41st Annual Salmonid Restoration Conference

March 26-29, 2024 Santa Rosa, CA

Holding Space—Restoring Habitat and Making Room for Innovation

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Welcome to the 41st Annual Salmonid Restoration Conference

If You Produce It, Will They Come?

Reckoning with Ever Fluctuating Circumstances

Many restorationists are likely familiar with the experience of feeling like you have learned some hard lessons and integrated adaptive management to avoid making the same mistakes. You assume the adaptive, think smarter posture but somehow the framework that you are working in keeps shifting so even though you think you've hatched the best plan for the moment, the floor drops out.

Not to be overly dramatic, but I think we have collectively arrived at this moment. The restoration field faced with unprecedented opportunity dared to dream bigger, built capacity, and most projects are now reckoning with the cost of inflation, budget freezes, and no real road map to keep up with insurmountable opportunity lacking sustainable funding sources.

In the specifics of the SRF Conference, we decided to go bigger and better in 2024 since we learned the hard lesson of having our conference sell out so early last year to the dismay and disgruntlement of so many of our valued restoration partners. We invested both literally and figuratively in a hybrid way to produce the conference that would maintain affordability and increase accessibility while accommodating the level of interest that the largest salmon restoration conference in CA affords.

What SRF Did in 2023 with Support from our State Partners:

- Produced the 40th Annual Salmonid Restoration Conference in Fortuna, CA
- Built ten-million gallons of water storage for flow augmentation in the South Fork Eel River
- Produced the 25th Annual Coho Confab in the Mattole
- Launched the Redwood Creek, SF Eel Storage & Forbearance Program
- Completed flow enhancement implementation plans for Redwood & Sproul Creeks, SF Eel
- Created a more robust Diversity, Equity, and Inclusion scholarship program

The state budget freeze and the lack of a federally-approved budget have thrown a wrench in our plan to go big, to create a venue where on-the-ground practitioners and their state, federal, and county cohorts get to really engage and make person-to-person progress on the "wicked problems" of water scarcity, salmonid recovery, and watershed restoration in a landscape of fire, climate change, and extended droughts.

When faced with the political construct of what is essential, it is hard not to ponder what we consider essential. SRF considers our restoration partners essential to the function, operation, and vision of restoring salmonids in California. We consider the California Conservation Corps and Watershed Stewards Program essential to the training of young professionals. We consider our colleagues at CDFW, Wildlife Conservation Board, the State and Regional Water Board, Department of Water Resources, and State Coastal Conservancy essential to the vision and execution of grant programs and policies in which we work to protect and restore salmon and their habitats. Your presence, participation, and myriad voices are essential to carry on the hard work of restoration.

Ever the pollyanna, I hope that something resolves that enables the level of participation that we value and depend on. I realize that SRF's conference concerns are a microcosm of a much larger problem that is impacting each CA state agency right now from health care to the environment and everything in between. Let's all take a moment to realize the magnitude of what it means to work collaboratively and to recognize the essential nature of what each partner brings to our ever-evolving table.

—Dana Stolzman, Executive Director

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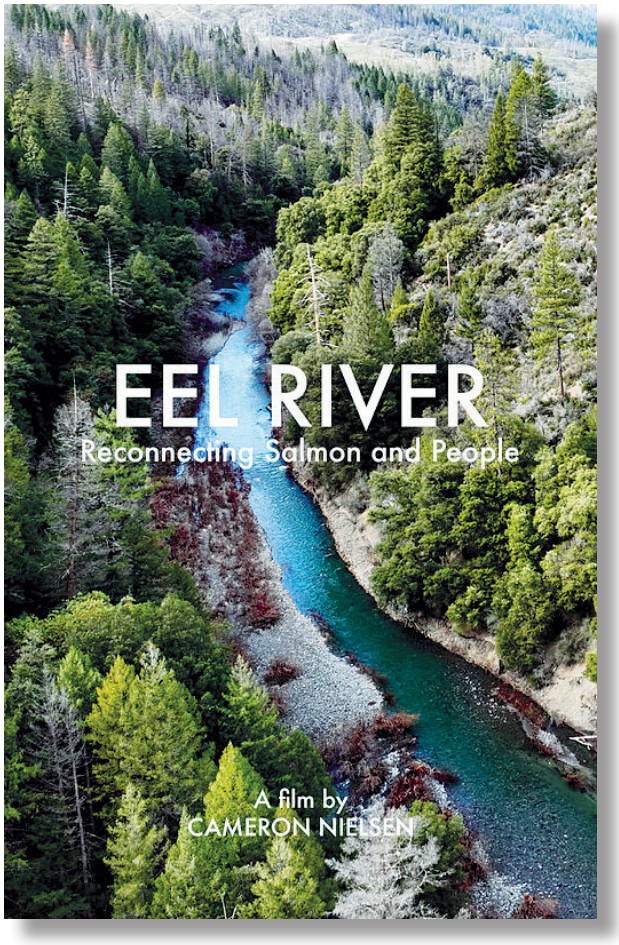
Conference Events

Wednesday, March 27

Membership Dinner at 6pm

Saralee Barn, Sonoma Fairgrounds

Join us for a Festive Dinner and Film Screening



Thursday, March 28

Poster Session from 7-10pm

Alexander Ballroom at the Hyatt

Co-hosted by SRF, McMillen, and RES

Friday, March 29

SRF Annual Membership Meeting 12:30pm to 1:15pm

Dry Creek Room, Hyatt

Banquet
Awards Ceremony
Silent Auction
and Papiba!
6:30pm to Midnight

Alexander Ballroom, Hyatt

Community Outreach, Collaboration Tools, and Tribal Engagement Workshop

Tuesday, March 26, 2024

Workshop Coordinators: *Kristen Wright, National Policy Consensus Center, Portland State University;* ***Leslie Wolff,*** *NOAA Fisheries, West Coast Region;* ***Mary Burke,*** *North Coast Program Manager, California Trout; and* ***Robin Hoffman,*** *Cultural Resources Program Manager and* ***Jason White, P.E.,*** *Engineer, Environmental Science Associates*

This workshop will build your knowledge and personal tools for collaborative success. The tools and practice sessions, with case studies, will deepen your understanding of the "science of collaboration." Participants will also develop a greater understanding for the role and mechanics of trust-building and what strategies can be implemented to build trust and reach durable agreements that lead to on-the-ground successful restoration. Kristen Wright, National Policy Consensus Center (NPPC) Director of Training and Academic Services, has designed customized collaborative training for salmonid restoration practitioners. The workshop includes two training modules, including a mix of presentations, discussion, and participatory exercises grounded in examples from the North Coast of California.

Specifically, part one focuses on the Fundamental Dynamics and Principles of Collaboration and provides a framework for evaluating and improving collaborative efforts with an eye toward creating mutually satisfying outcomes for involved parties. You will leave with a better understanding of a framework for developing mutual agreements and the impact and role that trust and social learning play in building effective agreements and lasting implemented solutions. Plus, each participant will have the opportunity to apply these principles to an actual case.

Part two will focus on Personal Tools for Collaborative Success. This session will provide three specific personal tools that participants will be able to immediately apply to their partnerships and collaborative settings. These skills and behaviors are research-based and highly-effective techniques for building trust, creating better working relationships, improving group deliberation and decision-making, and eliciting more collaborative behavior from others.

The afternoon session will focus on providing the regulatory background for tribal consultation, highlighting the benefits of tribal engagement early in project development, providing best practices and processes for tribal engagement, and reviewing multiple case studies that address these issues. The session will include agencies with additional tools to develop and implement approaches to successful tribal engagement and project design and implementation.

The Role of Conservation Hatcheries in Salmon Recovery Workshop and Tour

Tuesday, March 26, 2024

Workshop Coordinators: *Mariska Obedzinski, California Sea Grant; Rory Taylor, U.S. Army Corps of Engineers; Gregg Horton, Sonoma Water; and Bob Coey, National Marine Fisheries Service*

In many watersheds, particularly those at the southern edge of the range of anadromous salmonids, the Field of Dreams habitat restoration approach ("If you build it, they will come") to salmon recovery doesn't always happen at a fast enough pace to overcome land-use threats to highly imperiled populations. Assistance in the form of supplementing wild abundance via conservation hatchery releases can help buy time until ecological processes are restored to the point where habitat can support self-sustaining runs once again. Since hatchery releases allow the opportunity to mark and track fish, they can help identify bottlenecks to survival and inform habitat restoration efforts. To support endangered Coho salmon recovery and prevent imminent extirpation, the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) began releasing Coho into the Russian River watershed in 2004. After 20 years of hatchery releases, the Russian River Coho population has increased from a handful of adults returning each year to a few hundred, but it is still far from reaching the NMFS recovery target of over 10,000. The RRCSCBP has tested a suite of methods for spawning, rearing and releasing Coho; and intensive hatchery and stream monitoring is used to evaluate different strategies. Join us for a day to reflect on what strategies have been most successful, lessons learned, and next steps. The workshop will include a combination of talks, a tour of the Don Clausen Fish Hatchery at Warm Springs Dam, and a panel discussion. Topics will include hatchery practices, spawning approaches to maximize genetic diversity, release strategies, and monitoring approaches and results.

WSP member releases juvenile Coho salmon into a Russian River tributary. Credit: California Sea Grant

Nature-like Fishways: Modern Perspectives and Techniques

Tuesday, March 26, 2024

Workshop Coordinators: *Tyler Kreider, PE, Kleinschmidt; Mike Garello, PE, HDR, Inc.; and Mike Love, PE, Michael Love & Associates*

This instructor-led workshop, organized by the American Fisheries Society–Bioengineering Section, with funding from the Resources Legacy Fund, to presents a two-day-nature-like fishway workshop. This in-person workshop will occur over two days and will be instructed by several leading practitioners in the field of Nature Like Fishways (NLF) implementation, including representatives from both private and public agencies. The list of speakers includes Michael Garello (HDR), Michael Love (MLA), Jesus Morales (U.S. Fish and Wildlife Service), Tyler Kreider (Kleinschmidt), Bjorn Lake (NOAA Fisheries), Barry Chilibeck (Northwest Hydraulic Consultants), Brian Cluer (NOAA Fisheries), and Marcin Whitman (retired California Department of Fish & Wildlife). The goal of the workshop is to share knowledge of nature-like fishway design and long-term stability observations among practitioners, regulators, and operators to improve the collective awareness of contemporary NLF science and design methodologies to ultimately provide more effective and sustainable passage for fish. This workshop will include the following topics:

- History and state of nature-like fishways
- Application of NLFs to natural and built environments
- Site reconnaissance, project assessment, project development
- Identifying data and modeling needs and necessary in-field data collection
- Example design methods, practices, constraints, and uncertainties—also highlight current/ forthcoming design guidance documents
- Construction methods and oversight
- Monitoring
- Lessons learned from previously constructed NLFs
- Risk evaluation in NLF Design
- Getting the right rocks and placing them for long-term stability

Pool and Weir Nature-like Fishway constructed on small stream
Credit: Bjorn Lake, NOAA

City of Santa Rosa Urban Creek Tour

Tuesday, March 26, 2024

Field Tour Coordinator: Steve Brady, City of Santa Rosa

Join the City of Santa Rosa's (City) Storm Water & Creeks Team on a full-day tour to learn about urban creek challenges and tour a few of our past, present, and future creek restoration projects in Santa Rosa. Creeks are the lifeblood of Santa Rosa as over 100 miles of creek channels flow through the city limits, providing valuable wildlife habitat and recreational opportunities to our residents. Over 340 miles of storm drain lines connect City streets to these creeks which can present challenges in maintaining water quality and stream protection. The tour will highlight the City and Sonoma Water's Creek Stewardship Program, showcase low impact development (LID) features, and explore multiple creek restoration projects including: the Prince Memorial Greenway on Santa Rosa Creek (completed 2000-2005); the 1.3 mile-long Lower Colgan Creek Restoration (2015, 2022, planned 2025); and a blackberry removal and native plant revegetation project along Santa Rosa Creek (2018-2023). While traveling between sites, we will discuss illegal camping impacts, invasive vegetation management, stewardship initiatives, volunteer activities, and small-scale restorations throughout the city.

Lower Colgan Creek Restoration in southwest Santa Rosa. Credit: City of Santa Rosa

Process-based Restoration on the Uplands Tour

Tuesday, March 26, 2024

Field Tour Coordinators: *Brock Dolman and Kate Lundquist, Occidental Arts & Ecology Center*

Field Tour Contributors: *Damion Ciotti, U.S. Fish and Wildlife Coastal Program; Kevin Swift, Swift Water Design; and Loren Poncia, Stemple Creek Ranch*

This full-day field tour will focus on low-tech process-based restoration projects in two watersheds. The first half of the tour will take place in the headwaters of Dutch Bill Creek at the 80-acre Occidental Arts & Ecology Center (OAEC) site. OAEC has been creating permitting pathways, along with Just Transition Workforce Training programs, towards implementing innovative process-based restoration techniques to restore a number of eroding ephemeral (Class III) watercourses that run through the property. During the rainy season, these channels deliver sediment downstream to Dutch Bill Creek, one of the most critical watersheds in the Russian River basin for the recovery of endangered Coho salmon and threatened steelhead trout. Gullies also effectively dehydrate the adjacent landscape by draining shallow groundwater to their low points, just like pulling the drain out of a bathtub. One way of stabilizing and repairing gullies is to strategically pack them with brush in order to slow the flow and distribute the energy of water, trap soil and leaf litter particles, and ultimately arrest sediment delivery downstream. With various limbing and thinning defensible space projects underway, OAEC takes advantage of this opportunity to stack functions using the abundance of resulting material onsite (often called "slash") to stuff nearby gullies. As we thin and limb our forests and landscapes towards fire fuels reduction, let us remember that "Slash ain't trash—it's beneficial biomass!" Come learn from Brock Dolman how to "...take our fire fears and connect that with our water woes!" The second part of the field tour will be to Little Fallon Creek, a sub-tributary of Stemple Creek. Here the U.S. Fish and Wildlife Service, OAEC, and Swift Water Design partnered with Stemple Creek Ranch owner Loren Poncia to install a pilot beaver dam analogue (BDA) complex in 2023. Stemple Creek and lower Estero San Antonio lagoon suffer from excessive sediment inputs stemming from historic channel excavation and floodplain disconnection throughout the watershed. Beaver dam analogues may reduce transport of sediment through direct capture or restoring reconnection of channels to floodplains. Riparian forest restoration and protection of 13 km if creek was completed over a decade ago in lower Stemple Creek Watershed and presents an opportunity to work with landowners and install BDAs at these reforested stream reaches in working landscapes. The goal of this project is to further recover the site habitat by increasing its water and sediment storage capacity and provide an example for similar stream reaches in the watershed. Building upon this existing riparian stewardship effort presents an opportunity to employ low-tech-process-based restoration techniques at a spatial scale necessary to trap and store significant sediment before it reaches Estero de San Antonio lagoon.

Slash ain't trash it's beneficial biomass! Trees and ladder fuels removed to reduce fuel loads are used to stuff gullies, prevent erosion and sequester carbon at Occidental Arts & Ecology Center. Credit: Brock Dolman, Occidental Arts & Ecology Center

Forwarding the Fish & Fire Conversation: Where Do We Go From Here?

Wednesday, March 27, 2024

Workshop Coordinators: *Lenya Quinn-Davidson, University of California Agriculture and Natural Resources Fire Network; Josh Smith, Watershed Research and Training Center; and Will Harling, Mid Klamath Watershed Council*

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 habitat loss, while other systems wither in the absence of needed fire. Meanwhile, fire suppression activities pose a different set of threats, adding insult to injury for aquatic habitats and species. However, the two disciplines remain mostly siloed, with few opportunities to find shared value or to innovate together in management and policy efforts.

In 2023, we hosted an introductory Fire & Fish Workshop at the Salmonid Restoration Federation (SRF) conference in Fortuna, focusing on the many intersections—ecological, cultural, and spatial—among fish and fire. This workshop will build on that understanding, further exploring cross-disciplinary connections, identifying management implications and opportunities, and daylighting potential synergies in policy and action. This workshop will include three major themes for learning and dialogue: 1) Managing the Post-Fire Landscape, delving into the McKinney Fire as an example; 2) Examples of Integrated Management and Restoration, including projects that consider and address both upland and aquatic values; and 3) Prescribed Fire 101, an interactive session where participants will begin to see the landscape through the lens of fire and learn the nuts and bolts of prescribed fire planning and implementation.

2023 saw several fires burning in important watersheds, including the Smith River Complex in Del Norte County. Credit: Lenya Quinn-Davidson

Landscape-Scale Firing Operations During the 2023 SRF Lightning Complex Wildfires

Zeke Lunder, Deer Creek Resources

While increasing the pace and scale of prescribed burning has been getting a lot of ink and airtime, very few burning projects are actually being implemented at any sort of meaningful scale. Coincidentally, climate change is shrinking the number of days when weather conditions are conducive to low-severity under-burns favored by regulators. There is a growing recognition of the need for "in-season" burns that burn hot enough to achieve the fire effects with which our wildlands evolved. However, there is little political will to approve prescribed burns under more severe prescriptions.

Firefighters have been lighting massive backfires during large Western wildfires for decades, often with detrimental ecological and economic effects. Incident management teams on large fires are increasingly conscious of the need to manage the ecological effects of the fire they are putting on the ground.

The 2023 wildfire season in northwest California followed a wet winter and got off to a late start. After a couple months of below-normal summer temperatures, August brought a large number of lightning-caused ignitions. Because not enough firefighting resources were available to fight every fire, some of the more remote fires on the Six Rivers and Klamath National Forests were left to burn with fairly minimal suppression.

Recent mega-fires like the Caldor or Dixie Fire have largely burned within large contiguous blocks of forest where fire has been excluded for a long time—indeed, recent fire scars are one of the only things that limit the spread of a mega-fire. The 2023 Six Rivers Lightning Complex fires were burning within a 150,000-acre area which had not seen a large fire for over 100 years. Local fire managers saw an opportunity in the mild burning conditions to use fire to fragment this large block of fire-excluded forest as a buffer against future mega-fires; they developed a long-term firing plan to gradually ignite the ridges between several of the larger fires, with the intention of using the resulting 'backing fires' to reduce surface fuels and reintroduce fire into the area. Firing took place over a month and was accomplished with drones, helicopters, and crews on foot. The outcome was over 50 square miles of mainly low-severity wildfire.

Though the incident management teams made efforts to align their firing operations with atmospheric conditions that were optimum for smoke dispersal, smoke impacts to the local communities from the managed wildfires were significant, and the U.S. Forest Service faced some criticism for implementing the firing operations outside of normal environmental planning processes.

Intentional fire applied during fire suppression efforts will continue to be the dominant method of returning wildfire to forest lands of the American West—if nothing else because it is simply not possible to put out every backcountry fire. Watershed-scale thinkers and land managers should take this reality into account when developing their vision for large-scale ecosystem restoration. Well-placed-prescribed burns can create safety zones around communities which will allow land managers greater latitude in restoring wildfire to its rightful place in our forests.

Forwarding the Fish & Fire Conversation: Where Do We Go From Here?

Wednesday, March 27, 2024

Fish and Fire—The Big Picture

Gordon Reeves, Ph.D., 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 year which view disturbances, such as fire, as an integral component of aquatic ecosystems. 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 are not necessarily affected negatively. These new insights present the opportunity to consider adjustments to existing institutional management policies and practices on fire management and response with regard to aquatic ecosystems. This will also require convincing the public and interested parties about the validity of the new perspective and providing them with 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.

McKinney Fire Debris Flows and the 2022 Klamath River Fish Kill

Toz Soto, Karuk Tribe Department of Natural Resources (Presenter); and Co-authors:
Grant Johnson, Karuk Tribe Department of Natural Resources; 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 rainstorm. On August 4, biologists with the Karuk Tribe discovered a large-scale fish kill that 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 riverbanks 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 that often provide important elements (spawning gravel and large wood) that make quality fish habitat, but the scale and intensities of these events seems to be increasing and negatively impacting fish populations.

Forwarding the Fish & Fire Conversation: Where Do We Go From Here?

Wednesday, March 27, 2024

Post Wildfire Observations—A Whole Lot of Gray Area

Josh Smith, Watershed Stewardship Program Director, Watershed Research and Training Center (Presenter); and Co-authors: Nick Goulette, Director; Michelle Medley-Daniel, Watershed Research and Training Center (WRTC), Deputy Director and Fire Adapted Communities Network Director; and Cindy Buxton, WRTC Watershed Stewardship Program Manager

Wildfires are increasing in scope and scale across the west. This has real consequences for fisheries, often with ambiguous results, but they can also be surprisingly beneficial. Sometimes wildfires result in catastrophic sediment pollution in streams, other times they result in replenished spawning gravels. Sometimes we see stand-replacing high-severity fire, other times beautiful mosaic burns that benefit the ecosystem. More often than not, we see benefits for fish such as reductions in stream temperatures, surges in large wood leading to habitat improvements, and increases in overall streamflow. This presentation will highlight a wide variety of post-wildfire observations within the Trinity River Watershed that fisheries and fire professionals might find surprising and thought-provoking.

Post-Fire Process-Based Restoration (PBR)

Karen Pope, Ph.D., USDA Forest Service, Pacific Southwest Research Station (Presenter); and Co-authors: Adam Cummings M.S; David Dralle Ph.D.; and Joe Wagenbrenner Ph.D., USDA Forest Service, Pacific Southwest Research Station; Emma Sevier, M.S., California Polytechnic State University Humboldt; Kevin Swift, Swiftwater Design; and Jordin Jacobs, M.S., Oak Ridge Institute for Science and Education Fellow, USDA Forest Service, Pacific Southwest Research Station

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, where high-severity burns can have bare soils that enhance the transportation of water and sediment from hillslopes into stream channels. Targeted-process-based restoration actions in degraded, low-gradient meadows and streams in burned catchments attempt to leverage the expected sediment pulses by encouraging deposition and storage in incised reaches where it can increase opportunities for local floodplain recovery and reduce impacts to downstream fish habitat. We provide examples of process-based restoration in burned headwaters, describe an ongoing experiment to quantify sediment transport and retention following instream restoration of meadows in burned and unburned catchments and show how the approach could be joined with post-fire forest restoration to maximize watershed benefits and minimize harm. The evidence thus far suggests that instream wood structures, such as beaver dam analogs and post-assisted log structures, capture sediment and accelerate wet meadow vegetation recovery, likely protecting important downstream fisheries.

Long-Term Impacts of Natural Forest Fires on Streamflow

Gabrielle Boisrame, Desert Research Institute

Wildfires play a complex and important role in mountain forests of the western United States. While these landscapes evolved with relatively frequent, mixed severity, lightning-ignited wildfires and a century of fire suppression have led to forests that have denser tree cover and are more prone to high-severity wildfire than they would have been historically. In the 1970s, managers in Yosemite National Park began a natural experiment in which lightning-ignited fires would be allowed to burn naturally within an isolated watershed known as Illilouette Creek Basin. Fifty years later, we are able to track how this watershed has changed in response to repeated, mixed-severity wildfires that closely match historical fire return intervals. Using long-term streamflow measurements, aerial photography, and hydrologic models, we have been able to identify significant changes to the landscape and hydrology. These changes include greater extents of wet meadows as well as higher stream flows. Analysis of fire behavior in this watershed has also shown that the frequent burning in this area keeps individual fires from becoming too large or severe, which may reduce the risk of erosion and water quality impacts. Aquatic ecosystems are likely to benefit from the impacts of this restored fire regime, including improved water quality and quantity. These observations are vital to understanding how a natural fire regime in fire-adapted forests can impact future vegetation dynamics. Although both a dam and a 300-foot waterfall prevent salmon from entering the Illilouette Creek Basin itself, lessons learned from this natural experiment are relevant to other montane watersheds providing salmonid habitat. These observations are especially important as many wilderness areas now encourage using wildfire as a land management tool rather than continuing with strategies focusing only on fire suppression.

Restoring Beneficial Fire Processes in the Klamath Mountains to Improve Instream Habitat and Bring our Salmon Home

Will Harling, Mid-Klamath Watershed Council (Presenter);
and Co-authors: Charles Wickman, Mitzi Wickman, and James Peterson,
Mid-Klamath Watershed Council; and Toz Soto, Karuk Tribe Department of Natural Resources

The 2022 and 2023 wildfire seasons stand as stark bookends on the range of variability in wildfire behavior in the Western Klamath Mountains. In 2022, the McKinney Fire burned 97 homes and caused four fatalities in one night; and set the stage for the most impactful debris flows in the Klamath River in recorded history. In 2023, above-average winter precipitation and mid-summer thunderstorms provided record levels of lighting fire starts while moderating fire effects. The Six Rivers National Forest, working with the Karuk Tribe, community organizations, and Incident Management Teams, utilized confine and contain strategies to manage the 2023 SRF Lightning Complex from approximately 20,000 acres to a 50,000-acre footprint by aerially igniting strategic ridge systems. High severity fire was kept to less than 8% of the fire area and a critical fire entry was made into areas that had not seen fire in over 50 years. This use of managed wildfire tactics under the full suppression mandate was authorized from the highest levels of the Forest Service and is a powerful model for what could be accomplished on public forest lands throughout California. This talk will also discuss how state and federal legislation and funding are greatly expanding the use of prescribed and cultural fire in the Klamath Mountains and how these advances in policy and management can benefit instream fish habitat restoration projects.

Large-Scale Restoration in a Dynamic Estuary System: A Tour of the Garcia River Estuary Habitat Enhancement Project Tour

Wednesday, March 27, 2024

Field Tour Coordinators: *Peter Van De Burgt, The Nature Conservancy and Lauren Hammack, Prunuske Chatham, Inc.*

The Garcia River, in southern Mendocino County, supports populations of Coho salmon, Chinook salmon, and steelhead trout. Over the last 30 years, local community groups, public agencies, and non-profits have worked to conserve land and restore habitat throughout the watershed, from headwaters to river mouth. Yet, despite this long history of restoration, there remained a dearth of high-quality winter and spring outmigration habitat in the watershed. To address this need and to increase the watershed's winter carrying capacity for Coho salmon, The Nature Conservancy (TNC)—in close collaboration with a wide range of project partners including the Bureau of Land Management, NOAA Fisheries, CDFW, North Coast Regional Water Quality Control Board, Prunuske Chatham, Inc. (PCI), and others—developed and implemented the Garcia Estuary Habitat Enhancement Project. After more than seven years of development, the project was constructed in 2022. Focusing on both instream and off-channel habitat along a 0.5-mile reach of the estuary, project construction included 18 engineered large wood structures (composed of more than 350 logs and root wads) and over two acres of floodplain enhancement. Join us for a tour of the project site. We will have an opportunity to catch a bird's eye view of the entire project from atop the bluffs on the south side of the estuary before hiking down to see some of the project features up close. Staff from TNC, PCI, and other project partners will lead a wide-ranging discussion about the realities of implementing a complex restoration project in a dynamic and sensitive estuary environment. We'll discuss planning, design, permitting, construction methods, monitoring, lessons learned, and everything in-between.

Garcia River estuary *Credit: Keane Flynn*

Lagunitas Watershed Tour

Wednesday, March 27, 2024

Field Tour Coordinators: *Sarah Phillips, Marin RCD; and Eric Ettlinger, Marin Water District*

Lagunitas Creek watershed supports the largest population of wild Coho salmon in the California Central Coast (CCC) Evolutionary Significant Unit (ESU). A key factor limiting Coho salmon survival in Lagunitas Creek is access to high-quality winter habitat. Such habitat provides shelter from predators, high-flow refuge, and opportunities for feeding and growth. The Marin Municipal Water District (Marin Water) enhanced Coho salmon winter habitat over two miles of lower Lagunitas Creek by reconnecting historic secondary channels and installing large wood structures. These structures included bar apex jams, which combine multiple logs to mimic the old-growth logs no longer found in the watershed, and debris retention jams, which were intended to aggrade the streambed. While the project achieved many of its design objectives, this tour will highlight aspects of the project that were less than successful. To paraphrase Thomas Edison, the efforts undertaken weren't failures, but they provide many opportunities to identify bad ideas. Issues that will be discussed during this tour include evaluating impacts and benefits to existing habitat, understanding sediment dynamics when attempting stream aggradation, floodplain processes and evolution, revegetation planning, and working successfully with partner agencies.

Additionally, the tour will visit the most productive tributary to Lagunitas, San Geronimo Creek, to check out a more recently implemented project by Salmon Protection And Watershed Network (SPAWN), designed by Environmental Services Associates (ESA). The site includes a 100-year-old dam that was removed from a former golf course in order to provide year-round access to critical habitat The dam was one of the highest priority fish barriers in Central CA. Removing it created and restored an estimated five acres of creek habitat and included activities such as widening of floodplains, a new side channel, innovative 'tree islands,' and upland habitat vegetation restoration. The site is now called "Roy's Riffles" instead of "Roy's Dam."

Finally, we'll hear about an exciting up-and-coming project on that same former golf course property where many partners have come together in a collaborative effort to design an innovative habitat restoration project with ESA's design team. The lead on the project includes Trout Unlimited, with its supporting partner who is also the landowner, the Trust for Public Lands. The collaborative design process has also included local agencies that contribute by participating on the Technical Advisory Group (TAG).

Winter habitat in Lagunitas Creek
Credit: Sarah Phillips, Marin RCD

Dry Creek Field Tour: Partnerships in Habitat Enhancement and Monitoring for Salmonid Recovery

Wednesday, March 27, 2024

Field Tour Coordinators: *Justin Smith and David Cuneo, Sonoma Water*

This all-day tour features salmonid habitat enhancement projects and monitoring programs on both private and public lands within the Dry Creek Basin. We will highlight enhancement strategies that address salmonid recovery and that provide resilient long-term solutions. Tour projects will highlight collaborative efforts guided by the Russian River Biological Opinion and the Russian River Coho Salmon Captive Broodstock Program that are implemented by Sonoma Water and the United States Army Corps of Engineers (USACE). Project reaches are located on the mainstem of Dry Creek and include engineered log jams and off-channel and in-channel habitat enhancements. Since 2012, Sonoma Water and USACE have implemented projects in 17 enhancement reaches encompassing nearly 1,000,000 ft^2 over four (non-contiguous) miles stretching from just upstream of the confluence with the Russian River to Warm Springs Dam.

