40th Annual Salmonid Restoration Conference

April 25-28, 2023 Fortuna, CA

Deep Roots

—Celebrating 40 Years of Watershed Restoration

Conference Co-Sponsors

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Welcome to the 40th Annual Salmonid Restoration Conference

Deep Roots—Celebrating 40 Years of Watershed Restoration

The California watershed restoration field faces unprecedented climate extremes of catastrophic fire, extended drought, atmospheric rivers and historic flooding and yet we are in a time of unparalleled opportunities. As we inch towards Klamath dams drawdown for the largest dam removal project on Earth and ponder how to capture rain events to meet California's water demand, there is more funding and opportunity than the restoration field has ever had access to. As the Peanuts cartoon or Yogi Berra once said, "we are overwhelmed by insurmountable opportunities."

SRF and many of our restoration partners are poised to increase the scope of our work and grow our respective organizations to meet this watershed moment. Like many of our restoration partners, we are building the capacity needed to take on additional work and projects. It is both exciting and daunting that the CA funding climate finally aligns with the pace and scale of watershed restoration needed across California's diverse landscapes.

With the rapid rollout of new funding and streamlined permitting pathways, can the restoration field meet this unique moment? The SRF Conference agenda this year takes both a 30,000 foot view and a granular approach to restoration issues large and small. *How do we build trust amongst diverse constituents so we can collectively build the support required for truly collaborative projects? How can we utilize large working landscapes to sustain land uses and restore ecosystem processes? How can policies and permitting evolve to meet the scale of restoration needed to restore functioning ecosystems?*

As the watershed restoration field matures, we will need to develop sustainable approaches to restoration in a changing climate so that science-based decision making, resilience, and ecosystem processes remain the defining criteria for good projects. Like the evertrue maxim that *Fish Need Water*, the restoration field needs capacity and fish-centric results.

As SRF reflects on our 40 years of growing up with the watershed restoration field, we remain grateful for the support of our members, restoration leaders, and our many partners. Your ongoing support made it possible for us to return to in-person events in 2022 with the long-awaited conference in Santa Cruz, a Sediment and Erosion Control Field School in Trinity County, the Coho Confab in the South Fork Eel River, and a Klamath Dam Removal event in Siskiyou County.

SRF's Plans and Scope of Work for 2023 are even greater including:

- The 40th Annual Salmonid Restoration Conference in Fortuna
- 25th Annual Coho Confab in the Mattole
- Implementing a ten million gallons water storage and flow release project in the South Fork Eel
- Launching the Redwood Creek, SF Eel Storage & Forbearance Program
- Forest thinning planning study in Redwood Creek
- Completing Implementation Plans for Redwood & Sproul Creeks, SF Eel
- Initiating a multi-year hydrologic and restoration feasibility study in Cahto Creek
- Creating a more robust Diversity, Equity, and Inclusion scholarship program

As our scope and budget grows, we value our individual members and supporters even more. You are our backbone, our true north, and the reason our small non-profit has been able to accomplish big things!

—Dana Stolzman, Executive Director

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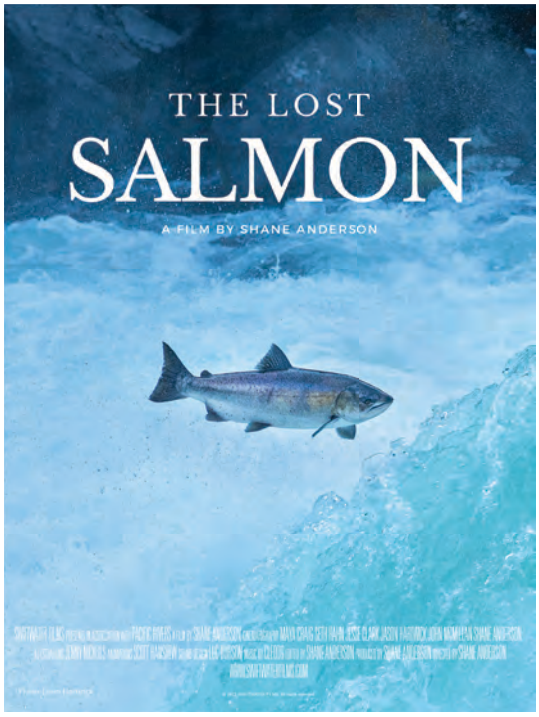
Thursday, April 27

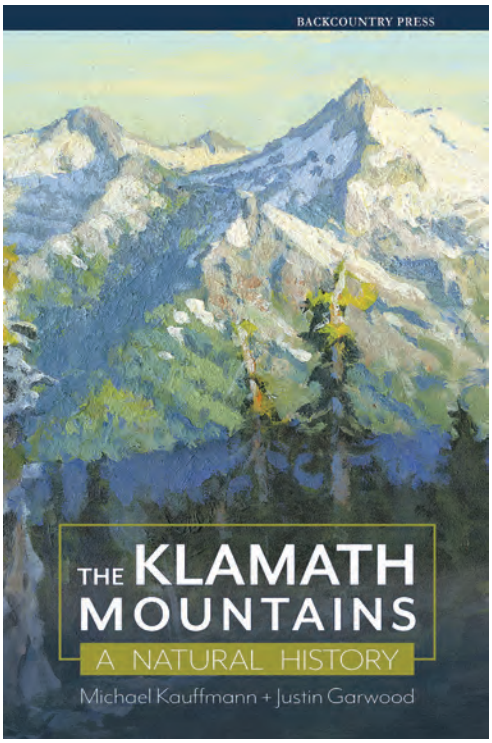
Thursday Afternoon Concurrent Sessions



Membership Dinner and Film Screening

Wednesday April 26

The SRF Annual Meeting will be at 5:15 pm followed by the Membership Dinner at the River Lodge with a special film screening of Shane Anderson's new film, *The Lost Salmon*



Klamath Mountains —A Natural History Booksigning

With authors Justin Garwood and Michael Kauffman

Thursday April 27 after the Plenary Session

Poster Session

Thursday April 27, 7-10pm

Canary and the Vamp will play at the conference banquet.

Banquet and Awards Ceremony

Friday April 28, 6:30pm to Midnight

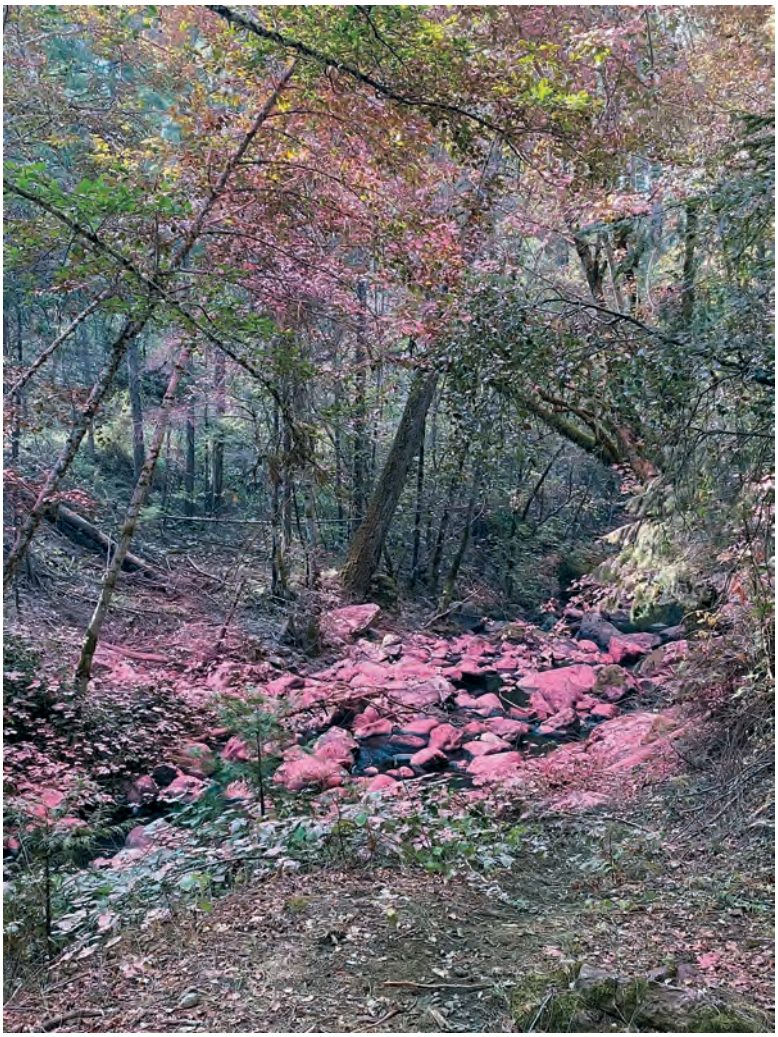
Design & Layout
by Jeri Fergus, Trees Foundation

Healthy Fire, Healthy Fish: Fates Intertwined, Strategies Aligned

Tuesday, April 25

Workshop Coordinators: *Lenya Quinn-Davidson, University of California Cooperative Extension and Northern California Prescribed Fire Council;* ***Will Harling,*** *Mid Klamath Watershed Council;* ***Eli Asarian,*** *Riverbend Sciences;* ***Damon Goodman,*** *California Trout;* *and* ***Josh Smith,*** *The Watershed Research & Training Center*

In recent decades, it has become increasingly clear that the West suffers simultaneously from too much fire and not enough. Fire exclusion has created vulnerable landscapes, far departed from the fire regimes through which they evolved. Losses are multifaceted: unprecedented high-severity fire is causing widespread forest loss, while other systems wither in the absence of needed fire. The effects of fire on fish are equally complex. There are direct impacts—retardant drops and dozer lines in streams, post-fire debris flows and fish kills, erosion, loss of riparian cover—but there are indirect connections that also require attention. Fire can improve streamflow, stream temperatures, and inputs like gravel and wood, providing many unrealized opportunities for alignment between the two fields. Likewise, fire management has largely failed to account for fish, and nascent approaches in fire planning should work to identify areas of overlap and mutual benefit. In this era, which some call the Pyrocene, process-based restoration for fish will necessarily involve fire as a process. This workshop will explore the many dimensions of fire and fish, including fire ecology for fisheries, impacts of fire on fish, opportunities for joint projects and policy, and a shared vision and strategy for healthier fire and healthier fish.



Retardant in Digger Creek
Photo credit: CalTrout

Fire and Water: The Essentials of Life

Margo Robbins, Co-Founder and Executive Director, Cultural Fire Management Council

Native people have been burning for thousands of years, keeping the ecosystems healthy and balanced. Fire is one of the essential tools available to us as humans to ensure healthy land, healthy water, healthy people. Fire has a causal relationship with the quality and quantity of water. The purposeful use of fire is beneficial to watersheds, and the plants, animals, and people that depend on the creeks, rivers, lakes, and wetlands that sustain life. We call the salmon home, back to their spawning grounds with smoke from our fire. In the absence of good fire on the land the water sources become depleted to the point where the rivers struggle to support a hospitable environment for fish to survive. Catastrophic wildfires erase the shady areas along the river and creek banks and cause severe erosion further depleting the water quality and the number of fish that are able to survive. In the past 100+ years land management practices, policies and priorities have resulted in an unprecedented number of catastrophic wildfires that continue to grow in size and severity, with astronomical amounts of money being poured into fire suppression. We are facing a climate crisis that is unparalleled in history. Government agencies are now turning to Native people to learn how to use fire to restore ecosystems and stem the tide of growing wildfires. This presentation provides an overview of traditional fire practices, fire's relationship to water, the myriad benefits of the purposeful use of fire, and strategies to increase the pace and scale of prescribed/culture burns.

Fire and Landscape Change in California: Lessons From Fire History

Carl Skinner, Retired USDA Forest Service Pacific Southwest Research Station

It is well known that northwestern California and southwestern Oregon are dominated by a Mediterranean Climate characterized by cool/wet winters and warm/dry summers with the degree of each condition moderated or enhanced by distance to the coast and elevation. This type of climate ensures that we have conditions conducive to the ignition and spread of fires on a regular and frequent basis.

Reconstructing the history of fire from place to place across watersheds helps shed light on how fire appears to have spread across the landscape and influenced the development of vegetative patterns over long periods of time. Thus, understanding fire history may also help us to better understand the long-term role of fire in the development and maintenance of riparian habitat and associated aquatic habitat? Tree-ring studies of fire scars and ages of older trees existing before the onset of fire suppression show us that fires occurred quite frequently—many times during the life spans of the older trees. The frequency of fire, interacting with topography and climatic variation, helped to create heterogeneous landscape patterns. The patterns do not appear to have been random, but instead were associated with topographic conditions. Since riparian zones are embedded within landscapes, they too were regularly influenced by the frequent fires. Further, riparian zones with permanent water helped to influence the spread of fires and enhance the heterogeneity of the landscape by occasionally inhibiting the spread of many low and moderate intensity fires. Fire scars in these areas appear about half as often as in the stands of the surrounding uplands. Ephemeral and intermittent riparian zones dry out as the fire season progresses and appear to have burned with equivalent frequency as the adjacent uplands.

Since the onset of fire suppression, it appears the patterns of vegetative heterogeneity have changed towards landscapes of much greater homogeneity. Fire suppression itself has led to changes in patterns of fire intensity since all but fires burning under the more extreme conditions have mostly been suppressed in their early stages. Fires tend to burn less frequently in most areas helping to increase stand density and fuel accumulation. These changes along with a warming climate with longer fire seasons helps to increase the area affected by high fire severity. Further, recent research suggests that once areas burn severely, they become more likely to burn that way in subsequent fires. Since riparian zones are embedded in the larger landscape, these longer-term effects do not exclude the riparian areas. Further, these repeated high-severity burns appear to inhibit recovery of initially forested areas and may lead to conversion of forested areas to non-forest over the long term.

Fish and Fire: Big Picture

Gordon Reeves, Oregon State University

Fire has been assumed to have negative effects on fish and their aquatic ecosystems. One primary reason for this is the perspective that aquatic ecosystems are stable through time, returning to an equilibrium condition shortly after disturbance. However, a dynamic perspective of aquatic ecosystems has emerged in recent years which view disturbances, such as fire as an integral component of aquatic systems. Also, several recent studies on the effect of fire on fish and aquatic ecosystems have found that native fish are well adapted to changes resulting from fire, and not necessarily affected negatively. This presents the opportunity to consider adjustments to existing institutional management policies and practices to the extent feasible. It will also require convincing the public and interested parties about the validity of the new perspective and provide them an understanding of the implications to policy and practices. This presentation examines the new perspective and the challenges of incorporating it, or some part of it, into policies, practices, and public perceptions and the consequences of not being able to make these changes.

An Exploration of Fish and Fire in California

Damon H. Goodman, California Trout

As a landscape-scale process that affects millions of acres annually across California, fire should be of critical concern in the conservation of river systems and aquatic habitats. However, fire remains severely under-represented in river management and fish conservation efforts. This presentation will explore the recent scope and scale of fire through the lens of anadromous watersheds in California, considering benefits and impacts to a set of focal species with varying life history strategies, distributions, and habitat requirements. Initial analyses show that fires have burned across more than 17% of the area of anadromous watersheds in California in the last decade. Fire extent varies by watershed, ranging from 9% to 32%, and the Klamath basin has the highest proportion of area burned. This analysis will explore different facets of the fire-fish overlap in California, and use models of fire potential to elucidate future concerns, impacts, and management opportunities. Through this work, we aim to quantify the spatial relationship between fish and fire, identify critical uncertainties in our understanding of complex fish-fire interactions, and encourage further integration of the two fields to maximize conservation and restoration opportunities.

Fire and Smoke Effects on Water Temperature: Fine Most of the Time

Eli Asarian, Riverbend Sciences

This presentation will summarize current knowledge of the effects of fire and smoke on water temperatures in rivers and streams, drawing upon research I have conducted in the Klamath Basin with colleagues, heavily supplemented by others' research from across the Western United States, and a few sprinkles of informed speculation.

Smoke generated during fires acts like a cloud, reducing solar radiation and air temperatures, which then cools water temperatures. This smoke-induced cooling has the potential to benefit cold-water adapted species, particularly because wildfires are more likely to occur during the warmest and driest years and seasons. Smoke reduces daily maximum temperatures more strongly than daily average temperatures. The cooling effect of smoke is greater in mainstem rivers than in small tributaries, because tributaries are already shaded by streamside trees so additional shading from smoke has less effect. Smoke cooling is most pronounced when stable atmospheric conditions allow inversions to continuously build for multiple consecutive days. Increasing smoke in the past decade in the Klamath Basin has suppressed the rise in August water temperatures, whereas July temperatures have increased rapidly due to climate-driven flow declines and rising air temperatures. Heat generated when riparian areas of small headwater streams burn at high intensity can increase temperatures for minutes to hours, but in mountainous terrain riparian zones typically burn at lower intensity than upper slopes.

At time scales of years, effects of fire on water temperatures are highly variable depending upon conditions. If riparian zones burn at low to moderate severity, and riparian canopy is not substantially diminished, water temperature effects may be undetectable. If intense post-fire precipitation triggers debris flows that bury stream channels in sediment slugs and eliminate riparian shade, large temperature increases can occur which then gradually diminish over years to more than a decade. If debris flows do not occur, water temperature effects are driven by the net balance of the riparian canopy losses (i.e., more solar radiation and less buffering of air temperatures) and hydrologic changes (i.e., increased flows from reduced forest water use across the watershed).

Toxicity of Fire Retardants to Chinook Salmon with Different Life Histories as Fry and Smolts

Joseph Dietrich, Ph.D. (Presenter), NOAA Fisheries—Northwest Fisheries Science Center, and Co-Author; Mary Arkoosh, Ph.D., Retired NOAA Fisheries—Northwest Fisheries Science Center

Long-term fire retardants are intended to be applied to land, but misapplications and accidental spills have occurred in waterways that resulted in fish kills. Fire retardant toxicity information provided by the manufacturers is typically limited to LC50 values (the concentration that resulted in mortality for half of the experimental subjects) for model aquatic organisms, e.g., rainbow trout and fathead minnow for fish, that may not indicate the sensitivity of threatened or endangered species to fire retardants. Specifically, Chinook salmon have different life histories that could result in exposures at different sizes and ages based on their freshwater rearing time. In addition, as salmon prepare for the transition from freshwater to seawater they are physiologically stressed, which could increase their sensitivity to waterborne contaminants. The authors conducted fire retardant exposures with stream-type and ocean-type Chinook salmon prior to smolting and while smolting. Lethal concentration curves were developed for four different fire retardant formulations (PHOS-CHEK 259F, LC-95A, D-75F, and P100-F) for these different groups to compare life-stage and life-history sensitivities. Exposure effects on gill pathology, and sub-lethal effects on smoltification status, pathogen susceptibility, and seawater tolerance were also investigated.

Chinook salmon sensitivities varied by the fire retardant formulation, with the unionized ammonia suspected as the likely cause of mortality. However, additional factors likely contributed to mortality and the proprietary compounds in these formulations and their effects are unknown. Chinook salmon were consistently more sensitive to fire retardant exposure at the smolt life-stage relative to pre-smolt. However, life-stage and fire retardant sensitivities did vary for Chinook salmon with different life histories. Histopathology of the gills indicated the presence of respiratory epithelial exfoliation and lifting, as well as phagosomes containing basophilic material, which may have been fire retardant material. The observed pathology may have affected oxygen diffusion across the gills and fish survival. However, exposed salmon were not more susceptible to Vibrio anguillarum infection, although the gill damage may have also minimized the pathogen's preferred route of entry. Likewise, prior exposure did not appear to affect the timing or indicators of smoltification. Consequently, pre-smolt salmon that survived exposures were able to recover and transition to seawater successfully. However, smolting salmon exposed to sub-lethal levels of fire retardants had significant mortality when immediately transitioned to seawater. Due to this carry-over effect, the lethal toxicity of fire retardant formulations is greater than the acute LC50 values suggest.

McKinney Fire Debris Flows and the 2022 Klamath River Fish Kill

Toz Soto (Presenter), Karuk Tribe, and Co-Authors; Grant Johnson, Karuk Tribe; and Shari Witmore, NOAA Fisheries

The McKinney Fire started on July 29, 2022 in the Scott Bar Mountains region of the Klamath River watershed. Within several days, the fire consumed approximately 60,325 acres of land including the small town of Klamath River. The severity of the fire left much of the landscape completely denuded of vegetation and susceptible to debris flows. On August 2, while the McKinney Fire was still burning, an intense rain event occurred directly over the recently burned landscape. The National Weather Service observed between 2-8 inches of rain per hour that fell in the basins of Klamath River tributaries, Humbug Creek, Little Humbug Creek, and Vesa Creek. The intense precipitation on the recently denuded landscape triggered debris flows that severely impacted water quality in the affected tributaries and mainstem Klamath River. The Karuk Tribe's downstream continuous water quality monitoring stations showed a rapid increase in turbidity followed by a rapid decline in dissolved oxygen after the rain storm. On August 4, biologists with the Karuk Tribe discovered a large-scale fish kill had occurred spanning more than 30 miles downstream of the McKinney burn. Tens of thousands of dead fish were discovered floating in eddies and washed onto the river banks covered in mud including native suckers, lampreys, juvenile salmonids and other aquatic species. In the months following the debris flows, persistent poor water quality forced adult salmon to seek refuge in lower reaches of tributaries and the success of spawning adult salmon is still unknown.

Fires and debris flows are natural processes important for healthy ecosystems and often provide important elements (gravel and large wood) that make quality fish habitat, but the scale and intensities of these events seems to be increasing and impacting fish populations. These tragic events highlight the need for improved forest management as a preventative action to reduce fuel loads and lower burn intensities to reduce frequency or risk of harmful debris flows. The Karuk Tribe is a longtime advocate for actions including prescribed burning and forest thinning after many decades of aggressive fire suppression caused forest fuel buildup and loss of biodiversity. There are major challenges in reversing this trend and the recent fish kill could be a catalyst for change much like the 2002 adult salmon kill changed water management in the Klamath River. Modern forest management practices, including fire suppression and reforestation with fire prone tree species in fire adapted landscapes are contrary to Karuk traditional management practices. The Karuk Tribe and partners are working to tip the balance in favor of traditional management practices like prescribed burning to increase landscape resiliency, improve health of aquatic ecosystems and reduce risk of future fish kills.

Food Webs of 10 Lakes Before and After a Mega-Wildfire

Christine A. Parisek, M.S. (Presenter), University of California Davis: Center for Watershed Sciences and Co-Authors: Steve Sadro, Ph.D., University of California Davis: Department of Environmental Science & Policy; and Andrew L. Rypel, Ph.D., University of California Davis: Department of Wildlife, Fish, & Conservation Biology, University of California Davis: Center for Watershed Sciences

There is an emerging imperative to understand ecological effects of climate-driven wildfires in California. The seven largest wildfires in state history all occurred within the last four years. Yet little is known about the extent to which direct fire effects alter fish populations. During summer 2021, the Dixie fire burned approximately one- million acres in Northern California. This massive fire engulfed the entire watersheds of 10 lakes along an ecosystem size gradient that our team sampled extensively pre-fire during summer 2020 in the Lassen National Forest, Caribou Wilderness, USA. These sampling efforts included studies of the fish populations and food webs of the burned lakes. We resampled these same ecosystems post-fire (summer 2022) to understand how severity of fire in the watersheds impacted lake ecology. While this project is ongoing, we have already observed declines in abundance of fishes in almost all lakes, and in some cases, the decline was substantial (CPUE declined 19-100%; mean 68%). Future research will examine how the fire-driven loss of fishes reverberates through food webs to affect the lake ecology more generally. We seek collaborative opportunities to continue this work and hope these data aid decision-makers in managing these resources moving forward.

Preparing Fish for Fire: Thoughts from the Modoc Sucker

Stewart Reid, Ph.D., Western Fishes

As biologists and resource managers working to conserve fishes in the West, we are no longer faced with hypothetical consideration of potential impacts from a possible large fire. Instead, we can reasonably expect that a large fire will occur in the foreseeable future and that it will directly impact the species we work with and often our own work sites. The question is how we plan for this and what approaches will help reduce or even avoid substantial impacts from the inevitable fire event. The Modoc Sucker is a small, attractive native fish that was ESA listed in 1985 and delisted as recovered in 2015, based on the resolution of principal threats to its long-term existence, including habitat conditions, non-native predators, and potential for genetic hybridization with the sympatric Sacramento Sucker. Nevertheless, it has a limited range, occurring primarily in three small, arid stream drainages in northeastern California and southern Oregon. Two of the three have been hit by significant fires in the last four years. Fortunately, in both cases the local fish populations have weathered the fire with no indication of major impacts. Riparian conditions appear to have played a significant role in avoiding. These include moist riparian buffer corridors, meadowed stream borders, presence of beaver, thinned adjoining conifer forests, and functioning stream structure, which includes deeper pools and aquatic vegetation or woody matrix. The goal of this talk is to promote collaborative approaches that combine the knowledge and needs of fish biologists, vegetation managers, land managers, resource users, and fire crews to develop riparian corridors that are resistant to fire and protect the stream communities they contain as well as facilitating the stakeholder community that work within them.

Integrated Meadows Restoration and Fuels Reduction in the Sierra Nevada to Manage Carbon and Water Stocks and Protect Native Trout

Sandra Jacobson, Ph.D. (Presenter),
and Co-Author, ***Marrina Nation,*** *California Trout, Sierra Region*

Managing the landscape of the Sierra Nevada in the face of climate change is of ecological and economic significance to the state of California. Healthy meadows are important for storing and releasing water seasonally, and along with healthy forests, sequester carbon. Degraded meadows have decreased capacity to hold water and store below-ground carbon. Forested land is also important for carbon sequestration, but when dead and dense stands predominate, the landscape is vulnerable to catastrophic wildfire. Sierra meadows with streamflow contain some of California's most vulnerable native inland trout species—Kern River Rainbow Trout, Lahontan Cutthroat Trout, and Golden Trout. Catastrophic fires can disrupt meadow function and stream integrity to present additional challenges to aquatic species.

California Trout, in partnership with the Sequoia National Forest and Plumas, are addressing these issues on a landscape scale through integrated fuels reduction and meadow restoration. This strategy aligns biodiversity, fisheries protection, carbon sequestration and water conservation. A suite of meadows in the Kern River watershed of Sequoia National Forest is targeted for restoration to enhance hydrologic functions and promote below-ground carbon sequestration on a long-term scale. Forest fuels thinning in strategic locations in Sequoia National Forest will provide carbon benefits through avoided wildfire emissions. Fuels reduction implemented near meadows has the additional advantage of creating landscape scale fuel breaks and ecological buffer zones. This integrated approach likewise advances solutions to meet California's emission and 30 x 30 goals by operationally, financially and ecologically linking activities that reduce carbon emissions with revenue from new carbon credit markets to sustainably support meadow and forest restoration activities, while using the biomass produced to generate renewable energy via emerging conversion technologies on a commercial scale.

