3		2		2			6							
A36	23	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	B1	B3	B4	B5	B7	B8	B9	B10	B11	B13	B14	B16	B17	B19	B20	B21	B22	B23	B26	B27	B28	B30	B31							
			3	9		5																										
A37	4	Increase escapement of naturally produced coho salmon to 1,400 adults	B1	B5	B11	B13																										
			7	4			5		5	8	5		2	4	5	4																
A38	16	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	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B28	B30														
			10				6		6	8	7			2	6	5																
A39	15	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	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B30															
			7	3		6	2	6	6	8		3	3	6	5		4															

B21	Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals	22
B22	Enhance or maintain food availability for fry and juvenile salmonids	5
B23	Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	21
B24	Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	15
B25	Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation	9
B26	Improve riverine thermal conditions for growth and survival of natural anadromous salmonids	14
B27	Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	21
B28	Increase coarse sediment transport and channel dynamics	14
B29	Minimize impacts of riverine bird predation on fry and smolts	4
B30	Increase spawning, incubation and emergence success of anadromous spawners	23
B31	Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high quality aquatic and terrestrial habitat	15

A40	15	Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B28	B30															
			2	4		5	7	2	7	3																						
A41	8	Enhance quality and maintain quantity of riparian bird nesting and foraging habitats	B3	B7	B12	B15	B18	B19	B25	B31																						
			9	4		6	3	6	7	8		4	5	6	5	2	2															
A42	15	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	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B28	B30															
			8		5		5	2	5	5	7			4	4		5				6		2									
A43	21	Maintain or increase tributary habitat	B1	B2	B3	B4	B5	B8	B9	B11	B13	B16	B17	B20	B21	B22	B23	B24	B25	B26	B27	B28	B30									
			3			2			9																							
A44	7	Minimize physical impacts to lamprey habitat	B1	B3	B11	B13	B20	B21	B24																							
			7	5		3	5	4	3	4	4		5	2	3		3	8	2	5	2	3	5		3		9					
A45	23	Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife	B1	B3	B4	B5	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B18	B19	B20	B21	B22	B23	B25	B26	B27	B30	B31					
				2	4																											
A46	3	Increase harvest of green sturgeon adults	B1	B13	B16																											
					3	2	3			7	4	5	7	4																		
A47	12	Enhance quality and maintain quantity of riverine bird nesting and foraging habitats	B1	B3	B7	B8	B10	B13	B14	B15	B18	B19	B25	B31																		
			4	7					6																							
A48	7	Increase escapement of naturally produced steelhead to 40,000 adults	B1	B13	B15	B18	B19	B25	B27																							
			7	3		4		5	6	6		2	4	5	6	4																
A49	14	Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B27	B30																
			11			4		4	9	6	2		3	4		3																
A50	15	Reduce clinical disease incidence in Trinity	B1	B3	B4	B5	B8	B9	B11	B13	B16	B20	B21	B23	B24	B27	B30															
			2	3	2		4	2	9	2	2		5		7				2		2		7									
A51	21	Encourage fine sediment deposition on floodplains	B1	B3	B5	B7	B8	B9	B10	B11	B13	B15	B17	B18	B19	B20	B21	B22	B23	B25	B27	B28	B31									
			9	2		4		2	4	8	5			4	4	4	3															
A52	17	Create channel form that reduces loss of	B1	B3	B4	B5	B7	B8	B9	B11	B13	B14	B16	B20	B21	B23	B27	B29	B30													
			9	2		4		2	4	8	5			3	4	4	4															
A53	17	Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes	B1	B3	B4	B5	B7	B8	B9	B11	B13	B14	B16	B20	B21	B23	B27	B29	B30													
			2		5	8																										
A54	5	Increase escapement of green sturgeon adults	B1	B11	B13	B16	B24																									
			2	10	3			5																								
A55	5	Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs	B3	B6	B7	B15	B19	B25																								
				3	4																											
A56	3	Increase harvest of naturally produced fall-run Chinook salmon adults	B1	B9	B13																											
				4	4																											
A57	3	Increase harvest of Pacific lamprey adults	B1	B13	B24																											
			2	9	3		11		2	2	2	4	4			2		2	3													
A58	17	Increase the size, frequency and topographic relief of bar/pool sequences	B1	B3	B4	B5	B8	B9	B11	B13	B14	B20	B21	B22	B23	B26	B27	B28	B30													
				3	7	3																										
A59	5	Increase population size, survival, distribution, and recruitment success of Western Pond Turtles	B3	B7	B12	B25	B31																									

Number	Objective	Number	# means objectives	# pupose objectives
B1	Increase freshwater production of anadromous fish	B1	48	27
B3	Increase physical habitat diversity and availability	B3	34	36
B13	Restore adult anadromous fish numbers to pre-Trinity River Dam levels in order to facilitate dependent tribal, commercial, and sport fisheries full participation in the benefits of restoration via enhanced harvest opportunities	B13	32	23
B5	Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	B5	28	15
B4	Increase and maintain coarse sediment storage	B4	27	32
B8	Create and maintain spatially complex channel morphology	B8	25	43
B20	Increase and maintain salmonid habitat availability for all freshwater (in-river and tributary) life stages	B20	25	32
B9	Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	B9	23	7
B11	Restore and maintain natural production of anadromous fish populations	B11	23	22
B16	Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	B16	23	4
B30	Increase spawning, incubation and emergence success of anadromous spawners	B30	23	20
B21	Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals	B21	22	35
B23	Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	B23	21	5
B27	Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	B27	21	15
A8	Increase harvest of naturally produced spring-run Chinook salmon adults	A8	21	2
B14	Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality	B14	17	31
A43	Maintain or increase tributary habitat	A43	17	21
B24	Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	B24	15	3
B31	Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high quality aquatic and terrestrial habitat	B31	15	29
A11	Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults	A11	15	8
A20	Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults	A20	15	4
A46	Increase harvest of green sturgeon adults	A46	15	3
B26	Improve riverine thermal conditions for growth and survival of natural anadromous salmonids	B26	14	29
B28	Increase coarse sediment transport and channel dynamics	B28	14	15
A13	Increase escapement of Pacific lamprey adults	A13	14	6
A56	Increase harvest of naturally produced fall-run Chinook salmon adults	A56	14	3

Sorted by means objectives, highest to lowest

Highlighted the top 15 (with >= 20 means objectives)

A57	Increase harvest of Pacific lamprey adults	A57	14	3
A30	Increase proportion of Natural Influence (pNI) to 0.7 or greater	A30	13	15
A37	Increase escapement of naturally produced coho salmon to 1,400 adults	A37	13	4
A54	Increase escapement of green sturgeon adults	A54	13	5
B7	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	B7	12	27
B17	Reduce fine sediment storage in the mainstem Trinity River	B17	12	26
A48	Increase escapement of naturally produced steelhead to 40,000 adults	A48	12	7
A23	Increase harvest of naturally produced coho adult salmon adults	A23	11	3
A24	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	A24	11	12
A25	Increase harvest of naturally produced steelhead adults	A25	11	2
B19	Establish and maintain riparian vegetation that supports fish and wildlife	B19	10	49
B2	Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish	B2	9	21
B25	Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation	B25	9	9
A5	Increase/maintain spawning habitat quantity and quality to 2,550,000 square feet in the upper 40 miles of the mainstem Trinity River	A5	9	18
A42	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	A42	9	15
B12	Increase population size, survival, distribution, and recruitment success of Western Pond Turtle (WPT)	B12	7	2
A22	Increase geomorphic unit and substrate patch diversity	A22	7	17
A49	Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes	A49	7	14
B15	Maintain Trinity River riverine bird populations and species diversity in the Program area	B15	6	3
A16	Increase and maintain macroinvertebrate populations	A16	6	18
A19	Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD	A19	6	25
A28	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	A28	6	16
A34	Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon	A34	6	17
A39	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	A39	6	15
A53	Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes	A53	6	17
B6	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (FYLF)	B6	5	5
B10	Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation	B10	5	15
B22	Enhance or maintain food availability for fry and juvenile salmonids	B22	5	18
A7	Increase channel/thalweg sinuosity	A7	5	21

A12	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	A12	5	14
A14	Increase structural and thermal diversity of aquatic habitats used by various age classes of Western Pond Turtles	A14	5	6
A18	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs	A18	5	5
A29	Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat	A29	5	13
A35	Provide optimal temperatures to improve spawning success of spring and fall-run Chinook salmon	A35	5	9
A41	Enhance quality and maintain quantity of riparian bird nesting and foraging habitats	A41	5	8
A52	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	A52	5	17
A59	Increase population size, survival, distribution, and recruitment success of Western Pond Turtles	A59	5	5
B18	Maintain Trinity populations and species diversity of birds using the riparian zone in the Program area	B18	4	3
B29	Minimize impacts of riverine bird predation on fry and smolts	B29	4	13
A1	Frequently exceed channel migration, bed mobilization, and bed scour thresholds	A1	4	21
A6	Minimize temperature impacts to other native fish habitats	A6	4	16
A27	Increase and maintain target coarse sediment transport rates	A27	4	19
A31	Increase bars, side-channels, alcoves, and other complex alluvial features	A31	4	22
A45	Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife	A45	4	23
A55	Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs	A55	4	5
A58	Increase the size, frequency and topographic relief of bar/pool sequences	A58	4	17
A4	Encourage bed-level fluctuations on annual to multi-year time scales	A4	3	19
A9	Route coarse sediment through all reaches	A9	3	21
A17	Limit impacts of hatchery fish predation on naturally produced juvenile salmonids to less than 20% over the 40 miles	A17	3	10
A21	Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River	A21	3	14
A47	Enhance quality and maintain quantity of riverine bird nesting and foraging habitats	A47	3	12
A26	Discourage invasive species	A26	2	25
A32	Increase recruitment of younger age classes of Western Pond Turtles	A32	2	7
A36	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	A36	2	23
A51	Encourage fine sediment deposition on floodplains	A51	2	21
A2	Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River	A2	1	12
A3	Transport fine sediment through mainstem at a rate greater than tributary input	A3	1	18
A10	Reduce fine sediment supply from tributary watersheds	A10	1	19
A15	Minimize physical impacts to other native fish habitats	A15	1	21

A38	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	A38	1	16
A40	Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes	A40	1	15
A33	Adapt timing of hatchery release to alter distribution of avian predators and minimize predation on natural fry and smolts	A33	0	15
A44	Minimize physical impacts to lamprey habitat	A44	0	7
A50	Reduce clinical disease incidence in Trinity River origin outmigrants in the Klamath River to less than 20% within 5 years	A50	0	15

Number	Objective	# means objectives	# pupose objectives
A8	Increase harvest of naturally produced spring-run Chinook salmon adults	21	2
A25	Increase harvest of naturally produced steelhead adults	11	2
B12	Increase population size, survival, distribution, and recruitment success of Western Pond Turtle (WPT)	7	2
B24	Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	15	3
A46	Increase harvest of green sturgeon adults	15	3
A56	Increase harvest of naturally produced fall-run Chinook salmon adults	14	3
A57	Increase harvest of Pacific lamprey adults	14	3
A23	Increase harvest of naturally produced coho adult salmon adults	11	3
B15	Maintain Trinity River riverine bird populations and species diversity in the Program area	6	3
B18	Maintain Trinity populations and species diversity of birds using the riparian zone in the Program area	4	3
B16	Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	23	4
A20	Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults	15	4
A37	Increase escapement of naturally produced coho salmon to 1,400 adults	13	4
B23	Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	21	5
A54	Increase escapement of green sturgeon adults	13	5
B6	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (FYLF)	5	5
A18	Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs	5	5
A59	Increase population size, survival, distribution, and recruitment success of Western Pond Turtles	5	5
A55	Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs	4	5
A13	Increase escapement of Pacific lamprey adults	14	6
A14	Increase structural and thermal diversity of aquatic habitats used by various age classes of Western Pond Turtles	5	6
B9	Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	23	7
A48	Increase escapement of naturally produced steelhead to 40,000 adults	12	7
A32	Increase recruitment of younger age classes of Western Pond Turtles	2	7
A44	Minimize physical impacts to lamprey habitat	0	7
A11	Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults	15	8

Sorted by purpose objectives, lowest to highest

A41	Enhance quality and maintain quantity of riparian bird nesting and foraging habitats	5	8
B25	Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation	9	9
A35	Provide optimal temperatures to improve spawning success of spring and fall-run Chinook salmon	5	9
A17	Limit impacts of hatchery fish predation on naturally produced juvenile salmonids to less than 20% over the 40 miles	3	10
A24	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	11	12
A47	Enhance quality and maintain quantity of riverine bird nesting and foraging habitats	3	12
A2	Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River	1	12
A29	Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat	5	13
B29	Minimize impacts of riverine bird predation on fry and smolts	4	13
A49	Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes	7	14
A12	Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year)	5	14
A21	Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River	3	14
B5	Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	28	15
B27	Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity	21	15
B28	Increase coarse sediment transport and channel dynamics	14	15
A30	Increase proportion of Natural Influence (pNI) to 0.7 or greater	13	15
A42	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	9	15
A39	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	6	15
B10	Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation	5	15
A40	Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes	1	15
A33	Adapt timing of hatchery release to alter distribution of avian predators and minimize predation on natural fry and smolts	0	15
A50	Reduce clinical disease incidence in Trinity River origin outmigrants in the Klamath River to less than 20% within 5 years	0	15

A28	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	6	16
A6	Minimize temperature impacts to other native fish habitats	4	16
A38	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	1	16
A22	Increase geomorphic unit and substrate patch diversity	7	17
A34	Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon	6	17
A53	Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes	6	17
A52	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	5	17
A58	Increase the size, frequency and topographic relief of bar/pool sequences	4	17
A5	Increase/maintain spawning habitat quantity and quality to 2,550,000 square feet in the upper 40 miles of the mainstem Trinity River	9	18
A16	Increase and maintain macroinvertebrate populations	6	18
B22	Enhance or maintain food availability for fry and juvenile salmonids	5	18
A3	Transport fine sediment through mainstem at a rate greater than tributary input	1	18
A27	Increase and maintain target coarse sediment transport rates	4	19
A4	Encourage bed-level fluctuations on annual to multi-year time scales	3	19
A10	Reduce fine sediment supply from tributary watersheds	1	19
B30	Increase spawning, incubation and emergence success of anadromous spawners	23	20
A43	Maintain or increase tributary habitat	17	21
B2	Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish	9	21
A7	Increase channel/thalweg sinuosity	5	21
A1	Frequently exceed channel migration, bed mobilization, and bed scour thresholds	4	21
A9	Route coarse sediment through all reaches	3	21
A51	Encourage fine sediment deposition on floodplains	2	21
A15	Minimize physical impacts to other native fish habitats	1	21
B11	Restore and maintain natural production of anadromous fish populations	23	22
A31	Increase bars, side-channels, alcoves, and other complex alluvial features	4	22
B13	Restore adult anadromous fish numbers to pre-Trinity River Dam levels in order to facilitate dependent tribal, commercial, and sport fisheries full participation in the benefits of restoration via enhanced harvest opportunities	32	23
A45	Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife	4	23
A36	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	2	23
A19	Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD	6	25
A26	Discourage invasive species	2	25

B17	Reduce fine sediment storage in the mainstem Trinity River	12	26
B1	Increase freshwater production of anadromous fish	48	27
B7	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	12	27
B31	Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high quality aquatic and terrestrial habitat	15	29
B26	Improve riverine thermal conditions for growth and survival of natural anadromous salmonids	14	29
B14	Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality	17	31
B4	Increase and maintain coarse sediment storage	27	32
B20	Increase and maintain salmonid habitat availability for all freshwater (in-river and tributary) life stages	25	32
B21	Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals	22	35
B3	Increase physical habitat diversity and availability	34	36
B8	Create and maintain spatially complex channel morphology	25	43
B19	Establish and maintain riparian vegetation that supports fish and wildlife	10	49

Appendix H: Revised Objective Hierarchy based on Pre-Workshop Assignment

Objectives here are rearranged using the homework responses as a guide.

Everything in purple is Nicole's comments.

Numbers refer to the numbers from the homework exercise. Numbers in () are the primary (i.e., most popular) responses that indicate the PURPOSE of that objective. The underlined number following the () is the number of the objective itself.

- **FUNDAMENTAL OBJECTIVE 1 (WHAT AND WHY): FACILITATE HARVEST**
  - Restore adult anadromous fish numbers to pre-Trinity River Dam levels in order to facilitate dependent tribal, commercial, and sport fisheries full participation in the benefits of restoration via enhanced harvest opportunities (Fundamental) (A8, A23, A25, A46, A56) B13 (Fundamental; Facilitate Harvest) I think there is an additional implied sociopolitical objective here, for which increasing numbers of fish is a means objective. It might be good to separate those out for the sake of clarity.
    - NATURAL FISH POPULATIONS - restoring natural fish production will result in increased abundance and increase harvest opportunities. See below for the objectives for NATURAL FISH POPULATIONS.
    - Increase harvest of naturally produced spring-run Chinook salmon adults (B13, B23) A8
      - Increase escapement of naturally produced spring-run Chinook salmon to 6,000 adults (B1, B11, **B13, B23**) A20
      - Increase naturally produced spring-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity (A8, A20, B13) B23
    - Increase harvest of naturally produced fall-run Chinook salmon adults (B9, B13) A56
      - Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults (B1, B11, B9, **B13**) A11
      - Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity (A11, A56, B13) B9
    - Increase harvest of naturally produced coho adult salmon adults (B5, B13) A23
      - Increase naturally produced coho salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity (A23, A37, B13) B5
      - Increase escapement of naturally produced coho salmon to 1,400 adults (B1, **B5**, B13) A37
    - Increase harvest of naturally produced steelhead adults (B13, B27) A25
      - Increase escapement of naturally produced steelhead to 40,000 adults (B1, **B13, B27**) A48

    - Increase naturally produced steelhead adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity (A25, A48, B13) B27
  - Increase harvest of green sturgeon adults (B13, **B16**) A46
    - Increase escapement of green sturgeon adults (B13, **B16**) A54
    - Increase naturally produced green sturgeon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity (A46, A54, B13) B16
  - Increase harvest of Pacific lamprey adults (B13, B24) A57
    - Increase naturally produced Pacific lamprey adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity (A13, A57, B13) B24
    - Increase escapement of Pacific lamprey adults (B1, B13, **B24**) A13
  - **QUESTION: Is hatchery supplementation beneficial to harvest? If so, should hatchery releases be mentioned here? It sets up a conflict in the objectives between releasing hatchery fish for harvest but minimizing impacts on natural populations, but isn't that the reality?**

- **FUNDAMENTAL OBJECTIVE 2 (WHAT AND WHY): RESTORE AN ECOLOGICALLY FUNCTIONING RIVER SYSTEM need to develop wording for this objective to support the non-harvest related goals.**
  - NATURAL FISH POPULATIONS (to support fish numbers for harvest and also healthy natural fish populations for a naturally functioning river system)
    - Restore and maintain natural production of anadromous fish populations (A8, A11, A20, A23, A25, A37, A46, A48, A56, B13) B11 (Fundamental; Natural Fish Populations)
      - Increase freshwater production of anadromous fish (B13, Fundamental) B1 Is this distinction between B1 and B11 necessary?
        - Discourage invasive species (**B1**, B5, **B6, B7**, B9, A26, **B11, B13**, B15, B18, **B19**, B21, B23, B24, B25, B27) A26 Currently under "other wildlife." Consider rewording as an overarching "ecological health" objective, OR repeating a similar one for "natural fish populations" (could be inclusive of hatchery fish). THIS IS A REPEATED OBJECTIVE FROM OTHER WILDLIFE.
        - (Increase reproduction) Increase spawning, incubation and emergence success of anadromous spawners (A24, A39, B1, B11) B30
          - Provide optimal temperatures to improve spawning success of spring and fall-run Chinook salmon (**B1, B9**, B11, B13, B21, **B23**, B26, B30) A35
          - Optimize adult utilization of suitable spawning habitat areas in the mainstem within 3-4 brood cycles following rehabilitation of fluvial river processes (**B1**, B5, B9, **B11, B13**, B23, **B27,** B30) A49
          - Optimize adult utilization of suitable spawning habitat areas in tributaries within 3-4 brood cycles following rehabilitation of fluvial river processes (**B1**, B5, B9, B11, **B13**, B23, B27, B30) A40

