Meeting Summary

FISH WORK GROUP

Tuesday September 14, 2021

WebEx

Tuesday, September 14, 2021: 10:00 AM

Participants

Core members: Kyle De Juilio (YTFP), Steve Gough (USFWS), Ken Lindke (CDFW, coordinator), Eric Peterson (USBR/TRRP), Karl Seitz (HVTFP), Eric Wiseman (USFS)

Other participants: Todd Buxton (USBR/TRRP), Taylor Daley (USFWS), Chad Martel (HVTFP), Oshun O'Rourke (YTFP), Bill Pinnix (USFWS)

Action Items Derived During the Meeting

Action Item 1: Work group members will provide Ken with rankings for proposed projects for FY2022 science priorities, one ranking per agency.

Action Item 2: Work group members will provide Ken with their vote for a new Fish Work Group coordinator between Kyle De Juilio and Bill Pinnix, one ranking per agency.

Action Item 3: Steve and Kyle will provide a single recommended target for the pre-spawn mortality objective or solicit the work group for further direction at the next meeting if necessary.

Action Items Outstanding from Previous Meetings

Action Item 1 (26 Oct 2020): Kyle and Bryan will work with the Trinity River hatchery technical team to develop a target for minimizing competition and predation on juvenile natural-origin salmonids by juvenile hatchery-origin salmonids.

Summary of Meeting by Agenda Item

Outstanding action items from previous meeting(s)

Action Item 1 (26 Oct 2020): Kyle and Bryan will work with the Trinity River hatchery technical team to develop a target for minimizing competition and predation on juvenile natural-origin salmonids by juvenile hatchery-origin salmonids

Kyle reported that the hatchery technical team is still overwhelmed with implementation of the hatchery genetics management plan, so they have not made progress on the target. There are recommendations in the HGMP to reduce competition, so they do need to address it. There is a predation-competition risk model that uses co-habitation as a surrogate for predation and competition. The metric is pretty well defined as the rate of outmigration, but the target in terms of a specific rate is not defined. Increasing the rate of outmigration of hatchery releases is desirable to reduce co-habitation with natural-origin fish, and the hatchery is experimenting with release timing and release group size. The rate of outmigration is measured using screw trap data, which is funded by TRRP, but the traps aren't necessarily designed for that purpose. For example, the screw traps aren't operated during the Chinook yearling releases.

Fish Work Group new coordinator selection

Ken stated that he thought Chris Laskodi was the most natural fit because he is the new Program fish biologist. However, because Chris wasn't at the meeting, Ken didn't think it was fair to nominate him. Ken then asked for each agency to speak and offer a recommendation. Kyle agreed that Chris would be good, but he is already coordinating the Riparian and Aquatic Ecology Work Group. Kyle volunteered himself. Karl did not have a recommendation from HVTFP because both representatives for the Fish Work Group are new and he had not conferred with other staff. USBR and USFWS did not have recommendations and/or had not followed up with other staff. Later in the meeting, after this agenda item was over, Bill joined the call and volunteered to be coordinator. Because USFS and NMFS were not in attendance, Ken agreed to solicit votes via email and report back. A few days after the meeting votes were in and Bill will be the next coordinator. The vote was 5-2.

Update on objectives/targets refinement

Ken reported that he had prepared a memo to James Lee on behalf of the Fish Work Group describing the work conducted over the past couple years on objectives/targets refinement and the current status. All other work groups prepared similar memos, which were incorporated into a status report for IDT and TMC. Ken expressed his opinion that objectives/targets refinement is not complete until every objective has an existing or proposed target, or development of a target has been intentionally deferred until a later time when additional specific information becomes available (e.g., through synthesis reports or other studies). He recommended setting this as a goal for the work group. Targets are still outstanding for two objectives: reduce pre-spawn mortality of adult fish, and the juvenile outmigration temperature targets at Weitchpec.

Kyle reported that he and Steve have been working on a pre-spawn mortality (PSM) target. Current management actions are focused on the temperature target, but not directly on a PSM rate. Every year we maintain 450 ft^3/s until 15 October to protect holding adult Chinook. That's a lot of water volume for that purpose and significantly higher than flows under natural conditions. Pre-spawn mortality has been monitored annually since 2001 with less consistent but still frequent estimates from 1955-1994. Annual PSM has been mostly below 10% with only four years considerably higher. All the high PSM occurred prior to ROD implementation. Ken noted that escapement was high in at least a couple of those years, and escapement would still be good even after accounting for high PSM. Kyle noted that higher PSM rates may not be a concern when escapement is high if sufficient numbers of adults live to spawn such that density-dependent factors are still at play in later life stages. He offered three potential targets for consideration and requested feedback from the group to move forward on one of these options:

- Given the baseline PSM rate seems to be about 10%, a rate of ≤10% could be the target.
- The high PSM rates were often associated with high escapement years, suggesting some density dependence. We may not want to maintain low PSM at the cost of high escapement because this could just defer density dependent mortality to later life stages, e.g., through redd superimposition or juvenile competition. A PSM target could be a function of escapement so that PSM is low when escapement is low, but increases with increasing escapement.
- A third option is a hybrid of the two. The target could be ≤10% until escapement targets are met, then increase to maintain escapement targets.