Observations from the Fireline

Josh Smith (Presenter), Watershed Stewardship Program Director, Watershed Research and Training Center, and Co-Authors: Nick Goulette, Director, WRTC; Michelle Medley-Daniels, Director, Fire Learning Network; Randi Paris, WRTC; Erin Banwell, WRTC; and Lenya Quinn-Davidson, Area Fire Advisor, University of California Cooperative Extension

Fire is an integral process in the Klamath Mountains, yet approaches to managing wildfires in the region are in many cases maximizing negative fire outcomes for fish and watershed health. There are several key issues with fire management processes and connections to community knowledge where we could improve those outcomes. In this presentation I will outline a number of observations and experiences from the 2008 fire complexes to last year's Monument Fire where through better connectivity and communication we could improve fire outcomes for fish, watersheds and communities.

Strategic Post-fire Stream and Meadow Restoration to Benefit Aquatic Diversity

Karen Pope, Ph.D. (Presenter), USDA Forest Service, Pacific Southwest Research Station, and Co-Authors: Adam Cummings, M.S., USDA Forest Service, Pacific Southwest Research Station; Garrett Costello, Symbiotic Restoration; and Kevin Swift, Swiftwater Design

Climate change and anthropogenic alterations to flow paths tend to increase the rate at which water flows through headwater catchments. This tendency is exacerbated in post-fire landscapes that typically have bare, hydrophobic soils that enhance the transportation of water and sediment from hillslopes into stream channels. Targeted low-tech restoration of low-gradient meadows and streams in burned catchments leverages the expected sediment pulses to encourage deposition in incised reaches where it can benefit local floodplain recovery instead of causing damage to downstream fish habitats. We provide example applications of process-based restoration in burned headwaters; describe an ongoing experiment to quantify sediment transport, changes to surface and groundwater, and ecological change following instream restoration of meadows in burned and unburned catchments; and show how the approach could be scaled to a watershed to maximize benefits and minimize harm. Evidence thus far suggests that instream wood structures, such as beaver dam analogs and post-assisted log structures, can capture sediment pulses in natural depositional zones and protect downstream fisheries and water infrastructure.

Restoring Instream and Upslope Processes in the Western Klamath Mountains to Bring Our Salmon Home and Put an End to Megafires

Will Harling (Presenter), Director, Mid Klamath Watershed Council,
and Co-authors: Charles Wickman, Fisheries Program Director, MKWC; Mitzi Wickman, Fisheries Project Coordinator, MKWC; James Peterson, Fisheries Project Coordinator, MKWC; and Toz Soto, Senior Fisheries Biologist, Karuk Tribe Department of Natural Resources

In the Western Klamath Mountains, the profound connections between fish and fire are exemplified by extreme interconnected events over the past three decades, including fish kills, megafires, debris flows, and lethally low summer base flows. This presentation highlights multiple and varied linkages between instream and upslope management actions over the past century that have resulted in critically low salmon runs and some of the most extreme wildfire behavior ever observed on our planet. Collaborative efforts to incorporate traditional tribal fire and fisheries knowledge into management actions demonstrate the critical need to drastically change fire policy and reframe fisheries restoration. Specific examples of planning efforts and projects incorporating process-based restoration to restore frequent fire, retain topsoil, increase summer base flows, and protect and enhance critical salmon habitats in the Western Klamath Mountains provide insights for communities and watersheds in California and the West that have been impacted by severe wildfires. This presentation will also cover practical tools for planning and implementing fish habitat restoration projects that are not only resilient to wildfires, but also leverage wildfires to improve future project benefits.

Using Fire to Change Hearts, Minds, Policies, and Landscapes

Lenya Quinn-Davidson, Area Fire Advisor, University of California Cooperative Extension

Just as fire-related losses in California have grown increasingly severe in the last decade, so too has the urgency of fire restoration. The bulk of California's ecosystems are fire adapted or fire dependent, and fire exclusion over the last century has created unprecedented landscape vulnerability, posing threats to human, terrestrial, and aquatic communities. Political and social interests are finally aligning with concepts that tribes, scientists, and community members have long understood: the best paths to landscape resilience will be the ones that center on beneficial fire and recognize the critical role of humans in delivering it. Significant progress has been made in California in recent years, including unprecedented funding, changes to state law, a Governor-endorsed strategic plan for restoring beneficial fire, and calls for culture change within the fire suppression agencies. However, it is the social movement around prescribed fire and cultural burning that has been most striking in recent years, and that offers the most promise for effecting real change. This presentation will share recent progress on prescribed and cultural fire in California, including recent changes in policy and capacity, and show how efforts to foster connection—among people, across political and social divides, between people and place, and across disciplines—will be the most powerful tools for change. The presentation will also highlight how this Fish & Fire Workshop is a unique opportunity to build new alliances, explore our shared potential, and accelerate innovative fire- and fish-focused conservation efforts throughout California.

Flow Enhancement Workshop

Tuesday, April 25

Workshop Coordinators: *Amy Campbell, The Nature Conservancy;*
and ***David Dralle,*** *Research Hydrologist, Forest Service, Pacific Southwest Research Station*

In this time of unprecedented drought severity and low flow conditions, this workshop will explore the restoration techniques, strategies, and range of projects that address water scarcity in California's salmon-supporting streams and rivers. From storage and forbearance and water-efficiency projects, to augmented flow release and indirect methods that alter the water balance (e.g. vegetation treatments), we will explore important factors and considerations that could lead to the success or failure of a flow enhancement project.

This workshop will delve into the science and tools available to inform the practicality of whether a flow enhancement project will deliver on long-term flow objectives given hydrogeomorphic properties and other underlying watershed conditions that contribute to inadequate summer flows, and will include discussions around other key factors to consider when designing projects such as water budgets, water rights, permitting, infrastructure retrofits, long-term maintenance, and the complexity around designing projects to provide security to both human and nature in a changing and unpredictable climate.

Beaver dam analogue slows and spreads flow in Middle Creek Meadow in the Plumas National Forest, part of the USFS Pacific Southwest Research Station Process-based Meadow Restoration Research Initiative. Photo credit: David Dralle, USFS

Assessing and Ensuring That Streamflow Enhancement Projects Result in Real Water for the Environment

Amy Campbell, The Nature Conservancy

Streamflow enhancement projects are complex and require an understanding as to the baseline conditions that exist instream and conservation objectives as well how water is used by people- whether this be for agriculture or rural domestic. This presentation will provide the context around why knowing this foundational information is so important to designing and implementing projects that result in real and meaningful water in California's streams and rivers and will set the groundwork for subsequent presenters in this workshop.

Water Budget Modeling Methods: Applications to Assessing Flow Augmentation Strategies for Salmonid Recovery in California

Christopher Woltemade, Ph.D., Prunuske Chatham, Inc.

Water budget models track flows of water through the entire hydrologic cycle, including precipitation, soil moisture, groundwater, evapotranspiration, and streamflow, typically on a monthly basis. These models have been developed and applied to address a wide range of water resources concerns, including management of water supply reservoirs, irrigated agriculture, forestry, and low-flow hydrology of streams. Within the context of salmonid restoration in California streams, water budget modeling has been adopted as a tool to assess and estimate hydrologic conditions that include dry season stream flows, groundwater recharge, and the impacts of various human use and water management strategies. For example, water budget approaches have been used to evaluate strategies for improving dry-season stream flow, such as reduced diversions from streams, enhanced infiltration and groundwater recharge, reduced impacts of groundwater withdrawals, and strategic releases of water from ponds.

This workshop session will explore methods to develop spreadsheet-based water budget models to assess dry season low flows and flow enhancement projects. Discussion will address the spatial resolution of models, modeling methods, sources of input data (climate, soils, evapotranspiration, irrigation demand), model calibration, and evaluation of errors. We will also address interpretation of model results with regard to streamflow generation, groundwater recharge, and impacts of human water use (e.g., direct stream diversions, groundwater pumping, and irrigation). Examples will illustrate the assessment of model results relative to a range of climate years (dry, average, wet), comparison with natural flows and flow objectives, and the potential for water management strategies to achieve flow objectives.

The workshop will include case studies of water budget applications across a range of scales within the Navarro River watershed. Participants should have a good working knowledge of Microsoft Excel and ArcGIS.

Water Budgets for Agricultural Streamflow Enhancement Projects

Katie Klug, Ph.D., Associate Engineer,
and Tommy Ostrowski, PE, Senior Engineer, Davids Engineering (Co-presenters)

Streamflow practitioners across the State are working with agricultural partners to identify, design, and implement streamflow enhancement projects through diversion improvements and/or on-farm water use efficiency improvements. These projects are technically and socially complex, requiring a balanced approach and deep understanding of the project's conservation objectives and the water needs of agriculture. Developing a water budget is foundational to this understanding; it requires a thoughtful and detailed effort to identify, monitor, and quantify the inflows and outflows (i.e., flow paths) from the area of interest and how they may change over time. This presentation will describe the process of developing an agricultural water budget and quantification of those flow paths typically considered, including surface water and groundwater use, crop water demands (including evapotranspiration), on-farm conveyance losses, and the potential water conservation benefits that different project design alternatives may yield for both agriculture and the environment. This discussion will highlight common gaps in available data and include case studies to illustrate the practical applications of agricultural water budgets in Northern California with focus on the use of these budgets for designing and implementing streamflow enhancement projects in the Shasta Valley.

Slash Ain't Trash, It's Beneficial Biomass

Brock Dolman, Occidental Arts & Ecology Center's WATER Institute

This presentation will take us upslope from the primary fish bearing waterways to explore ideas & examples of integrated Process-based Restoration actions at the nexus of fire, water, soil, carbon & biodiversity. The talk will focus on decades of class 3 drainage restoration experience at OAEC paired with forest health and fuel load mitigation projects through the reutilization of so-called 'slash' materials as beneficial biomass resources for degraded upland streams. It will feature details on our experience with the repair of active headcut erosion, re-aggradation of incised drainages, reduction of sediment delivery, sequestration of carbon and amplification of recharge while reducing fuel loads & ultimately striving to enhance flows for salmonid recovery in Dutch Bill Creek.

Slow the Flow: Large-scale Flow Enhancement Implementation Strategies

Joel Monschke, Civil Engineer/Geomorphologist, Stillwater Sciences;
and Tasha McKee, Water Program Director, Sanctuary Forest (Co-presenters)

Over the past decade Sanctuary Forest and supporting collaborators including Mattole Salmon Group, Stillwater Sciences and others have been implementing flow enhancement pilot projects in the Mattole River headwaters that detain winter runoff and release flows during the spring and summer. Projects have included instream weirs that increase in-channel, floodplain, and lower hillslope groundwater storage, and terrace recharge ponds. While successful at increasing late spring and early summer streamflow, these passive release projects have not provided measurable flow benefits during drought conditions in August through October, the critical limiting period when lack of instream flows often result in juvenile coho mortality. More recently, sealed ponds with valved outflow pipes that can be turned on during the critical low flow period have been constructed. The combination of these passive and managed flow enhancement approaches is expected to provide flow enhancement benefits throughout the dry season.

This workshop session will describe projects completed to date and the measured groundwater and flow benefits resulting from those projects. Innovative planning tools, construction methods, and lessons learned will be discussed. Developing projects in the planning, design and construction phase in neighboring Redwood and Sproul Creek watersheds (South Fork Eel River tributaries) will also be described with a focus on opportunities and constraints when developing projects within a watershed context.

Did it Work? Methods of Hydrograph Analysis and Inference for Quantifying and Attributing Flow Enhancement in Headwater Catchments

Mia van Docto (Presenter), Conservation Hydrologist, Trout Unlimited;
and David Dralle, Research Hydrologist, Forest Service, Pacific Southwest Research Station

Despite significant investment in flow enhancement projects across the seasonally dry American West, detecting the magnitude of flow changes, and attributing effects to underlying restoration measures, remains challenging. In this workshop session, we overview hydrograph and paired catchment approaches for detecting, quantifying, and attributing changes in streamflow resulting from the implementation of a flow enhancement project.

Humboldt Bay Estuary Restoration Field Tour

Tuesday, April 25

Field Tour Coordinators: *Mike Love, Michael Love & Associates, and Bob Pagliuco, NOAA Restoration Center*

The tour will visit recently completed estuary restoration projects around Humboldt Bay, exploring a variety of project types. The tour will include discussion of the project planning process, construction challenges, and results from post-implementation physical and biological monitoring for both newly constructed projects and those implemented several years prior. The tour includes stops at the following sites:

The White Slough tidal marsh restoration project on the Humboldt Bay National Wildlife Refuge restores subsided salt marsh using spoils from other restoration sites and enhances shoreline protection along Highway 101.

The City of Eureka's Elk River estuary enhancement project, completed in 2022, creates tidal channels with a public access component.

The Martin Slough enhancement project, completed in 2021, uses modern tide gates to provide fish passage and enlarge estuarine habitat in constructed off-channel ponds and slough channels, while also reducing flooding on agricultural lands and the City of Eureka municipal golf course.

The Wood Creek tidal restoration project Phase 1 and 2 on the Northcoast Regional Land Trust's (NRLT) Freshwater Farms Reserve restores tidal influence and creates a diversity of estuarine habitats while providing public access and a setting for environmental education.

The South Jacoby Creek Floodplain Restoration Project, completed in 2019, captures out of bank floodwaters and routes them into a constructed freshwater wetland at the head of tide to reduce floodplain stranding while providing slow-water habitat for non-natal fish on a cattle ranch owned by the City of Arcata.

The tour will also include discussion of restoration projects in the planning phases connected to these sites. Project proponents participating in the tour include staff from the US Fish and Wildlife Service, City of Eureka, City of Arcata, Redwood Community Action Agency, NRLT, Michael Love & Associates, GHD, Northern Hydrology and Ross Taylor & Associates.

One of the several complex channels found in the South Jacoby Creek Floodplain Restoration Project.
Photo credit: Conor Shea

Habitat Restoration Projects in the Lower Mattole River Field Tour

Tuesday, April 25

Field Tour Coordinator: *Richard Sykes, Mattole Salmon Group*

This tour focuses on the lower Mattole River and estuary to view and discuss past, present and future projects to improve conditions for salmonids. The tour will include visits to Mattole Estuary and Slough, Lower Bear Creek and McGinnis Creek. This will include examples of floodplain restoration, slough rehabilitation and reconnection, large wood structure installation, and a proposed stream restoration-reconnection project. The tour will be provided by staff from the Mattole Salmon Group, Mattole Restoration Council, the US Bureau of Land Management and Mike Love and Associates.

The Mattole River estuary
Photo credit: Mattole Salmon Group.

Process-based Restoration & Effectiveness Monitoring in McGarvey Creek Field Tour

Tuesday, April 25

Field Tour Coordinators: *Sarah Beesley, Yurok Tribal Fisheries Department, and Rocco Fiori, Fiori GeoSciences*

Attendees on the McGarvey Creek field tour will be able to see a variety of restoration features including constructed wood jams, off-channel wetlands, and beaver dam analogues / wood-based check dams as well as fisheries monitoring sites within a coastal tributary of the Lower Klamath River. We will be discussing everything from restoration objectives and approaches, planning, design, permitting, construction, lessons learned, and how our long-term and on-going physical and biological monitoring is informing the process.

Looking upstream at McGarvey Beaver Dam Analogue Site 1 (constructed in 2018). *Photo credit: Sarah Beesley*

California Lamprey Considerations for People Restoring Streams Workshop and Field Tour

Wednesday, April 26

Workshop Coordinators: *Katrina Nystrom, Salmonid Restoration Federation; Marisa McGrew, Wiyot Tribe; and Abel Brumo, Stillwater Sciences*

Most of the restoration and conservation activities that occur in Pacific coastal streams are intended to promote salmonid recovery but could also benefit native lampreys. This workshop will highlight the efforts of the Pacific Lamprey Conservation Initiative (PLCI) and its Restoration Subgroup to bring attention to these ecologically and culturally important species and leverage the expertise of individuals studying and working to restore them in California. The goals of the workshop are increasing awareness of native lamprey species, enabling stakeholders to identify different lamprey species in the field, and empowering participants with the knowledge and practical tools to incorporate lamprey needs and conservation practices into their restoration projects and in-water work activities.

The workshop will include a morning classroom session and an afternoon field tour. The classroom session will include presentations covering lamprey biology and systematics, cultural and ecological importance, and differences in life history and habitat requirements from salmonids. The afternoon field tour will visit local streams to observe lampreys and their habitats. The tour will include discussions of techniques for lamprey sampling and salvage, best management practices, and opportunities to integrate lamprey into salmonid-focused restoration projects.

Pacific Lamprey climbing their way up the Eel River to reach spawning grounds.
Photo credit: Steward Reid and Damon Goodman

Fostering Enthusiasm and Partnerships to Advance Lamprey Conservation

Josh Boyce, Ph.D. (Presenter), Supervisory Fish Biologist, USFWS
and Co-Author; Alicia Marrs, Pacific Lamprey Conservation Initiative

In 2004, a petition to list Pacific Lamprey under the Endangered Species Act (ESA) was deemed "not warranted" by the U.S. Fish & Wildlife Service (USFWS) due to a lack of information and defined distinct population segments. This decision and the cultural importance of Pacific Lamprey sparked a collaborative effort to restore this important species outside of the ESA listing process, and in 2008, the Pacific Lamprey Conservation Initiative (PLCI) was formed. PLCI is a diverse collaboration of Native American tribes, federal, state and local agencies, non-profits, and others working together to conserve and restore lamprey populations and their habitats in Alaska, California, Idaho, Oregon, and Washington. This group of more than 176 organizations uses research, conservation actions, and outreach to achieve long-term persistence of Pacific Lamprey and support traditional tribal cultural use.

As awareness grows, there is a renaissance underway in research and conservation for native lamprey species and at its epicenter is PLCI. Researchers and students are studying lamprey biology, ecology, and cultural importance more than ever before. Engineers, restoration practitioners and funding boards are finally considering lamprey. Important conservation actions are being implemented for lampreys, but so much more can and should be done. As one of the newest fish habitat partnerships (FHPs) under the National Fish Habitat Partnership, PLCI also seeks ways to collaborate with other FHPs and partners across the West and Nation to increase awareness and understanding of the cultural and ecological importance of Pacific Lamprey and identify ways to leverage existing knowledge and resources to protect, restore and enhance fish habitat for the benefit of all aquatic species, and the communities they support.

2022 was a big year for lampreys and PLCI. New and existing partners had the opportunity to sign on to the Pacific Lamprey Conservation Agreement demonstrating their commitment to supporting lamprey conservation and PLCI, and partners across PLCI's 18 Regional Management Units (RMUs), spanning the entire U.S. West Coast, contributed to the update of the Pacific Lamprey Assessment. All of this led to Lamprey Summit V and the 6th Annual Lamprey Information Exchange in December 2022, where partners dove deeper into the science and strategies to send PLCI into the next five-year chapter of the partnership with a focus on collaborative science and conservation.

The momentum continues into 2023! This presentation will cover ways attendees can get involved by participating in their local RMU (seven of the 18 RMUs are in California), the Lamprey Technical Workgroup and/or any of its 13+ subgroups and considering applying for funding to implement lamprey conservation projects.

Seeking Sand: Habitat Constraints for Lampreys

Stewart Reid (Presenter), Western Fishes
and Co-Authors; Damon Goodman, CalTrout, and Josh Boyce, U.S. Fish and Wildlife

Lampreys of many species are distributed throughout western North America. The large anadromous Pacific Lamprey has arguably the broadest latitudinal range of any freshwater fish along the Pacific Coast. The principal constraints on its freshwater distribution are unobstructed passage (waterfalls are not necessarily a barrier); availability of water both for access from the sea and survival during freshwater residency; and the availability of suitable rearing substrates for the larval stage (ammocoetes). Ammocoetes are filter-feeders that live in stream bottoms for up to seven years or more and grow to nearly 20 cm before transforming. They require fine, oxygenated substrates in which to burrow. Some substrate mechanisms create poor conditions for the successful rearing of ammocoetes. These include sediment trapping by dams, hydraulic mining, stagnant water bodies, and streambed management policies that focus on gravels and cobbles rather than balanced substrate composition. Examples are drawn from distribution studies in the Trinity (northern California) and Rogue (southern Oregon) drainages.

Reconnecting Pacific Lamprey with their Historical Habitats in California

Damon H. Goodman (Presenter), CalTrout
and Co-Authors: Stewart B. Reid, Western Fishes; and Josh Boyce, USFWS

Pacific Lamprey are a key player in the ecology of California's rivers as ecosystem engineers and food web heroes. Man-made barriers are a primary factor limiting abundance and block access to approximately half of their historical distribution in California. Fishways are commonly designed without consideration for lamprey and can create obstacles or even direct threats. To address this issue, we focused on improving our understanding of their distribution, behavior and passage capabilities. This information has provided a foundation for the development of novel and low-cost approaches to remediate barriers that are now applied across California and beyond. On the Eel River we used an experimental framework to develop and implement a tube passage system at California's tallest and longest fishway. Lamprey passage efficiency improved from 6% to over 90% after implementation and over 10,000 individuals passed in the first year alone. In San Luis Obispo Creek we modified a weir to provide lamprey passage allowing for the first documented case of natural recolonization in a drainage without an existing downstream population and extending the southern extent of their distribution by over 200 km along the coast. Considering the needs of lamprey in passage designs will further support ecological restoration of California's rivers.

Pacific Lamprey: Anthropocene Sentinel for Pacific Northwest Water Quality

Cynthia LeDoux-Bloom, Ph.D. (Presenter), Department of Fisheries Biology, Cal Poly Humboldt, and Co-authors: Laurie Porter, Lamprey Project Lead, Columbia River Inter-Tribal Fish Commission; and Justin Alvarez, Department of Fisheries, Hoopa Valley Tribe

Anadromous and semelparous, Pacific lamprey *Entosphenus tridentatus*, is of immense cultural significance to Pacific Northwest tribes, an important tribal food source, a tribal trust species for the USFWS, and a species of concern for the State. The Oregon Health Authority issued consumption levels for the general and vulnerable populations of Pacific lamprey based upon Mercury (Hg) and polychlorinated biphenyls (PCBs). The Columbia and Trinity River basins provide the main source of human drinking which includes many Indian Reservations and both are listed as impaired waterbodies 303(d) water quality standards. It has been shown that lamprey can be used to detect levels of Hg due to their multi-year, freshwater filter feeding juvenile phases. Our studies have demonstrated that larvae bioaccumulate contaminates (e.g Pyrethroids, Hg, etc.) and can be used to monitor long-term water quality for human and aquatic species use. Adults can be used to assess contaminant presence (e.g., Hg and PCB) in the nearshore ocean waters and are also an important tribal food source. Use of larvae and adults as bio-indicators to monitor marine and freshwater ecosystem health throughout the Pacific lamprey range is a possibility. We discuss the planning of the Pacific Northwest regional framework to use Pacific lamprey as the sentinel species for water quality monitoring.

Filter Feeding by Larval Pacific Lamprey for Reducing Escherichia Coli and Improving Water Quality

Parker Kalan, M.S. (Presenter), Tenera Environmental, Inc., and Co-Authors: John Steinbeck, M.S., Tenera Environmental, Inc; Freddy Otte, Natural Resources, City of San Luis Obispo; and Crow White, Ph.D., Biology Dept. California Polytechnic University

Filter feeding aquatic organisms such as bivalves provide an ecosystem service for supporting water quality management by reducing concentrations of bacteria and other harmful organisms in watersheds. In a controlled laboratory experiment, we tested the ability for the filter-feeding larval, or ammocoete, stage of Pacific Lamprey (*Entosphenus tridentatus*) to reduce Escherichia coli bacteria concentration in a freshwater environment. Replicate, closed-system aquaria containing water that was naturally inoculated with *E. coli* were treated with populations of wild-caught *Pacific Lamprey ammocoetes* and non-filter-feeding juveniles (*macropthalmia*), and monitored daily for *E. coli* concentration. Over the five-day monitoring period, *E. coli* concentration declined in all the aquaria, including the controls, due to natural die-off of the bacterium. Importantly, we also observed a significant difference in the rate of decline among the treatments, with *E. coli* concentration declining more rapidly in the ammocoete treatment compared to the control treatment and aquaria with only non-filter feeding *macropthalmia*. Further, one aquarium representing a non-replicated treatment with a very high density of ammocoetes exhibited the fastest rate of decline in *E. coli* concentration compared with any of the other aquaria, including the replicate aquaria with a lower density of ammocoetes. This experiment provides evidence that the filter-feeding larval stage of Pacific Lamprey can reduce *E. coli* concentration in freshwater. Our findings suggest that, in the wild, Pacific Lamprey populations may promote water quality enhancement in natural systems for benefiting ecological communities, including salmonid populations, and human use of watersheds, including recreation and fishing. A further understanding of this potential ecosystem service could be gained from future research evaluating the effect of lamprey population density on *E. coli* concentration reduction, the ability for lamprey to maintain reduced *E. coli* concentration in a freshwater environment with a continuous resupply of *E. coli* over time, and the magnitude of these effects in natural watersheds of varying water quality.