- Increase growth - need to develop an overarching objective for this group
    - 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 (**B1**, B5, B9, B11, **B13**, B27) A24
        - Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year) (B1, B11) A12
    - Improve riverine thermal conditions for growth and survival of natural anadromous salmonids (A24, A28, A39, B1) B26
        - Improve thermal regimes for rearing growth and survival of juvenile steelhead, coho salmon and Chinook salmon (**B1, B5**, B9, B11, **B13**, B23, **B26**) A34
    - 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 (**B1**, B5, B9, B11, **B13**, B23, B27) A28
    - 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 (**B1**, B5, B9, **B11**, B13, B23, B27) A39
    - Enhance or maintain food availability for fry and juvenile salmonids (A24, A39, B1, B11) B22
        - Increase and maintain macroinvertebrate populations (B1, B11, **B22**) A16 This could be food or as a surrogate for water quality conditions, or both
- Increase survival - could separate into predation, competition, disease, food availability, and lethal habitat conditions (e.g. temperature, stranding)
    - Minimize impacts of riverine bird predation on fry and smolts (A24, A39, B1, B11) B29
        - Adapt timing of hatchery release to alter distribution of avian predators and minimize predation on natural fry and smolts (B1, **B2, B29**) A33
    - Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish (A8, A11, A20, A30, A48, B1, B13) B2 (repeated for survival)
        - Limit impacts of hatchery fish predation on naturally produced juvenile salmonids to less than 20% over the 40 miles (B2) A17
    - Reduce temperature related pre-spawning mortality and protect in-vivo egg viability of anadromous spawners in the mainstem Trinity River (B1, B11, B26, B30) A2

            - Reduce clinical disease incidence in Trinity River origin outmigrants in the Klamath River to less than 20% within 5 years (**B1, B11**, B13)A50
            - 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 (**B1**, B2, B5, B9, **B11**, B13, B23) A38
            - Reduce fry stranding in the upper 40 miles of the mainstem Trinity River by 50% following rehabilitation of fluvial river processes (**B1**, B5, B9, **B11**, B13, B21, B23, B27) A53
        - Preserve genetic integrity of natural fish - this is implied but need an inclusive objective statement.
            - Minimize impacts of predation, competition, and genetic interactions between and among hatchery and natural anadromous fish (A8, A11, A20, A30, A48, B1, B13) B2 (repeated for genetics)
            - Increase proportion of Natural Influence (pNI) to 0.7 or greater (**B1, B2**, B5, B9, B11, **B13**, B27) A30
        - Improve aquatic habitats to support fish reproduction, growth, and survival
            - Maintain appropriate thermal conditions within the river - objectives mentioning temperature are mostly in growth, survival, and reproduction. They are the "Why" but not the "How" - need to articulate the "How"
            - Maintain appropriate structural conditions within the river and on the floodplain.
- 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 (A18, A59, B18) B7 The subobjectives seem to go farther than just "minimize adverse impacts"
    - Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation (A18, A59, B3, B7, B8, B14) B25
    - Establish and maintain riparian vegetation that supports fish and wildlife (A12, A19, A29, A41, B13, B20) B19
        - Discourage invasive species (**B1**, B5, **B6, B7**, B9, A26, **B11, B13**, B15, B18, **B19**, B21, B23, B24, B25, B27) A26 Currently under "other wildlife." Consider rewording as an overarching "ecological health" objective, OR repeating a similar one for "natural fish populations" (could be inclusive of hatchery fish).
    - OTHER AQUATIC SPECIES
        - Minimize physical impacts to other native fish habitats (B1, B16, B24) A15 Minimize impacts, but there are also positive goals associated with "other species." This objective may not be necessary, or should be more clearly stated.
        - Minimize temperature impacts to other native fish habitats (B16, B24, B26) A6 too vague
        - Maintain Trinity River riverine bird populations and species diversity in the Program area (B25) B15

            - Enhance quality and maintain quantity of riverine bird nesting and foraging habitats (**B15**, B19, **B25**) A47
        - Increase population size, survival, distribution, and recruitment success of Western Pond Turtle (WPT) (A59, B25) B12
            - ~~Increase population size, survival, distribution, and recruitment success of Western Pond Turtles (B7, **B12**, B25) A59~~ Duplicate of B12
            - Increase recruitment of younger age classes of Western Pond Turtles (B7, **B12**, B25) A32
            - Increase structural and thermal diversity of aquatic habitats used by various age classes of Western Pond Turtles (B7, **B12**, B25) A14
    - RIPARIAN SPECIES
        - Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat (B3, B10, B15, **B19, B25**, B31) A29
            - Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic / riparian wildlife (**B1**, B3, B7, B13, **B19**, B21, B25, **B31**) A45 consider parsing this out by anadromous fish habitat, other aquatic species habitat, and riparian habitat
        - Maintain Trinity populations and species diversity of birds using the riparian zone in the Program area (B25) B18
            - Enhance quality and maintain quantity of riparian bird nesting and foraging habitats (B15, **B18, B25**) A41
        - Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (FYLF) (A18, A55, B7, B25) B6
            - ~~Increase population size, survival, distribution, and recruitment success of Foothill Yellow-legged Frogs (B6, B25) A18~~ Duplicate of B6
            - Increase quality and quantity of breeding and rearing habitat for Foothill Yellow-legged Frogs (**B6**, B25) A55

- **PHYSICAL HABITAT (THIS IS THE HOW: A Major means objective for restoring an ecologically functioning river)**
    - Increase physical habitat diversity and availability (A42, B1, B11, B20) B3
        - Increase and maintain salmonid habitat availability for all freshwater (in-river and tributary) life stages (A8, A11, A20, A23, A25, A37, A54, A56, B1, B11, B13) B20
        - Increase/improve habitats for freshwater life stages of anadromous fish to the extent necessary to meet or exceed production goals (A8, A11, A20, A37, A46, A48, A54, B11, B13) B21 This seems redundant with the harvest and natural production objectives and B20 above
            - 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 (**B1**, B5, B9, B11, **B13**, B21, B23, B27) A42
            - Increase/maintain spawning habitat quantity and quality to 2,550,000 square feet in the upper 40 miles of the mainstem Trinity River (B1, B21, B30)A5

  - Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River (B13, **B20, B21**, B23) A21
  - 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 (**B1,** B5, B9**, B11**, B13, B20, B21, B23) A52
  - Maintain or increase tributary habitat (**B1**, B3, B9, B1, **B13**, B23, **B27**) A43
  - Minimize physical impacts to lamprey habitat (B1, B13, **B24**) A44
  - Reduce fine sediment storage in the mainstem Trinity River (A5, A16, B30) B17
    - Transport fine sediment through mainstem at a rate greater than tributary input (B17) A3
    - Reduce fine sediment supply from tributary watersheds (B17) A10
- Create and maintain spatially complex channel morphology (A31, A58, B3) B8
  - Increase coarse sediment transport and channel dynamics (A4, A31, B3, B8) B28
    - Route coarse sediment through all reaches (B3, **B8**, B28) A9
  - Encourage bed-level fluctuations on annual to multi-year time scales (B3, B8) A4
  - Increase bars, side-channels, alcoves, and other complex alluvial features (B1, **B3, B8**, B11) A31
    - Increase and maintain coarse sediment storage (A4, **A31**, B3, B8) B4
  - Increase channel/thalweg sinuosity (B3, B8) A7
  - Increase geomorphic unit and substrate patch diversity (B3, B8) A22
  - Increase the size, frequency and topographic relief of bar/pool sequences (B3, **B8**) A58
  - Frequently exceed channel migration, bed mobilization, and bed scour thresholds (B3, B8, B14, B28) A1
  - Increase and maintain target coarse sediment transport rates (**B3**, B4, B8) A27
    - 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 (B3, **B8, B14**, B31) A36
  - Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high quality aquatic and terrestrial habitat (A29, A41, A47, B1, B8, B11) B31 Could duplicate for riparian and aquatic species or reword
    - Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality (A29, A31, B31) B14
    - Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD (**B3**, B8, B19, **B31**) A19
    - Recover riparian vegetation area equal or greater than disturbed by physical rehabilitation (A19, A29, A41, A45, A47, B19, B25, B31) B10

- Encourage fine sediment deposition on floodplains (**B10**, B17, B19, B31) <u>A51</u>

Appendix I: Klamath Objectives Hierarchy Presentation

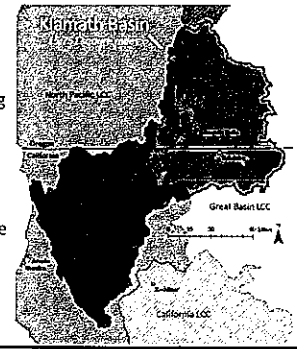
Developing Conservation Objectives for Landscape-scale Conservation in the Klamath River Watershed

Nicole Athearn

May22, 2013

Klamath Landscape Conservation Planning

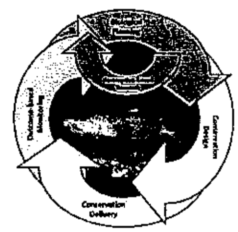
- Finite watershed with shared resource issues
- Recent history of working together internally and with partners
  - e.g., dam removal discussions
- Shared objectives and the beginnings of a "One Service in the Basin" approach



Landscape-level Concerns

- Degraded ecosystem function
- Need to manage for many species with competing needs
- Connections among land use, water quality/quantity, habitats, cultural values, economic prosperity
- Need for efficiency given limited funding and other resources (e.g., water); need to identify priorities

Developing a Conservation Strategy



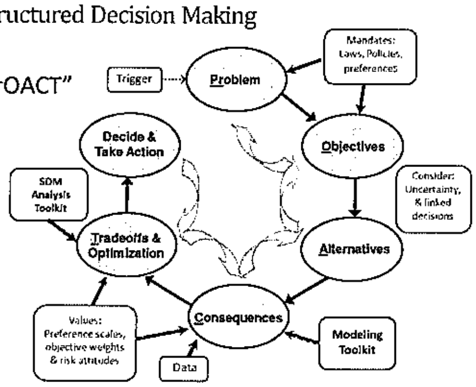
Problems:
1. Uncertainty
2. Time (not enough)
3. Money (not enough!)

Challenge:
To find a way to **maximize the benefits** of the work we do, while **minimizing costs** and **reducing uncertainty** so that future work is more effective

Connection to big-picture goals + landscape-level prioritization + adaptive management + partnerships =
SHC

Structured Decision Making

"PrOACT"



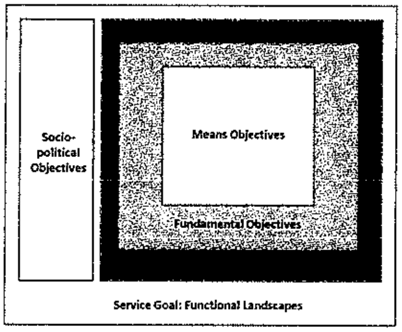
Service's Goal

For Landscape-scale Conservation

To characterize and maintain functional landscapes capable of supporting self-sustaining fish, wildlife, and plant populations.

Fundamental Objective:
Biological component of achieving functional landscapes in the Klamath River watershed.

Objectives – Clarifying Terms



Fundamental Objective	Means Level 1 Objective
Restore natural hydrologic processes and conditions	Achieve naturally functioning riverine communities Achieve naturally functioning riparian communities Restore natural hydrologic connectivity Restore natural stream flow Improve the quantity, quality, and distribution of wetland communities Reduce the hypereutrophic state of lentic systems in the upper Basin
Restore natural upland processes and conditions	Improve the quantity, quality, and distribution of forested upland communities Improve the quantity, quality, and distribution of non-forested upland communities Improve connectivity and distribution of habitats
Achieve viable populations of priority species by reducing the impacts of threats	Maintain genetic and life history diversity Improve population resiliency Improve priority populations' ability to resist perturbation Achieve sufficient population redundancy
Improve community resistance and resilience to long-term perturbations, particularly climate change, within identified priority habitats	Increase native biological diversity Achieve appropriate levels of habitat heterogeneity Preserve the roles of strongly-interacting species that influence community structure
Mitigate or reduce the impact of wide-reaching environmental stressors	Contaminants, climate change, and others

"Achieve Naturally Functioning Riverine Communities"

Objectives represent attaining desired conditions, such as:

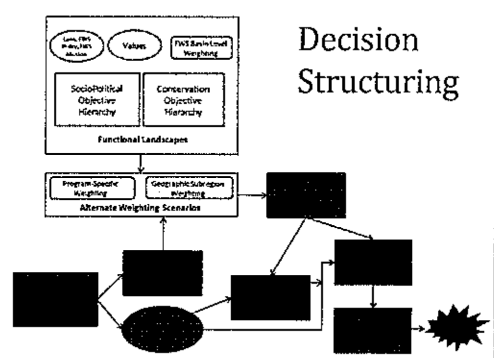
- High water and sediment quality
- Instream channel complexity (e.g., from large wood or boulders)
- Channel sinuosity and/or longitudinal complexity
- Reduced fine sediments in the channel substrate
- Presence of low-velocity side channels and pools
- Presence of channel bank cover, such as resulting from emergent aquatic vegetation or bank structural characteristics

Fundamental Objective	Means Level 1 Objective
Sustain or improve species resistance and resilience to stressors within the Klamath River watershed.	Conserve, restore, rehabilitate, and enhance hydrologic and other physical processes that provide conditions supporting self-sustaining populations of native species dependent on <u>natural and managed aquatic systems</u>. Conserve, restore, rehabilitate, and enhance physical processes that provide conditions supporting self-sustaining populations of native species dependent on <u>natural and managed upland systems</u>.
Reduce or eliminate stressors that contribute to the disruption of ecological processes within the Klamath River watershed.	e.g., disease, contaminants, invasive species, dams and other development, water cycle stressors including diversions
Reduce or eliminate stressors that directly contribute to the decline of, or hinder recovery efforts for, Federally listed, tribal trust, and public trust species within the Klamath River watershed.	e.g., listed species, migratory birds, anadromous fishes

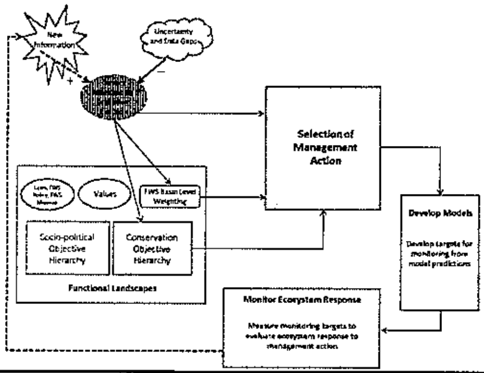
"Improve resilience to stressors"

- Conserve, restore, rehabilitate, and enhance hydrologic and other physical processes that provide conditions supporting self-sustaining populations of native species dependent on **instream (below bank full)** systems.
- Conserve, restore, rehabilitate, and enhance physical and biological processes that provide conditions supporting self-sustaining populations of native species dependent on **riparian** systems.
- For **wetland** systems:
  - Create **managed wetlands** to re-establish key ecological functions that support target and/or native wetland-dependent species in areas where hydrology has been modified beyond practical restoration potential.
  - Conserve, restore, rehabilitate, and enhance isolated **palustrine wetlands** where appropriate (based on historic presence) to re-establish physical and biological processes that provide conditions supporting self-sustaining populations of target and/or native wetland species assemblages.
- And so forth for lacustrine, spring, and estuarine systems.

Decision Structuring



Incorporating New Information



Thoughts

- Development of conservation and restoration objectives has broad implications for decision making, within or outside of a DSS
- Stated objectives lead to greater transparency and restoration effectiveness
- Inclusion of objectives does not imply preference or priority

Trinity River Restoration Program

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26 October 2018

To: TRRP Interdisciplinary Team and Technical Work Groups

From: Mike Dixon, Interdisciplinary Team Coordinator/Implementation Branch Chief

Subject: Guidance for objectives and refinements exercise

This memo is to provide guidance to work group coordinators and their respective work group members on refinement of programmatic means objectives and targets, and to provide consistency of this effort throughout the Program. The guidance provided in this memorandum was jointly developed by the IDT Coordinator/Implementation Branch Chief, Work Group Coordinators, Executive Director, and other Partner staff at the October 10, 2018 IDT meeting in Arcata.

Numerous objectives were identified in the Record of Decision (ROD) and the Integrated Assessment Plan (IAP), and work groups have been tasked with finalizing the refinement of those objectives to a manageable set that can be monitored by the Program to measure success toward meeting our overarching goals and fundamental objectives. Specifically, this memo provides definitions for the hierarchical categories used to organize objectives and targets, some specific instructions on decision making during refinement, and an example table that work groups are expected to complete and provide to the Science Coordinator and/or IDT at the completion of the metrics refinements task.

Means objectives are derived primarily from the ROD and the IAP, and the primary task of the work groups is to refine the complete set of those means objectives down to a manageable set that can be quantified and monitored with some regularity (e.g., annually) to measure progress. In addition, a target must be identified for each means objective that is retained at the end of this exercise, with a few exceptions. There are some objectives that were proposed in the ROD or the IAP that either can't be quantified in a meaningful way (i.e., a target cannot be identified) or the Program does not have management authority over actions that would affect progress toward meeting the objective. Work groups are instructed to take one of the following actions when presented with such an objective:

1. Omit the objective from further consideration by the Program.
2. Retain the objective, but flag it as one that the Program does not measure or use to infer progress toward success.

Definitions

Overarching Goal: This is the single unifying primary goal that the Program is founded upon. The goal, as stated below, was agreed upon at the Objectives Workshop in May 2013, and is not currently up for reconsideration or redefining.

> "Restore and sustain natural production of adult 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. The TRRP strategy for accomplishing this goal restores and perpetually maintains fish and wildlife resources (including T&E species) by restoring the processes that produce a healthy alluvial river system."

Fundamental Objectives: These are the broadest objectives directly influenced by TRRP decisions, which can be viewed as ends in and of themselves. These should be concise and understandable. The two fundamental objectives stated below were agreed upon at the Objectives Workshop, and are not currently up for reconsideration or redefining.

1. Restore and sustain natural production of anadromous fish populations downstream of Lewiston dam to pre-dam levels.
2. Restore the processes and attributes of a healthy alluvial river system.

Means objectives: These represent way stations on the progress toward a fundamental objective. These must have a link to a management action to be included as a means objective.

Examples:

1. Increase naturally produced fall-run Chinook salmon adult production in the Trinity River Basin to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity.
2. Provide optimal temperatures to minimize pre-spawning mortality, protect in-vivo egg viability, and improve spawning success of spring and fall-run Chinook salmon.
3. Improve thermal regimes for outmigrant salmonid growth and survival (dependent on water year type).
4. Increase proportion of Natural Influence (pNI) used as a surrogate for genetic interactions, i.e., mixing of hatchery and natural fish.

Target: This is a measurable value or range of values demonstrating that a means objective has been met. **The target should include specifics for the duration, frequency, time of year, magnitude, and location, if they apply.**

Examples:

1. 62,000 adult fall-run Chinook salmon
2. 60 degrees F (July 1 to September 14), 56 degrees F (September 15 to September 30) at Douglas City
3. <62.6 degrees F (extremely wet, wet, and normal years), or <68 degrees F (dry and critically dry years) prior to July 9 at Weitchpec
4. pNI ≥ 0.50

Additional Guidelines

The purpose of this section is to provide some of the sideboards of the refinements of means objectives and targets task. It is important for work group members to remember that this task is not the end-all-be-all of objectives/targets defining, refining, adding, or removing. The effort is meant to reduce the current set of means objectives to a manageable set that eliminates redundancies and reflects the current understanding within the Program. It is also important to remember that any formal changes to objectives or targets are the purview of the TMC.

1. Objectives that are redundant should be combined—to the degree possible—or omitted, resulting in distinctly different means objectives at the completion of the task.
2. Objectives that are no longer relevant should be omitted, with documentation of the rationale and science supporting the omission.
3. New means objectives can be proposed, but must be distinctly different than already existing objectives. New objectives should be accompanied by a well-documented justification and must be directly related to a specific management action.
4. New targets should be identified and proposed for means objectives that are retained and for which appropriate targets have not yet been defined.
5. New targets can be proposed for objectives that already have quantifiable targets, if they are accompanied by sufficient science-based justification (whether empirical, modeling based, or from the literature). However, work group members should be aware of targets that are codified in law. If a work group achieves consensus on recommended changes to a target codified in law, the proposed change should be well-documented and presented to the TMC for consideration.
6. Work groups can change objectives, if scientifically-based justifications for a change are well-documented. If the changes simply add clarification in language or add specificity necessary to make an objective quantifiable, the level of documentation can be at the discretion of work group members.

Example table

The table below is meant to serve as a starting point for work groups to organize means objectives and targets, and to identify the management actions that affect them. Work groups are encouraged to add columns to the right of the "Management Action" column as they see fit. An example of an additional column that was discussed in a recent IDT meeting is "Data Sources," which was intended to identify the research or monitoring work that has been or is currently being implemented by the Program to inform a given objective. Note that the content in the table below is only provided as an example and has not yet been reviewed by work groups.

Means 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
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	flow management
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.	flow management
Increase proportion of Natural Influence (pNI) used as a surrogate for genetic interactions = mixing of hatchery and natural fish	pNI $\geq$ 0.5	channel rehabilitation, flow management (increase natural populations)

Trinity River Restoration Program

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January 12, 2021

VIA ELECTRONIC MAIL ONLY

Memorandum

To: James Lee
TRRP Science Coordinator

From: Ken Lindke
Environmental Scientist, CDFW
Fish Work Group Coordinator

Subject: Fish Work Group deliverable for Program objectives/targets refinements

The Fish Work Group reinitiated refinement of fish-related programmatic objectives and their associated targets at their 25 June 2018 meeting after a hiatus beginning sometime in 2014. Over the course of the 11 meetings held in that time work group members distilled the set of existing objectives and their associated targets, including consideration of those presented in the Integrated Assessment Plan, to the 14 objectives and 12 targets described herein. Two additional targets have been carried forward but need revision, and development of four additional targets have been deferred until a later date when additional information necessary for their completion is available. Three objectives were kept but are not recommended to be quantified to measure program success

The work group first distilled a large number 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. In a few cases existing objectives were combined into a single objective. A subgroup was formed for each target that did not already have a clearly defined quantifiable target. 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 memo 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.