A Dry Creek habitat enhancement under construction on private property. This project was built by McCullough Construction. Implementation of the project was managed by the USACE. The photo of this newly constructed project was taken during the 2023 construction season. *Credit: Justin Smith*

Napa River Restoration: Mid-Upper Napa River Tour

Wednesday, March 27, 2024

Field Tour Coordinators: *Rick Thomasser and Jeremy Sarrow, Napa County Flood Control and Water District; Jorgen Blomberg, Principal ESA; Jason White, Restoration Engineer ESA; Leslie Ferguson, Restoration Specialist, San Francisco Regional Water Quality Control Board (SFRWQCB)*

The Napa River Restoration Project (Project) is a 13.5-mile-large-scale river restoration project located in the mid-upper Napa River between St. Helena and Oak Knoll in Napa County. The project includes two project reaches—the Rutherford Reach (4.5 miles) and the Oakville to Oak Knoll Reach (9 miles) implemented between 2008-2021. The Project restores spawning and winter/ spring rearing habitat for steelhead and Chinook salmon. Both projects included the removal and setback of vineyards; expansion of riparian and channel habitat through channel widening; floodplain, secondary channel, and alcove grading; and addition of large wood and boulder features that will support resilient geomorphic processes. Secondary components of the Project included biotechnical stabilization, vegetation management, and site revegetation. The restoration actions are not continuous over the 13.5 miles, but instead occur in a mix of high-quality nodes and long-reaches of connected floodplain habitat, resulting in more diverse and resilient ecosystem functions.

The tour will provide a 'timeline' review of several project sites on vineyard properties to demonstrate the establishment and evolution of physical processes, specific habitat conditions, and ecosystem response to restoration actions. Examples of each of the restoration actions mentioned above will be highlighted.

Notably, this project is a win-win for the environment and the landowners adjacent to the river. The landowners have been voluntarily removing vineyards and allowing berms to be set back and lowered—in many locations 75 feet back from the river—allowing for more uniform and predictable flood management and rededication of agricultural land uses to riparian habitats. These actions improve localized hydraulic and geomorphic conditions, reduce channel instability and bank erosion, allow for a wider floodplain and riparian zone, and at the same time provide the landowners with a more reliable berm system set-back from the river. Equally important, the landowners express an interest in preserving the Napa River ecosystem for their children and future generations. In the two Projects combined, more than 40 landowners have converted nearly 56 acres of farmland to wildlife habitat. This Project has ongoing monitoring and maintenance through a Community Facilities District (CFD) voluntarily funded by the project landowners.

The Napa County Flood and Water Conservation District has overseen the design and implementation of this Project with the collaboration of more than 40 landowners and Rutherford D.U.S.T. Society, Napa County Resource Conservation District, Fish Friendly Farming, ESA (designers), and an agency Technical Advisory Committee (SFRWQCB, National Oceanic and Atmospheric Administration, and California Department of Fish and Wildlife). This collaborative Project represents the epitome of a collaborative community and local/state agency effort to restore a living and resilient river.

Riparian corridor expansion and increased channel complexity for velocity refuge and improved food production. Credit: Jorgen Blomberg

Realizing a Vision of Multi-benefit Restoration in the Laguna de Santa Rosa/ Mark West Creek Watershed: Workshop and Tour

Wednesday, March 27, 2024

Workshop Coordinators: *Anne Morkill and Clayton Creager, Laguna de Santa Rosa Foundation*

The Laguna de Santa Rosa/ Mark West Creek watershed is the largest sub-watershed of the Russian River, encompassing 254 square miles in the heart of Sonoma County where the majority of people live, work, and play. The Laguna de Santa Rosa is a vital and unique wetland ecosystem that is home to a wide range of plant and animal species, including Coho salmon and steelhead trout. Over the past 150 years, development and landscape modification throughout the watershed have altered flows and increased fine sediment and nutrient supplies, thereby severely impacting habitat conditions for many threatened and endangered species. This workshop will highlight a range of collaborative multi-benefit-restoration efforts within the Laguna/Mark West Creek watershed focused on improving conditions for both fish and wildlife and the local community.

Join us for a series of presentations and an interactive dialogue that will range in breadth from landscape-scale-restoration planning to site specific project design and implementation. The topics covered will include the development of watershed-wide fine sediment and nutrient TMDLs, innovative regulatory and voluntary conservation measures that facilitate large-scale restoration on both private and public lands, and the design and implementation of multi-benefit restoration projects in the watershed. We'll also share highlights of the recently completed Laguna de Santa Rosa Restoration Plan that identifies opportunities for re-creating critical habitats within an altered landscape that is vulnerable to continued land uses and climate change. The presentations will culminate in an interactive dialogue to build commitment and momentum for realizing our shared vision of an enhanced Laguna de Santa Rosa that supports native fish and wildlife for part or all of their lifecycle in a resilient landscape where people can also thrive.

The workshop will be held at the Laguna Environmental Center, featuring 360-degree open views of the watershed, and offers afternoon site visits to see completed and proposed restoration projects along the Laguna de Santa Rosa and tributary creeks. Presenters include the San Francisco Estuary Institute, Sonoma County Water Agency, North Coast Regional Water Quality Control Board, City of Santa Rosa, Sonoma Resource Conservation District, Cal Trout, and invited panelists from the Sonoma County Agricultural and Open Space Preservation District, California Department of Fish and Wildlife, private landowners, and more.

Aerial photo of the Laguna de Santa Rosa which is the largest wetland complex on the North Coast. *Credit: Steve Gibbs*

Water Quality in the Laguna de Santa Rosa Watershed

Matt Graves, North Coast Regional Water Quality Control Board

Human changes to the landscape in the Laguna de Santa Rosa (Laguna) watershed have both increased the influx of pollutants and decreased the capacity of watersheds to assimilate those pollutants. Reduction in wetland acreage, a loss of floodplain access, and diminished function of foothill sausals have led to impairment of the watershed. Degraded water quality contributes to biostimulation, a situation in which physical, chemical, and biological conditions interact to promote the growth of aquatic primary producers such as algae and aquatic macrophytes. Biostimulation impacts a number of beneficial uses in the Laguna watershed, the most sensitive of which is the use of water that supports cold water ecosystems including, but not limited to, preservation or enhancement of salmonid species. Elevated turbidity levels reduce salmonid growth rates, stream temperatures often exceed lethal thresholds for the species, and increased nutrient inputs deplete dissolved oxygen, creating anoxic conditions that prevent successful spawning and rearing. The North Coast Regional Water Quality Control Board is developing total maximum daily loads and an action plan that prescribes regulatory and non-regulatory implementation actions necessary to restore and maintain conditions for species survival. By supporting the water quality conditions that protect salmonid populations; other less sensitive beneficial uses will be protected as well. The action plan under development will include efforts focused both on controlling pollutant sources and reconciling the needs of watershed inhabitants, aquatic and human. The magnitude of degraded water quality in the Laguna watershed and the efforts necessary to address them are significant and will require extensive, ongoing coordination between key watershed partners. A systematic, coordinated approach to recovery could benefit from the establishment of a watershed-wide planning and implementation entity.

Salmon in the Laguna?

Charlie Schneider, California Trout

Wetlands worldwide have undergone marked reductions in area and function due to modifications made by humans. Studies on the use of wetlands by salmonids in the last 20 years have shown that these types of habitats can be valuable to the growth and survival of juvenile salmonids. Coho salmon (*Oncorhynchus kisutch*) require specific habitat types for optimal growth and survival at different life stages. During their first winter, Coho are highly mobile, seeking low-velocity habitats where invertebrate production is high. Coho generally prefer calmer water than other salmonid species and are often found in side channels, backwaters, and other areas with slow currents. The lack of these micro-habitats in many basins, including the Russian River, can be a limiting factor to the recovery of populations. It has been assumed that the Laguna de Santa Rosa does not support salmonids due to water quality impairments; historically, there is evidence that salmonids may have utilized the habitat. This study investigates the potential for the Laguna de Santa Rosa to support Coho salmon during the winter rearing season through: 1) a case study of historic conditions and observations, 2) the installation of a Passive Integrated Transponder (PIT) tag antenna array to quantify immigration and emigration of hatchery-origin Coho salmon to the area, and 3) temperature and dissolved oxygen measurements at the antenna site to determine water quality conditions during the winter high-water season. PIT tag detections indicated that a few hatchery Coho salmon used the area during winter 2018/19. We hope this study serves as a starting point for more research into Coho and other salmonid use of the Laguna de Santa Rosa, including a more thorough water quality evaluation and comprehensive planning efforts that assess the potential to reconnect portions of the Laguna to benefit salmonids.

Projects and Policies in the Lower Laguna Watershed Designed to Support Habitat Restoration

Neil Lassettre, Ph.D., Sonoma Water; and Sean McNeil, City of Santa Rosa (Co-presenters)

The Laguna de Santa Rosa watershed has a significant number of tributaries within the City of Santa Rosa (City). The City and Sonoma Water have a long history of working together on the Creek Stewardship program in the City of Santa Rosa. The Creek Stewardship Program began in 1992 and has developed recreational trails along creeks, placed hundreds of creek signs that provide the name of the creek at each road crossing, supported volunteer events to clean up the creeks, and developed community engagement to support the health of the creeks in Santa Rosa. Now the two agencies have joined forces together again to try to support the greater Laguna de Santa Rosa watershed by performing reach-wide restoration projects and efforts to manage stream channels for flood control and habitat. In this talk, there will be a discussion of the City-wide Creek Masterplan (Creek Masterplan). It will also discuss how the city developed a planning tool to protect, enhance, and restore creeks in Santa Rosa and Sonoma Water's efforts to provide flood protection and implement riparian restoration on the mainstem of the Laguna and adjoining tributaries using its Stream Maintenance Program, the Water Quality Trading Framework developed by the North Coast Regional Water Quality Control Board. In particular, the Creek Masterplan identified three key restoration reaches that have been completed, including the Brush Creek Restoration Project, the Prince Memorial Greenway, and Lower Colgan Creek Restoration Project Phases 1 and 2, as well as future restoration projects like Pierson Street Restoration, Roseland Creek Restoration, and Lower Colgan Creek Restoration Phase 3.

The Sonoma Water Stream Maintenance Program (SMP) manages stream channels for flood control and habitat restoration. The SMP guides stream management activities and details avoidance measures, revegetation and enhancement, and subsequent performance monitoring. Sonoma Water applies the guidance to improve habitat while minimizing flood risk. The program also provides California Environmental Quality Act (CEQA) coverage for voluntary restoration activities in the mainstem Laguna and lower Colgan Creek that generate water quality credits under the North Coast Regional Water Quality Control Board's Water Quality Credit Trading Framework. Transfer of credits to the City enabled Sonoma Water to recover costs for the project and provide match for a CDFW Prop. 1 grant that resulted in the Laguna de Santa Rosa Restoration Plan. Additionally, the credits partially funded 65% designs and a CEQA document for a high priority project identified in the Restoration Plan near the confluence of the Laguna and Mark West Creek. Looking to the future, the City, Sonoma Water, and a group of other stakeholders are working together to try to implement projects identified in the Restoration Plan, including the restoration of one of the ancient lakes of the Laguna, Ballard Lake, and realigning Mark West Creek near its confluence with the mainstem Laguna de Santa Rosa closer to its historical path.

Realizing a Vision of Multi-benefit Restoration in the Laguna de Santa Rosa/ Mark West Creek Watershed: Workshop and Tour

Wednesday, March 27, 2024

Streamflow and Beyond: The Multiple Benefits of Small-scale Water Storage and Forbearance Projects

Jessica Pollitz, P.E., Sonoma Resource Conservation District; and Mary Ann King and Troy Cameron, Trout Unlimited (Co-Presenters); and Co-authors: Mia van Docto, Trout Unlimited; and Mariska Obedzinski, California Sea Grant

Sonoma Resource Conservation District, Trout Unlimited, and California Sea Grant will provide lessons learned from storage and forbearance rainwater harvesting projects in fire-affected watersheds in Sonoma County, with a focus on Mark West creek. This project was developed, primarily with Wildlife Conservation Board support, to link streamflow enhancement and fisheries conservation with wildfire and drought preparedness efforts. We will begin by providing an overview of implemented projects and associated streamflow and fisheries monitoring, and then discuss lessons learned from our community outreach efforts, tips for constructing tank projects in fire-prone landscapes, and the evolution of our thinking around the multi-benefit role of small-scale storage in streamflow enhancement.

A Look to the Future: Restoration Plan for the Laguna de Santa Rosa

Neil Lassettre, Ph.D., Sonoma Water and Scott Dusterhoff, San Francisco Estuary Institute (Co-presenters)

In 2016, Sonoma Water and project partners San Francisco Estuary Institute and the Laguna Foundation received a grant from CDFW to develop the Laguna-Mark West Master Restoration Planning Project (Project). The goal was to improve ecological functioning of the 100-year floodplain of the Laguna de Santa Rosa by restoring historical habitat. The project consisted of a conceptual Restoration Vision (Vision) that formed the basis for a Restoration Plan (Plan). Concurrent to developing the Vision and Plan, the Project team, a Technical Advisory Committee (TAC), and a Management Advisory Committee (MAC) identified a High Priority Project (HPP) site to develop 65% designs and complete a CEQA document to ready the HPP for implementation.

The first step in the Project was to develop the Vision that identified opportunities for multi-benefit habitat restoration and land management. Vision development began by understanding the landscape function from past, present, and potential future perspectives. This included syntheses of published and unpublished information regarding conditions in the Laguna's surrounding watershed, technical analyses constructing the historical ecology of the Laguna, and the magnitude of change in habitat conditions over the past two centuries. The Project team also held meetings with the TAC and MAC to identify short- and long-term restoration and management concepts that formed the Vision, including wetland and riparian restoration, riparian restoration, and infrastructure redesign.

Building on the Vision, the Plan identified restoration opportunities and developed conceptual designs used to establish implementable restoration projects. The concepts range from partial restoration of historical ecosystems, with emphasis on functions such as nutrient removal or sediment trapping, to establishment of historical habitats modified for increased resilience in a changed climate. Further, the Restoration Plan included a framework for planning landscape-scale restoration that can be refined over time, prioritization and sequencing criteria to evaluate how project concepts address objectives, and to assess why certain restoration projects should be pursued sooner than others.

The Project team and the TAC chose the HPP site from among six identified during the visioning process. The site sits along 119 acres adjacent to a 3,200 ft reach of the Laguna between the confluences of Santa Rosa Creek and Mark West Creek. The HPP concept seeks to restore historically occurring freshwater marsh, wet meadow, and riparian forest habitats by realigning the Laguna to its historical path across the floodplain. Sonoma Water brought the project concept to 65% design and analyzed project impacts in an Initial Study and Mitigated Negative Declaration. The HPP site and a site just downstream provide great opportunity for implementing projects in the near term.

The Plan provides a toolkit for improving the Laguna landscape. The use of these tools and the ultimate success of restoration efforts will require landowner and tribal support, adequate funding, and coordination among agencies responsible for managing the Laguna and its surrounding watershed. The path forward will be challenging, but with commitment and collaboration the Laguna community can achieve a reconciled Laguna landscape that supports desired ecosystem functions for people and wildlife.

Through the Evolution of Language, We Weave a Narrative for the Future

Armando Quintero, Director, California State Parks

As we reflect on the history of conservation and public lands in the United States and the world, we can see the influence of science, society, and values on our community cultures. I have spent a lifetime thinking about reconciling ideas, science, and teachings with interpreting natural and cultural history in the context of parks and the natural systems on which we depend. The languages we speak and the words we use define the world and define us. I hope to engage you in a thought-provoking look at our work at California's State Parks and how language and stories affect our work every day.

Making the Most of Opportunities for Salmon Recovery in a Warming World

Jennifer Quan, Regional Administrator, NOAA Fisheries West Coast Region, and Kristen Koch, Director, SWFSC, NOAA Fisheries

This is a time of great opportunity and urgency for restoring the salmon and steelhead that mean so much to California and its communities. Together, we must move faster than the impacts of climate change that are relentlessly altering the landscape and warming rivers to lethal temperatures for salmon. The collaboration we need is evident in this restoration conference, the strength and ambition of California's new Salmon Strategy, and the generational commitment of federal funding through the Bipartisan Infrastructure Law and Inflation Reduction Act (IRA). Environmental justice is one of NOAA Fisheries top priorities, so we must make sure that science is accessible and understandable to the public and our future workforces.

This is key to restoring native cultures and underserved communities. The partnership, innovation, and momentum behind dam removal and watershed restoration in the Klamath Basin and elsewhere along the coast demonstrate bold thinking that goes beyond merely avoiding extinction to further restoring healthy and abundant fish populations that can again contribute to tribal cultures, our economy, environment, and landscape. Advanced technologies give us the tools to outpace climate change and the increasing demands and impacts of population growth to ensure that salmon continue to play a vital role in our lives. Behind every fish and every drop of water we protect are the people who care about them, depend on them, and want them to remain an essential part of our landscape and diversity of native species.

The Cultural and Environmental Significance of the Klamath Dam Removal

Frankie Myers, Vice Chairman of the Yurok Tribe,
and Mark Bransom, CEO, Klamath River Renewal Corporation (Co-presenters)

The removal of the Lower Klamath Project, four hydroelectric developments on the Klamath River, is the largest dam removal project in history. The removal of the dams will open up more than 400 miles of historic spawning habitat for salmon and other species and improve water quality conditions downstream. In November 2020, the Klamath River Renewal Corporation (KRRC), the entity tasked with the removal of the dams, filed its Definite Decommissioning Plan (DDP) which is the comprehensive plan to physically remove the Lower Klamath Project and achieve a free-flowing condition and volitional fish passage, site remediation and restoration, and avoidance of downstream impacts. Renewal Corporation received the Licensure Surrender in November 2022 approving facility removal and habitat restoration. In mid-2023, deconstruction began with the removal of Copco No. 2, and improvements were made to the Copco No. 1 and Iron Gate dams in preparation for the drawdown period. This presentation will provide an overview of the cultural and environmental significance of the Klamath dam removal and implementing the long-term restoration vision for the Klamath river.

Frankie Myers is serving his second term as Vice Chairman of the Yurok Tribe, California's largest federally recognized tribe. Frankie and his wife (Molli Myers, Ridge to Riffles) are raising five kids on tribal lands in Humboldt County, where their families have lived since time immemorial. Frankie is currently running for CA State Assembly District 2. He has worked with for-profit corporations, family farmers/ranchers and conservation groups, as well as tribal, state, and federal lawmakers, to solve some of the most complex challenges in Northern California.

Mark Bransom is the CEO of Klamath River Renewal Corporation (KRRC) brings over 25 years of planning, engineering, and construction experience in water resources and environmental management for state and local governments, federal agencies, Tribal Nations, NGOs, and private sector clients throughout the Western United States. In addition to technical expertise, Mark is a skilled facilitator with experience building consensus among diverse project stakeholders and developing highly collaborative and transparent processes.

Healthy Rivers, Healthy Communities: How River Conservation Heals Climate Change, Biodiversity Loss, and Environmental Injustice

Ann Willis, Ph.D., California Regional Director, American Rivers

Climate change, biodiversity loss, and environmental injustice are three generational crises of our time. Healthy rivers are key to healing ecosystems and communities suffering from these crises. As scientists in California who focus on salmon restoration, we are uniquely placed to influence policy and management of California's rivers. And, given that California has more river miles than any other state in the contiguous U.S., our work has a major impact on nearly every community. By taking on roles in all aspects of conservation, communication, and policy – particularly in river conservation – scientists will show how river conservation solidifies and amplifies California's leadership in solving global crises.

Klamath Dam Removal —Meeting the Moment and Planning for the Future

Thursday, March 28, 2024

Session Coordinators: *Bob Pagliuco, Marine Habitat Resource Specialist, National Oceanic Atmospheric Administration (NOAA) Fisheries Restoration Center, and Mike Belchik, Senior Water Policy Analyst, Yurok Tribe*

The Klamath River Basin once supported the third most productive salmon runs on the contiguous U.S. Pacific Coast, and is home to runs of spring- and fall-run Chinook salmon, Coho salmon, and steelhead, in addition to populations of Pacific lamprey, eulachon, green sturgeon, and resident native fishes such as bull trout, redband trout, and several species of suckers. The Klamath Basin is home to several tribes, including the Yurok, Hoopa, Karuk, Quartz Valley, Shasta Indian Nation, Modoc Nation, and Klamath Tribes, who are inextricably tied to this land for harvesting plants, terrestrial animals, and fish for sustenance and cultural practices. The degradation of habitat and decline of these culturally important species have significantly altered the tribes' major food sources, cultural practices, and way of life.

The Klamath River dam removal project is the largest dam removal project in the country and will remove four mainstem dams. This monumental project will provide over 420 miles of reconnected habitat, improved water quality conditions, a reduction in blooms of toxic blue-green algae and disease and is expected to increase commercial and sport fisheries while producing positive effects on traditional tribal ceremonial and fishing practices.

This session will highlight the current state of dam removal, science and monitoring, future restoration needs, and what lies ahead following implementation of the largest river restoration project in the country.

Planning and Implementation for the Removal of the Four Dam Complex of the Lower Klamath Project

Mort McMillen, Executive Vice-President McMillen Inc. (Presenter),
and Co-author: Mark Bransom, Chief Executive Officer, Klamath River Renewal Corporation

The Lower Klamath Project consists of four hydroelectric developments on the Klamath River, located in the western United States. The restoration of the Klamath watershed, spanning 15,000 square miles of California and Oregon, is the largest dam removal project in history, opening more than 400 miles of habitat. In September of 2016, the Klamath River Renewal Corporation (Renewal Corporation) filed an Application for Surrender of License for Major Project and Removal of Project Works (License Surrender). The Renewal Corporation filed the License Surrender Application as the dam removal entity for the purpose of implementation of the Klamath River Hydroelectric Settlement (KHSA). In November 2020, the Renewal Corporation filed its Definite Decommissioning Plan (DDP), which is the comprehensive plan to physically remove the Lower Klamath Project and achieve a free-flowing condition and volitional fish passage, site remediation and restoration, and avoidance of downstream impacts. Renewal Corporation received the Licensure Surrender in November 2022 approving facility removal and habitat restoration. The Proposed Action consists of the deconstruction of J.C. Boyle

Dam/ Powerhouse located in Oregon, and Copco No. 1 Dam/ Powerhouse, Copco No. 2 Dam/ Powerhouse, and Iron Gate Dam/ Powerhouse, all located in northern California. This paper discusses the planning effort and strategy developed and implemented to execute the project, including the organization structure of the Renewal Corporation designed to efficiently execute a multi-discipline engineering and construction project, challenges, and strategy to work through a vast regulatory process, and execution of a progressive design-build contract to meet set project budgets and schedule.

Klamath Dam Removal —Meeting the Moment and Planning for the Future

Klamath Dam Removal—Restoration Update

Dave Coffman, PG., Director, Northern California and Southern Oregon RES

Drawdown of the reservoirs behind the three remaining Lower Klamath Project dams (Iron Gate, Copco No. 1, and J.C. Boyle) in Northern California and Southern Oregon began the first week of January 2024. By the time of this presentation, the initial drawdown will have been underway for nearly three months. RES and their local and tribal subcontractors, working alongside the Klamath River Renewal Corporation (KRRC), will likewise be nearly three months into the restoration of those former reservoir footprints. Specific restoration activities to date will have included assisted sediment evacuation, initial revegetation (seeding, bare root, and container plants), water quality monitoring, fisheries monitoring, and sediment export monitoring. This presentation will provide a visual overview of drawdown-year restoration activities and a discussion of planned activities for the duration of the drawdown year (2024) and into the restoration construction year (2025).

Researching What "Water Quality" Means as it Relates to the Future of the Klamath River with Dam Removal

Brook M Thompson, Yurok Tribal Member, Ph.D. Student, Environmental Studies, University of California Santa Cruz (Presenter); and Co-authors: Desiree Tullos, Biological & Ecological Engineering; and Bryan Tilt, Professor of Anthropology, Oregon State University

Learn about current research being done in partnership with the Yurok Tribe and Oregon State University on what "Good Water Quality'' means to different groups on the Klamath River when it comes to algae, salmon, parasites, nutrients, sediments, and more through an interdisciplinary team integrating science and social understanding of what it means to have a healthy river post dam removal. We are a group of scientists and engineers with the goals of building partnerships, advancing science, providing educational experiences, documenting and comparing western and indigenous knowledge, and supporting equitable decisions in a post-dam removal Klamath. After over two decades of advocacy and planning, the four hydroelectric facilities on the Klamath River are being removed in 2023-2024. Some significant improvements to the river are expected. The presence and impacts of Harmful Algal Blooms (HABs) will be reduced. Native salmon and lamprey will have access to a nearly two-fold increase in accessible habitat area. Other responses to the changing river are less certain, such as how post-dam water quality and flow management impact the health of the food web, or how decision processes influencing river health intersect across different cultures. As the basin moves beyond dam removal, this project aims to provide a forum where diverse perspectives on water quality and river health can be represented in making management decisions. A major theme of this project is evaluating the different ways people who know the river understand its health. We are thus engaging multiple groups in the basin as participants in this project, with the Yurok Tribe as full partners. The Yurok traditional homelands are at the mouth of the Klamath River and their economic livelihood and cultural identity have been closely associated with riverine and nearshore fisheries. The Tribe is both steering project direction and represents one of the ways of knowing we will document. Other groups whose understanding of river health will be surveyed include recreational outfitters, multi-generational water users, fishers, and conservationists.

A Release Study Assessing the Survival of Juvenile Spring-Run Chinook Salmon in the Upper Klamath River Basin to Inform Reintroduction

Rachelle Tallman, Ph.D. Candidate, University California, Davis (Presenter); and Co-authors: Mark Hereford, Klamath Anadromous Fish Biologist/Reintroduction Coordinator, Oregon Department of Fish and Wildlife (ODFW); Tommy Williams, Ph.D., Research Fisheries Biologist, NOAA Southwest Fisheries Science Center; Bob Pagliuco, Marine Habitat Resource Specialist, NOAA Fisheries; Shahnie Rich, Restoration Biologist, The Klamath Tribes; Robert Lusardi, Ph.D., Adjunct Professor; and Andrew Rypel, Ph.D., Professor, UC Davis Center for Watershed Sciences

Four hydroelectric dams on the Klamath River are slated for drawdown by 2024; however, two dams will remain: Link River and Keno Dams. This historic dam removal will restore hundreds of miles of anadromous fish passage, but it remains unclear whether native fishes will recover post-dam removal. The Oregon Department of Fish and Wildlife (ODFW), The Klamath Tribes (TKT), and the NOAA-Southwest Fisheries Science Center (NOAA-SWFSC) plan to actively reintroduce pathogen-screened spring-run Chinook salmon into suitable habitats within tributaries of Upper Klamath Lake. The goal of this reintroduction is to reestablish self-sustaining populations of spring-run in the upper basin. It has been over 100 years since spring-run have accessed the upper basin, and there is uncertainty surrounding the fishes' ability to survive and breed within this heavily altered habitat. Reintroduced spring-run would need to migrate through the hypereutrophic conditions of Upper Klamath Lake (UKL) and over two dams as part of their out-migration to the ocean. There is interest to assess their survival prior to an official reintroduction effort. During the spring of 2022, we released juvenile spring-run from the Klamath Fish Hatchery into the Wood and Williamson Rivers to evaluate juvenile salmon survival to the entry of UKL, through UKL, and Link River Dam. This study will provide crucial data that ODFW, TKT, and NOAA to design an optimal reintroduction program to support a self-sustaining population of spring-run Chinook in the upper basin.

The Klamath Basin Fisheries Collaborative: Science and Collaboration across a Newly Connected Basin

Summer Burdick, United States Geological Survey (Presenter);
and Co-authors: Betsy Stapleton, Scott River Watershed Council;
Jacob Krause, United States Geological Survey;
and Nancy Leonard, Pacific States Marine Fisheries Council (PSMFC)

The Klamath Basin Fisheries Collaborative (KBFC) works with over 30 entities to efficiently share Passive Inductive Transponder (PIT) tag data gathered by collaborators. Collaborators share their project-specific data with the KBFC database that is accessible using a web interface and web services. This collaborative database is a powerful tool for understanding the effects of dam removal on imperiled migratory species. The KBFC's culture of mutual trust among entities, which is essential for data sharing and collaboration, was built by: 1) writing a data sharing agreement, 2) drafting a charter that outlines working principles, 3) forming a leadership team, and 4) holding annual meetings. We will review examples of how shared data are used to understand fish movement prior to dam removal. Then we will discuss plans for using shared PIT tag data to address short-term and long-term responses of migratory salmonids to dam removal in the Klamath Basin.

Evaluating the Effectiveness of Dam Removal on the Klamath River Using SONAR and Radio Telemetry

Damon H. Goodman, California Trout (Presenter); and Co-authors: Bob Pagliuco, NOAA Fisheries; Toz Soto and Alex Corum, Karuk Tribe; Oshun O'Rourke, Yurok Tribe; Kurt Bainbridge and Crystal Robinson, California Department of Fish and Wildlife (CDFW); Mark Hereford, ODFW; Keith Denton, Keith Denton and Associates; Nicholas A. Som, USGS California Cooperative Fish and Wildlife Research Unit, California Polytechnic University Humboldt; Cyril Michel, UC Santa Cruz, NOAA Fisheries; and Thomas Williams, Ph.D., Fisheries Ecology Division, Southwest Fisheries Science Center, National Marine Fisheries Service

The removal of four dams on the Klamath River will restore hydrologic connectivity to the Upper Klamath River Basin. For anadromous fish, habitat and ecological processes not available for over 100 years will be accessible. Traditional ecological knowledge, as well as historical accounts, provide us some general understanding of the historical movement patterns and distribution of anadromous fish, although greater understanding is required to inform future restoration and fish management actions. For this reason, monitoring plans focused on evaluating the re-establishment of salmon populations as they return to their historical range in the Klamath Basin is critical. Of particular interest is how many salmon and steelhead disperse into the reconnected watershed and the timing of that dispersal. The questions of interest include what are the species and life-history-specific timing of fish movement into the restoration reach (i.e., location of Iron Gate Dam and upstream throughout the upper Klamath Basin) and habitat used by fish as they move through the restoration site. This project will result in abundance estimates of salmon and steelhead entering the reach previously blocked by the dams and follow their migrations to spawning grounds. Understanding the time of movement and habitat use of adult fish moving upstream to historical habitat will inform current and future restoration actions to effectively use available funds in the most impactful manner, guiding future restoration efforts in the newly accessible habitats. In addition, these data will provide a foundation for assessing key Endangered Species Act viability criteria such as diversity, spatial structure, and abundance. Our study combines a SONAR fish counting station, species composition sampling, and radio telemetry with study designs adapted from the Elwha River and other large-scale dam removals. This effort will be guided by the expertise of Tribal members, NGO staff, and federal and state agency staffs that have implemented monitoring on the Elwha River or other coastal rivers throughout the Western United States. The project will provide a toolset to support information to inform the sequencing and prioritization of future restoration and monitoring in the Klamath River as well as other dam removals around the world.