Steve noted that all the proposed targets are post-season assessments, so they couldn't be used to guide real-time management actions. Also, they're all proposed as annual targets, rather than something like a running average that could accommodate natural perturbations (e.g., a single high mortality year during an otherwise good period of years). Ken noted that all the high PSM rates were pre-ROD, which could be interpreted as evidence that ROD releases have been effective at reducing PSM. He asked if there have been other factors identified that could explain the observations, e.g., high escapement as mentioned earlier. Kyle noted that all the high PSM years occurred in a 10 year period of 1980-1989. In particular, he noted that there were only a few years of high PSM, but we invest a lot of resources (i.e., water) every year to prevent something that is uncommon to begin with. Maybe the question shouldn't be whether PSM is bad, but instead, is the resource investment appropriate for the risk. Todd pointed out that PSM isn't necessarily bad. It is a natural phenomenon and imposes selective pressures on the population that affect the genetic composition of the stock. There was no clear preference among the group as to which target would be best. Ken recommended that Kyle and Steve continue working to come up with a single recommendation that could be debated at a later work group meeting.

Ken provided a brief update on the juvenile outmigration temperature target, which was essentially the same information provided at the 6 January 2021 meeting (see meeting summary for details). He asked that anyone who has the time or interest in collaborating on development of this target should contact him. Kyle said the temperature synthesis report currently in peer review would be a good resource for further development of this target.

<u>Discuss ideas for FY22 science priorities and identify pre-proposal authors</u>

The group was presented with six concepts, pre-proposals or brief descriptions of which are provided as attachments to this meeting summary. Due to time constraints, there was little discussion beyond the PI's presenting their concepts. The group agreed to provide Ken with rankings for these projects, one ranking per agency.

<u>Juvenile synthesis report preview</u>

Bill presented results of the juvenile synthesis report and a discussion was had regarding the different juvenile Chinook Salmon metrics presented (abundance, total biomass, juveniles-per-spawner [JPS], and biomass-per-spawner [BPS]). Juvenile Chinook Salmon showed a positive response to the implementation of the ROD flows, but no significant trend in abundance or biomass post-ROD implementation. Because of a density dependent relationship between spawners and juveniles (fewer juveniles produced at high spawner abundance), JPS and BPS showed evidence of a positive trend post-ROD implementation. Kyle pointed out that if JPS or BPS were maximized as primary metrics of the program then we would be more successful if the number of spawners was low. A short discussion followed and partners agreed that total biomass was a more appropriate metric to measure program success, but that BPS is a good measure of the productivity or capacity of the upper Trinity River restoration reach.

12:30 PM Adjourn

Update and improvements to the RBM10 model for predicting water temperatures in the Trinity River

Todd Buxton, Ph.D., Hydrologist, Trinity River Restoration Program, Project management, model testing
Yong Lai, Ph.D., Hydraulic Engineer, U.S. Bureau of Reclamation, 1D flow modeling, model refinement
Eli Asarian, Aquatic Ecologist, Riverbend Sciences, Tributary flow and temperature boundary conditions
Russel Perry, Ph.D., Research Fish Biologist, U.S. Geological Survey, Model calibration and code update
Nick Swyers, Fish Biologist, U.S. Geological Survey, Graphical user interface (GUI) development

Besides water itself, water temperatures are the primary driver of biological productivity in rivers. As such, water temperature management in the Trinity River is challenged by the need to meet both the cold-water requirements of adult salmon and warmer water needs of juvenile salmonids, foothill yellow-legged frogs, and western pond turtles. To help design flow releases to the river and evaluate management actions to meet these requirements, the RBM10 temperature model was developed by the U.S. Geological Survey and U.S. Fish and Wildlife Service to estimate daily average water temperatures in one dimension (1D; cross section and depth averaged) between Lewiston Dam and the confluence with the Klamath River (Jones et al., 2016). Since its release, minor improvements to RBM10 have been implemented and version 1.7.5 is current. We propose developing a version 2.0 RBM10 model to address major shortcomings of the current model that have arisen through its widespread use. Toward this end, a list of tasks, their need, and estimated date for completion (assuming a January 1 start date) follows.

Task 1: Develop 1D flow models using Hec-Ras and SRH-1D (hereafter 1D models) using the latest terrain models for the Trinity River between Lewiston Dam and the Klamath River. Cross sections now used in RBM10 for flow predictions outside the restoration reach are hand drawn (not surveyed). February 1.

Task 2: Extend RBM10 to accept flow results directly from the 1D models. This will enable temperature estimates by RBM10 at flows as low as around 50 cfs. This capability is needed for evaluating consequences of extreme drought on the Trinity River and effects of low flows that enable temperature stratification in river pools according to preliminary results of the TRRP-funded pool stratification study. Flow widths and areas in RBM10 are currently estimated by power function relationships to discharge instead of accepting the modeled flow attributes directly. These conversions may not accurately represent flow attributes at low discharges given the model’s current limitation is to discharges ≥300 cfs. May 1.

Task 3: Refine boundary conditions to improve the accuracy of tributary inputs of flow and temperature to the river. The current method assigns changes in discharge between flow gages on the river proportionately by tributary watershed area. However, when large changes in river flows occur, negative flow from tributaries can result and cause error in predictions of water temperatures in the river, particularly when running flow scenarios that differ from historical flows. July 2.