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 exceed escapement objectives and facilitate expanded harvest opportunity	Increase escapement of naturally produced steelhead to 40,000 adults.	Channel rehabilitation, flow management, gravel augmentation, watershed restoration
	Harvest target is undefined.	
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

Objective	Target	Management Action
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
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

Objective	Target	Management Action
provide thermal regimes that promote growth and survival throughout the rearing and outmigration periods for native juvenile salmonids	Outmigration: current temp targets for Weitchpec, but need to be revisited	Flow management
	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	Current temp targets for Douglas City and North Fork, but need to be revisited	Flow management
Minimize competition and predation by hatchery smolts on wild fry and juveniles	Target remains undefined	

Notably, four 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 may 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.

Attachments

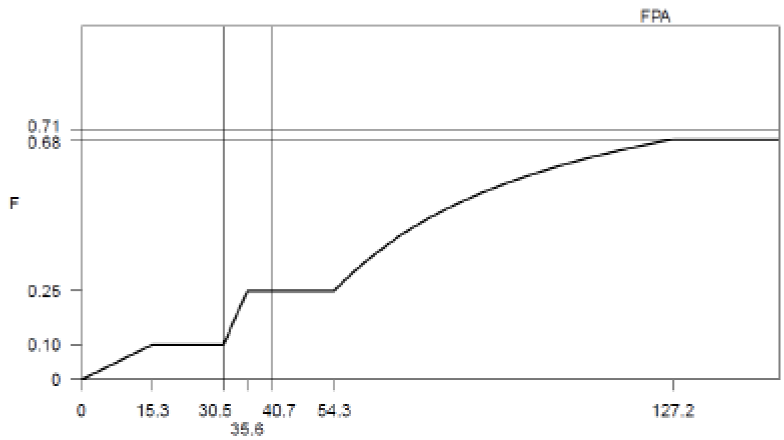
Fish Harvest Metric: fall Chinook Salmon harvest target
Spring Chinook Fish Harvest Target
Reduce Brown Trout population
Memo: Juvenile salmonid physical habitat target
Memo: Salmonid food production target recommendations
Memo: Juvenile salmonid temperature target recommendations
Memo: Compatibility of new juvenile rearing temperature range with existing adult temperature threshold

Fish Harvest Metric
Developed by the Fish Workgroup
Trinity River Restoration Program

The TRRP is seeking quantitative metrics from which to gauge program success. In the case of fully restored naturally produced fall Chinook, the TRRP recognizes an interannual spawner return of 62,000 adult naturally produced fish (ages 3, 4, and 5) after harvest impacts upon the maturing population. However, the complement of Trinity River naturally produced fish contributing to fisheries in advance of this spawning return to meet the TRRP harvest goal has not been quantified. Hence, this paper proposes an approach for deriving a numeric target for fishery contributions of Trinity River naturally produced fall Chinook in the restored condition.

The purpose of this metric is to measure progress towards achieving one of the TRRP's fundamental goals for restoring fish populations to pre-dam levels to enable tribal and non-tribal fisheries. The TRRP has embraced the annual return of 62,000 naturally produced and 9,000 hatchery produced adult fall Chinook as described in the 1983 Trinity EIS. These returns are presumed to be fish remaining AFTER exposure to marine and terminal fisheries or commonly referred to as the "escapement."

In contrast to the TRRP annual escapement goal of 62,000 naturally produced adult fall Chinook (TRRP escapement goal), both marine and river fisheries affecting Trinity AND Klamath fall Chinook are generally managed by the Pacific Fishery Management Council (PFMC) for an aggregate Klamath River Fall Chinook (KRFC) conservation standard for "natural area spawners" as defined by a control rule (Figure 1). While these fish may include individuals which themselves were progeny of fish spawning in the wild, this is not exclusively the case, and many of the natural area spawners may have been produced at either Trinity River Hatchery or Irongate Hatchery (Klamath River). The fraction of potential natural area spawners which are available for harvest in excess of conservation in any year are identified as the annual spawner reduction rate (SRR) which ranges from a maximum SRR of 68% to an SRR of 0% (no fishing). Maturing fish destined to either Trinity River Hatchery (TRH) or Irongate Hatchery (IGH, Klamath River) comingle with spawners destined to natural areas during their escapement migration.



Along with the conservation of natural area spawners in any year,

Figure 1. PFMC Control Rule for KRFC. Force of fishing mortality "F" (SRR) is plotted on mantissa and pre-exploited potential natural area spawner ocean abundance (ages 3, 4, and 5 KRFC) are plotted on abscissa. Note, at abundances where natural area escapement exceeds 127.2K, "F" asemtotes at 0.68. Abundances of KRFC in excess of this point could accommodate TRRP restoration goals for both escapement and harvest.

Uncertainty has been expressed by some within the TRRP over the compatibility of PFMC management and TRRP goals given the apparent computational differences in the PFMC control rule for managing natural area escapement and the TRRP escapement goal for naturally produced fish. However, at high stock size (which itself is a TRRP objective), the PFMC control rule fully accommodates the TRRP escapement goal. For example, at extremely high levels of abundance in the upper right quadrant of the PFMC control rule, where SRR reaches an asymptote (68% SRR), abundance of Trinity River naturally produced fall Chinook could conceivably exceed 62,000 after fishery exploitation.

Ignoring the fairly complex nature of Chinook maturation rates and interannual variation in the composition of the run of KRFC with respect to hatchery or natural origin fish, the minimum Trinity Natural Origin + Trinity River Hatchery (TRH) Origin Population to sustain "full-fishing" (SRR=0.68) AND the TRRP escapement objectives may be expressed as:

[(TRRP Escapement Goal for Trinity River Naturally Produced Fall Chinook + TRRP Escapement Goal for TRH Produced Fall Chinook) / (1-SRR)]; or

$$(1)\ P_{min} = (P_{nat} + P_{hat}) / (1 - SRR)$$

Where:

SRR = asymptotic force of fishing mortality (F) = annual spawner reduction rate = 0.68
P_{nat} *= Trinity River natural-origin population TRRP goal = 62,000*
P_{hat} *= TRH hatchery-origin population TRRP goal = 9,000*

Substituting current TRRP escapement objectives for TRH and Trinity River naturally produced fall Chinook into equation 1:

$$P_{min} = (62{,}000+9{,}000) \ / \ (1-0.68) \ = \mathbf{221{,}875} \text{ (pre-exploited population size).}$$

Combined terminal and ocean harvest of TRH and Trinity River natural origin potential spawners at full fishing (SRR=0.68) may be estimated as:

$$\textbf{(2)}\ H_F = SRR * P_{min}$$

Where:

HF = full marine + terminal harvest (with SRR = 0.68)

Using the pre-exploited population size derived above from current TRRP escapement goals, we have:

$$(0.68 \ * 221{,}875) \ = 150{,}875 \text{ (TRH and Trinity River natural origin adults)}$$

Total adults harvested may be further categorized into natural origin fish by applying the proportion natural fish from the EIS goals:

$$\textbf{(3)}\ H_{FN} = \textit{fishery natural adult harvest} = P_n * H_F$$

Where:

p_n = *Trinity River natural proportion* = $P_{nat} \ / \ (P_{nat} + P_{hat})$

Applying this natural proportion to the total harvest of BOTH TRH and Trinity River natural origin fall Chinook, yields the TARGET for Trinity River naturally produced adult fall Chinook contributing to fisheries at restored population levels:

$$((62{,}000/62{,}000+9{,}000)) \ \ * 150{,}875 \ = 131{,}750 \text{ (Trinity River naturally produced adults contributing to fisheries)}$$

This approach is simplistic in that it ignores contributions to marine fisheries of non-maturing Chinook and assumes hatchery/natural origin proportions to be consistent with TRRP goals. We also assume that proportions of natural vs. hatchery origin fall Chinook are consistent with TRRP goals for each (e.g. 62,000 natural/9,000 hatchery origin). However, the approach presents an alternative for identifying an interim numeric goal for fishery contributions of naturally produced fish complementary to the TRRP numeric escapement goal while aligning with contemporary fishery management implemented by PFMC. This approach ignores the complement of Klamath River fall Chinook of both hatchery and natural origin which would also contribute to fisheries and escapement.

Spring Chinook
Fish Harvest Target
Developed by the Fish Workgroup
Trinity River Restoration Program

The TRRP is seeking quantitative metrics from which to gauge program success. In the case of fully restored naturally-produced Spring Chinook, the TRRP recognizes an interannual spawner goal of 6,000 adult naturally-produced fish (ages 3, 4, and 5) after harvest impacts upon the maturing population. However, the complement of Trinity naturally-produced fish contributing to fisheries in advance of this spawning return or the TRRP "harvest goal" has not been quantified. Hence, this paper proposes an approach for deriving a numeric target for fishery contributions of Trinity naturally-produced spring Chinook in the restored condition.

The purpose of this target is to measure progress towards achieving one of the TRRP's fundamental goals for restoring fish populations to pre-dam levels to enable tribal and non-tribal fisheries. The TRRP has embraced the annual return of 6,000 naturally-produced and 3,000 Trinity River Hatchery (TRH)-produced adult spring Chinook as described in the 1983 Trinity EIS[1]. These returns are presumed to be fish remaining AFTER exposure to marine and terminal fisheries or commonly referred to as the "escapement."

Trinity naturally-produced spring Chinook are not subject to the same management rigor as fall Chinook originating from the Klamath Basin. However, this stock is "in the fishery" experiencing some distributional and temporal overlap with fall Chinook and therefore benefits from some of the protections provided under harvest rate management for Klamath River fall Chinook employed by the Pacific Fishery Management Council (PFMC) process[2]. A related paper has been prepared for the TRRP providing a more detailed discussion of the PFMC management process. Presently, there has not been an effort to identify stock recruit parameters for Klamath Basin spring Chinook as have been developed for the fall race. Hence, as a surrogate, we propose using the Spawner Reduction Rate (SRR) presently modeled for fall Chinook by PFMC for calculating the potential harvest of spring Chinook under a case of full exploitation. The provisional estimates presented here for Trinity naturally-produced spring Chinook may be refined when and if a more deliberate management control structure is developed for Klamath Basin spring Chinook under the PFMC.

In the case of fall Chinook management, the fraction of potential natural-area spawners which are available for harvest in excess of conservation in any year are identified as the annual spawner reduction rate (SRR) which ranges from a maximum SRR of 68% to an SRR of 0% (no fishing). At high stock size where SRR reaches an asymptote (68% SRR), the abundance of

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[1] U.S. Department of the Interior. 1983. Final Environmental Impact Statement for the Trinity River Basin Fish and Wildlife Management Program, Trinity River, Northwestern California. U.S. Fish and Wildlife, Lead Agency. Statement number: INT/FES 83-53 (DES 83-23). October 29, 1983. 58 pp.

[2] Pacific Fishery Management Council (PFMC). 2016. Pacific Coast Salmon Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the coasts of Washington, Oregon, and California as Amended through Amendment 19. PFMC, Portland, OR 91 pp.

Trinity naturally-produced spring Chinook could conceivably exceed 6,000 after fishery exploitation.

Ignoring the fairly complex nature of Chinook maturation rates and interannual variation in the composition of the run with respect to hatchery- or naturally-produced fish, the minimum Trinity naturally-produced + TRH-produced population to sustain "full-fishing" (SRR=0.68) and the TRRP escapement targets may be expressed as:

[(TRRP escapement target for Trinity naturally-produced spring Chinook + TRRP escapement target for TRH-produced spring Chinook) / (1-SRR)]; or

$$\textbf{(1)}\ P_{min} = (P_{nat} + P_{hat}) / (1 - SRR)$$

Where:

SRR = asymptotic force of fishing mortality (annual spawner reduction rate = 0.68)
P_{min} *= minimum population to sustain "full fishing" and meet TRRP goals*
P_{nat} *= Trinity naturally-produced population TRRP goal = 6,000*
P_{hat} *= TRH-produced population TRRP goal = 3,000*

Substituting current TRRP escapement targets for TRH- and Trinity naturally-produced spring Chinook into equation 1 yields the pre-exploited population size:

$$P_{min} = (6{,}000+3{,}000) / (1-0.68) = 28{,}125$$

Combined terminal and ocean harvest of TRH- and Trinity naturally-produced potential spawners at full fishing (SRR=0.68) may be estimated as:

$$\textbf{(2)}\ H_F = SRR * P_{min}$$

Where:

H_F *= full marine + terminal harvest (with SRR = 0.68)*

Using the pre-exploited population size derived from equation (1) and current TRRP escapement targets equation (2) yields the minimum harvest of combined TRH-and Trinity naturally-produced adults at full exploitation:

$$\textbf{(3)}\ H_F = 19{,}125$$

Total adults harvested may be further categorized into naturally-produced fish, H_{FN}, by applying the proportion natural fish (6,000/6000 + 3,000 = 0.67 naturally-produced fish) from the EIS targets to equation (3):

$$\textbf{(4)}\ H_{FN} = P_n * H_F$$

Where:

p_n *= Trinity natural proportion =* $P_{nat} / (P_{nat} + P_{hat})$

Applying this natural proportion to the combined harvest of both TRH- and Trinity naturally-produced spring Chinook, yields the target for Trinity naturally-produced adult spring Chinook contributing to fisheries at restored population levels:

(5) H_{FN} = *12,750 (Trinity naturally-produced adults contributing to fisheries)*

This approach is simplistic in that it ignores contributions to marine fisheries of non-maturing Chinook and assumes that the proportion of naturally-produced individuals to be consistent with TRRP goals for (i.e. p_n= 0.67). However, the approach presents an alternative for identifying an interim numeric target for fishery contributions of naturally-produced Trinity spring Chinook complementary to the TRRP numeric escapement goal for this stock while aligning with contemporary fishery management implemented by the PFMC. This approach ignores additional Klamath Basin naturally-produced spring Chinook (e.g. Salmon River) which would also contribute to Klamath Basin fisheries and escapement in addition to the Trinity naturally-produced fish.

Reduce Brown Trout population
Developed by the Fish Work Group
Trinity River Restoration Program

Means objective:
Reduce Brown Trout population to decrease predation on and competition with native naturally produced fish

A target to assess a reduction in the Brown Trout population on the Trinity River remains currently undefined. Proposed targets address dual concerns of predation and competition effects of Brown Trout on naturally produced fish.

Proposed targets:

- To address the effect of predation of Brown Trout on naturally produced fish, we propose a catch target of no more than 5 individuals over 35cm per season at Junction City weir and carcass survey combined.

  The 35cm break is derived from isotopic diet analysis within the Trinity River basin and literature on Brown Trout from other drainages. That size is the point where most of the Brown Trout population switches from a primarily invertebrate diet to a more piscivorous diet (Alvarez and Ward 2019, Jensen et al. 2012, Jonsson et al. 1999).

- To address the effect of competition between Brown Trout and naturally produced fish, we propose a catch target of fewer than 200 age 1+ Brown Trout (8cm<FL<15cm) at the North Fork screw trap between January 1 and August 31.

  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 North Fork 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:
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, California Department of Fish and Wildlife and 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.

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Trinity River Restoration Program

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June 5, 2020

VIA ELECTRONIC MAIL ONLY

Memorandum

To: Ken Lindke, CA Dept. of Fish and Wildlife
Fish Work Group Coordinator

From: Ken Lindke, CA Dept. of Fish and Wildlife
Fish Work Group Coordinator

Aaron Martin, Yurok Tribe Fisheries Program

Subject: Juvenile salmonid physical habitat target

Background

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. An objective explicitly for juvenile salmonid habitat first appeared in the Integrated Assessment Plan (TRRP and ESSA 2009): "increase the amount and improve the quality of rearing habitat available to native juvenile salmonids." Unfortunately, a metric or target was never developed to measure success toward meeting this objective. Herein we present for consideration a target that can be used to measure success toward meeting the Program objective within the environmental study limits of individual restoration sites.

Juvenile salmonid habitat can be defined in terms of three fundamental elements and their interactions: physical habitat (e.g., water depth, velocity and distance to cover), temperature, and food availability (TRRP and ESSA 2009). The Program does not currently have a habitat model that integrates these three fundamental elements or their interactions. The S3 model does include all three elements, but it is not a habitat model, per se, and assumes a fixed level of food availability. In the absence of an integrated habitat model, the fish work group has developed separate targets for each of the three fundamental elements to augment existing targets where available. Temperature targets for juvenile salmonid outmigration, measured at Weitchpec, were first established in USFWS and HVT (1999), and additional temperature targets for rearing juvenile salmonids in the restoration reach were recently developed. The fish work group also recently developed targets for food availability that uses the timing and magnitude of geomorphic flows as a surrogate for macroinvertebrate production. This memo proposes a restoration site-scale physical habitat target that could be used to measure success toward achieving restoration objectives at the 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.

Methods of estimating physical habitat used in the past and going forward

All studies to date on the long-term performance of rehabilitation sites have been based on physical measurements of juvenile salmonid habitats (see De Juilio et al. 2014, Goodman et al. 2016, Boyce et al. 2018, Boyce et al. 2020 in prep.). The Program has used other methods to quantify habitat using hydrodynamic models, including weighted usable area (WUA) and Capacity (Som et al. 2017), which appear in design reports and post-construction reports. The Fish Work Group recently recommended that juvenile salmonid physical habitat be estimated using Capacity in all TRRP work going forward, which is detailed in the meeting summary for 20 April 2020 and a memo from the fish work group to the TRRP Science Coordinator dated 9 May 2020. A habitat target should be based on the method used to estimate habitat, so this change in methods used by the program makes it difficult to apply the results of previous work to future planning. Specifically, it is uncertain how well the changes in habitat relative to pre-construction conditions as presented by De Julio et al. (2014), Boyce et al. (2018) and Boyce et al. (in prep.) translate to other measures of habitat such as Capacity. Unfortunately, this is the only empirical information available in the Trinity River for us to base our target on.

Evolution of channel rehabilitation sites in terms of maintaining physical habitat

Post-construction changes in habitat provided by Boyce et al. (in prep.) are the most useful for developing a new target because habitat change was quantified over a range of flows, generally from 300-2000 cfs, rather than just at summer (Boyce et al. 2018) or winter (De Juilio et al. 2014) baseflow. Boyce et al. (in prep.) demonstrated that habitat gains compared to pre-construction conditions, in terms of area under the curve (AUC) of the flow-to-habitat relationship, were generally high immediately after construction but diminished through time. Exceptions were Upper Bucktail Dark Gulch, where AUC habitat gains were more than 400% compared to post-construction conditions, and Lewiston Cableway, where AUC decreased nearly to pre-construction levels seven years post-construction. Lewiston Cableway can be considered a failure in terms of improving juvenile salmonid habitat in the long-term to achieve juvenile salmonid habitat objectives. Boyce et al. (in prep.) demonstrated that most sites maintained at least 80% of construction-related habitat gains several years post-construction.

De Julio et al. (2014), Boyce et al. (2018), and Boyce et al. (in prep.) have demonstrated that evolution of newly constructed sites in terms of juvenile physical habitat stabilizes fairly quickly. However, it is reasonable to expect that the highest peak flows provide the maximum potential for geomorphic site evolution, and that hydrologic conditions may not allow for high peak flows for several years after construction at some sites. Since implementation of the ROD, there has not been a 10-year period without a wet or extremely wet water year. Maximum flow releases that occur in these water year types result in the greatest geomorphic change. Consequently, we should expect most resettling of a constructed site to a "self-sustaining" condition to occur within 10 years.

Proposed new target

A restoration site-scale habitat target should account for the observed and consistent pattern that construction-related gains in habitat diminish over time, while also setting an acceptable level for that change in habitat availability. Successful restoration sites minimize that reduction over time, or, in best case scenarios increase habitat. We propose the following site-scale target:

> 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.

This target assumes that 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. By defining the target in terms of design conditions, as opposed to as-built conditions, the target also serves as a check on implementation of designs. If as-built conditions show less habitat gain than design conditions, this infers a failure of implementation or interpretation of the design. In this scenario, a target based on the design condition results in greater expectation for habitat gain than if the target were based on as-built conditions. Conversely, if as-built conditions show more habitat gain than the design condition, implementation exceeded design expectations and the site should be considered a success (i.e., meeting our targets and objectives). Because of the extensive and collaborative design process employed by the TRRP, including vetting at multiple levels, no design should be implemented that does not demonstrate a substantial and meaningful gain in juvenile salmonid habitat. It stands to reason then, that if implementation meets or exceeds design conditions, that site construction and the associated habitat gains should be considered a success. By defining the target over 10 years, we ensure that the site will experience maximum dam releases, and thus maximum geomorphic change that can be expected under managed flow releases. By defining the target to evaluate habitat gains from 300-3,500 cfs, we ensure the target covers nearly all the managed flows that are experienced by rearing juvenile salmonids. Dam releases in excess of 3,500 cfs only occur for a few days per year in most years and after the majority of juvenile salmonids have emigrated from the restoration reach.