Central Valley Lamprey: An Overlooked Presence in High Use Watersheds

Christina Parker, MNR (Presenter), California Department of Fish and Wildlife,
and Co-authors: Pascale Goertler, M.S., Delta Stewardship Council;
and Dr. Brittany Davis, California Department of Water Resources

Native lamprey species in the Central Valley of California serve important ecological roles in rivers and tributaries, are culturally important, and face similar conservation challenges as salmonids. Concerns of declining lamprey populations along the eastern Pacific Ocean have led to collaboration of tribes, and local, state, and federal agencies to increase understanding of ecology and life history. To identify knowledge gaps and migratory triggers, we conducted a literature review of publications on migration timing in flow impaired and unimpaired habitats related to temperature, river pulse and flow, salinity, photoperiod, and turbidity for anadromous species native to western North America. We synthesized migratory triggers for anadromous fishes in the genus' *Oncorhynchus* (salmon), *Entosphenus* and *Lampetra* (lamprey), and *Acipenser* (sturgeon). Salmonids have benefited from early and extensive attention in peer review publications and lamprey lag far behind despite many species occupying the same habitat as salmonids and sturgeon. Following the literature review we turned to existing sources of survey data to determine potential for filling knowledge gaps for lamprey species. Currently there are no long-term existing surveys targeting lamprey in the Central Valley and understanding of lamprey life history specific to California is often only through by-catch during surveys targeting other species. To evaluate monitoring data with spatial and temporal range, we compiled lamprey catch data from 78 rotary screw traps operating in 16 rivers and four watersheds. The San Joaquin River watershed, where catch was largely driven by a few traps, had higher catch per day and catch per minute than the Sacramento River watershed. Catch occurred during almost all streamflow conditions and in almost the full ranges of temperature and turbidity conditions. Primarily positive correlation of weekly lamprey catch between rotary screw traps from the same watershed indicated seasonal synchrony across traps and that adjacent traps are recording similar migratory signals. These findings and data can be used for future analysis to increase understanding of lamprey life history for management, restoration projects, and conservation efforts.

Lamprey Diversity in California: Genomic Approaches for Untangling an Understudied Species Complex

Grace Auringer, Ph.D. student (Presenter), University of California, Davis,
and Co-authors: Pascale A.L. Goertler, Delta Stewardship Council, Delta Science Program;
Matthew A. Campbell, Ph.D., University of California, Davis and University of Alaska, Fairbanks;
Amanda J. Finger, Ph.D., University of California, Davis

Lampreys, a group of jawless, eel-like fishes, are extant representatives of the first known vertebrates. At least six species of lamprey (*Entosphenus spp.* and *Lampetra spp.*) occur in California watersheds. Similarly to anadromous salmonids, anadromous lamprey species benefit their native ecosystems in numerous ways; however, conservation actions designed to protect and restore salmonids do not always benefit lampreys and may even have unintended negative consequences for lamprey populations. All six native lamprey species are listed as California Species of Special Concern, yet little is known about genetic differentiation of these diverse lamprey populations throughout the state. In this study, we applied restriction-site associated DNA sequencing (RADseq) to lamprey samples collected opportunistically through several ongoing fish monitoring surveys in 2018-2019. Our preliminary dataset captures individuals from various species, life stages, and geographic locations throughout northern California. Analysis of 480 individuals genotyped at variable SNPs (single nucleotide polymorphisms) throughout the genome revealed genetically distinct clusters of individuals that allowed us to infer species identity for unidentified samples. Two anadromous species, Pacific lamprey (*Entosphenus tridentatus*) and River lamprey (*Lampetra ayresii*), are highly genetically divergent. We observed novel species distribution patterns, shedding light on underestimated species diversity in certain regions of California. For many sampling locations, multiple lamprey species were found at the same site during the same sampling period, suggesting sympatry is common for lamprey in California. Ongoing research efforts aim to generate a SNP monitoring panel specific to lamprey populations in the SF-Bay Delta, Klamath, Sacramento, and San Joaquin watersheds.

The Future Is Now: How To Use Practical Remote Sensing Tools To Gain New Perspectives In River Restoration And Watershed Assessment

Wednesday, April 26

Workshop Coordinators: *Emily Fairfax, California State University, Channel Islands; Eli Asarian, Riverbend Sciences; Adam Cummings, U.S. Forest Service Pacific Southwest Research Station; and David Dralle, U.S. Forest Service Pacific Southwest Research Station*

Do you want to travel through time, see patterns and colors not visible to the naked eye, and soar thousands of feet in the sky over your field sites? You can—with remote sensing! This full-day workshop provides a hands-on introduction to get you started using remotely sensed datasets and tools for restoration planning and assessment. Thanks to recent technological advances and ever-expanding availability and quality of data, what was once only possible in science fiction is now readily doable from the comfort of your home or office. And this workshop will show you how.

We demystify this avalanche of data by introducing attendees to easy-to-use "no-code" and "low-code" remote sensing tools, ranging from just your web browser to GIS softwares to simple snippets of R and Earth Engine code. In the morning we will walk attendees through: 1) the multitude of types of data available (e.g. vegetation, topography, land cover, land use, and climate) and what they are useful for, and 2) how to efficiently access and analyze these data to better understand landscape conditions and subsequent response to disturbances and/or restoration work. In the afternoon, participants who bring laptops will have a hands-on opportunity to explore data, test-drive tools, and work on projects with instructors available for guidance, discussion, and troubleshooting. If you are brand new to remote sensing , there will be introductory-level mini-projects with step-by-step instructions provided for you to try out. If you are more experienced, we encourage you to come with a location and/or question in mind and work with the instructors to incorporate new remote sensing perspectives.

Examples of practical topics includes in this workshop are: 1) where to find and browse historical and current satellite imagery, aerial photographs, and other remote-sensed data products; 2) how to delineate watersheds upstream of a point; 3) how to generate summarized time series of vegetation, land cover, and climate for areas of interest to assess effects of management, beaver activity, fires, floods, and landscape changes; and 4) tools for analyzing topography. Participants will be given handouts with a list of tools and applications.

To provide attendees with a taste of the potential available through remote sensing techniques more advanced than what we are teaching in this workshop, we will also include a few brief lightning talks featuring examples of remote sensing work conducted by the instructors in support of river restoration.

Changing Tides: Managing CDFW Lands for Marsh, Slough, and Dune Habitat in the Eel River Estuary Field Tour

Wednesday, April 26

Field Tour Coordinators: *Chris Loomis and Allan Renger, CDFW; Alex Blessing, The Wildlands Conservancy; and Jeremy Svehla, GHD*

This tour will showcase a recently completed 850-acre tidal marsh, slough, and dune restoration project completed at CDFW's Ocean Ranch Unit and the Wildlands Conservancy's Eel River Estuary Pers Preserve portion of the Centerville Slough and Russ Creek Restoration Project in the Eel River Estuary. The Ocean Ranch tour will include a walk along the newly created trail network and viewing opportunities of project elements including levee and tide gate removal, designed channel reconfiguration, constructed habitat features for fish, wildlife, and plant communities, invasive plant eradication, and improved public infrastructure. We will discuss the history of the land, development of the project, design, permitting, construction, and on-going management and monitoring of the site. The Wildlands tour will discuss previous and current restoration planning efforts and future implementation strategies. The tour will include stops on the Preserve to highlight future restoration opportunities including coastal dunes, tidal wetlands, fresh-brackish ecotones, and public access amenities.

This tour will showcase a recently completed 850-acre tidal marsh, slough, and dune restoration project completed at CDFW's Ocean Ranch Unit in the Eel River Estuary. *Photo credit: Chris Loomis, CDFW*

Cooperative Restoration Partnerships in the Van Duzen River Watershed Field Tour

Wednesday, April 26

Field Tour Coordinators: *Anna Halligan, Trout Unlimited, Eel River Watershed Improvement Group; Isaac Mikus, ERWIG; Keith Lackey, Humboldt Redwood Company; Tom Leroy, Pacific Watershed Associates; and Leah Tolley, NOAA Restoration Center*

Tour attendees will be provided with an overview of the watershed including a description of its geology, fishery assemblages, historic land use impacts, and restoration objectives. The tour will include site visits to three off channel pond restoration features, instream large wood installations, and fish passage barriers. Discussions will be focused on collaborative restoration efforts, restoration planning at a watershed scale, effectiveness monitoring, how to consider non-native fish, permitting, and much, much more.

Lawrence Creek Hydrologic Reconnection of Critical Salmonid Habitat – Pond 2 was designed, permitted, and implemented during 2018 and juvenile Coho Salmon and Steelhead Trout have consistently been observed annually during post project monitoring. *Photo courtesy Trout Unlimited*

Securing a Stronghold: Different Approaches for Design and Collaborative Process in Prairie Creek and Redwood Creek Restoration Projects Field Tour

Wednesday, April 26

Field Tour Coordinators: *Mary Burke, Cal Trout; Bob Pagliuco, NOAA Restoration Center; and Leslie Wolff, NOAA Fisheries*

Join us for a field tour of lower Prairie Creek, a salmon and climate stronghold, and view past, present, and future habitat restoration projects. We will also visit Redwood Creek's estuary and discuss the exciting possibility of levee modification and estuarine habitat restoration with project partners. We will see examples of, and discuss with technical experts: small stream restoration, large wood additions, floodplain connectivity, backwater habitat, levee modification, and associated revegetation and invasive plant controls, and project effectiveness monitoring. We will provide the best available information on population status and recovery potential for salmon, steelhead, including recent project monitoring results as well as some insight into eulachon and smelt in this watershed. The project sites offer the opportunity to learn how different levels of project collaboration are integrated into design approaches and will include lessons learned from a collaboration, design, implementation, monitoring, and project management perspective. The tour will be led by Mary Burke, Senior Project Manager with California Trout and Leslie Wolff, Hydrologist with NOAA Fisheries West Coast Region, and Bob Pagliuco with NOAA Restoration Center. Tour stops will include presentations from each project team:

- Introduction and Setting the Watershed Context, Mary Burke, CalTrout; Leslie Wolff, NOAA Fisheries; Bob Pagliuco, NOAA RC
- Redwood Creek Estuary Restoration—Development of the Locally Preferred Alternative (Concept Design), Mary Burke, CalTrout; Leslie Wolff, NOAA Fisheries
- Large Wood Installation in Prairie Creek at Davison Meadow, Vicki Ozaki, NPS (Retired); Andrew Morin, NPS; Aaron Martin, Yurok Tribal Fisheries Department
- Large Wood Design at Elk Meadow Cabins on Prairie Creek, Leslie Wolff, NOAA Fisheries; DJ Bandrowski, Yurok Tribal Fisheries Department; Andrew Morin, NPS; Aaron Martin, Yurok Tribal Fisheries Department; Bob Pagliuco, NOAA RC
- Prairie Creek Floodplain Restoration with 2 of 5 years of implementation completed, Mary Burke, CalTrout; Bob Pagliuco, NOAA RC; Leonel Arguello NPS; Jeff Anderson, Northern Hydrology and Engineering; John Bair, McBain Associates; DJ Bandrowski, Yurok Tribal Fisheries Department

The Lower Prairie Creek Early Implementation Pond shortly after construction
Photo credit: Bob Pagliuco

Elk River Stewardship: A Watershed-Scale Remediation and Restoration Program Field Tour

Wednesday, April 26

Field Tour Coordinators: *Darren Mierau and Katy Gurin, California Trout; and Jay Stallman, Stillwater Sciences; Tim Metz, Restoration Forestry, Inc.; and Bonnie Pryor, Northern Hydrology and Engineering*

The Elk River watershed is currently the focus of intensive efforts to resolve complex land-use and water quality impairment issues. Beginning in the late 19th C., the watershed was subjected to 170 years of poor land stewardship and environmental degradation, first with harvest of the old growth redwood forests, railroad construction, and conversion of floodplains and wetlands to agricultural lands. In the recent past (1988-2000), poorly regulated timber harvest in Elk River left a legacy of sediment impairment, habitat degradation, and local property damage from frequent nuisance flooding. In response, this landscape-scale recovery effort—built on a foundation of biological and physical process analyses supported by hydrodynamic and sediment transport modeling and extensive outreach to landowner, agency, and academic partners—is finally ready to launch into implementation.

The Elk River Recovery Program is focused on (1) rehabilitating miles of non-natal rearing habitat for threatened salmonid populations in Elk River tributaries, the mainstem, and the stream-estuary ecotone, (2) restoring floodplain connectivity and riparian vegetation diversity, (3) implementing a managed retreat strategy in the face of oncoming sea level rise through extensive tidal wetland restoration and drainage infrastructure improvements in the lower valley, (4) and addressing health and safety concerns for the rural residential communities living along the Elk River.

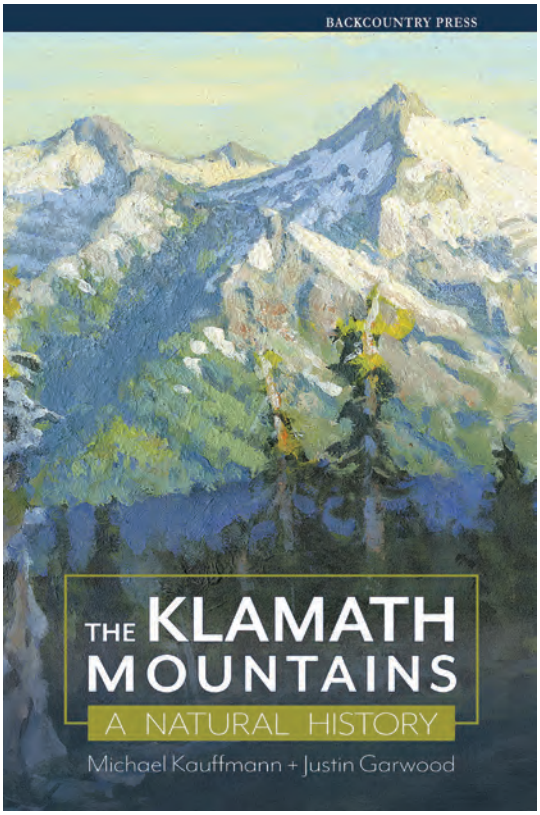
This tour will feature stops at locations along the lower 13 miles of the mainstem Elk River and South Fork Elk River into the BLM Headwaters Forest Reserve. Featured discussions will include: 1. Current status of ongoing planning and design in the tidal and lower valley reaches, with overview of conceptual restoration designs, application of new "Cutting the Green Tape" permitting tools, and key habitat restoration components; 2. A focus on remediation of legacy sediment and reduction of nuisance flooding in the "impacted" lower reaches of the north and south forks, and upper mainstem; 3. Opportunities for expansive aquatic and riparian restoration at a privately-owned, 77- acre ranch on the South Fork Elk River; and 4. Recent accelerated recruitment treatments conducted by BLM and Restoration Forestry Inc., in the BLM Headwaters Forest Reserve

Winter flooding of Berta Road, which is the only ingress/egress road for numerous residents on the south side of Elk River valley."
Photo Credit: Darren Mierau.

Natural History of the Klamath Mountains: How Honesty, Accuracy, and Receptivity Guide us to Better Stewardship of Definable Landscapes

Justin Garwood and Michael Kauffmann (Co-editors of Klamath Mountains Natural History*)*

The Klamath Mountains are a world-renowned temperate biodiversity hotspot and a new book The Klamath Mountains: A Natural History celebrates this region for the first time. With contributions from a diverse group of 34 authors, this book provides a new way of cataloging natural history by weaving abiotic, biotic, and cultural themes together. The Klamath Mountains are defined by ancient geology—which provides the boundaries for this natural history and offers a universal invitation for humans to comprehend and appreciate the ecosystems we inhabit. Through intentional learning and personal connections to the natural world guided by honesty, accuracy, and receptivity, we can all deepen our relationships with landscapes—a process that is inextricably tied to our own wellbeing. Human-caused climate change is the defining environmental issue of our time and is locally impacting the Klamath Mountains with increasing air temperatures, less rainfall and snowpack, and related altered hydrology and water quality. These emerging conditions—especially influenced by recent droughts—have amplified the destruction caused by naturally occurring disturbance regimes such as fire in dense forests, accelerated erosion, and fish diseases. The persistence of salmonids in the region is supported, in part, by their complex life histories. This is a product of their genes and regional factors such as local precipitation regimes and the distribution of localized cold-water habitats. Salmonscapes often reach much farther than anadromy and host many other cool niche specialists—including many clandestine endemic species like snails, conifers, and salamanders. In this talk the book's co-editors Justin Garwood and Michael Kauffmann will discuss their experiences and growth as naturalists, ecologists, and lovers of place by highlighting stories of regional cold niches and the diversity they maintain.



The Water Remembers: A Calling to Follow Indigenous Knowledge and Law to Restore Ecosystem and Community Resiliency in the Klamath Basin

Amy Cordalis, Yurok Tribal Member, founder of Ridges to Riffles

The Water Remembers: A calling from the Klamath River to incorporate Indigenous law and knowledge into climate restoration and resiliency strategies. People, and water, have memories that flow through generations carrying not only intergenerational trauma but wisdom too. Since time immemorial, the Yurok people have lived along the lower Klamath River observing its natural rhythm. From observation grew an understanding of how the entire ecosystem worked together. From understanding grew respect for the ecosystem that cared for the Yurok people. This knowledge and respect were incorporated into Yurok law, policy, and knowledge which was stifled during colonization in the 1800 and 1900s. Now the Klamath Basin is in ecological, cultural, and economic crisis and this knowledge may be the key to restoring the Klamath Basin.

Connecting the Omics: Genomics, Phenomics, and TEK are Keys in Restoring the Klamath Basin Post Dam Removal

Keith Parker, M.S. *Senior Fisheries Biologist, Yurok Tribe*

Salmon and other fish of the Klamath Basin have been keystone cultural and biological species for tens-of-thousands of years. Uncounted generations of indigenous people have enjoyed the bounty of the fisheries resource as an integral component of the way of life; intertwined with cultural, ceremonial, subsistence, and commercial aspects of existence. Such a relationship exemplifies Tribal ability to maintain a sustainable fishery and illustrates the depth of traditional knowledge possessed. It has been estimated that prior to European contact, indigenous people in the Basin consumed more than 2-million pounds of Chinook and Coho salmon, along with sturgeon, lamprey, steelhead, and eulachon. Post European contact, Tribal food security and food sovereignty has been decimated. From 1915-1928, annual catch and escapement of Fall Chinook salmon neared 400,000 fish; 1978-1995 average escapement decreased to 58,820. In 2018, the Basin met the criteria for overfished status and remains so with a 2020-2022 geometric mean of Fall Chinook adult spawning escapement in natural areas of 25,857. A minimum 3-year geometric mean spawning escapement of 40,700 natural area adult spawners are necessary to maximize sustained yield and rebuild the fishery. The Yurok Tribe collects phenotype information (bio, catch-effort, and disease survey data), scales for aging and snouts for coded wire tag recoveries from in-river salmon 8-months of the year. Tissue samples have also been collected 2018-2022 from approximately 20,000 Trinity River Hatchery returning adult Chinook salmon and in-river carcass samples below the hatchery. Genotyping at loci which have been found to be diagnostic for specific life history traits is in progress. Yurok Tribal fishery data are indispensable components for multiple management objectives including modeling (cohort reconstruction, forecasts of ocean abundance), evaluation/analyses (run-size, CWT expansions, harvest rates, stock status for ESA listings), and for managing ocean fisheries. A core component of Tribal sovereignty is data sovereignty. It is an inherent right of a Tribe to collect, analyze, and model data to inform management decisions impacting indigenous lands which best align with Tribal stewardship responsibilities. The Yurok Tribe is at the forefront of effective data collection, control, and ownership, while balancing data sharing with Federal and State co-managers and technical workgroups. Interdisciplinary efforts which integrate the phenomics, genomics, and traditional ecological knowledge will be vital in successfully repopulating salmonids to the Upper Basin post dam removal, as well as rebuilding the Lower Basin populations, in the face of climate variability (extreme fire events, increasing temperatures, winds, drought).

Why We Fish:
Decolonizing Salmon Rhetorics & Governance for Climate Resilient Futures

Cutcha Risling Baldy, Department Chair Native American Studies, Cal Poly Humboldt

Indigenous peoples have distinct, informed, ancient knowledge about the natural world as a result of their ongoing interconnection to land and more-than-human relatives. This includes a science which has matured over thousands of years, building empirical evidence and methodologies based on much longer relationships with our more-than-human relatives. Salmon governance in California has decentered rhetorics of relationship for rhetorics of economy and science which leads to devastating impacts not only on salmon but also for Native peoples Considering that much of recent history has been dominated by attempts to shame, disrupt and sever our salmon relationships it is important to recognize how Indigenous peoples continue to practice salmon rhetorics that utilize ancient interconnections with salmon to solidify current interrelationships with salmon. This exploration and analysis of rhetoric and governance based in Indigenous Science and traditional ecological knowledge illuminates California Indian rhetorical strategies and community discourse as key to the future development of policy, law, and salmon restoration for salmon futures.

Evolving Policies and Tools to Advance Salmon Restoration: Flows, Cannabis, and Funding Opportunities

Thursday Afternoon Concurrent Sessions

Session Coordinators: *Kelly Souza, California Department of Fish and Wildlife; Matt Clifford, Trout Unlimited; and Monty Schmitt, The Nature Conservancy*

This hybrid session will include presentations about direct and indirect impacts of cannabis cultivation on the environment; advancements in tools and applications that quantify cultivation, species response or water use; and opportunities or partnerships that highlight the remediation and restoration of watersheds affected by cannabis cultivation.

After the break, the session will focus on policy shifts and practical tools to advance the pace and scale of restoration and address water scarcity, groundwater management, and tribal inclusion.

A Site-Specific Analysis to Understand the Role of Human Influence and Drought on Streamflow Conditions in a Small Humboldt County Watershed

Kelly Souza (Presenter), and Co-authors: Joe Kermish-Wells, M.S., Marguerite McCann, M.S., Chris O'Keefe, M.S., and Elijah Portugal, M.S., California Department of Fish and Wildlife; and Kate Crosby, Ph.D., Local Bounti

Redwood Creek, tributary to the South Fork Eel River, has a high biological resource value, potential for species recovery, and competing water needs. It has been identified as a watershed of regional concern because it is experiencing significant adverse impacts during these unprecedented drought conditions, due to surface and groundwater diversions. We wanted to understand the role of human influence (cultivation and domestic use needs) on streamflow and whether water year alone (drought) accounts for the unprecedented low flows in Redwood Creek. To assess the role of human influence, we used satellite imagery to map the total area under cultivation and factored that area by industry estimates of daily plant use. Mapping efforts revealed that water use in Redwood Creek was dominated by licensed cultivation and the amount of water used for cultivation is substantially more than that needed for domestic use. To assess the role that water year plays in observed flow conditions, we used a scaling and pairing technique to compare a long-term flow record from a stream with a permanent gauge (in this case, Bull Creek), to estimate flow in an ungauged watershed (Redwood Creek). We found that while dry years do contribute to lower flows, water year alone does not account for the statistically significant differences in scaled flows between Bull and Redwood creeks. In fact, both water year and site are significant, but results indicate that the effects of site are more significant than those of water year.

How CDFW's Cannabis Restoration Grant Program Can Contribute to Salmonid Restoration

Virginia O'Rourke, California Department of Fish and Wildlife

The California Department of Fish and Wildlife's mission is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. The Department's Cannabis Restoration Grant Program (CRGP) is committed to promoting ecosystem restoration and ecological health throughout California. We offer multiple funding opportunities for tribes, public agencies, and non-profits interested in restoring ecosystem function and improving habitat connectivity. Come join us to learn more about CRGP funded projects that clean-up and remediate cannabis impacted watersheds, restore ecosystem function, conserve water resources, and improve soil health. These same grant funds can be used by your organization to help us restore salmonid habitat in California. We have something to offer everyone and encourage you to join us for this presentation as we review current funding opportunities, highlight successful case studies, and discuss how you can apply for cannabis grant funds.

Modeling Streamflow Depletion from Cannabis Cultivation in California's North Coast Salmon-Bearing Streams

Philip Georgakakos, Ph.D. (Presenter), University of California, Berkeley,
and Co-authors: David Dralle, Ph.D., Forest Service, Pacific Southwest Research Station;
Chris Dillis, Ph.D., University of California, Berkeley; and Jesse Hahm, Ph.D., Simon Fraser University

Cannabis has been intensively cultivated in many of California's salmon-bearing watersheds for decades, particularly in the North Coast. Multiple sources have raised concerns that water extraction for cannabis agriculture in these regions could negatively impact streams that support threatened salmonids. However, quantifying the effects of cannabis water use on streamflow using empirical methods is complicated by the high natural variability in streamflow conditions, complex watershed hydrology, and uncertainty in cannabis water use practices. In this study, our team quantified the potential impacts of cannabis water withdrawals on streamflow in two representative north coast watersheds, using a scenario-based approach. This approach allowed us to explore the relative effects of cannabis cultivation area, irrigation water source (well or surface diversion), irrigation efficiency, water year type, and watershed lithology on streamflow depletion risk. Our analysis focused on two heavily studied watersheds—Elder Creek and Dry Creek—which represent the dominant lithologies found in the Eel River watershed. Scenarios were calibrated with data collected from permitted cannabis farms to estimate water-use sources, timing, and application rates. Our models predict that water extraction could impact streamflow (amount of summer baseflow and number of days without surface flow) in both streams. In the study watersheds, hypothetically populated with 1% aerial cannabis cover, our model predicts that water extraction has the potential to de-water Elder Creek, a perennial salmon bearing stream, and could accelerate drying on Dry Creek, an intermittent stream, by five weeks. Flow impacts are predicted to be greater in drier years and impacts from well-water extraction are delayed relative to surface water diversion. We hope that this work can inform regional assessments to identify watersheds in the region that may be most sensitive to water diversions and to guide management actions that limit impacts to salmon-bearing streams.

Efficient Science Tools to Identify Streamflow Objectives to Support Flow Enhancement Project Development and Implementation, and Trigger Management Actions Under Critically Dry Conditions

Julie Zimmerman (Presenter), The Nature Conservancy,
and Co-authors: Jennifer Carah and Kirk Klausmeyer, The Nature Conservancy

Using traditional methods, developing flow objectives to support development of flow enhancement projects or other changes in water management can be a long and expensive process, which poses a barrier to quick decision making and project development. There are new, efficient desktop tools available to assist in identifying flow objectives more quickly, and this presentation will introduce several and describe how they can be used to support project planning, development and implementation and help increase the pace and scale of flow and fish habitat restoration, or support changes in water management in very dry years. Tools described will include the Natural Flows Database, a tool developed by The Nature Conservancy, USGS and other partners, which generates estimates of natural flows (expected streamflow in the absence of human modification) in all the streams and rivers in California from 1950 to the present. We will also discuss the California Environmental Flow Framework, a statewide approach to develop stream segment-scale ecological flow criteria that protect native aquatic species and communities. This approach uses the natural range of variation of functional flow metrics at any potential location of interest in California. Additionally, we will discuss the Drought Flows Monitor webtool, which uses predicted monthly flow data from the Natural Flows Database to evaluate when dry conditions may pose an extraordinary risk to aquatic ecosystems and in which streams, and to predict extraordinarily dry conditions up to a few months prior to the dry season. The tool can be used to highlight watersheds with critically dry conditions and used to trigger action quickly and efficiently.