Task 4: Update meteorological inputs in RBM10 to enable temperature estimates for January 1, 1980 through 2021. Temperature estimates in RBM10 are currently limited to the 2018 calendar year. July 1.

Task 5: Calibrate and validate the updated RBM10 model. September 1.

Task 6. Update the GUI for RBM10 to 1) enable user choice to model flows with either 1D model or the current method and 2) output results for locations in 0.1-mile increments. The current GUI is only able to output results for every river mile and provides no choice in estimates of thermal advection. June 1.

Task 7. Reporting, publication, and RBM10 v.2.0 release. December 15.

Estimated budget: $105,000.

Development of SRH 2-D as a Tool Used to Inform Project Site Design and Performance

Developed by: Dave Gaeuman (dgaeuman@yuroktribe.nsn.us) and Kyle De Juilio (kdejuilio@yuroktribe.nsn.us)

Background

Thermal diversity of side-channels, backwaters, and edge habitats from reduced mixing and pooling of side slope and tributary inputs provides for the diverse needs of aquatic biota (Gallagher 1999; Hayashi and Rosenberry 2002). Thermal heterogeneity in the lateral dimensions can provide resolution to perceived conflict between management for salmonids and other species (e.g., Northwestern Pond Turtles, Foothill Yellow-legged Frogs) (Railsback et al. 2016) by providing a greater range of temperature conditions (TRRP and ESSA 2009).

Mechanisms for water to differentiate on margins and floodplains through reduced mixing allow for local variability beyond the larger longitudinal dimensions regulated by single species temperature management criteria and captured by most data collection efforts. Local variability can be exploited by motile ectothermic biota moving laterally to thermoregulate. Management actions of flow release and channel rehabilitation were modeled using Sediment and River Hydraulics two-dimensional hydraulic, sediment, temperature, and vegetation model (SRH-2D) and demonstrated to have impacts on localized thermal gradients in the recent temperature synthesis (Asarian et al. in draft).

Application of SRH-2D analyses presented in the temperature synthesis demonstrated that the unrestored channel exhibits nearly entirely mixed conditions leading to almost no variability in temperature over a range of conditions. However, the opposite was true for the project design condition, where a wide range of temperatures were observed (Figure 1 and Table 1). The IAP (TRRP and ESSA 2009) recommended the development of thermal heterogeneity metrics, and SRH-2D shows promise to be able to fulfill that recommendation. However, the module has not been formally validated or published.

Scope of Work

We propose to do a formal validation study across both complex and simple channel morphology in the Trinity River to quantitatively assess whether SRH-2D can successfully simulate spatial variability in water temperatures within a stream reach. Assuming model performance is judged to be satisfactory, SRH-2D can be incorporated into site design and effectiveness monitoring. Temperature distributions derived from SRH-2D could be used to better inform existing models like the Foothill Yellow-legged Frog Assessment Model (FYFAM) and the Stream Salmonid Simulator (S3), though this effort will not result in a workflow that would allow for this.

This effort would consist of placing an array of remote temperature loggers in the Trinity River channel and marginal habitats during 3 different times of year and flow conditions (spring during low flow, spring during high flow, and mid-summer) for a 7-day period. The empirical water temperature distribution would then be compared to SRH-2D temperature outputs based on stream flow and temperature data from the nearest USGS gage and meteorological recorded at existing automated weather stations.