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Trinity River Restoration Program

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TO: KEN LINDKE, FISH WORK GROUP COORDINATOR

FROM: KYLE DE JUILIO (YUROK TRIBE), STEVE GOUGH (UNITED STATES FISH AND WILDLIFE SERVICE), AND JUSTIN ALVAREZ (HOOPA TRIBE)

SUBJECT: **SALMONID FOOD PRODUCTION TARGET RECOMMENDATIONS**

DATE: OCTOBER 2020

Background

The TRRP was formed as a result of the 2000 Trinity River Record of Decision (ROD; DOI 2000). The ROD set in motion the implementation of a restoration strategy initially described in the Trinity River Flow Evaluation Final Report (TRFEFR; USFWS and HVT 1999) using three broad categories of management actions: 1) increased annual flow regimes and variable reservoir releases; 2) fine and coarse sediment management; and 3) mainstem channel reconstruction (mechanical channel rehabilitation). The TRRP established a partnership of Federal, State, County, and Tribal Governments to guide these management actions through an Adaptive Environmental Assessment and Management framework (AEAM). In 2009 an Integrated Assessment Plan was developed to prioritize the scientific investigations of the TRRP and set a course for AEAM. Freshwater salmonid habitat, described as limiting production in the TRFEFR (USFWS and HVT 1999), was established as one of six primary objectives (ESSA 2009). Fish habitat assessments described in the IAP are intended to

> *"quantify changes over time in the amount, distribution and quality of habitat, and improve our understanding of the linkages between river channel complexity, quantity of fish habitat, fish use of habitat and fish production. Linking assessments of habitat availability, food availability, temperature, and habitat potential to carrying capacity and production will enable the Program to predict whether fish production goals can be achieved."*

Specific recommended assessments include:

> *1)available habitat for different salmonid life-stages based on a combination of (a) suitability-based habitat mapping (SBHM) and (b) 2-Dimensional modeling of suitable habitat (to extend habitat estimates to other species, life-stages, flows and locations not captured by SBHM); 2) water temperatures at specific times within specific reaches in regard to TRFE temperature objectives for salmonids and evaluating these in the context*

of the desired biological response; and 3) food (macroinvertebrate) abundance and availability during key time periods for salmonids.

While the first two recommended studies have been incorporated as part of the TRRP's long-term monitoring, the third, centered on the timing, abundance, and availability of food has only begun to be investigated in 2018. Sub-workgroups of the TRRP Fish Workgroup have been formed and tasked with developing objectives and targets to identify a desired condition and measure progress of the program toward achieving that condition.

This is a continuation of the efforts of the TRRP workgroups to complete the tasks described in the IAP:

Re-rank assessments based on both temporal sequence (use decision tree) and dependence on results of other studies (contingent assessments)
Refinement of performance measures – Interim targets – to be revised as information and adaptive management moves forward

1. Identify which objectives may need TMC guidance prior to developing interim targets.
2. Utilize the Program workgroups (TMC Subcommittee Report 2004) as the forum for developing interim targets with the IAP SC tracking/managing efforts.

Provide short-term feedback to improve Program management actions by testing key hypotheses and reducing management uncertainties.

Proposed Objectives and Targets

Objectives should describe the desired condition or trend in general terms while targets will detail specifics of metrics, whether it be a threshold or trend. Each objective may have more than one target (IDT memo 2018). The target proposed herein falls under the IAP Objective:

Increase the amount and improve the quality of rearing habitat available to native juvenile salmonids

Annual Flow Releases

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 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). A prudent step to help refine and solidify targets would be to conduct studies to verify the processes determining BMI species composition documented on neighboring watersheds are occurring in the Trinity River.

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 (BMI) and salmonid life histories are influence 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. In recognition of this the below target is proposed.

Target 1. 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.

> *Target1.1* – 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 between 3 and 18 months prior to peak juvenile salmonid abundance are desirable in the absence of more recent disturbance.

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 would serve as a metric. A proportion of the longitudinal extent of the restoration reach applicable to each ranking (described in Table 1.) would be used to evaluate effectiveness of management at meeting the quantifiable target for longitudinal disturbance (≥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).

Table 1. Example of possible metric for matching scour disturbance to biota phenology. Time periods in the 2 columns on left are prior to April 1 or estimated peak juvenile salmonid abundance date of management year. Right hand column would be calculated using gage date or proposed hydrograph for water year (WY) in question.

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

Incorporation

This objectives and target may not necessarily stand alone. This information may offer guidance to the timing and frequency of geomorphic events, even though they are implemented for a different purpose. For example, scouring flow events have many purposes within the Program, such as geomorphic work and riparian scour. The proportion of area for this target may also be able to be refined or expanded to a 2 or 3-dimensional target using information from other work groups. The subgroup of the fish work group did not attempt to describe or estimate the area or depth of scour resulting from different flow magnitudes throughout the restoration reach. Incorporating this suggested target into other existing objectives and targets (e.g. riparian scour) may be more effective input or feedback to managers than having similar targets for multiple objectives which may conflict.

We hope that these draft objectives and targets are helpful in furthering the efforts to prioritize and implement AEAM.

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Trinity River Restoration Program

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TO: KEN LINDKE, FISH WORK GROUP COORDINATOR

FROM: SETH NAMAN (NOAA), KYLE DE JUILIO (YUROK TRIBE), AND KATHERINE OSBORNE (HOOPA TRIBE)

SUBJECT: **JUVENILE SALMONID TEMPERATURE TARGET RECOMMENDATIONS**

DATE: JANUARY, 2020

Background

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 1 (excluding the July 1-September 14 threshold). The temperature thresholds in Table 1 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. Currently, there are no water temperature objectives for the Upper Trinity River developed specifically for rearing salmonids. The current Trinity River temperature thresholds, developed for adult salmonids, were thought to be sufficient for rearing juvenile salmonids (USFWS and HVT 1999; Table 5.13), based on the information in Brett (1952).

Table 1. Water temperature thresholds for the upper Trinity River

	Temperature Thresholds (°F)	
Date	Douglas City (RM 93.8)	North Fork Trinity River (RM 72.4)
July 1 through Sept 14	60	-
Sept 15 through Sept 30	56	-
Oct 1 through Dec 31	-	56

The Trinity River Flow Evaluation (USFWS and HVT 1999) recommended temperature objectives for the Trinity River above the confluence with the Klamath River at Weitchpec juvenile salmonids migrants (Table 2). Temperature objectives vary annually based on the water year type (extremely wet, wet, normal, dry, and critically dry), the time of year, and target different salmonid species. The Trinity River Flow Evaluation established these temperature objectives by determining water temperature requirements of each salmonid species and grouped them together by optimal, marginal, and unsuitable thermal tolerances based on literature reviews by Zedonis and Newcomb (1997) (Table 2). The date for the temperature objective of each species was determined by calculating 80 percent emigration at the Willow Creek rotary screw trap site based on data from 1992 to 1995.

Table 2. Temperature thresholds for outmigration in the lower Trinity River from USFWS and HVT (1999).

Steelhead (May 22)	<55.4 °F in EW,W, N water years @ Weitchpec
	<59 °F in D, CD water years @ Weitchpec
Coho (June 4)	<59 °F in EW,W, N water years @ Weitchpec
	<62.6 °F in D, CD water years
Chinook (July 9)	<62.6 °F in EW,W, N water years
	<68 °F in D, CD water years

Though the water temperatures in Table 1 are called “objectives” in various TRRP documents such as USFWS and HVT (1999), they are more accurately thought of as thresholds because any water temperature between 32°F and those Table 1 would comply. Managing water temperatures in this manner does not account for the range of temperatures at which a particular stock of salmonids grows at a maximum rate, for a given amount of ration. This also contributes to biologist and managers approaching water temperature management from the perspective of “colder is better” because any water temperatures colder than the objectives are thought of as either sufficient or beneficial. This is an overly simplistic management scheme because cold water temperatures that fall below the optimal growth range also impair growth. In order to develop a new recommended rearing water temperature objective for rearing salmonids, we reviewed more recent studies as well as recent Trinity River water temperature data.

In summary, shortcomings of current water temperature thresholds have been identified relative to juvenile salmonid growth:

- Temperature targets in the Upper Trinity River were developed for holding adult Chinook Salmon, not for rearing juvenile salmonids.
- There are no temperature targets in the upper Trinity River for rearing juvenile salmonids
- Temperature targets are expressed as “less than” a certain value (threshold), so extremely cold water temperatures, which may not suit juvenile salmonid rearing or other ecological functions, comply with the target.
- Temperature targets for outmigrants are at Weitchpec, meaning the entire length of the Trinity River must always be colder than the targets, which may negatively affect fish growth and other ecological processes upstream of Weitchpec.
- Current temperature thresholds in the upper Trinity River do not relate to or tie into ecological processes like temperature patterns of tributaries, the potentially beneficial effects of temperature heterogeneity, invertebrate production, or fish growth and movement.

Other Ecological Considerations

In many regions throughout the US, a positive relationship between stream order and water temperature has been reported, unless the stream has a high baseflow index (Segura et al. 2015). This is likely a result of higher heat accumulation through the stream network for large basins, or the convergence of water and air temperatures as water travels downstream (Segura et al. 2015, and references therein). However, due to the constant releases from Lewiston Reservoir, as well as the current temperature thresholds imposed by regulatory processes, the mainstem Trinity River is now colder than most, if not all of the tributaries upstream of the North Fork Trinity River. For example, in 2017 (Extremely Wet) and 2018 (Critically Dry) the Rush Creek was often 10°C warmer than the mainstem Trinity River (Figure 1). The negative effects of this have been described by some authors (e.g. Wheeler et al 2014), but the consistently low water temperatures are assumed by most fisheries regulatory agencies to be either positive or at least not harmful. However this is a flawed assumption. For example, low water temperatures can mean slow metabolism and slower growth (Iwama and Tautz 1981; Railsback reducing the size at which smolts enter the sea, thereby lowering their survival rate. Additionally, smaller smolts have lower osmoregulatory capabilities, and generally lower freshwater survival.

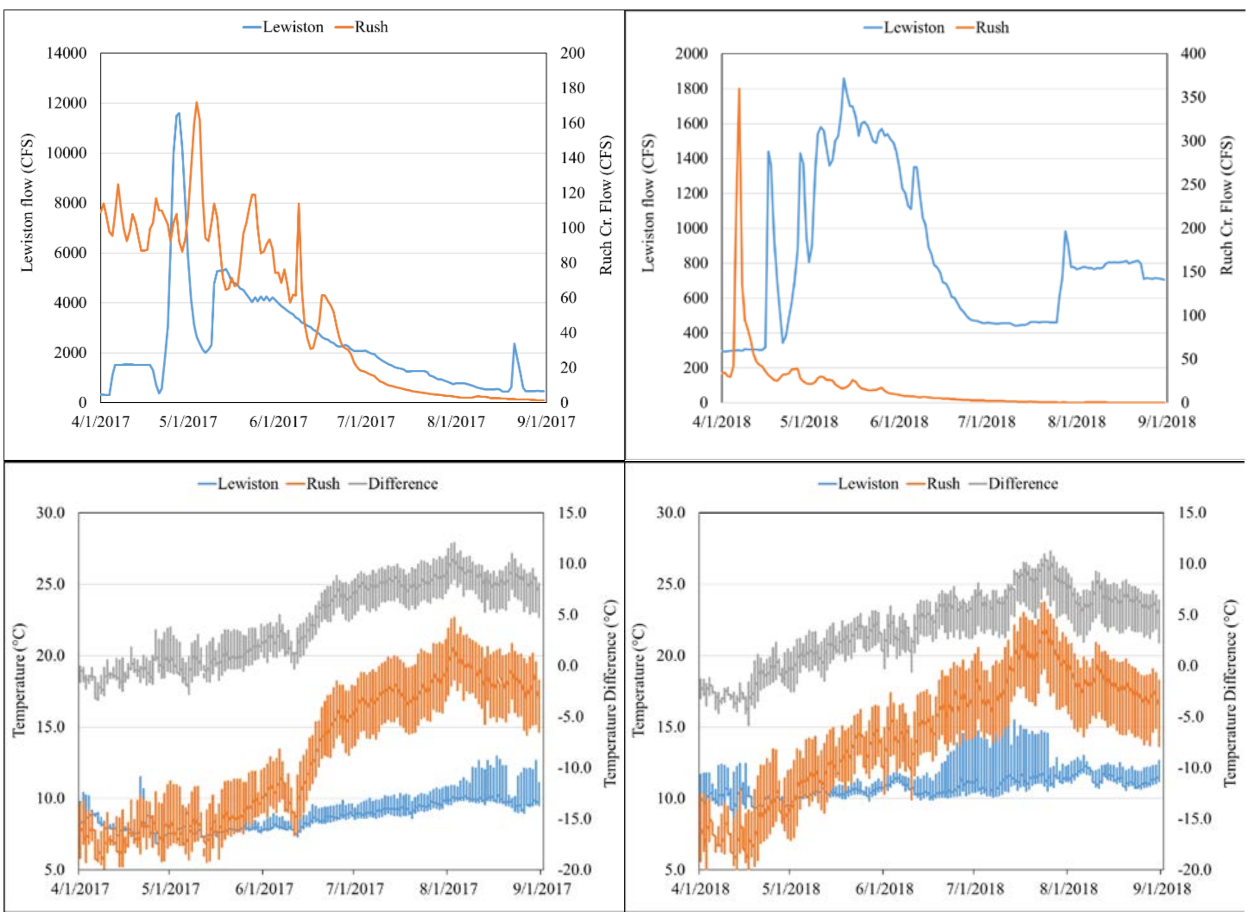

Figure 1. Discharge, water temperature, and temperature difference of the Trinity River at Lewiston and Rush Creek during the summer month of 2017 (ext. wet) and 2018 (crit. dry).

Not only has the flow regime of the Trinity River been fundamentally altered, the temperature regime has been dramatically changed as well (USFWS and HVT 1999). Little effort has been placed on understanding the ramifications the change in temperature regime has had on the invertebrate community or fish growth, behavior, migration and fitness, or other important ecological connections.

Alternatives to a Single Temperature Threshold

There are several alternatives to using a single daily average temperature threshold to monitor water temperatures in a river system. The 7 day average of the daily average (7DADA), 7-Day Average of the Daily Maximum (7DADM), Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWMT) are other metrics that could be employed to monitor water temperature objectives in the Trinity River. Additionally, these metrics have been more widely utilized other river systems in recent decades as managers have moved away from simplistic daily average thresholds. Monitoring water temperatures in these ways are also less sensitive to small daily violations, which may or may not be biologically meaningful.

MWMT is the highest seven-day average of the daily average temperature (Figure 2). In simple terms, it is the average temperature during the warmest seven-day period of the year (Asarian 2016). To calculate MWMT, first calculate maximum temperature for each day. Then calculate the 7-Day Average of the Daily Maximum (7DADM), which is calculated for each day as the average of the daily maximum temperature for the three prior days, the current day, and three following days. Finally, select highest 7DADM value of the year to obtain MWMT. A similar process is used to calculate MWAT, except daily average is used instead of daily maximum. Because there is a difference between chronic and acute temperature stress, and with the recognition that a single temperature threshold is insufficient to guide future temperature monitoring to meet fishery and restoration objectives, we recommend a range of values, using the 7 day average of the daily average (7DADA).

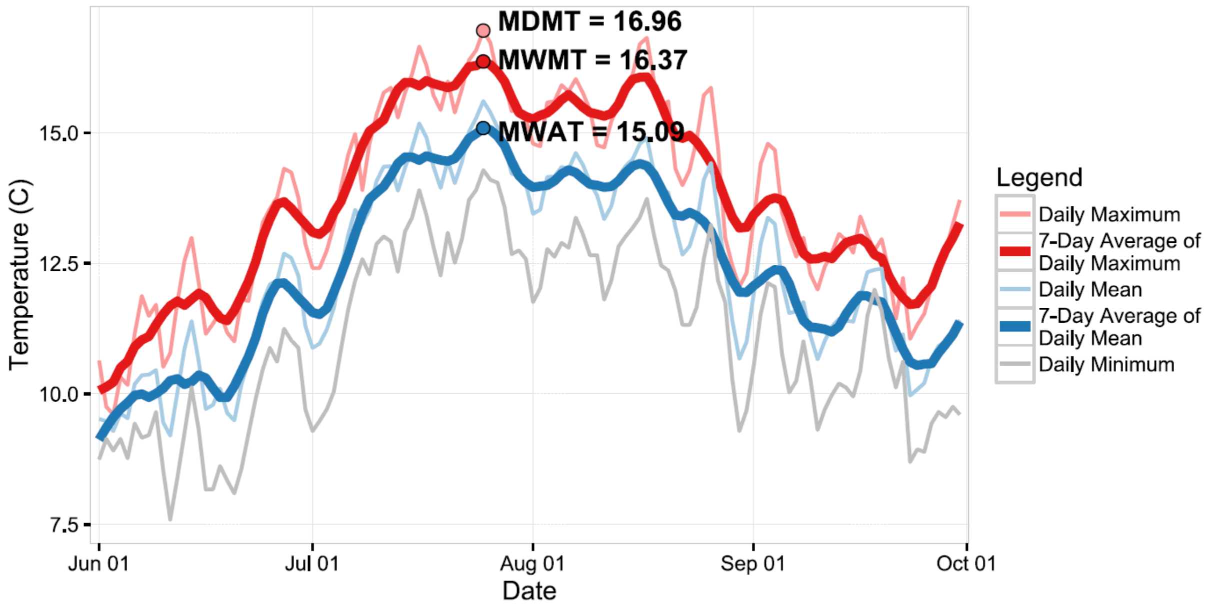

Figure 2. Comparison of daily average, daily maximum, daily minimum and MDMT, MWMT, MWAT, 7DADM, and 7DADA (Asarian 2016).

Literature Review

In order to make an informed recommendation on new temperature targets reviewed literature on rearing water temperatures for Coho Salmon which are the least temperature tolerant of the three salmonid species in the Trinity River. Our literature review was not exhaustive, but we believed it was necessary to update the information found in Brett (1952) and Konecki et al (1991) that has largely formed the basis of previous recommendations for juvenile salmon rearing temperatures, or Coho Salmon specifically.

Elsner and Shrimpton (2019) found a mean temperature preference of Fraser River B.C. Coho Salmon of 16.5°C for parr, and 15.5°C for smolts. Lusardi et al. (2019) found that Shasta River, California Coho salmon absolute growth rates peaked at a mean daily average water temperature of 16.6 ºC. It should also be noted in the study by Lusardi et al. (2019), the site with the highest growth rate also contained the greatest invertebrate biomass as this has bearing on the relationship between ration and water temperature. Results of water temperatures on salmonid growth in studies reviewed by Carter et al. (2005) are provided in Table 3. Sullivan et al. (2000) found that an MWMT of 13°C to 16.5°C would result in no more than a 10% reduction in maximum growth (Reviewed in Carter et al. 2005). Railsback and Rose (1999) found for rainbow trout that predicted growth varies with fish size and food consumption , but in general, their model predicted growth to be high between 10°C and 22°C, peaking at about 15°C (59°F).

Table 3. Salmonid growth chart based on literature reviewed by Carter (2005).

Salmonid Growth Chart	Negative Gowth Positive Growth Marginally Imparied Growth Maximum Growth																	
Species	Temperature (C^0) - MWAT																	
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Chinook - juvenile		///					//////			////				////	////	////	////	////
Coho - Juvenile		///					//////		////						////	////		
Steelhead Juvenile		///	///				//////			////						////	////	////
Species	Temperature (C^0) - MWMT																	
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Chinook - juvenile		///					//////				/////			////	////	////	////	////
Coho - Juvenile		///					//////		////					///	////	////		
Steelhead Juvenile		///	///				//////			////				////	////	////	////	////

Proposed Temperature Targets

Based on the results of the studies described above, we recommend utilizing a 7DADA of 13°C to 16.5°C (55.4°F to 61.7°F) as targets in the Trinity River upstream of the North Fork Trinity River from April 1 to July 31. Water temperatures outside of this range would considered as impairing growth of juvenile salmonids during the rearing period (Figure 3). The 7DADA would allow for daily tracking of the target but it would not be overly sensitive to small violations in water temperatures that occurs using a single daily average threshold, which may or may not be biologically meaningful. Also using a range of values, rather than a single threshold captures the true nature of optimal salmonid growth, which occurs in a range of temperatures, falling above or below which impairs optimal 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 most water year types, just as the Trinity River begins to achieve the recommended targets in the optimal rearing range for juvenile salmonids, there is a large reduction in temperatures of 5°F to 7°F that occurs in 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 juvenile salmonid rearing 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, Klamath River, and Ocean.