We will address these objectives with a combination of multi-beam imaging SONAR and radio telemetry. SONAR imagery will provide imagery of passing fish on a continuous basis, while weekly instream tangle net sampling in the vicinity of the SONAR site will provide field-based data to transform imagery into species-specific passage estimates. The tangle net sampling will also provide fish for radio telemetry tagging. Monitoring of radio-tagged fish with fixed sites and mobile tracking will provide detailed information on movement and habitat use as adult salmon and steelhead migrate and spawn in the newly accessible habitat and the environmental variables that affect their migration.

Klamath Dam Removal and The Future of Dam Removal in California: 4 Down, 150 to Go

Ann Willis, Ph.D., California Regional Director, American Rivers (Presenter);
and Co-authors: Meghan Quinn, Esq, California Dam Removal Program Director, American Rivers;
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and Serena McClain, Senior Director, River Restoration and Dam Removal Program, American Rivers

The Klamath River dam removal project highlights the complexity and impact of removing a series of large dams from a single river. However, the removal of Iron Gate, Copco 1 & 2, and JC Boyle dams is widely acknowledged to be the first step in the broader Klamath recovery. A wide range of restoration projects are underway throughout the watershed, varying in treatment, scale, and approach. But what about the future of dam removal in the watershed?

American Rivers plans to remove 30,000 obsolete dams from waterways throughout the United States by 2050, with approximately 2,000 occurring in California. California staff are currently evaluating and identifying small, priority dam removal projects based on ecological benefits, climate change resilience, and environmental justice considerations. In parallel with the University of California, Berkeley, which assigns a priority removal ranking to large dams (listed in the National Inventory of Dams [NID]) based on ecological considerations, the output of these two efforts will form the basis for a list of 150 top priority dam removal projects. Preliminary results indicate that 102 small dams and/or barriers remain in the lower Klamath watershed (i.e., in California) and that several of these barriers rank in the top 150 statewide priority removal sites.

American Rivers will present its Active 150 tool and its application to California and the lower Klamath watershed, which identifies potential dam removal projects that are a priority for removal and ready for feasibility work, advancing projects to the fundraising and shovel-ready state. The California Active 150 list combines data from the California Fish Passage Forum, statewide prioritization lists, and other datasets to build a comprehensive assessment of priority dam removal projects and their likelihood of progressing to removal through parameters such as barrier uses and landowner cooperation. The outcome of this project is to provide a living project list that details ecologically beneficial opportunities on which dam removal practitioners can partner, furthering the river-driven recovery of the Klamath watershed.

Aquatic Ecology, Disturbance, and Floodplains

Session Coordinator: *JD Wikert, U.S. Fish and Wildlife Service*

This session demonstrates a wide breadth of knowledge around ecology, hydrology, geomorphology, modeling, predation, restoration, planning, coordination, outreach, and regulation that are all part of successful management of salmonid populations. If you want to know more about more, this is the session for you.

Timing of Periphyton Scour and Recovery for Food Web Dynamics in a Mediterranean System

Eric Peterson, Trinity River Restoration Program, Bureau of Reclamation (Presenter)
and Co-authors: Chris Laskodi, Trinity River Restoration Program, Yurok Tribal Fisheries;
Ben King, Cal Poly Humboldt; and Ken Lindke, Trinity River Restoration Program, CDFW

The Trinity River in northern California has been at the forefront of river restoration for decades. Impairment began in 1960 as Trinity Dam began to regulate flows to fill a 3 km^3 (2.4 million-acre feet [MAF]) reservoir and (beginning 1964) to divert up to 90% of the river's water out of basin to the Central Valley. Even before the diversions began, concerns were raised about sand deposition on river riffles. Over the decades more water has been allowed to flow past the dam for water temperature/ fish health and a suite of flow-related studies culminated in the establishment of annual restoration flow releases beginning around 2001. The fundamental understanding was that restoration of the river required geomorphic pulse flows that could move gravels of sufficient size to refresh spawning beds and scour young *Salix spp.* (willows). To accommodate continuation of diversions, elevated releases were limited to late-spring and summer after the reservoir inflow was known. Therefore, the Trinity River now has geomorphic flows, but in late spring, not in winter when Mediterranean systems typically experience peak flows.

The smolt-to-spawner ratio in the Trinity River increased with the onset of restoration flows, but the out-migrating juveniles are slightly smaller, which may be related to a lack of corresponding increase in adult populations. The Trinity River Restoration Program is investigating potential issues with water temperatures for growth and with instream food webs. Primary production has been monitored via photo monitoring of periphyton at approximately two-month intervals for nearly four years. Due to drought, only minor geomorphic disturbances were monitored until 2023 when multiple disturbance events during winter and spring, with varying spatial extents, demonstrated the scouring of periphyton from the riverbed and regrowth over subsequent months. Development of periphyton on floodplains was also documented. Scrub samples of periphyton for documenting community composition have noted frequent presence of *Chironomidae* and other invertebrates that are excellent food resources for juvenile salmonids. Although the periphyton study did not quantify presence of benthic macroinvertebrates (BMI), sampling of BMI in a separate study corroborates the development of food webs for juvenile salmonids (particularly *Chironomidae*) following either disturbance or wetting of floodplains simultaneous with periphyton growth.

Implications of this study are that geomorphic flows provide disturbance events that scour periphyton from riverbeds and that regrowth occurs over the subsequent weeks to months. Unregulated Mediterranean stream and river systems experience geomorphic events primarily in winter such that regrowth of periphyton (and hosted BMI) occurs in concert with juvenile salmonid food demand. Withholding of geomorphic flows on the Trinity River below the dam until late spring may deplete autochthonous resources when juvenile salmonid populations and their demand for food are peaking. Revision of flow management to enable geomorphic restoration flows in winter should enable periphyton community development that supports BMI populations as juvenile salmonid food demands increase, thus promoting fish growth and increasing the potential for rebuilding salmonid populations.

Effects of Scour and Marginal Habitat Inundation of Trinity River Invertebrate Communities

Ben King, Cal Poly Humboldt (Presenter);
and Co-authors: Alison O'Dowd, Professor and Department chair, Environmental Science and Management, California Polytechnic University;
and Chris Laskodi, Trinity River Restoration Program, Yurok Tribal Fisheries Program

The Trinity River in northern California has a long history of anthropological alterations to its physical processes. Hydraulic mining transferred large amounts of sediment from hillsides into the stream channel, dramatically altering channel morphology and fish habitats. In addition to mining impacts, the Bureau of Reclamation began the Trinity River Division (TRD) of the Central Valley Project (CVP) in 1959. This began a period of extensive water diversions from the Trinity River to the central valley that diverted up to 90% of the Trinity River water. Today, more water remains in the river, however negative impacts persist. Regulated flow releases have shifted the timing and magnitude of high flows on the Trinity River 2-4 months later, from winter to late spring. Studies on other river systems have demonstrated the importance of bed scour in "resetting" benthic macroinvertebrate (BMI) communities that reduce invulnerable prey taxa and promote more available prey taxa for juvenile salmonids. Furthermore, high flows result in the inundation of marginal habitats, which provides opportunities for fast-growing BMI prey taxa to colonize.

The winter of 2023 had significant hydrological variability as a result of natural rain events and a winter variable flow period that was implemented on the Trinity River for restoration purposes. This period consisted of a few high-magnitude peak flow events, as well as elevated base flows throughout. This provided the opportunity to study the relationship between scour and marginal habitat inundation on BMI biomass, particularly taxa that constitute important juvenile salmonid food (i.e., *chironomids, ephemeropterans*). Following scour events, total BMI biomass declined sharply at all sampling sites and slowly recovered over time. Increasing inundation durations of marginal habitats resulted in a dramatic increase in biomass and abundance of juvenile salmonid BMI food taxa, particularly chironomids. The magnitude of this pattern was most substantial at the site nearest Lewiston Dam, which also boasts the highest spawning density of Chinook salmon and represents a high-traffic area for out-migrating juveniles. These results support the hypothesis that the timing of hydrological peaks and elevated base flows plays an important role in the availability of juvenile salmonid food resources.

The implications of this study are that high-flow events can act as a '"reset" button for BMI communities. As such, it may be important for this reset to occur prior to the critical growth period for juvenile salmonids. Elevated winter base flows inundate marginal habitat and can provide substantial food resources for juvenile salmonids in areas already providing suitable physical habitat for rearing (low velocity, presence of cover). Hydrographs that do not provide these events (such as regulated hydrographs prior to this) may have resulted in depressed food availability, relative to a more natural hydrograph. Hydrographs designed with process-based restoration in mind have the potential to enhance juvenile salmonid food availability that can result in more successful juvenile salmonid outmigration and stronger adult returns in the future.

O. mykiss Resilience, a Remarkable Example within the Lower Santa Ynez River Basin Santa Barbara County, CA

Timothy Robinson, Ph.D., Fisheries Division Manager, Cachuma Operation and Maintenance Board (Presenter), and Co-authors: Scott B. Engblom, Project Biologist, and Scott J. Volan, Project Biologist, Cachuma Operation and Maintenance Board

Water Year 2023 yielded significant stormflow throughout the wet season within the Santa Ynez River basin in southern Santa Barbara County. It was the seventh wettest year but the second largest inflow year to Lake Cachuma over the 71-year record due to multiple atmospheric rivers impacting the region. The first large storm of the year occurred on 1/9/23, resulting in the second-highest daily inflow recorded and the largest single-day lake level increase (32 feet). Before the storm season, the sediment deltas in the lake were exposed due to drought conditions and low lake levels. The high inflow mobilized sediment from the exposed lakebed and transported sediment from the watershed, which was likely partially sourced from banked sediment in the tributary floodplains following past large-scale fire events (Zaca Fire 2007, Whittier Fire 2017, and Thomas Fire 2017). The rapid input of sediment to the lake resulted in a density current (turbidite) of thick fine sediments that translated across the bottom of the lake to the Lower Santa Ynez River (LSYR) and lower Hilton Creek below. The high sediment load (essentially mud) released downstream impacted the fishery for many miles, depositing fine sediments up to and over one foot deep in some locations. The thick suspended sediment in the water column resulted in poor water quality conditions, specifically very low dissolved oxygen concentrations and widespread fish mortality of rainbow trout (*Oncorhynchus mykiss—O. mykiss*), largemouth bass (*Micropterus salmoides*), sunfish species (*Lepomis cyanellus, microlophus + macrochirus)*, black bullhead catfish (*Ameriurus melas)*, channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), etc. Speculation suggests that some *O. mykiss* escaped perilous conditions by seeking refuge in habitats with inflowing tributary streamflow that had better water quality conditions or going up into tributaries with sufficient discharge for upstream passage. The next large storm on 2/25/23 filled and spilled the reservoir resulting in high streamflow that washed out much of the deposited fine sediments and diluted the high turbidity from the bottom of the lake that allowed the remaining O. mykiss to successfully spawn, sustain the population, and increase the overall population within the LSYR basin. Evidence of spawning was observed in areas never seen before. What started as a tragic situation ended as one of the better reproduction years since programmatic monitoring began in the mid-1990s. Specific examples will be presented that demonstrate the remarkable resilience of *O. mykiss* within the LSYR basin and as a species in general. The Santa Ynez River is part of the Monte Arido Highlands Biogeographic Population Group and is a National Marine Fisheries Service-designated Core 1 watershed with critical habitat for the recovery of the endangered Southern California steelhead (*O. mykiss*).

A Vision for Enhancing and Managing the Lower Stanislaus River for Fish, Wildlife, and People

JD Wikert, U.S. Fish and Wildlife Service and Rocko Brown, Cramer Fish Sciences (Co-presenters)

We implemented a floodplain and side-channel restoration project in 2012 on the Stanislaus River. The project goals were to reduce stranding of adult salmonids in the existing side channel and to convert perched floodplain into annually inundated habitat for rearing juvenile salmonids. A multi-year drought and beaver herbivory hampered revegetation success above the floodplain, while the floodplain facilitated natural recruitment of native vegetation. Regulatory design constraints (elderberry setbacks) resulted in a more dynamic floodplain evolution but also reduced the opportunity for additional floodplain creation (concerns over water surface elevation increases). Gravel mobilization in the main channel has reduced flows to the side channel under low-flow conditions. Maintenance of projects, especially gravel augmentation projects, is essential in watersheds without a suitable bedload of mobilized sediments upstream of the project site. Designing for diversity and evolution of the project as well as periodic evaluation and maintenance are highly desirable in river restoration.

Fish-Friendly Farms and Floodplains

Jarrad Fisher, San Mateo Resource Conservation District (Presenter),
and Co-authors: Erik Stromberg, PLA, CERP Principal Landscape Architect
and Matt Thomas, PE, CFM Principal Civil & Hydraulic Engineer, Restoration Design Group Inc.

The Butano Creek Backfield Floodplain and Streamflow Enhancement Project restored floodplain and improved flow enhancement components, both of which have direct and indirect benefits to instream and adjacent floodplain and terrestrial habitats.

The project resulted in over 5 acres of reconnected floodplain with 4.2 acres of Stage 8 floodplain and 1 acre of gently sloped, stage-resilient riparian habitat. This was accomplished by lowering the historic floodplain surface by as much as 9 feet and installing multiple different types of roughness elements in the adjacent stream reaches, ensuring the stream accesses the new floodplain during winter base flows and that the floodplain is inundated for significant time during most winters. This improved connection will also increase the stream's access to an additional 100 acres of historic floodplain, providing access 2.5 times as frequently as current conditions allow and offering low-velocity aquatic habitat for juvenile Coho salmon and steelhead. More frequent inundation of Butano Creek's floodplain environment will also enhance adjacent wetlands and is expected to benefit special-status reptiles and amphibians.

The project design also included the placement of 15 to 20 habitat structures (roughness elements) within the newly created floodplain surface and added in-channel habitat features, including one engineered logjam and several post-assisted log structures/ living riffles. Additionally, the native vegetation that was removed during floodplain grading was reused in planting, except for senescent alders which were used to add roughness in select bank and floodplain areas. Together, these features increased habitat complexity and are expected to disperse energy during high flows, help reverse channel incision, and restore geomorphic processes such as aggradation and floodplain storage of sediment.

In addition to floodplain and habitat restoration, this project improved the agricultural viability of the field at the site. In creating the floodplain, fill was removed from the existing farm field which regularly flooded. That fill was used to raise the elevation of a smaller portion of the farm field, so that it will flood less and will be more productive for the farmer.

The project's second objective is to increase dry-season (June-October) flows in Butano Creek during Phase 2 of construction in summer 2024. Restoring flow during this critical window and meeting the farm's existing irrigation needs requires a substantial change in water diversion practices, from the present regime, which relies on dry-season withdrawals, to one requiring wet-season withdrawals only by improving water storage for subsequent dry-season irrigation. With the implementation of the project, dry-season diversions will no longer occur.

The project will facilitate this transition by expanding capacity at an existing off-channel storage pond, from 5.2 to 16 acre-feet and establishing a forbearance agreement that institutes this new regime. The project will reduce instantaneous diversion rates by 0.22 cubic feet per second from April to May and 0.51 cubic feet per second from June to October, returning an estimated 2 acre-feet of water to the stream each month and increasing dry-season flows by 124 percent. The flow benefits resulting from the Project will be realized all the way to the stream's terminus at Pescadero Marsh.

Wildfire and the Recovery of Southern California Steelhead

Mark Capelli, National Marine Fisheries Service (NMFS)

In 2012, NMFS published a Southern California Steelhead Recovery Plan to guide the recovery of this federally listed endangered species. Southern California steelhead occupy wildfire-prone watersheds from the Santa Maria River in Santa Barbara County to the Tijuana River at the U.S.-Mexico Border. This landscape is characterized by a Mediterranean climate, tectonically active and highly erosive soils, and a fire-dependent chaparral/ coastal shrub-dominated plant community. These features create an unstable landscape to which steelhead have adapted over evolutionary time.

The effects of wildfires are diverse and complicated and can be both beneficial and deleterious to steelhead and steelhead habitats (e.g., promoting a temporary increase in base flows and spawning gravel recruitment, but accelerating fine sedimentation of pool habitat). Adverse effects on aquatic habitats can be pronounced in tectonically active and semiarid environments such as southern California. Even small wildfires can have a widespread effect on stream habitats, due to sediment-transport processes, though only the most extensive wildfire burn areas with the potential to trigger a catastrophic debris flow have the potential to extirpate steelhead from an entire watershed. These disturbance events have become more frequent, intense, and extensive as a result of climate change and the increased wildland/urban human interface with chaparral/coastal shrub and forested lands, including the 4 U.S. National Forests in southern California.

Some of the more significant adverse wildfire effects to steelhead habitats include: (1) increases in slope erosion and sedimentation of water courses (including pools and riffles) leading to loss of spawning, rearing, and refugia habitat; (2) modification of run-off patterns (including higher peak flows, but also in some cases sustained base flows because of reduced evapotranspiration); (3) changes in the water temperature regime as a result of both reduction or loss of riparian vegetation (including higher water temperatures and reduced dissolved oxygen levels); (4) alteration of nutrient transport and loading within watercourses (affecting both instream vegetative growth and invertebrate production); (5) spread of non-native, invasive vegetation (which may affect both evapotranspiration rates and invertebrate production important to rearing juvenile steelhead); and (6) firefighting techniques, such as the use of fire retardants and physical modifications of the landscape to create temporary or permanent fire breaks.

Wildfires followed by prolonged droughts coupled with small magnitude storms, can compound the adverse effects of wildfire. Post-fire dry gravel processes continually deliver fine sediments to stream channels that degrade steelhead habitats. Small storms with limited capacity to move this sediment through the stream channel network, and flush accumulated sediments from pool, spawning, and riffle habitats, can prolong the re-establishment of habitats conditions which are suitable for steelhead spawning, rearing, and over-summering refugia.

Wildfire, with its potential post-fire geomorphic disturbances now plays an outsized role in the life-history of this species. NMFS's recovery plan adopted a recovery strategy of population redundancy and spatial distribution (and natural recolonization) to ensure the long-term viability of southern California steelhead. This strategy is aimed to maximize the potential for the recovery and persistence of southern California steelhead by expressly taking into account the ecological and evolutionary role of wildfires.

Lightning Tales: Sharing Stories of Inspiration and Hope

Thursday Afternoon Concurrent Sessions

Session Coordinators: *Eli Asarian, Riverbend Sciences, and Sarah Phillips, Marin Resource Conservation District Description*

This session will feature "lightning" (5 minutes or less) talks in which presenters share nuggets of hope and inspiration. On this heating planet, a career in ecological restoration is bound to have discouraging moments. In 1949, Aldo Leopold wrote "One of the penalties of an ecological education is that one lives alone in a world of wounds." However, given the current widespread understanding of global environmental degradation, you are no longer actually alone even if it sometimes feels like it. In addition, despite daunting challenges, all hope is not lost. Against all odds, the fish are still here. The world is still wondrous and beautiful. New generations are bringing diverse perspectives and re-envisioning the future. Come share your story! Here are some thought-provoking questions to help your brain start flowing:

- What motivates you to keep going?
- Who has had the greatest impact on you and why?
- What do you know now that you wish someone had told you years or decades ago?
- What is your favorite book/article/lecture/quote, and how does it guide and/or inspire you?
- What have you found to be a hidden gem that needs more time in the limelight?

Share a distilled and focused insight with the SRF community. Weave your philosophical musings and heart-stirring experiences. We welcome any and all to share their gems of wisdom that have carried them through the days, months, years, or decades. Be brave. Whether this is your first conference or you're an old-timer, we want to hear from anyone who is willing to step up and inspire our restoration community. We aspire for people to leave this session feeling replenished, motivated, energized, and connected. A similar session in 2022 was well-received, so by popular demand, we are convening a new round!

The Future of Restoration is Bright

Alison O'Dowd, Ph.D., Department of Environmental Science & Management, Cal Poly Humboldt

What motivates me to keep going in a world of wounds? The amazing people doing the work of restoration and those learning how to do restoration in the future keep me inspired. As a professor at Cal Poly Humboldt, I have the privilege and honor to teach the next generation of restoration ecologists. From the moment an incoming freshman enters our program they can be part of a place-based learning community called 'Klamath Connection' that allows them to learn about and connect to our local ecosystems. Our program concentration in Ecological Restoration gives students opportunities to see restoration in action and learn about restoration planning, implementation, and monitoring. The Cal Poly Humboldt Natural Resources Club volunteers with local restoration events every weekend. Students can take a 2-week summer field course about restoration throughout the Klamath Basin. It is incredible to watch students go from wide-eyed first-year students to graduating seniors who have passion, knowledge, and connections to launch them into the field of restoration.

Listening to the River with Youth

Shannon Wedgley, Scott River Watershed Council

Leading the Scott River Watershed Council 2023 Youth Environmental Summer Studies (YESS) program inspired me by the willingness of high school-aged youth to work hard and learn about the natural world. I will share the inspiration and enthusiasm of the diverse group of youth I had the privilege to mentor over the summer of 2024 as they met their peers from across the Klamath Basin and pushed the limits of their known world in an environment virtually free of electronic stimulation.

A Watershed Runs Through You—Wisdom from Freeman House

Cassie Pinnell, Vollmar Natural Lands Consulting

'A Watershed Runs Through You' is a recently published posthumous collection of essays, talks, and reflections on salmon, restoration, and community by Freeman House, and edited by Jerry Martien. "Freeman House was a social activist and commercial fisherman turned watershed restorationist who co-founded the Mattole Restoration Council and Mattole Salmon Group on the Mattole and Sinkyone ancestral lands of Northern California. He passed away in 2018 at the age of eighty, leaving a tremendous legacy of bioregional awareness and community-based environmental organizing through his decades' worth of writings and the organizations that uphold his visions to this day". Cassie Pinnell had the wonderful fortune of spending time with Freeman as a member of the Mattole community and serving as a board member with him on the Mattole Restoration Council board before serving a stint as the Executive Director of the MRC. With the blessing of Freeman's family, Cassie will read a short excerpt of Freeman's words of inspiration and hope.

Sapiens, Braiding Sweetgrass, and Re-Envisioning Humanity's Role on Planet Earth

Eli Asarian, Riverbend Sciences

This talk blends lessons from two wondrous books. In *Sapiens: A Brief History of Humankind*, Israeli historian Yuval Noah Harari explains that human beings became so successful because we are the only species that can collaborate flexibly in extremely large numbers. Chimpanzees collaborate flexibly, but only in small numbers; ants collaborate in large numbers, but only rigidly. Our unique ability is founded on the development of language, enabling belief in shared imagined realities. While appearing superficially real, the structures that control our lives (e.g., culture, religion, governments, and money) are in fact invented fictions—and can therefore evolve and change. In *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants*, Native American botanist Robin Wall Kimmerer highlights the power of cultural origin stories in determining how we see our role in the world. She contrasts the Bible's Genesis origin story (Adam, Eve, and the Garden of Eden) with her peoples' origin story of Turtle Island, where humans are not only integrally part of nature but are a key source of the world's productivity and diversity, and our purpose is to tend to that fertility. From this perspective, we need to not only do the physical work of restoring salmon habitat and rehydrating our watersheds, but also to evolve our stories about the purpose of human beings. Can we re-envision humans as a positive ecological force? As Bill Tripp of the Karuk Tribe says, a lot of time is spent focusing on ecosystem services (i.e., what nature provides to humans)—but what about human services to ecosystems?

Recovery:
the Common Ground Between Coho Salmon and Major Depressive Disorder

Elizabeth Ruiz, California Department of Fish and Wildlife

What do major depressive disorder and Coho salmon have in common? The answer is recovery- a structured, meaningful, and intentional movement toward goals of healing and restoration. There is no magical turning point for major depressive disorder, and there will likely be no magical turning point for Coho salmon recovery. Instead, it takes methodical, persistent work and a present, supportive community. From personal experience, I will share how I learned to persist through the ups and downs of depression and anxiety, and the realization that this journey is mirrored in the work we all do for our salmon and steelhead.

Help the Fish *and* Help the People

Julie Weeder, NOAA Fisheries

Looking back on my 20 years in the restoration field, I realize some deep truths have gradually become apparent to me. For much of my career, I've been frustrated and impatient about landowners who weren't on board with restoration happening on their land. Why were they so difficult? Didn't they see how important this was for the fish? Putting myself in the shoes of a landowner, and assuming positive intent, has helped me change my perspective. I would definitely want to help fish, but I'd also need to still make a living from my land. Solutions that address the landowners' needs in addition to making gains for aquatic habitat are objectively those that result in durable change. It's important to ask landowners what is important to them and understand what problems they are having, and factor that information into crafting a solution that helps the fish *and* helps the people. It can be done!

Lessons from Tyson Yunkaporta's Aunties

Mary Power, Ph.D., Professor of the Graduate School of Integrative Biology, UC Berkeley, and Faculty Director, UC Berkeley, Angelo Coast Range Reserve

In Sand Talk[1], Tyson Yunkaporta yarns with his Aboriginal aunties on a road trip across Australia. One aunty describes an Aboriginal approaching The Other (another human, a plant, animal, or landform): "First, we respect (with careful attention); then we connect (spend time with, communicate); then reflect (on what we've learned); then, if needed, we direct (some action, if helpful). "White people", she said, "do the same four things, but in the reverse order."

Our "just get under the hood and fix it" attitude in restoration merits reflection. Channel restorations may prove useless or worse if done with too little attention to water, heat, sediment budgets, or natural history. Curiosity-driven science probing for causation in ecosystems inspires 'respect,' and sometimes awe, for nature. If we respected, then connected with an ecosystem and reflected on what we and others have learned, we might avoid mistakes like introducing pikeminnow into Lake Pillsbury.

1 Yunkaporta, Tyson. 2020. Sand Talk. How Indigenous thinking can save the world. Harper Collins Publishers, NY.

Hitch Magic: How the Universe Conspires to Support Great Work

Kevin Swift, Swift Water Design

Every restoration project is guaranteed to have obstacles, heartbreak, and loss built in. So how do we keep moving forward, finding hope, and laughing (later) at the gruesome Type 2 fun of restoration? In our crew, we depend on what's been named "Hitch Magic"—synchronicity, the kindness of strangers, perfect accidental timing, and other impossible things that happen all the time. I'll offer a couple stories of, and a strategy for actually creating, your own Hitch Magic.

Everything but the Kitchen Sink Approach to Keeping Your Batteries Charged: One Fish Biologist's Perspective on Inspiration & Lessons Learned

Sarah Beesley, MS, Yurok Tribe Fisheries Department

I recently hit the half-century mark and have been worrying and caring for the earth and all the critters since the start. Over the past 20 years working as a fish biologist for the Yurok Tribe I've employed a bazillion different ways to stay inspired and keep my batteries charged: some no brainer go to / fail-safe methods and other maybe more questionable, perhaps silly measures. My time spent fighting to save salmon, support Yurok cultural lifeways, and a sustainable life has been amazing and filled with tremendous highs and catastrophic lows. I will share some of these experiences with the hope that it may help others stay inspired and effective as eco-warriors.

River Ecologist: Profession or Disease?

Bill Trush, Cal Poly Humboldt, River Institute

It's not a job. It's not a career. It is a life-long adventure. First, accept Charles Bukowski's challenge (in moderation): "Find what you love, then let it kill you." Next, you'll need to embrace, if not seriously consider, these actions / attitudes / realities each summarized by a notable quote: (a) "A man ceases to be a beginner in any given science and becomes a master in that science when he has learned that . . . he is going to be a beginner all his life."—R. G. Collingwood, *The New Leviathan* (1942), (b) To enjoy (def.): "To love something for its own sake and for no other reason" (*Leonardo Da Vinci Fieldbook No.2*), and (c) "Simplicity is the ultimate sophistication."—Leonardo Da Vinci. An incredible life-long experience will be sharing your adventure with others, thus accomplishing life's meaning and purpose: "The meaning of life is to find your gift. The purpose of life is to give your gift away."—Pablo Picasso. And ending on a practical note, as an expert witness during a federal hearing, never ever answer with "I said what I meant and I meant what I said."—Dr Seuss. But it was fun.

Close Encounters of the Coho Kind

Jonathan Warmerdam, North Coast Regional Water Quality Control Board

A short story reflecting on the transformative effects that a close encounter with juvenile salmon can have on an individual, a community, and a watershed as a whole.

Proof of Concept

Erik Stromberg, PLA, CERP, *Restoration Design Group, Inc.*

18 years of experience working in urban streams captured in a single observation. How the Channel Evolution Model in action, and good timing, brought rapid change to one project before we even started. A reminder of the power of streams.

A Lightning Lightning Tale

Karen Pope, Ph.D., USDA Forest Service, Pacific Southwest Research Station

Aquatic ecologists and fish biologists tend to be wary of lightning. Early in my career I experienced the power of an electrical storm and ever since have used my story as a cautionary tale. I will share my experience on Castle Peak in Tuolumne Meadow and share some practical advice when deciding whether and when to stay or go.