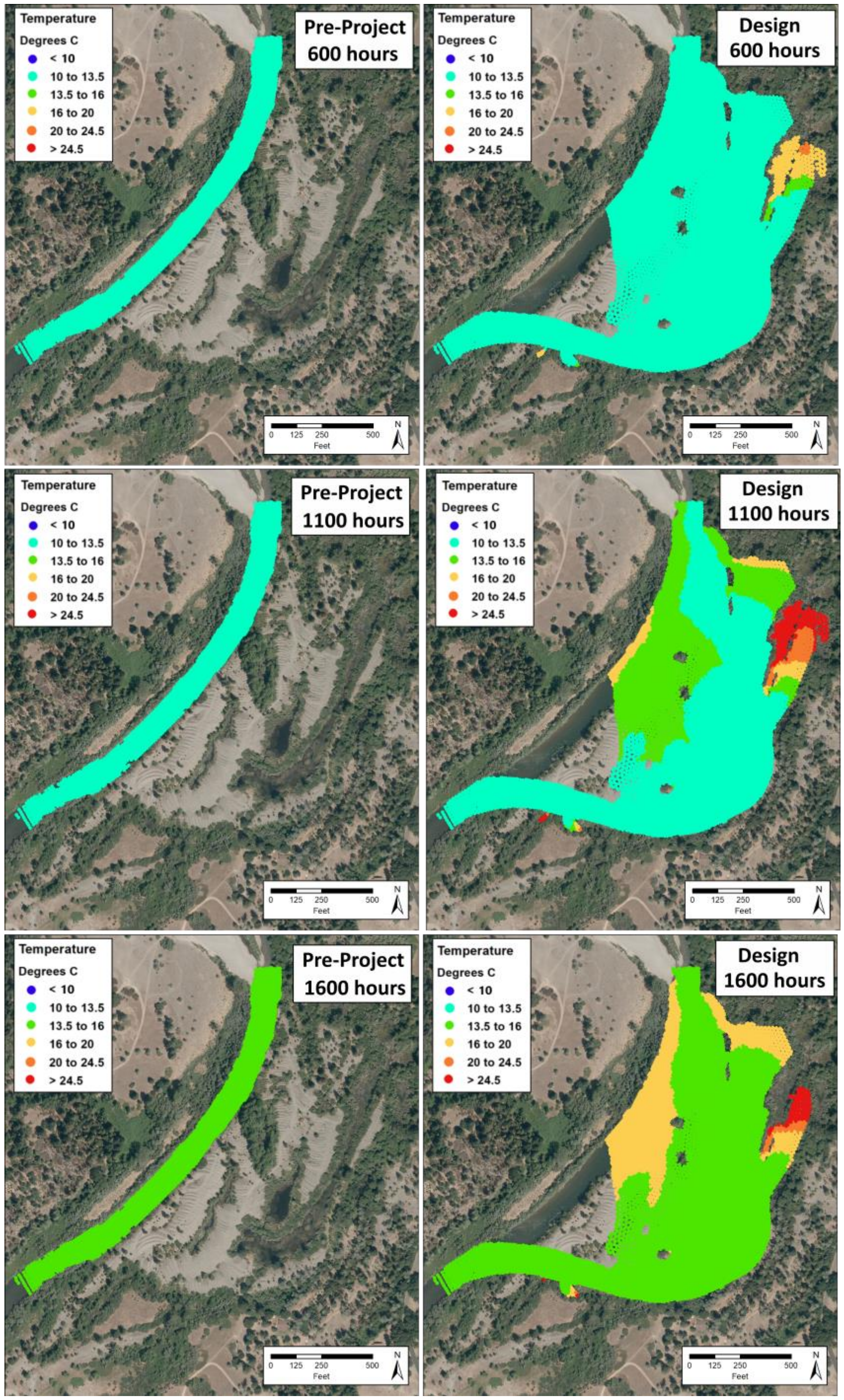

Figure 1. Map of modeled temperature output from the draft Temperature Synthesis (Asarian et al. in draft) for pre-project (left) and design (right) conditions in the Oregon Gulch reach computed with meteorology and hydrology inputs for extremely wet hydrology on July 25th, 2019. Flow direction is from the bottom of the image to the top. Temperature categories are based on thresholds for juvenile salmonid growth from Carter (2005), where growth ceases at <5 °C, growth reduced by >20% at 5-10 °C, growth reduced by 10-20% at 10-13.5 °C, growth reduced by <10% at 13.5-16 °C, maximum growth range and increased prevalence of disease at 16-20 °C, growth reduced <20% and high prevalence of disease at 20-24.5 °C, and >24.5 °C is unsuitable for salmonids but can benefit other species.

Table 1. Results from Temperature Synthesis (Asarian et al., in draft) SRH-2D temperature modeling at the Oregon Gulch rehabilitation site for pre-project and design conditions under extremely wet and critically dry hydrology for three different times of day and times of year. T_μ = area-weighted average temperature, T_σ = standard deviation of temperatures, and T_r = range of temperatures.

Year	Date	Q ft³/s	Time	Pre-project			Design		
				T_μ °C	T_σ °C	T_r °C	T_μ °C	T_σ °C	T_r °C
2018 - Critically Dry WY	14-Apr	600	6:00	10.00	0.024	1.0	10.00	0.057	4.0
			11:00	11.00	0.000	0.5	11.39	0.478	9.0
			16:00	13.50	0.031	1.0	13.58	0.425	14.0
	19-Apr	1270	6:00	8.50	0.011	1.0	8.50	0.064	5.0
			11:00	9.50	0.029	1.0	10.10	0.689	13.5
			16:00	12.49	0.054	1.0	12.63	0.606	15.5
	25-Jul	425	6:00	15.51	0.071	1.0	16.48	1.812	8.5
			11:00	15.88	0.221	1.5	17.82	3.930	19.5
			16:00	17.36	0.225	1.0	19.93	5.368	22.5
2019 - Wet WY	13-Apr	1410	6:00	9.00	0.000	0.5	9.00	0.092	5.5
			11:00	9.50	0.000	0.5	10.20	0.880	13.0
			16:00	12.00	0.000	0.5	12.31	0.951	17.5
	19-Apr	6570	6:00	7.51	0.200	3.5	7.51	0.188	5.0
			11:00	8.73	1.601	18.5	8.69	0.988	17.5
			16:00	9.85	2.423	20.5	9.92	1.822	20.5
	25-Jul	700	6:00	12.00	0.000	0.5	12.45	1.256	9.5
			11:00	12.50	0.037	1.0	13.95	2.929	20.5
			16:00	14.51	0.057	1.0	16.10	3.456	23.0

Temperature is dynamic across space, time of day, season, and flow. Should the model be sufficiently validated that it is deemed useful, a significant task will be the development of summation tools and terms to describe thermal heterogeneity across the conditions that are expected to be present at the site or considered the most important. While the temperature synthesis attempted to summarize this information, we propose to more fully develop a robust and concise summary of temperature modeling results which could be presented during future evaluations.