Water From Bedrock: Efforts to Condition New Groundwater Wells to Protect Streamflow for Salmon in Sonoma County

Monty Schmitt, The Nature Conservancy and Matt Clifford, Trout Unlimited (Co-presenters)

As communities throughout Northern California struggle to mitigate the impacts of persistent drought and strive for climate resiliency, reliance on groundwater is increasing and leading to a proliferation of new wells. Groundwater diversion from shallow aquifers can deplete streamflows and threaten habitat for salmon and steelhead often already diminished by surface diversions. Pressured by litigation based on the Scott River groundwater decision, Sonoma County has proposed amendments to its ordinance governing the permitting of new groundwater wells to meet obligations to protect public trust resources in the Russian River and its tributaries. This presentation will explore the technical challenges, legal issues, and policy implications to develop and implement a model well ordinance to consider potential impacts on streamflows before issuing permits to drill new or replacement wells, especially in fractured bedrock regions largely overlooked by SGMA. As other cities and counties come under pressure to sustainably manage surface and groundwater resources to protect riverine ecosystems and meet domestic and agricultural demands, the Sonoma County ordinance will likely serve as an example.

Granting Equity. The Future of CDFW's Granting Programs

Timothy Chorey, FRGP State Coordinator, California Department of Fish and Wildlife

Over the last 6 months CDFW's Watershed Restoration Grant Branch (WRGB) has taken purposeful steps to make granting more Just, Equitable, Diverse, and Inclusive (JEDI). WRGB recognizes the importance of having diverse grantees to accomplish restoring California's lands, waterways, and species health. WRGB recognizes the need to expand who, where, and how restoration work is funded. This presentation will lay out the important systematic changes WRGB has taken to lead CDFW to making granting more equitable. It will detail historic granting inequalities and how CDFW has made engagement improvements, solicitation and awarding changes, applicant and grantee technical assistance improvements, and more. CDFW hopes this presentation will help continue and magnify the conversation on granting equity and derive new and more effective changes the Department can lead.

Large-Scale Fisheries Habitat Restoration in Working Landscapes

Thursday Afternoon Concurrent Sessions

Session Coordinators: *Jay Stallman, Stillwater Sciences, and Ann Willis, American Rivers, California Regional Director*

Habitat restoration and conservation across working lands is a critical component to resilient, landscape-scale recovery of listed and at-risk anadromous salmonid populations. Working lands encompass a large percentage of critical habitat, which presents unique challenges and opportunities for scaling conservation work beyond isolated refugia within public lands and other high value protected areas. This session features large-scale, multifaceted, and interdisciplinary habitat restoration and conservation efforts on working lands from the semi-arid middle and upper Klamath basin to the heavily forested outer North Coast Ranges and temperate stream estuary ecotone in north coastal river valleys. Topics include emerging science; creative technical approaches to planning and design; avenues for stakeholder engagement; cooperative agreements between private landowners, tribes, and public agencies; and funding and permitting mechanisms unique to habitat restoration on working landscapes.

Klamath Reservoir Reach Restoration Plan: Assessing Habitat Conditions and Prioritizing Restoration Post-Dam Removal

Bob Pagliuco (Presenter), NOAA Restoration Center,
and Co-authors: Chris O'Keefe and Brett Holycross, Pacific States Marine Fisheries Commission;
and Nell Scott and Tommy Cianciolo, Trout Unlimited

With the removal of the four major Klamath River dams expected to begin in early 2024, the newly accessible habitat above the dams has become more important than ever. Though much restoration work has occurred in the Upper Klamath Basin above Link River Dam, the watershed areas between Iron Gate Dam and Link River Dam (the 'Reservoir Reach') have previously been a low priority for identifying and implementing restoration activities.

In 2020, the NOAA Restoration Center secured funding to create a prioritized restoration action list for the Reservoir Reach and partnered with Pacific States Marine Fisheries Commission (PSMFC) and Trout Unlimited (TU) to develop the list and the following report. Restoration projects were identified using a mix of methods, including literature reviews, GIS desktop analysis, field surveys, aerial imagery analysis, and geographic grade line analysis.

The team convened a science panel to provide feedback on our protocols, methods and scope and their input was incorporated in the work plan. Once restoration projects were identified, a Technical Advisory Committee (TAC) was compiled from appropriate federal, state, tribal, non-profit, and consultant experts. The TAC reviewed methods, projects, and prioritization criteria and most importantly, the TAC scored all the identified projects to produce the final prioritized project list.

Through the methods identified above, the team assessed habitat conditions, identified limiting factors, and identified restoration actions throughout 63 miles of mainstem habitat and 39.4 miles of tributary habitat from Iron Gate dam to Link River Dam. This effort resulted in the identification and prioritization of 82 habitat restoration projects, 78 potential diversion screening projects and 38 potential flow restoration projects.

This Plan was developed to provide funders, researchers, permitting agencies, restoration practitioners and other interested parties a snapshot of current habitat conditions, limiting factors, and prioritized actions to protect, restore and improve habitat conditions and riverine processes.

Forest and Mountain Meadow Resiliency, Fisheries Restoration, and River Recovery Actions on Working Lands in the Scott River

Charnna Gilmore (Presenter), Executive Director, Scott River Watershed Council, and Co-authors: Erich Yokel and Betsy Stapleton, Scott River Watershed Council

The Scott River watershed is part of the traditional homeland of the Shasta Indian Nation, supports one of the largest populations of Coho Salmon in the Klamath basin, and is home to rural communities with a deep connection to the land and reliant on its natural resources. The watershed encompasses diverse biomes ranging from montane forests and mountain meadows with hundreds of miles of cold, headwater tributaries to the mainstem Scott River coursing through a large alluvial valley with historically complex low gradient riverine and floodplain habitats. The Scott River Watershed Council (SRWC), a place-based non-profit organization dedicated to holistic restoration of the Scott River from its headwaters to the Klamath River, is working with public and private landowners to (1) restore forests and mountain meadows where cold water sources are impacted by fire suppression, grazing, logging, and road building; (2) implement process and form-based restoration (e.g., augmenting large wood, reconnecting floodplains, and building beaver dam analogs and off channel habitat features) to improve Coho rearing habitat in tributaries; and (3) remediate the legacy hydrologic and geomorphic effects of bucket-line dredging within a five mile reach of the mainstem Scott River. A technical team assembled by SRWC is currently developing a reach-wide plan that includes large-scale restoration actions, priorities, and phasing for the critical portion of the dredger mined mainstem reach that annually dewaters and disconnects the upper 20 percent of the watershed. Given intensifying drought conditions driven by climate change and the associated increased regulation of surface water and groundwater resources during the dry season, SRWC has also recently initiated a stakeholder directed effort (including Tribes, agricultural producers, community members, other NGOs, and regulatory agencies) to evaluate factors responsible for channel degradation and hydrologic impairment in the mainstem Scott River throughout Scott Valley, identify potential restoration approaches, and develop a regulatory strategy to achieve landscape-scale recovery.

Habitat Restoration on the Working Landscapes of the Smith River Plain

Marisa Parish Hanson and Monica Scholey, Smith River Alliance (Co-presenters)

The Lower Smith River and its coastal plain tributaries present a compelling opportunity to advance recovery of salmonids. The Smith River is one of the wettest in California, the river is undammed, and much of the watershed is under designations that protect its forests, wildlife, and waters. However, the part of the watershed most in need of restoration is the broad floodplain that is dominated by farmlands, where the anadromous tributaries are constrained by pastures and undersized stream crossings.

Most of the Smith River watershed consists of steep forested terrain with high gradient streams: 40% of the watershed is sloped with over 50% gradient and does not provide the low-gradient habitats that support coho rearing (Parish and Garwood 2016). Comparatively, the relatively flat Smith River Plain is ideal for overwintering juvenile coho salmon. Moreover, according to the National Marine Fisheries Service (NMFS), legacy agricultural practices are the greatest contributor to loss and degradation of Smith River coho salmon habitat (2014) in the Smith River basin.

In 2013, Smith River Alliance (SRA), in partnership with CDFW, initiated a monitoring effort focused on juvenile salmonid habitat availability and use across the private properties of the Smith River Plain. These efforts evolved into restoration planning and ranking of projects based on fisheries data, environmental factors, input from state, federal and local agencies, as well as local landowners, to develop the Smith River Plain Stream Restoration Plan (2018). This Plan identifies and ranks 137 restoration projects, and the years of collaboration have been critical to establishing trust with landowners on the design and implementation of potential projects.

To date, SRA has multiple projects with 100% designs, and several initiatives are funded for implementation. We will present a summary of our monitoring, planning, and lessons learned through the unique challenges and opportunities of restoring working lands. We will highlight a few projects to illustrate permitting pathways we have utilized as well as landowner discussions that shape projects and allow us to advance restoration on the Smith River Plain.

A Vision, Plan, and Strategy for Comprehensive Recovery of Lower Elk River, Tributary to Humboldt Bay

Darren Mierau (Presenter), CalTrout, and Co-authors: Bonnie Pryor and Jeff Anderson, Northern Hydrology and Engineering; and Jay Stallman, Stillwater Sciences

Few watersheds have experienced a more difficult path to recovery than Elk River, the largest tributary to Humboldt Bay (58.3 mi2), located in north coastal California and within the Wiyot Tribe's ancestral territory. Arrival of colonial settlers in 1849 and thereafter brought resource extraction methods and land uses that permanently altered the Elk River watershed. Nearly all ancient redwood forests were logged multiple times and extensive valley bottomlands throughout the coastal plain were converted to agricultural uses. Logging and splash damming; construction of transportation, flood control, and drainage infrastructure; and rural residential development have left an enduring imprint on Elk River. These impacts, in combination with overfishing throughout the region, caused severe habitat degradation and the eventual collapse of salmonid populations (including Chinook, coho, steelhead, and coastal cutthroat) in the watershed. Our team has collaborated with landowners, tribes, state and federal agencies, and other stakeholders in a process to remediate, rehabilitate, and restore this unique and productive river system. The process involved assessing conditions within 18 miles of the Elk River channel and floodplain (The Elk River Recovery Assessment), initiating a major community outreach program (The Elk River Stewardship Program), and developing a detailed plan that provides a roadmap for design, permitting, implementation, and monitoring of recovery actions (The Elk River Recovery Plan). We partitioned the Stewardship Program footprint (spanning more than 1,700 acres) into four Planning Areas, each of which is undergoing a comprehensive design process within an integrated regulatory strategy. Proposed Actions include land acquisitions, sediment and vegetation management, restoration of tidal marsh, riparian, and salmonid rearing habitats, and major upgrades to drainage and utility infrastructure. Implementing the plan will increase the resiliency of the restored ecosystem and existing land uses to climate change. We estimate that construction implementation will be phased over an approximately 10-year period at a cost of about $50 million. Engagement continues through the Elk River Stewardship Program as we advance engineering design and fundraising.

Trout Unlimited's North Coast Coho Project —Over 20 years of Restoration on Industrial Timberlands

Anna Halligan, North Coast Coho Project Director, Trout Unlimited

This presentation will be focused on the restoration partnerships that Trout Unlimited's North Coast Coho Project has established with timber companies to recover salmon and steelhead populations and improve watershed health in coastal Northern California. It will begin with an introduction to the program and its history working with state and private forestry professionals on restoration and recovery efforts, and will expand to review how the program and its work have changed over the years and how we hope to work in the future. The presentation will also include discussion topics about how resources and expertise can be leveraged to complete a project, how restoration contributes to resource based economies in rural and underserved communities, and the importance of establishing common goals and objectives while taking into consideration regular operations and maintenance needs.

Garcia River Estuary Enhancement Project and TNC's Approach to Restoration on the Mendocino Coast

Peter van de Burgt, The Nature Conservancy,
and Lauren Hammack, Prunuske Chatham, Inc., (Co-presenters)

Over the last two decades, The Nature Conservancy has worked with landowners on working lands in the lower alluvial valleys of key watersheds along the Mendocino Coast to promote salmonid restoration. This approach has centered on forging relationships, acquiring conservation easements or fee title lands, and working in lockstep with landowners to plan, design, and implement large floodplain and instream restoration projects that are compatible with the ongoing use of the land. This viability of this approach was most recently demonstrated through the successful implementation in summer 2022 of the Garcia River Estuary Salmonid Habitat Enhancement Project, a large-scale estuary restoration effort that took place on a mix of working and public lands. The Garcia project, ten years in the making, included two large floodplain enhancements and construction of 18 engineered log jams over a 0.5-mile reach of the river's tidally dynamic middle estuary zone. During this presentation, Peter van de Burgt, TNC's North Coast Restoration Project Manager, will discuss TNC's approach to restoration on working landscapes on the Mendocino Coast and how it led to the Garcia project and Lauren Hammack, fluvial geomorphologist at PCI, will describe the Garcia project in detail, including its design, construction, and expected outcomes.

Fish Passage Design and Implementation Lessons Learned

Thursday Afternoon Concurrent Sessions

Session Coordinators: *Jason White, Environmental Science Associates; Travis James, Michael Love & Associates; and Lucas Walton, Prunuske Chatham, Inc.*

Fish passage remains a significant issue for salmonids throughout California. Salmonids' life history strategy to move about and utilize various habitats within a watershed is critical to their survival as a species, particularly in the face of climate change. Barriers that prevent fish movement can break the salmonid life cycle with dire consequences to a population in a given watershed. The California Department of Fish and Wildlife collects barrier data from various agencies and organizations in California and compiles them into the Passage Assessment Database (PAD). The PAD currently lists thousands of total, partial, and temporal barriers in the State in need of removal. The PAD also lists hundreds of barriers that have been remediated. Though there is much work to do when it comes to addressing fish passage in California, many barriers have already been successfully removed, with a wide range of successes and setbacks that can be learned from.

This session focuses on fish passage design and implementation lessons learned. It's been over 13 years since the release of the Part XII of California Salmonid Stream Habitat Restoration Manual: Fish Passage Design and Implementation. The work that has been performed under the guidance of this manual and beyond has much to offer in the way of lessons learned. This session will cover recent innovations, practical experiences, and challenges encountered in designing and implementing fish passage projects throughout the State of California.

Lesson Learned Constructing a Horizontal Fish Screen at Derby Dam

Dan Kaler, P.E., Farmers Conservation Alliance

Derby Dam, located on the Truckee River outside of Reno, Nevada USA, is the oldest capital project owned and operated by the U.S. Bureau of Reclamation. The dam was built in 1905 without provisions for upstream or downstream fish passage. This had blocked access to spawning and rearing habitat for Lahontan cutthroat trout (LCT). LCT are endemic to the Truckee River and are listed under the U.S. Endangered Species Act. To restore aquatic connectivity and provide fish passage around the dam, a three-part fish passage project was planned. First, an upstream fish way channel was designed and constructed; second, selected gates on the dam were replaced incorporating autonomous control; and third, a horizontal fish screen facility was designed to safely bypass fish downstream of the dam. The fish screen facility is a screen array of Farmers Conservation Alliance horizontal fish screens, designed to accommodate up to 600 cfs. This talk will focus on the third and final part of the fish passage project and will include a synopsis of the project and the lessons learned. The project was deemed substantially complete in September 2020.

Carmel River Reroute and Dam Removal Project: Challenges in Design and Construction of a Step-Pool Channel

Robert Mussetter (Presenter), Program Manager, Tetra Tech, Inc.,
and Co-authors: Shawn Chartrand, Assistant Professor, Simon Fraser University; Brian Cluer, Sr. Geomorphologist, NOAA Fisheries Service; Michael Burke, Principal Water Resources Engineer, Inter-Fluve, Inc.; and Marcin Whitman, Hydraulic Engineer, California Department of Fish and Wildlife (retired)

The bulk of the Carmel River Reroute and Dam Removal (CRRDR) project was constructed in 2014 and 2015. To avoid the need to relocate approximately 1.3M yd3 of sediment that had deposited in the reservoir since its construction in the early-1920s, the river through the former San Clemente reservoir was rerouted into the downstream reach of San Clemente Creek via a cut through the approximately 300-foot-high bedrock ridge that separates the river and the creek. Construction of the new channel into a series of step-pool sequences, plane-bed reaches and resting pools, was completed in late-2015. The channel reconstruction design was driven by detailed technical specifications that included a range of flood-frequency design criteria for various project elements and stringent criteria for in-channel hydraulic conditions to ensure fish passage (focused primarily on steelhead) over a broad range of low to high flows. Three floods with recurrence intervals of 2-, 15- and 45-years occurred during the next two winters after construction causing significant alteration of the constructed channel. The constrained design criteria, challenges during construction, the behavior of the river under flood conditions and the subsequent channel and riparian habitat evolution provide an interesting set of circumstances and outcomes that may benefit planning and execution of future, similar projects in steep, semi-confined, coarse-grained rivers.

Mill Creek Fish Passage Project: Design, Construction & Lessons Learned

Justin Bodell, RLA, (Presenter), Landscape Architect,
and Co-authors: Luke Walton P.E., Civil Engineer, Lauren Hammack, Geomorphologist,
and Mike Jensen, RLA, Landscape Architect, Prunuske Chatham, Inc.

A historic flashboard dam with a smooth concrete and rubble spillway blocked access to approximately 11.2 miles of high-quality spawning and rearing habitat in Mill Creek in Sonoma County. The channel upstream of the dam had filled with sediment, and incision occurred downstream of the dam that resulted in an approximate 6 to 8-foot tall fish passage barrier that was listed as one of the five "immediate restoration actions" for coho recovery in the Russian River. Prunuske Chatham, Inc (PCI) along with Trout Unlimited designed and constructed a barrier modification project to restore access through the dam site, with construction ending in 2016. The design included a steep roughened ramp to increase adult access over the spillway and a lower slope fishway/side channel to increase juvenile access around the dam. The site's many natural and anthropogenic constraints prevented the use of a lower-gradient fish passage solution; a variance was required to release the project from meeting traditional fish passage criteria. Despite this, post construction monitoring documented successful passage of adult coho through the site in subsequent years. This presentation will discuss alternatives considered during design, challenges encountered during construction, post-construction monitoring results, and lessons learned from the Mill Creek dam removal project.

Embrace Change: Combining Engineering and Geomorphic Principles to Design Resilient Fish Passage on San Geronimo Creek

Jason Q. White, Environmental Science Associates

As part of the San Geronimo Creek Restoration Project, the Salmon Protection and Watershed Network (SPAWN) partnered with Trust for Public Land (TPL), the landowner, to remove a longstanding fish passage barrier. San Geronimo Creek is a major tributary in the Lagunitas Creek watershed which supports the largest southernmost spawning run of endangered Central California Coast Coho Salmon. On San Geronimo Creek, a series of steel and concrete weirs were originally built in 1996 to replace a dam and improve fish passage. Commonly referred to as "Roy's Pools'', the ad hoc structure did not function as intended, perpetuating the fish passage barrier while also trapping juvenile Coho Salmon. Funded by the California Department of Fish and Wildlife (CDFW) Fisheries Restoration Grant Program, the barrier was removed in 2021 to open access to over four-square miles of valuable salmonid spawning and rearing habitat.

The Project's designer, Environmental Sciences Associates (ESA), combined engineering and geomorphic principles in designing the fish passage improvements. Removing the 10-foot-tall steel and concrete structure and restoring fish passage required realigning and reconstructing 550 feet of streambed. The new streambed design consisted of engineered rock structures that would be stable under extreme hydraulic forces. However, even the most well-engineered instream structures have experienced geomorphic change and failure during large winter storms. ESA's design approach embraced potential geomorphic change by designing for natural adjustment of the engineered rock structures during high flows. By doing so, the outcome is a resilient streambed that continues to provide natural fish passage even after torrential rainfall events.

Led by SPAWN, and supported by ESA, the design was constructed by Hanford ARC over two seasons in 2020 and 2021. Immediately following construction, the San Geronimo Watershed received approximately 10 inches of rain in an early 2021 season storm, putting the design approach to the test. The newly designed channel endured heavy flows, maintained its structural integrity, and underwent geomorphic change that made for an even more natural streambed surface. Following the huge storm many adult Coho Salmon were observed swimming upstream through what is now referred to as "Roy's Riffles".

This presentation covers the design choices that were informed by past ESA and industry lessons regarding engineered instream rock structures, and how such choices were put to the test and further lessons were learned.

Implementation When Design Cannot Progress Past a Conceptual Level: North Fork Battle Creek Fish Passage Improvement Project

P. Travis James, P.E., Senior Project Engineer, Michael Love & Associates, Inc.

North Fork Battle Creek is regarded as a uniquely important watershed because of the abundant, year-round influence of cold-water springs. These cold-water springs support steelhead and a broad diversity of Chinook salmon, including winter-run, which are now extirpated from the watershed and in danger of extinction. Anthropomorphic impacts such as dams limited access to much of the watershed. Beginning in 1999, the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project) was initiated to address some of these impacts, including the removal or modification of dam structures. In addition to the dam structures, two additional fish passage barriers were identified. The focus of this talk is one of these sites, which lies between Eagle Canyon diversion dam and North Fork Feeder Diversion Dam; both dams received vertical slot fishways as part of the Restoration Project.

Prior to construction, the project site consisted of very large, basalt boulders jumbled in the channel. The boulder configuration resulted in a 12-foot drop with no receiving pool. Remedying this drop was the objective of the project.

In 2015, MLA began the design process by first collecting field data and then developing alternatives. Some alternatives would have created relatively predictable hydraulic outcomes (e.g. concrete fishways) but considerable drawbacks, especially with respect to maintenance. As part of a technical working group, it was determined that the best long-term solution was to construct a nature like channel through the reach, but that many unknowns would remain until construction, including what material would be uncovered under the large boulders.

This presentation will cover the design elements that provided a flexible framework for implementation given the unknown conditions, the construction methods and results, and the lessons learned.

Beale Lake Dam Removal and Roughened Ramp

Mark Gard (Presenter), Senior Hydraulic Engineer, CDFW;
and Co-authors: Heather Hanson, Jessica Pica, and Paul Cadrett, U.S. Fish and Wildlife Service

The dam on Beale Lake, located on Beale Air Force Base, was removed in the summer of 2020, opening up 6 miles of anadromous fish habitat on Dry Creek. The project also included construction of a roughened ramp to maintain a jump pool at the base of a waterfall that was at the upstream end of Beale Lake. All of the sediment removed from the lake was used as part of the fill for creating the roughened ramp. The project was designed by U.S. Fish and Wildlife Service fish passage engineers, using the stream simulation method. Project success was demonstrated in the fall of 2021, when adult fall-run Chinook salmon were observed upstream of the project site.

Final Design, Material Sourcing, and Construction Methods of the Nelson Dam Roughened Channel Fishway

Michael C. Garello, PE, (Presenter), and Anna Mallonee, PE, HDR Engineering, Inc.

Nelson Dam was an 8-foot tall by 180-foot-wide channel-spanning concrete structure originally constructed in the 1940's across the Naches River near Yakima, Washington. The structure facilitated the diversion of irrigation water over 8,000 residents and commercial farmers connected to the City of Yakima's distribution system and along the Naches-Cowiche Canal. Nelson Dam was a known barrier to upstream migrating fish and has altered the profile of the Naches River for miles, causing decreased sediment continuity and increased flooding potential upstream. Throughout over two-decades of planning, stakeholder engagement, and design, the City of Yakima has successfully replaced Nelson Dam with a new roughened channel fishway. This multi-phased project will result in improved water supply reliability, restored fish passage, and enhancement of natural river processes meeting numerous regional and local objectives for the Naches River and Yakima Basin. This presentation will focus on the unique methods used for final design and construction of the roughened channel elements including the rock foundation, sheet pile seepage wall, rock bands, rock clusters, and pilot channels. Construction risk mitigation tactics such as the pre-construction material sourcing strategy as well as the phased dewatering approach will also be provided. Lessons learned resulting from final construction of the first project phase will be discussed.

Modeling Salmonid Habitat: Stream State, Forest Conditions, and Future Climates

Thursday Afternoon Concurrent Sessions

Session Coordinator: *Jonathan Halama, MPH, Ph.D., U.S. EPA*

This session's focus is modeling of salmonid habitats from an aquatic stream reach to full watershed scale. Through the sharing of ideas and techniques we can further endeavors toward strengthening salmonid populations through the improvement of both the fish's direct habitat and the surrounding area (riparian zone to the ridgeline) that all ultimately influence habitat conditions. Modeling efforts that help us further understand summer low flow conditions, mitigate winter flooding, reduce high summer stream temperatures, and improve cold-water refuges will be the focus of this session. A welcomed component will be any modeling techniques that possess the inclusion of climate change scenarios within the watershed evaluations to better understand and help mitigate how future climate conditions may impact the state of salmonid habitats. This session brings together people focused on modeling to share techniques and results to improve our understanding and enhance our watershed planning in hopes to maintain and improve critical salmonid habitat.

Habitat Mosaics Support Variation in Salmon Foraging and Growth Potential Under Extreme Drought Conditions

Rachael E. Ryan, Ph.D. Candidate, SERC PGS D (Presenter), Fellow University of California, Berkeley,- Department of Environmental Science, Policy & Management Carlson Lab & Grantham Lab, and Co-authors: Stephanie M. Carlson, Professor, and Theodore E. Grantham, Associate Professor of Cooperative Extension, University of California, Berkeley

Climate change in California is increasing the frequency and intensity of drought events, with observed trends towards drier summers expected to continue. Coho Salmon populations (*Oncorhynchus kisutch*) at the southern end of their range in California are especially at risk as juveniles spend a year in freshwater, making them vulnerable to summer drought conditions. However, a mosaic of stream habitats available to juveniles might buffer the population against the effects of extreme environmental fluctuations, providing refuge and driving variation in juvenile traits that lead to diverse life history strategies. In this study, we investigated spatiotemporal variation in habitat and juvenile Coho Salmon trait expression in response to extreme drought conditions. We sampled 15 pools spanning four streams in the Lagunitas Creek watershed in Marin County, California, which contains an endangered, natural-spawning Coho Salmon population. Throughout the spring and summer of 2021 amidst a historic drought, we collected physical habitat data, invertebrates, and underwater footage of fish. We used the abiotic and biotic conditions of each pool to model the growth potential of juvenile Coho Salmon across time and analyzed videos of fish to assess foraging behavior. Five out of fifteen pools were uninhabitable to juvenile Coho Salmon by the end of summer due to drying or severely depleted dissolved oxygen levels. The remaining pools showed variation in current velocity, temperature, depth, and drift invertebrate concentration as the summer progressed, leading to differences in the magnitude and timing of growth opportunities for juvenile Coho Salmon which can drive life history diversity. Overall, we found that extreme drought reduced the habitat mosaic and carrying capacity across the watershed, but within the viable habitat potential for life history variation persisted. Our results highlight the importance of maintaining diverse habitats across a watershed to both provide refuge during drought and sustain population diversity, which is critical for long-term population stability.