Fire, Floods, & Finding Hope: The Hulsman Ranch Story

Garrett Costello, Symbiotic Restoration

The Hulsman Ranch story centers around a California meadow struggling with channel incision. Partnering with NRCS and a multi-generational landowner, plans included constructing post-assisted log structures (PALS) and beaver dam analogues (BDAS0 to drive sediment capture, promote floodplain connectivity, and help establish strong riparian vegetation. Before implementation, the Sheep Fire swept through the Hulsman Ranch property in late August 2020. The fire's destructive effects were widespread and dramatic. Seeing an opportunity to capture sediment, we leapt into action to implement structures in October 2020. In October 2021, a bomb cyclone hit the Sheep Fire burn scar. Mass amounts of sediment sloughed off the landscape. Homes and infrastructure on the ranch were washed out, devastating the landowner. However, the structures not only withstood the flooding, they filled to the top with sediment. In one weather event, the structures effectively captured sediment that brought the incised channel closer to its floodplain and kept the sediment from affecting wildlife downstream.

Mostly Natural—Collaborative Management Strategies in the Trinity River, CA

Justin Alvarez, Hoopa Valley Tribal Fisheries

Many western rivers have undergone significant shifts in species compositions due to introduced species, altering the biological dynamics of their ecosystems. In contrast, the Trinity River has successfully preserved its native species, experiencing minimal intrusion by invasive counterparts. In 2018, a coalition of managers united to implement suppression of an invasive fish, prioritizing the maintenance of native populations. This collaborative effort serves as a notable example of proactive river management, showcasing strategies to mitigate the impact of introduced species and sustain the integrity of native ecological assemblages. This case presents a unique opportunity for understanding and implementing effective strategies in river management to mitigate the impact of introduced species and uphold the integrity of native ecological assemblages.

It Takes More Than a Village: Restoration / Reconciliation of the Laguna de Santa Rosa

Clayton Creager, Laguna de Santa Rosa Foundation (Presenter)
and Co-author: Anne Morkill, Laguna de Santa Rosa Foundation

The Laguna de Santa Rosa is an expansive freshwater wetland complex spread along a 22-mile floodplain from Cotati to the confluence with the Russian River near Forestville in Sonoma County, CA. The Laguna de Santa Rosa is within the ancestral lands of Coast Miwok and Southern Pomo tribes and currently encompasses most of the county population that lives and works within its 254 square mile watershed. Land conversion for agriculture and development over the past 150 years has led to a decrease in habitat for native species and an increase in the delivery of streamflow, fine sediment, and nutrients to the Laguna. For years, there has been a recognized need to develop a coordinated restoration plan for the Laguna de Santa Rosa that clearly lays out achievable restoration actions to improve overall ecosystem health while addressing the needs of residents that call the Laguna home, including underserved communities of color that lack access to the ecosystem benefits of natural areas, such as Roseland which is predominantly Latinx.

The challenges of conducting restoration/ reconciliation actions within highly developed watersheds can be greater than in more pristine settings and must be understood within an environmental justice framework. The Restoration Plan for the Laguna de Santa Rosa released in August 2023 lays out such a framework to improve overall ecosystem functions and services for people and wildlife, and to enhance the environmental, agricultural, and tribal benefits of current and future land uses within a landscape matrix that will be resilient under a changing climate. Implementation will require commitment, innovative regulatory mechanisms, and meaningful input from a wide range of stakeholders including local agencies, policymakers, non-profits, residents, landowners, land and water managers, and tribal representatives to realize our vision of a healthy Laguna de Santa Rosa for wildlife and people for generations to come.

Accelerating Restoration —Updates and Examples to Help Get the Job Done

Thursday Afternoon Concurrent Sessions

Session Co-Coordinators: *Erika Lovejoy, Sustainable Conservation and Brad Henderson, California Department of Fish and Wildlife (CDFW)*

The State has prioritized the 30x30 conservation and Cutting Green Tape initiatives, catalyzing agencies to develop new ways to address the urgent needs around habitat loss, species decline, and climate change. There is significant new funding available at both the federal and state levels to move work forward and all the pieces need to be aligned to accelerate restoration and increase impact. Agencies are responding to the call for action and collaborating with project implementers and restoration experts to create wide-reaching efficient permitting tools that expand partnerships with project proponents and increase the State's capacity to tackle environmental problems. This session will provide efficient permitting implementation and policy updates and case examples of projects to highlight newly developed and precedent-setting regulatory tools that create a separate permitting pathway for a wide variety of aquatic habitat restoration projects of all sizes. The audience will also be engaged to hear their questions—and potential solutions—to help increase the pace and scale of restoration in California.

Less Paperwork, More Restoration —Hot Tips and New Tools for Expedited Habitat Restoration Permitting

Katie Haldeman and Stephanie Falzone, Sustainable Conservation (Co-presenters)

There is a critical need for more landscape-scale projects that restore degraded habitats, increase habitat connectivity, improve water quality, and boost our resilience to climate change, to benefit both wildlife and people. The Accelerating Restoration Program at Sustainable Conservation has worked to incentivize and increase the pace of restoration by making it easier for project proponents to get through the permitting and regulatory review process by creating expedited, alternative pathways for restoration. The Program also develops online tools that augment agency resources to help guide applicants on the use of these permitting pathways.

Through its Statewide Restoration Permitting Initiative, Sustainable Conservation provided technical assistance for a collaborative effort between the Army Corps of Engineers, NOAA Restoration Center, U.S. Fish & Wildlife Service (USFWS), and State Water Resources Control Board (SWRCB), with input from the California Department of Fish and Wildlife and restoration project proponents. This effort resulted in the approval of statewide expedited and coordinated permitting pathways in August of 2022—the SWRCB Statewide Restoration General Order with an accompanying programmatic environmental impact report, and the USFWS Statewide Programmatic Biological Opinion (PBO). These authorizations cover the same set of ten aquatic and riparian restoration types, including improvements to fish passage and floodplain restoration.

To support the implementation of the new statewide authorizations and their use with complementary permitting pathways, the Program launched an Accelerating Restoration website to help project proponents and agency staff find and successfully use a suite of efficient permitting pathways. A new tool on the website is designed to produce a set of project-relevant environmental protection measures from the menu of options in the new statewide authorizations and four longstanding PBOs that the NOAA Restoration Center administers.

Sustainable Conservation will provide an overview of the USFWS PBO benefits, implementation updates, and tips for how to use this precedent-setting authorization that covers 72 federally listed species and 40 critical habitat areas. We will also demonstrate how to plan projects more quickly and meet compliance needs with a real-time demonstration of the new environmental protection measures selection tool using the USFWS PBO as an example.

Three Years of Cutting the Green Tape: Program Updates and Case Studies from the California Department of Fish and Wildlife

Jennifer Olson, California Department of Fish and Wildlife (Presenter),
and Co-author: Brad Henderson, Environmental Program Manager, CDFW

California has many regulations in place to protect natural resources from the impacts of development and resource extraction. Unfortunately, beneficial habitat restoration can be slowed by these same regulations. Historically, the pace and scale of environmental restoration have been insufficient to address threats to California's biodiversity from anthropogenic stressors such as habitat loss and climate change. Complex and overlapping permitting processes can result in the implementation of fewer and smaller restoration actions at a slower pace and a greater expense. In response, the state of California has identified "Cutting the Green Tape" as a priority initiative to increase the pace and scale of environmental restoration. Many are familiar with the concept of "red tape," and in this context, "green tape" represents the extra time, money, and effort required to implement restoration projects because of inefficiencies in environmental review, permitting, and granting processes. Cutting the Green Tape means improving regulatory processes and policies so that habitat restoration can occur more quickly, simply, and cost-effectively. This presentation will provide an overview of the California Department of Fish and Wildlife's Cutting the Green Tape (CGT) Program, and the specific permitting and regulatory tools that are in use or under development for increasing the pace and scale of restoration in California. Additionally, the presentation will provide updates and case studies from projects that have used CGT permitting tools and discuss insights from a recent interagency permitting summit intended to increase collaboration between state agencies to better achieve CGT goals.

Updates on New Regulatory Tools to Accelerate Restoration

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 action and utilizing new statewide tools to support the implementation of beneficial aquatic habitat restoration projects.

Since 2021, several new regulatory tools have been produced that enable state agencies to better support large-scale restoration. Those new tools, combined with existing ones, create a more streamlined and efficient regulatory framework that greatly reduces the historic barriers to increasing the pace and scale of restoration. Additionally, state agency staff have been working to institute a paradigm shift in how restoration projects are reviewed and regulated, with the goal of maximizing the utility of this new and robust regulatory toolbox.

North Coast Water Board staff will present an update on the utilization of these tools, how and when they apply, lessons learned and tips for success, and will discuss deliberate efforts on the part of state agency staff to instigate a mindset shift with the goal of increasing the pace and scale of restoration.

Programmatic Permitting for Restoration Projects Through NOAA Restoration Center—Insider Tips on How to Use Efficient Permitting Tools for Your Good Work!

Ruth Goodfield, NOAA Restoration Center

NOAA Restoration Center (RC) 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 and are working with several other state and federal agencies on coordinated approaches to advance projects through the regulatory process and get to construction faster. More than 250 projects have been implemented using NOAA's progressive approach to permitting projects and the RC team is a major conduit for efficient permitting, funding, and technical assistance.

In this presentation, the RC will provide specific information about available permitting tools developed exclusively for restoration projects instead of the old-school method that treats all projects with a development-oriented lens! The presentation will include important information about eligibility for different project types and the various geographic areas included for each of our regional programmatic permits. We will share our expert perspective on how to effectively navigate the process when applying for Endangered Species Act (ESA) coverage and best partner with federal agencies on species recovery. Hot topics will include how to create the 'federal nexus' (!) needed to use efficient permitting from different federal agencies, the roles various agencies play along the pathway to efficient permitting, how new policies are being applied, and highlights of the most relevant new federal funding available for aquatic habitat restoration.

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

Accelerating Restoration —Updates and Examples to Help Get the Job Done

A Practitioner's Perspective

Jim Robins, Alnus Ecological (Presenter) and Co-author: April Zohn, Ducks Unlimited, Inc.

A suite of new initiatives, permitting tools, and funding opportunities have created a unique opportunity for project proponents to increase the pace and scale of restoration projects across the State of California. In the past five years, several statewide restoration-specific permit mechanisms and CEQA compliance processes have been made available to project proponents. A clear understanding of this evolving regulatory landscape can make the permitting and environmental review process more efficient, predictable, and outcome-focused. Restoration practitioners also have a responsibility to work collaboratively with regulatory agencies to find the best applications for these tools and to utilize them in a manner that is transparent, efficient, and adequately protective of sensitive species and habitats. This partnership is critical to ensuring the success and durability of this new paradigm of restoration-focused permitting, and for creating a space that allows the tools to evolve and improve as they are more widely utilized.

In this presentation, the authors will speak to their experience developing integrated regulatory compliance strategies that effectively capitalize on restoration-specific permitting tools, with specific examples around best practices for successfully navigating new (e.g., USFWS Statewide Restoration Programmatic Biological Opinion [BO]) and older (e.g., Habitat Restoration Enhancement Act [HREA]) permit pathways. The presentation will also emphasize that early collaboration with regulatory agencies can significantly inform and improve the design of projects and that strong and transparent working relationships between the restoration and regulatory communities increase the efficiency and predictability of the permitting process and improve project outcomes. This early and ongoing collaboration with regulatory partners is particularly important in light of Sackett v. EPA, which will impact the role that the USACE may play in a project, as well as the nexus to ESA Section 7 consultations. Finally, the presentation will highlight opportunities to leverage the protective measures incorporated into these new permit mechanisms to ensure consistency across permits—enabling practitioners and construction crews an easier path to interpreting and implementing these measures.

Fire and Fish: Landscape-Level Fuels Reduction and Fisheries Habitat Enhancement Through the CA Vegetation Treatment Program (CalVTP)

Cassie Pinnell and Drew Barber, Vollmar Natural Lands Consulting (Co-presenters)

Climax fire negatively impacts salmonid habitat through reduction of shade, loss of woody debris recruitment, increased sedimentation, and chemical influences. Climax fire has consumed approximately 60% of Northern California; the majority of these fires have been in the interior region. Coastal regions that support salmonid habitat are heavily forested and remain unburned and in severe threat of wildfire. Due to landscape fire suppression over the last 100 years, there is a large need for fuels reduction to improve forest resiliency. The scale and pace of these efforts must keep ahead of the looming wildfire threat. Permitting, funding, and project design can slow the process. The Board of Forestry and Fire Protection's California Vegetation Treatment Program (CalVTP) is a useful tool to expedite the implementation of wildfire resilience projects while also providing opportunities to support habitat restoration projects for salmonids.

The Humboldt County Resource Conservation District (HCRCD) was awarded a CAL FIRE Forest Health Grant for the Mattole and Salmon Creek Forest Health and Wildfire Resilience Project, in partnership with the Mattole Restoration Council and Mattole Salmon Group. Under this project, they are weaving fish benefits into fire protection via the CalVTP pathway. In-stream habitat restoration activities include placing approximately 400 whole trees in-stream to improve aquatic and salmonid habitat in McGinnis Creek, a tributary to the Mattole River. Whole trees will be removed from grassland areas under the CalVTP program and transported to in-stream placement sites by helicopter. Wood placement will be designed to enhance spawning and rearing habitat for steelhead, Coho, and Chinook salmon by increasing the incidence of pools and quantity and complexity of pool cover; promoting the sorting of gravel and the deposition of more suitably sized spawnable material; raising the streambed elevation in suitable locations to connect floodplain features at lower flows; and encourage the development and maintenance of side-channels and alcoves as wood features encourage stream meandering and more heterogeneity of floodplain inundation.

Thiamine Deficiency in California Salmon and Steelhead

Thursday Afternoon Concurrent Sessions

Session Coordinators: *Nate Mantua, Southwest Fisheries Science Center, and Abigail Ward, University of California Davis, Center for Watershed Sciences*

Thiamine deficiency was first detected in California's Central Valley Chinook salmon fry in early 2020 and has since been documented in at least some of California's steelhead, Coho, and Chinook salmon populations every year since then. This session invites presentations on any aspects of thiamine deficiency relevant to this emergent stressor on California's salmon and steelhead.

Widespread Thiamine Deficiency Found in California Salmon and Steelhead

Nate Mantua, Ph.D., NOAA/NMFS, Southwest Fisheries Science Center

Thiamine (vitamin B1) deficiency (TD) in marine systems is a globally-significant emerging threat to fish and wildlife. In 2020, newly hatched Chinook salmon (*Oncorhynchus tshawytscha*) fry in California's Central Valley (CCV) hatcheries were observed swimming in corkscrew patterns and dying at high rates due to insufficient thiamine. We subsequently quantified the extent, causes, and impacts of TD to California salmon. We established an egg surveillance effort that found TD in CCV Chinook salmon from 2020—2023. We found TD in Klamath River and Trinity River Coho salmon (*O. kisutch*) and coastal and CCV steelhead (*O. mykiss*) populations in 2021 and 2022. Diet studies on Chinook salmon linked the proximate cause of TD to their feeding almost exclusively on a booming population of northern anchovy (*Engraulis mordax*) in the ocean. We analyzed common salmon prey and found anchovy had both the highest lipid content and the highest activity levels of thiaminase, a thiamine-degrading enzyme linked with TD in other species and systems. We investigated natural sources of thiamine by measuring dissolved thiamine and microbial community composition across spatial and temporal gradients in the water column and hyporheic zone of marine and freshwater systems. Our laboratory studies defined the relationship between thiamine concentrations in eggs and early life-stage survival in Chinook salmon offspring (LC50= 2.5 nmol/g), which we used to predict the magnitude of thiamine-dependent fry mortality ranged from 9%-36% for winter-run Chinook salmon over 2020-2023. Chinook salmon treated with (1) pre-spawning adult thiamine injections, and (2) thiamine egg baths at fertilization, had egg thiamine concentrations increased above levels found to impact early life-stage survival. We do not understand steelhead diets and ocean migration patterns well enough to understand our observations of high and low egg thiamine concentrations for different coastal and CCV steelhead populations. Our research suggests California's already stressed salmon populations are likely to remain at risk of TD and its health impacts as long as their forage base is dominated by northern anchovy.

Bridging the Gap: Steelhead Ocean Foraging Ecology and the Link to Thiamine Deficiency Complex

Abigail Ward, MSc, University of California, Center for Watershed Sciences Davis (Presenter), and Co-authors: Nate Mantua, Ph.D., NOAA, Southwest Fisheries Science Center, Fisheries Ecology Division; Carson Jeffres, Ph.D. Center for Watershed Sciences, UC Davis; Jacques Rinchard, Ph.D., State University of New York; Jarrod Ludwig, M.Sc. Student, State University of New York; Bruce Finney, Ph.D., Idaho State University; Thomas Williams, Ph.D. NOAA, Southwest Fisheries Science Center, Fisheries Ecology Division; and Rachel Johnson, Ph.D. Center for Watershed Sciences, UC Davis and NOAA, Southwest Fisheries Science Center, Fisheries Ecology Division

Thiamine deficiency complex (TDC) is a nutritional deficiency of vitamin B1 that was first observed in California Chinook salmon in 2020, when hatcheries in the Central Valley (CCV) began reporting high juvenile mortality rates and sporadic swimming behaviors. Monitoring of TDC has been ongoing since this initial discovery and although steelhead (anadromous *O. mykiss)* have been a focus in our monitoring efforts in hatcheries, this species has been wildly understudied in comparison to Chinook salmon with little progress made to understand their foraging ecology and the main drivers behind TDC within these populations. Since 2021, 41.94% of the steelhead sampled have had total egg thiamine concentrations below healthy concentration levels (8 nmol/g) with the percentage of individuals with high thiamine values dropping by 7.66% in 2022. Variability in steelhead thiamine values has been observed between Central Valley hatchery populations as well as between Central Valley and coastal hatchery populations. In the Central Valley, differences between Mokelumne River Hatchery, averaging 12.5 nmol/g, and Nimbus Fish Hatchery, averaging 5.55 nmol/g, were observed over 2021-2022. The greatest variability observed among coastal hatcheries includes an average 11.1 nmol/g at Trinity River Hatchery in 2021 and 4.8 nmol/g at Mad River Hatchery in 2022. This variability over years and among populations has prompted questions about understanding steelhead distributions and their marine diets. Differing foraging ecology in combination with their iteroparous reproductive strategy and varying migration patterns provides unique stressors whose effects on TDC aren't entirely understood. In 2022, eggs were collected from 138 spawning steelhead females in hatcheries around the Central Valley and additional paired tissues were collected from a subset of individuals including eyes, muscles, scales, fin clips, and otoliths. Samples of eggs of coastal hatcheries include 30 samples from each of the Trinity River, Mad River, and Warm Springs hatcheries in 2022. Here, we will integrate multiple approaches to link foraging ecology of steelhead with TDC. We will reconstruct freshwater and marine migrations using Sr isotopes in otoliths, diet history using δ13C and δ15N in sequential eye lens laminae and fatty acids in eggs. These results could have significant influence over management practices as we begin to understand patterns of TDC in steelhead and migration behaviors contributing to reproductive success.

Baseline Forage Fish Nutritional Quality in the California Current Ecosystem

Freya Rowland, Ph.D., U.S. Geological Survey, Columbia Environmental Research Center (Presenter), and Co-authors: Jarrod Ludwig, State University of New York; John Field, NOAA/NMFS Southwest Fisheries Science Center, Fish Ecology Division; David Walters, U.S. Geological Survey, Columbia Environmental Research Center; Rachel Johnson, Ph.D. NOAA/NMFS Southwest Fisheries Science Center, Fish Ecology Division and UC Davis; Carson Jeffres, Ph.D. UC Davis; Nate Mantua, NOAA/NMFS Southwest Fisheries Science Center, Fish Ecology Division; Donald Tillitt, U.S. Geological Survey Columbia Environmental Research Center; and Jacques Rinchard, State University of New York

The nutritional quality of prey can strongly affect the health, growth, survival, and reproductive success of predators. Thiamine deficiency complex (TDC) is a growing concern in many regions and species of the world and is strongly linked to diet. Previous work shows that TDC can arise from prey with low thiamine, high lipids, and high thiaminase activity. Yet the relationship between thiamine, thiaminase, and lipids within an animal has been difficult to quantify due to averaged data. Here we present paired data of thiamine, thiaminase activity, and total lipids in 21 prey items for predatory fishes within the California Current Ecosystem. Prey items showed large variations in quality both intra- and interspecifically. Thiamine content was often inversely related to thiaminase activity, but there were no discernable patterns between thiamine and lipids. We use these data to make a consumption 'risk' index that may make a predator susceptible to TDC. For example, Northern Anchovy (*Engraulis mordax*) tend to be high in thiaminase, low in thiamine, and high in lipids, making them a riskier prey item for predators than juvenile Rockfish or Market Squid which typically had high thiamine, low thiaminase, and low lipid content. Overall, our results suggest that shifts in food webs—such as the shift to an Anchovy-dominated forage base—may be increasing the probability of TDC in predators.

Developing a Dose-Response Model for Thiamine Deficiency in Central Valley Chinook

Miles Daniels, Ph.D., University of California, Santa Cruz and NOAA Fisheries Southwest Fisheries Science Center (Presenter); and Co- authors: Steve Lindley, Ph.D., NOAA Southwest Fisheries Science Center; Heather Bell, M.S., and Anne Todgham, Ph.D., University of California, Davis

Thiamine deficiency (TD) is thought to affect various life stages of Chinook salmon but was first detected in Central Valley stocks at the fry stage in 2020. To better understand the impacts of TD on fry survival, a series of laboratory experiments were conducted to explore the relationship between egg thiamine concentration and survival to develop a dose-response model for thiamine-dependent fry mortality (TDFM; %). More specifically, batches (n = 35-200) of eyed-eggs from late-fall, winter, spring, and fall Chinook salmon were sourced from local hatcheries. A sub-sample of each egg batch was used to estimate egg thiamine concentration (nmol g-1) with the remainder held in aquaria without feed and observed for 120 days post-hatching. At the endpoint of the study, the proportion of fry surviving was recorded. A sigmoid dose-response model that predicts TDFM based on egg thiamine concentration was fit to the laboratory data within a Bayesian framework. This presentation will describe the results from the laboratory experiments and fit of the dose-response model and share information in relation to population-level estimates of TDFM in Central Valley Chinook salmon stocks from brood years 2020-2023.

High School Students Investigating Thiamine Deficiency in Central Valley Salmon Alongside Researchers

Peggy Harte, M.Ed., University of California, Davis and Center for Community and Citizen Science; and Abigail Ward, University of California, Davis, Center for Watershed Sciences (Co-presenters), and Co-authors: Rachel Johnson, Ph.D., NOAA Fisheries; and Carson Jeffres, Ph.D., Center for Watershed Sciences, UC Davis

The Spinning Salmon Program involves watershed scientists collaborating with teachers and students to monitor the behavioral effects of Thiamine Deficiency Complex (TDC) in an ongoing iterative program across 5 CA counties. The interdisciplinary approach allows participants from both continuation and traditional high schools as well as in college opportunity programs to engage in this project. In 2020, as scientists investigated the cause of Thiamine Deficiency Complex in California's salmon, the team at the Center for Community and Citizen Science, in collaboration with researchers at the Center for Watershed Sciences, NOAA Fisheries, and the California Department of Fish and Wildlife, developed an observation protocol and lesson sequence as part of the Classroom Aquariums Education Program. The scientists measure the thiamine concentrations in the eggs and students measure the survival and TDC symptoms of the progeny. Student data, submitted twice weekly, is being used to quantify the relationship between egg thiamine and juvenile survival, a missing piece of information needed by the broad coalition of scientists working on solving the TDC puzzle. With a focus on equity and access to underserved communities, year two expanded with a concentration on collaboration with high school students attending continuation schools and others enrolled in college opportunity programs. Lessons developed to support this project connected students with researchers directly through a variety of ways, highlighting college and career technical education pathways in addition to supporting the answering of student-generated questions. We will be sharing results from year two of this program as it has expanded into five counties in California. We will also share an outline of program development and highlight lessons learned from the second year, focusing on developing the researcher/classroom/teacher/student collaboration process. Attendees will also learn more about effective practices for connecting underserved youth directly with scientific researchers in a collaborative and iterative way.

Assessing the Patient(s): Status, Trend, and Validation Monitoring to Understand the State of Salmon Populations and Recovery Efforts in Coastal California

Friday Morning Concurrent Sessions

Session Coordinator: *Gabe Rossi, Ph.D., UC Berkeley*

~ A Community Working Toward Salmon Recovery Without Adequate Monitoring is Like a Doctor Treating a Patient Without Adequate Assessment ~

Salmon recovery is a massive enterprise. In California, hundreds of millions of dollars are spent on salmon and salmon habitat recovery efforts each year. And yet, only a small fraction of those funds are used to evaluate the state of our salmonid populations. For many populations and watersheds, there is limited monitoring—particularly for juvenile life stages. Thus, we are uncertain if, or to what extent, our actions are effective. Validation monitoring for recovery efforts depends on a basic understanding of the status and trends of populations. Each type of monitoring is needed to effectively manage salmon. Today salmonid population monitoring in California is conducted by dedicated organizations including tribes, non-profits, watershed groups, county, state and federal agencies, and universities. However, there is a critical need for higher-level visioning, coordination, communication, methodological consistency, and timely reporting to effectively evaluate the state of our salmon populations and to inform ongoing recovery efforts. How do we get there? Botkin et al. (2000) framed the fundamental question of validation monitoring for the Columbia River basin: "If actions are taken in an attempt to improve the status of salmon populations..., what measurements are necessary, feasible, and practical to determine whether the actions are successful?" In this session, we will ask that same question for our California coastal salmon streams. This session will bring together monitoring practitioners working in watersheds across California. We will highlight ongoing monitoring efforts—both successes and challenges; learn about the most pressing monitoring needs in California; and consider novel methods that can advance our monitoring goals. In addition to the presentations, a panel of speakers will address these questions and work toward a convergent vision of what salmonid monitoring in California can and should be.

Assessing the Patient(s): Status, Trend, and Validation Monitoring to Understand the State of Salmon Populations and Recovery Efforts in Coastal California

Friday Morning Concurrent Sessions

Sequential Monitoring to Inform Reintroduction and Restoration of Anadromous Salmonid Populations in Watersheds Along the California Coast

Tommy Williams, Ph.D., Southwest Fisheries Science Center, NOAA Fisheries

Monitoring efforts in California have greatly improved over the past 20 years, largely motivated by the declining numbers of returning adult salmon and steelhead and the number of populations at risk of extinction. The current focus of most monitoring efforts is on adult returns, likely because federal viability criteria and recovery plans, as well as the Coastal Monitoring Plan, were developed simultaneously. As we are learning from large-scale restoration actions, it takes multiple generations to establish viable populations in areas where they have been extirpated or populations are at low numbers even when appropriate habitat and habitat processes exist. In coastal basins of California, current adult-focused monitoring efforts produce data for, at best, only a few populations in each evolutionary significant unit (ESU) or Distinct Population Segment (DPS); with such sparse data, assessing overall trends in abundance or distribution at the ESU level remains difficult. Further, many populations are very far from viability/ recovery targets; thus, the value of getting precise estimates of adult abundance versus collecting data for other life stages needs consideration. A phased, sequential monitoring strategy, where the targeted life stage, frequency, and spatial extent of sampling changes through time, based on (1) existing information gaps and (2) current status of populations (i.e., distance from recovery targets), could provide stronger information for assessing ESU viability through time. Such a phased monitoring approach, using appropriate viable salmon population (VSP) performance indicators, could inform fisheries management and restoration activities through successive restoration, reintroduction, and monitoring phases. Monitoring frameworks developed in response to the removal of two dams on the Elwha River and the upcoming removal of four dams on the Klamath River provide a sequential approach framework that considers the ecological, physical, and environmental conditions as well as the different life histories and ecology within and among the different species.

Leveraging a 25-Year Monitoring Program to Evaluate Restoration Actions in the Yolo Bypass Floodplain

Nicole Kwan, California Department of Water Resources (Presenter), and Co-author: Lisa Vance, CA Department of Water Resources

For 25 years the Yolo Bypass Fish Monitoring Program has collected data on fish, invertebrates, and water quality in the Yolo Bypass floodplain, the largest remnant floodplain of the Sacramento River, and its perennial canal. Juvenile salmonids are monitored through biweekly beach seining and seasonal screw trap operations, with prey resources sampled year-round in drift- and invertebrate-net tows. Decades of research stemming from this program have highlighted the importance of this floodplain ecosystem for juvenile salmonid rearing and success and contributed to the design of several restoration projects. Two tidal restoration projects, Yolo Flyway Farms and the North Delta Fish Conservation Bank, were completed within the program's monitoring extent over the past several years. Here we evaluate whether these adjacent restoration sites had any effect on juvenile salmonids and their food sources in the Yolo Bypass. We also discuss the program's role in providing baseline data to two other significant salmonid restoration projects within the Bypass that are currently in progress and how the program aims to maintain long-term data consistency while also adapting to best inform the salmon monitoring needs of today.

Assessing the Patient(s): Status, Trend, and Validation Monitoring to Understand the State of Salmon Populations and Recovery Efforts in Coastal California

An Integrated Monitoring Approach to Support Salmonid Recovery in the Russian River Watershed

Mariska Obedzinski and Andrew Bartshire, California Sea Grant (Co-presenters), and Co-author: Gregg Horton, Sonoma Water

Over the last two decades, multiple monitoring efforts have been developed to inform salmonid recovery in the Russian River watershed. Examples include monitoring to evaluate a Coho salmon conservation hatchery program, implementation of the California Coastal Monitoring Program, environmental monitoring to inform streamflow and habitat restoration efforts, and targeted research to identify survival bottlenecks. Each monitoring effort is designed to answer specific questions, but collectively these efforts are helping to piece together the larger picture of population dynamics and evaluate recovery at a broader scale. A key component of integration is a centralized database and equally important is making the data available to those working to restore salmon populations. Through case studies on Pena Creek and other Russian River tributaries, we provide examples of how results from different monitoring and research projects are being integrated and shared through web-based mapping tools and other means to directly support ongoing salmonid recovery.

