35th Annual Salmonid Restoration Conference

March 29-April 1, 2017 in Davis, CA

Restoring Watersheds and Rebuilding Salmon Runs

Conference Co-sponsors

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Welcome to the 35th Annual Salmonid Restoration Conference

Restoring Watersheds and Rebuilding Salmon Runs

The Salmonid Restoration Conference has become the largest salmon restoration conference in California and brings together scientists, engineers, restoration practitioners, planners, regulators, and the next generation of watershed stewards. In this time when the value of science and the institutions that are mandated to protect our public trust values are challenged by the federal administration, it is more important than ever to convene and build a resilient watershed restoration movement that embraces vigorous science, innovative techniques, and meaningful restoration partnerships.

Salmonid Restoration Federation (SRF) is excited to be hosting the 35th Annual Salmonid Restoration Conference in Davis, CA—a hub of the Central Valley heartland where academia, scientific research, and California policy decisions evolve. The theme of this year's conference is "Restoring Watersheds and Rebuilding Salmon Runs," and the conference agenda highlights innovative efforts to restore legacy watersheds, salmon reintroduction to historic habitats, and our shared vision to revive and restore ecological function to Central Valley working landscapes.

Workshops will include Fish Passage from Tidewater to the Sierra; State of Beaver Restoration in California; What We've Learned About West Coast Floodplains: Lessons from the Landscape, and Evaluating Salmon Habitat; and Watershed Conditions to Inform Salmonid Recovery Actions.

Field tours will include Watershed Day at the Capitol, a Legislative Tour that starts at the Cal EPA building with legislative speakers and where participants will break into groups to meet with their representatives and legislators to discuss watershed-related bills and initiatives. For the first time, we will also be offering a rafting tour of Stanislaus River restoration sites. Additional tours include: Yolo Bypass and Putah Creek restoration projects, American River gravel augmentation and floodplain restoration sites, and multi-use floodplain projects in the Lower Sacramento Valley.

Concurrent sessions include a Central Valley track focused on recovery planning and restoration, reviving the San Joaquin River from tributaries to the Delta, and Visioning Salmon Recovery—Restoring Ecological Function in the Central Valley's Working Landscapes through Science, Collaboration, and Structured Decision Making. A strategies and techniques track will explore reintroduction of salmon into their historic habitats, strategies for restoring benefits to juvenile salmon, and include a session on utilizing aerial vehicle technology to support salmonid restoration planning and engineering. There will also be a biology and physical session track exploring how sediment slows fishery recovery, the role of hatcheries, and estimating juvenile salmonid survival across diverse spatio-temporal scales.

Dana Stolzman,
SRF Executive Director
and Conference Agenda Coordinator

Some SRF Board and staff members after our Board retreat.

The Plenary session will focus on restoring salmon and sustainable water management in California from a global, state, and regional perspective. SRF has an all-star lineup of keynote speakers including NASA Scientist Jay Famiglietti who will give a presentation on the "Epic California Drought as Viewed from Space: Drought vs. Chronic Water Scarcity and Implications for Sustainability." Jay Lund from the Center of Watershed Sciences and co-author of the book *Managing California's Water: From Conflict to Resolution* will present on salmon restoration and re-engineering of water in California. Felicia Marcus, chairwoman of the State Water Control Board, will present on water management challenges and opportunities.

The production and coordination of the annual conference is a collaborative process that engages Salmonid Restoration Federation's Board of Directors, our co-sponsors, and our colleagues. We sincerely thank all of the field tour, workshop, and session coordinators who do an outstanding job of creating a dynamic agenda as well as all of the dedicated presenters who are sharing their knowledge and expertise.

We appreciate all of our co-sponsors who generously contribute their ideas, time, and resources to the production of the conference. Thanks to all the conference participants who migrate tirelessly to participate in the premier salmon restoration conference in California and for joining us in our efforts to enhance the art and science of restoration and ultimately recover wild salmonid populations.