Modeling Benefits of Refuge Habitat for Salmonid Populations with InSTREAM

Steven F. Railsback, Ph.D. and PD (Presenter), Lang Railsback & Associates,
and Bret C. Harvey, Ph.D., USDA Forest Service Pacific Southwest Research Station

InSTREAM and InSALMO are individual-based simulation models of trout populations and freshwater life stages of salmon, designed to evaluate effects of physical habitat and flow, temperature, and turbidity regimes. These models have been used at numerous sites for instream flow and temperature assessment, habitat restoration design and evaluation, evaluating potential benefits of fish passage projects, and predicting effects of climate change. We used InSTREAM to evaluate potential benefits of groundwater-fed thermal refuges to trout populations under warming conditions. The model represents multiple acute and chronic effects of temperature on fish and eggs. We simulated a range of refuge availability in a 1-km stream reach, over a range of increasing temperature regimes. The model's credibility was increased by showing that it reproduced a variety of patterns observed in real trout using thermal refuges. The model predicts that high refuge availability can substantially increase survival and population persistence, but not all impacts of high temperatures can be mitigated by refuges. Several common assumptions about how trout use refuges were not supported by the simulations.

Modeling the Influences of Diversions and Forest Practices on Streamflow in Streeter Creek Near Laytonville, CA

Julia Petreshen (Presenter), Thomas Gast & Associates, and Jim Graham, Ph.D., Cal Poly Humboldt

Streeter Creek, tributary to Tenmile Creek, serves as refugia habitat for juvenile steelhead during the summer season. With recent drought years, Streeter Creek has gone dry during the summer. To better understand the influence of land cover, forest practices, and timing of water diversions, streamflow was modeled in Streeter Creek using the Streams Across Lands (SAL) model. Using proposed plans for increasing water storage and diversion forbearance at Black Oak Ranch, streamflow was modeled to predict the impact of the project. The SAL model was used to predict streamflow under varying climatic scenarios, as well as implementation of forest thinning and forbearance from summer diversions in Streeter Creek. Results indicate that the timing of water diversion and forest thinning will increase summer baseflow despite continued drought conditions. This project is sponsored by the Eel River Recovery Project and funded by a California Coastal Conservancy Proposition 1 grant.

Streams Across Lands (SAL): A New Stream Flow Modeling Method

Jim Graham, Ph.D. (Presenter), Associate Professor, Cal Poly Humboldt
and Julia Petreshen, Thomas Gast & Associates Environmental Consultants

Streams Across Lands (SAL) is a new stream flow modeling method for small watersheds in the Pacific Northwest. SAL is based on standard hydrological equations for water flow on the surface, through soil, and in stream channels. The model includes evapotranspiration modeling based on cover type characteristics including leaf area index (LAI), stem area index (SAI), and height of the canopy. The model can be used with standard spatial datasets including Soil Survey Geographic Database (SSURGO, NRCS) and National Land Cover Data (NLCD). SAL models streamflow at various time steps using weather and observed discharge data ranging from 5-minute observations to daily averages. SAL was tested primarily within the Elder Creek watershed because of the availability of data and minimal anthropogenic influence. SAL does not require calibration to a hydrograph and showed a high level of correlation with the observed discharge at the Elder Creek USGS station (USGS 11475560). SAL includes an easy-to-use graphic interface within the BlueSpray GIS application and provides a variety of graphic outputs for use in watershed analysis and community outreach.

Habitat Modeling of Salmonid Movement and Survival in Degraded and Restored Watersheds

Greg Blair, ICF

I present results from modeling salmon (*Oncorhynchus spp.*) life history across multiple watersheds and populations. This has provided useful insights into the effects of habitat conditions and the expression of life history traits. The analysis uses the Ecosystem Diagnosis and Treatment (EDT) model to build working hypotheses to direct habitat restoration and protection activities and has been applied in multiple watersheds in California, Oregon, and Washington.

EDT is a hierarchically organized, spatially explicit model that analyzes aquatic habitat along multiple salmonid life history pathways. An EDT analysis includes a watershed-wide estimate of the survival landscape for a historical and current condition. Overlain is an analysis of the potential of a population to express various life history pathways within the freshwater environment. Survival along a life history pathway is estimated by the quantity of habitat encountered, its quality, the seasonality of habitats encountered, and the amount of exposure to these factors.

Field studies are finding salmon may express many different life history pathways from emergence to ocean entry. This knowledge has contributed to a much improved understanding of the importance of a watershed-wide approach to managing and restoring salmon populations. Each pathway has a unique history of exposure to habitat conditions in time and place. My results show the relative importance of rarer, more distant, or seasonally specific habitats compared to primary natal habitats supporting spawning and early rearing. My modeling suggests simple pathways of spawning and rearing in the natal environment to smoltification can persist and may be the primary pathway in degraded watersheds. I show how the contribution of more novel life histories may have disappeared from a population due to habitat degradation external to natal habitat and can contribute to recovery.

However, how might the loss of some habitats have influenced the potential expression of life histories within a population? Salmon life histories are plastic in response to environmental conditions but much like other traits (e.g., river entry timing and spawn timing) likely include a heritable genetic component. I show through modeling coho life histories overlaid on several watershed survival landscapes of current and reconstructed historical habitat conditions how expression of some life histories may still persist, and others may have disappeared.

A significant challenge remains assuming pathways are heritable. Specifically, how to reestablish lost life histories once lost? This challenge is much like recovery of fitness in a population subject to past introgression of hatchery salmonids that had experienced multiple generations of artificial selection. I show how combining knowledge of pathways historically viable but no longer present because of current conditions with a simple phenotypic trait model with a heritable component leads to a better understanding of population status and in some cases more novel strategies for species recovery. My analysis suggests simply creating the habitat to support a life history is not all that is needed, multiple generations may be necessary and possibly innovative use of fish from populations that may still express desired life histories.

Individual Based Modeling of Stage 0 Treatment on Juvenile Chinook

Aleah Hahn, M.S. Student (Presenter), and Co-authors: Desiree Tullos, PE, Oregon State University, and; Steve Railsback, Cal Poly Humboldt

The South Fork McKenzie (SFM) River in the Oregon Cascade range was dammed in 1963 to generate hydroelectric power and limit flooding. The dam restricts upstream access to spawning habitat for pacific lamprey, threatened bull trout, and threatened spring-run Chinook salmon. The river's historically alluvial channel became single threaded and incised, transporting spawning sediments and degrading habitat. In 2018, 1 kilometer of river of the SFM was modified to the Stage 0 condition, a multi-threaded channel with large wood loadings, expected to reflect the pre-disturbance condition for alluvial systems (Cluer and Thorne 2013). The Stage 0 condition for the South Fork McKenzie elevated the incised channel to the geomorphic grade line, reconnected historic side channels, increased floodplain connectivity, and distributed large wood throughout the reach. This process increased the wetted area at base flow conditions from 11 acres to 50 acres. This study is examining how spawning and rearing habitat changes from Stage 0 treatment may translate into numbers and sizes of juvenile spring-run Chinook across water years and reservoir releases. The individual-based model inSALMO is applied with field observations to examine mechanisms through which changes in hydraulics, food availability, and water temperatures between treated and untreated sites affect juvenile Chinook. Profiles of depth and velocity were collected in both the treated reach and an untreated section upstream to represent both reaches' hydraulic profiles. inSALMO was applied using the observed hydraulic profiles and additional inputs, including food availability and temperature. Early results suggest that the increased area of the Stage 0 reach provides a greater quantity of food, for the same density of food, which in turn results in more large ocean-bound juveniles. Expected future water temperatures as a result of climate change are likely to reduce juvenile size as an increase in water temperature will increase each individual's standard metabolic rate. Field observations indicate that the treated reach has lower velocities than the untreated reach. With lower velocities in the Stage 0 reach, juveniles may increase their size at a faster rate given the food inputs are held constant when compared to the untreated reach. Given the diversity of Stage 0 sites, quantitative results from SFM may not be generalizable to all Stage 0 projects, but the model results provide insight regarding the mechanisms by which Stage 0 can produce larger juveniles, which can be used in design of future projects.

Predicting Fish Movement Near Infrastructure in Different River and Reservoir Environments

R. Andrew Goodwin, Ph.D., PE, Environmental Laboratory, U.S. Army Engineer Research and Development Center

The decisions of volitional, freely moving fish frequently dictate the success of multi-million dollar engineered structures and management actions. In managed waterways supporting the needs of human society, structures are often used to facilitate the safe travel of fish around obstacles such as dams or diversions that can hinder their movement or survival. In other cases, structures are used to facilitate the capture or limit the spread of invasive species. The engineering design of waterways infrastructure designed for fish typically involves some form of build-and-test. The ability to predict fish response to infrastructure during the engineering design phase has the potential to save time and money as well as living resources. Research in decision-making, perception, and fish-flow interaction dates back more than a century. A numerical model simulating a reduced form of animal cognition and perception, using algorithms dating back (in some cases) more than a century, can reproduce fish movement patterns observed near infrastructure. For the past 25 years, the U.S. Army Corps of Engineers, Research and Development Center (ERDC), has been working on a management tool that can hindcast and predict future fish response to infrastructure designs and management actions. Development of the tool—a Eulerian-Lagrangian-agent Method (ELAM)—has leveraged over $65 million dollars worth of river and fish movement/passage data near infrastructure. The model is not perfect, and limitations will be discussed. However, the ELAM model has achieved unique success in predicting future 3-D/2-D fish movement, guidance, and passage/entrainment and also has accurately predicted patterns prior to the availability of field data in some cases. Further, the ELAM has performed well on out-of-sample data where the future condition was different from the calibration conditions. The model does not attempt to represent the true cognitive architecture of fish; rather, the decision-support tool attempts to leverage researched non-linear relationships between stimuli, perception, and action to make predictions of what fish will do at the scale of river infrastructure. Central to model performance is the notion that fish are attuned to more than one environmental signal and more than one timescale. Emerging theoretical developments suggest the potential exists for inverting downstream-moving behavior rules to describe upstream-moving fishes. Fish movement depends on the species, but work unifying past data into a common framework—and advanced by a growing community of ELAM users—facilitates value-added benefits to existing data, the ability to understand fish behavior more quickly, and the ability to better incorporate animal behavior into the fast-paced nature of engineering design projects.

The Eel River:
A River of Opportunity with Implications Beyond its Basin

Friday Morning Concurrent Sessions

Session Coordinator: *Alicia Hamann, Executive Director, Friends of the Eel River*

The Eel River is the third largest watershed in California and is home to several runs of native, wild salmonids and species of interest. The watershed holds unique opportunities in a variety of realms: for salmonid recovery, establishing legal precedent for enforcement of the Endangered Species Act, connecting communities and building a recreation economy, adapting a proactive approach to sea level rise, and so much more. This session will explore those opportunities, how a variety of organizations are working together to achieve them, and their implications within and beyond the Eel River basin.

Wiyot Natural Resources Department's Past, Present, and Future Work on the Wiya't: Restoring the Wiyot Tribes' Role as Stewards of Their Ancestral Territory

Adam Canter, Wiyot Natural Resources Department

The Wiyot people have an interconnected relationship with the waters and fishes of the Wiya't (Eel River). Since time immemorial, the Wiyot Tribe have depended on and provided stewardship over the Wiya't, Wigi (Humboldt Bay), and the (Batawa't) Mad River. In the mid-1800s, gold and timber exploitation brought European settlers to northwest California, resulting in a decimation of the Wiyot population and culture. Furthermore, continued habitat destruction and water extraction have exacerbated the degradation of the Wiya't. As a result, traditional and cultural fishing is no longer permitted by the State of California. Despite this, the Tribe is still committed to using its resources to work toward the restoration of the Wiya't and other habitats spanning its ancestral territory. Through previous and future projects, the Tribe is re-establishing its role as stewards of their natural resources. This presentation will discuss the past, current, and future work of the Wiyot Natural Resources Department (WNRD) with an emphasis on essential collaborations across the Eel River watershed. Topics will include research essential to the management of culturally important species, invasive species management, restarting a lamprey management plan, and starting a habitat restoration program.

Monitoring Populations of Adult Salmonids in the Eel River Basin: Historical Context and Advancing Modern Abundance Estimates to Inform Recovery Targets and Recovery Efforts within the Basin

David Kajtaniak, California Department of Fish and Wildlife

Once supporting thousands of California Native Tribe members with sustenance and cultural resources and subsequently robust commercial and sport salmon fisheries, the Eel River (Wiyot) has a legacy of wild salmon abundance. As California's third largest watershed, estimates of over a half a million Chinook and Coho salmon combined were harvested per year at the turn of the 19th century (Moyle et al. 2017). More recently, runs have crashed to far less than 10% of the historical abundance of fish remaining (Moyle et al. 2017). However, modern escapement estimates have been largely expert opinion based on a few indices throughout the watershed. This lack of monitoring data and a comprehensive monitoring plan for California Coastal (CC) Chinook Salmon made it difficult to establish population status and trend, consequently decelerating the development of recovery planning efforts. To address these issues the California Department of Fish and Wildlife (CDFW) developed a strategic monitoring approach and plan for near-future and longer-term implementation, which included recommendations for deploying Dual-frequency IDentification SONar (DIDSON) technology in the Eel River to monitor CC Chinook Salmon populations (Lacy et al. 2016). This sonar monitoring has also been extended to capture additional data on North Coast winter steelhead populations and observations of Green Sturgeon and Pacific Lamprey.

CDFW, partnering with NOAA West Coast Fisheries, Trout Unlimited, Pacific States Marine Fisheries Commission, Round Valley Indian Tribes, California Trout and PG&E initially deployed sonar technology in the Mainstem Eel River (upstream of the South Fork Eel River) in the fall of 2018 to monitor the run-timing and produce abundance estimates of adult salmonid species. Additional camera stations have been deployed in the South Fork Eel River, Middle Fork Eel River and most recently the Van Duzen River. Cumulatively, these efforts will be critical for understanding adult Chinook Salmon and steelhead movement and their numbers for the entire basin, and will help guide recovery and restoration efforts in light of future management plans.

Life History Characterization of Wild Steelhead in the Eel River

John Carlos Garza, Ph.D. (Presenter), NOAA SWFSC and University of California, Santa Cruz
and Co-authors: Devon Pearse, Ph.D., NOAA SWFSC;
and Kerry Reid, University of California, Santa Cruz

Understanding life-history trait variation in species of conservation concern is essential for effective management. Steelhead (*O. mykiss*) are extensively supplemented through hatcheries to ensure their continued persistence, but this has been shown to lead to divergence in life history traits from wild populations. We monitored a wild steelhead population at the top of the mainstem Eel River from 2009 - 2017. The Van Arsdale Fisheries Station and fishway (1922) allows steelhead to reach the spawning grounds above Van Arsdale Reservoir, which constitute a significant amount of all steelhead habitat in the basin. We conducted a large-scale pedigree reconstruction effort with single-nucleotide polymorphism (SNP) genetic markers. In addition, we sequenced five regions of the genome on chromosome Omy28 that have been shown to be associated with ecotypic differentiation in steelhead. We were able to reconstruct ~570 parent-offspring trios with high confidence and found that most offspring returned as three and four year olds. Iteroparity rates were higher than hatchery populations (8.7 % of fish returned in subsequent years) and were mostly females. Comparisons of relatedness (rxy) between simulated random mating and actual mating showed no deviation from random mating in this system. The Omy28 SNPs identified likely summer-run steelhead entering the fishway in late summer, as well as a number of heterozygous adults (4%). Some of these heterozygous individuals produced offspring that returned in subsequent years.

Totally RAD Impassable Barriers: How Geologic Features Separate Summer and Winter-run Steelhead in the Eel River and Beyond

Samantha Kannry, TRIB Research

The Eel River is home to the southernmost population of summer-run steelhead. Preservation of adaptive complexity, such as the summer-run life history, is essential to the resilience of steelhead throughout their range. As a consequence of their life-history strategy, summer-run in Northern California have experienced severe declines in recent decades, due to dams, diversions and subsequent flow alteration, increasing stream temperatures, climate change, and reliance on disturbed headwater reaches for spawning and rearing. This led to the 2021 endangered listing under the California Endangered Species Act. We used Restriction Site Associated DNA Sequencing (RAD) methods to examine the distribution of the two run-types in the Eel River. We observed distinct segregation between winter and summer-run steelhead correlated with flow-dependent barriers in the Van Duzen, Middle Fork Eel and Upper mainstem Eel Rivers. Our findings from the Eel led to additional questions about barriers and historical/contemporary presence of summer-run steelhead in adjacent watersheds. We wanted to obtain a more comprehensive picture of the distribution of the summer-run life-history throughout Northern California. We expanded our research into the North Fork Eel, Mattole, Mad, Klamath and Smith Rivers and Redwood Creek. We have collected tissue samples above and below numerous flow-dependent and impassable barriers throughout these basins. Our research has provided valuable information for designing conservation, restoration, and management strategies for steelhead in the Eel River and will continue to do so in the rest of Northern California and beyond.

Physical and Biological Constraints on the Capacity for Life-history Expression of Anadromous Salmonids: an Eel River, California, Case Study

Alyssa M. FitzGerald, Ph.D. (Presenter), and Co-authors: Sara N. John, University of California, Santa Cruz and NOAA Southwest Fisheries Science Center; David A. Boughton, Lee R. Harrison, Ph.D., and Nathan J. Mantua, Ph.D., NOAA Southwest Fisheries Science Center; Joshua Fuller, NOAA Fisheries West Coast Region; and Benjamin T. Martin, University of Amsterdam

Recovery of anadromous salmonid populations is complicated by their complex life histories. We examined the spatiotemporal interplay of stream temperature, geomorphic features, and a species' thermal sensitivity mediated by biological interactions in a case study of steelhead trout (Oncorhynchus mykiss) and Chinook salmon (Oncorhynchus tshawytscha) in California's Eel River watershed. We estimated habitat suitability and fish capacity for each salmonid run and freshwater life stage during average, cool, and warm years in each of the watershed's sub-basins, including a historically occupied high-elevation subbasin upstream of an impassable dam. Our estimates varied depending on whether we accounted for exposure to the Sacramento pikeminnow (Ptychocheilus grandis), an introduced predator and competitor. Our results indicate that the dammed sub-basin has substantial salmonid capacity relative to the rest of the watershed and could provide an important cool-water refuge during warm years and from pikeminnow, potentially improving the productivity and resilience of multiple anadromous salmonid populations. Our approach can be applied in any setting where spatially explicit habitat metrics can be estimated and population-specific and life-stage-specific habitat criteria can be specified.

Advocacy on the Eel: How an Endangered Species Act Take Claims and Federal Energy Regulatory Commission Litigation Can Remove Barriers to Salmonid Recovery Nationwide

Redgie Collins, Esq., Legal and Policy Director, California Trout

The PG&E-held Potter Valley Project currently blocks almost 300 miles of salmonid habitat at the headwaters of the Eel River. The Project consists of Scott Dam, Cape Horn Dam, and a diversion and powerhouse facility that moves water from the Eel River to the East Branch of the Russian River. The Project was built in the early 1900s and loses roughly $7-10 M a year. Scott Dam fully blocks migratory access to high-quality, cold-water habitat in the 288-linear river-mile watershed above it. Access to this upper habitat would nearly double the historic spawning grounds found on the entirety of the watershed and would restore the aptly named Gravely Valley to its historic ecological rearing grounds. A coalition of California-based conservation groups and Tribal Nations are advocating for Scott and Cape Horn Dam removal under the Potter Valley Project decommissioning process before the Federal Energy Regulatory Commission ("FERC"). The utility is currently in a surrender proceeding and its fate lies in PG&E's project plan which will be released by December, 2023. This represents a massive opportunity for the removal of Scott and Cape Horn Dams.

In support of the removal process, CalTrout, Trout Unlimited, Friends of the Eel River, and PCFFA are bringing two related suits to push for the removal of project facilities. The current project operations cause "take" by killing or harming salmon and steelhead, at levels that have not been approved by the fisheries service. Specifically, the project causes take in excess of that authorized by the prior biological opinion, and the National Marine Fisheries Service has concluded that biological opinion expired with the license in April of 2022. The already-filed litigation seeks to compel FERC to undertake with the National Marine Fisheries Service a legal review called Endangered Species Act consultation and add interim measures to the license conditions, including for flows and operations of the fish ladder, while the process to determine the ultimate fate of the dams plays out.

The second suit will be versus PG&E itself for killing and otherwise harming Endangered Species Act listed salmon and steelhead. Together, the suits have several objectives that make them compelling enough for our groups, which do not often engage in litigation, to be optimistic about the potential outcomes.

These two sets of litigation would set important precedent on how to push utilities to remove obsolete hydropower projects.

Approaches to Build Trust and Engage Our Diverse Communities

Friday Morning Concurrent Sessions

Session Coordinators: *Mary Burke, California Trout; Leslie Wolff, Hydrologist, NOAA Fisheries, West Coast Region; and Natalie Arroyo, Humboldt County 4th District Supervisor*

Restoration practitioners strive to build a world that can sustain life, including the full spectrum of our human communities. We recognize that people need to get on board with restoration and regeneration as we face threats of habitat loss, climate change, and impacts to human health. Doing this well remains a challenge in our field. This session will focus on ways that restoration practitioners have done and can do community-building work. We will discuss justice and equitable outcomes in our project work. This session invites presenters to share tools, stories, and exciting interactive approaches to demonstrate what truly effective and diversity-minded community engagement looks like, on a project or policy level. We also welcome presenters who would like to share ideas on the strengths of relationship development, collaborative frameworks, and cultural transformation in our rapidly changing world.

Diversifying Connections to Support Healthy Habitats

Carla Avila-Martinez, Redwoods Rising Fellow,
and Leslie Parra, Outreach Program Manager, Save the Redwoods League (Co-presenters)

Protecting and restoring salmonid habitat will be most successful when there is diverse community support and diverse perspectives working together. In many cases, the first step is to simply connect underrepresented communities to environments they normally don't have access to. Save the Redwoods League is making an enormous effort to connect underrepresented communities to Redwood forests throughout the state of California. Inviting communities of color to experience forests and rivers can be life-changing for many students and families. Carla and Leslie have witnessed this firsthand as they have extensive experience connecting underrepresented communities to the outdoors. Once there is a connection, a spark of curiosity may be formed that inspires stewardship and builds a diversified workforce, which is critical for the health of our redwood ecosystems. This talk will cover diversifying community connections to restoration, strategies for fostering an inclusive restoration workforce, and the presenters' personal experiences as women of color in the restoration and science education field.

The Intergenerational Struggle of Being a River-Based Community in Modern Day America

Danielle Frank, Hupa Tribal Member; Youth Coordinator, Save California Salmon

In this presentation, I will be giving my perspective as a nineteen-year-old water protector and indigenous activist following in the footsteps of my ancestors. Growing up as a Hupa tribal member with Yurok and Karuk ancestry, all I've ever known is struggle. I've only heard the stories of the perfect health our land once was in; I've never witnessed this. In my lifetime, our homelands have always been suffering. Water diversions, fish kills, hydroelectric projects, and greedy corporations have been present in my territories long before the day I was born. Although this is true, I feel as if I have known the waters that run through my home before they were merely surviving. I feel as if I knew them before they were constantly fighting for basic survival. I believe this is due to the direct link I have to my homelands through my ancestors. My great uncle, Howard McConnell, was one of the original water warriors fighting for the removal of the Lower Klamath Hydroelectric Project alongside his right hand man Troy Fletcher. My father took me to Salem, Oregon at just seven years old to witness a signing of papers regarding the dam removal, and that was my first introduction to the Federal Energy Regulatory Commission. Fighting for these waters and lands is hereditary in my family; other families pass down family heirlooms, and we give our future generations a fight for survival. I will be using this presentation to discuss mainly the intergenerational struggle, but I will also be mentioning climate finance and reparations.

Bridging Cultural Fault Lines in the Middle Klamath to Build a Restoration Movement

Will Harling, Mid Klamath Watershed Council

The Middle Klamath region, including the Western Klamath Mountains, exists on an extreme cultural gradient from far right conservative communities in the Shasta and Scott Valleys to the East, to far left liberal communities along the coast. In the rugged mountains between, three of the largest tribes in California have persisted through genocide, land theft, and assimilation and continue to practice Pikyavish, World Renewal, a religion based on survival in place. Their leadership and dedication has led to the largest dam removal project in the U.S. becoming a reality, and is bringing indigenous fire management back after a century of failed attempts at fire exclusion and suppression. This presentation will reflect on the approaches used by the Mid Klamath Watershed Council to support tribal movements, and expand restoration actions on public and private lands in the Middle Klamath Region. Early attempts at collaboration that failed, and later efforts that succeeded provide valuable insights into creating the facilitating conditions for building trust and a restoration movement. Grassroots organizing principles, community engagement programs, and the development of partnerships, including the Western Klamath Restoration Partnership, will be described.

Bedrock Principles for Successful Restoration Partnerships

Stephen Greenwood, MPA, National Policy Consensus Center, Hatfield School of Government, Portland State University

Just as there is science of salmon restoration, there is also a science to creating the successful collaborative partnerships required for salmon restoration. Building upon 30 years of work in the field of collaborative governance, and hundreds of collaborative projects, we will present research findings, and provide real-life examples on the skills and approaches that can make a positive difference for success on the ground and in our communities.

- How to foster win-win partnerships
- Ways to build trust and re-build from an atmosphere of distrust
- Why it matters who convenes the collaborative partnership
- How to keep group meetings from bogging down

Centering Environmental Justice: Examples from the North Coast

Natalie Arroyo, Humboldt County Supervisor, District 4

Today, many watershed restoration and ecological enhancement projects cannot happen effectively without involving "frontline" communities (those most impacted by the proposed changes or living with the challenges of past-failed resource management approaches). Often, these frontline communities are tribal nations, people of color, and poor neighborhoods who are left out of the decision-making process. This talk will provide a variety of examples of environmental justice at work on the North Coast, with a particular emphasis on projects that ultimately benefit fish, wildlife, and people. Following these brief examples, participants will be invited to talk with one another to consider and share other inspiring examples of environmental justice at work in their communities.