Fifty Years of Juvenile Salmonid Monitoring in Lagunitas Creek and Why It's Time to Try Something New

Eric Ettlinger, MS, Aquatic Ecologist, Marin Municipal Water District

In 1970, the California Department of Fish and Game established the first juvenile salmonid index in the Lagunitas Creek watershed. Additional index reaches were added in subsequent years and by 1998 Marin Water staff were electrofishing 13 index reaches annually. In other parts of California, juvenile salmonid monitoring methodologies were evolving to provide more statistical vigor, data validation, and reproducibility. Marin Water's monitoring methods remained static on Lagunitas Creek for decades, partly due to funding and staffing constraints, but largely by design to track long-term salmonid population trends made possible by an increasingly valuable dataset.

Between 2012 and 2014, with funding from CDFW, Marin Water established a life-cycle monitoring station under the Coastal Monitoring Plan (CMP), significantly expanding juvenile salmonid monitoring in the watershed. That effort was abandoned after the sampling design was determined to be inappropriate for watersheds as small as Lagunitas Creek.

In 2023, Marin Water convened an advisory group to chart a path forward for juvenile salmon monitoring and defined four goals for future monitoring:

- Continue to fulfill regulatory requirements
- Identify the principal factors limiting Coho salmon population growth and guide future restoration actions
- Maintain the ability to compare past and future abundance estimates
- Reduce salmonid incidental mortalities

The monitoring advisory group proposed a strategy focused on expanded passive integrated transponder (PIT) tagging of juvenile Coho salmon, as is being done elsewhere, including the Russian River and tributaries to Humboldt Bay. This strategy would allow Marin Water to estimate overwinter survival in multiple streams and investigate the factors contributing to differential survival rates. Using estimates of smolt abundance and overwinter survival would allow Marin Water to back-calculate fall juvenile abundance. Continuing to monitor a subset of historic index reaches would maintain the ability to track long-term trends. Finally, salmonid incidental mortalities could be reduced by shifting from multiple-pass, depletion electrofishing to single-pass electrofishing combined with seining.

When this strategy was implemented for the first time in summer 2023, few habitats proved to be conducive to seining, and low Coho abundance resulted in tagging fewer fish than anticipated. Incidental mortality rates of juvenile Coho salmon were similar to previous years, although steelhead mortality rates were significantly reduced. Data from multiple PIT antenna arrays and downstream-migrant traps will be collected in winter/ spring 2023-24 to test the efficacy of calculating overwinter survival and fall-juvenile abundance estimates.

Assessing the Patient(s): Status, Trend, and Validation Monitoring to Understand the State of Salmon Populations and Recovery Efforts in Coastal California

Low Mainstem Survival of Juvenile Salmonids in Coastal California Rivers Impairs Recovery and Masks Survival Bottlenecks

Gabe Rossi, Ph.D., University of California, Berkeley, and Gregg Horton, Sonoma County Water Agency (Co-presenters), and Co-authors: Philip Georgakakos, Ph.D.,University of California, Berkeley; Jason Shaffer, California Trout; and Rachel Hein, University of California, Berkeley

Salmon restoration investments in coastal California have emphasized instream flow, habitat improvement, and connectivity—primarily focused on spawning and rearing tributaries that are critical to Coho salmon and steelhead. In contrast, fewer restoration investments have been focused on mainstem rivers. Yet, new studies from two California north coast rivers indicate that mainstem survival and habitat use of juvenile Coho salmon may be a critical bottleneck that limits salmon recovery and confounds marine survival estimates.

Without a clear distinction between tributary, riverine, estuarine, and marine survival, identifying survival bottlenecks will be challenging. In the last decade, acoustic-tagging technology has emerged as a tool that allows researchers to track movement and estimate survival of juvenile salmonids traveling long distances from natal streams to the estuary. While acoustic telemetry has been used extensively throughout the Pacific Northwest, and in California's Sacramento–San Joaquin River system, the first acoustic telemetry studies to evaluate riverine survival in coastal CA rivers were conducted in the last three years.

Here, we present findings from our acoustic telemetry studies in the Russian and South Fork Eel Rivers. These studies show a wide range of juvenile Coho salmon survival, within and between years, and as a function of natal origin. Many groups of fish experienced high riverine mortality, sometimes exceeding 90%. Applying acoustic telemetry, in a mark-recapture modeling framework allowed us to evaluate how environmental factors help to explain survival and to start unraveling drivers of in-river mortality. Collectively, these studies suggest that a major shift in restoration focus may be needed—with a new emphasis on improving survival in mainstem rivers by reducing identified sources of mortality. Restoration actions focused on mainstem rivers are challenging for numerous reasons, but if mainstem survival and habitat use are not improved, any dollar spent on salmonid habitat improvement in tributary streams becomes devalued from a population-recovery perspective—since juvenile salmon require a functioning mainstem to express life-history diversity and to survive their journey to the sea!

Monitoring Adult Salmon and Steelhead Abundance in the Eel River Watershed and Future Monitoring Concepts to Inform Factors Limiting the Recovery of Salmonids in the Eel

David Kajtaniak, California Department of Fish and Wildlife

CDFW, partnering with NOAA West Coast Fisheries, Trout Unlimited, Pacific States Marine Fisheries Commission (PSMFC), and Pacific Gas and Electric (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 (California Trout), Middle Fork Eel River (Round Valley Indian Tribes and McBain Associates), and most recently the Van Duzen River (CDFW and PSMFC). A tremendous amount of collaboration and work between state and federal agencies, private companies, California tribes, and non-governmental organizations has occurred to conduct sonar monitoring in the Eel River watershed. Cumulatively, these monitoring efforts are critical for understanding adult Chinook Salmon, Coho Salmon, and steelhead movement and their population estimates for the entire basin. Currently, this information informs fisheries/watershed management and regulatory priorities and increases capacity in Tribal fishery programs.

Building upon this baseline data there is the need for further program coordination between these sub-watersheds and the entities in charge of collecting the data. Program coordination would benefit data analysis and overall evaluation of these salmon populations. Sonar monitoring is effective, but there could be room to improve upon species apportionment. Juvenile salmonid studies are ongoing in the South Fork Eel River as well as monitoring associated with restoration projects in the Eel River estuary. An opportunity exists to correlate adult sonar monitoring data with these monitoring efforts and future studies of salmonid life cycle stages within the watershed. This would include geographically designed juvenile salmonid monitoring that overall could provide a more robust understanding of the number of adults entering the system, production of juvenile fish, and outmigration numbers. The development of this monitoring framework would help decipher limiting factors in salmonid recovery and guide future restoration actions in the Eel River Watershed.

Controlling Sacramento Pikeminnow in the South Fork Eel River to Benefit Native Salmon

Phil Georgakakos, Ph.D., University of California, Berkeley (Presenter), and Co-authors: Gabe Rossi, UC Berkeley; Marisa McGrew, Wiyot Tribe; Alex Juan, Cal Poly Humboldt; Abel Brumo and Sam Rizza, Stillwater Sciences; Jason Shaffer, California Trout; Rachel Hein, UC Berkeley and California Trout; Stacy Giraldo, Wiyot Tribe; and Matt Metheny and Darren Mireau, California Trout

Presently, a significant movement, characterized by substantial energy, resources, and novel collaborations, is dedicated to restoring wild salmon populations in the Eel River. A major obstacle in this effort is the presence of a non-native predatory fish, the Sacramento pikeminnow (*Ptychocheilus grandis*), a piscivorous cyprinid. Pikeminnow pose a threat to all native fish species in the Eel River, including recovering salmon and lamprey, and their widespread distribution in the drainage further limits restoration efforts. In the South Fork Eel River, pikeminnow exhibit a seasonal migration, a portion of the population moves upstream in the spring to occupy headwater reaches—prime habitat for rearing juvenile steelhead and Coho salmon.

In spring and summer 2023, our team used a seasonal resistance-board weir to capitalize on pikeminnow migration and attempt to block their access to the critical salmon-rearing habitat in the headwaters. Complementing the weir, we used various removal techniques targeting pikeminnow, including gillnetting, seining, boat electrofishing, spearfishing, and hook and line sampling throughout the South Fork Eel. To gauge the effectiveness of these interventions, we expanded on existing snorkel survey efforts, incorporating them into a Before-After Control-Impact (BACI) study design to assess pikeminnow abundance. Our findings indicate that these methods can successfully reduce pikeminnow numbers, particularly large reproductive individuals, and prevent their access to the essential salmon-rearing habitat in the headwaters. While applicable to other systems, we underscore the importance of gathering initial information on pikeminnow movement and timing to optimize weir placement and guide targeted suppression efforts to specific reaches.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Friday Morning Concurrent Sessions

Session Coordinators: *Monty Schmitt, The Nature Conservancy; Matt Clifford, JD, Trout Unlimited; and David Dralle, Ph.D., U.S. Forest Service, Pacific Southwest Research Station*

Groundwater contributions to instream flows, particularly in the dry season, are essential for the restoration of rivers and the recovery of salmonid populations. Historic logging practices, changes in land use, the legacy of fire exclusion, and increasing well diversions have all contributed to depleted streamflows. Efforts to manage groundwater resources, like the Sustainable Groundwater Management Act and recent efforts by county planning departments, have yet to address the complex technical and regulatory issues associated with avoiding or mitigating existing cumulative impacts and permitting for new wells. Additionally, existing state-wide legislation manages groundwater only in large groundwater basins like the Central Valley, neglecting the essential role of hillslope groundwater systems in the small headwater watersheds that support salmon populations. Increasingly, groundwater infiltration and recharge projects are being proposed, but securing permits for restoration actions and predicting the benefits of actions are not always straightforward. This session will address three main challenges and explore solutions regarding groundwater modeling of streamflow depletion in diverse (geology, biome, etc.) landscapes; designing and permitting infiltration and flood recharge projects; and efforts to develop county groundwater well ordinances to protect public trust resources.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Evaluating Hydrologic Effects of Scott and Shasta River Irrigation Curtailments Using Remote Sensing and Streamflow Gages

Eli Asarian, Riverbend Sciences (Presenter), and Co-authors: Michael Pollock, Ph.D., NOAA Fisheries; Bronwen Stanford, The Nature Conservancy; and Nicholas Murphy, The Nature Conservancy

This presentation will summarize a recent analysis of the Scott and Shasta rivers of Northern California that illustrates the value of remote sensing for assessing water use and highlights why water conservation efforts should focus on reducing consumptive water use. To protect culturally and economically important salmon populations during a severe drought, California's State Water Board issued emergency regulations intended to reduce agricultural surface water diversions and groundwater pumping. Verifiable records of water diversions and groundwater pumping were unavailable, so we used remote sensing and stream flow gauge data to assess the hydrologic effects of these curtailments. Conditions in agricultural fields in the curtailment year 2022 were compared with previous years, evaluating the magnitude and seasonal timing of 1) evapotranspiration (ET) (i.e., consumptive use) from Open ET, and 2) indices of vegetation greenness from the Landsat and Sentinel-2 satellites. Fields were grouped according to irrigation sources (groundwater vs. surface water). In Shasta Valley, where most irrigation is obtained from surface water diversions that are regulated by a Watermaster and applied to grass pastures, curtailments effectively reduced ET, and river flows increased. In Scott Valley, where most irrigation is obtained from groundwater wells and applied to alfalfa, curtailments did not reduce ET and river flows were not affected. A likely major reason for the lack of Scott River flow increases was that groundwater use was allowed to continue under Local Cooperative Solutions (LCS) agreements in which water users agreed to reduce pumping by 30% from a prior year baseline. Groundwater pumping was not measured and compliance was primarily self-reported with limited independent verification, facilitating the potential for widespread non-compliance. Our methods use publicly accessible datasets and easy-to-use online tools (OpenET, Climate Engine, and Sentinel-Hub EO Browser) that are available for regulators and stakeholders to use in future years to enhance regulatory compliance, inform the development of improved policies, and close data gaps related to consumptive water use estimates.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Small-Scale Groundwater Recharge Opportunities for Streamflow Augmentation, Little Mill Creek, Navarro River Watershed

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

The Little Mill Creek watershed within the Navarro River basin was selected for a pilot project to identify enhanced infiltration and groundwater recharge management techniques across landscapes of forest, agriculture (vineyard), rangeland, rural roads, residential lots, streams, and riparian zones. Site investigations of 8 parcels representing 465 acres (45% of the 1,050-acre watershed) identified 65 potential project sites, including multiple sites for each landscape type.

Conceptual designs were developed for five selected recharge projects, with one of those selected for additional engineering design. The selected project combines the strategic release of water from an existing pond with the restoration of the deeply incised tributary channel that conveys the pond release to Little Mill Creek. The proposed design incorporates a series of grade control structures to raise the tributary channel bed to approximate the longitudinal profile of an inset terrace and develop a series of low-gradient reaches. Resulting increases in the riparian zone water table elevation would retain additional groundwater within approximately 25 acres of adjacent hillslopes later into the spring when streamflows seasonally decrease. This groundwater would be released to streams beginning in the late spring or early summer as the riparian water table drops.

Quantitative estimates of increased infiltration and groundwater recharge were developed for all potential projects and water budget methods were used to estimate stream flow augmentation. The complete portfolio of all identified potential recharge projects has the potential to increase groundwater resources by 35 acre-feet in average precipitation years, 23 acre-feet in dry years, and 13 acre-feet in very dry years. These include projects that may generate streamflow over a period of weeks and others that would generate delayed response over months, depending on locally dominant hydrogeologic processes. With full implementation of those projects, Little Mill Creek dry-season stream flows would be increased by approximately 0.03 cubic feet per second (cfs) during average precipitation years, with less increase in dry and very dry precipitation years. Strategic pond releases could supplement that flow during critical periods. Those small increases are significant, as streams commonly cease to flow during summer and fall under existing conditions and even small increases in flow can extend the period in which suitable salmonid habitat is supported.

Each of the techniques evaluated for the Little Mill Creek watershed could also be applied on additional Navarro River tributary watersheds to generate meaningful flow increases for critical Coho and steelhead habitat and are transferable to other watersheds throughout the California North Coast. The landscape conditions in the Little Mill Creek watershed are challenging due to steep slopes, limited access, and minimal non-forest land cover (e.g., agricultural and residential areas). Watersheds with less steep terrain and a more accessible variety of land covers are likely to have a high potential for groundwater recharge to enhance stream flows.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Regional Approaches to Groundwater Management to Mitigate Streamflow Depletion: Case Studies from Napa, Sonoma, and Lake Counties

Matthew O'Connor, Ph.D., *O'Connor Environmental, Inc.*

Concerns regarding the effects of groundwater pumping on streamflow in the North Bay region of Northern California have escalated significantly in recent years owing to extended periods of drought, climate change, and the imperiled status of fish populations in freshwater streams. These concerns are compounded by new regulatory limitations on access to groundwater and surface water for agricultural, municipal, and private domestic users under some circumstances through curtailment of Water Rights during severe droughts in the Russian River and, eventually, through implementation of the California Sustainable Groundwater Management Act. Finally, the common law Public Trust Doctrine effective in the State of California has been used as the basis for recent litigation against some County governments, questioning whether their groundwater management policies fulfill their responsibilities regarding maintenance of streamflow and associated benefits to the public.

Given the foregoing changes, challenges, and conflicts, there is a new impetus to seek solutions that may mitigate impacts to water resources and reconcile competing interests. A range of approaches to groundwater management policies and practices intended to mitigate effects on surface water have been or are being developed. Three case studies from Napa County, Sonoma County, and Lake County will be used to illustrate the components and qualities of strategies for managing groundwater where mitigating streamflow depletion is the primary objective. The similarities and differences between the various approaches being implemented will be evaluated. Local hydrogeological, ecological, and social/ political/ cultural factors that significantly affect these approaches will be highlighted.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Incorporating Site Characterization into Natural Landscape Engineering and Streamflow Enhancement Projects: Case Studies from the Upper Mattole Watershed

Tasha McKee, Sanctuary Forest, Inc., and Wyeth Wunderlich, EBA Engineering (Co-presenters)

Sanctuary Forest is working with collaborating agencies and partners to address water scarcity impacts on salmonid and wildlife habitat in the Mattole River Headwaters. This presentation will focus on two strategies for increasing groundwater storage, including instream and upslope approaches and the combined benefits of stacking strategies. The Mattole River watershed receives substantial volumes of precipitation during the wet season; however, late-dry-season streamflow in the Mattole River is driven by seasonally recharged groundwater reserves, some of which drain rapidly via high-conductivity-subsurface pathways. Among the primary goals of SFI water projects in the Upper Mattole is to increase and augment groundwater reserve volumes and to slow preferential pathways to prolong the dry season streamflow recession. In this talk, we will review pilot projects conducted along Baker Creek and Lost River, two important Coho-rearing tributaries, by discussing project outcomes, challenges, and lessons learned, including the application of aquitards to slow the groundwater declining limb in both instream and upslope settings.

Water resources projects that use natural engineering approaches to restore or enhance watershed and stream function are being implemented at increasing rates. These projects are especially important in seasonally dry climate regimes such as California. To identify design challenges and improve outcomes in these crucial projects, EBA Engineering utilizes a data-driven site characterization approach which is employed in other disciplines, such as environmental geology, to improve a site-specific understanding of subsurface conditions which may ultimately be critical to designing a successful project. EBA Engineering is working with SFI on a geotechnical investigation to conduct pre-construction site characterization of the subsurface conditions for a streamflow enhancement project in a subbasin of the South Fork Lost River, in the Upper Mattole Watershed of Northern Mendocino County, California. The project proposes the construction of a subsurface dam built cross-gradient to the direction of flow, which is to be amended with low-conductivity materials, such as bentonite or cement grout, to reduce the permeability of the subsurface structure. The goals of the project are to increase the duration of water storage and release from the landscape during the dry season and enhance habitat for wildlife and wetland vegetation. To assess the subsurface conditions, EBA Engineering directed an excavator to dig five test pits to observe subsurface material composition and continuity and take samples for geotechnical laboratory analysis. The results of this investigation will ultimately be used to tailor the site design to improve the chances of successful outcomes at the project site.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Groundwater into Streamflow: Principles and Guidelines for Cities and Counties to Develop Well Ordinance to Protect Streamflow for Salmon Habitat

Monty Schmitt, The Nature Conservancy

In response to recent droughts and growing water demands, reliance on groundwater has increased as has the number of new wells. Groundwater pumping from shallow aquifers can significantly deplete streamflows and threaten important habitat for salmonids, often already diminished by surface diversions. Pressured by litigation based on the Scott River groundwater decision, cities and counties throughout California must grapple with figuring out how to amend their well ordinances to meet obligations to protect public trust resources. This presentation will summarize recently developed principles and guidelines to help local governments amend their well ordinances in the absence of clear standards from state agencies and to ensure the protection of streamflows needed for salmonid habitat and riverine ecosystems.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

An Overview of Existing Legal and Policy Tools for Regulating Groundwater Withdrawals to Protect Surface Streamflow in California

Matthew Clifford, JD, Trout Unlimited and Redgie Collins, JD, California Trout (Co-presenters)

Groundwater withdrawals are a significant contributor to streamflow depletion, which is a major cause of the decline of California's native salmon and steelhead populations. A longstanding challenge for efforts to better manage groundwater to protect flows in surface streams is the fact that state law generally regulates surface water and groundwater as separate resources and regulates the latter very lightly when in reality they are different components of a unitary resource and the management of one often has profound implications for the other. Although this situation began to change with the enactment of the Sustainable Groundwater Management Act (SGMA) in 2014, that law has had little application in the small- to mid-sized watersheds in the coastal geography that is home to most of California's imperiled runs of anadromous fish; and where it has been applied the protections it has provided for surface flows have been modest at best.

This presentation will provide an overview of tools that are available under existing law to regulate the extraction of groundwater to protect surface flows, as well as examples of their application in coastal California watersheds. In addition to SGMA, these tools include county and municipal well drilling ordinances, the common-law public trust doctrine, Section 1602 of the Fish and Game Code, and the designation of Outstanding National Resource Waters under the Clean Water Act. The presentation will also provide an overview of recent developments regarding the application of Fish and Game Code Section 5937, a tool that can be used to require minimum stream flows below dams and diversions. While none of these tools is an adequate substitute for the kind of comprehensive scheme for the conjunctive management of surface and groundwater that would be the most efficient and effective way to meet human and ecosystem needs, they can be used to help bridge the gaps in existing policy and integrate groundwater management into efforts to protect surface streamflows.

Beaver and Process-Based Restoration: Opportunities and Obstacles 1

Friday Morning Concurrent Sessions

Session Coordinator: *Karen Pope, Ph.D., USDA Forest Service*

Climate change represents a major threat to freshwater aquatic ecosystems in California and the Pacific Northwest, home to important but increasingly sensitive taxa, including salmonids. The impacts of climate change on certain freshwater ecosystems may be ameliorated by the engineering activities of beavers (*Castor canadensis*), which were once common throughout North America but experienced dramatic declines due to fur harvest in the 18th and 19th centuries. Many streams and rivers have not been recolonized by beavers due to a lack of local source populations or because the habitats have been simplified and degraded, impairing beaver recolonization. Strategic stream, meadow, and river restoration applications with beaver and process-based restoration (PBR) have the potential to play a larger role in the multi-tiered efforts to manage pressing climate-related threats to forests and water supply by increasing resistance to wildfire, increasing base flows, and reducing sedimentation in unwanted reaches and reservoirs. In these systems, beaver restoration and PBR have the potential to recover stream complexity, increase surface and groundwater storage, and regain floodplain connectivity, resulting in improved salmonid habitat. However, we are just beginning to develop the restoration tools, scientific backing, and workforce to meet the demand for increasing the pace and scale. For example, we launched the new California Process-Based Restoration Network in 2022 with the goal of increasing capacity to restore degraded riverscapes in California (calpbr.org). In addition to building the human capacity to implement restoration projects, research and monitoring remain important for understanding and identifying where and when beaver restoration and PBR can succeed and what approaches are best to maximize ecohydrological benefits. The primary goals of this session are to (1) share what has been done, how it is working, and the scientific basis that supports it; and (2) explore the various impediments to scaling up the more effective practices.

Re-beavering California: Adding a New Tool to the Restoration Toolbox

Valerie Cook, California Department of Fish and Wildlife

In 2023, following many years of advocacy in California and rapidly evolving science demonstrating the critical role of North American beavers (*Castor canadensis*) as both ecosystem engineers and keystone species, the California Department of Fish and Wildlife (CDFW) established a Beaver Restoration Program. Despite their near-extirpation in the 1800s, with the relatively recent paradigm shift surrounding beavers, they are increasingly recognized as an ultimate nature-based solution and a virtually untapped resource in California's fight against our greatest ecological threats: climate change, drought, wildfires, and habitat loss. As such, a primary goal of CDFW's new program is to gather a comprehensive understanding of where, when, and how beavers can be utilized to restore ecosystems and their processes and apply that knowledge to effectively utilize beavers as a tool in restoring and conserving habitats throughout California. This restoration of both ecosystem processes and habitat factors critical to numerous species of interest to CDFW are the fundamental reasons behind the objective of restoring beavers to their keystone role within California's watersheds. The "re-beavering" of California involves not only CDFW's promotion of non-lethal strategies to manage human-beaver conflict but also the translocation of beavers into target restoration sites for population re-establishment. As the program prepares to solicit beaver restoration project proposals (i.e., beaver translocation requests), interest in beaver restoration is expected to exceed the initial capacity of the program, and a science-backed strategy for evaluating potential project benefits and selecting priority watersheds is needed. As such, reliance upon the best available science, identification of stressors, needs, and restoration opportunities on the landscape, a clear understanding of the relationship between beavers and species/ habitats of conservation interest, and acknowledgment of the gaps in current knowledge will all be critical. This strategic approach also represents an opportunity for interagency collaboration on watershed-scale projects to support the restoration of critical habitats, species recovery, and improved drought resiliency. This presentation will provide an update on the status of the program and progress toward this strategy and is intended to facilitate discussion about available resources, research needs, and effective outreach to stakeholders.

The Process Paradox: Overcoming Challenges for Process-Based Restoration in the Regulated Rivers of California's Central Valley

Rocko Brown, Ph.D., PE, Cramer Fish Sciences

Over a century of human expansion and development has severely impacted natural processes in Central Valley rivers that provide habitat for threatened fauna and critical ecosystem services. This has led to well-known reductions in habitats such as wetlands, stream channels, and floodplains, which have contributed to population-level impacts on ESA-listed Pacific Salmon (*Oncorhynchus spp.*).

While there are numerous examples of "restoration" in these rivers, many of these actions could more accurately be defined as enhancement or mitigation. A currently popular movement in the field of river restoration is process-based restoration, which aims to "re-establish normative rates and magnitudes of physical, chemical, and biological processes that sustain river and floodplain ecosystems." While the aims are broad and ambitious, in practice they have often mired actions that would improve these damaged rivers. For chronically impaired rivers to meet their social, geomorphic, and ecological potential requires a multitude of tools that transcend fads, political priorities, and ideological constructs.

In this presentation, I will discuss how ideological constructs such as form vs. process are distractions from our basic understanding of what rivers need and how we can fix them. I will demonstrate how process-based restoration is possible even in highly-disturbed and regulated rivers given four basic ingredients: water, sediment, space, and time. However, achieving this in regulated rivers requires focus and coalitions of stakeholders that can establish clear goals and objectives that can be maintained over time in the context of continued human impacts. With this more pragmatic approach, there is reason for hope that society can sustainably use these rivers as resources and enhance ecosystem services and habitat for threatened and endangered fauna.

Evaluating and Forecasting Restoration Benefits for Trout and Salmon with Spatially Explicit Modeling

Bret Harvey, Ph.D., USDA Forest Service Pacific Southwest Research Station (Presenter), and Co-authors: Jason White, USDA Forest Service Six Rivers National Forest; and Steve Railsback, Lang, Railsback and Associates

One obstacle to the implementation of effective stream restoration is our limited ability to forecast the consequences of restoration alternatives for highly-valued animal populations, including salmonid fishes. For animal populations, forecasting cannot rely only on the evaluation of local physical habitat, because factors such as climate change and invasive species can strongly influence outcomes. Process-based, individual-based, spatially explicit models of animal populations provide a comprehensive way to address the challenge of forecasting the consequences of restoration. We applied such a model to evaluate a Stage-0 / valley-bottom restoration project in Whychus Creek, Oregon and assess its potential as a forecasting tool.

Existing hydraulic models of the pre-and post-restoration conditions at the project site revealed a change from a single-thread channel to complex flow paths spanning the valley bottom. We used these hydraulic models and extensive photographs of the study area to delineate habitat cells to simulate the two scenarios with the fish model. The pre-restoration scenario included >5500 habitat cells and the post-restoration scenario >7000 habitat cells to represent the same 650-m reach. The model also used daily streamflow data for the site, while daily temperature and turbidity regimes were extrapolated from sporadic observations. Fifteen-year simulations included rainbow trout, brown trout, and Chinook salmon.

The simulations indicated substantial benefits of restoration for both resident trout and Chinook salmon. A higher abundance of resident trout under post-restoration conditions occurred every year, even as reproductive success varied widely due to annual variations in temperature and streamflow. The increase in abundance of trout age 1 and older under the post-restoration scenario versus the pre-restoration scenario averaged about 5X, similar to the increase documented in limited field sampling at the site. Simulation of Chinook salmon under pre- versus post-restoration scenarios did not suggest strong differences in spawning success but did indicate profound improvement in the ability of the reach to retain and grow age-0 salmon following restoration. Under pre-restoration conditions, age-0 Chinook salmon did not remain in the reach after May, but under post-restoration conditions, outmigration from the reach typically continued into July.

The model we applied can directly incorporate an array of potential restoration measures, including physical alterations, flow enhancement, changes in fish passage, and place restoration alternatives in the context of other important factors, including climate change. As this study illustrated, interactions between restoration and climate can be critical in determining outcomes for salmonid fishes. The process of developing the simulations also highlighted the value of hydraulic modeling, continuous monitoring of key driving variables (streamflow, temperature, turbidity), and consistent monitoring of key responses (salmonids!), to achieve the goals of measuring, understanding, and forecasting restoration effects.

Short-Term Hydrologic Responses to Process-Based Restoration

Emma Sevier, MS, California Polytechnic State University Humboldt (Presenter), and Co-authors: Margaret Lang, Ph.D., California Polytechnic State University Humboldt; Karen Pope, Ph.D.; Adam Cummings, MS; David Dralle, Ph.D.; Joe Wagenbrenner, Ph.D., USDA Forest Service, Pacific Southwest Research Station; Kevin Swift, Swiftwater Design; Jordin Jacobs, MS; and Katelyn Wilcox, MS, Oak Ridge Institute for Science and Education Fellow, USDA Forest Service, Pacific Southwest Research Station

Ecologically functioning meadows provide critical ecosystem services including water retention, groundwater and carbon storage, and fire breaks that support downstream aquatic habitats. Degradation from past and current land use has resulted in incised channels that dewater shallow groundwater and alter the magnitude and timing of water and nutrient fluxes. Meadows usually occur in low-gradient areas with broad alluvial floodplains where water naturally slows, spreads, and infiltrates into fine-grained soils. These baseline geomorphic characteristics make meadows relatively easy to restore with the potential for larger areal gains than higher gradient stream reaches with more confined floodplains. Process-based restoration techniques (PBR), including beaver dam analogs (BDAs), leverage existing fluvial processes to increase restoration efficiency within degraded meadow systems. Despite its potential, PBR is relatively untested, and we aim to quantify its potential short-term hydrologic effects. We combined field-based hydrologic monitoring of groundwater and streamflow with hydrodynamic modeling to examine how instream BDA structures affect surface water hydraulics, groundwater storage, and discharge in a degraded northern Sierra Nevada meadow. By focusing on the building blocks of successful process-based restoration, we show how quickly and effectively hydrological processes can be manipulated to attain foundational restoration goals.