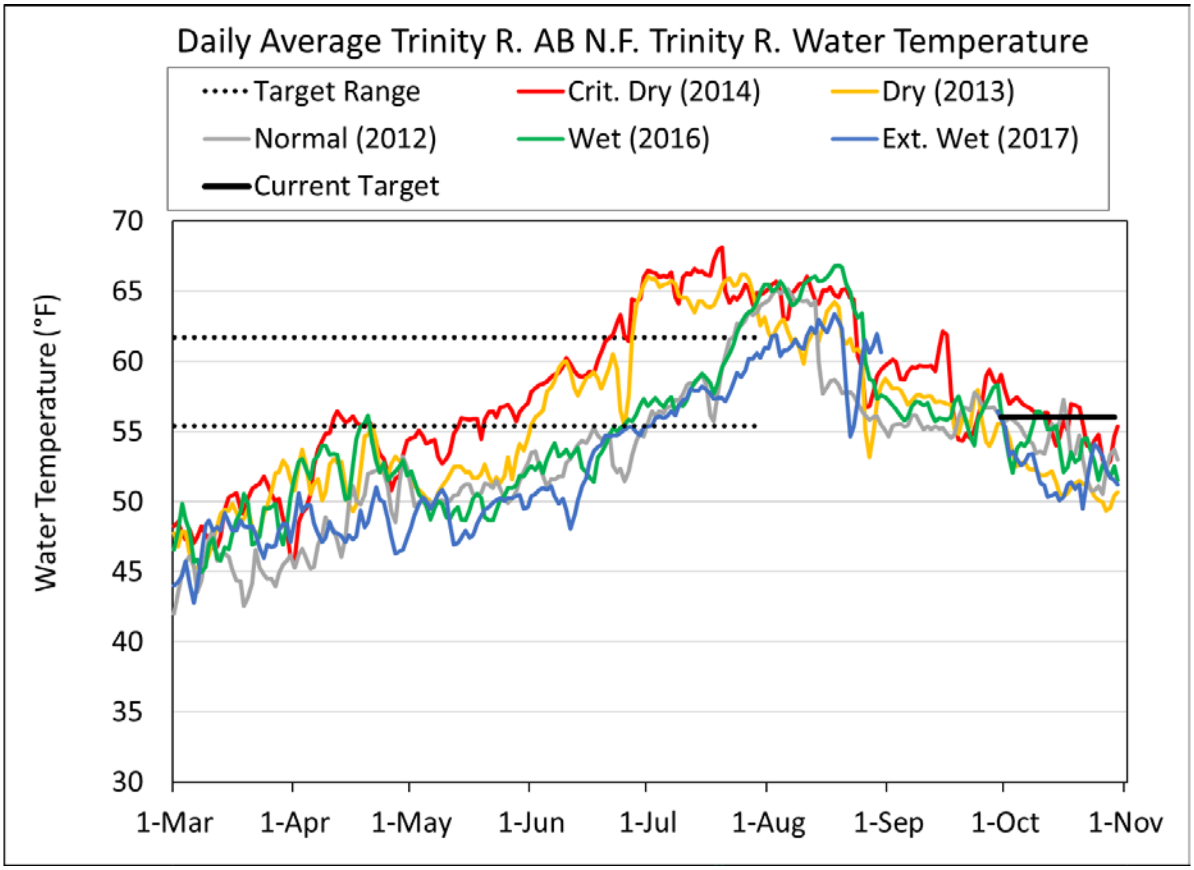

Figure 3. Water temperatures for one of each of the five water year types in the Trinity River above the North Fork Trinity River. Note the 5°F to 7°F reduction in temperature that occurs in all water year types in the end of April coincident with the onset of TRRP restoration flow releases from Lewiston Dam.

Measure of Cumulative Thermal Deviation from Rearing Temperature Target Range

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 difference between the observed or predicted 7DADA from each day, between April 1 and July 31. Negative deviations would be subtracted from each other, and positive deviations would be added together to quantify CTD both less than and greater than the proposed temperature target range.

In addition to the CTD, the number of days of deviation could be reported. For evaluating implemented hydrographs observed data from the USGS gage would be used to calculate the 7DADA for each day, and for proposed hydrographs RBM-10 would be used to generate predicted daily average temperatures at the gage site for the period of record and the 50% and 10% exceedance would be used to report expected CTD for average (50% exceedance) and extreme (10% exceedance) conditions, consistent with the way other temperature targets in the basin are evaluated for hydrograph development and selection.

Relationship to Juvenile Salmonid Outmigration

The average date of 60% of juvenile Chinook Salmon outmigration to the Pear Tree rotary screw trap located near the North Fork Trinity River is April 22 (Table 4). Prior to this date, Trinity River water temperatures are typically less than the optimal rearing temperatures for growth (Figure 3). Approximately half the Chinook Salmon upstream of the Pear Tree trap would remain in that reach after the start of the temperature target range on April 1, and rearing Coho Salmon and Steelhead would be present throughout the duration of the proposed temperature target range.

Table 4. Comparison of percent (%) juvenile Chinook outmigration at Pear Tree rotary screw traps by February 1 and the (%) juvenile Chinook outmigration by onset date for spring flow releases above winter baseflow.

Year	% Outmigration (February 1)	Spring Flow Release Date	% Outmigration (release date)
2003	11%	April 30	74%
2005	14%	April 22	72%
2006	0%	April 12	50%
2007	0%	April 27	53%
2008	1%	April 23	46%
2009	2%	April 27	50%
2010	8%	April 23	62%
2011	14%	April 22	58%
2012	1%	April 21	49%
2013	5%	April 21	53%
2014	0%	April 23	47%
2015	16%	April 22	83%
2016	46%	April 21	87%
Averages	9%	April 22	60%

Our working hypothesis is that growth of the remaining Chinook Salmon, Coho Salmon and Steelhead would be improved if water temperatures in the Trinity River were inside the proposed target range in the spring months for a longer time period. Our preliminary analyses with growth output from a bioenergetics model suggest this is the case. Further modeling and empirical observations should test this assumption.

Further work on modeling these recommendations using a variety of hypothesized rations should be undertaken, as well as modeling in the Stream Salmonid Simulator (S3). Additionally, care should be taken not negatively impact incubating Steelhead or Coho Salmon fry in the first half of April. We also recommend that potential effects to holding spring-run Chinook Salmon be evaluated. Beginning in August, adult temperature objectives could supersede those of the recommended juvenile rearing temperatures.

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Trinity River Restoration Program

P.O. Box 1300, 1313 South Main Street, Weaverville, California 96093

TO: KEN LINDKE (CDFW), FISH WORK GROUP COORDINATOR

FROM: SETH NAMAN (NOAA)

SUBJECT: **COMPATIBILITY OF NEW JUVENILE REARING TEMPERATURE RANGE WITH EXISTING ADULT TEMPERATURE THRESHOLD**

DATE: OCTOBER 21, 2020

Because there is spatial and temporal overlap in the new juvenile rearing temperature range at the Trinity River above North Fork Trinity River and the current adult water temperature threshold at Douglas City, you asked that I look into the compatibility of the two standards in case they might conflict. I used the temperature differences between the two sites during the month of July, the only month with temporal overlap, to assess their compatibility.

The upper limit of the new recommended juvenile rearing temperature range is 61.7°F at the Trinity River above North Fork Trinity River from April 1 to July 31. The adult temperature threshold is 60°F from July 1 through September 14 at Douglas City, before the location of the threshold moves downstream to the Trinity River above the North Fork Trinity River. The juvenile rearing temperature range and the adult threshold difference in July is 1.7°F. Unless the typical water temperature gain between the two sites in the month of July was less than 1.7°F, the recommended juvenile rearing temperature target range would be compatible with the current adult temperature threshold.

I used 6 recent water years to calculate the July water temperature difference. Some recent years had missing or erroneous data at one more sites. I found that the typical water temperature gain between Douglas City and the Trinity River above North Fork Trinity River in July is approximately 3°F to 6°F (Figure 1; Table 1). Therefore, unless the typical water temperature gain between the two sites in the month of July was less than 1.7°F, the recommended juvenile rearing temperature target range is compatible with the current adult temperature threshold.

Table 1. Average temperature difference (Trinity River above North Fork Trinity River minus Douglas City) in July for 6 recent years.

Year	July Temperature Difference (Avg °F)
2012	4.3
2014	6.1
2016	3.8
2018	5.5
2019	4.9
2020	5.7

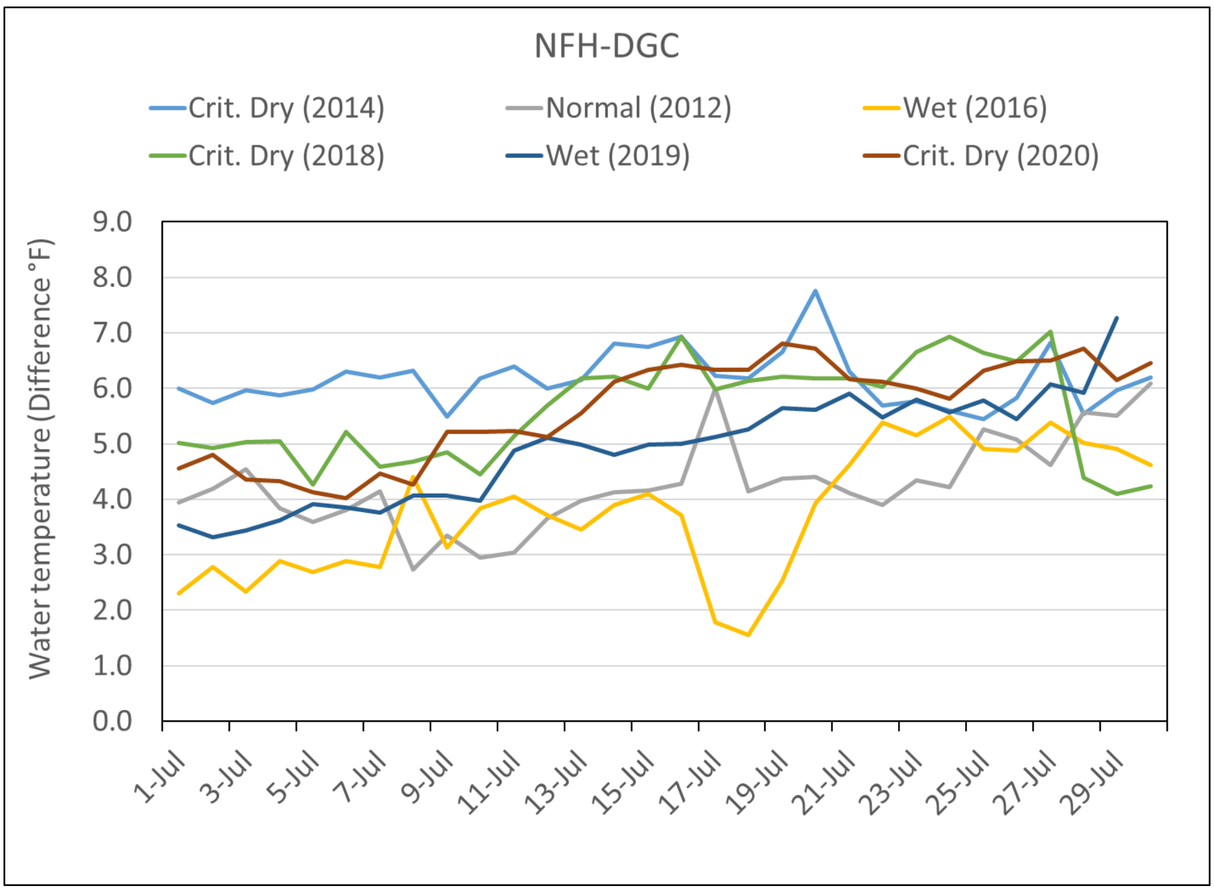

Figure 1. July water temperature difference (Trinity River above North Fork Trinity River minus Douglas City) for 6 recent years.

Trinity River Restoration Program

P.O. Box 1300, 1313 South Main Street, Weaverville, California 96093

Telephone: 530-623-1800, Fax: 530-623-5944

May 5, 2022

VIA ELECTRONIC MAIL ONLY

Memorandum

To: James Lee
Science Coordinator

From: William Pinnix
Supervisory Fish Biologist, USFWS
Fish Work Group Coordinator

Subject: Fish Work Group recommendation for Program objectives/targets refinements

The fish workgroup is recommending eliminating the water temperature targets at Weitchpec.

The current temperature targets as listed in the IAP were developed in the 1990's when limited information was available on how elevated flows would impact the ecology in the Trinity River, and specifically how the increase in discharge would impact Chinook Salmon. The water temperature values were calculated from data gleaned from literature, mostly from laboratory experiments, with the goal of prolonging conditions optimal for juvenile Chinook Salmon smoltification (Zedonis and Newcomb, 1997, USFWS and HVT 1999). Those analyses in the 1990's did not analyze the longitudinal effects on temperature and the resulting slowing of juvenile Chinook Salmon growth that would result.

A considerable volume of hypolimnetic water must be released from Lewiston Dam to meet water temperature targets at Weitchpec, which decreases water temperature in the entire river upstream. Recent data (Pinnix et. al *in review*) suggest that the resulting cooling of the river (Asarian et al. *in review*) during spring ROD releases has led to slower growth and smaller juvenile Chinook Salmon size at outmigration. While existing temperature targets in Weitchpec are designed to promote and prolong temperature most conducive to smoltification, size is a prerequisite for the ability to go through this physiological change. Chinook and Coho salmon must attain a size of 90 mm or larger to have hypo-osmoregulatory abilities (Conte et al. 1966 and Ewing and Brinks 1982 as cited in Zedonis and Newcomb 1997). In addition, cooler temperatures and elevated flows during spring ROD releases encourage juvenile Chinook Salmon to reside longer in the Trinity River, effectively delaying emigration. Artificially delayed emigration can lead to juvenile salmon entering the Klamath River later in the year when water quality conditions (e.g., increased temperature gradient between Trinity and Klamath Rivers and increased disease load in the Klamath River) are stressful for juvenile salmon, thereby potentially inducing additional mortality. In the 1990's the disease issues in the Klamath River, *Ceratonova shasta*, were either much less of a problem or poorly understood. The hypotheses underlying outmigration temperature targets in the 1990's that ul colder temperatures would improve river conditions and lead to increased growth have been partially supported by observations since ROD implementation. Fish production has increased (Pinnix et. al *in review*), but it comes at the cost of suppressed growth and potentially increased mortality downstream from monitoring locations due to hostile conditions in the lower Klamath River.

Thermal suppression of water in the upper Trinity River not only slows growth and development (i.e. smoltification) of juvenile salmonids, but can have deleterious effects on other aspects of ecology that have evolved to warming temperatures in spring, such as: negative impacts on turtle and frog recruitment and development, delaying spring-run Chinook Salmon adult migrations, delaying and/or slowing benthic macroinvertebrate development, and inhibiting riparian recruitment on lower banks of newly disturbed/restored sites.

For these reasons, the fish workgroup recommends that the Weitchpec outmigration temperature targets no longer be used by the Program. We recommend keeping the objective to provide thermal regimes that promote growth and survival of juveniles through the outmigration period. It has become evident that the current Weitchpec targets are inappropriate for meeting this objective. Management actions required to achieve these targets are now known to result in counterproductive conditions in areas upstream.

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Trinity River Restoration Program

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TO: JAMES LEE, SCIENCE COORDINATOR

FROM: KYLE DE JUILIO (YUROK TRIBE), KARL SEITZ (HOOPA TRIBE) AND SETH NAMAN (NOAA) -- AUTHORS

VIA: WILLIAM PINNIX, FISH WORK GROUP COORDINATOR

SUBJECT: **ADULT SALMONID TEMPERATURE OBJECTIVE RECOMMENDATIONS**

DATE: MAY 23, 2022

Background

In March of 2022, the Trinity River Restoration Program's (TRRP) Fish Workgroup formed a subgroup to review and refine existing temperature objectives for adult salmonids in the Trinity River. The effort to review water temperature objectives took on special significance following record setting drought conditions in the previous three years, combined with low Trinity Reservoir storage levels and exceptionally warm water temperatures released from Trinity and Lewiston dams. The adequacy of the TRRP's adult salmonid temperature objectives to positively impact salmon populations has not been reviewed since the Trinity River Record of Decision (ROD) was signed in 2000.

The importance of suitable water temperature for most life stages of salmonids was recognized in early efforts to restore populations of salmonids to the Trinity River. The North Coast Regional Water Quality Control Board (NCRWQCB) established water temperature objectives for the Trinity River through the basin planning process starting in the late 1970s, with several amendments following in subsequent decades (NCRWQCB 2011; Table 1). The California State Water Resources Control Board published Water Order 90-05 in 1990, which set the terms of Reclamation's water permits on the Sacramento and Trinity Rivers. The objectives set by the NCRWQCB were adopted by USFWS and HVT (1999), and modeling indicated that in most years, the flows resulting from the Trinity River ROD would be adequate to meet the objectives.

Table 1. From USFWS and HVT 1999. Water temperature objectives for the Trinity River.

	Water Temperature Objective (°F)	
Date	Douglas City (RM 93.8)	North Fork Trinity River (RM 72.4)
July 1 through Sept 14[a]	60	-
Sept 15 through Sept 30	56	-
Oct 1 through Dec 31	-	56

[a]Not included in Water Order 90-05

However, these temperature objectives were not explicitly developed for the protection of Coho Salmon (*Oncorhynchus kisutch*) adults or embryos. They were largely developed for Chinook Salmon (*Oncorhynchus tshawytscha*) and thought to be sufficient for the needs of Coho Salmon. More recent studies (Martin et al 2017; Anderson et al 2022) have found that even the temperature objectives in Table 1 are inadequate for survival of Chinook Salmon eggs which decreases rapidly with temperature increases greater than 53.5 °F under natural spawning conditions. The objectives in Table 1 also did not establish criteria for water temperature released from Lewiston Dam, thereby tacitly implying water temperatures released from Lewiston Dam would always be colder than water at downstream compliance points (longitudinal warming).

In unregulated waters of the Trinity River watershed, annual water temperature thermal maxima generally occur in July or early August and thermal minima generally occur in January. In general, water temperature warms in a downstream direction throughout the year (Asarian et al., in review). Existing water temperature objectives did not establish the need for normal water temperature patterns, to which salmonids are adapted. While normal longitudinal and seasonal patterns do occur in some years, neither occur during critically dry water years with low Trinity Reservoir storage (Asarian et al., in review). At low reservoir storage, warm water from the surface of the reservoir is entrained into the Trinity Dam outlet works (USBR 2012). Under such scenarios, temperature of the water released from Lewiston Dam can be *warmer* or the same temperature as water temperatures at downstream compliance locations (Asarian et al. in review), unable to cool the river as intended. This can lead to seasonal thermal maxima of water released from Lewiston Dam to occur as late as November (e.g. 2021; Figure 1). These unnatural longitudinal and seasonal temperature patterns caused by operation of Trinity Reservoir releases have the potential to harm fish, including ESA listed Coho Salmon. Specifically, at very low reservoir storage levels and under dry conditions, temperature of water released from Lewiston Dam can increase though November when natural water temperature trends would be cooling. Salmon are adapted to lay temperature-sensitive eggs when reliable natural seasonal cooling would provide water temperature suitable for egg survival and development.

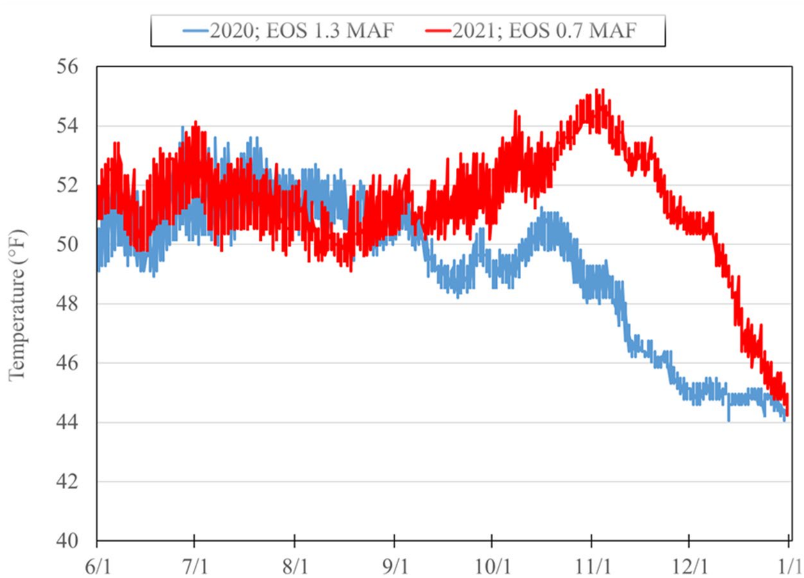

Figure 1. Temperature of water released from Lewiston Dam (USGS Gage #1152550) in 2020 (EOS 1.3 MAF) and 2021 (EOS 0.7 MAF). Note the seasonal warming that occurred until November in 2021.