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Celebrating a Culture of Restoration

Honoring our Watershed Heroes

Every year, the Annual Salmonid Restoration Conference provides an opportunity to honor the contributions that individual practitioners have made to California's fisheries restoration field. Prior to the conference, Salmonid Restoration Federation (SRF) accepts nominations for the awards listed below. Award recipients are honored during the Conference Cabaret and Banquet that is held on the final night of the four-day conference.

Restorationist of the Year

SRF's Restorationist of the Year Award was conceived as a way to honor grassroots salmonid habitat restorationists. It was first presented in 1992 to Bill Eastwood, co-director of the Eel River Salmon Restoration Project, to acknowledge his work to help salmon and for his innovative design modification to the McBain downstream migrant trap.

The award was renamed the Nat Bingham Memorial Restorationist of the Year award following Nat's death in 1998. Nat was a fisherman and a tireless advocate for salmon. Since Nat's death, SRF has honored a restorationist each year at our annual conference with a roast and toast during the Cabaret and Banquet. The honored recipient gets to steward an exceptional brass sculpture, created by noted sculptor Dick Crane, that captures the spirit of salmon, of fish-loving people, and the state of California where these practitioners live and work a life dedicated to the recovery of the species. At the awards ceremony, the previous recipient parts with the sculpture and passes it onto the next honoree.

Lifetime Achievement Award

The Lifetime Achievement Award honors a lifetime of work and contribution to the salmonid restoration field in California.

The Golden Pipe Award

The Golden Pipe is an award for innovators in the salmon restoration field, whether their work be fish passage design, engineered log jams, or championing beavers as restoration partners.

Gordon Becker Memorial River Advocate Award

The restoration community mourns the loss of our cherished colleague and friend, Gordon Becker. He was an adventurer, a scientist, and an effective advocate for healthy rivers and fisheries. Gordon served as an expert witness in the campaign to remove or modify Stanford University's 125-year old Searsville Dam and Stanford's water diversions that harm threatened steelhead trout in San Francisquito Creek. His deep knowledge and enthusiasm for restoring the San Francisquito Creek watershed's native steelhead population helped to propel restoration efforts forward. Gordon shared his expertise freely, as well as his hopes and dreams for a better future for western rivers and watershed management.

The Gordon Becker Memorial River Advocate Award is for candidates who have been strong river advocates or stewards.

Conference Events

Thursday, March 30

SRF Annual Membership Meeting 5:30 - 6:30pm
SRF Membership and Supporter Dinner 6:30pm
Screening of ***Return of the River*** 8pm

Friday, March 31

Poster Session and Reception 7 - 10pm

Thank you to our exclusive beer sponsor!

Saturday, April 1

Banquet, Awards Ceremony, and Dance!
Doors open at 6:30pm

Dance to The Nibblers Saturday evening at the banquet!

Who will be the 2017 Restorationist of the Year?

What We've Learned About West Coast Floodplains: Lessons from the Landscape

Wednesday, March 29

Workshop Coordinators*: Eric Ginney, Environmental Science Associates (ESA); Jacob Katz, Ph.D., California Trout; Corey Phillis, Ph.D., Metropolitan Water District of Southern California (MWD); and Brian Cluer, Ph.D., NMFS West Coast Region*

Across the West, floodplains of all sizes and landscapes are today better understood and appreciated for what they contribute to native species. In particular, floodplain science and its relation to salmonid ecology has matured markedly in the past two decades, and this workshop examines what we now know about the physics, biology, and ecology of floodplains in a variety of landscape positions, from headwaters to estuaries. We consider these processes relative to the life histories of key salmonid species/runs, and remark upon restoration priorities relative to key limiting factors in juvenile growth and ultimately escapement. This workshop will serve as a foundation for a subsequent tour in the Sacramento Valley's large flood basins and a session focused on floodplains and restoration during this year's conference.

photo by Brian Cluer

Give Floods a Chance: Extending the Duration of Flood Events on Agricultural Landscapes in the Central Valley for Fisheries Benefits