Scale Dependence and Habitat Selection by American Beaver (*Castor canadensis*)

Caroline Gengo, UC Davis Center for Watershed Sciences (Presenter), and Co-authors: Sarah Yarnell and Rob Lusardi, UC Davis, Center for Watershed Sciences; and Doug Kelt, UC Davis, Department of Wildlife

Animals interact with their environment at multiple scales (Johnson 1980). Understanding the impacts of these scales informs both conservation and ecological theory (Levin and Macarthur 1967, Weins 1989). As both keystone species and ecosystem engineers, American beaver (*Castor canadensis*) are crucial components of their habitats and landscapes. The historic decline of beaver has led to dramatic changes in flow patterns, sediment distribution, biotic interactions, and ecosystem function in streams throughout the United States (Wohl 2021). While beaver habitat preference and use have been well studied in mesic areas of eastern and central United States (Jenkins and Busher 1979, Muller-Schwarze 2011), further research is needed to understand how these prior findings will transfer to a diversity of habitats in the western United States. As process-based restoration gains popularity in the United States and globally, a deeper understanding of how beavers select habitats at multiple scales is essential for landscape and resource managers. Our study aims to answer three related questions: (1) At what scale do beavers select habitat? (2) What habitat components are beavers selecting for in headwater systems? (3) What habitat components regulate beaver dam density?

The scale at which a system is studied may impact the results that emerge (Weins 1989). This promotes bias in habitat predictive modeling as inputs are manipulated based on scale. Tailoring habitat scales to the ecology of the species will improve predictive modeling. We use a combination of remote sensing and field-based surveys to monitor habitat conditions at the reach, segment, and watershed scale throughout our study sites. Beaver will be trapped, tagged, and tracked using radio telemetry in Spring 2024 which, along with ongoing beaver dam surveys, will determine habitat use. Comparing the predictive power of habitat metrics at various scales will help determine the scale at which beavers select habitat. Habitat surveys done at appropriate scales can be used to assess habitat preference (use relative to availability) and potential impact (dam density). These assessments can help land managers and restoration practitioners create and identify habitats conducive to beaver colonization, promoting increased health and resilience in headwater stream systems.

Process-Based Restoration in the Upper Klamath Basin: Stories, Lessons Learned, and Continued Challenges

Charlie Erdman, Trout Unlimited (Presenter), and Co-author: Tommy Cianciolo, Trout Unlimited

Like elsewhere in the West, riverscape restoration strategies used in the Upper Klamath Basin have evolved over the last decade. Today, restoration practitioners are more focused on implementing process-based restoration techniques that blend a more fluid understanding of fluvial systems, attempt to restore wood accumulation, beaver activity, and dynamism to riverscapes, harness natural energy to achieve project goals, and minimize post-fire impacts. We provide an overview of process-based restoration, mainly of the low-tech variety, implemented in the Upper Klamath Basin over the last five years by Trout Unlimited in partnership with private landowners, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the Catena Foundation, Anabranch Solutions, and Swift Water Design. We also discuss preliminary monitoring results, focusing on riparian vegetation productivity, water quality, floodplain connectivity, fish, and groundwater. Finally, we present lessons learned and offer potential solutions to the continued challenges that this type of riverscape restoration offers in the Upper Klamath Basin. Hopefully, as capacity for this type of work continues to grow and evolve, so too does our collective understanding of restoring processes to fluvial systems and our ability to adapt to these evolutions in ideas and practices. Process-based restoration strategies, albeit relatively new in the Upper Klamath Basin, can offer creative and often cost-efficient means to achieve riverscape restoration benefits, assist in successful anadromous salmonid reestablishment of the Upper Klamath Basin, and restore a healthy system for all the basin's inhabitants.

Beaver and Process-Based Restoration: Opportunities and Obstacles 1

The Bright Green Future for Process-Based Restoration

Michael M. Pollock, Ph.D., National Oceanic and Atmospheric Administration (Presenter),
and Co-authors: Karen Pope, Ph.D., United States Forest Service
and Damion Ciotti, United States Fish and Wildlife Service

In the past two decades, process-based restoration has evolved from concept to widespread on-the-ground implementation. Beaver-based restoration in particular has been embraced by the restoration community, arguably because there is a strong scientific understanding of how beavers shape ecosystems and how they can be used to restore ecosystems. Less clear is how to restore other processes important to alluvial systems, such as sediment transport and deposition, natural rates for the infiltration, storage, and release of water, organic matter, and nutrient processing, and the natural transfer, storage, and release of thermal energy. Largely absent from process-based restoration discussions is how to restore biological processes such as intraspecies competition, commensalism, natural selection, and evolution, particularly in the context of a changing climate. Herein, we provide an overview of the development of the theory and practice of process-based restoration over the past two decades and look forward to developing trends. We examine how stronger consideration of biological processes, particularly in the context of climate change, is reshaping the science and practice of restoration.

Did this Thing Come with Instructions? Exploring Design in Restoration

Friday Morning Concurrent Sessions

Session Coordinators: *Eric Ginney, ESA, and Brian Cluer, Ph.D., NMFS*

Restoration is undergoing a paradigm shift where embracing natural processes to create and sustain habitat over time has started to replace the immediacy of habitat construction. Process-based restoration and the need to increase the pace and scale are now well-established in theory and application underpinning habitat restoration. Society is demanding a faster pace to salmonid habitat restoration to support recovery, as evidenced by the recent unprecedented flood of restoration funding. We need to do more, do it faster, and become even more effective. How will we efficiently design and deliver more and larger projects faster, and how will a relatively finite number of regulators efficiently and effectively review them?

Considering the question above, there are characteristics and tendencies of the restoration design process to balance competing interests, yielding a tension inside the design process stemming from efforts to strike that balance. Oftentimes (but not always) this is a healthy tension in the design process that receives attention, curiosity, and careful consideration: one example is dynamism versus certainty in outcomes; another is the long-term ecosystem uplift balanced against short-term impacts. But these tensions don't just play out in the abstract mind of a fisheries biologist, engineer, or geomorphologist—they play out within design teams and with landowners, public works officials, agency regulators, and citizen advocates. The fear of lawsuits, of doing harm, and failing (even the perception of failure!), is very real and can drive us toward increased design efforts to increase certainty and immediacy, reducing risks of all sorts (from ecological to reputational). Risk aversion can drive up costs, reduce progress, limit resiliency and other positive outcomes, sustainability, and even reduce collaboration.

Application of engineering principles to the restoration design process, while bringing benefits in terms of professional accountability and rigorous analysis, has often increased the degree of risk aversion. The problem with risk aversion is often emphasizing stability over dynamic processes, even when the true risks (consequences of something bad happening) are low or tolerable. Risk reduction can compound as project development proceeds from concept to design, review, and approval. At each step, fear of uncertainty may push the process and/or the design further from collaboration and a shared sense of success or failure.

Is all of that just inherent? This session will examine these factors, and others, and consider approaches to address these challenges including examples of ways to design and construct projects not commonly undertaken today. Session attendees will be better informed across a wide variety of perspectives and, optimally, will support them in making the call for a broader dialogue in the restoration engineering practitioner community on this subject.

This is a sensitive topic and we realize that. We also realize this is a broad topic, that context (such as risk) matters, and that one conference session is not adequate to discuss the breadth and nuance. We aim to get the conversation started and hope to create a thoughtful and reflective dialog that may, over time, result in some guidance on these basic questions.

Reflections of A Grumpy Old Engineer on the Design Process

Rachel Shea, PE, Michael Love & Associates, Inc.

Back of the napkin versus full plans and specifications? Something in between? How do we determine what level of design is the most suitable? What are the consequences? How can we learn and move forward? This talk explores the benefits and consequences of a range of levels of engineering design and makes suggestions on how to best select what is appropriate while managing expectations and minimizing costs and risks.

Did this Thing Come with Instructions? Exploring Design in Restoration

Pragmatic Aspects of Engineering and Geologic Involvement in Restoration

Jon Mann, PE, and Colin Hughes, PG, CEG, California Department of Fish and Wildlife (Co-presenters)

Continued improvements to environmental social perspectives and governmental structures regarding the relative value of healthy stream corridors in environmental planning processes are needed to conserve and restore the natural environment that is vital to human existence. The increasing human population and geographic distribution of human development across the landscape, much of which is "engineered", only causes the need for protecting and restoring natural ecosystems. Engineers and geologists have played a prominent role in land development, and while many have strived to balance protecting the environment from increasing development, it has resulted in substantial disturbance to natural ecosystems. These professions have evolved through time with a growing subset of these career fields working to conserve and restore the environment, especially rivers and creeks. Standards of practice in the planning, design, and implementation of restoration projects have improved but there is always room for more improvement. This background and the contemporary roles and responsibilities of professional engineers and geologists in protecting and restoring nature will be presented with an emphasis on appropriate levels of analytical and design processes for select types of restoration. Suggestions for improvements to societal and governmental structures relative to engineering and geology that may aid in increasing the pace, scale, and effectiveness of restoration will also be presented.

It's All Relative - Why Context is Important in Ecosystem Restoration

Jeff Sanchez, PG, PH, and Kristine Pepper, P.E, California Department of Fish and Wildlife (Co-presenters)

Specialists from the Department of Fish and Wildlife Conservation Engineering Branch will present perspectives, examples, and recommendations for the design and permitting of restoration projects. The unique context of each site and project is a primary factor informing the acceptable level of risk, design detail, and supporting information necessary for Department review and permitting. While stability may be a necessary element of some projects, others may have the goal of increasing stream dynamism or evolution; both restoration approaches require planning, analysis, and the participation of a diverse group of experienced and qualified practitioners. The inclusion of appropriately licensed professionals on the design team may be required for certain restoration project elements depending on the project context. Ultimately the Department has a vested interest in the pace, scale, and success of ecosystem restoration in California and has funding and technical support available to support ecosystem restoration.

Did this Thing Come with Instructions? Exploring Design in Restoration

Toward a Next Generation of Project Planning, Design, and Implementation

Darren Mierau, Regional Director, California Trout

The Planning, Design, and Implementation of salmonid and riverine restoration projects have undergone rapid and extensive changes in the past 25-30 years. California's community of restoration practitioners has come a long way to establish process-based restoration as the primary focus; developed routine and robust engineering design, permitting, and implementation processes; and we've increased our capacity to match the rapid increases in funding availability to implement more and bigger projects each year. We've established the environmental restoration industry, a "green infrastructure", as a legitimate and worthy endeavor. We have much to be proud of and much to learn from.

However, along with this rapid evolution, project designs, the engineering review process, and project construction have all grown more rigid, less ecological and more civil engineering, less experimental, and yes, way more expensive. We also may be running out of the "low-hanging fruit" category of projects, those no-brainer projects that didn't really require prioritization and competitive selection.

To respond to these rapid changes in our industry and ultimately meet our goals of protecting and recovering our cherished fish and watershed resources, we need to continue to evaluate, adapt, and evolve. This presentation will focus on three interrelated topics:

We need more watershed-scale master planning and less of the current 'competitive, shotgun-scatter' approach to project selection to establish a more 'directed-action' approach to project prioritization and selection for funding.

We have to reduce, and where feasible avoid, over-engineering and over-construction of projects; this will require us to re-assess the design process, consider more project alternatives, incorporate value-engineering, and transfer project liabilities, that are currently borne by project proponents and engineers, to the State.

Implementation is not enough; we MUST pair project implementation with a science and monitoring framework, to learn from projects (not all, just some; see #1 above), then advance new information and insights into the subsequent phases of design. This may result in fewer but more meaningful projects being funded per capita but will increase the probability of attaining meaningful recovery in the long term.

I don't have all the answers, but I really think we need to talk about these topics. Come join us!

Considering Construction at the Inception of Your Restoration Project

Mark Cederborg, Outset Advisors

The Benefits of Considering Construction at the Inception of Your Restoration Project: Ecological restoration often includes active implementation of specific field activities, frequently with the support of a construction contractor. This is often a critical stage of restoration, since it is the most intense period of activity, with the highest risk for ecological damage, and a substantial portion, if not most, of a project budget expended in a short period of time. It also typically involves handing a project package (plans, permits, specifications) over a "wall" from a well-calibrated project team to a party—the contractor—that is least familiar, and by default, the least vested in the project at the handoff. The contractor is then expected to fully understand the project background, plans, permits, intent, and risks, often within a matter of weeks, and provide a guaranteed cap on cost. Then, if awarded the work... the contractor must bring trade workers to the project and ensure that they understand it. To minimize risk, project proponents are placed in a defensive posture and must scramble to ensure that construction parameters are as constrained as possible, which includes guessing at every possible undesirable scenario and attempting to 'engineer' the construction process to ensure the contractor and its trade workers stay within the bounds set by nearly every other stakeholder, except the contractor and the trade workers. To meet the pace and scale of our economic sector's growth, we must start exploring simple ways to dramatically improve the construction contracting experience, without turning the public contracting process upside down. The first step is to prioritize construction as soon as a project is conceived—it will only get easier from that point forward. This presentation will introduce basic considerations for a more collaborative approach to the construction of ecological restoration that still follows public contracting conventions.

Employing Non-Engineered Techniques to Allow Fish Passage in Heavily Disturbed, Industrially Logged Landscapes

Thomas Leroy, P.G., CEG, Pacific Watershed Associates

Much effort has been put into removing or augmenting fish passage barriers throughout the Pacific Northwest over the last several decades. Most of these efforts have been at locations of important infrastructure such as roads, dams, and railroads where it is relatively easy to identify and treat these barriers. Generally, these efforts are supported by extensive engineering which can be very expensive and time-consuming. In many coastal watersheds subjected to industrial-scale logging, the landscape scale disturbances have resulted in less obvious but still impactful fish barriers. These barriers are typically observed as large wood accumulations that have formed as a result of river channels redistributing the available wood from myriad small- and medium-sized wood jams into a small number of very large jams. These large wood jams often impact the distribution of sediment in transport and are often flow-dependent, temporal barriers to fish migration. In this talk, we discuss the distribution and attributes of these log jams and provide an example of how a multidisciplinary team of restorationists successfully employed non-engineered techniques to remove such a barrier. Techniques discussed in this presentation may be useful to other restorationists working in heavily disturbed, low-risk stream systems.

Eel River Dam Removal: Opportunities and Considerations

Friday Morning Concurrent Sessions

Session Coordinator: *Charlie Schneider, Cal Trout*

Dam removal proposed as part of the license surrender and decommissioning of PG&E's Potter Valley Project has created an enormous opportunity to recover salmonids and other species of interest in the mainstem Eel River. The Eel is the third largest watershed in California and dam removal would create California's longest free-flowing river. This session will explore the opportunities and considerations associated with dam removal, how salmon might respond, and what associated restoration might be needed.

Why Eel River Dam Removal Is Urgent: Safety, Supply, and Salmonid Recovery

Alicia Hamann, Friends of the Eel River

Removal of the two dams in the Eel River headwaters is nearly assured. However, to secure the benefits of dam removal for salmonid recovery, dam removal must happen soon. This presentation will explore factors related to dam safety which are increasing the momentum for Eel River dam removal by reducing the reliability of Potter Valley Project water supplies.

The Potter Valley Project (PVP) is a failed hydroelectric project owned by Pacific Gas & Electric (PG&E) that consists of two dams on the Eel River and an inter-basin diversion into the Russian River. The larger of the two dams, Scott Dam, is rated as a high-hazard facility by the California Division of Safety of Dams (DSOD), meaning loss of life is likely in the event of dam failure.

When conservation groups suggested dam safety questions be included in relicensing study plans for the project, the Federal Energy Regulatory Commission (FERC) responded that dam-safety studies are "beyond the scope necessary for relicensing or unnecessary for the development of future license conditions." It is very difficult for the public to assess the risks, as nearly all of the details about dam safety issues at the PVP are classified by PG&E as Critical Energy Infrastructure Information.

In March of 2023, PG&E announced that, in light of a new seismic safety analysis of Scott Dam, it will reduce reservoir storage by about a quarter. The California DSOD emphasized that PG&E may not revert this change without authorization.

Meanwhile, different dam safety concerns around the buildup of sediment also prevent PG&E from fully emptying the reservoir. PG&E can't empty it too quickly and must leave at least 12,000 acre-feet.

A final factor is the National Marine Fisheries Service's requirement to preserve a supply of cold water through the dry season to protect Eel River fisheries. Thus, PG&E can neither fill nor drain the Pillsbury Reservoir at the heart of the project. Rather, it must use much of the project storage to protect Eel River fisheries until the Scott and Cape Horn dams are removed.

These three factors greatly reduce the amount of water supply available for diversions to the Russian River. Though some Russian River water users oppose dam removal, the baseline has shifted. The current status quo is not working for water users and their supply could be improved with a new project.

Multiple evaluations of the watershed behind Scott Dam have confirmed the high-quality aquatic habitat in the upper basin—288 miles of spawning, 180 miles of rearing habitat for steelhead, and 94 stream miles of spawning and rearing habitat for Chinook. Across the entire Eel watershed, the upper mainstem has the second highest proportion of cool-water refugia and suitable channel type for all salmonid life stages. To make this even more exciting, resident trout behind Scott Dam still contain the genetics to be summer steelhead—an incredible opportunity to restore the southernmost run of summer steelhead on the planet.

An Explanation of Regulatory Pathways for Potter Valley Project Decommissioning (and Other Boring Stuff)

Steve Edmondson, NOAA Fisheries

PG&E's Hydro System:

Hydropower development has drastically altered natural hydrologic conditions and aquatic habitat in California, resulting in substantial reductions in salmonid abundance.

PG&E operates the largest hydropower portfolio in the country. The PG&E hydroelectric system diverts 11 million acre-feet annually, accounts for 2.25 million acre-feet of storage, and extends 500 miles from Mt. Shasta to Bakersfield, includes 27 FERC licenses, 174 dams, more than 100 reservoirs, and a total generation capacity of 3,896 MW, accounting for approximately 5% of California's electric energy.

ESA-listed species impacted by PG&E hydroelectric operations include two species of threatened Chinook salmon, one species of endangered Chinook salmon, one species of threatened Coho salmon, one species of endangered Coho salmon, three species of threatened steelhead, and one species of threatened sturgeon.

The combined impacts of falling electricity prices (particularly baseload), increasing interconnection of PG&E's energy grid with rooftop solar, increasing numbers of PG&E's customers opting for alternative electricity providers, and PG&E's aging hydroelectric facilities, lead PG&E to conclude that many of its hydroelectric projects are no longer economically viable (see PG&E March 2018 briefing.)

Potter Valley Project:

PG&E recently halted relicensing and filed notice that it will not seek a new license. Consequently, FERC issued a notice soliciting license applications for the newly "orphaned" facilities.

The project is located on the Eel River and includes two dams, Cape Horn Dam and Scott Dam. Cape Horn Dam has fish passage facilities (requiring upgrading), while Scott Dam has no fish passage facilities. Scott Dam blocks passage for threatened Northern California Coast steelhead and California Coastal Chinook salmon to as much as 280 miles of habitat.

For over 100 years, the project has transferred water from the Eel to the Russian River.

Over this time, human population growth and a multi-million-dollar grape growing industry have been supported, in part, by this inter-basin transfer including part of the drinking water supply for half of a million people in Sonoma and Marin Counties.

This creates an uncertain future with the potential for major impacts to water supplies in the Russian River and significant impacts to five listed ESA species in both the Eel River (Northern California Coast steelhead, Southern Oregon/ Northern California Coast Coho, and California Coastal Chinook) and Russian River (California Coastal Chinook, Central California Coast steelhead and Central California Coast Coho).

U.S. Representative. Jared Huffman has engaged stakeholders in discussions toward a "Two-Basin Solution." The National Marine Fisheries Service (NMFS) is participating in these discussions and providing significant technical assistance to the effort.

Navigating a FERC surrender and decommissioning, procedural path, capable of addressing multiple resource needs is inherently complex. Crafting a final, durable solution will require an understanding of the scope of potential scenarios within a framework of FERC's jurisdiction, relevant case law, and existing precedent.

Hydropower Dam Decommissioning—Data and Decision-Making

Meghan Quinn, American Rivers

Only 46 federally regulated hydropower dams have been removed, less than three percent of the 2,025 dam removals that have occurred in the United States as of 2022. As hydropower dams across the country are aging and becoming uneconomical, unsafe, and obsolete, many dam owners are deciding to remove them. However, the decommissioning and removal of a hydropower dam entails years of process and regulatory hurdles contributing to an average timeline of more than five years. Each project requires collaboration and patience to navigate decision-making, project planning, site analysis, project design, stakeholder engagement, and aligning funding resources.

Research shows the Federal Energy Regulatory Commission (FERC) relicensing process is the most common time when dam owners or licensees decide to remove a dam. Of the thirty-four licensed hydropower dams that have been removed, twenty-three were initiated during the relicensing process. During the relicensing process, additional mitigation measures may be required to obtain a new license. In these instances, the expenses of maintaining a project coupled with bringing a project up to current safety and environmental standards, frequently evaluated and applied during the relicensing process, can render a project uneconomical.

Many of the 56 California hydropower projects that will be up for relicensing in the next decade are old, uneconomical, and cause greater harm to the environment and social justice than can be justified by the amount of power they generate. While most hydropower dams continue to serve a societal purpose by generating power, many others—both publicly and privately owned—have reached the end of their useful life or have operational costs that exceed the revenue from generation (economically marginal). Those dams can become public safety risks, impact fish and other aquatic life, and can be costly liabilities to their owners. Dam removal is a path to resolving all these issues, which dam owners are exploring with increased frequency.

The Potter Valley Project provides an interesting case study in dam safety and fish passage mitigation impacts on profitability. On the Eel River, a robust coalition of conservation organizations has been able to daylight numerous issues with facilities, which ultimately resulted in a decision by the dam owner to surrender and decommission the project. This talk will provide an overview of hydropower dam removal decision-making to set the stage for a discussion of the Potter Valley Project decommissioning.

Identifying Instream Flow Needs in the Eel River in a Post-Potter Valley Project Ecosystem

Scott McBain, McBain and Associates (Presenter), and Co-authors: Tim Caldwell, Suzanne Rhoades, Andrea Hamilton, and Katrina Harrison, McBain and Associates

The scheduled decommissioning of the Potter Valley Project (PVP) by PG&E is a unique opportunity in dam removal science and management. Unlike other dam removals, water diversion from the Eel River to the Russian River is likely to continue after dam removal and will require identification of the instream flow needed to maintain and restore Eel River aquatic resources downstream of the point of diversion. An Ad-Hoc Committee convened by Congressman Huffman in 2018 evaluated many potential future streamflow scenarios for the PVP and Lake Mendocino (Russian River), with one scenario showing promise for satisfying both Eel River ecological goals and Russian River water supply objectives. We are evaluating and refining the promising water supply scenario identified by the Ad-Hoc Committee by relying on a combination of traditional and new approaches to identify instream flow needs in the Eel River. Our approach focused on the life history needs of fish and aquatic species that utilize the Upper Eel River for the freshwater portion of their life history and are likely to be affected by future streamflow management. The key components considered include: 1) functional flow components (e.g., CEFF), 2) adult and juvenile fish passage needs, 3) water temperature and streamflow triggers for juvenile outmigration, 4) juvenile fish survival and growth using bioenergetics and individual-based modeling, and 5) contextualization of a refined Eel River instream flow scenario with reference or unimpaired flow conditions. Consideration of instream flow needs is based on the percent of unimpaired approaches and builds on recent approaches used elsewhere in California that develop instream flow needs that fall within the variation of reference or unimpaired conditions. This presentation will first provide an overview of the Huffman Ad-Hoc water supply management scenario, then present our application and results of these instream flow methods for refining post-decommissioning instream flow recommendations for the Eel River.

Designing a New Eel-Russian River Diversion Facility: Fish Passage Alternatives after Removal of Cape Horn Dam

Kevin Jensen, PE, McMillen, Inc. (Presenter), and Co-author: David Manning, Sonoma Water

As the surrender and decommissioning process for the Potter Valley Project advances, ensuring the continued reliable diversion of water from the Eel River to the East Branch Russian River is a key component and co-equal goal of the Two-Basin Solution Partnership. Consideration of continued diversions must address several important factors, including modern-day fish passage criteria, availability of water for diversion given in-stream flow requirements and run-of-river conditions, and flexibility in accommodating changes to mid- and long-term sediment loading associated with the removal of Scott Dam, among others. To address these needs and constraints, Sonoma Water and the Mendocino Inland Water and Power Commission received a grant from the California Department of Water Resources to develop preliminary engineering designs for new fish passage and water diversion facilities at the Cape Horn Dam site. Assuming the removal of Cape Horn Dam, an alternatives analysis has been underway that is considering the replacement of the dam's current function with either a gravity or pumped water diversion near the existing Van Arsdale Diversion facility along the Eel River. Throughout the process, multiple resource agencies, Native American tribes, and non-governmental organizations have been engaged and have provided important feedback to help identify a viable Two-Basin Solution. Evaluation of alternatives and the identification of a preferred concept to carry forward into engineering design are targeted for the Spring of 2024. In this talk, we will share some of the details of the alternatives under consideration, walk through the evaluation framework, and provide an update on the selection of a preferred alternative.

Evaluating the Trojan Y Chromosome Strategy for the Removal of Invasive Sacramento Pikeminnow from the Eel River, CA

Alex Juan, Cal Poly Humboldt (Presenter), and Co-authors: Andre Buchheister, Rafael Cuevas Uribe, and Darren Ward, Cal Poly Humboldt

In the decades since their 1980 introduction, non-native Sacramento Pikeminnow (*Ptychocheilus grandis*) have come to dominate Northern California's Eel River Basin. Known to prey on and compete with threatened native species such as salmonids, lampreys, and suckers, their invasion has been of major ecological and management concern from the start. Despite this, years of manual suppression have not successfully extirpated or significantly reduced what is now a substantial invasive population.

One recently proposed solution is the Trojan Y Chromosome (TYC) Strategy, a novel genetic biocontrol method that aims to extirpate an invasive population by eliminating females. This is accomplished by producing and stocking fish with YY sex chromosomes which breed and produce all-male offspring, shifting the sex ratio of the population until it collapses due to a lack of females. The goal of this project is to evaluate the feasibility of using the Trojan Y Chromosome Strategy to eliminate Sacramento Pikeminnow from the Eel River Basin, which will be accomplished by creating a simulation model of the system. Specific objectives are: 1) to estimate the number of YY Sacramento Pikeminnow and the timescale of stocking needed to achieve elimination; 2) to evaluate how manual pikeminnow suppression, YY pikeminnow survival, and YY pikeminnow phenotype (egg or sperm-producing) affect the effectiveness of a TYC program; and 3) to compare the feasibility of a TYC program across spatial scales. The results of this work will directly influence not only the decision to implement a YY stocking program but also the stocking numbers and management strategies used if one is put into place.

Eel River Watershed, a Resilience Refuge: Identifying a Riparian Corridor Strategy for Climate Resilience Following Dam Removal

Christine Davis, California Trout

Recent planning frameworks created to support conservation and restoration actions in California have identified the North Coast and Klamath regions as areas with some of the highest connectivity for species movement while simultaneously containing lands with the greatest risk of landscape conversion (Cameron et al., 2022; Schloss et al., 2022; Theobald et al., 2020). If the patterns of land fragmentation continue, in turn, connectivity for species movement will be impaired, making it more difficult for species to move to different locations as the climate shifts. The opportunity for improving the protected area network with strategic conservation planning in the North Coast of California, combined with the intent of California's 30x30 initiative to protect 30% of lands supportive of biodiversity and climate resilience by 2030, make the North Coast region in particular need of a climate-informed-biodiversity-conservation strategy when choosing areas for conservation. Conservation planning is a decision process of "when, where, and how" to protect biodiversity and connectivity (Pressey & Botrill, 2009). For connectivity planning in a watershed, a decision process is necessary because strategically identifying conservation suitability within connective riparian corridors can result in the protection of threatened biodiversity and connectivity at a landscape level (Krosby et al. 2018).

Biodiversity and landscape connectivity are two key pieces in urgent need of strategic focus as climate impacts and land use practices threaten the key habitat of anadromous fish and other species in the Eel River Watershed. Here we identify a methodology to identify a connected network of riparian areas in the Eel River Watershed to promote the resilience of biological diversity and protection of existing connectivity while considering the economic costs of conservation and the importance of climate refugia. To identify where there are gaps in the conservation of riparian corridors in the Eel River Watershed, data are incorporated into a spatial landscape analysis involving GIS, Marxan conservation planning software, and expert opinion. These data include climate-corridor ranking for refugia characteristics of riparian areas (data in process), priority habitat species, canopy cover, and anadromous fish species distribution among others.

The protection and potential restoration of strategic parcels within riparian corridors, if implemented, may improve landscape resilience against future threats to biological diversity and connectivity. In a fragmented landscape where multiple stakeholders and agencies are active managers, working proactively with a systematic and repeatable planning process for conservation will be a key step in the future of biodiversity protection and connectivity and thus, climate resilience across the watershed. The resulting landscape analysis provides a starting point to organize multiple data into sets of maps and to start agency and private landholder negotiations about how to implement conservation and restoration across the Eel River Watershed.

Juvenile Salmonid Spatial Structure Surveys as a Platform for Assessing Drought Effects and Informing Management Decisions on a Landscape-Scale

Chris Loomis and Seth Ricker, California Department of Fish and Wildlife (Co-presenters), and Co-authors: Bri Ordung, Jolyon Walkley, and Sarah Gallagher, CDFW

Drought is a significant driver of ecological and evolutionary dynamics of stream biota. Under anticipated climatic shifts towards more volatile precipitation, relative variability in streamflow permanence is expected to increase more than discharge itself. Our understanding of the consequences of drought for threatened and endangered salmonid species, particularly for intra-seasonal drought events, is lacking in coastal northern California, limiting management actions and appropriate responses to extreme drought. CDFW staff conducted two years (2022 and 2023) of dry season snorkel count surveys in coastal streams of the Mendocino coast and the Eel River to assess occupancy and abundance patterns of juvenile rearing Coho salmon and steelhead. Over two surveys periods, after spring recession and before fall pulse flows, juvenile salmonid abundance and habitat data were collected and paired with dry stream mapping to evaluate the extent and magnitude of stream desiccation coupled with fish response. Here we present the resulting occupancy and abundance patterns of juvenile salmonids between water years within dry seasons and the extent of habitat change observed. This adaptation to the single-season visit juvenile salmonid population spatial structure monitoring can provide a construct for assessing dry season drought effects and provide a foundation of information from which management and restoration decisions can be evaluated. We also reflect on the use of this methodology and its implications for landscape-scale monitoring of species status and trends.