Deliverables

The products from this effort would be a case study and validation at both an unrestored and restored site, which presented validation and summary data for 2-D temperature modeling and empirical data. The report summarizing this information would be completed within 6 months of completion of data collection Data collection would occur over the 6 - 12 months following funding. An estimated cost of this effort $20,000 - $30,000.

Literature Cited

Asarian, E., K. De Juilio, D. Gaeuman, S. Naman, and T. Buxton. *in draft*. Synthesizing 87 years of scientific inquiry into Trinity River water temperatures. Report prepared for the TRRP in response to solicitation for synthesis reports 2018.

Gallagher, S.P. 1999. A note on observations of thermal habitat diversity at channel rehabilitation and control sites in the Trinity River during April 1998. Report by U.S. Fish and Wildlife Service, Arcata, CA. http://www.trrp.net/library/document/?id=1478

Hayashi, M. and D.O. Rosenberry. 2002. Effects of Ground Water Exchange on the Hydrology and Ecology of Surface Water. Groundwater. 40(3): 309-316. https://doi.org/10.1111/j.1745-6584.2002.tb02659.x

Railsback, S.F., B.C. Harvey, S.J. Kupferberg, M.M. Lang, S. McBain, and H.H. Welsh. 2016. Modeling Potential River Management Conflicts between Frogs and Salmonids. Canadian Journal of Fisheries and Aquatic Sciences 73:773–784. doi: 10.1139/cjfas-2015-0267.

Trinity River Restoration Program (TRRP) and ESSA Technologies Ltd. 2009. Integrated assessment plan. TRRP, Weaverville, California. https://www.trrp.net/library/document/?id=400

Effects of Scour and Inundation on Trinity River Aquatic Communities

Kyle De Juilio and Chris Laskodi (Yurok Tribe)

Alison O'Dowd, Ph. D (Humboldt State University)

Justin Alvarez (Hoopa Valley Tribe)

Background

Physical habitat is hypothesized to be limiting on the Trinity River for salmonids (USFWS and HVT 1999). Generally, this is considered to be a limitation of planform complexity, which limits complexity of associated habitat species criteria (depth and velocity). However, physical processes also alter habitat through scour on an annual or semi-annual basis affecting species assemblage and prey availability, by removing periphyton from rock surfaces and causing mortality to macroinvertebrate populations (Cross et al. 2011; Parker and Power 1997; Power and Parker 2008; Wooton et al. 1997). The riverbed is most susceptible to disturbance when it is not 'water worked' (Buffington and Montgomery 1997). This means that the first or largest flood of the year is the most disruptive to active channel substrates. The first and largest floods in the Trinity River pre-dam happened between December and March, caused by rain on snow events (Buxton and Bradley, in review). The contemporary (post-dam) hydrology causes the first and largest floods to occur in late April or May due to dam releases after the water year type has been determined and environmental flow release volumes are made available. This shift in timing moves flow releases 2-4 months later than occurred prior to dam construction. This several month delay could disrupt reproduction, dispersal, or other phenology of aquatic organisms including juvenile salmonids. Since scour can act like a 'reset button' for benthic macroinvertebrate and algal communities (Davie et al. 2012; Milner et al. 2013), it is important scour events occur prior to juvenile salmonid presence during the late winter/early spring.

In addition to the scour disturbance of habitat, inundation of marginal habitat transforms terrestrial habitat into aquatic habitat at high flow levels. Similar to scour, post-dam hydrology has altered the frequency, timing and duration of marginal inundation. Pre-dam flows on the Trinity River reached annual minimums in late summer (August/September), followed by initial increases in the fall (October/November). Prior to the damming of the Trinity River, winter snow that accumulated at higher elevations of the watershed led to snowmelt hydrographs in the spring (March and April) and sustained higher flows well into May in the wettest years. The pre-dam spring recession limb occurred between March and June with minimum flows in August or later (USFWS and HVT 1999). The natural, pre-dam hydrology of the Trinity River inundated marginal habitats for roughly 10 months, whereas the current regulated hydrology has reduced the typical marginal inundation period to only 2-3.5 months. The duration of marginal habitat inundation is important, as it can affect the overall productivity of the biota within. It is not clear how an increased marginal inundation period on the Trinity River would influence invertebrate food resources for salmonids, but a study on the Mokelumne River showed macroinvertebrate biomass peaked at 12 weeks and abundance peaked at 18-20 weeks of inundation (Merz and Ochikubo Chan 2005).

Scope of Work

We plan to conduct monthly benthic monitoring in order to describe seasonal changes in aquatic invertebrate species composition and capture before and after samples to document impacts and succession of habitats that experience catastrophic drift events due to streambed scour. We will also conduct benthic surveys of inundated marginal habitat to assess invertebrate colonization and productivity compared to adjacent perennially wetted areas. The introduction of artificial substrates will also occur monthly and will be used to characterize colonization of available habitats by algae, diatoms, and macroinvertebrates at different times of year. Artificial substrates will enable us to complete portions of the study regardless of water year type (an issue that occurred in previous years).

Collection of macroinvertebrates will be completed by Yurok and Hoopa Valley Tribe technicians and Humboldt State University professor and graduate student. All sample processing, data analysis, and reporting will be completed by the Humboldt State University River Institute.

Deliverables

April of 2023: Annual Progress Report for FY2022, including results from 2023 survey season.