***Louise Conrad** and **Pascale Goertler (Co-Presenters), Lynn Takata, Brian Schreier,** and **Ted Sommer,** California Department of Water Resources*

Floodplain restoration is a management priority in the Sacramento-San Joaquin Delta region because of their enhanced food webs and critical growth benefits to juvenile salmon. The Central Valley landscape today contains only a vestige of historic floodplain habitat as it has largely been reclaimed as farmland or urban areas. The current Biological Opinion for endangered and threatened runs of Chinook salmon requires the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR) to restore tens of thousands of acres of floodplain habitat. Much of the DWR and USBR restoration efforts are focused in the Yolo Bypass because of evidence from previous research of growth and survival benefits of Yolo Bypass rearing. Restoring the Yolo Bypass for Chinook salmon benefits will involve a suite of efforts, including enhancing fish passage to allow juveniles increased access to floodplain rearing, and landscape restoration efforts to improve juvenile rearing habitat. However, another critical issue is the duration of flood events in the Yolo Bypass. Agricultural fields in the Yolo Bypass are designed to drain faster than would be typical of historic conditions, such that there is insufficient time for juvenile salmonids to reap expected floodplain benefits before drainage. For this reason, a major focus of our current research is to examine potential benefits to extending the duration of natural flood events on some land parcels. In addition, there is an urgent need to understand how young Chinook salmon can take advantage of different habitats, including various potential habitats within floodplains (e.g. agricultural lands, pasture lands, natural floodplains) and riverine habitats. We present data on juvenile salmon growth rates from managed agricultural floodplains and naturalized floodplains in the Yolo Bypass and other Central Valley locations. Within various floodplain habitats, we observed surprisingly consistent growth rates despite variation in food web composition, geography, and water source. We also examined inter-annual and spatial variation in prey resources and juvenile salmon diet, to understand juvenile salmon floodplain habitat use across a range of hydrologic conditions. We show that juvenile salmon growth rates are consistently higher than riverine growth rates. We also show that juvenile salmon diet in the Yolo Bypass varied temporally, utilizing Diptera taxa during flooded years and switching to a diet more dominated by zooplankton and terrestrial prey in drought conditions. Juvenile salmon are still using the Yolo Bypass for rearing and are able to forage successfully despite the drought conditions. Therefore, floodplain-tidal slough complexes, like the Yolo Bypass, are valuable rearing areas in both environmental extremes, and juvenile salmon (and possibly other forage fish species) are able to respond to the variability in prey quality and temperature stress. Collectively, this work suggests that farmlands, natural floodplain landscapes, and even floodplain-tidal slough complexes can provide functional and essential nursery habitat for juvenile salmon. Focusing on improving access through enhanced connectivity, and ensuring ample time for flooded conditions to persist, may be the right emphasis for rapid support to the freshwater rearing phase of juvenile salmon, rather than providing a specific type of floodplain habitat.

Construction and Preliminary Assessment of a Coastal Floodplain Reconnection and Channel Incision Reversal Project on Butano Creek, San Mateo County, CA

Chris Hammersmark Ph.D.(Co-presenter), *cbec, inc. eco engineering;*
Irina Kogan (Co-presenter), *San Mateo County Resource Conservation District;*
John Klochak, *U.S. Fish and Wildlife Service,* ***Setenay Bozkurt Frucht, P.E.,*** *San Francisco Bay Regional Water Quality Control Board; and* ***Jim Robins,*** *Alnus Ecological*

Butano Creek drains 23 cubic miles of the Santa Cruz Mountains in San Mateo County, California. Land use and channel management practices in the last two centuries have doubled sediment input, disconnected channels from their floodplains through incision, eliminated floodplain sediment storage, and led to flooding issues in the lower watershed. Incision and floodplain disconnection not only eliminated sediment storage in the valley but also transformed these storage areas into sources substantially contributing to elevated sediment loads. Removal of large wood, channel incision, and floodplain disconnection are the primary causes of a significant reduction in the complexity and function of habitats that are home to a number of sensitive species, including several Endangered Species Act (ESA) listed anadromous fish and herpetofauna.