Here we review current data on water temperature, Trinity Reservoir dynamics, Trinity River Hatchery information, and biological needs of the three native salmonid species (Coho Salmon, Chinook Salmon, and steelhead [*Oncorhynchus mykiss*]). We synthesized this information to develop recommendations for water temperature objectives for water released from Lewiston Dam that are protective of adults and embryos of all native salmonids. We do not include any recommendations associated with migration requirements, as the measures that are currently in place under Water Right Order 90-05 are protective of migrating salmonids after September 15th and we do not propose to change those measures at this time. Prior to September 15th there are temperature requirements within the NCWQCB basin plan for holding spring-run Chinook Salmon on the Trinity River above Douglas City. Protective flow releases from Lewiston Dam can be implemented by Reclamation under a 2017 ROD based on technical input from an advisory group of basin managers to protect migrating fall-run Chinook Salmon by alleviating conditions that could cause or precede a fish kill event downstream of Lewiston Dam, such as the event that occurred on the lower Klamath River in 2002.

Trinity Reservoir Dynamics

Temperature of water released from Trinity Dam is generally sufficiently cold to support spawning and embryo development of native salmonids. However, when storage in Trinity Reservoir is low (less than 1,250 thousand-acre-feet (TAF)), temperature of water released from the main outlet works through Trinity Dam begins to increase (USBR 2012; Figure 2). Thermal inertia in Trinity Reservoir, combined with reductions in reservoir storage through the summer and fall months, can cause a lag between maximum air temperatures in the summer and peak water temperature at depth within the reservoir. Peak air and water temperature in unimpaired Northern California streams typically occurs in July, while warming of water at the outlet works of Trinity Reservoir occurs throughout the summer and does not peak until *November* in years of low reservoir storage (Figure 2). In addition, apparent long-term effects of climatic change have resulted in an increase of 0.5 -1.0°C at the main outlet works from 1998-2019 compared to 1972-1990 (Asarian 2022, in review; Figure 3).

The auxiliary outlet works on Trinity Dam is approximately 114ft lower in elevation than the main outlet works providing access to colder water (Figure 3 and 4) and has been used for this purpose when necessary to meet the requirements of State Water Order 90-05. Additionally, the rate at which water transits Lewiston Reservoir influences the temperature of water released to the Trinity River with the greatest influence typically occurring in July and August when air temperature is at the annual peak (USBR 2012). This warming effect increases as transit time increases and as the difference between water release temperature at Trinity Dam and air temperature increase (USBR 2012).

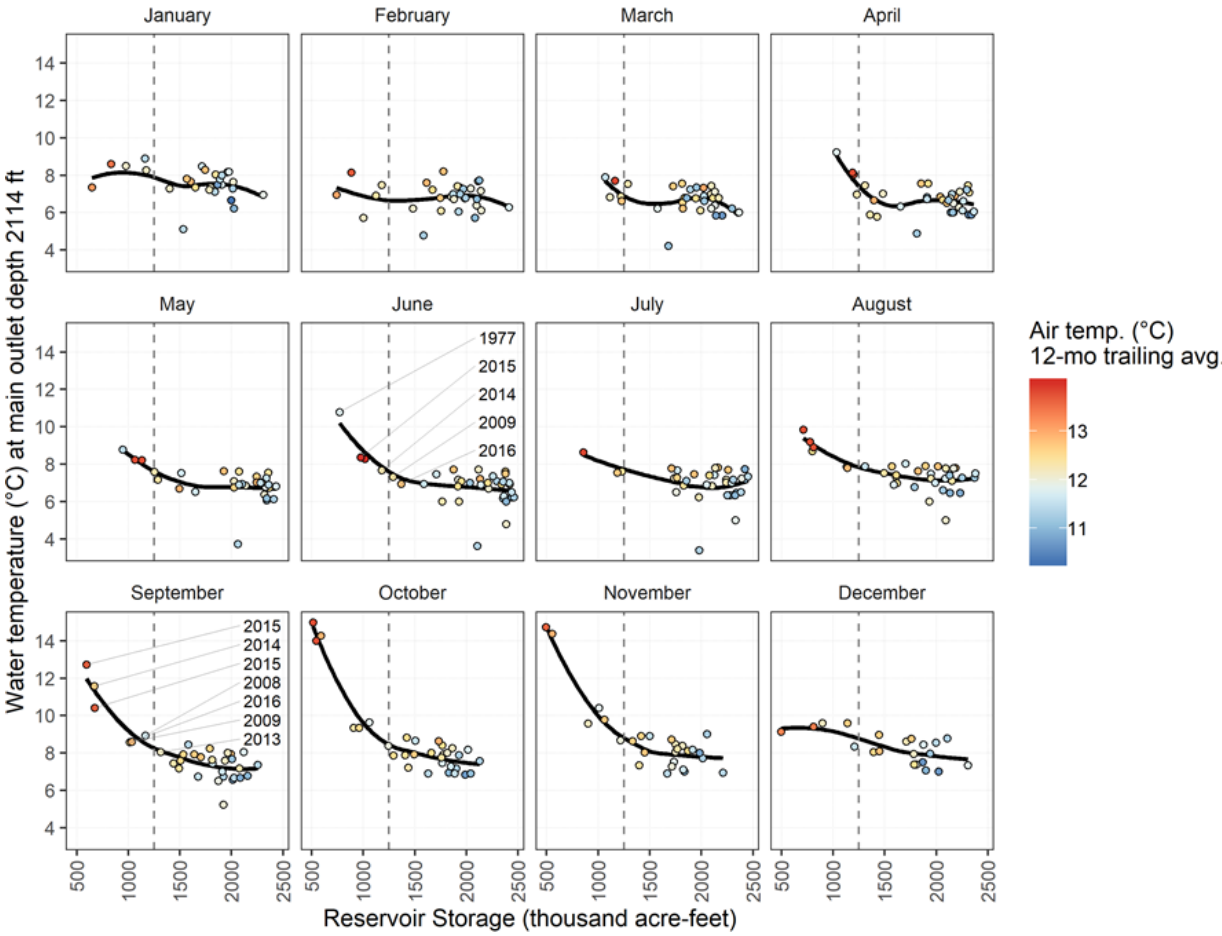

Figure 2. From Asarian et al., in review. Relationship of Trinity Reservoir storage volume to water temperature at main outlet elevation (2114 ft) for all months (January–December) in 38 years from 1972–2019, excluding years without data. Data extracted from reservoir profiles measured by USBR (2020). Lines are LOESS (Locally Estimated Scatterplot Smoothing) smoothers. Vertical dashed line at 1,250 thousand acre-feet (AF) indicates approximate slope break below which temperatures rise steeply as reservoir storage declines, in months when reservoir thermal stratification is stronger (April-November).

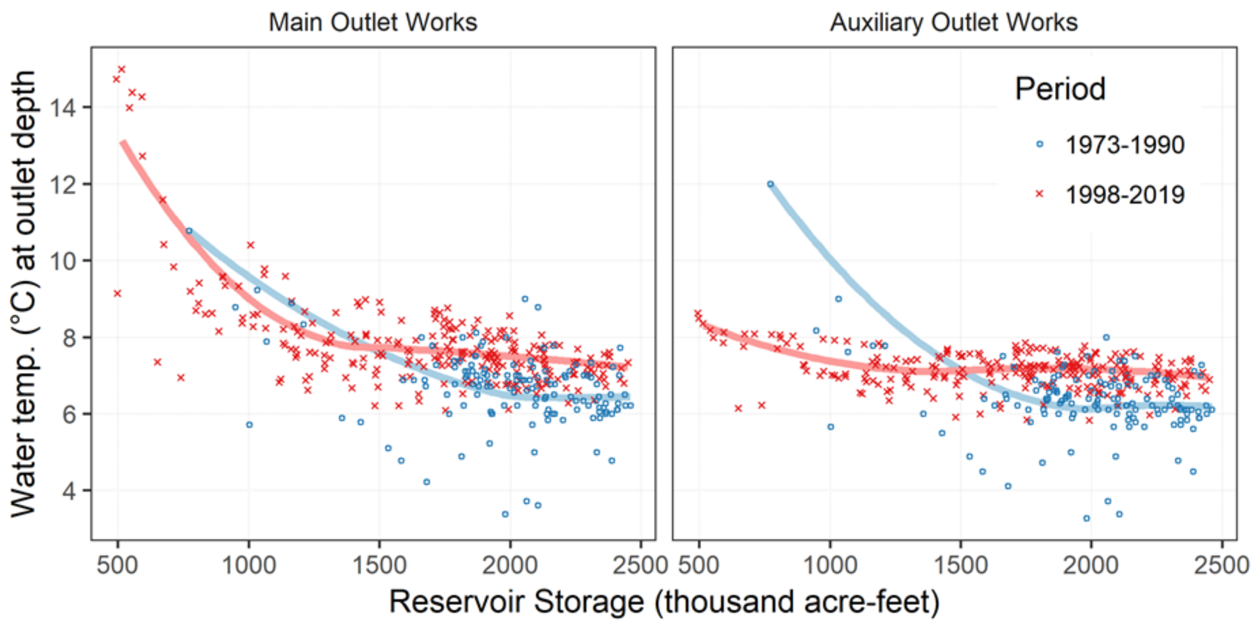

Figure 3. From Asarian et al., in review. Comparison of the 1972–1990 and 1998–2019 time periods for the relationship of Trinity Reservoir storage volume to water temperature at elevation of main outlet (2114 ft) and auxiliary outlet (2000 ft) for all months (January–December) in 38 years from 1972–2019, excluding years without data. Data extracted from reservoir profiles measured by USBR (2020). At low reservoir storage, a few high temperature values cause the blue trend line for 1973–1990 be higher than red trend line for the 1998–2019, but this an artifact of particular conditions that occurred in 1977 and not representative of the overall period [1]. Lines are LOESS (Locally Estimated Scatterplot Smoothing) smoothers.

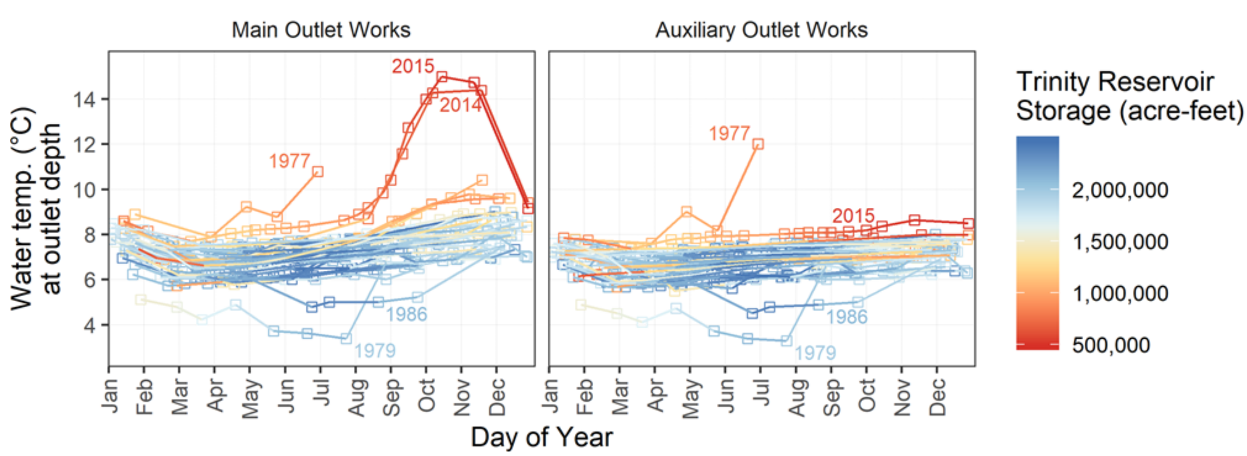

Figure 4. From Asarian et al., in review. Seasonal patterns of water temperature in Trinity Reservoir at elevation of the 28 ft diameter main outlet (centerline of 2114 ft) and auxiliary outlet (2000 ft) in the years 1972–2019, extracted from reservoir profiles measured by USBR (2020).

Recent Water Temperature

Trinity River Coho Salmon are part of the Southern Oregon Northern California Coastal Coho Salmon Evolutionarily Significant Unit that was listed under the federal ESA in 1997 and are the least temperature tolerant native salmonids in the Trinity River (Carter 2005). Abundance of Coho Salmon in the Trinity River has continued to decline since their listing and was exacerbated during 2021 when storage in Trinity Reservoir dropped below 750 TAF and incubating embryos were subjected to excessively warm water temperature during late fall 2021 (Figure 1). Coho Salmon embryos at Trinity River Hatchery (TRH) during 2021 were often exposed to average daily water temperature of approximately 12˚C during the month of November (Figure 6; CDFW Mark Clifford, personal communication, February 14, 2022) above the 6 to 10˚C range necessary for optimal survival of incubating Coho Salmon (USEPA 2001 and WDOE 2002).

Warm water temperature was also present in the Trinity River below Lewiston Dam during fall of 2021 (Figure 6), suggesting that survival of Coho Salmon embryos naturally incubated in the upper Trinity River was also potentially impacted. Water temperature in the Trinity River below Lewiston Dam is of concern given the large number of salmonids that typically spawn in this section of the mainstem Trinity River, especially in the first 40 miles of the Trinity River below Lewiston Dam. Furthermore, the upper two miles of the Trinity River (near Lewiston, where Figure 6 temperature were measured) during some years contains the highest density of naturally spawned salmon of all species in the Trinity River, as documented in 2008 (Sinnen et al., 2010 as cited in NMFS 2016). Given the research by Martin et al. (2017) and Martin et al. (2020), survival of salmon eggs in natural spawning areas was likely *even lower* than in TRH due to differences in water velocity and oxygen levels in the hatchery environment versus that of salmon redds in the natural environment.

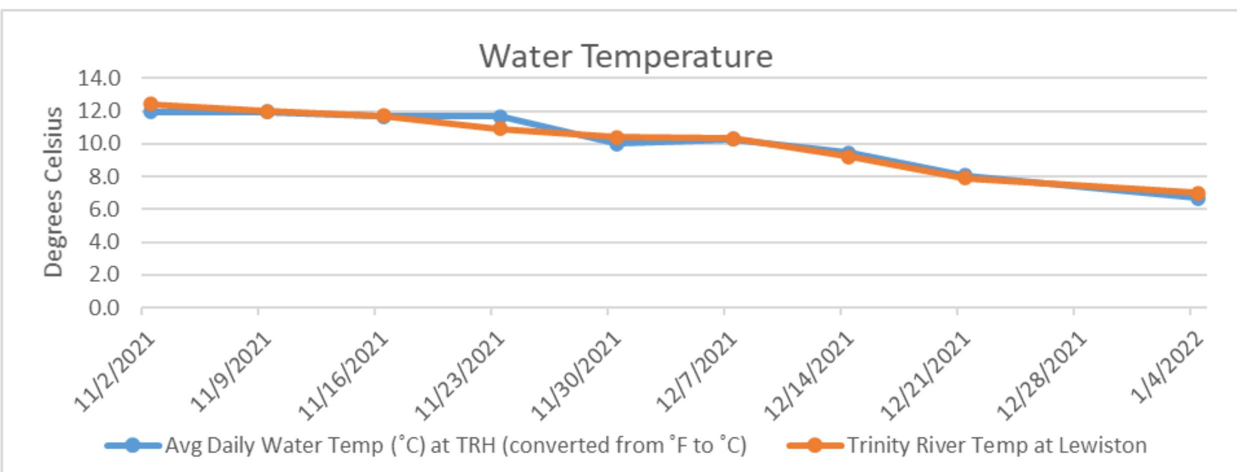

Figure 6. Daily average water temperatures at TRH (CDEC station LFH) and in the Trinity River near Lewiston CA (USGS 1152550), November 2, 2021, to January 4, 2022. Dots represent dates fish were spawned at TRH.

Literature Review

Salmonids have evolved with the temperature regimes they historically encountered during migration and spawning (Carter 2005). Deviations in stream temperature outside of this historical range can result in migration delays, increased pre-spawn mortality, and increased mortality during spawning and incubation (Carter 2005).

Chinook Salmon Water Temperature Requirements

Chinook Salmon prefer water temperature below 18°C during their upstream migration (USEPA 2003; WDOE 2002). Holding water temperature for spring-run Chinook Salmon should not exceed 14°C to be protective, while protective water temperature for fall-run Chinook Salmon is below 17°C for holding (WDOE 2002). Once spawning begins water temperature is recommended to remain below 13°C with the preferred range of 5.6 - 12.8°C (ODEQ 1995; Martin et al 2017). While 13.3°C was previously thought to be protective of Chinook Salmon eggs, one key finding of Martin et al. (2017) and Martin et al. (2020) is that thermal tolerance of embryos in their natural habitat is substantially lower than expected from laboratory experiments. This occurs because water velocity in redds is lower than that of laboratory experiments, causing less oxygen to be available to eggs in redds than in laboratory settings for any given water temperature (Martin et al. 2017; Martin et al. 2020).

Coho Salmon Water Temperature Requirements

Bell (1986) reported that Coho Salmon migration was delayed at 21.1°C and Flett et al. (1996) observed Coho Salmon frequently migrating through waters warmer than 20°C had reduced quality and rapid deterioration of eggs (as cited in Richter and Kolmes 2005). Coho Salmon migration has typically been observed when water temperature is between 7.2° and 15.6°C (Bescheta et al. 1987) with a preferred range of 11.7-14.5° (Bell 1986). In California, the typically observed water temperature range for Coho Salmon migration is between 4° and 14°C (Hassler 1987). For Washington state waters, Hicks (2000) recommended that water temperature in lower mainstem river segments used primarily by salmonids as migration pathways should not exceed 17°C as a 7-day average of the daily-maximum water temperature between June 1 and September 1. Additionally, water temperature should not exceed 14°C as a 7-day average of the daily-maximum water temperature from September 1 to June 1, with no single daily-maximum water temperature greater than 17°C. Coho Salmon spawning activities have been observed between 4.4-13.3°C water temperature (Hicks 2000). However, Bell (1973) suggested that for successful spawning of Coho Salmon water temperature should be in the range of 7.2-15.6°C. Brungs and Jones (1977) suggested that to be fully protective of Coho Salmon during spawning, the Maximum Weekly-Average Temperature (MWAT) should not exceed 10ºC and the daily maximum temperature should not exceed 13ºC.

We stress that we currently do not have a robust temperature dependent egg mortality model for Trinity River Coho Salmon based on field observations. As described above, laboratory experiments and resulting models of the relationship between water temperature and egg survival likely overestimate the water temperatures at which salmonid eggs can safely develop in the natural environment (Martin et al 2017; Martin et al 2020).

Steelhead Water Temperature Requirements

Steelhead migration requirements are similar to those of Chinook Salmon with avoidance of water temperature greater than 21°C and not found at or above 24°C (WDOE 2002). Holding and rearing areas should not exceed 18°C maximum weekly-maximum water temperature (MWMT) (USEPA 2003; WDOE 2002). Preferred daily average water temperature for spawning and incubation periods for steelhead are similar to Chinook Salmon, with a range of 4.4 - 12.8°C (WDOE 2002) and 6-10°C (USEPA 2001), respectively. MWMT should not exceed 13°C for the incubation period (USEPA 2003).

Literature Review Summary

Water temperature tolerance and preference for salmon species progressively get colder through migration, holding, spawning and incubation (Table 2). As embryos approach emergence as alevin, water temperature tolerance and preference increase. As such, incubation has the narrowest range of temperature tolerance making it the most vulnerable life stage to abnormally high water temperature. Coho Salmon are the least temperature tolerant species, requiring the coldest water temperature in most life-stages compared to the other species (Table 2). For the period September 15 to October 31, when Chinook Salmon have begun to spawn and other species are still migrating or holding, the incubation requirements for Chinook Salmon are the coldest among species. From November 1 to December 31 while Coho Salmon are spawning the requirements for their incubation are the coldest among species (Table 2). From January 1 to March 1 all three species have eggs in the gravels requiring similar water temperature sufficiently cold to support embryo development (Table 2).

Table 2. Summary of preferred species and life-stage dependent water temperature ranges and recommended weekly average maximum (7-DADM) and daily (1-DM) maximum water temperature targets to be fully protective from the literature review. All temperatures are in °C.

Species	**Temperature**	**Life stage**		
		Migration	**Spawning**	**Incubation**
Chinook	Preferred	*7.2 – 14.5*	*5.6 – 12.8*	*6 - 10*
	7-DADM	*14.2 – 16.8*	*11 – 12.8*	*11 – 12.8*
	1-DM	*20 - 21*	*13.5 – 14.5*	*13.5 – 14.5*
Coho	Preferred	*11.7 – 14.5*	*4.5 - 10*	*1.3 – 10.9*
	7-DADM	*14 - 17*	*9.5 - 13*	*9 - 12*
	1-DM	*20 - 21*	*17.5*	*13.5 - 14.5*
Steelhead	Preferred	*16 - 17*	*3.9 – 12.8*	*5 – 11.1*
	7-DADM	*16 - 18*	*13*	*13 – 14*
	1-DM	*21 - 23*	*15*	*13.5 – 14.5*

Recommendations

Review of Existing Water Temperature Targets

Water temperature targets that are in place at Douglas City and the North Fork are sufficiently protective of migrating and holding salmonids from September 15 to March 1. We recommend that these targets, set by Water Rights Order 90-05 remain in place for that purpose. Since these targets are not protective of spawning salmonids and incubating embryos, we suggest temperature targets for water released from Lewiston Dam be adopted throughout this period to ensure that suitable thermal conditions for reproduction are available downstream of Lewiston Dam.