December 2023: a presentation of results will be made to the Flow and Fish work groups summarizing results in 2023, the information will address TRRP research, management, or information need.

April of 2024: Final Report, including details of all survey results. This document will provide key data for the providing adaptive management recommendations, .doc format.

Budget

Total: $140,000-180,000

References

Buffington, J.M. and D.R. Montgomery, 1997. A systematic analysis of eight decades of incipient motion studies, with special reference to gravel-bedded rivers. Water Resources Research 33(8):1993-2029

Buxton, T.H. and D.N. Bradley (In Review) Evolution of tributary junctions and their capacity for rearing juvenile Chinook salmon (Oncorhynchus tshawytscha) on a regulated river. Ecohydrology journal.

Cross, W.F, C.V. Baxter, K.C. Donner, E.J. Rosi-Marshal, T.A. Kennedy, R.O. Hall, Jr., H.A. Wellard Kelly, and R.S. Rodgers. 2011. Ecosystem ecology meets adaptive management: food web response to a controlled flood on the Colorado River, Glen Canyon. *Ecological Applications* 21(6): 2016-2033.

Davie, A. W., S. M. Mitrovic, and R. P. Lim. 2012. Succession and accrual of benthic algae on cobbles of an upland river following scouring. Inland Waters 2(2):89-100.

Merz, J. E. and L. K. Ochikubo Chan. 2005. Effects of gravel augmentation on macroinvertebrate assemblages in a regulated California river. River Research and Applications 21:61-74.

Milner A. M., A. L. Robertson, M. J. McDermott, M. J. Klaar, and L. E. Brown. 2103. Major flood disturbance alters river ecosystem evolution. Nature Climate Change 3(2):137-41.

Parker, M.S., and M.E. Power. 1997. Effect of stream flow regulation and absence of scouring floods on trophic transfer of biomass to fish in Northern California rivers. UC Berkeley Technical Completion Reports; https://escholarship.org/uc/item/90f0p629.

Power, M.E., M.S. Parker, and W.E. Dietrich. 2008. Seasonal Reassembly of a River Food Web: Floods, Droughts, and Impacts of Fish. Ecological Monographs 78(2):263-282.

USFWS (U.S. Fish and Wildlife Service) and HVT (Hoopa Valley Tribe). 1999. Trinity River flow evaluation final report. USFWS, Arcata, California and HVT, Hoopa, California. http://www.trrp.net/library/document/?id=226

Wooton, J.T., M.S. Parker, and M.E. Power. 1996. Effects of Disturbance on River Food Webs. Science 473(5281):1558-1561.

Trinity River *Ceratonova shasta* sampling proposal

Hoopa Valley Tribal Fisheries Department

TRRP Fish Workgroup

Background

Ceratonova shasta is a parasitic disease found in the Klamath Basin that affects salmon and steelhead. *C. shasta* can have an enormous negative impact on juvenile salmonid survival and is known to have a larger effect when environmental conditions are not favorable (ie. warm temperatures and low dissolved oxygen). For over a decade there has been consistent monitoring for *C. shasta* in the mainstem Klamath, primarily in the mid and upper reaches, but the most recent sampling efforts in the Trinity River were nearly a decade ago. *C. shasta* was not detected in the Trinity the at that time however, given the low water conditions, lack of geomorphic flows, and observed changes in algae in both the Trinity and lower Klamath, it would be prudent to ensure that is still the case. There were fish with clinical signs of *C. shasta* caught in the lower Trinity in 2021 but the cause of the abdominal swelling was not confirmed.

Project Description

The Hoopa Valley Tribe will collaborate with Oregon State University to quantify *C. Shasta* spore concentration two locations in the Trinity Basin which complement the existing sampling being performed in the Klamath. The sampling will be conducted weekly in concert with the sampling efforts being performed in the Klamath and can be used to inform both the existing FASTA team and TRRP staff about conditions in the Trinity as compared to the Klamath. The sampling locations are the mainstem Trinity in Hoopa and upstream of the confluence with the South Fork Trinity River.

Objective

Determine if *C. shasta* is currently present in the Trinity River and if so, what is the density level of the parasites, how does parasite load vary temporally over the spring outmigration period and spatially as you move upriver, and how does this compare to the parasitic loads found in the Klamath River?

Task

Determine the density *C. shasta* parasites in Trinity River water samples to during spring juvenile salmonid outmigration periods. Weekly, 1L river water samples will be collected every 2 hours for 24 hours by an ISCO automatic sampler and pooled. After 24 hours, 4 1L samples will be taken manually from the 12L pool by Hoopa tribal biologists and filtered within 24 hours. The concentrated captured material will be sent (FedEx or UPS overnight) to OSU for molecular analysis to determine the total *C. shasta* DNA in three of the four samples using qPCR (as per Hallett and Bartholomew 2006, Hallett et al. 2012); the fourth sample will be archived frozen. All water samples are simultaneously tested for assay inhibition. Water sample analysis will be rolling with updates available weekly during salmonid outmigration.

Water collection will occur at the following two sites, weekly, March through July:

1. Hoopa Reservation on Trinity River (THR)
2. Mainstem Trinity upstream of South Fork (TBD; TXX)

The water samples will be tested by molecular assay (qPCR) for total *Ceratonova shasta*, *C. shasta* coho genotype II.