Channel change and sediment budget analyses completed in the course of developing a sediment total maximum daily load (TMDL) for the watershed have revealed that, historically, the lowland valley functioned as a wet meadow and included an extensive and well-connected floodplain that provided diverse habitats, as in a stage 0 channel system (*sensu* Cluer and Thorne, 2013). This type of channel has recently been shown to be of very high value for the variety of physical, biological and chemical functions that it supplies. The lowland floodplain also provided a critical sediment storage function as a capacitor metering sediment input from Butano Creek into the Pescadero estuary, which is a key nursery habitat for anadromous fish species and which has experienced a significant reduction in its tidal prism and extent due to accelerated sedimentation. A hydraulic and sediment transport model was developed to explore opportunities for floodplain restoration along Butano Creek. The analysis showed that reconnecting the channel and floodplain by reversing channel incision via channel roughening and aggradation can restore wetland and channel habitat, sediment, storage, and fish passage functions while reducing flooding problems, preparing the way for potential evolution over time to a stage 0 reach.

A project that reconnects the floodplain along a mile reach and restores approximately 100 acres, or ~10%, of the historical floodplain was constructed on Peninsula Open Space Trust land in late summer 2016. Project elements include a roughened channel/rock ramp grade, two constructed engineered log jams, two jams constructed by induced recruitment of live bankside alders into the channel, and bankside berm breaches. These project features will roughen the channel, force channel aggradation, and increase floodplain inundation as well as sediment deposition. Assessment is underway and includes monitoring of channel bed morphology, channel habitat type, floodplain sediment deposition, groundwater level changes and floodplain inundation/off-channel habitat increase.

Implementation of this project is just the start; additional projects will be needed to restore full function to the system. Additional analysis investigating the thresholds of sediment reduction and floodplain reconnection required to restore habitat, ecological function, sediment storage, and transport equilibrium has been conducted. The goal of this threshold analysis and system restoration is to identify a sustainable restoration solution that provides complex and diverse habitat patches while allowing for existing land uses in the valley.

Coho Habitat Enhancement on the South Fork Ten Mile River: Moving from Riverine to Estuarine

David Wright, The Nature Conservancy

The Ten Mile River watershed sustains a vital, independent population of coho salmon in the Central California Coast Evolutionarily Significant Unit (CCC ESU). Over 90% of the watershed is owned by timber or ranching interests, and, due to cooperation from landowners over the past ten years, extensive habitat restoration has occurred in the riverine component, particularly in South Fork Ten Mile. In the near future, habitat enhancements intended to increase coho abundance will begin in the estuary.

In the South Fork, from 2004 to 2014, over ten miles of core coho spawning and rearing habitat has been treated with Large Wood Accumulation structures designed to promote increased pool habitat for rearing in summer and increased juvenile refugia and access to floodplains in winter. In 2013 The Nature Conservancy was awarded a California Department of Fish and Wildlife (CDFW) Fisheries Restoration Grant Program (FRGP) award to design 20 conceptual estuarine habitat enhancement structures, and in 2016 was awarded implementation funding to build out four of the designs.

This presentation will first cover observations and results from the ten-year interim of riverine habitat enhancements, and then move to the estuarine enhancement plan, which is scheduled for implementation in 2018. In addition to a discussion on the various designs created to increase estuary floodplain inundation, the Before-After-Control-Impact (BACI) study designed to measure project effectiveness will also be discussed.

The Nature Conservancy and its partners intend that this project fulfill a twofold purpose: movement towards coho recovery, and a research effort to help determine the effectiveness of different on-the-ground recovery prescriptions.