New Proposed Temperature Targets

Managers should ensure water released from Lewiston Dam is cold enough to support salmonid reproductive requirements, particularly in years of low Trinity Reservoir storage. Potential impacts of thermal lag due to the latent heat energy in Trinity Reservoir captured during summer can result in disruptions to species reproductive cycles under low reservoir storage conditions. Lag in seasonal water temperature change can set up ecological traps for migrating and spawning fishes; fish migrating in anticipation of seasonal cooling in the fall can experience rising temperatures once they reach spawning grounds, reducing the likelihood of successful reproduction. The temperature targets in Table 3 are intended to prevent impacts of warm water released from Lewiston Dam on salmonid production

The Fish Workgroup recommends selecting conservative water temperature targets due to lack of access to habitat upstream of Lewiston Dam that would have been colder than unregulated water temperature in Lewiston. Also, targets should be provided as daily average temperature (DAT) to be consistent with existing targets and allow for easy incorporation by managers. While acute temperature impacts are a concern, daily fluctuations at the release point tend to be small and DAT targets should offer sufficient protection.

From September 15 to October 31 Chinook Salmon eggs are the species and life stage requiring the lowest water temperature, a DAT at or below 12 °C (53.5°F) to be fully protective (Table 3). From November 1 to December 31, Coho Salmon eggs are the species and life stage requiring the lowest water temperature, a DAT at or below 10 °C (50°F) to be fully protective. From January 1 to March 1 a DAT of 8.9°C or lower (48°F) is recommended to promote optimal egg incubation for all native salmonids (Table 3).

We recommend that the TRRP adopt the water temperature targets for Lewiston Dam presented in Table 3 to be protective of the preservation and propagation of native salmonids. These release temperature targets are compatible with the targets established by Water Order 90-05 and intend to ensure that an adequate portion of the 40-mile Trinity River restoration reach is providing ideal conditions for reproduction of native salmonids (Table 3).

Table 3. 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.

Date	New Temp Objective (°F)	Existing Temp Objective (°F)	
	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

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Fish work group steps for refining objectives
5/5/2014

The fish work group first started with an Excel workbook with the first tab that outlined the fundamental objectives agreed to by TRRP partner agencies at the objectives workshop:

1. Restore and sustain natural production of anadromous fish populations in the Trinity River basin downstream of Lewiston dam to pre-dam levels.
2. Restore the processes and attributes of a healthy alluvial river system.

We believed it was important to adhere to the same wording that was used at the objectives workshop of fundamental and means objectives and to remind ourselves of the definitions of these. The fish work group also added the words "in the Trinity River basin" to primary objective number one above. We started with the list of objectives from the IAP that were given as a list to all parties for the objectives workshop. We also added one or two at this point that we thought were missing. Next we pulled out all the anadromous fish means objectives (directly related to fish management actions), of which there were 53. With a separate column, we identified the management actions associated with each means objective. Examples of management actions that we used were "flow," "gravel," or "reservoir," among others. We then started a notes column next to the management actions column and began to identify redundant means objectives. An example is below:

Number	Objectives	"Direct" Fish Means Objective	Management action/comments	Notes/redundancies
A39	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	yes	flow, channel rehab, gravel	Redundant with A24. Combine wording with similar objectives

We realized that we had some means objectives that were closely aligned to the fundamental objective of "restore and sustain natural production of anadromous fish populations downstream of Lewiston dam to pre-dam levels." An example of one of these would be "Increase naturally produced fall-run Chinook salmon adult production to the extent necessary to meet or exceed escapement objectives and facilitate expanded harvest opportunity." For means objectives like this, we termed them "outcome" based under the management actions column. We separated these from the other means objectives, because they are the result of what happens after TRRP manipulates flow, gravel, and channel rehab. Of the 53 objecives, we had 34 with management actions associated with them, and 19 that were outcome based. An example is below:

Number	Objectives	"Direct" Fish	Management action/comments	Notes/redundancies

		Means Objective		
A11	Increase escapement of naturally produced fall-run Chinook salmon to 62,000 adults	yes	outcome	

Next we carried over 30 of the original 34 means objectives to another worksheet because we combined and deleted a few of the originals. Then we went through all of these 30 and organized them by type (e.g. temperature/flow, habitat, hatchery). We also added a column for life stage, to helps us discern which life stage the objective was referring to. We read all of these 30 together, and identified which ones were redundant with each other. Here is an example:

	Number	Objectives	Management action/comments	Redundancies	life stage	Joe's notes - 1
Fish Food	A16	Increase and maintain macroinvertebrate populations	flow, riparian, gravel	Redundant with X1, B22	Fry, juvenile, smolt	
	B22	Enhance or maintain food availability for fry and juvenile salmonids	flow	redundant with A16, X1	fry and juvenile	
	X1	Promote sufficient salmonid forage base	flow, riparian, gravel	Redundant with A16, B22	Fry, juvenile, smolt	used this wording for fish food objective

We then kept going with this process, deleting, and combining objectives in successive worksheets. We did this also with the objectives that were deemed outcome based. After all the redundancies had been identified, deleted, and or combined with other objectives we separated them (flow, temp, or in the case above fish food, which we eventually deleted) into different worksheets and began to develop metrics for these. For example for the temperature objectives, we used those from the TRFE and the EIS. Others we obtained from literature or other sources. We arrived at 20 objectives of the original 53, and developed metrics for these. However, the Fish Work Group still has work to do refining some of these metrics for the objectives. The list as of now is below.

Number	Means objective type	Means objective	Metric	Supporting information	Notes

1	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 undefied.	1983 EIS.	Joe P. was unable to find good scientific basis for TRRP numeric goals.
2	Fish Population/harvest	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 undefied.	1983 EIS.	Joe P. was unable to find good scientific basis for TRRP numeric goals.
3	Fish Population/harvest	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 undefied.	1983 EIS.	Joe P. was unable to find good scientific basis for TRRP numeric goals. NOAA recovery goal for Trinity basin wide coho production is nearly 10X this metric.
4	Fish Population/harvest	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 undefied.	1983 EIS.	Joe P. was unable to find good scientific basis for TRRP numeric goals.
5	Fish Population/harvest	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		

6	Fish Population/harvest	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		
7	Fish production	Limit redd superimposition by increasing suitable spawning habitat areas throughout the restoration reach.	Metric not yet defined		Ideas-1) average distance from dam 2) average distance from dam excluding reach 1 3) average distance between redds 4) set up goals for each reach for % of total.
8	Fish production	Minimize fry stranding in the upper 40 miles of the mainstem Trinity River	Do not exceed ramping rates in EIS (binary metric yes/no)		
9	Fish production	Reduce brown trout population to decrease predation on native naturally produced fish in the mainstem Trinity River.	Negative trend in CDFW JC weir CPUE data (binary metric yes/no)		Trend should be less than zero
10	Fish Habitat	Increase/maintain salmonid fry and juvenile rearing habitat	Increase habitat by a minimum of 400 % following rehabilitation of fluvial attributes		NEEDS REFINEMENT-interime metric tiered to detecting changes in outmigrants and not specifically related to changes needed to meet fundamental objectives
11	Fish Habitat	Increase/maintain spawning habitat quantity and quality	Increase to 2,550,000 square feet	Unknown origin.	NEEDS REFINEMENT, including quality of spawning

					gravels- see above
12	Fish Habitat	Maintain or increase adult holding habitat from baseline conditions in the mainstem Trinity River	pools ≥ 2.4 m (8 ft) and with a surface area ≥ 72 m² (775 ft²) under baseflow conditions	Adult holding habitat email from A. Martin to T. Hayden Sep 9, 2013.	Neeed to calculate either number of pools or square footage to finalize metric
13	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.	TRFE	
14	Water temperature	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	TRFE	
15	Water temperature	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	TRFE	
16	Water temperature	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	TRFE	

17	Water temperature	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.	TRFE	
18	Hatchery	Increase proportion of Natural Influence (pNI) used as a surrogate for genetic interactions = mixing of hatchery and natural fish	pNI $\geq$ 0.5	CAHSRG (2012)	requires actions by partner agencies to evaluate the impact - not a clear linkage to TRRP action
19	Hatchery	Minimize predation by hatchery smolts on wild fry and juveniles	< 0.05 fry/hatchery fish	Naman and Sharpe (2011)	requires actions by partner agencies to evaluate the impact - not a clear linkage to TRRP action. predation<20% in the. 40 miles of river, in the IAP.
20	Hatchery	Minimize competition by hatchery smolts on wild fry and juveniles	Surrogate-Release date after April 15. (Yes or no binary metric)	Kostow 2012	requires actions by partner agencies to evaluate the impact - not a clear linkage to TRRP action. One idea is to use volitional migration as a surrogate for residualism. Fish per lb is another, also, no small grade steelhead. Or release hatchery fish on the peak of spring water release.

Trinity River Restoration Program

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February 17, 2022

VIA ELECTRONIC MAIL ONLY

Memorandum

To: James Lee
TRRP Science Coordinator

From: Todd Buxton
Physical Scientist, TRRP
Physical Workgroup Coordinator

Subject: Physical metrics

Over the past several years, the TRRPs physical workgroup has considered existing metrics and new ones proposed by Dave Gaeuman (Yurok Tribe), Scott McBain and Smokey Pittman (McBain Associates in consultation for the Hoopa Valley Tribe), and myself for assessing the physical process domain and attributes in the Trinity River restoration reach. The targets the group considered for final approval notably rely on data already collected by the TRRP for other purposes or have been collected in the past but require new funding to be restarted. The outcome of these considerations is that seven metrics have been approved by the workgroup for periodic evaluation on the Trinity River. Each metric is summarized by its descriptive title, author, the applicable means objective, metric symbol, target-trend-or distribution, the metric's connection to a primary objective of the restoration program, its spatial extent for application, measurement unit, frequency of measurement, and data dependencies for application in Appendix A. Narrative descriptions of the metrics are provided in the following pages.

Topographic Variability as Measure by *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 90^{th}, 75^{th}, 25^{th}, and 10^{th} 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 Extent as Measured by Integrated Wetted Width (I_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:

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

where W_i is the mean wetted width at discharge Q_i, DQ_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.

Sediment mobility

Means Objective: 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 ($D_{50,\text{surface}}$) and the average subsurface median grain size ($D_{50,\text{subsurface}}$) both to the median bed load diameter ($D_{50,BL}$) to respectively produce values of D^*_{surface} and $D^*_{\text{subsurface}}$ that target >1.0. After Paola and Seal (1995), D^*_{surface} and $D^*_{\text{subsurface}}$ ≤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 $D^*_{\text{subsurface}}$ 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 $D_{50,\text{surface}}$ 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 $D_{50,\text{subsurface}}$ 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.

Active Bar Area

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:

1. Presence:
    - (1) Are active bars present or not?
    - (2) Should they be present (i.e. do skeletal pre-dam bars exist or is it a transport reach)?
2. Magnitude: How does active bar area (per length of channel) compare:
    - (1) between reaches,
    - (2) relative to gravel augmentation locations,

(3) relative to channel rehabilitation sites and
(4) relative to tributary confluences.

3. Trend:
   (1) Is active bar area increasing?
   (2) Is active bar area reaching reach-specific targets? Requires a target to be set per Coarse Sediment Storage synthesis report)

<u>Spatial Extent</u>: The 40-mile TRRP reach, divided into geomorphic sub-reaches.
<u>Frequency:</u> Every five years.
<u>Algorithm:</u> 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." 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.
<u>Other Items to Consider:</u>

1. 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.
2. 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.
3. 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.
4. 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.

5. 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).
6. Active bars provide numerous ecological, physical and biological functions aside from providing juvenile salmon habitat (e.g. FYLF breeding habitat).
7. 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.

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:

1. Mobilization of matrix surface particles (D_{84}) on alternate bar surfaces during Normal and wetter water years >6,000 cfs)
2. Mobilization of subsurface particles ($\geq 1D_{84}$ depth) during Wet and Extremely Wet years
3. Mobilization of subsurface particles ($\geq 2D_{84}$ depth) during Extremely Wet years

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.

8. 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.
9. 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)
10. 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.

Appendix A. Summary of physical metrics approved by the Physical workgroup.

Description	Developer	Means Objective	Metric	Target, trend, or distribution	Connection to primary objective(s)	Spatial Extent	Measurement Unit	Frequency	Dependencies
Topographic Variability (R^*)	Gaeuman	Topographic variability	R^*	Increase R^* through time	A more complex riverine topography provides a broader suite of hydraulic/hydrologic conditions resulting in a greater variety and amount of rearing habitat over a range of flows below 2,000 cfs.	Project Reach	Geomorphic Sub reaches	Five Year Topo Updates; Design Development	Topo only
Normalized Wetted Area as a Function of Discharge (A_w')	Gaeuman	Inundation effectiveness	f_w	Locally increase f_w through time	Wetted area is a key driver of habitat availability at moderate discharges, of fish production, and of riparian health. More width correlates with increased rearing habitat	Project Reach	Geomorphic Sub reaches	Five Year Topo Updates; Design Development	Topo + Hydraulic model
Sediment Mobility	Buxton	Maintain sediment mobility at thresholds that aide physical and biological processes	Critical Shield parameter for D_{50} (τ^*_{50})	$0.025 \le \tau^*_{50} \ge 0.085$	Bar and river bed mobility and scour drive the processes (erosion and deposition) that build and maintain bars and riffles and limit riparian encroachment.	Sediment Monitoring Stations at Lewiston, Limekiln, and Douglas City		Annually when Max ROD Q > 4000 cfs	Bedload sampling data, pebble counts
Fine Sediment Storage	Buxton	Promote coarse sediment mobility, riparian vegetation recruitment, lamprey populations, and groundwater storage.	Hiding function (b)>-0.9	b > -0.9	Fine sediment supply increases coarse sediment transport, fine sediment storage promotes riparian recruitment, groundwater storage and improves lamprey habitat.	Sediment Monitoring Stations at Lewiston, Limekiln, and Douglas City		Coincident with Sediment Monitoring	Bedload sampling data
Channel Migration	Buxton	Promote channel migration to increase channel complexity and floodplain development	Migration distance	Increase amplitude of meanders through time	Increasing the extent of laterally mobile channel will create new alluvial features, increase wood recruitment, and build new floodplains.	Project Reach	Meander amplitude	Five Year Topo Updates	Air photos?
Active Bar Area	McBain/ Pittman	Increase coarse sediment supply and transport rate, increase large roughness features to induce coarse sediment deposition (active bars).	Area/length of channel (sq ft/ft)	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	Additional coarse sediment storage via active bars satisfies ROD scaled-down alluvial river strategy, provides the raw material for building and maintaining the geomorphic features which increase rearing habitat over a range of flows below 2,000 cfs.	Project Reach	Geomorphic Sub reaches	Five Years	None (independent field mapping)
Bed Mobility and Scour	McBain/ Pittman	Increase rates of bed mobility and scour - deterministic 2-D model	% of point bar surface area mobilized	Mobilize D84 on alternate bar surfaces at flows >6,000 cfs	Bar and river bed mobility and scour drive the processes (erosion and deposition) that build and maintain bars and riffles and limit riparian encroachment.	Project Reach	Entire 40-miles	All years with Normal or wetter hydrographs	Topo + Hydraulic model+D84 maps

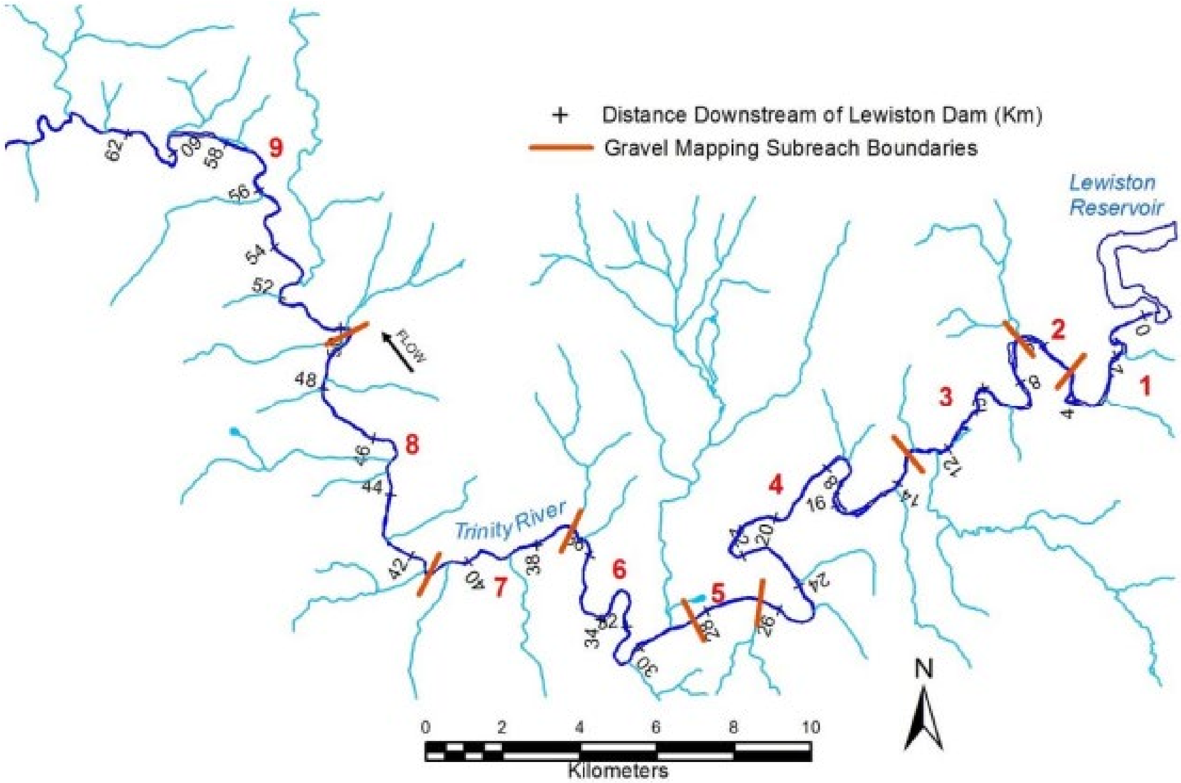
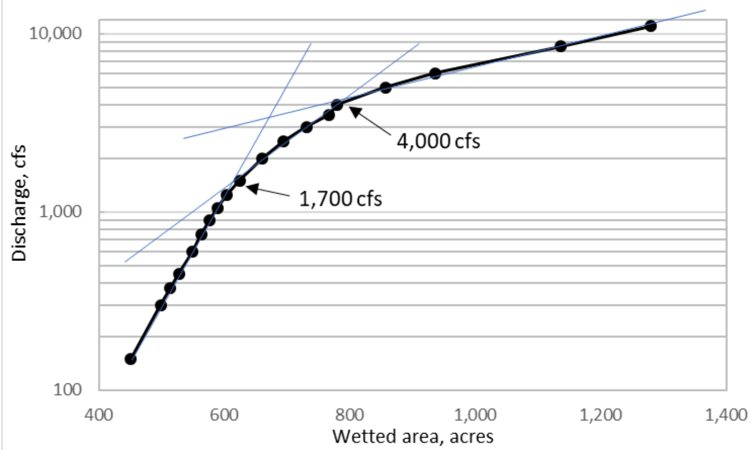


Figure 3. Map of the Trinity River showing the nine gravel mapping subreaches from Lewiston Dam downstream to the North Fork Trinity River confluence.

Functional flow considerations in hydrograph development

Primary production, macroinvertebrates: Prior to June 15, inundate surfaces for 28d for establishment of biofilm, 35d for macroinvertebrate establishment, and 63d for peak macroinvertebrate production. See figure for wetted area of mainstem channel-connected area versus discharge relationship modeled for the restoration reach with SRH2D using 2016 topography.



Foothill yellow legged frogs (FYLF): vary flows before peak discharge to delay FYLF breeding until after the peak flow event to prevent scour of egg masses on bars. Duration for tadpole development from egg masses is ~25 days in typically cold water in Trinity River and ~2 weeks in warmer water.

Riparian recruitment: Maintain moist soil on surfaces wetted by 2,000 - 4,500 cfs for cottonwood recruitment beginning in the average seed dispersal period (May 15-May 28) and lasting 21-29 days. During targeted period, flow stage should be ≤0.25 m below targeted surface. Following peak discharge in targeted period, recede stage ≤0.10 ft per day at Trinity River at NF Trinity River gage. Note that riparian plants can survive steeper recessions (i.e., recessions closer to 0.10 ft/day) later in the year.