Deliverables

This project will produce a technical report describing the findings and any important conclusions drawn from the data. Additionally, this data may be used as the basis for continued monitoring in the future if spores are detected in the Trinity River.

Timeline

Sampling will occur March through July of 2022. Reporting will conclude by March of 2023.

Literature Cited

Hallett SL, Bartholomew JL (2006) Application of a real-time PCR assay to detect and quantify the myxozoan parasite *Ceratomyxa shasta* in river water samples. *Diseases of Aquatic Organisms* 71:109-118.

Hallett SL, Ray RA, Hurst CN, et al. (2012) Density of the waterborne parasite *Ceratomyxa shasta* and its biological effects on salmon. *Applied and Environmental Microbiology* 78:3724–3731.

Budget

Item	Quantity	Unit Price	Total Cost
1L sample bottles	2	$120/6-pack	$240
ISCO 3700 automatic water sampler	2	$4055	$8110
Solar panels	2	$100	$200
Marine battery	2	$200	$400
Tubing	2	$200	$400
Temp loggers	2	$120	$240
Filter paper discs	2	$180/100-pack	$360
Vacuum filtration apparatus	1	$1565	$1565
Miscellaneous sampling supplies			$200
Postage	22	$30	$660
DNA extraction and PCR at OSU	132	$40/sample	$5280
C. shasta assays at OSU	132	$20/sample	$2640
Total genotyping at OSU	44	$31/sample	$1364

OSU consultant fees	22	$80/hour	$1760
Hoopa Staff			
Salaries			$23,420
Benefits			$10,071
Travel			$1064
Sub-Total Direct Costs			$57,974
Indirect costs (65.69% of wages)			$15,385
Project Total			$73,359

Comparing physical and bioenergetic metrics of juvenile salmonid habitat at channel rehabilitation sites in the Trinity River

Yurok Tribe: Emily J. Cooper, M.S.–Restoration Ecologist; Kyle DeJuilio–Fisheries Biologist; David Gaeuman, Ph.D.–Geomorphologist; Aaron Martin–
Hoopa Tribe: Justin Alvarez, M.S.–Fisheries Deputy Director; Chad Martel, M.S.–Fish Biologist
Arcata Fish and Wildlife Office: Josh Boyce, Ph.D.–Fish Biologist

Physical rearing habitat, hypothesized to limit salmon production in the Restoration Reach of the Trinity River, is characterized by depth, velocity, and in-water escape cover criteria. It is currently expressed as Capacity, or the number of fish that can occupy an area given particular values of the three criteria. Approaches that use physical variables with habitat suitability curves (HSC) to identify instream flow needs of salmonids is computationally convenient and widely used in fisheries management. However, many studies have found shortcomings to physical HSC based approaches (Barinaga 1996, Rosenfeld et al. 2012, Hayes et al. 2016, Naman et al. 2019) including overestimation of habitat at low flows (Rosenfeld et al. 2012, Hayes et al. 2016), misinterpretation of the relationship between habitat preference and the fitness consequences of habitat use (Naman et al. 2019), and to poorly manage the needs of multiple species (Castleberry et al. 1996, Davies et al. 2014; Shirvell 1986). The Integrated Assessment Plan (IAP, TRRP and ESSA 2009) identifies juvenile salmonid abundance, growth, and survival to be controlled by three interacting components, including the physical environment (e.g. hydraulic conditions), water quality (e.g. temperature), and food resources (Smith and Li 1983, Fausch et al. 1984, Nielson 1992, Harvey and Railsback 2009, Piccolo et al. 2014). These latter two components have received less attention in the Trinity River.

Profitable feeding locations for drift foraging fish can be lacking during lower streamflows, and therefore incorporating this dynamic into habitat assessment can better predict juvenile salmonid densities (Hayes et al. 2016, Naman et al. 2019). Bioenergetics modeling is a readily available method and effective alternative for habitat assessment that encompasses physical, temperature, and productive components pertinent to rearing salmonids. Naman et al. (2020) released a software tool that generates HSC curves based on bioenergetics (NREI model) for given temperature, depth, and velocity outputs of 2-D hydrodynamic models, offering a perspective on the ability of juveniles to exploit food resources given a set of physical parameters.

We propose a comparison of Capacity and NREI habitat estimates derived from 2-D hydrodynamic models developed during the design phase of an estimated 6 sites where modeling materials already exist, including: Oregon Gulch, Deep Gulch, Sheridan Creek, Connor Creek, Sky Ranch, and Dutch Creek channel rehabilitation sites. This will result in spatial map outputs and streamflow to habitat curves that can be used to test the hypothesis that the benefit of physical rearing habitat is overvalued at lower streamflows and that the relationship between discharge and Capacity and discharge and NREI models will differentially respond over a range of streamflows. The NREI model requires data inputs that already exist in the Trinity River, including hydraulics (e.g. depth and velocity, Bradley 2018), temperature (Asarian et al. 2021, *in review*), and drift concentration, as well as taxonomic size and composition of benthic and drift macroinvertebrates (Starkey-Owens 2020, Williamshen 2021).