Lawrence Creek Off-Channel Habitat Restoration and Monitoring

Bob Pagliuco (Presenter), *NOAA Restoration Center;* ***Matt Goldsworthy,*** *NMFS West Coast Region;* ***Leah Mahan,*** *NOAA Restoration Center;* ***Margaret Tauzer,*** *NMFS West Coast Region;* ***Liz Perkins,*** *Ocean Associates/NMFS West Coast Region;* ***Doug Chow,*** *NMFS West Coast Region; and* ***Keith Lackey,*** *Humboldt Redwood Company*

Juvenile coho salmon seek slow velocity areas as rivers rise during storm events, and studies have shown a significant increase in the growth and survival of juvenile coho salmon who occupy off-channel habitats for refuge or rearing opportunities. Additionally, off-channel features also provide lentic habitat that many wildlife species rely upon for crucial reproductive or migratory life history purposes. These habitats have become limited in availability due to a number of factors, including channelization and loss of wetlands. In 2014, the Humboldt Redwood Company (HRC) identified an abandoned secondary channel that had the potential to become off-channel habitat in Lawrence Creek (located within the Van Duzen River watershed) and asked the National Marine Fisheries Service (NMFS) to partner on the project. NMFS conducted the physical surveys, created the design, and a small competitive internal grant from NOAA provided part of the funding for construction of the project. HRC procured all of the permits, donated several days of heavy equipment and operator's time, and provided several large logs with substantial root wads to build the off-channel structures.

In September of 2015, over 2,000 cubic yards of sediment were excavated and removed to create an off-channel pond that is approximately ¼ acre in size and 150 feet long by 45 feet wide. The pond was built to provide two separate deep-water pools, which range from four to six feet deep or deeper as flows rise and backwater into the feature from Lawrence Creek. In addition to the deep-water pools, the pond was designed with shallow edge water habitat ranging from one to two feet deep along the margins of the pond to provide a diversity of habitat types and conditions to maximize potential food resources and other ecosystem benefits. The pond was designed with the outlet sill positioned near the 35% exceedance flow elevation, which provides connectivity and flow from Lawrence Creek for approximately 120 days of the year.

The NOAA Restoration Center has been monitoring water quality parameters (dissolved oxygen and temperature) as well as salmonid presence and growth through the use of minnow traps and PIT tags on a monthly basis since the project was completed. This presentation will provide details on the planning, design, implementation and monitoring results of the first constructed off-channel feature in the Van Duzen River Watershed.

Floodplain Restoration Strategies, Efforts, and Monitoring on the Lower Mokelumne River

Robyn Bilski (Presenter) and Michelle Workman, *East Bay Municipal Utility District; and* ***Kirsten Sellheim*** *and* ***Michael Beakes,*** *Cramer Fish Sciences*

Restoration of the lower Mokelumne River floodplain began over a decade ago, in the upper one-mile reach of the river, just downstream of Camanche dam. Rehabilitation to the river's longitudinal profile raised the riverbed elevation to pre-dam conditions, expanded and improved salmonid spawning habitat, and increased bed slope and floodplain connectivity. Although the improvement of spawning habitat was the focus of these projects, topography surveys and modeling have documented the expansion of off-channel habitats within the one-mile reach at a variety of flows. Initially, these projects relied on in-basin gravel quarries as the source of material.

More recently, however, by identifying areas adjacent to the stream bank that contain tailings from historic mining activity, restoration projects within this reach have also incorporated juvenile salmonid rearing habitat along with the long-term spawning habitat rehabilitation. The excavation and recontouring of these areas has provided several seasonal floodplain habitats for juvenile salmonid rearing and the coarse gravel from the excavated materials has been used to improve or expand nearby spawning habitats. Pre- and post-project topographic surveys were used to calculate the total yield of coarse alluvium and compared with core samples taken during the initial site assessments. In addition, hydrodynamic modeling has provided the information needed to optimize flows for inundation of the newly constructed habitats. Currently, floodplain revegetation efforts are underway.