Starting At Home: Co-Creating An Inclusive Restoration Organization

Jen Rice, Independent Consultant

Environmental organizations tend to function with a particular set of analytical principles and worldviews that have historically distanced marginalized populations, including native communities. As a result, our organizations often miss out on the expertise and contributions that result from a deep wealth of knowledge currently practiced in native communities. At this pivotal moment, how might the restoration sector engage, repair, and rebuild with native and marginalized communities to better address overwhelming environmental challenges? What are some tangible, applied ways that our organizations and sector can keep improving through the uncertainty and environmental chaos of the coming years?

Examining external partnerships naturally surfaces questions about the internal practices of an organization. Evolving into truly co-creative, generative relationships with marginalized communities requires an organizational culture shift that focuses on "how things are actually done around here" beyond "how we say we get things done". Organizational (and sector) culture—including core values, mindsets, behaviors, policies, practices, and more—is effectively the water we are all swimming in that has a powerful, often overlooked, influence on our work.

Inclusive organizations value curiosity. Fostering open, curious mindsets and behaviors like listening deeply help us develop new ways of gaining knowledge and tools. Mindset and behavior shifts toward valuing a diverse set of perspectives require collective practice, breed creativity, and help us become innovative and resilient through times of change.

After five years of diversity, equity and inclusion (DEI) learning and exploration during the spring and summer of 2022, a diverse subset of CalTrout staff began to take a more expansive look at organizational culture beyond their DEI work. We will share the story of how this group and the organization deepened their efforts to create a more inclusive culture—as individuals, within teams, across the organization, with their partners, and out into the restoration sector.

Cal-PBR Network: Process Based Restoration in a Changing Climate

Friday Morning Concurrent Sessions

Session Coordinators: *Carrie Monohan, Ph.D., The Sierra Fund; Karen Pope, Ph.D., Pacific Southwest Research Station USDA; and Kate Lundquist, Occidental Arts and Ecology Center*

The Cal-PBR network is a diverse collaborative of natural resource professionals that promote process-based restoration approaches to increase the capacity of degraded river and stream ecosystems to self-heal. These projects prioritize channel evolution and dynamism over stabilization measures and allow present day natural processes and climate conditions to create and maintain the restored habitat. Common goals focus on water and sediment retention, biodiversity and vegetation productivity, fire resiliency, and climate change adaptation. This session will focus on projects that look at designing, permitting and implementing process based restoration projects to restore incised and degraded streams, forest health and remove system constraints to increase ecosystem resiliency in a changing climate.

Doing the Impossible Before Breakfast

Kevin Swift, Swiftwater Design

Many of our riverscapes show significant incision and the resultant dehydration and degradation of the surrounding wet meadow and riparian habitat. Channel depths of greater than 2 meters tend to trigger statements like "that channel will take X hundred (or Y thousand) years to fill using beaver dam analogs". Disproving those myths, we have undertaken multiple successful projects where form-based construction was proposed as the only possible solution. We used a process-based restoration approach to gain floodplain connection and stage-zero habitat in less than 5 years using only free, local materials, sound design methods, human-portable tools, and on-site energy. We created braiding channel networks while maintaining the recovering (and often only remaining) riparian habitat in the inset channel. We discuss lessons learned about using degraded channels as safety valves, derelict irrigation infrastructure as a restoration tool, and erosion and head-cutting as vital parts of a well-designed build. We hope our results encourage you to question and counter the naysayers and invest in appropriate and well-designed PBR approaches to maximize the restorative value of our shared tax dollars.

Hydraulic Mines and Process-Based Restoration: Pilot Project at Grizzly Creek Diggins

Carrie Monohan, Ph.D., (Presenter), The Sierra Fund
and Co-authors: Nick Graham and Debbie Page Dumroese, Sierra Fund

Hydraulic mine remediation requires fuels reduction from the surrounding forested areas, on-site erosion control, and organic soil amendments to be successful. Hydraulic mine impacted lands are highly erosive landscapes with drought-, insect-, and disease-stressed vegetation that are often avoided during traditional forest health restoration projects. Restoring these sites with Process-Based Restoration involves using erosion control techniques from more arid regions and utilization of forest by-product biochar. Amending the soil with biochar reduces soil temperature, increases soil moisture potential and soil carbon, and improves water quality. Process-Based Restoration works with nature to heal nature, and can result in returning mine-scarred landscapes to greater hydrologically functional watersheds and address the ongoing legacy impacts of the California Gold Rush.

A Practical Restoration Model for Restoring the Sprague River Valley

Mike Edwards (Presenter), and Co-authors: Damion Ciotti and Jared McKee, U.S. Fish and Wildlife Service; Wally MacFarlane, Cashe C. Rasmussen, and Joseph M. Wheaton, Ph.D., Utah State University

We developed a model to assist the Partners for Fish and Wildlife Program in prioritizing process-based restoration projects in the Sprague River watershed of the southern Oregon Cascades. The Sprague River has a significant amount of floodplain levees and irrigation ditches which have disrupted floodplain and channel connectivity important for fish habitat. The model identifies floodplain spaces disconnected by infrastructure versus areas disconnected by incision alone. In doing so, it provides practitioners with a planning tool for prioritizing where to modify or remove infrastructure (e.g. levees or ditches) versus opportunities to apply "low-tech" approaches of installing wood structure delineated by the Beaver Restoration Assessment Tool. Projects may be prioritized based on the quantity of floodplain space they reconnect or their location relative to important habitat areas for two endangered species of suckers. The model is an important tool for partners and landowners for communicating the goal of restoring a dynamic river corridor and not just a single stable river channel or discrete habitat. The model may also be used to inform restoration planning and track progress at the watershed scale for public funded programs. This was a collaborative effort between the U.S. Fish and Wildlife Service and Utah State University. This approach may be important for other stream and river systems facing a combination of infrastructure constraints in addition to lack of wood structure.

Beaver Dam Analogues—Summary of Five Years of Monitoring in the Scott River

Erich Yokel (Presenter), and Co-authors: Charnna Gilmore and Betsy Stapleton, Scott River Watershed Council; and Michael M Pollock, Ph.D., NOAA Fisheries

The first Beaver Dam Analogues (BDAs) in California were installed in the Scott River Watershed in 2014. The BDAs were installed in highly degraded alluvial stream reaches to increase the habitat capacity for all life stages of coho salmon, improve water quantity and quality and enhance riparian and aquatic ecosystems to benefit fish and wildlife.

Biological and physical monitoring of the reaches enhanced by the BDAs has been performed since the inception of the project to document the projects' effectiveness. In 2018, the California Department of Fish and Wildlife Fisheries Restoration Grant Program provided funding to undertake four years of monitoring on the BDAs effects on salmonid utilization and growth, the ability of adults and juvenile fish to pass the structures and the physical effects of the structures on water quality and quantity.

The Scott River Watershed Council (SRWC) has collaborated with the Karuk Tribe, Yurok Tribal Fisheries, NOAA Fisheries and the California Department of Fish and Wildlife to utilize PIT tags to monitor coho salmon utilization, growth and survival in reaches treated with BDAs and other restoration techniques. Coordination and communication between the Tribes and Agencies in the Klamath Basin have generated a greater understanding of the effectiveness of restoration and successful life strategies utilized by coho salmon.

The SRWC has collaborated with Cal Poly Humboldt to study juvenile fish passage at BDA structures and to monitor and analyze the coho salmon utilizing the BDA ponds (and other restored and untreated habitats) using PIT tags and with UC—Davis to assess the food webs available to anadromous salmonids in BDA ponds versus untreated habitats. Additional collaborations with Cal Poly Humboldt to assess the effects of BDAs on water storage and water quality have been completed.

This presentation will summarize the results of the biological and physical monitoring of BDAs in highly degraded alluvial reaches that support coho salmon.

Looking Forward, Not Back to Inform Restoration Design in a Rapidly Changing Climate

Craig Benson, Cal Poly Humboldt

One of the most influential decisions made by restoration designers and practitioners is the selection of the reference ecosystem/reference condition/remnant (SER Primer, 2004) for their project. In the United States, the reference condition could be pre-human disturbance more than 10,000 years ago, pre-European colonization 200-500 years ago or pre-impact, i.e. before the beginning of the current type of degradation, perhaps 50-100 years ago. In some cases, the reference condition is simply a comparable intact ecosystem or the best available minimally impacted condition. In any case, the reference condition is often a historic state and the ecosystem may be on a different trajectory that is a historic condition. Under global climate change, the reference condition may need to be selected, not from a past condition, but instead from the current ecosystem trajectory that is consistent with changes in climate, land use, fragmentation of habitats and/or missing keystone species. In this session we will discuss some of the implications of climate change for restoration on the North Coast of CA and the Pacific Northwest. We will discuss a half dozen methods that a restoration planner/designer can employ to improve the chance of restoration adaptability or success under a rapidly changing climate.

Beaver Restoration Policy Updates

Kate Lundquist (Presenter),
and Co-author: **Brock Dolman**, *Occidental Arts & Ecology Center WATER Institute*

Occidental Arts & Ecology Center WATER Institute (OAEC) has been working to integrate beaver and process-based restoration into California's practices and policies for over two decades. Thanks to the work of many restorationists, tribes, advocates, agencies and NGOs our state leaders have taken the visionary step of funding and creating a new Beaver Restoration Program and developing a new Beaver Management Plan. OAEC will discuss how this program and other statewide advocacy efforts fit into its aspirations to restore beaver and what role the Cal PBR Network and SRF community can play in making these efforts successful.

Please May I Get Upstream? Reintroducing Extirpated Salmon Runs Upstream of Dams

Friday Morning Concurrent Sessions

Session Coordinators: *Eric Ginney, ESA, and Randy Beckwith, DWR*

Climate change, aging water infrastructure, outdated water management schemes, successive years of drought, and increasing demand for water resources have precipitated strong declines in salmonid populations throughout California. Compounding this, longitudinal and lateral disconnections from historical spawning and rearing habitat has triggered a loss of salmonid life history diversity, making species less resilient to change. As a result, reintroductions of salmonids to historical habitat upstream of dams has occurred or is proposed as a recovery strategy.

While dam removal may be a viable option in some watersheds, for the large, Central Valley "rim dams" such as Oroville and Shasta dams, removal is not presently contemplated. Rather, trap and haul projects and technologies are being considered and piloted upstream of these large dams and reservoirs. Novel methods are being proposed to enable key runs of salmonids to complete their life history and this session seeks abstracts that describe critical efforts now underway, as well as abstracts that examine the methods, science, and policy implications of salmonid reintroductions to historical habitat.

Please May I Get Upstream?
Reintroducing Extirpated Salmon Runs Upstream of Dams

Yes You May:
Fighting Extinction in the Central Valley with Salmon Reintroductions

Brian Ellrott (Presenter), and Co-authors: Stacie Fejtek Smith, Ph.D., NOAA Fisheries, West Coast Region, California Central Valley Office; and Rachel Johnson, Ph.D., NOAA Fisheries Southwest Fisheries Science Center & University of California Davis

To save species from extinction in California's Central Valley, NOAA Fisheries believes it is necessary to work with co-managers and stakeholders to reintroduce winter-run Chinook salmon, spring-run Chinook salmon, and steelhead to historical habitats upstream of some high-head dams. Extensive extirpation of historical salmon populations has placed these species at risk of extinction. The proximate problem afflicting these species is that their historical spawning habitat, initial rearing areas, and climate refugia are largely inaccessible due to the presence of large dams. In addition to habitat loss, substantial habitat degradation also contributes to the dire status of these species, and anthropogenic climate change is exacerbating conditions. Predictions from decade plus old and recent climate models for the Central Valley are bearing out as we observe warming air and water temperatures, declining total precipitation, increasing variability in precipitation with more frequent floods and droughts, and declining snowfall. Because many anadromous salmonid populations have been extirpated in the Central Valley due to dams, and climate change is expected to further constrain the ability of resource managers to provide suitable water temperatures and flows downstream of the dams, reintroductions to the historical habitats that allowed these species to persist and thrive through environmental disturbances for at least tens of thousands of years are needed. The Central Valley Technical Recovery Team recommends just such an effort: "To recover Central Valley salmon and steelhead ESUs, some populations will need to be established in areas now blocked by dams or insufficient flows. Assuming that most of these dams will remain in place for the foreseeable future, it will be necessary to move fish around the dams." This presentation will cover why salmon and steelhead reintroductions are needed to avoid extinction and recover listed salmonids, NOAA Fisheries' reintroduction priorities, and recent progress of efforts by NOAA Fisheries, the California Department of Fish and Wildlife, the Winnemem Wintu Tribe, the United States Fish and Wildlife Service, the United States Forest Service, and the United States Bureau of Reclamation to minimize drought impacts and return salmon to their home.

Please May I Get Upstream?
Reintroducing Extirpated Salmon Runs Upstream of Dams

Winnemem Wintu Tribe Perspectives on Co-Stewardship of the McCloud River Nur

Honorable Chief Sisk, Winnemem Wintu Tribe

The name of my tribe, Winnemem Wintu, translates to Middle Water people and is taken from the name of our river, the Winnemem Waywakit, which is bounded by the Upper Sacramento to the West and the Pit River to the East.

Now known to most as the McCloud River, it rises from glacial waters in the Cascades, and it runs so clean you can clearly see the rocks, sand and insects that populate its bottom. A series of well-known waterfalls cascade over its basaltic lava beds in feathery ribbons of white and foam.

Because of its beauty, most people here in Northern California probably believe the McCloud is healthy and pristine. But that is only because they don't remember, as my tribe does, how it used to be before it was butchered by dams and left clinging to its life.

The Shasta Dam was built during World War II and flooded the lower 26 miles of our river under its reservoir. It also blocked our sacred relative, the salmon, from traveling to its traditional spawning places. In 1965, the McCloud Dam was built on the upper river and started diverting water to the Pit as part of a lucrative hydroelectric project. Because of these diversions, our once powerful and rushing river, which once had a winter flow of 6,000 cubic feet per second, now trickles at a mere 200 cfs.

Our river is starved on one side and swollen on the other. And yet they are not done with it. As we fight to bring our salmon back, we also fight against a proposal to raise the Shasta Dam as well as a McCloud Dam relicensing that could sustain the crippling diversions for another 50 years.

Just as they have carved up our river, so too have they tried to break our bond with it by extricating us from our traditional lands and refusing to acknowledge our history and right to exist. But they underestimate our resilience: our spiritual connection to our river remains strong and unbroken.

Considerations for Assisted and Non-assisted Passage at Large Dams

Jon Mann, P.E., California Department of Fish and Wildlife

Providing volitional (non-assisted) fish passage at large dams with highly fluctuating storage reservoirs can be very technically challenging and may be completely infeasible or impractical. If technically feasible but highly expensive, the challenges to providing volitional passage are more about societal values or lack of understanding. What it means to be volitional can also vary. Developing solutions to these challenges benefit from an inclusive approach to build understanding and ideally assign high societal (and fair) values to providing fish passage, volitional or non-volitional. Fisheries recovery goals and long-term sustainable fisheries management are integral to developing the best solutions that may need to adapt and evolve over time. Technical and less technical considerations through an applied example for assisted and non-assisted passage will be presented.

20+ Years of Restoration on the Trinity River: What Have We Learned, and Where Do We Go From Here?

Focusing Trinity River Science—A Plan for Addressing Key Uncertainties

Darcy Pickard, M.S., P.Stat. (Presenter), Pickard Environmental Consulting, and Co-authors: Justin Alvarez, Hoopa Valley Tribe; Kyle DeJulio, Yurok Tribe; Liam Gogan, Trinity County; James Lee, Trinity River Restoration Program; Ken Lindke, California Department of Fish and Wildlife; Seth Naman, National Marine Fisheries Service; Chadwin Smith, Ph.D., Headwaters Corporation; Nicholas Som, Ph.D., U.S. Fish and Wildlife Service and California Polytechnic University, Humboldt; and Paul Zedonis, Bureau of Reclamation

Lewiston Dam, part of the Central Valley Project, was constructed in 1963 near Lewiston, California, limiting anadromous fish distributions, degrading fish habitat, and contributing to the decline of Chinook and Coho salmon. In 2000 a Record of Decision (ROD) was signed to restore the processes that produce a healthy alluvial river through a combination of five management actions: flow management, habitat rehabilitation, sediment management, watershed rehabilitation, and infrastructure improvements. The ROD also specified use of an adaptive management program to ensure implementation was guided by the best available information. Implementation began in earnest in 2004 with the first ROD flow releases and the first channel rehabilitation site was constructed in 2005.

Program partners and local stakeholders are heavily invested in the Trinity River Restoration Program (TRRP) and there has been understandable frustration on all sides in the perceived lack of response by salmonid populations twenty years later. While the Program has accomplished a substantial amount since the ROD, a recent review conducted by Headwaters Corporation identified several structural and functional challenges in the TRRP including lack of clarity in overall Program goals, partner roles, and Trinity Management Council decision-making and the need for a guiding adaptive management plan to provide focus and formalize the process by which scientific findings are used to inform and improve management decisions.

This led to the development of a new Science Plan to provide guidance on how the TRRP should conduct science to reduce critical management uncertainties and support the successful implementation of the Program strategies to achieve Program goals. The plan was collaboratively developed with technical representatives from all interested Program partners. The committee strived for consensus and documented uncertainties where there were remaining disagreements.

Development of the plan resulted in both process and technical advances which are expected to lead to more focused and effective adaptive management in the future. This includes a formalized process for how science decisions are made and how scientific information is interpreted and utilized to inform future decisions. Technical advances include an honest reflection of what has / has not worked, recognition of new challenges in the Trinity (e.g., drought) and changes to scientific methodologies since 2000, development of a holistic conceptual model which builds on insights over the past twenty years and provides a common vision across disciplines, and identification of the top five remaining uncertainties that provide focus for the next phase of the Program:

- Wetted width - Can adjusting site rehabilitation and flow management strategies result in increased rates of wetted width expansion over a range of discharges?
- Nutrient flux—Can changing management actions result in greater transfer of energy through trophic levels?
- Temperature regime—Can we manage temperatures to benefit multiple life stages of salmonids while meeting other species needs?
- Fish production—At what life stage and/or what habitat resource do bottlenecks to production occur?
- ROD effectiveness - Can we achieve the Program goals with the tools and decision space provided by the ROD?

From Rock Piles to Riparian: Recovering Riparian Function and Vegetation on the Trinity River, CA

John H. Bair, MA, Senior Riparian Ecologist, McBain Associates

Riparian function is physically limited to areas where the off-channel groundwater table is higher than would be available from local precipitation alone, which are typically areas with direct interaction between aquatic systems (i.e., rivers) and adjacent river bottomlands (i.e., floodplains). Prior to the 2000 Trinity River Record of Decision anthropogenic effects from gold dredge mining and dam construction resulted in armored, uniform channels with near-channel areas that are hydrologically disconnected by steep tailing piles that are substantially higher than the groundwater table, are coarse textured (cobbles, boulders), and unable to support riparian vegetation. Dredger tailings have been mechanically removed or reconfigured to reduce the distance between the surface and groundwater table, which restores hydrologic connectivity and facilitates riparian function, restores aquatic habitat, and recovers riparian vegetation. Generally, the revegetation goal is to re-establish structurally diverse, species rich vegetation in project areas appropriate for their life histories. Revegetation often includes only a few species to establish the primary components of riparian habitat (active restoration), but true restoration is achieved when constructed surfaces can recruit multiple cohorts of woody plants and a broader range of woody and herbaceous riparian plants that are reflective of less impaired systems regionally (passive restoration).

Restoring riparian function has required constructing surfaces that are at an elevation close to shallow groundwater and include fine sediment. Constructing smaller areas that are lower and frequently inundated has been found to increase passive riparian plant recruitment and active revegetation success rather than constructing large, higher elevation areas that have fewer passive recruitment opportunities and must be revegetated and irrigated. Currently floodplains are designed to be inundated at less than the annual maximum streamflow to ensure frequent inundation. Surfaces that are inundated annually or more frequently have had the greatest opportunity for passive riparian plant recruitment. The inclusion of wood and microtopography in floodplain construction has also maximized spatial opportunities for passive riparian plant recruitment by taking advantage of how regulated streamflows and downstream tributary flow accretion interact with constructed floodplains. In addition, constructed floodplain manipulation after construction can greatly improve both active and passive riparian recruitment. During construction, fine sediments and small wood pieces have been salvaged and reincorporated back into the constructed floodplains during revegetation to increase local soil moisture retention and support active revegetation and passive recruitment. Salvaged cottonwood and willow clumps, cuttings installed into groundwater, nursery grown container plants, and bare root plants have all been successfully planted in constructed floodplains when the proportion of fine sediment to coarse sediment exceeds 20%. Emergent plants can be planted on channel margins where soil moisture is sustained through capillarity over the whole year. On floodplain surfaces that are higher above the shallow groundwater table, clusters of willow and cottonwood cuttings placed in holes that are dug to the visible groundwater have led to the greatest survival. In summary, the Trinity River Restoration Program is successfully restoring riparian function to dredged rivers using a combination of lowering tailing piles, constructing frequently inundated floodplains and active revegetation.

Evolution of Tributary Junctions and their Capacity for Rearing Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) on a Regulated River

Todd H. Buxton (Presenter), *U.S. Bureau of Reclamation, Trinity River Restoration Program,*
and Co-author: ***D. Nathan Bradley,*** *U.S. Bureau of Reclamation, Technical Service Center*

The Trinity River in northern California was adjusting to unregulated flood and mining impacts when it was dammed and flow regulation began in 1960. We examine the subsequent evolution of the river's alluvial channel through 60 years of increases in regulated mainstem flow regimes in an unconfined and confined valley where Rush and Indian creeks respectively join the river downstream from Lewiston Dam. The resulting capacity of the tributary junctions for rearing Chinook salmon fry in the current flow regime is evaluated with hydraulic modeling and an empirical model developed for the Trinity River. Results indicate that morphologic changes at Indian Creek were relatively minor after damming because mainstem flows were restricted to an already narrow channel in comparison to the channel at Rush Creek. Conversely, active channel and bar areas significantly declined at Rush Creek because flooding and the mainstem sediment supply was more severely reduced by flow regulation, which enabled riparian vegetation to colonize the expansive alluvial surfaces that were present. These changes reduced instream habitat, suggesting salmon populations in large valleys may be at higher risk below dams than in smaller valleys where the reduced flow is confined to an already narrow channel. However, the relatively wide and unconfined valley responded more positively to increases in flow and sediment through time to yield significantly higher capacities for rearing Chinook fry. Therefore, while unconfined reaches may be particularly susceptible to change when a river is dammed, they may also provide the greatest opportunity for restoration of salmon populations.

Assessing Salmon Rearing Habitat with Physical Capacity and Flow Durations in the Trinity River

Emily Cooper-Hertel, M.S. (Presenter), and Co-authors: David Gaeuman, Ph.D., Kyle DeJuilio, and Aaron Martin, Yurok Tribe Fisheries Department; Josh Boyce, Ph.D., Damon Goodman, M.S., and Nicholas Som, Ph.D., U.S. Fish and Wildlife Service; and Justin Alvarez, M.S., Hoopa Valley Tribe

The TRRP aims to restore salmonid habitat for population recovery through mechanical restoration and flow management targeted in the 64-km reach below Lewiston Dam, known as the restoration reach. Restoration strategies are intended to evolve through adaptive management regarding habitat assessment, restoration action, and rehabilitation effectiveness monitoring. This work synthesizes data collected in the Trinity River restoration reach for flows, hydraulics, and fish distribution. These data informed the development of a spatially explicit, flow specific hydrodynamic fish capacity model we used to assess TRRP's efforts to rehabilitate habitat for juvenile Chinook Salmon (*Oncorhynchus tshawytscha*). Habitat capacity responded similarly to flows among seven sub-reaches with distinct hydrology, and we identified where rehabilitation has increased juvenile salmon capacity and where it has not in those reaches. Rehabilitated areas had greater capacity than non-rehabilitated areas in four out of seven sub-reaches. Evaluation of capacity-flow relationships between sub-reaches and rehabilitation sites showed that capacity was generally greater in upstream areas compared to downstream areas. We evaluated changes in habitat capacity in response to inter-annual hydrology variability from 2020 to 2006 to 2020 with constant physical channel conditions, and capacity decreased by 21% from decreasing hydrology over time. Under current management, we found that winter baseflow limits capacity during 70% of the rearing period, especially for the fry life stage, and we found that fry capacity tends to be limited over a wider and more frequent range of flows in downstream reaches. Throughout the entire restoration reach, increasing baseflow to 14.2 m3/s decreases capacity by 7%, but increasing base flow to 28.3 m3/s, 42.5 m3/s or 56.7 m3/s would increase capacity by 2%, 18% or 25%, respectively, during the rearing period. We recommend future evaluations of habitat capacity integrate both spatial and temporal metrics by quantifying changes with flow durations throughout the rearing period; that rehabilitation efforts prioritize designing features that inundate for long durations during the rearing period to facilitate juvenile salmonid rearing; and finally that alternative flow management during the rearing period be evaluated for its role in alleviating habitat bottlenecks for fry and pre-smolt life stages in winter and spring.

Quantifying the Morphologic Underpinnings of Salmonid Habitat

David Gaeuman (Presenter),
and Co-authors: ***Emily Cooper*** *and* ***Kyle De Juilio,*** *Yurok Tribe, Fisheries Dept.*

Topographic diversity is widely held to be an important factor contributing to the quality and availability of salmonid habitat, as well as to the integrity of aquatic ecosystems in general. While individual elements of topographic complexity, such as side channels, alcoves, and wood jams, can be readily identified, structural diversity at the landscape scale have, until recently, remained difficult to describe and quantify. Modern surveying methods supporting the acquisition of 3-dimensional terrain models, however, now make it possible to evaluate topographic diversity at the landscape scale. Herein, we introduce two new landscape-scale metrics for quantifying topographic attributes linked to the availability of salmonid rearing habitat and discuss a newly-identified factor linked to the selection of salmonid spawning locations. The first metric quantifies in-channel topographic complexity in terms of the variability of water depths at a reference discharge. The second metric quantifies the rates at which the extents of inundation expands with increasing discharge, and demonstrates the dependence of in-channel complexity and standard variables that define rearing habitat suitability on wetted area. Salmonid redds are shown to be preferentially located where hydraulic forces tend to decrease as flood discharge increases, and topographic attributes of those locations are evaluated.