The modeling will be completed within 6 months of receipt of funding and a final report will be prepared and presented to the Program within a year of receipt of funding. The project collaborators are prepared to execute this project successfully having previously conducted habitat assessments for the TRRP over multiple spatial and temporal scales. Also, in preparation for the proposed project, David Gaeuman has explored the use of the NREI model using depth and velocity predictions generated from a hydrodynamic model of the Sheridan Creek rehabilitation site. Estimated budget: $25,000-$40,000.

Literature Cited

Asarian, J. E., K. DeJuilio, D. Gaeuman, S. Naman, and T. Buxton. 2021, *in review*. Synthesizing 87 years of scientific inquiry into Trinity River water temperatures. Prepared for Yurok Tribe Fisheries Department and Trinity River Restoration Program.

Barinaga, M. 1996. A recipe for river recovery? Science 273:1648-1650.

Bradley, D. N. 2015. Trinity River 40-mile hydraulic model: Development and analysis, technical report No. SRH-2016-27. Prepared for Trinity River Restoration Program, August 2016.

Fausch, K.D. 1984. Profitable stream positions for salmonids: relating specific growth rate to net energy gain. Canadian Journal of Zoology 62:441–451.

Harvey, B.C., and S.F. Railsback. 2009. Exploring the persistence of stream-dwelling trout populations under alternative real-world turbidity regimes with an individual-based model. Transactions of the American Fisheries Society 138:348–260.

Hayes J. W., E. Goodwin, K. A. Shearer, J. Hay, and L. Kelly. 2016. Can weighted usable area predict flow requirements of drift-feeding salmonids? Comparison with a net rate of energy intake model incorporating drift-flow processes. Transactions of the American Fisheries Society 145:589-609. DOI: 10.1080/00028487.2015.1121923.

Naman, S. M., J. S. Rosenfeld, J. R. Neuswanger, E. C. Enders, and B. C. Eaton. 2019. Comparing correlative and bioenergetics-based habitat suitability models for drift-feeding fishes. Freshwater Biology. DOI: 10.1111/fwb.13358.

Naman, S. M., J. S. Rosenfeld, J. R. Neuswanger, E. C. Enders, J. W. Hayes, E. O. Goodwin, I. G. Jowett, and B. C. Eaton. Bioenergetic habitat suitability curves for instream flow modeling: Introducing user-friendly software and its potential applications. American Fisheries Society DOI: 10.1002/fsh.10489.

Piccolo, J. J., B. M. Frank, J. Hayes. 2014. Food and space revisited: The role of drift-feeding theory in predicting the distribution, growth, and abundance of stream salmonids. Environmental Biology of Fishes 97: DOI: 10.1007/s10641-014-0222-2.

Richter, B.D. R.M. Mathews, D.L. Harrison, and R. Wigington. 2003. Ecologically sustainable water management: managing river flows for ecological integrity. Ecological Applications 13(1):206–224.

Rosenfeld, J. S., R. Ptolemy, and M. J. Bradford. 2012. Modelling available habitat versus available energy flux: Do PHABSIM applications that neglect prey abundance underestimate optimal flows for juvenile salmonids? Canadian Journal of Fisheries and Aquatic Sciences 69(12):1920-1934. DOI: 10.1139/f2012-115.

Smith, J. J., and H. W. Li. 1983. Energetic factors influencing foraging tactics of juvenile steelhead trout, Salmo gairdneri. Pages 173–180 in D. L. G. Noakes, D. G. Lindquist, G. S. Helfman and J. A. Ward, editors. Predators and prey in fishes. Dr. W. Junk, The Hague, Netherlands.

Starkey-Owens, T. R. 2020. Impacts of flow releases on invertebrate drift and juvenile Chinook salmon (*Oncorhynchus tshawytscha*) diet on the Trinity River below Lewiston Dam. Master's Thesis. Humboldt State University, Arcata, CA.

TRRP and ESSA Technologies Ltd. 2009. *Integrated Assessment Plan, Version 1.0 – September 2009*, Report prepared for the Trinity River Restoration Program, Weaverville, CA. 285 pp. https://www.trrp.net/library/document/?id=400.

Williamshen, J. S. 2021. Response of invertebrate drift to dam-release restoration pulse flows from Lewiston Dam on the Trinity River, CA. Master's Thesis. Humboldt State University, Arcata, CA.

Determining Invertebrate Utilization by Juvenile Chinook Salmon via Stable Isotope Analysis

Hoopa Valley Tribal Fisheries Department

TRRP Fish Workgroup

Background:

There are a handful of proposals starting to look at invert production and how to improve foraging opportunities for fish. Work by Tomas Starky- Owens and Jasmine Shen looked at availability and Tomas looked a little at stomach samples/Diet. Stable isotope analysis can be more informative as to the relative importance of different food sources to fish of different sizes than stomach samples because some bugs digest faster than others and would have a lower detection probability.

Purpose:

To better inform what inverts are being utilized by juvenile fish so that management actions can be tailored to increase the abundance of those invert species.

Method:

Sample inverts at the screw trap and using kick nets along the upper 40 miles of the Mainstem below lewiston dam. Separate them by genus and functional feeding group. Run the samples for Carbon and Nitrogen Stable isotopes. Take tissue samples from wild chinook ranging in size from 30 to 90 mm and run those for stable istope as well. Calculate the proportion of the diet made up of each invert species or functional feeding group.

These data could provide the baseline for future evaluations to see if our management actions result in changes in diet.

Budget:

~$25,000