As restoration efforts move downstream, the results of site assessments adjacent to spawning areas in the upper reaches of the lower Mokelumne River will be utilized to determine their potential for enhancing spawning and rearing habitat. The amount of coarse gravel available for restoration, the acreage of floodplain that could be developed, and the estimated cost of implementing the restoration projects will be reviewed. In addition, analysis of juvenile fish community and salmonid outmigration monitoring data, land use coverage, and lidar data will be used to identify other potential floodplain restoration sites outside of lower Mokelumne River spawning reaches. These efforts will facilitate planning and prioritization of future restoration opportunities that is based on ecological, logistical, and financial considerations.

Restoring Riparian Conditions on the Mattole Estuary Floodplain

John Summers (Presenter) and Cassie Pinnell, Mattole Restoration Council

The Mattole River contains populations of three Pacific salmon species: Southern Oregon/Northern California Coast (SONCC) coho salmon, California Coastal (CC) Chinook salmon, and Northern California (NC) steelhead. Currently, summer habitat conditions in the lower river and estuary are generally poor for juvenile Pacific salmon, due to a history of logging-related sedimentation and extreme weather events. The area is broad, shallow, and lacks complex habitats for fish to hide from predators. Many of the riparian floodplains are void of long-lived riparian tree species that provide shade, floodplain stability, and future wood recruitment. As part of a larger restoration effort with multiple project partners, the Mattole Restoration Council has been working to re-establish riparian vegetation by a combination of intensive container planting, stream barbs, and willow baffle installation.

To address challenges of successfully establishing native vegetation on gravel bars and floodplains with little soil, we have employed a technique that has proven to be very successful on previous riparian restoration sites throughout the Mattole: planting large 15'-25' willow cuttings into trenches that have been excavated down to groundwater by an excavator. Gravel bars are mostly void of organic matter or soils that can maintain moisture for these rooting willows throughout the summer months. To address this issue, we place 16"-24" diameter Douglas-fir and grand-fir logs into the planting trench. This provides some structure to the trench and acts as a sponge, maintaining soil moisture throughout the hot summer months. Trenches are backfilled and watered throughout the summer to increase rooting potential. This year we installed over 6,000 feet of willow baffles.

In an effort to restore riparian conditions on the more stable floodplains, we have installed 12,500 container plants from locally-sourced seed. Establishing a diverse mix of long-lived riparian species on more stable floodplains (floodplains that have had established vegetation for a couple of decades) is an important component to increasing floodplain stability, shade, and food and habitat for fish and wildlife. In January 2016, we began implementation of the riparian container planting component of the project on lower river floodplain enhancement sites. To address poor growing conditions, we have targeted areas with better soils and installed irrigation systems during the dry season. All the seeds for these plants were collected in the lower Mattole river and grown at the MRC Native Plant Nursery.

During this presentation, we will share our methods, preliminary survivorship data, and lessons learned.

Planning Tools to Evaluate Salmonid Habitat Restoration in the Yolo Bypass

***Chris Campbell (Presenter)**, cbec, inc.; **Manny Bahia**, California Department of Water Resources; **Josh Israel, Ph.D.**, U.S. Bureau of Reclamation; **Duncan MacEwan, Era Economics**, and **Paul Bergman**, Cramer Fish Sciences; and **Reed Harris**, Reed-Harris Environmental, Ltd.*

Significant modifications have been made to the historic floodplains of California's Central Valley for water supply and flood damage reduction purposes. The resulting losses of rearing habitat, migration corridors, and food web production for fish have significantly hindered native fish species that rely on floodplain habitat during part or all of their life history. To support the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (a collaboration between the California Department of Water Resources and U.S. Bureau of Reclamation) previous evaluation efforts were improved with the development of a suite of planning tools to analyze benefits and impacts to agriculture, fish, waterfowl, and water quality in the Yolo Bypass. A calibrated two-dimensional hydrodynamic model was developed for the Yolo Bypass, which serves to characterize the effects of increased frequency, depth, and duration of floodplain inundation in the lower Sacramento River Basin and assess the improvements to fish passage throughout the Yolo Bypass. The two-dimensional model also provides the required hydrodynamic inputs into the other planning tools that include an agricultural economics model, a fish benefits model, and a mercury cycling model. Each of the planning tools are in various states of development and refinement as part of an ongoing evaluation process as managers continue to try and find sustainable and locally acceptable solutions for agriculture, fish, recreation, and terrestrial species in the Yolo Bypass. Preliminary results and lessons learned will be shared to include the importance of value engineering and stakeholder engagement.