Synthesizing 87 Years of Scientific Inquiry into Trinity River Water Temperatures

Seth Naman (Presenter), NOAA Fisheries, and Co-authors: J. Eli Asarian, Riverbend Sciences;
Kyle De Juilio and David Gaeuman, Yurok Tribe Fisheries Program;
and Todd Buxton, Ph.D., Trinity River Restoration Program

Trinity River in northern California once supported large runs of anadromous salmonids that were an important food source for Native American Tribes throughout the region. The effects of flow regulation on hydrology and fish populations from construction of Trinity and Lewiston dams in 1963 has been well documented. However, changes in the temporal, longitudinal, and lateral temperature regimes of the Trinity River have been less studied. We synthesized 87 years of temperature data from dozens of sources and used physical and biological models to evaluate the effects of flow regulation and impoundment on river ecology and regulatory temperature compliance. When comparing the pre-dam era to the other eras, the largest impact to water temperatures in the Trinity River has been at Lewiston, immediately downstream of Lewiston Dam. Prior to dam construction, water temperatures at Lewiston experienced a 19 °C variation in daily average water temperature, from 4 °C in early January to 23 °C in late August. After dam construction, average daily water temperatures only varied 3 °C, from 7 °C in early January to 10 °C in late August. Trinity Reservoir dynamics and flow regulation causes the river to be unnaturally warm in winter and cold in summer, leading to a series of ecological impacts such as suppressed juvenile salmonid growth, changes in invertebrate life cycle, and effects to salmonid egg incubation. We also evaluated the effects of past and future climate change, and found that the deepest and coldest water in Trinity Reservoir has warmed by approximately 1 °C in recent decades. These findings could be applied to future flow management of the Trinity River and other river systems with large water impoundments to more effectively meet fish and wildlife population objectives.

Opportunities for Restoring Ecosystem Function and Phenological Synchronicity Through Flow Management on the Trinity River, CA

Ken T. Lindke, M.S. (Presenter), California Department of Fish and Wildlife,
and Co-authors: Chad E. Abel, M.S., Trinity River Restoration Program, U.S. Bureau of Reclamation;
Kyle De Juilio, Yurok Tribe Fisheries Department; Seth Naman, M.S., National Marine Fisheries Service;
and Emily E. Thorn, Ironwood Consulting Inc.

Rivers and streams in the Pacific Northwest exhibit extremely high variability in flow magnitudes, geomorphic dynamism, and ecosystem processes on both intra- and inter-annual scales. The timing, duration, magnitude and variability of these processes have shaped on evolutionary time scales the phenologies of the aquatic organisms that exploit them. What happens to river ecosystems when patterns of physical processes are abruptly and dramatically altered through anthropogenic intervention such that physical and biological processes no longer align in time and space? On the Trinity River in Northwest California, the construction of impassable dams and dramatic water abstraction have decoupled physical and biological phenologies, leaving this once iconic river and the fish and wildlife that depend on it in a severely depressed state. To address the decline in fish and wildlife populations, numerous pieces of legislation and a decades-long study led to the signing of a record of decision in 2000 establishing the Trinity River Restoration Program. The Program was tasked with "rehabilitating the river itself" by "restoring the attributes that produce a healthy, functioning alluvial river system" and given a set of management tools to heal the river, including annual water allocations and rulesets to design flow releases. Twenty years of prescribed flow management has improved conditions in the Trinity River, but progress has not met expectations. Advancements in our understanding of river ecosystems in recent decades have elucidated functional flow components missing from current management practices. This presentation will describe some of those components, how they provide ecosystem services, and propose specific management actions that can be implemented to restore ecosystem function by reconnecting physical processes to evolved phenologies of aquatic organisms.

Riparian Corridors: The Link Between Upland and Instream Restoration

Friday Afternoon Concurrent Sessions

Session Coordinators: *Tom Leroy, Pacific Watershed Associates; Elise Ferrarese, Trout Unlimited; and David Roon, Oregon State University*

Riparian corridors are a crucial component of a healthy ecosystem and provide a link between upland and instream watershed processes. Riparian forests, within coastal streams of the Pacific Northwest, significantly influence the stream morphology and overall productivity of aquatic habitat which can, in turn, provide a basis for the health of salmonids throughout their range. Aquatic habitat conditions and associated riparian ecosystem functions needed by salmon and steelhead are diverse and perhaps only marginally understood, but it is clear that restoring disturbed riparian zones to conditions where they can provide multiple ecosystem services is critical to recovering threatened salmon populations resulting from past anthropogenic disturbances, including industrial logging and development. Riparian forests contribute to bio-fluvial-geomorphic processes and overall productivity of a watershed in myriad ways, including: stream bank stability, instream large wood recruitment, stream shading and temperature regulation, nutrient cycling, sediment capture and filtering, food web productivity, carbon dynamics, flood and drought attenuation, and providing floodplain dead standing and downed large wood. In this session we invite speakers to present research and case studies related to riparian forest restoration, and linkages between riparian conditions and salmonid life-cycle requirements. We encourage speakers to create presentations that allow the audience to understand the importance of characterizing existing riparian conditions, evaluating and determining desired future conditions, and developing action plans for riparian forests that allow them to reestablish fully functioning ecosystem services.

Redwoods Rising: Resetting the Standard of Parks Management

Andrew Morin (Presenter), Fisheries Biologist, Redwood National & State Parks, National Park Service, and Co-author: Marisa Parish, Environmental Scientist—Aquatic Program Lead, CA Department of Parks and Recreation, North Coast Redwoods District

State and Federal Park lands are often jewels of intact ecosystems and contain relics of untouched landscape protected for future generations. Though this is not always the case and not the condition of the Mill Creek or Prairie Creek watersheds of northern California. These watersheds have a history of industrial logging prior to acquisition by the National Park Service (NPS) and California State Parks (CSP). These basins have overly dense forests crisscrossed with old skid and logging roads, a lack of instream wood, and forest composition with shifted species distributions that drastically contrast that of the historic conditions. Few habitats within these basins were untouched during logging activities and the riparian corridors are no exception. Fortunately, since acquisition, the trajectory of these basins have been guided by management decisions focused on ecosystem health. Today a landscape scale restoration initiative, Redwood Rising, is underway in these basins to heal the scars of past logging and accelerate the trajectory to old-growth conditions that would naturally occur if left untouched.

Redwood Rising is a collaborative project between CSP, NPS and Save the Redwoods League (SRL). The restoration actions in the two project basins, Greater Mill Creek (GMC) in Del Norte County and Greater Prairie Creek (GPC) in Humboldt County, have many similarities but many differences as well due to the history and geology of the areas. Forests in both basins are being thinned to reestablish natural species composition and reduce forest density thus improving the health of the trees and forest floor. Roads are being removed from both basins to restore natural hydrologic conditions, reduce potential sediment delivery to streams, and restore natural forest growth. Finally, the project is restoring the riparian and stream corridor and the processes that connect these two critical habitats.

We will present an overview of the larger Redwood Rising initiative and focus on the efforts of restoring the riparian corridors and stream habitat. Restoration actions include installing Large Wood structures, planting the riparian corridors (sometimes using creative Elk protection features), and strategically thinning riparian trees. Finally, we will provide an overview of our plan to expand aquatic monitoring in both areas with a common protocol, the EPA's Wadeable Stream Survey.

Incorporating Invasive Species Management into Riparian Restoration Design and Implementation at the Redwood National and State Parks Visitor Center and Restoration Project

Amy Livingston (Presenter), and Co-author: John Bair, Senior Riparian Ecologist, McBain Associates

The Redwood National and State Parks Visitor's Center and Restoration Project is a combined salmonid habitat restoration project and trails gateway for future visitors to Redwood National Park. The project is located in Yurok ancestral territory and is a collaborative effort being led by the landowner, Save the Redwoods League. Project partners include the Yurok Tribe, State and Federal agencies, California Trout, local consulting firms, and Redwood Community Action Agency. The primary goal of the restoration project is to significantly increase salmonid abundance by increasing rearing habitat and protecting or restoring access to tributaries and wetlands. The project reconnects Prairie Creek to its former floodplain and creates backwater ponds and wetlands important for juvenile salmonid rearing. The project area includes approximately 62 acres and converts the former Orick mill site and adjacent pasture into native wetland, riparian, transitional, and upland habitats. Project work is occurring in phases and the first phase of implementation was in 2021. Implementation is expected to continue until 2025 when it is anticipated that the property will be transferred to Redwood National Park. An additional project goal is to minimize occurrences of invasive plant species and successfully restore native vegetation. Several invasive plant species occur at the site including reed canary grass (*Phalaris arundinacea*), invasive manna grass (*Glyceria fluitans*), Canada thistle (*Cirsium arvense*), Himalayan blackberry (*Rubus armeniacus*), and others. Reed canary grass and invasive manna grass can choke area of slow-moving water preventing fish passage and juvenile salmonid utilization, and both species have the potential to negatively affect the restoration outcome if not managed. Invasive plants also create challenges to restoring species-rich native vegetation. To address these challenges, the project's revegetation design incorporated innovative strategies for invasive plant management, including three types of ground surface treatments designed to limit invasive plant establishment and control erosion, mowed construction buffers, and strategic selection of species, plant materials, and planting densities. An intensive ground surface treatment using cardboard, redwood mulch, and coir fabric is being applied in areas that are vulnerable to reed canary grass establishment. An Invasive Plant Treatment Plan was developed with input from project partners to guide management actions prior to the first phase of implementation and for the duration of implementation. Post construction invasive plant management is also anticipated. Management strategies in the plan include combinations of mechanical, manual, and chemical treatments. Chemical use is limited and mechanical and manual treatments have been prioritized. The plan relies heavily on excavation of target invasive species during implementation. Excavated invasive plants are buried to a depth of six feet and covered with clean soil. The plan includes monitoring and reporting to an Adaptive Management Committee so strategies may be adjusted as the project progresses. After two years of implementation, initial invasive plant re-establishment is limited, but continued invasive plant management remains a priority.

Evaluating the Effects of Riparian Forest Thinning on Stream Ecosystems in Coastal Northern California Watersheds

David Roon, Oregon State University (Presenter), and Co-author: Jason Dunham, USGS

Riparian forests provide a variety of ecosystem functions for adjacent streams and rivers, and due to these linkages, changes in riparian forest conditions can have direct implications for stream ecosystems. Resource managers across the Pacific Northwest are interested in thinning second-growth riparian forests to address a range of stream and riparian restoration objectives. However, more information is needed on thinning effects before it can be applied as a viable restoration strategy. To evaluate the effects of riparian forest thinning on stream ecosystems, we conducted a replicated manipulative experiment, where we experimentally thinned riparian canopies in three watersheds in second-growth redwood forests of coastal northern California and evaluated the aquatic responses across multiple parameters and trophic levels. In this presentation we detail how riparian thinning influenced stream ecosystems including the effects on riparian shade, light, stream temperature, stream periphyton, macroinvertebrates, as well as amphibian and fish populations. Reductions in riparian shade increased solar radiation to the stream channel, which increased stream temperatures both locally and further downstream. Increases in solar radiation had limited influence on stream food webs, where responses were primarily limited to lower trophic levels. These results were then incorporated into bioenergetics models to evaluate the implications of shifting thermal and trophic resources for coastal cutthroat trout populations. Collectively, results from this watershed-scale experiment provide a whole-system, mechanistic evaluation of instream responses to proposed forest restoration actions in second-growth riparian forests.

Is More Light Food for Fish? Results from a Riparian Buffer Manipulation on Private Timberland in the Oregon Coast Range

Ashley Sanders (Presenter), and Co-authors: Dana Warren, Dept. of Forest Ecosystems and Society, Oregon State University; and Ashley Coble, National Council for Air and Stream Improvement, Inc.

Light, mediated by the riparian canopy, is an important driver of ecosystem productivity in small headwater streams. The legacy of clearcutting and replanting of riparian forests in the Pacific Northwest has caused more uniformly dense riparian canopies that shade second-growth streams more than old growth streams with structurally heterogeneous riparian stands. Though stream food webs largely rely on allochthonous sources of carbon, many studies suggest that patches of increased light can release epilithic biofilms from light limitation and stimulate upper trophic levels (Kaylor & Warren, 2017; Kiffney et al., 2003), though recent evidence suggests this many not happen in all streams (Roon et al., 2022). Using timber harvest as a mechanism to manipulate the riparian canopy, we implemented a before-after control-impact (BACI) study to explore how changes to the light environment affect stream temperature, net standing stocks of periphyton, and cutthroat trout (*Oncorhynchus clarkii*) demographics across 10 small streams on private timberland in the Oregon Coast Range. Two replicate blocks each contained one fixed-width buffer, one reduced fixed-width buffer, a variable retention buffer, and a canopy gaps buffer, in addition to an unharvested reach that was left untouched. We found that changes in riparian canopy did not always translate to changes in light at the stream level due to blowdown of the buffer trees, the addition of fine logging debris, and understory growth. We found a positive relationship between the change in light at the stream level and change in stream temperature across sites. The response in adult cutthroat trout during the first post-treatment year did not necessarily correspond with increases in light, however many of the harvested streams experienced an increase in young-of-year in the first post-treatment year that aged into greater abundances of adults in the second post-treatment year. Adult cutthroat growth and body condition remained largely unchanged, even decreasing at some sites. Our findings suggest that the path from riparian manipulation to trout conservation is not linear and may be controlled more by changes in stream temperature than trophic shifts.

Effects of Experimental Riparian Canopy Gaps on Fish, Salamanders, Biofilms and Ecosystems Processes in Headwater Streams

Dana Warren (Presenter), and Co-author: Allison Swartz, Oregon State University

Stream ecosystem processes are strongly influenced by the age, stage, and structure of riparian forests. While streams in late-success forests have complex forest structure with regular patches of high light associated with canopy gaps, headwater systems with young and mature riparian forests generally have simple closed canopies with low light availability in the understory. Observational studies have suggested that the light patches in late successional forests can alleviate light limitation for benthic biofilms and increase bottom-up drivers of stream productivity. And, beyond stream ecosystems, increasing canopy complexity has been suggested as a key restoration goal in riparian zones. Creating canopy gaps over the stream may be a useful tool to increase forest structural complexity and enhance aquatic primary production, however there are also potential concerns about cutting trees directly adjacent to the stream. To evaluate the ecological effects of individual canopy gaps on streams—positive or negative—we conducted a canopy gap experiment. Working in the western Cascades of Oregon we implemented a replicated before-after control impact study across 6 streams. In each stream we had an unmanipulated reference reach and a reach in which we cut a canopy gap that was designed to mimic the loss of a dominant canopy tree. We found that temperature increases were undetectable to small and across these six streams and the degree of temperature increase was more closely linked to stream size than canopy gap size. Benthic primary production increased in all gap reaches, but we did not see a concurrent response in stream nutrient demand as we expected. We evaluated fish and salamander responses in five of the six sites and found that relative to the reference reaches, vertebrate densities in the treatment reaches increased in two sites, remained largely unchanged in two sites and declined in one site. Adult cutthroat trout biomass increased at four of the five streams. Although increases were small the magnitude of the response in cutthroat trout was positively related to the magnitude of the light response. In sum, our study suggests that individual gaps alone are not likely to create notable increases in stream fish, however, they also do not create notable decreases. Our findings suggest that individual gaps may not be an ideal restoration treatment if the goal is solely increased fish production. However, if there are other larger riparian forest structural goals, creating canopy gaps are a viable tool that will not negatively impact the system.

Riparian Canopy Modification Experiment: Lessons Learned and Results from Salmonid and Coastal Giant Salamander Monitoring in an Experimental Watershed in Northwestern California.

Mathew T. Nannizzi (Presenter), Green Diamond Resource Company,
and Co-author: Trent McDonald, West Inc.

Timber management approaches establishing continuous dense mature riparian buffers along watercourses with the intent of providing cold water temperatures, high levels of large wood, and sediment filtration may overlook the importance of overall productivity in aquatic ecosystems. Here we provide our findings from a pilot project in northwestern California evaluating the response of local instream productivity to riparian canopy thinning using a mark-recapture study of salmonids and aquatic larval salamanders. Growth and movement of anadromous salmonids (*Oncorhynchus spp.*) and larval Coastal Giant Salamanders (*Dicamptodon tenebrosus*) were monitored bi-monthly within a 600 m reach of continuous stream habitat starting August 2014 and concluding in February 2018. Throughout the study, the majority of recaptured animals demonstrated high fidelity to within site location. Examination of the effects of the riparian treatment on growth and movement showed equivalent or higher growth rates in the treatment reach for both salmonids and larval salamanders. Further results on growth and movement will be presented surrounding this study as well in the context of general *Oncorhynchus spp*. and *D. tenebrosus* ecology.

Effectiveness of Meadow and Wet Area Restoration as an Alternative to Watercourse and Lake Protection Rules

Christopher G. Surfleet, Professor, California Polytechnic State University, San Luis Obispo

The California Forest Practice rule (CFPR) 14 CCR § 933.4 [e] allows the removal of streamside trees within the watercourse lake protection zone (WLPZ) if the project benefits meadow or aspen habitat. This study quantified the hydrologic response, vegetation response, water quality, and soil disturbance following implementation of this CFPR on three meadows near Lake Almanor, California. The restoration removed encroached lodgepole pine in historic meadow habitat and adjacent to watercourses in the meadows, one watercourse provides spawning habitat for rainbow trout (*Oncorhynchus mykiss*). Debris dams and constructed riffles were additionally installed in one watercourse to slow streamflow, enhancing meadow recharge. This study used a before, after, control, intervention (BACI) study design. There were two pairs of control intervention areas used. Marian Meadow (MM) and a Control Meadow (CM) have been paired in a long-term study beginning in the 2014 water year continuing to the present. Rock Creek Meadow (RCM) and Marian Meadow (MM) were paired more recently with monitoring beginning in RCM in the 2019 water year. Previous research had established that MM hydrology had stabilized by the 2019 water year following its 2016 restoration, making it a viable control. Networks of soil moisture, shallow groundwater wells, and sap flow measurements were used to evaluate the meadow's hydrologic response to restoration. Vegetation plots with 100% species identification and cover were evaluated each year in RCM from 2019 through 2022. Near stream transects and soil bulk density measurements quantified the soil disturbance from the restoration activities adjacent to the fish bearing watercourse. Stream temperature, streamflow, stream particle size, and pool habitat were used to measure the water quality before and after restoration in RCM. The study unexpectedly included an effect of the 2021 Dixie fire on the meadow restoration. An increase in water temperature occurred from the removal of the streamside trees associated with the restoration, however streamflow is intermittent and did not exceed thresholds conducive to rainbow trout spawning. Soil disturbance was present due to tree removal activities, however little to no increase in soil compaction was detected. Stream pool and particle size analysis showed a slight decrease in quality; however, this appears to be a response to the Dixie Fire rather than the restoration activities. The vegetation recovery was complex, the first couple of years after the restoration treatment the vegetation surveys show a decline in richness and diversity. Improvements show up in summer 2022, the start of the third growing season at RCM. Both groundwater and soil moisture increased following restoration, but the amount and type of response varied by meadow. It is difficult to separate the response of the hydrologic conditions due to the Dixie Fire and installation of debris dams and constructed riffles to slow streamflow and enhance recharge. However, collectively all these factors converged toward a wetter meadow habitat. Permit requirements associated with the stream structure work were run through the timber harvest plan that implemented the restoration. This created conflicts and delays in the stream structure implementation associated with the project.

Planning and Evaluation of Dam Removal, Salmon Recovery, and Habitat Restoration

Friday Afternoon Concurrent Sessions

Session Coordinator: *Mike Belchik, Yurok Tribe*

This session will explore and highlight the major planning and design issues and challenges shared by recently completed or in-planning dam removal projects. How do we document and evaluate the "lessons learned" information for already-completed projects and their precedents, and build-in effectiveness monitoring and adaptive management into upcoming projects so science and fish response can better inform restoration planning.

Overview of Regulatory Processes for Klamath River Dam Removals

Matt Robart, M.S. (Presenter), and Co-authors: Diane Barr, and Lisa DeRose, M.S., Camas LLC

Installation of the Klamath Hydroelectric Project began in 1911, eliminating anadromous fish passage to the upper Klamath Basin for over 100 years. Decades of diminishing salmon returns and poor water quality eventually made Tribal and other dam removal advocates impossible to ignore. Over 20 years of advocacy, activism, planning, development of stakeholder agreements, and relationship-building have brought us to the brink of implementing the largest dam removal in history. The process has been long and arduous, but momentum and enthusiasm were never absent. No roadmap, directions, or user's manual exists for a project this scope and scale. In this presentation, we discuss an overview of the regulatory processes to-date, the current project status, pitfalls, and lessons learned.

Every dam removal project will bring its own set of unique challenges, yet many of the regulations encountered on the Klamath will apply to other projects in California and nationally. Navigating the Federal Energy Regulatory Commission process, NEPA, CEQA, Clean Water Act, Endangered Species Act, Historic Properties Preservation Act, and other federal, state, and local regulations can be accomplished through building partnerships, and trust with all parties involved.

Lessons Learned from Flood Impacts to Habitat Improvement Efforts after Dam Removal: Process-based vs Form-based Restoration Efficacy

Matt Berry, M.S. (Presenter), Sierra Streams Institute, and Co-authors:
Kyle Leach P.G., and Jeff Lauder, Ph.D., Sierra Streams Institute; David Herbst Ph.D., Sierra Nevada Aquatic Research Laboratory and Institute of Marine Sciences, University of California Santa Cruz, and Marine Science Institute, University of California, Santa Barbara;
and Kevin Swift, Swift Water Design

Dry Creek is a 114.6 mi2 watershed draining southwesterly into the Bear River in the Northern Sierra Nevada foothills. Dam removal on Dry Creek started in early July of 2020 with form-based restoration techniques used to provide anadromous fish passage and improve habitat. A low flow single channel was constructed to provide fish passage under seasonal low flow periods. Ten bioengineered root wads were buried to serve as bank stabilization, 10,000 cubic yards of rock were imported, irrigation and jute netting with 4 inches of fill soil were then hydroseeded and planted with native grass plugs, and a mixture of native perennial forbs and annual wildflowers. Estimated costs were $3,310,082 which included sediment removal, channel reconstruction, stream diversion, removal of the entire dam, fish ladder, bridge pier, and pipe, pier reconstruction, and environmental permitting. On October 24, 2021, a rain event measured at 4,400cfs—roughly 3,500cfs above the average peak October flows—blew out the restoration efforts, eroding banks and scattering soil and boulders forming two distinct channels. Shortly after the high flows, Chinook Salmon (*Oncorhynchus tshawytscha*) were seen and verified through environmental DNA (eDNA) surveys upstream of the old dam for the first time in over 80 years. Here we discuss Process-Based Restoration (PBR) vs form-based techniques and their impacts in a post-dam removal restoration project using monitoring data from; first-year pre- and post-implementation vegetative, wildlife, salmonid, hydrogeomorphic, water quality, and benthic macroinvertebrate data. We then discuss lessons learned from historic flood impacts on artificial floodplain and channel construction.

Los Padres Alternatives Study: Feasible Alternatives for Maintaining or Removing Los Padres Dam and Implications for Steelhead in the Carmel River Watershed

Jonathan Stead (Presenter), and Co-authors: *Seth Gentzler, P.E.,* AECOM; *J. Aman Gonzales, P.E.,* California-American Water; and *Thomas Christensen,* Monterey Peninsula Water Management District

California American Water (Cal-Am) owned and operated two dams (San Clemente Dam and Los Padres Dam) on the Carmel River in Monterey County, California. After removal of the 106-foot-high concrete arch San Clemente Dam in 2016, attention is focused on the 148-foot-high embankment Los Padres Dam approximately 6 miles upstream, which has lost considerable storage volume to sediment accumulation. In 2017, stakeholders embarked on the Los Padres Dam and Reservoir Alternatives and Sediment Management Study to identify feasible alternatives for managing accumulated sediment in Los Padres Reservoir, to identify feasible alternatives for maintaining or removing Los Padres Dam, and to evaluate the effects of feasible alternatives, including on an important population of South-Central California Coast Steelhead and its habitat. Considerable progress has been made towards identifying a preferred alternative for Los Padres Dam. In general, the alternatives evaluated benefit steelhead in the Carmel River by either restoring natural processes to the river or through the continued augmentation of summer flows and improving managed fish passage facilities. Dam removal stands out as having multiple benefits for steelhead but comes at the cost of losing the ability to augment summer rearing habitat with flow releases downstream of Los Padres Dam. It is difficult to predict how the steelhead population would respond to a loss of wetted channel in the lower river, where production is currently highest, combined with the ecosystem restoration that comes with dam removal. Details will be provided during this presentation on key technical and ecological drivers of the analysis, the remaining feasible alternatives under consideration, their anticipated effects on steelhead, and lingering questions with bearing on the long-term future of Los Padres Dam and steelhead in the Carmel River Watershed.

South-Central/Southern California Steelhead 5-Year Reviews

Mark H. Capelli, National Marine Fisheries Service

NOAA Fisheries has released the 2022 5-year reviews for steelhead populations in south-central and southern California listed under the U.S. Endangered Species Act. The review found the south-central and southern California steelhead populations—ranging from the Pajaro River in Monterey County to the Tijuana River in San Diego County at the U.S. border with Mexico—should retain their current respective threatened and endangered listing status.

The last 5 years have been challenging for West Coast salmon and steelhead as climate change and related impacts to the environment continue to degrade fish habitats, reducing summer flows and warming water temperatures. Lower rainfall has also reduced the accessibility to upstream steelhead spawning and rearing habitats by delaying or shortening the breaching of sandbars at the mouths of coastal estuaries. A series of marine heatwaves have also reduced steelhead ocean survival and growth in the North Pacific Ocean by increasing algal and diatom blooms that affect the productivity of steelhead prey or shift the species to less suitable prey. Increasing ocean acidification and projected changes in coastal upwelling along the California Current is expected to create additional stresses on the growth and maturation of steelhead in the marine environment, and the size and condition of steelhead returning to their freshwater habitat to reproduce.

The review highlighted the declining population trends in response to the drought and the effects of wildfires in all nine of the Biogeographic Population Groups within south-central and southern California. Prior to the era of large dam construction, periodic local extirpation and regeneration of steelhead runs likely occurred naturally. Currently nearly all the drought refugia that would help steelhead abundance rebound is located above impassable barriers, underscoring the importance of restoring fish passage between lower and upper reaches of core recovery watersheds.