Collaborative Conservation of Ishyâat in a Spring-Run Chinook Salmon (*Oncorhynchus Tshawytscha*) Stronghold: Results from the First Year

Amy Fingerle, UC Berkeley student (Presenter), and Co-authors: Toz Soto, Karuk Tribe; Matthew R. Sloat, Ph.D., Wild Salmon Center; Tasha Q. Thompson, Ph.D, Wild Salmon Center, Michael R. Miller, Ph.D, UC Davis; Beau Quinter, Karuk Tribe; Karuna Greenberg, Salmon River Restoration Council; Miranda Velarde, Salmon River Restoration Council; Theodore E. Grantham, Ph.D, and Stephanie M. Carlson, Ph.D., UC Berkeley

Spring-run Chinook Salmon (*Oncorhynchus tshawytscha)* are imperiled across their range. The Salmon River hosts the largest remaining non-hatchery population of spring-run Chinook Salmon in the Klamath Basin, making it a high priority for efforts to conserve Klamath Chinook salmon biodiversity. In 2023, UC Berkeley and the Karuk Tribe, Salmon River Restoration Council, UC Davis, and Wild Salmon Center began a multiyear study in the Salmon River to improve understanding of run-type distribution and the degree to which interbreeding among spring-run and fall-run Chinook Salmon is occurring. We collected fin clips from adult carcasses and juveniles captured via a suite of methods. We then genotyped these fish at the GREB1L genomic region, where alleles strongly correlate with run timing (spring-run or fall-run). Results from our first year indicate that fall-run Chinook Salmon spawn upstream of dynamited seasonal-hydrologic migration barriers that historically maintained a degree of reproductive isolation between runs, and that heterozygous Chinook Salmon are a major component of the run-type composition of Salmon River Chinook salmon. We discuss this cooperative effort, plans for 2024 and beyond, and the implications of this work in the context of spring-run Chinook Salmon recovery and reintroduction, Klamath dam removals, and Indigenous-led fisheries stewardship.

Ocean Ranch, Episode II: Return of the Sculpin, Smelt, Shrimp, Stickleback…Oh and Salmon, Estuarine Monitoring Post-Restoration at Ocean Ranch in Wiya't (Eel River)

Marisa McGrew, Wiyot Tribe (Presenter), and Co-authors: Kaydee Boozel, James Ray, Allan Renger, Chris Loomis, and Dave Kajtaniak, CDFW

The California Department of Fish and Wildlife (CDFW), Ducks Unlimited, and other partners restored 571 acres of estuarine salt marsh at the Ocean Ranch Unit (ORU) of the Eel River Wildlife Area (ERWA). Last year's SRF Conference field tour of ORU highlighted the on-the-ground restoration work, including lowering and removing levees and tide gates, reconfiguring channels, and constructing habitat features to reintroduce tidal exchange and improve connectivity in the Eel River estuary. Monthly fisheries monitoring has taken place since February of 2023 by CDFW, the Wiyot Tribe's Natural Resources Department, and Watershed Stewards Program Corps members and is planned to continue for five years; what have we observed in these tidal waters over the first year since restoration was completed?

This presentation will display the methods used in monitoring efforts, fish assemblage, and the importance and excitement of continuous monitoring in an estuarine environment. Estuaries are some of the most productive environments with rich species diversity that provide foraging habitat and a zone for physiological transition for salmonids. The Ocean Ranch Restoration Project is one of the largest restoration projects to take place in an estuarine environment in California. There is also an opportunity for these monitoring efforts to complement existing salmonid monitoring that occurs higher up in the Eel River watershed. Monitoring efforts in the estuary and lower river can help guide future restoration opportunities in this river that once provided massive runs of salmon, steelhead, and Pacific lamprey.

Assessing the Patient(s): Status, Trend, and Validation Monitoring to Understand the State of Salmon Populations and Recovery Efforts in Coastal California

Implementing and Monitoring Lateral Connectivity for a Large-Scale Salmonid-Rearing Habitat Restoration Project on the Yuba River

Sam Diaz, CBEC Inc., Eco Engineering and Avery Scherer, Cramer Fish Sciences (Co-presenters); and Co-authors: Kirsten Sellheim and April Sawyer, Cramer Fish Sciences; Chris Hammersmarck, cbec Eco Engineering; Aaron Zettler-Mann, South Yuba River Citizens League; Paul Cadrett, United States Fish and Wildlife Service; and Jeff Mathews, Yuba Water Agency

Anthropogenic actions on the Lower Yuba River dating back to the Gold Rush altered geomorphic and hydraulic conditions, and subsequently available habitat for rearing juvenile salmonids. The Hallwood Side Channel and Floodplain Restoration Project was completed in the fall of 2023 to address the U.S. Fish & Wildlife Service Anadromous Fish Restoration Program's goal to double the natural production of Central Valley anadromous fish. Specifically, the Project was designed to enhance ecosystem processes for juvenile rearing fall and spring-run Chinook salmon and California Central Valley steelhead. The Project is supported by numerous stakeholders, and leverages relationships with aggregate mining landowners, facilitating innovative, economical habitat enhancement. The design process targeted increasing inundation frequency and duration during the rearing period in a network of perennially and seasonally inundated side channels, removing unnatural constraints between the main channel and floodplain areas, and reducing predator habitat. Over five years of construction, 157 acres of juvenile salmonid-rearing habitat was created, including nearly two miles of restored side channels and alcoves and more than six miles of seasonally flooded side channels.

The Project included a robust monitoring program that measured the effect of restoration on a range of ecological parameters thought to influence salmonid habitat use and productivity and riparian ecosystem function using a Before-After-Control-Impact study framework. Specifically, we monitored salmonid and non-native predator density, juvenile salmonid growth and residence time, predation, invertebrate prey (drift) density and biomass, and changes in acreage of a range of habitat types, including terrestrial and aquatic vegetation. We also examined factors influencing natural riparian tree recruitment and survival following restoration. Future years of monitoring will document Project performance under a broader range of environmental conditions and with subsequent construction phases completed.

Drought Refuge Monitoring in Selected Central California Coho Salmon (*Oncorhynchus kisutch*) Watersheds

Elizabeth Ruiz, California Department of Fish and Wildlife (Presenter), and Co-authors Callie Schultz, Monica Tonty, Derek Acomb, David Hines, and Manfred Kittel, California Department of Fish and Wildlife

Following Governor Newsom's drought emergency proclamation in spring 2021, the Department of Fish and Wildlife (CDFW) received State funding to address drought conditions and help build resilience to drought. In the summers of 2021, 2022, and 2023, CDFW Bay Delta Region biologists implemented monitoring projects in several sub-watersheds of the lower Russian River Basin in Sonoma County, Pescadero Creek in San Mateo County, and Scott Creek and other watersheds in Santa Cruz County to assess Coho salmon (*Oncorhynchus kisutch*) habitat availability and quality in the late summer. Identifying and protecting drought-resilient habitat that can support salmonids during the driest months of the year could be a key management strategy in the recovery of these populations under increasingly volatile climatic conditions.

In San Mateo and Santa Cruz counties, we mapped late-season conditions of surface flow via wet-dry surveys to inventory where wetted habitat may persist. In tributaries of the Russian River, where there is a robust dataset demonstrating where perennial flow remains even in drought years, we characterized pool habitats under low flow conditions to determine the suitability of those habitats for over-summer rearing of juvenile salmonids. Additionally, to better understand the relationship between riffle crest thalwegs and stream flow, we installed three streamflow gages in tributaries where surface flow disconnection is uncommon even during drought years.

We will summarize the results of these monitoring projects and provide recommendations for improving or maintaining the integrity of these drought refuge habitats. Ultimately, data collected in these projects will increase CDFW drought preparedness in these basins and will inform future drought-related management actions to support threatened and endangered salmonids.

Assessing the Outcomes of a Half Century of Hatchery Intervention for a Critically-Endangered Coho Population

Alexander Johanson, University of California, Davis

Pacific salmonids in California have exhibited precipitous declines over the last century. Central Coast Coho salmon (*Oncorhynchus kisutch*) have been reduced to less than 1% of historical abundance and the Tomales Bay Watershed has been designated as a priority region for Coho recovery by the National Marine Fishery Service. While the main tributaries Lagunitas, Olema, and Walker Creeks, all support runs of Coho, Walker Creek is unique since its population had declined so drastically that by the 1970s hatchery intervention was necessary to prevent extirpation. While the population has rebounded to an extent, hatchery stocking is ongoing and there has yet to be any formal analysis of the effects of this continuous activity and its impacts on the wild descendants of hatchery individuals. To determine if there were differences in size and out-migratory behavior between the wild and hatchery Coho, we implanted the Walker Hatchery juveniles with PIT Tags prior to their fall releases and operated a downstream migrant trap in 2022 and 2023. We then compared the Walker smolt data to the Lagunitas smolt data. Preliminary results indicate that in both years, all three populations (Lagunitas wild, Walker wild, and Walker hatchery) exhibited significant differences in length and mass at outmigration when compared to each other. While the Lagunitas individuals were smallest on average and with higher deviation in both years, they had the largest abundance in 2022, but were eclipsed by Walker wild in 2023. In both years, Lagunitas Coho started their outmigration sooner and ran longer in 2022, but Walker wild had the latest outmigrants in 2023. In 2022 and 2023 there were significant differences between the Lagunitas and the Walker populations for outmigration date. The Walker populations had similar outmigration behavior in 2022 but were significantly different in 2023. While year-round life cycle monitoring efforts are still limited in the Walker Creek watershed, these results indicate that hatchery intervention has increased the abundance of Walker Creek Coho and that the continued stocking of hatchery juveniles increases diversity for the Walker population. Enhancing monitoring efforts in this tributary will be of substantial value in identifying variables associated with outmigration differences in hatchery versus wild Coho and potentially identifying factors that are currently limiting Coho recovery. Once these obstacles have been identified, targeted restoration plans can be created to help increase CCC Coho abundance toward recovery targets.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Friday Afternoon Concurrent Sessions

Session Coordinators: *Monty Schmitt, The Nature Conservancy; Matt Clifford, JD, Trout Unlimited; and David Dralle, U.S. Forest Service, Pacific Southwest Research Station*

Groundwater contributions to instream flows, particularly in the dry season, are essential for the restoration of rivers and the recovery of salmonid populations. Historic logging practices, changes in land use, the legacy of fire exclusion, and increasing well diversions have all contributed to depleted streamflows. Efforts to manage groundwater resources, like the Sustainable Groundwater Management Act and recent efforts by county planning departments have yet to address the complex technical and regulatory issues associated with avoiding or mitigating existing cumulative impacts and permitting for new wells. Additionally, existing state-wide legislation manages groundwater only in large groundwater basins like the Central Valley, neglecting the essential role of hillslope groundwater systems in the small headwater watersheds that support salmon populations. Increasingly, groundwater infiltration and recharge projects are being proposed, but securing permits for restoration actions and predicting the benefits of actions are not always straightforward. This session will address three main challenges and explore solutions regarding groundwater modeling of streamflow depletion in diverse (geology, biome, etc.) landscapes, designing and permitting infiltration and flood recharge projects, and efforts to develop county groundwater well ordinances to protect public trust resources.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Unified Modeling Approaches to Estimating Streamflow Depletion due to Groundwater Pumping

Nicholas Murphy, The Nature Conservancy (Presenter); and Co-authors: Monty Schmitt, The Nature Conservancy; Sam Zipper, Ian Gambill, and Shawn Saving, University of Kansas; Matt O'Connor, Ph.D., and Jeremy Kobor, MS, PG, O'Connor Environmental Inc.; and Ben Kerr, Foundry Spatial

Functional flows for streams and rivers (with an emphasis on dry season baseflows), groundwater well ordinances that are protective of public trust resources, and sustainable groundwater management protecting groundwater-dependent ecosystems at a statewide level, all rely on an in-depth understanding of surface water-groundwater dynamics. Currently, technical gaps exist that limit our ability to evaluate streamflow depletion impacts due to groundwater pumping. Several existing project areas lie at the intersection of these issues. In Sonoma County, county permitting agencies are in the process of implementing a revised well ordinance to assess impacts to public trust resources for future well-permitting decisions. In the Scott River watershed, degraded instream flows have resulted in passage and habitat impacts to salmonids. Statewide, regional agencies are grappling with the development of sustainability criteria to prevent undesirable results related to interconnected surface water-groundwater resources under the Sustainable Groundwater Management Act. In all cases, estimates of streamflow depletion due to groundwater pumping are necessary to inform water resources management decisions. This presentation presents a suite of modeling approaches to evaluate streamflow depletion caused by groundwater pumping in Sonoma County and Scott Valley, CA. Working with experts in both analytical and numerical groundwater modeling techniques, these pilot projects serve as use-case investigations, helping to develop unified modeling solutions to evaluate streamflow depletion in these project areas and build trust across stakeholder groups as transparent modeling best practices are better understood.

The Other Water Users: How Plant and Human Water Use Impact Streams

Dana A Lapides, USDA-ARS Southwest Watershed Research Center (Presenter), and Co-authors; David Dralle, Pacific Southwest Research Station, United States Forest Service; W Jesse Hahm, Department of Geography, Simon Fraser University; John Hammond, U.S. Geological Survey, Maryland-Delaware-District of Columbia Water Science Center; Daniella M Rempe, Jackson School of Geosciences, University of Texas; and Sam Zipper, Kansas Geological Survey

Groundwater inflows to streams regulate streamflow timing and magnitude as well as water quality, serving as an essential control on aquatic ecosystems. Upstream extractions of subsurface water, by both groundwater pumping and plant water use, can impact groundwater contributions to streams. In this presentation, we will: (i) explore how plant water use impacts streamflow generation using two case studies in which we are able to quantify the role of plant water use on streamflow and (ii) survey commonly-used methods for modeling streamflow depletion from groundwater pumping to consider the limitations in our ability to account for or disentangle plant water use from human water use. The findings demonstrate that further work is needed to develop reliable benchmarking datasets for streamflow depletion research and to develop techniques for distinguishing the impacts of groundwater pumping and climate on streams and the communities that rely on them.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Quantifying Streamflow Depletion from Groundwater Pumping using Storage-discharge Functions in Headwater Catchments

Phil Georgakakos, Ph.D., UC Berkeley (Presenter),
and Co-authors: David Dralle Ph.D., Forest Service; Chris Dillis Ph.D., UC Berkeley; Jesse Hahm Ph.D., Simon Fraser University; Dana Lapides Ph.D., US Forest Service; and Ted Grantham Ph.D., UC Berkeley

Predicting streamflow depletion from groundwater pumping in salmon-bearing headwater catchments has long posed challenges. This is particularly true in regions such as northern California, where hydrologic dynamics differ from those in lowland systems with extensive aquifers and less seasonal patterns of precipitation—the settings in which many classic groundwater models were developed. To address this challenge, we present a novel framework designed to estimate streamflow and assess the potential for depletion resulting from groundwater pumping in headwater catchments. Our method leverages groundwater storage-discharge sensitivity functions and is appropriate for catchment-scale inference. These models require discharge measurements, which are used to estimate groundwater storage that drives streamflow and can in turn be used to estimate discharge at the next timestep.

To illustrate the utility of this strategy, we present a case study using hypothetical cannabis agriculture as the water user in two well-studied streams within the Eel River basin, Dry Creek and Elder Creek. Empirically assessing the impacts of groundwater use for cannabis agriculture on streamflow is complicated due to the distributed network of extraction, high natural variability in streamflow conditions, the complexity of watershed hydrology, and uncertainties associated with cannabis water-use practices. In this case study, we use a scenario-based approach to quantify the potential of multiple parameters to deplete streamflow. These parameters include cannabis cultivation area, irrigation water source (well or surface diversion), irrigation efficiency, water year type, and catchment lithology. Our models show when Elder Creek, a perennial salmon-bearing stream, is hypothetically populated with 1% areal cannabis cover, groundwater extraction may lead to complete dewatering in the late dry season. In Dry Creek dry season intermittency could be accelerated by five weeks. Notably, flow impacts are projected to be more pronounced in drier years and the impacts from well-water extraction exhibit a delayed effect relative to surface water diversion. The application of storage-discharge functions, such as those presented in our case study, could be widely applied to gauged headwater streams to estimate the impacts of various groundwater users that have been historically challenging to study.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Approaches for Evaluating Streamflow Depletion: Shedding Some Light on the Secret, Occult, and Concealed Nature of Surface Water/ Groundwater Interactions

Jeremy Kobor, MS, PG, Senior Hydrologist, OEI, Inc. (Presenter),
and Co-author: Matt O'Connor, Ph.D., President, OEI, Inc.

Evaluating reductions in streamflow due to groundwater pumping (streamflow depletion) is a particularly intractable problem due to the inherent difficulties in directly measuring depletions, the large number of factors responsible for causing depletion, and the heterogeneity and general lack of comprehensive characterization of subsurface hydrogeologic conditions. These challenges led to a 1904 Texas supreme court decision declaring that the movement of groundwater was 'so secret, occult, and concealed that any attempt to administer a set of legal rules would be practically impossible'. Significant progress has been made toward developing approaches for characterizing and regulating surface water/ groundwater interactions and streamflow depletion in the 120 years since this statement was made; nevertheless, our understanding of these processes remains incomplete.

Effective management requires a clear differentiation between "acute"' and "cumulative" streamflow depletion. Acute depletion occurs when wells are closely connected to streams and the response time of streamflow depletion to pumping is relatively short (months or less). Cumulative streamflow depletion is triggered by the influence of the total groundwater use in the basin on the overall water balance and may occur on much longer timescales. Evaluation approaches and regulations tailored to the type of streamflow depletion they are intended to protect against are most likely to be effective. Approaches for quantifying streamflow depletion range in complexity from simple water balance methods to analytical streamflow depletion functions to complex integrated surface water/groundwater numerical models. Here we discuss the application of numerical modeling of streamflow depletion in four high-priority Coho watersheds in the lower Russian River and how these tools were combined with analytical depletion functions and a simple water balance approach to help inform the development of an updated well ordinance for Sonoma County.

Numerical model findings indicate that groundwater pumping results in complex feedback with other hydrologic processes such as groundwater recharge and evapotranspiration by riparian vegetation, and that in bedrock aquifers, streamflow depletion can take decades to fully manifest, further complicating efforts to regulate groundwater for the protection of streamflow. Acute streamflow depletion impacts are best minimized by stream setbacks and/ or storage and forbearance projects and analytical depletion functions appear to be an appropriate tool for evaluating these protections. However, our analysis suggests that this type of depletion is relatively rare in the bedrock-dominated lower Russian River tributary watersheds and that these types of regulations may be ill-suited to protecting against cumulative streamflow depletion. Effective regulation of cumulative depletion requires a more holistic approach as the individual impacts of any given well may be small but become significant when combined across a watershed. Water balance approaches can provide effective risk-assessment level analyses for cumulative depletion, but ultimately numerical models may be needed in critical areas where more accurate and detailed information is needed. The Sonoma County example provides a roadmap for how to apply a variety of approaches for estimating streamflow depletion within the context of creating an adaptive regulatory framework.

From Groundwater to Streamflow: Exploring the Science, Projects, and Policies to Manage Groundwater Resources to Support Streamflows for Salmon and Public Trust Resources

Process Controls on Low Flows in Salmon-Supporting Headwater Catchments: What Do We Know (and Not Know, but Could) That Can Help Inform Management?

David Dralle Ph.D., USDA Forest Service Pacific Southwest Research Station (Presenter); and Co-authors: Jesse Hahm Ph.D., Simon Fraser University; Daniella Rempe Ph.D., University of Texas at Austin; and Bill Dietrich Ph.D., UC Berkeley

Groundwater aquifers inside of hillslopes sustain dry season stream baseflows that are essential for salmon survival. However, hillslope groundwater systems in upland landscapes are difficult to monitor and there are important unanswered questions regarding the connection between groundwater storage and low flow volumes.

This presentation begins with an overview of our current understanding of groundwater systems and low flows in headwater catchments. Observational, modeling, and remote sensing studies shed some light on the hillslope drivers of groundwater recharge and drainage to streams. Other studies highlight the influence of geomorphic and hyporheic processes in the channel that can affect surface water presence/ absence. We discuss how some of this science is currently being used to guide management and highlight new opportunities from emerging studies.

Next, we consider some important unanswered questions regarding our understanding of groundwater and flow. For example, where do trees (broken down by species, age class, and hillslope position) get their water in the summer and how does this impact flow? The deeply weathered, structured subsurface of headwater hillslopes stores water in shallow unsaturated soils, unsaturated weathered bedrock (rock moisture), and saturated (below the groundwater table surface) weathered bedrock. How might plant water extraction from these different zones impact flows in different ways? What are the implications for flow enhancement strategies? How are these hillslope processes linked to the channel environment and channel restoration strategies, such as headcut reinforcement or beaver dam analogue construction?

Effects of Short-Term Flow Reductions on Juvenile *O. Mykiss:* an Experiment at the Sierra Nevada Aquatic Research Lab

Kelly Goedde-Matthews, UC Davis Center for Watershed Sciences (Presenter); and Co-authors: Robert Lusardi, Ph.D., UC Davis, Department of Wildlife, Fish and Conservation Biology; and Nann Fangue, Ph.D., UC Davis, Department of Wildlife, Fish and Conservation Biology

Cold freshwater habitats are rapidly declining in response to climate change and practices associated with anthropogenic water use. This is having deleterious effects on the species that rely on these habitats. State and federal regulations currently allow water trucks to pump water from streams for dust abatement associated with timber harvest or for agricultural activities such as cannabis cultivation. While there are guidelines and regulations limiting the amount and rate of water that can be pumped from streams, the effects of these repeated short-term flow reductions have not been robustly monitored nor quantified. Additional research would be beneficial to evaluate whether current water drafting regulations in California are effectively maintaining fish in good condition, particularly during low flow or drought-stricken periods. This study uses an experimental approach to test the effectiveness of existing regulatory limitations on water drafting. Using a series of replicated experimental streams at the Sierra Nevada Aquatic Research Lab, we tested the effects of repeated short-term flow reductions on juvenile *Oncorhynchus mykiss*. Half of the channels were exposed to a drafting treatment that reduced flow from 1.7 cfs to 0.6 cfs twice daily, five days a week. 1.8 cfs was maintained in the remaining channels throughout the duration of the experiment. This study evaluates fish condition in response to repeated short-term flow reductions, as authorized under existing regulations. Primary response variables include those associated with growth, motility, and physiology. Preliminary results suggest increased mortality and reduced growth rates when fish were exposed to drafting treatments compared to *O. mykiss* in control channels. The results of this study will inform conservation and management practices to ensure continued protection of freshwater habitats and the species that depend upon them.

Oops! I Didn't Mean to Do That —Restoration Endeavors with Unintended Outcomes

Friday Afternoon Concurrent Sessions

Session Coordinator: *Rachel Shea, PE, Michael Love & Associates*

It's time to air your dirty laundry of unforeseen restoration outcomes so that your SRF friends do not repeat them. This session is intended to create an accepting space to discuss restoration actions that you have tried and may not have worked out as well as you anticipated. It's better to share information on what hasn't worked whether it is in monitoring, design, or construction so that we can all move forward to improve our fisheries.

A River Ran Through It...

Paul DeVries, Ph.D. PE, FP-C, Kleinschmidt Associates

River, floodplain, and fish habitat restoration and enhancement are noble objectives involving projects that can provide a forum for overcoming technical challenges, allow for creativity, and lead to a sense of accomplishment. Opportunities and funding for projects have been extensive. It is not surprising then that there has been such a great supply of practitioners in our field. But as the young, frolicking restoration designers venture into the dark barn to party, they may run into some foreboding aspects and unsettling outcomes. The inherent uncertainty in our field is often manifested by the river ignoring what we would like it to do, sometimes with impacts to private property, infrastructure, and public welfare that result in the exposure of the designer or project owner to significant financial loss. This talk gives sobering examples where the project owner or designer was blamed for some undesirable outcome, how that impacted them professionally and financially, and what protections were missing. The circumstances, names, and places have been changed to protect the innocent and avoid violating confidentiality requirements and the terms of a settlement agreement. The focus is on how language in contracts, reports, and designs is important, in what ways are landowner agreements insufficient, what to expect with outside experts, why liability insurance companies may not be our friend where monetary damages are involved, and what does a 'deductible' really mean?

Oops! I Didn't Mean to Do That —Restoration Endeavors with Unintended Outcomes

Unanticipated Outcomes after Wildfire in the York Creek Dam Removal Project

Aaron Sutherlin, Riverscapes and Shorelines Director, WRA

In 2020, the Upper York Creek Dam, located outside St. Helena in Napa County, was removed to restore access for steelhead to more than 1.5 miles of spawning habitat. The 50-foot earthen dam was built around 1900 to create a water supply reservoir and blocked all fish passage. WRA worked closely with the City of St. Helena, National Marine Fisheries Services, Napa County Resource Conservation District, and other agencies and stakeholders to develop a process-based design approach for the creek after the dam was removed that would provide increased habitat for steelhead, facilitate fish passage, and protect the adjacent road and downstream infrastructure. The design included the excavation of a pilot channel through the accumulated sediment behind the dam and the installation of a series of log structures to capture the remaining sediment as it was washed downstream during flood events. Despite extensive planning and careful implementation, no one could have foreseen the Glass Fire sweeping through the project site shortly after completion. After the fire, there were significant concerns about how the project would function after such an impact and what repairs might be needed. Surprisingly, only a few of the log structures required repairs or replacement, for which WRA helped the City of St. Helena apply for insurance funds to cover the costs. The presentation will cover how impacts from the fire were assessed and repaired, the strong ecological performance of the project in spite of the impact, and other lessons learned in dealing with unexpected challenges in river restoration.

Dredge Tailings are Made of Giant Drain Rocks

Charnna Gilmore and Betsy Stapleton, Scott River Watershed Council (Co-presenters)

The Scott River Dredge Tailings encompass the Scott Valley for 5 miles. They are composed of piles of cobbles and dewater yearly, thereby denying fish access to 20% of the watershed. They are a daunting challenge, with no significant restoration efforts until 2014 when the Scott River Watershed Council (SRWC) implemented beaver dam analogues (BDAs) as a pilot project and experienced remarkable success. Emboldened by the BDA success, SRWC proceeded with floodplain excavations at two sites in the tailings, along with the installation of engineered log jams (ELJs). Unexpected consequences were encountered, which required creative problem-solving and close coordination with funders and permitters. We will discuss the problem, how we remediated it, the lessons learned, and the ecological uplift achieved.

Oops! I Didn't Mean to Do That —Restoration Endeavors with Unintended Outcomes

Honolulu Bar Restoration—A Decade Later, How Did We Do?

J.D. Wikert, U.S. Fish & Wildlife Service

We implemented a floodplain and side-channel restoration project in 2012 on the Stanislaus River. The project goals were to reduce stranding of adult salmonids in the existing side channel and to convert perched floodplain into annually inundated habitat for rearing juvenile salmonids. A multi-year drought and beaver herbivory hampered revegetation success above the floodplain, while the floodplain facilitated the natural recruitment of native vegetation. Regulatory design constraints (elderberry setbacks) resulted in a more dynamic floodplain evolution but also reduced the opportunity for additional floodplain creation (concerns over water surface elevation increases). Gravel mobilization in the main channel has reduced flows to the side channel under low-flow conditions. Maintenance of projects, especially gravel augmentation projects, is essential in watersheds without a suitable bedload of mobilized sediments upstream of the project site. Designing for diversity and evolution of the project as well as periodic evaluation and maintenance are highly desirable in river restoration.

Lessons Learned—Hemphill Diversion Facility Fish Passage and Screening

Jon Burgi, P.E., Project Manager, McMillen, Inc.

The Nevada Irrigation District (NID) owns and operates the Hemphill Diversion Structure on Auburn Ravine near Lincoln, CA. Since the 1930's, NID has used the facility to divert water from Auburn Ravine into the Hemphill Canal to deliver water to area irrigators. The existing 64-foot-wide concrete structure with removable flashboards created an 8-foot-tall fish barrier to upstream migration of salmon and steelhead. Additionally, the historic point of diversion is unscreened.

NID contracted with McMillen in September of 2021 to prepare an alternatives analysis and design for replacing the existing diversion structure with a roughened ramp fishway and a renovated diversion including fish screening. Construction took place in the summer of 2022 and water began to flow down the roughened rock ramp in October, providing volitional passage for salmon and steelhead.

Lessons learned through challenges encountered throughout the conception, design, construction, and commissioning of the Hemphill Fish Passage and Screening Project will be presented. While the technical aspects of this passage/screening project were not complex, this project highlights some of the challenges of coordination between clients, agencies, consultants, and contractors. For this project, these challenges resulted in schedule delays during planning, design, and construction which led to overall project cost increases. The challenges faced and responses to those challenges will be shared along with suggestions for how agency, client, consultant, and contractor personnel might better prepare for these challenges in future projects.

Oops! I Didn't Mean to Do That —Restoration Endeavors with Unintended Outcomes

Learning From What Does Not Work —The Experimental Nature of Streamflow Restoration

Tasha McKee, Sanctuary Forest

I look forward to sharing stories of projects that did not work out as hoped and that led to a more thorough understanding and assessment of the streams we work in and the processes we are trying to affect. Thirteen years ago, we developed a collaborative team to develop and implement pilot projects to improve summer flow. I was very optimistic and thought that within 10 years we could restore flows to several of our most important Coho tributaries. We set about learning from other parts of the country and the world and applied concepts and techniques. This presentation will focus on our instream work to address entrenched channels with beaver dam analogs (BDAs) - both post and weave structures and log weirs. In our first projects, we did not understand the importance of sediment sources and potential bedload. In these entrenched channels, approximately three feet of the streambed depth had been lost due to stream cleaning and wood removal. Somehow, we thought that if we installed wood to raise the channel, natural processes would deposit gravel upstream of the structures. However, this only happened in one tributary, and in the other two tributaries, there was not a sufficient sediment source to provide the bedload. We had created weirs and BDAs within a sediment-deficient process with the consequences of weir and BDA scour, along with significant challenges in maintaining fish passage over the structures. Today we are learning that restoring floodplain connection and reversing channel entrenchment is not as easy as adding wood and that even wood loading can cause downstream sediment-starved impacts. The "Oops" goes back to the beginning of our early settlers and the many generations that followed who did not understand the natural processes essential for rearing habit and salmon abundance. Perhaps the most important lesson is humbleness- realizing that there is a lot that we do not know, learning from our mistakes, learning from others, and not giving up. And - if we have lost our streambeds - sometimes the best way to build them back up and restore floodplain connectivity includes grading the floodplain and using the floodplain material to place in the stream.