Floodplain Restoration Planning in the South Fork Eel River

Julie Weeder, NOAA Fisheries

State and Federal recovery plans lay out a roadmap to recovery by prioritizing watersheds and identifying all the actions necessary for each species to recover to the point where it is self-sustaining. This recovery is expected to take decades to centuries. We must first prevent extinction in order to ultimately recover the species. To prevent extinction of ESA-listed Chinook salmon, coho salmon and steelhead in the South Fork Eel River, NOAA Fisheries, NOAA Restoration Center, and the California Department of Fish and Wildlife are leading the development of a pilot Strategic Action Plan (SAP). Building on state and federal recovery plans, the SAP will focus restoration efforts on (1) the few sub-watersheds with the most potential for habitat improvement and fish response and (2) the actions that address the habitat deficiencies most limiting recovery in the short-term. In the South Fork Eel River, as well as nearly all other North Coast rivers, restoration priorities will focus on floodplain condition. This presentation will describe the floodplain restoration needs of each life stage of three Pacific salmon species, methods and data used to identify the desired location and type of floodplain and other restoration, participants at each stage of the process, and potential future uses of the SAP to bring about on-the-ground restoration focusing on key limiting factors including floodplain condition.

Evaluating Salmon Habitat and Cumulative Effects to Inform Recovery Actions

Wednesday, March 29

***Workshop Coordinators: Thomas H. Leroy,** and **Danny Hagans,** Pacific Watershed Associates*

This workshop will provide restorationists and land managers with information on tools and techniques to evaluate and improve watershed conditions for salmonids and other native fishes at a watershed scale. The three focus topics of the workshop will be: (1) Big picture planning and recovery strategies where we will explore regional and community planning and targeting of relevant ecological needs, (2) Monitoring instream factors and salmon distribution to quantitatively evaluate status, trend, and recovery direction to inform restoration, and (3) Specific methods for identifying, characterizing, and prioritizing restoration actions within a watershed to provide the most cost-effective implementation strategy for sub-watersheds. Specific workshop presentations will include: a re-evaluation of salmonid population and effectiveness of recovery actions to date, results from a variety of monitoring and assessment efforts and stream characterization techniques including the Environmental Protection Agencies Environmental Monitoring and Assessment Program (EMAP-West) and the California Surface Water Ambient Monitoring Program (SWAMP), and discuss a variety of methodologies for identifying, characterizing, and prioritizing specific restoration needs and opportunities within a watershed that include large woody debris loading, fish barrier removal, identifying off-channel habitat opportunities, and sediment reduction, all aimed toward restoring physical and biological form and function. Finally, we will finish the day with a panel discussion where everyone is invited to engage in more in-depth discussions of the day's talks and consider the most relevant ideas in relation to their watershed. Attendees will take home from this workshop a baseline understanding of several scientifically sound techniques for evaluating watershed conditions, their limitations, and how to strategically employ them in their local watersheds to inform and prioritize salmon recovery.

photo by Tom Leroy

State of the Salmonids—Fish in Hot Water

Patrick Samuel (Presenter), *California Trout;* ***Peter Moyle, Ph.D.,*** *University of California, Davis, Department of Wildlife, Fish and Conservation Biology; and* ***Rob Lusardi, Ph.D.,*** *California Trout and University of California, Davis*

In 2008, California Trout and UC Davis authored a report summarizing threats and status of each salmonid species in California. The authors drew upon scientific literature and input from scientists and fishery managers to produce an analysis, which painted a bleak outlook for salmonid persistence in California over the next century. Since then, new scientific research, improved genetic techniques, and management actions focused on aiding the recovery of salmonids throughout California have been stymied by continued drought, climate change, and increasing demand for limited water resources. In light of new information and increasing uncertainty over drought-exacerbated stressors on salmonids, California Trout collaborated with the Center for Watershed Sciences at UC Davis to compile and analyze the most up-to-date evidence and expert judgment to re-evaluate the status of California's 31 extant runs of salmon and trout.