Significant research on southern populations of steelhead have been undertaken since the last 5-year review. Recent work has improved our understanding of the genetic architecture underlying mixed coastal populations of steelhead and rainbow trout, including how the relationship between the anadromous and non-anadromous form of the species contributes to the persistence of both forms. New research has also documented dispersal of steelhead from their natal watersheds to non-natal watersheds—potentially an important mechanism for naturally re-colonizing steelhead habitats that have been de-populated as a result of physical modification of habitats (e.g., construction of artificial barriers such as dams or road crossings) or natural environmental perturbations (e.g., wildfire, debris flows, droughts, or catastrophic floods).

Recovery actions in NOAA Fisheries' two recovery plans for these two southernmost steelhead populations assign a high priority to reconnecting upper and lower watersheds by removing or modifying dams and other fish passage barriers, restoring flows in mainstems and tributaries, riparian and estuary restoration, controlling non-native invasive plants and aquatic predators, reducing excessive groundwater extractions, and preventing the loss of local remnant steelhead populations.

Reintroduction of Spring-Run Chinook Salmon in the San Joaquin River: Evaluating Efficacy of Decision-Making in the Captive-Breeding Program.

Kasey C. Pregler (Presenter), and Co-authors: Stephanie M. Carlson, University of California, Berkeley, Department of Environmental Science, Policy, & Management; Anthony J. Clemento and John Carlos Garza, University of California, Santa Cruz and Southwest Fisheries Science Center, National Marine Fisheries Service; Mike Grill and Paul Adelizi, California Department of Fish & Wildlife

Captive-breeding programs and reintroduction initiatives are increasingly implemented to combat population declines and extirpations. In implementing a captive breeding program, a number of decisions are made, including the source of the broodstock and mate pairing system. Captive-breeding programs are also known to induce selective pressures; therefore it is critical to evaluate whether conservation goals are being met. Here, we evaluate the progress of a captive breeding program for a threatened salmonid in the San Joaquin River in the Central Valley, California, USA. Spring-run Chinook salmon were extirpated from the upper San Joaquin River following the construction of the Friant Dam in 1942. A captive-breeding program was established in 2012, in an effort to reestablish spring-run Chinook salmon in the San Joaquin River using fish from extant populations in the Central Valley. Each year, eggs are subsampled from crosses performed at the nearby Feather River Hatchery. Through an analysis of ~ 10 years of genetic monitoring and phenotypic data, we asked whether the program has minimized inbreeding and selective pressures induced by captive breeding. Phenotypic data included traits of the adult broodstock (e.g. age-at-maturity, body size) and early-life history survival of captive progeny. We found that the breeding program has adequately captured the genetic diversity of the source population and that mate pairings guided by kin relatedness reduced inbreeding. We also found that traits of the female parent influenced the survival of their offspring; survival of captive progeny was lower when female parents were older or when egg size was smaller. More broadly, these findings provide a case study for how to evaluate the success of captive-breeding programs given the challenges associated with conserving small populations.

Follow the Science: The Role of Scientific Decision-Making in the Big Notch Project

Dennis Finger, Department of Water Resources

The twenty-first and late twentieth centuries have brought widespread declines of native fisheries throughout California's Central Valley, including for salmonids and sturgeon. Conservation actions, though, can be equitable means by which shared societal ideals of endangered species protection are upheld, and science is needed to enact such measures accurately and fairly. Scientific contributions have established much of the justification for restoration projects, as studies on juvenile salmonid growth have found floodplains to be beneficial habitat for fish rearing, particularly in the Yolo Bypass. Such studies led to regulatory requirements for State Water Project operations that eventually spurred design of the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Big Notch Project), a project that will allow additional entrainment of juvenile salmonids and passage for adult salmonids and sturgeon through the Yolo Bypass floodplain. Just as science inspired the regulatory mandates behind the enactment of the Big Notch Project, scientific studies have guided the project throughout the design and planning process.

A project as ambitious as the Big Notch Project—which will have the ability to inundate 30,000 acres of floodplain—must be intensely defensible, and the most effective way to accomplish that has been by using the best available science to inform every decision. Thorough studies enabled decision-makers to design a project that maximizes biological benefits without compromising existing land uses, develop mutually agreeable project operational windows, and respond to project opposition justifiably and professionally. This scientific reliance will persist into the future as well, as plans for adaptive management include biological monitoring, land use compatibility, and studies on the continued benefit of the restored floodplain habitat.

Diet, Growth, and Survival of Juvenile Coho Salmon (*Oncorhynchus kisutch*) in Restored Off-Channel Habitats in Tributaries to Humboldt Bay

Joshua Cahill, Cal Poly Humboldt Department of Fisheries Biology and Katherine Stonecypher, Cal Poly Humboldt Department of Environmental Science & Management (Co-presenters), and Co-authors: Darren Ward, Ph.D., Cal Poly Humboldt Department of Fisheries Biology; and Alison O'Dowd, Ph.D., Cal Poly Humboldt Department of Environmental Science & Management

Off-channel habitats in floodplains and estuaries provide critical winter rearing habitat for Coho Salmon (*Oncorhynchus kisutch*), the loss of which has been identified as a limiting factor for Coho Salmon populations in Humboldt Bay. Off-channel habitats provide refuge for juvenile Coho salmon from high velocity winter flows in mainstem reaches. The loss of these habitats may also reduce the expression of diverse life history strategies. Previous studies suggest that Coho Salmon that rear in off-channel habitats exhibit higher growth and survival than mainstem-rearing cohorts.

Starting in the mid-1800s, large-scale conversion of floodplain and estuarine habitats for agriculture contributed to a loss of habitat complexity and decline of salmonid populations. While urban and industrial land use has subsequently increased in California, much of the Humboldt coastal plain remains a working landscape of dairies and beef production. There is increasing interest in converting coastal pasturelands back into wetlands that can provide winter habitat for juvenile Coho Salmon. Working with agricultural operators and landowners through easements, land purchases, and other agreements, numerous off-channel habitat restoration projects have been implemented, with more in progress. Generally, these projects combine salmon conservation with other objectives that include continued grazing, maintaining open space, and recreational access.

Multiple studies have documented extensive colonization of restored off-channel habitat by juvenile coho salmon. Off-channel habitat restoration may also improve overwinter survival in juvenile Coho Salmon and promote growth through increasing the abundance of invertebrate prey. However, a deficiency in robust monitoring of salmonid populations and associated restoration projects poses challenges to evaluating how the use of restored wetlands by juvenile Coho Salmon changes over time as newly restored sites mature and develop typical wetland plant and invertebrate communities.

The objectives of this study are to 1) compare estimates of growth and survival of juvenile Coho Salmon rearing in off-channel habitats constructed at different times throughout Humboldt Bay tributaries to their stream-rearing counterparts; and 2) investigate spatiotemporal variations in temperature, dissolved oxygen, prey availability, and diet across a gradient of restored off-channel and mainstem stream habitats. Preliminary results indicate that Coho Salmon quickly colonize restored off-channel ponds and exhibit higher growth rates than mainstem rearing counterparts. Diet samples indicate seasonal variation in common prey items and growth corresponding with increasing temperatures and flow events. Taxa present in off-channel pond diet samples are distinct from mainstem samples and vary among sites. Results of this study can be used to quantitatively assess the role of restored off-channel floodplain and estuarine habitats in growth and overwinter survival of threatened Coho Salmon populations and inform future off-channel restoration projects in Pacific coast watersheds.

Session Coordinators: *Ruth Goodfield, NOAA Restoration Center , Erika Lovejoy, Sustainable Conservation , and Jake Shannon, North Coast Regional Water Quality Control Board*

Solving the Puzzle to Accelerate Restoration —Statewide Progress on Efficient Permitting

Erika Lovejoy, Sustainable Conservation

The major laws created to protect the environment—while essential—do not provide a separate approval process for advancing beneficial projects that fix environmental problems. Without alternative pathways in place, restoration projects are subject to the same regulatory procedures as housing, shopping malls, and other development projects. It can be a very expensive, lengthy and complex process and sometimes a major disincentive to getting this important work done.

The State's Cutting Green Tape Initiative and Governor Newsom's Executive Order N-82-20 both call for immediate actions to simplify the permitting process so essential projects to restore degraded habitats, recover endangered species, and adapt to climate change can be implemented at an accelerated pace and larger scale while complying with existing regulations. Project proponents desire more regulatory certainty, efficiency, and partnership with the agencies to achieve their collective environmental goals.

Sustainable Conservation has been collaborating with project proponents and state and federal agencies as a technical partner to help create innovative, dedicated regulatory pathways for restoration that both meet environmental protection mandates and efficiently move projects forward. The NOAA Restoration Center has been a major leader and early adopter of this type of work, and now, through a collaborative effort between the U.S. Army Corps of Engineers, NOAA Restoration Center, U.S. Fish & Wildlife Service, and the State Water Resources Control Board, along with input from the California Department of Fish and Wildlife (CDFW), two new statewide alternative pathways for projects of all sizes were approved in August. They serve as companions to CDFW's Habitat Restoration and Enhancement Act and other existing tools for efficiently permitting restoration projects.

Sustainable Conservation will provide a high-level overview of the significant progress made to simplify permitting for restoration in California, technical resources available to help project proponents and agency staff utilize new regulatory tools, and highlights of future work to incentivize and accelerate restoration. This presentation will set the stage for agencies to present on the details of their groundbreaking new authorizations designed to "cut green tape" and create a more coordinated, expedited, and collaborative process for regulatory review of restoration.

Permitting Efficiencies for Restoration Projects Through NOAA Restoration Center

Ruth Goodfield, NOAA Restoration Center

The NOAA Restoration Center (RC) is excited to be part of this very collaborative and proactive group of agency staff helping restoration proponents get good things done on the ground and in the stream for California's salmonids.

Along with technical assistance and funding opportunities, the NOAA RC has worked with Sustainable Conservation to develop some pretty terrific permitting efficiencies to aid restorationists in project implementation.

With significant assistance and support from Sustainable Conservation, NOAA Restoration Center now has programmatic consultations for restoration projects benefitting anadromous salmonid habitat throughout California. We also hold a General Consistency Determination with the California Coastal Commission to aid in permitting restoration work occurring within the coastal zone.

In this presentation, the RC will provide specific information about these permitting tools, including explanation of eligibility, project types, and the various geographic areas covered for each programmatic permit. We will give details on the overall administrative process and timeline when applying for ESA coverage. Finally, we will introduce RC staff available throughout California and the technical assistance we are able to provide to the restoration community.

Aquatic Restoration Projects Made Easier in California Thanks to New Statewide Programmatic Endangered Species Act Section 7 Consultation Available to Federal Agencies

Marissa Reed (Presenter), and Co-authors Kasey Sirkin, U.S. Army Corps of Engineers, and Gregory Schmidt, U.S. Fish and Wildlife Service

In support of a coordinated multi-agency effort to develop statewide programmatic authorizations for restoration, in August 2022, the U.S. Fish and Wildlife Service finalized a statewide programmatic consultation to help simplify implementation of important aquatic habitat restoration projects in California.

The statewide programmatic consultation and accompanying materials cover 72 federally listed species and 40 critical habitat areas for 10 types of restoration projects. Currently, eligible projects funded, authorized or carried out by the U.S. Army Corps of Engineers, NOAA Restoration Center, or the U.S. Fish and Wildlife Service may be covered by the consultation. However, any federal agency interested in using this consultation for eligible restoration projects may join the consultation as a "late arriving lead action agency."

Agencies can expect this consultation to promote regional consistency in project design criteria and conservation measures, expedite regulatory review of restoration projects across the state, and create a reporting process to document effects to listed species.

This presentation will highlight the requirements for coverage under the statewide programmatic consultation, provide answers to some frequently asked questions, and explain how to work with lead action agencies to apply the consultation for eligible projects. U.S. Army Corps of Engineers representatives will outline the process for applying the consultation for eligible projects that require U.S. Army Corps of Engineers authorization.

Applying New Tools to Support Aquatic Habitat Restoration Projects

Jonathan Warmerdam (Presenter), and Jake Shannon,
North Coast Regional Water Quality Control Board

Many of California's watersheds are impaired due to the legacy of past land use practices combined with contemporary new stressors such as development pressures, catastrophic wildfires, and climate change. To address these impacts, the North Coast Regional Water Quality Control Board has been taking actions and utilizing new statewide tools to not only address sources of pollution, but to also support the implementation of beneficial aquatic habitat restoration projects. Together – pollution control and restoration actions – are recognized as being essential to restore and maintain the chemical, physical, and biological integrity of the waters of the North Coast, and in other parts of the state.

In 2015, the North Coast Regional Water Quality Control Board adopted a Policy in Support of Restoration in the North Coast Region, Resolution No. R1-20015-0001, which was subsequently incorporated into its Water Quality Control Plan (Basin Plan). The Restoration Policy is primarily a narrative expressing support for restoration and similar type projects that describes in detail: (1) the importance of restoration projects for the protection, enhancement and recovery of beneficial uses, (2) the obstacles that slow or preclude restoration actions, (3) the legal and procedural requirements for permitting restoration projects, (4) the ongoing Regional Water Board effort to provide support towards the implementation of restoration projects, and (5) direction to staff to continue to support restoration in the future.

Recent advances in permitting and CEQA (California Environmental Quality Act) efficiencies are helping restoration practitioners, Tribes, and regulatory agencies, to take actions to protect and restore watersheds. Examples include but are not limited to: (1) the State Water Resources Control Board's recent adoption of a new statewide Restoration General Order, (2) new legislation that developed a Statutory Exemption for Restoration Projects, (3) the Cutting Green Tape Initiatives being led by both the California Natural Resources Agency and California Department of Fish and Wildlife, and (4) permit coordination program activities.

The North Coast Water Board staff will present on some of the recent experiences and lessons learned utilizing these new tools to support the implementation of aquatic habitat restoration projects.

Cutting the Green Tape with the California Department of Fish and Wildlife

Brad Henderson, California Department of Fish and Wildlife

The California Department of Fish and Wildlife (CDFW) has been funded to implement a new statewide Cutting the Green Tape (CGT) program focusing on developing procedures and tools designed to improve its restoration granting and permitting activities. The State of California has identified Cutting Green Tape as a priority initiative to increase the pace and scale of ecological restoration, conservation, climate adaptation, and stewardship. Within the California Natural Resources Agency (CNRA), the Cutting Green Tape Initiative is focused on improving regulatory processes and policies so that ecological restoration and stewardship can occur more quickly, simply, and cost-effectively. CDFW's CGT program also supports and complements CNRA's "30 by 30" initiative, a commitment to achieving the goal of conserving 30 percent of California's lands and coastal waters by 2030.

CDFW's CGT program is advancing several new approaches to support improved and enhanced restoration activities within its granting and environmental review programs. Throughout the first full year, the CGT program has continued to employ the tools and efficiencies previously developed across a wide spectrum of the state, beginning with our existing grant programs. The CGT restoration permitting strike team (CGT Strike Team) is hard at work across the state, matching restoration projects with the most efficient permitting tools. During Fiscal Year 21-22, CDFW funded, permitted, or assisted with environmental review exemptions for over 146 projects, 134,515 acres, and 103 stream miles saving an estimated $1,552,600 dollars with an average permit processing time of 70 days. At the same time, the CGT Program has continued to develop and support new initiatives, including advancing statewide CGT directives, and implementing the new California Environmental Quality Act (CEQA) statutory exemption for eligible restoration projects (SERP).

CDFW will provide an overview of the CGT program's organization and structure followed by a review of its new restoration permitting tools, the new CEQA statutory exemption, and how the CGT Strike Team is engaging in the restoration granting process. Restoration practitioners will learn who we are, what we do, and how to connect with us.

Constraints and Initial Solutions to Increasing the Pace and Scale of Riverscape Restoration: Summary from the 2023 NOAA Organized Riverscape Restoration Workshop

Brian Cluer, NOAA Fisheries

The National Marine Fisheries Service organized a four-day workshop in early 2023 to address the essential need to restore riverscapes for the conservation and recovery of salmonids. Several hundred people participated from all parts of the restoration community, including managers and staff from state and federal agencies, tribal communities, watershed councils, conservation organizations, private landowners, and private consultants who oversee, fund, regulate, or design and implement river restoration projects. The workshop began with overviews of the science that underpins process-based restoration with the help of over two dozen scientists in the field. Examples of large-scale process based restoration projects spanning across the diverse West Coast Region were summarized with the help of many practitioners on the cutting edge of restoration practice. With the foundation laid for why and how to restore riverscapes, the workshop dug into the hard work of identifying and discussing the constraints, risks, fears, and traditions that reduce the effectiveness and hold back the pace and scale in restoration. With the constraints daylighted, the workshop participants discussed and prioritized them, with the goal that the participants collaborate to find solutions. This presentation will summarize the outcomes of the workshop and highlight solutions both short term and longer term.

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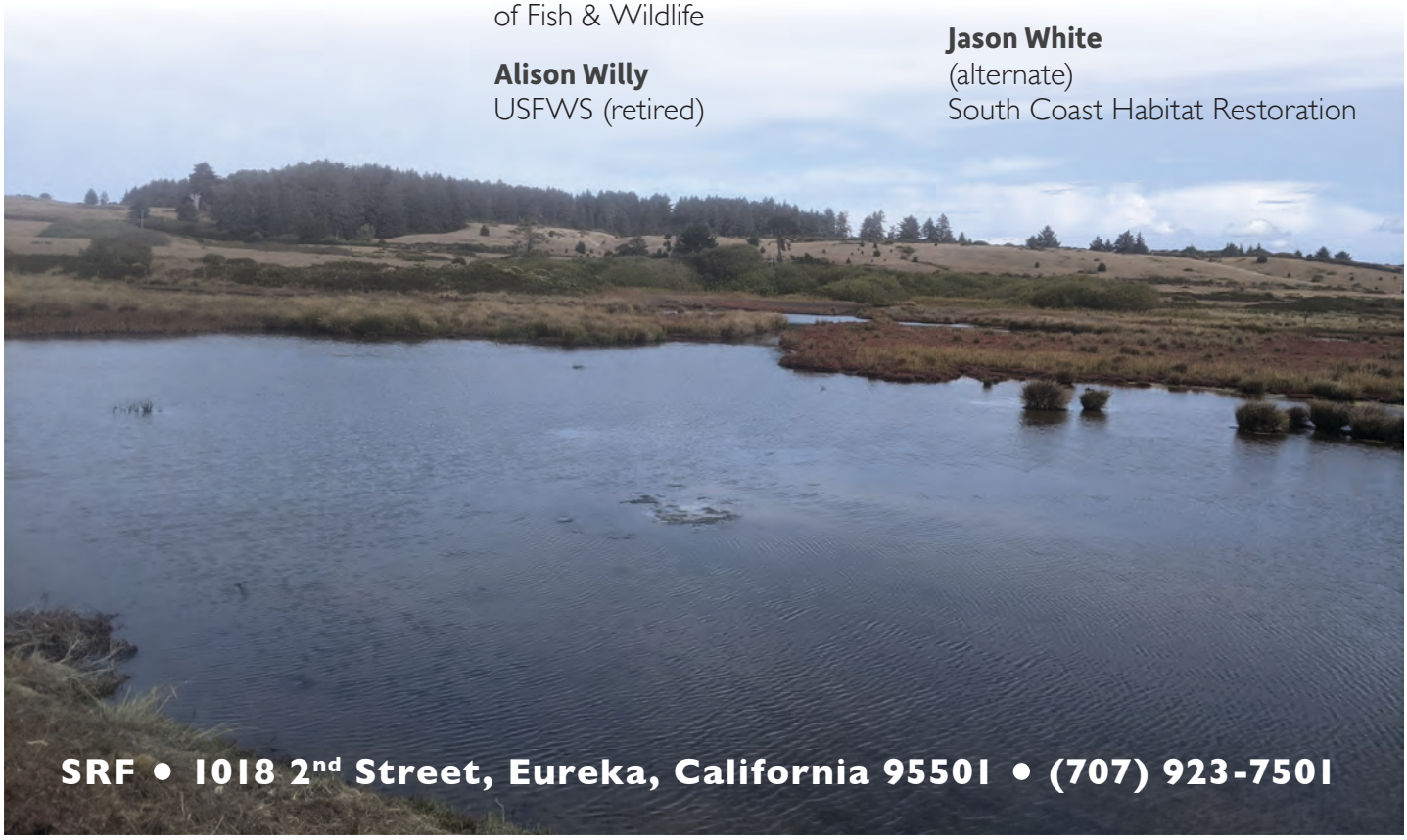

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Points to Linear Isopleth, or How I Visualize Large Wood Density
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Klamath Meadows Partnership
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Monitoring the Effects of Wildfire on the Availability of Pool Habitat for Juvenile Coho Salmon
Presented by Korri Basinger
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Influence of Climate Change and Abiotic and Biotic Environmental Factors on Patterns of Aggression in Juvenile Coho Salmon
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Assessment of Projected Benefits of Restoration Projects
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Concentrations of Environmental DNA for Estimating Juvenile Chinook Salmon Abundance in the Sacramento River
Presented by Jacqueline Bridegum
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Restoration Strategies to Enhance Climate Change Resiliency in the Mattole Headwaters
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California Environmental Water Network
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Matilija Dam Removal and Sediment Management
Presented by Mark Capelli
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Feasibility Study Evaluating the Potential for Salmon Reintroduction to the North Fork Feather River Watershed Above Lake Almanor
Presented by Theo Claire
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Design of Riffle-Pool Wood Habitat Structures and Gravel Augmentation on Lagunitas Creek
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California Freshwater Shrimp Population Trends in Lagunitas Creek, CA
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Habitat Suitability and Abundance of *Oncorhynchus mykiss* in San Luis Obispo Creek Headwaters
Presented by Ashley Del Core
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Extreme Weather Events affecting Spawner Survey Results on the South Fork Eel River
Presented by Tiffany Douglas
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Field Study of Water Temperature for Head-of-Reservoir Collection System in Shasta Reservoir
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New Statewide Tools to Accelerate Aquatic Habitat Restoration Permitting
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The Lower Tule River Native Aquatic Species Management Plan: Small Rivers can Provide Big Habitat for Native Species
Presented by Megan Fee
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Carmel River Lagoon Steelhead Population Monitoring
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The Importance of TEK in Environmentalism
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Fins and Feathers: Providing Habitat and Food for Salmon and Birds in the Central Valley
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Engaging Communities to Restore Riparian Corridors f or Fish and Wildlife Habitat on Working Lands
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Russian River Voluntary Water Sharing Program
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California Central Valley Office of NOAA Fisheries
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Modeling Alternative Future Land Use and Climate Change Scenarios (1990–2100) for All Major Puget Sound River Basins (~30,000 km2)
Presented by Jonathan Halama
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It's Wet and Green and Salmon Were Seen:
Creating Additional Fish Habitat and Promoting Fish Passage in Auburn Ravine
Presented by Caroline Hamilton
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Big ELJs and Blasting: Exploring Methods to Initiate Channel Widening Processes
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Severe Weather Events' Increasing Impact on Monitoring
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Habitat Restoration and Enhancement Act
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Evaluating the Trojan Y Chromosome Strategy for the Removal of Invasive Sacramento Pikeminnow (*Ptychocheilus grandis*) from the Eel River
Presented by Alexander Juan
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Sonar Monitoring in the Eel and Van Duzen Rivers
Presented by David Kajtaniak
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TRIB Research: Exploring the Nexus Between Community and Conservation
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West Coast Region Salmon Story
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Hydraulic Monitoring of Constructed Steep Boulder Channels
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Influencers of Migration Timing of the Threatened Spring Run Central Valley Chinook Salmon
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Beaver Restoration In California: Updates From the Bring Back The Beaver Campaign
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30 Years of Habitat Typing: Have We Learned Anything?
Presented by Ophelia Macdonald
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The Juvenile Salmonid Collection System: Overcoming Barriers to Reintroduce Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*) Above Shasta Reservoir
Presented by Kevin Marr
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Extreme Weather Events Affecting Spawner Survey Counts in the South Fork of the Eel
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Sproul Creek Flow Enhancement, SF Eel
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Streamflow Enhancement in Redwood Creek, South Fork Eel
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Fish Habitat Assessment Using LiDAR and Hydraulic Modeling
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BMI in San Luis Obispo Creek Watershed
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Periphyton Monitoring in the Trinity River, California
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Long Term Monitoring of Coho Salmon (*Oncoryhnchus kisutch*) in the Little River Watershed
Presented by Erin Phillips
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Monitoring and Evaluation of Salmonid Habitat Restoration Large Wood in Salmonid Habitat Restoration
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CDFW Northern Region Fisheries Restoration: Headwaters to the Sea
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Assessing Head-of-Reservoir Fish Communities Prior to Salmon Reintroduction
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Steelhead and Sulfur, Lake Cachuma Dynamics and the Downstream *O. mykiss* Population
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Hydrologic Outcomes for Ecological Meadow Restoration in the Northern Sierra Nevada Mountains
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Functional Flows for Functional Restoration: Considerations for Implementing CEFF Around Existing Restoration Projects
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Restoration in the Scott River Watershed
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The California Conservation Corps in Fisheries
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Variation in Run-timing and Freshwater Residency of Steelhead trout (*Oncorhynchus mykiss*) in Freshwater Creek, Humboldt County, CA
Presented by Kasie Tyler
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Mapping Fall-Run Chinook Salmon Spawning in the Lower Reaches of Clear Creek, CA from 2008-2020
Presented by Teresa Urrutia
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Garcia River Estuary Habitat Enhancement Project
Presented by Peter van de Burgt
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Coho & Steelhead Movements across the Pescadero Creek Watershed
Presented by William Ware
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Assessment of Juvenile Chinook Salmon Migration and Survival in the Sacramento Valley
Presented by Alexandra Wampler
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Watershed Steward Program Outreach Poster
Presented by Watershed Stewards Program
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A Geomorphic Assessment of Process-based Restoration of Burned and Unburned Meadows in the Southern Sierra Nevada
Presented by Kate Wilcox
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Salmonid Restoration Federation's Mission Statement

Salmonid Restoration Federation was formed in 1986 to help stream restoration practitioners advance the art and science of restoration. Salmonid Restoration Federation promotes restoration, stewardship, and recovery of California native salmon, steelhead, and trout populations through education, collaboration, and advocacy.

SRF Goals & Objectives

1. **To provide affordable technical education and best management practices trainings to the watershed restoration community.**
2. **Conduct outreach to constituents, landowners, and decision-makers to inform the public about the plight of endangered salmon and the need to preserve and restore habitat to recover salmonid populations.**
3. **Advocate for continued restoration funds, protection of habitat, enhanced instream flows, and recovery of imperiled salmonids.**

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