Expanding Process-Based Restoration in California with a Network Approach

Carrie Monohan, Ph.D., The Sierra Fund (Presenter),
and Co-authors: Karen Pope, Ph.D., Pacific Southwest Research Station, USDA and John Downs, CDFW

Okay, we are getting better at understanding what to do, so now the important question becomes how are we going to meet the critical need to restore thousands of degraded low-gradient streams and meadows across California? While it is important to have professional restoration practitioners to show what is possible and to test the limits, the existing companies are spread thin and travel extensively to implement restorations statewide. To increase the efficiency, pace, and scale of restoration, we envision a systems approach that results in local aquatic restoration collaboratives that work with upland restoration practitioners to implement stream restoration in sync with upland treatments such as forest thinning and controlled burns. The collaboratives would include local tribes and work closely with National Forest and State partners to prioritize, design, fund, permit, and implement restoration projects within the watersheds they care most about. The California Process Based Restoration (Cal PBR) Network Technical Advisory Committee will serve as a central informational hub to track projects and help guide planning in a way that builds capacity to support future planning, implementation, and project management of restoration projects on National Forest System lands. A pilot of this approach is being planned to inform the development of a replicable model to increase the pace and scale of implementing process-based restoration. A restoration template that includes the plans, lessons learned, and other products created as part of this project will be shared at Cal PBR's quarterly meetings, SRF annual conferences, and Cal PBR trainings. All materials will be shared widely to inform and expedite future projects.

Process-Based Restoration Enhances Geo-Hydro-Biodiversity in Riparian Systems Post Dam Removal: A Case Study of Dry Creek in the Northern Sierra Nevada Foothills

Matt Berry, M.S., Sierra Streams Institute (Presenter), and Co-authors: Jeff Lauder Ph.D., Josh Zupan, Jonathan Gomez, and Kyle Leach P.G., Sierra Streams Institute

Dam removal projects in the western United States typically rely on conventional form-based restoration techniques, which are resource-intensive and have a significant carbon footprint. This study explores the effectiveness of integrating process-based restoration methods with form-based designs in the context of a dam removal project in Dry Creek, a 114.6 mi^2 watershed in the northern Sierra Nevada foothills.

Methods: Dam removal on Dry Creek commenced in July 2020, employing form-based restoration techniques to enhance anadromous fish passage and habitat. However, restoration efforts were compromised by high flow events in October 2021 and December 2022. The research aims to assess the long-term impact of both form and process-based restoration techniques on the riparian ecosystem by analyzing pre- and post-implementation data, including vegetative, wildlife, salmonid, hydrogeomorphic, water quality, and benthic macroinvertebrate parameters. The Surface Water Ambient Monitoring Program (SWAMP) protocol was utilized to measure water quality, benthic macroinvertebrates, and physical habitat. The study also draws insights from historic flood impacts on artificial floodplain and channel construction.

Results and Conclusions: Preliminary findings indicate a notable increase in the percentage of EPT (*Ephemeroptera, Plecoptera, Trichoptera*) in riffles during spring ("peak flow") and a decrease in riffles in the fall ("base Flow"). In the pools it was the opposite, lower % EPT in spring but higher in fall. This positive outcome may be attributed to beaver pools serving as refugia for macroinvertebrates during low flow periods, creating a biologically rich habitat for aquatic life.

The study observed minimal plant cover after high flow events; however, this absence facilitated the natural regeneration of riparian species such as cottonwood, willow, alder, ash, sycamore, and button willow. After two years of growth, these species are now thriving and reaching heights exceeding head height. These encouraging results underscore the potential of process-based restoration approaches to foster geo-hydro-biodiversity in riparian ecosystems following dam removal, presenting a more sustainable and resilient alternative to traditional form-based techniques.

Symbiotic Restoration on Martis Creek, Truckee California —A Story of Inter-species Cooperation

Catherine Schnurrenberger, Botanist, and Peter Kulchawik, C.S. Ecological Surveys and Assessments (co-presenters), and Co-author: Brian Hastings, Geomorphologist, Balance Hydrologics

The 2011 Martis Watershed Assessment by Balance Hydrologics characterized a 2-mile reach of Martis Creek and adjacent meadow through Martis Valley, near Truckee, California, as a moderately incised channel impacted by legacy ranching and logging activities. Like many Sierra Nevada meadows systems, the creek was incised enough to dewater adjacent meadow and riparian vegetation, causing a loss of wetland area and function. However, evidence of a small beaver (*Castor canadensis*) population and the fact that the reach is owned by a single landowner (U.S. Army Corps of Engineers) presented a significant opportunity for process-based, reach-scale restoration.

In 2018, designs were completed that targeted restoration of up to 70 acres of wet meadow and enhancement of up to 2 miles of stream channel and habitat. Design elements included a variety of instream structures (beaver dam analogs and instream wood jams) and minor grading to promote inset floodplain habitat. The project was implemented in the summer of 2019 with minor adaptive management in 2020, 2021, and 2022.

The project was expected to increase stream and groundwater levels and the frequency, extent, and duration of overbank flows in Martis Creek. In turn, these changes were expected to translate into significant changes in plant community composition, structure, and dynamics. This monitoring program was designed to track the response of plant communities to hydrologic changes and, given the strong relationships between meadow/ riparian hydrology and plant communities, use plant community data to infer changes in hydrologic conditions where direct measurement of surface and or groundwater levels were not available.

Only three years after project implementation, the rise in surface and ground-water levels had a drastic effect on meadow/ riparian vegetation in several reaches of the project area, reconnecting hydrology to relic channels and the previously disconnected floodplain. Beaver activity increased throughout the restoration project—and evidence indicates that beavers are maintaining our structures. Vegetation data from cover point plots showed that 9 of 16 plots had a significant increase in wetland or hydrophytic species. Wetland species dominance increased by five percent across the whole project, however, this increase was much greater in the reaches where beavers are active. The beaver activity enhanced some of the anticipated changes to hydrology and the prevalence/ dominance of hydrophytic plants. Though cover point plots were useful in detecting some changes, vegetation mapping of a larger area captured changes on a larger scale, sometimes in areas where we humans did not anticipate changes!

Well? Did It Work?

Kevin Swift, Swift Water Design (Presenter),
and Co-author: Karen Pope, Ph.D., USDA Forest Service, Pacific Southwest Research Station

Well, it's been five years, 3,000 structures, and 50 built miles since Swifty's Disaster Circus started throwing sticks in cricks. Probably time to see if that massive effort, sacrifice, taxpayer money, and carbon input has done any good, yeah? In this talk I'll do my best to highlight some quantifiable results from builds past, using whatever's lying around—drone footage, groundwater wells, NDVI, camera traps, temperature loggers, V-STAR sediment surveys, internet gossip, wandering around in flip-flops chasing the "squish vs. crunch" edge of things, frog counts, and so on.

If everything works out, by the end we'll have some sense of what PBR can do, based on a single flow of experience from southern Idaho to the Klamath to the Kern to the Coast. We'll take a look at desert systems that get 8 inches of rain a year, coastal systems that get that much in a day, rowdy mid-elevation Sierra streams, post-fire recovery, tiny frog builds, over-appropriated systems, and so on.

Note for the hardcore nerds amongst us, it won't be much true hard science with charts and graphs and things, because we're field beavers, not lab rats. Think, "a bit less than science, much more than hand-waving" and you'll be in the ballpark. The hope is to share a larger slice of the work, spark some interesting discussions, and maybe sucker some poor grad student into doing a master's thesis on all this stuff (free monitoring, woohoo!).

Process-Based Restoration in Burned Headwater Meadows: Exploring Potential for Sediment Storage and Floodplain Reconnection

Kate Wilcox, Oak Ridge Institute for Science and Education Fellow, USDA Forest Service, Pacific Southwest Research Station (Presenter); and Co-authors: Adam Cummings, MS, USDA Forest Service, Pacific Southwest Research Station; Chris Pluhar, Ph.D., California State University, Fresno; David Dralle, Ph.D., USDA Forest Service, Pacific Southwest Research Station; Kevin Swift, Swiftwater Design; Emma Sevier, MS, California Polytechnic State University Humboldt; Joe Wagenbrenner, Ph.D., USDA Forest Service, Pacific Southwest Research Station; John Whiting, MS, USDA Forest Service, Pacific Southwest Research Station; Paul Richardson, Ph.D., California Geological Survey; and Karen Pope, Ph.D., USDA Forest Service, Pacific Southwest Research Station

Post-wildfire sedimentation poses threats to critical salmonid habitat and downstream infrastructure, but beaver-inspired restoration could be an effective strategy for mitigating adverse post-fire impacts and rejuvenating vital headwater meadows. We found that implementing process-based restoration in incised meadows within burned watersheds re-establishes meadow floodplain connectivity and effectively stores sediment, potentially protecting downstream ecosystems. The 2020 Creek Fire burned hundreds of meadow catchments in the southern Sierra Nevada, California, many of which were already degraded due to land use practices. We measured suspended sediment and bedload yields and mapped geomorphic features of three incised meadows, two that were burned in the Creek Fire (Lower Grouse and McCreary Meadows) and one nearby control meadow that was not affected by recent wildfire (Ahart Meadow). Post-fire monitoring spanned a relatively dry water year (2022), during which sediment yields were low across burned and unburned watersheds, and an extremely wet water year (2023), during which we observed substantially higher flows and increased sediment transport.

Between 2022 and 2023, lower Grouse Meadow (burned) and Ahart Meadow (unburned) were restored by installing beaver dam analogs (BDAs) and we observed rapid geomorphic and hydrologic change. In the restored burned meadow, many pools associated with BDAs filled with sediment and we found that BDAs were more effective at capturing fine sediment than naturally occurring large wood. We also observed immediate post-restoration hydrologic responses such as the activation of side channels and a dramatic increase in groundwater levels.

To capture the maximum amount of post-fire sediment within the meadows, restoration structures should be installed immediately after fire. However, during extended dry periods, peak sediment transport may be delayed, highlighting the importance of building structures that can persist for multiple years. Methods for extending structure life include incorporating sod and willow cuttings that can take root and hold the structures in place. By pairing post-fire sedimentation with process-based restoration, this study provides a unique opportunity to transform a potential negative into a powerful tool for restoring important meadow habitats.

Do Beaver Dam Analogs Facilitate More Optimal Foraging by Juvenile Coho?

Brandi Goss, Ph.D. Candidate, UC Davis (Presenter); and Co-authors: Robert Lusardi, Ph.D., Assistant Professor, UC Davis and Ethan Baruch, Ph.D., Senior Environmental Scientist, CDFW

NOAA has listed beaver restoration as a top priority for Southern Oregon Northern California Coast Coho. However, beaver reintroduction can be ecologically and socially challenging due to concerns surrounding disease, genetics, and private land use. A growing body of evidence suggests that beaver dam analogs (BDAs) provide a range of thermal, geomorphic, hydrologic, and biological benefits to aquatic ecosystems and may provide important benefits to native fish communities. As a result, they may be a viable alternative in cases where traditional beaver restoration is not possible. Yet, we know little about how and if changes to macroinvertebrate community composition due to BDA installation translate to changes in trophic pathways in BDA habitat that could affect fish communities. These shifts in macroinvertebrate prey abundance and community structure warrant additional study because recent research points to the importance of prey resources for thermal resilience in listed Coho salmon. Additionally, optimal foraging theory indicates that characteristics of prey communities, like abundance and diversity, may influence feeding efficiency and predator growth. Prey community characteristics may be particularly important with juvenile salmonids where visual prey recognition and image learning play important roles in foraging success. We calculated more traditional metrics (e.g., density, species richness, diversity indices) to characterize the macroinvertebrate community. We also used stable isotope analysis to reconstruct food webs and compare trophic pathways in BDA habitat and adjacent traditional stream habitat to understand better how BDAs influence aquatic food webs. Dietary contribution results showed that Coho in both the BDA and traditional stream reaches have high contribution percentages from predatory invertebrates (BDA: 62.6%; traditional stream: 32.1%). This trend is much more pronounced in the BDA reach fish, with a mean contribution almost double that of the traditional stream reach fish. When these values are considered relative to the abundance of predatory invertebrates in each community, we found that Coho are feeding on predatory invertebrates at 1.99 (BDA) and 4.45 (traditional stream) times their relative abundance in the macroinvertebrate community. The differences in quantity (greater density in BDA), composition (reduced diversity in BDA), and spatial arrangement (more variance in density in BDA) of food resources in these two habitats might be resulting in more optimal foraging in the BDA habitat.

10 Years of Experience Working with Beaver for Restoration in a Human Dominated Landscape

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

The Scott River Watershed Council (SRWC) began partnering with beavers and humans for nature-based restoration in 2014. SRWC has performed scientific water quality, geomorphic change, and fish response monitoring on both natural beaver ponds and beaver dam analogue created habitats. Additionally, we utilize our placed-based naturalist's eye to understand how beavers interact with restoration actions to understand their contributions and the limitations on their ability to thrive imposed by the highly degraded environment we jointly inhabit. We will share the results of these endeavors in this session.

Fish Passage and Other Intriguing Talks

Friday Afternoon Concurrent Sessions

Session Coordinator: *Shane Scott, SSA Environmental*

This conference session offers a comprehensive look at aquatic ecosystem restoration and management in North America, focusing on innovative and collaborative approaches. It begins with a discussion on aquatic organism passage solutions at culverts and fish barrier management, highlighting novel techniques for aquatic species migration. This is followed by an exploration of the collaborative efforts required for fish passage restoration in the Napa River watershed. Another presentation details the adventurous and rigorous methods used in reintroducing steelhead into Jalama Creek, involving explosives and helicopters. The session also includes a talk on the ecological and social impacts of dam removal on the East Branch Russian River, emphasizing ecosystem revitalization. The challenges posed by abandoned cannabis cultivation sites and their impact on remote landscapes are another key topic. The session concludes with a study on the migration patterns of juvenile Chinook salmon in the Sacramento Valley, underlining the importance of habitat conservation. Each presentation underscores the multifaceted approach needed to address contemporary environmental challenges.

Aquatic Organism Passage (AOP) Solutions at Culverts and Fish Barrier Management in North America

Shane Scott, President, SSA Environmental

Culverts, bridges, and similar in-water structures rank second only to dams in their obstruction of fish and other aquatic organisms. These structures have a detrimental impact on habitat connectivity for numerous species, as they restrict access to crucial spawning and rearing habitats. Significant efforts have been devoted to the removal and replacement of culverts to enhance aquatic organism passage (AOP). These projects are resource-intensive and may take years to complete. In addition, the number of AOP barriers is so numerous that many will not be addressed in a timely manner, if at all. However, there are many opportunities to improve AOP through barrier modification where removal or replacement is not feasible or timely.

This presentation aims to provide an insightful exploration of low-cost, rapid solutions for retrofitting culverts and similar structures to improve AOP. The spectrum of corrective actions will include retrofitting culverts with weirs and floating ramps to improve access and passage through the culvert. Real-world case studies will be presented to demonstrate how barriers can be modified to improve AOP. We will also describe computational fluid dynamic modeling used to quantify the AOP benefits of these culvert modifications. Additionally, we will describe a fish passage barrier assessment and prioritization program being used to plan and implement corrective actions to overcome AOP barriers on a watershed scale.

Going Slow and Going Together—Navigating Project Meanders and Building Consensus to Restore Fish Passage in the Napa River Watershed

Patrick Samuel, M.A., Bay Area Director, California Trout; Frances Knapczyk, Ph.D., Program Director, Napa County Resource Conservation District; Andrew Smith, P.E., Senior Restoration Engineer and Matt Erickson, Watershed Planner, CDFW (Co-presenters); and Co-authors: Chris Feng, P.E., Restoration Engineer, WRA; Erik Schmidt, Regulatory Specialist, WRA; Kristine Pepper, P.E., Senior Hydraulic Engineer, CDFW; Erica Johnson, Grant Manager, State Coastal Conservancy; Rob Carnachan, Senior Environmental Planner, WRA; and Steve Rodriguez, CDFW

Napa RCD, CalTrout, and WRA, Inc. will present a current fish passage restoration project that involves replacing a privately-owned bridge, removing a non-functional fish ladder, and restoring a natural channel on Sulphur Creek, a major tributary on the western side of the Napa River watershed. Sulphur Creek supports threatened Central California Coast steelhead, Chinook salmon, and Pacific lamprey with some of the best year-round cold-water habitat within the Napa River basin. CalTrout and Napa RCD hold three grants with CDFW and the State Coastal Conservancy to develop 100% designs and environmental compliance documents and have retained WRA, Inc. for technical assistance for the project. Once implemented, the project will enhance access to 3.2 miles of high-quality spawning and rearing habitat.

This presentation will focus on the design considerations, pivots, permitting, and lessons learned from navigating from conceptual to 100% designs despite technical, environmental, and social challenges over a four-year period. The existing bridge and fish ladder on Sulphur Creek presented several technical challenges, including channel narrowing, limited fish passage functionality, erosion, and blockage by debris.

The landowners and owner of the bridge expressed a desire early on to keep the 100+ year-old bridge in place and the conceptual design process suggested it would be possible to do so while considerably improving fish passage. However, subsequent engineering investigations revealed that the bridge itself was the major barrier to fish, not the failed fishway. As a result, the project team worked to build consensus with landowners, grant managers, and other stakeholders to pivot the project towards bridge replacement and secure additional funding to revise the project design.

Throughout this process, RCD and CalTrout have worked closely with Sulphur Creek stakeholders and local residents to advance a consensus design and obtain environmental compliance. Over the past decade, the bridge owner, bridge users, adjacent property owners, tribes with ancestral territory in the region, permitting agencies, and CDFW and SCC have all come together to provide input on a host of challenging issues in addition to fish passage, including preserving winery truck access, fire safety, site aesthetics, and adding plants with indigenous values.

Although the design period has included the COVID-19 pandemic and a catastrophic fire (2020 Glass Fire) in the project reach, everyone has remained committed to realizing enhanced stream function for fish, wildlife, and other ecosystem benefits. As a result of this close coordination and open communication, this project has evolved and now has broad acceptance in the community and the landowners are excited to see construction as soon as possible. One benefit of the delays to the project was the ability to explore the use of new state permitting pathways in the form of the CDFW Statutory Exemption for Restoration Projects (SERP) and the SWRCB Statewide Restoration General Order (SRGO). This project incorporated the use of these pathways to save significant time and money in the design phase of the project and presenters will share examples and specifics of our experience navigating this new permitting landscape with our agency partners.

Explosives, Helicopters, and Hard Work: Restoring Steelhead to Jalama Creek

Laura Riege, The Nature Conservancy (Presenter); and Co-authors: Jeff Kozlowski, ICF; Meredith Hardy, California Conservation Corps; Brendan Belby, Stantec; David Kaplus, Foothills Blasting Company; Rachel Robin, ICF; Walter Heady, The Nature Conservancy; Jeanette Howard, The Nature Conservancy, Ben Herbert, California Conservation Corps; Keith Miller, The Nature Conservancy; and Tessa Artruc, ICF

The Nature Conservancy's Jack and Laura Dangermond Preserve located at Point Conception in Santa Barbara County encompasses and protects ninety-four percent of the 24.5 square mile Jalama Creek watershed. However, a small but significant concrete dam located only half a mile upstream from the ocean almost completely blocked southern California steelhead migration in and out of the watershed. Recent surveys of the watershed document good habitat, but no redds or O. mykiss of any size class. The last steelhead was documented in the watershed nearly 30 years ago in 1994 by the California Department of Fish and Game. The Southern California Steelhead Recovery Plan identifies removing barriers as the highest priority recovery action in the watershed. The challenge was how to remove this concrete dam located in a steep canyon at the base of a 220-foot-tall nearly vertical bluff that is only accessible by foot through Vandenberg Space Force Base. This talk will describe how explosives, helicopters, and the California Conservation Corps were the most cost-effective and environmentally friendly solution to removing this first barrier to restoring steelhead to Jalama Creek. Success measures include benthic macroinvertebrate monitoring before and after dam removal as well as long-term snorkel and redd surveys. Permitting through the Habitat Restoration Enhancement Act helped cut green tape to get the project done.

Pulling Back the Redwood Curtain: Revealing the Ecological Challenges of Abandoned Cannabis Cultivation Sites in Remote Landscapes

Drew Barber, Vollmar Natural Lands Consulting (Presenter);
and Co-author: Mason London, Naiad Biological Consulting

In remote areas, far removed from county-maintained roads and concealed by the redwood curtain, lie numerous neglected properties. These lands, characterized by poorly constructed roads, improperly designed culverts, abandoned ponds, and remnants of past cultivation sites, number in the hundreds, if not thousands. Many of these parcels, with known violations, face environmental penalties that surpass the dwindling value of the properties. Left without maintenance and lacking the means to cover fines or implement necessary fixes, these sites pose a looming ecological threat. Economic pressures, coupled with a gold rush mentality and a lack of viable solutions, have given rise to this predicament.

This issue is not confined to the immediate surroundings; its repercussions affect downstream rivers, streams, and the aquatic life they support. While significant investments are being made to safeguard and enhance aquatic habitats downstream, attention must also be directed to these uphill legacy problems capable of undoing ecological progress, reminiscent of past boom-bust cycles driven by logging.

Assessment of Juvenile Chinook Salmon Migration in the Sacramento Valley

Alexandra N. Wampler, Ph.D. Student, University of California, Davis (Presenter);
and Co-authors: Derrick J. Alcott, Postdoctoral Researcher, University of California Davis;
Carson A. Jeffres, Watershed Sciences, University of California Davis; Nann A. Fangue, Department of Wildlife, Fish, and Conservation Biology, University of California, Davis; Paul Buttner, California Rice Commission; and Andrew L. Rypel, Watershed Sciences, University of California, Davis

In California, juvenile Chinook salmon (*Oncorhynchus tshawytscha*) utilize divergent routes and life histories during out-migration. For example, some life history strategies include spending up to a year in freshwater ecosystems before completing ocean out-migration. Yet surprisingly little is known about the drivers behind out-migration success. To further understand the interactions between habitat and migration behavior, we examined the migration patterns of juvenile Chinook salmon in the Sacramento River and neighboring floodplains using Juvenile Salmon Acoustic Telemetry Systems (JSATS). We obtained yearling late-fall run Chinook salmon and young of the year fall run Chinook salmon from Coleman National Fish Hatchery. We then conducted a rearing experiment for a six-week period with two treatment groups: laboratory rearing and floodplain rearing. The yearling fish were surgically implanted with JSATS tags before initiation of rearing treatment, which enabled us to permit volitional exit from the floodplain. Young of the year fish reared on the floodplain were held in cages for the rearing period before receiving JSATS tags and being released. Laboratory-reared yearlings and half of the tagged young-of-the-year fish were released into the floodplain site during an active flood, while the other half of the young-of-the-year fish were released into the Sacramento River. Laboratory-reared yearlings were released into the same floodplain during a natural flood event at the commencement of the rearing period. Once reaching a predetermined size, we deployed a subset of fall-run juveniles into cages on the study floodplain and held the remaining juveniles in the laboratory for the rearing treatment. After six weeks, a subset of juveniles from each treatment were tagged with JSATS and separated into two release groups equidistant from the San Francisco Bay. One group was released into the Sacramento River while the other group was released into the study site floodplain during an active flood event. We explore the significance of rearing conditions, age class, and migration routing of these experimental groups with the intention of informing water and habitat managers.

Lessons From The Successful Collaboration to Restore the Aquatic Ecosystem of Martin Slough

Steve Allen, P.E., Principal, GHD, Inc. (Presenter) and Dagan Short, P.E., Senior Project Engineer, GHD

Large-scale ecosystem restoration requires years of active collaboration by many partners to make the vision become a reality. The time required for planning, design, environmental clearances, permitting, construction, and post-construction monitoring often takes decades to complete. Construction of in-stream projects provides the final key action of many years of planning for projects intended to improve flood conveyance, stream function, climate resiliency, and habitat values in multi-objective projects. Larger projects add the complexity of multiple years of construction phasing to bring the intended designs to fruition.

This presentation will highlight the many challenges and successes associated with the large-scale habitat enhancement project in Martin Slough with over 6,200 feet of channel, 4.7 acres of salt marsh, 2.1 acres of brackish wetlands, and multiple fish passage structures necessary to provide anadromous fish passage.

This project is now fully constructed with positive post-construction biological monitoring results showing expanded use by hundreds of Coho salmon and tidewater gobies along with Pacific lamprey, Dungeness crab, and many other aquatic species. Floodplain enhancements of new salt marshes, freshwater wetlands, and expanded riparian areas are all functional with their new vegetation maturing quickly. Adjacent landowners have seen first-hand the reduction in flood duration and improved channel conveyance which shows the benefits of an integrated multi-objective stream and floodplain enhancement project.

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Meadow Dam NLF *Credit: BAL*

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Poster Session Directory

Field Forms for Fish Monitoring
Presented by Andrew Bartshire
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Collaborative Action For A Healthy Watershed
Presented by Charles Bottino
Russian River Confluence
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Fish Community Shifts Over Time in a Central Valley Creek
Presented by Anne Boyd
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Trees Foundation Information
Presented by Sarah Brooks
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California Environmental Water Network
Presented by Amy Campbell
The Nature Conservancy
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Selected Projects:
Upper Sacramento River Side Channel Restoration
Presented by Rebekah Casey
Geographical Information Center, North State Planning & Development Collective, CSU Chico
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Scott River Riparian Shade Model
Presented by Saul Cervantes
CCC Watershed Stewards Program with AmeriCorp
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Bringing Salmon Home:
Lessons Learned from the Juvenile Salmonid Collection System on the McCloud River
Presented by Theo Claire
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Pacific Gas and Electric is Preserving Salmonid Habitat Through Conservation Easements on Watershed Properties
Presented by Cheryl Davis
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Let's Continue Cutting through Green Tape:
An Update on the CEQA Statutory Exemption for Restoration Projects (SERP)
Presented by Desiree Dela Vega
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Impact of Restoration Work on Water Temperature in San Geronimo Creek
Presented by Charlotte Diamant
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Evaluating Side Channel Restorations for Juvenile Salmonids in the Upper Sacramento River
Presented by Greyson Doolittle
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Adult Survival Estimates Based on Early Emigrant and Spring Migrants of Coho Salmon in Freshwater Creek
Presented by Tiffany Douglas
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Sustaining Salmonids through Behavioral Mitigation for Turbine and Spillway Entrainment
Presented by Seth Eisele
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A New Tool to Help You Use Efficient Permitting Pathways
Presented by Stephanie Falzone
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Connecting Salmon and Waterfowl, How to Build the Bridge
Presented by Cliff Feldheim
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Evaluating the Impacts of Flow Diversion on Chinook and Steelhead in an Intermittent Stream Using an Individual Based Modeling
Presented by Andrea Hamilton
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Campbell Creek Culvert Replacement and Fish Passage Barrier Removal
Presented by Caroline Hamilton
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Spinning Salmon Year 3:
High School Students Investigating Thiamine Deficiency Complex Alongside Researchers
Presented by Peggy Harte
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Poster Session Directory

Butte Creek Floodplain Restoration
Presented by Allen Harthorn
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Statewide Projects that Enhance Stream Flow
Presented by Tom Hicks
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Relating Watershed Characteristics to Streamflow in the Navarro River Watershed
Presented by Megan Kownurko
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Range-wide Assessment of the Life History of Central Valley Steelhead (New Study)
Presented by Levi Lewis
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Sourcing Small Wood for Restoration Actions
Presented by Daniel Logan
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Minimizing Bank Disturbance When Installing
Large Wood Into Stream Channels
Presented by Daniel Logan
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Beaver Restoration in CA
Presented by Kate Lundquist
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Restoring Streamflows in the Navarro Watershed
Presented by Linda MacElwee
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Early Out Migration Population Contribution to Returning Coho Spawners.
Presented by Katharine Major
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Wood In World Rivers
Presented by Elektra Mathews-Novelli
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Rediscovering Old Ways with New Knowledge.
Presented by Logan McKinnon
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Water Resiliency in the Trinity River Watershed
Presented by Lesli Mounivong
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Marshall Ranch Streamflow Enhancement Project
Presented by Katrina Nystrom Sheldon
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BMI Study: What's Living in the SLO Creek Watershed
Presented by Freddy Otte
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Tidal Swamp Presentation
Presented by Fran Recht
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The Confluence of Private Investment and River Restoration in Mitigation Banking
Presented by Angela Robinson
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Envisioning a Healthier Walnut Creek Watershed: A Collaborative Approach to Restoring Creeks, Wetlands, and Riparian Corridors
Presented by Heather Rosmarin
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Innovative Culvert Retrofits to Improve Fish Passage
Presented by Shane Scott
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Culvert Retrofit to Improve Fish Passage: A Success Story
Presented by Shane Scott
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Restoration Planning for Coho Salmon and Steelhead Trout in Lower Scotts Creek, Santa Cruz County
Presented by Christopher Surfleet
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Exploring the Effects of Black Spot Disease on Juvenile Steelhead Body Condition in Santa Clara County, California
Presented by Olivia Townsend
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A Spatial & Temporal Analysis of Water Temperature in Chorro Creek
Presented by Anya & Zoe Weinstein & Vavrek
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The Effectiveness of Channel Widening Towards Reversing Incision of the Napa River
Presented by Jason White
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San Ysidro Creek Debris Basin Modification Project
Presented by Jason White
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Auburn Ravine— Upstream passage success. Downstream Passage and Rearing Opportunities. And.....Don't Forget the Lamprey!
Presented by Kayla Wolak
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Hydrologic Modeling Applications in Habitat Restoration
Presented by Katherine Woodworth
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Restoration in a Community Forest
Presented by Karen Youngblood
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Ocean Ranch Restoration Project
Presented by April Zohn
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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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