Fine sediment transport: Depending on the targeted area for transport of fines, discharge should be increased above 3,000, 1,000, and 2,000 cfs at Lewiston, Limekiln Gulch, and Douglas City, respectively. Continue to increase flow above threshold discharge to maintain entrainment and routing of fines. Increase flow above 4,500 cfs to deposit fines outside the main channel.

Bed load transport: Increase flow above 3,500, 2,500, and 2,000 cfs at Lewiston, Limekiln Gulch, and Douglas City to mobilize the coarse armor layer. Afterwards, flow increased steeply to a short peak followed by a rapid decrease in flow generally maximizes loads per unit volume of water due to clockwise hysteresis that is common on the Trinity River. Successive high, short peak discharges typically transport a cumulatively higher load and route more coarse sediment than a high peak that is maintained for a protracted period.

Geomorphic change: Rapid decreases in flow from stages that inundate banks waterlogs and promotes collapse of banks that encourages adjustment of channel position (meandering), wood recruitment, and formation of diverse edge habitats for fish.

EIS up- and down-ramp rates

Lewiston Dam Release (ft^3/s)	When Increasing Flow [a]	When Decreasing Flow [b]
At or above 6,000	1,000 cfs per 2 hours	500 cfs per 4 hours
6,000 to 4,000	1,000 cfs per 2 hours	400 cfs per 4 hours
2,000 to 4,000	500 cfs per 2 hours	200 cfs per 4 hours
500 to 2,000	250 cfs per 2 hours	100 cfs per 4 hours
300 to 500	100 cfs per 2 hours	50 cfs per 4 hours

<u>Water temperatures for salmonids</u>:

1) The 7-day moving average of daily average temperatures should be maintained between 13.0 – 16.5 C at the Trinity River above NF Trinity River gage.

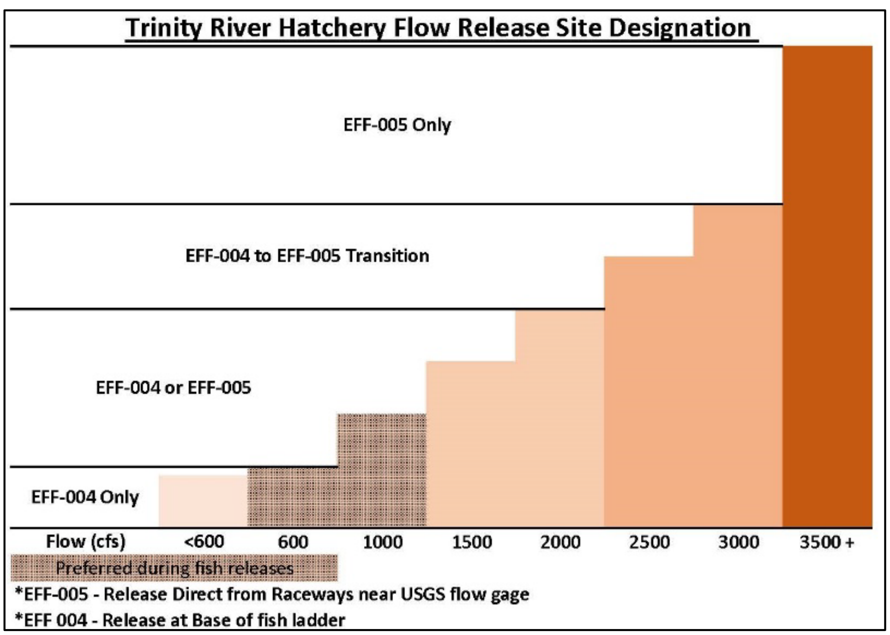
2) Meet temperature targets for juvenile salmonids (in Celsius)

	Start date	End date
Juvenile outmigrant temperature criteria	22-Apr	22-May
normal and wetter	13	13
dry and drier	15	15
	23-May	4-Jun
normal and wetter	15	15
dry and drier	17	17
	5-Jun	9-Jul
normal and wetter	17	17
dry and drier	20	20

3) Meet temperature targets for adult salmonids (in Celsius)

Temperature criteria for adult salmonids	Start date	End date
at Douglas City (RM 93.8)	1-Jul	14-Sep
	15.6	15.6
	15-Sep	30-Sep
	13.3	13.3
at NF Trinity River (RM 72.4)	1-Oct	31-Dec
	13.3	13.3

<u>Hatchery fish</u>: Provide 600 – 1,000 cfs and increasing flows for a week following that start of hatchery fish releases (April 20, May 18, June 15 targeted for WY20).



<u>In-channel construction</u>: Release discharge from Lewiston Dam ≤1000 cfs from July 15 - September 15.

Trinity River Restoration Program

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TO: CHRIS LASKODI, RIPARIAN AND AQUATIC ECOLOGY (RAE) WORK GROUP COORDINATOR

FROM: KYLE DE JUILIO (YUROK TRIBE), DON ASHTON (MCBAIN ASSOCIATES), AND JAMES LEE (TRRP; BUREAU OF RECLAMATION)

SUBJECT: **FOOTHILL YELLOW-LEGGED FROG REPRODUCTION TARGET RECOMMENDATIONS**

DATE: DECEMBER 2020

Background

The TRRP was formed as a result of the 2000 Trinity River Record of Decision (ROD; DOI 2000). The ROD set in motion the implementation of a restoration strategy initially described in the Trinity River Flow Evaluation Final Report (TRFEFR; USFWS and HVT 1999) using three broad categories of management actions: 1) increased annual flow regimes and variable reservoir releases; 2) fine and coarse sediment management; and 3) mainstem channel reconstruction (mechanical channel rehabilitation). The TRRP established a partnership of Federal, State, County, and Tribal Governments to guide these management actions through an Adaptive Environmental Assessment and Management framework (AEAM). In 2009 an Integrated Assessment Plan was developed to prioritize the scientific investigations of the TRRP and set a course for AEAM. Rehabilitation and protection of wildlife habitats to maintain or enhance populations was established as one of six primary objectives (TRRP and ESSA 2009). Wildlife assessments were suggested by the IAP for:

> *"evaluating the long-term responses (e.g., survival, reproduction, productivity, abundance, species diversity, etc.) to the cumulative effects of managed flows, coarse sediment management, habitat rehabilitation, and other management actions. Assessments will also assist in evaluating success in establishing the amount and characteristics of riparian habitat that meet the needs of wildlife species."*

Specific recommended assessments include:

1) *distribution of habitats for Foothill Yellow Legged Frogs and Western Pond Turtle; and –*
2) *abundance, survival and productivity of Foothill Yellow Frog and Western Pond Turtle.*

Since the completion of the IAP the recommended studies have been incorporated as part of the TRRP's long-term monitoring to varying degrees. Sub-workgroups of the TRRP RAE Workgroup have been formed and tasked with developing objectives and targets, using findings from studies and literature to identify a desired condition and methods to measure progress of the program toward achieving that condition.

This is a continuation of the efforts of TRRP workgroups to complete the tasks described in the IAP:

> *Re-rank assessments based on both temporal sequence (use decision tree) and dependence on results of other studies (contingent assessments)*
> *Refinement of performance measures – Interim targets – to be revised as information and adaptive management moves forward*
>
> *1. Identify which objectives may need TMC guidance prior to developing interim targets.*
> *2. Utilize the Program workgroups (TMC Subcommittee Report 2004) as the forum for developing interim targets with the IAP SC tracking/managing efforts.*
>
> *Provide short-term feedback to improve Program management actions by testing key hypotheses and reducing management uncertainties.*

Proposed Objectives and Targets

Objectives should describe the desired condition or trend in general terms while targets will detail specifics of metrics, whether it be a threshold or trend. Each objective may have more than one target (IDT memo 2018). The target proposed herein falls under the IAP Objective:

> *Rehabilitate and protect wildlife habitats and maintain or enhance wildlife populations following implementation*

As with the IAP, the objectives and targets presented here focus on FYLF. FYLF are an indicator species evolved to the rain and snow melt driven hydrology of the mainstem Trinity River. FYLF populations are particularly sensitive to the impacts of dams, diversions and flow regulation, and as a result their numbers have diminished over much of their range, including the mainstem of the Trinity River (Lind et al. 1996, Hayes et al. 2016).

Annual Flow Releases

While other management actions can help to provide wildlife habitats, annual flow releases are particularly influential to the reproductive success of the Foothill Yellow-legged Frog (FYLF). This is in large part due to the temperature dependent phenology of the species (Kupferberg 1996, Wheeler et al. 2015) and the vulnerability of the egg mass life history stage to changes in flow (Lind et al. 1996, Kupferberg et al. 2009).

Linking annual phenology of wildlife with temperature and flow regimes requires an understanding of important thresholds or cues that elicit behaviors from target species. In the complex environment of large river management for multiple species, it also involves an understanding of when it is most important to provide for a given species.

With this understanding we put forward the following targets for two RAE proposed objectives:

RAE proposed objective - Maintain a range of temperatures over various flow regimes needed by native species

- *Proposed Target*- achieve daily average water temp of 10 ^{o} C at the above NF USGS gage on or before May 1 during critically dry and dry water years; and maintain or increase for 14 days.

- *Proposed Target* – Limit 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 ^{o} 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. This target aims to promote timely oviposition and reduce scour of egg masses. This target is best prioritized in drier than Normal water years, and while it still should be considered by managers in Normal and wetter years, it should be weighed appropriately against other objectives.

RAE proposed objective - Maintain flow variability over a broad temporal range to promote scour and inundation to promote habitat complexity

- *Proposed Target* - Limit recession rate to 0.03 m/d for 35 days after achieving 10 ^{o} C for 10 days, at the gage above NF (USGS 11526400). This rate only applies to recession below the flow level at the end of the 10-day period when 10 ^{o} C was achieved. This target aims to reduce desiccation of egg masses by minimizing stage reduction during incubation. This target is best prioritized in drier than Normal water years, and while it still should be considered by managers in Normal and wetter years, it should be weighed appropriately against other objectives.

The above targets attempt to minimizing cold-water pulses associated with increased flows release during breeding and rearing season and allow for lateral warming to encourage timely breeding and high success. While protecting egg masses, the most vulnerable life stage of the FYLF, from direct mortality caused by management actions in years where high recruitment would be expected. The targets and thresholds proposed to support these RAE objectives are based largely on parameters derived for use in the Foothill Yellow-legged Frog Assessment Model (Railsback and Harvey 2015), supporting scientific literature (Kupferberg 1996, Kupferberg et al. 2009, Wheeler et al. 2015, Railsback et al. 2016, others), unpublished data (Welsh and Wheeler 2014), and personal knowledge (Pers. obs. K. DeJuilio, D. Ashton, others). The model, which has been used to assess hydrograph development and selection on the Trinity River over the past several years, was developed in collaboration with regional aquatic ecologists and leading species experts using the best available science.

Breeding of FYLF has been documented to occur after daily average water temperatures rise above 10 ° C (Kupferberg 1996, Wheeler et al. 2015), and when water stage is relatively stable (Welsh and Wheeler 2014, Wheeler et al. 2015). It can take 14 days after these conditions are present to result in 80% of adults being ready to spawn (Railsback and Harvey 2015). After oviposition, immobile egg masses are vulnerable to scour and desiccation (Kupferberg et al. 2009) for a period of 21 days or less, depending on water temperature (Railsback and Harvey 2015). In the week after hatching, tadpoles develop swimming capabilities allowing mobility to seek calmer waters or track receding shorelines during mild to modest flow fluctuations; swimming ability decreases again as tadpoles near metamorphosis.

The sum of time needed to elicit breeder readiness and egg mass development for 80% of the population was selected for the target duration. While recession rates were taken from unpublished data (Welsh and Wheeler 2014), the limit to magnitude of discharge increase was derived from personal knowledge and literature on the susceptibility of egg masses to scour. Egg masses appear to be vulnerable to scour at velocities over 0.13 m/s and with little survival occurring over 0.3 m/s mid column velocity (Railsback and Harvey 2015), and survival probability decreases with the duration of flows. To avoid increases in velocity on exposed gravel bars where spawning occurs increases to discharge must be limited. There are ways to more thoroughly examine the relationship of change in velocity with discharge within suitable habitat for oviposition (e.g. FYFAM). As velocity and habitat suitability for oviposition are spatially explicit and dependent on flow this problem can only be addressed over a small spatial scale or single flow. The sub-group putting this forward does not have the resources to conduct such and undertaking in the timeline available for target development.

Incorporation

The objectives and targets presented here should not be viewed alone, but in the context of all of the other objectives provided by all workgroups. Other objectives associated with riparian scour and stranding also suggest recession rates and flow increases at this time of year can affect cottonwood recruitment. If there are opportunities to coordinate targets and ensure they are not in conflict, the sub-group presenting these targets would welcome collaboration.

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TO: CHRIS LASKODI, RIPARIAN AND AQUATIC ECOLOGY (RAE) WORK GROUP COORDINATOR

FROM: CHRIS LASKODI (YUROK TRIBE) AND ERIC PETERSON (TRRP; BUREAU OF RECLAMATION

SUBJECT: **INCREASING THE WIDTH OF THE AQUATIC-TERRESTRIAL INTERFACE TARGET RECOMMENDATIONS**

DATE: DECEMBER 2020

Background

The TRRP was formed as a result of the 2000 Trinity River Record of Decision (ROD; DOI 2000). The ROD set in motion the implementation of a restoration strategy initially described in the Trinity River Flow Evaluation Final Report (TRFEFR; USFWS and HVT 1999) using three broad categories of management actions: 1) increased annual flow regimes and variable reservoir releases; 2) fine and coarse sediment management; and 3) mainstem channel reconstruction (mechanical channel rehabilitation). The TRRP established a partnership of Federal, State, County, and Tribal Governments to guide these management actions through an Adaptive Environmental Assessment and Management framework (AEAM). In 2009 an Integrated Assessment Plan was developed to prioritize the scientific investigations of the TRRP and set a course for AEAM. Rehabilitation and protection of wildlife habitats to maintain or enhance populations was established as one of six primary objectives (TRRP and ESSA 2009). Wildlife assessments were suggested by the IAP for:

> *"evaluating the long-term responses (e.g., survival, reproduction, productivity, abundance, species diversity, etc.) to the cumulative effects of managed flows, coarse sediment management, habitat rehabilitation, and other management actions. Assessments will also assist in evaluating success in establishing the amount and characteristics of riparian habitat that meet the needs of wildlife species."*

Specific recommended assessments include:

> *Promote diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and high quality aquatic and terrestrial habitat*

Since the completion of the IAP the recommended studies have been incorporated as part of the

TRRP's long-term monitoring to varying degrees. Sub-workgroups of the TRRP RAE Workgroup have been formed and tasked with developing objectives and targets, using findings from studies and literature to identify a desired condition and methods to measure progress of the program toward achieving that condition.

This is a continuation of the efforts of TRRP workgroups to complete the tasks described in the IAP:

> *Re-rank assessments based on both temporal sequence (use decision tree) and dependence on results of other studies (contingent assessments)*
> *Refinement of performance measures – Interim targets – to be revised as information and adaptive management moves forward*
>
> 1. *Identify which objectives may need TMC guidance prior to developing interim targets.*
> 2. *Utilize the Program workgroups (TMC Subcommittee Report 2004) as the forum for developing interim targets with the IAP SC tracking/managing efforts.*
>
> *Provide short-term feedback to improve Program management actions by testing key hypotheses and reducing management uncertainties.*

Proposed Objectives and Targets

Objectives should describe the desired condition or trend in general terms while targets will detail specifics of metrics, whether it be a threshold or trend. Each objective may have more than one target (IDT memo 2018). The target proposed herein falls under the IAP Objectives:

> *Establish and maintain vegetation that supports fish and wildlife*

As with the IAP, the objectives and targets presented here focus on increasing the width of the aquatic-terrestrial interface to expand riparian and wetland habitats. 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.

Management Actions

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).
With this understanding we put forward the following target for one RAE proposed objectives:

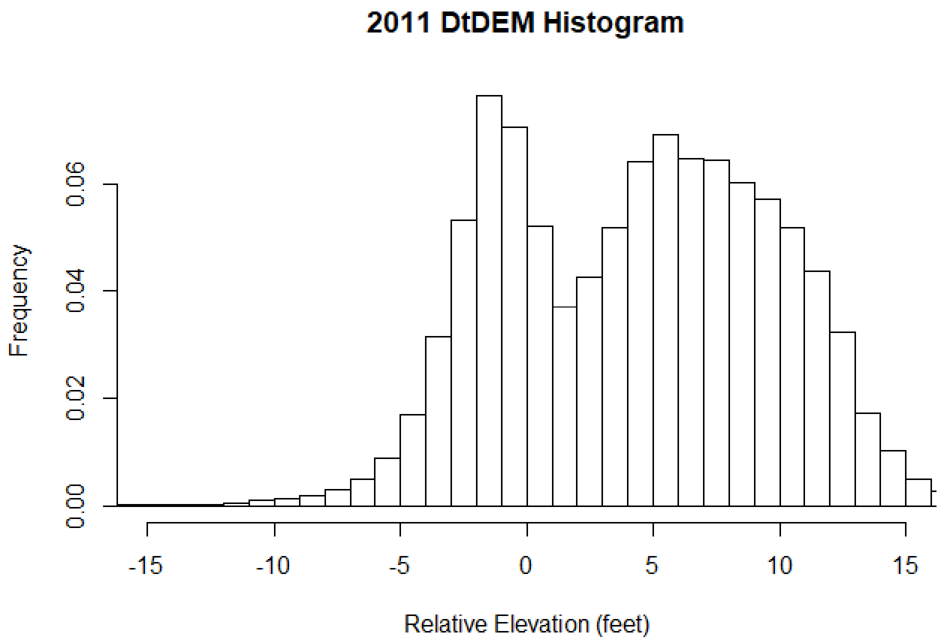
RAE proposed objective - Increase the width of the aquatic-terrestrial interface within the restoration reach that are colonized by native wetland and riparian plants

- *Proposed Target*- Increase area less than 6 feet above summer baseflow water surface elevation within the margins of the maximum fishery flow

The above target is an attempt to expand the riparian corridor along the mainstem Trinity River. This target is based on IAP objective 5.1 to promote diverse riparian vegetation on various surfaces. 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 creating diverse riparian vegetation on multiple surfaces. Riparian vegetation patches that are distributed across upper bars, floodplains, and high flow channels will provide a continuous vegetation corridor while discouraging the formation of riparian berms along the low water channel (TRRP and ESSA 2009). Increasing the width of the riparian corridor is important to bird, mammal, and herpetofauna species.

Data sources

This target will rely on already existing data collected by the Program. LIDAR, bathymetry, and photogrammetry will be used to develop DEMs for the restoration reach. This data is already collected periodically (every several years) and evaluation should occur on these timescales. One advantage to using this data is it allows analysis on multiple scales. An example of the potential analysis can be seen in Figure 1. 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.



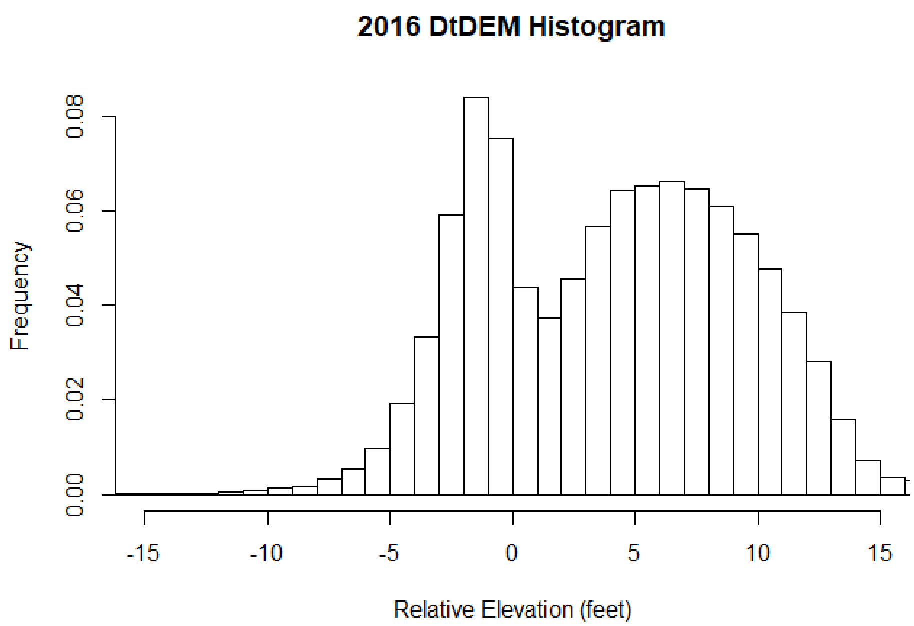


Figure 1. An example of an analysis used to determine the height of selected surfaces above baseflow conditions. These graphs are used to describe the change of the relative frequency of elevations within the restoration reach.

Incorporation

The objectives and targets presented here should not be viewed alone, but in the context of all of the other objectives provided by all workgroups. If there are opportunities to coordinate targets and ensure they are not in conflict, the sub-group presenting these targets would welcome collaboration.

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