The 2016 update of the State of the Salmonids report synthesizes scientific information to raise public, management agency, and legislative awareness of declining salmonid populations across California. This update identifies actions to reverse these declines, and advocates for implementation of specific strategies to help restore populations. Here, I present a brief overview of the original 2008 report, explain the impetus for the current update, and discuss the research methods, analysis, and scoring used to generate current species status scores. I highlight emerging trends and themes in species status and common threats, and discuss California Trout's efforts to share our findings. Finally, I discuss specific calls to action to be shared with scientific and management communities, legislators, and the general public across print and interactive multimedia platforms.

Is Habitat Restoration Targeting Relevant Ecological Needs for Endangered Species?: Using Pacific Salmon as a Case Study

Katie Barnas (Presenter), *NOAA Fisheries;* ***Stephen L. Katz,*** *Washington State University,* ***David Hamm,*** *Hamm Consulting; and* ***Monica Diaz*** *and* ***Chris Jordan,*** *NMFS*

Conservation and recovery plans for endangered species around the world, including the U.S. Endangered Species Act (ESA), rely on habitat assessments for data, conclusions and planning of short and long-term management strategies. In the Pacific Northwest of the United States, hundreds of millions of dollars ($US) per year are spent on thousands of restoration projects across the extent of ESA listed Pacific salmon—often without clearly connecting restoration actions to ecosystem and population needs. Projects are often chosen and funded based on agency/organization needs or availability of funds with little or no centralized planning nor post-project monitoring. The need therefore arises for metrics to identify whether ecosystem and species level restoration needs are being met by the assemblage of implemented projects. We reviewed habitat assessments and recovery plans to identify ecological needs and statistically compared these to the distribution of co-located restoration projects. We deployed two metrics at scales ranging from the sub-watershed to ESA listing units; one describes the unit scale match/mismatch between projects and ecological concerns, the other correlates ecological need with need treated by projects across units. Populations with more identified ecological concerns contained more restoration effort ($p < 0.05$), but the frequency of ecological concerns in recovery plans did not correlate with their frequency as restoration targets. Instead, restoration projects were strongly biased towards less expensive types. Many ESA-listed salmon populations (78%) had a good match between need and action noted in their recovery plan, but fewer (31%) matched at the smaller sub-watershed scale. Further, a majority of sub-watersheds contained a suite of projects that matched ecological concerns no better, and often worse, than a random pick of all project types. These results suggest considerable room for gains in restoration funding and placement efficiency even in the absence of centralized planning. This analytical approach can be applied to any species for which habitat management is a principle tactic, and in particular can help improve efficiencies in matching identified needs with explicit management actions.

Managing Landscape Cumulative Effects Using Innovative Planning Technology and Process

Barry Wilson, R.P.F., CE, Analytic Ltd.

The art of strategizing within a scenario planning framework is a lot like storytelling. By weaving together scientific methods of quantitative analysis with often less tangible but equally important social objectives, scenarios (stories) are carefully crafted to link certainties and uncertainties about the future to the decisions that must be made today. This process enables us to describe a future worth creating—and then to reap the rewards of preparing for it and making it happen. The approach is very powerful when a group of people are able to gain a shared understanding of the full suite of diverse values desired and the cause / effect relationships between them. But describing all of the simultaneous interactions in a watershed and accounting for their combined cumulative effects on important values measured across the triple bottom line can be an incredibly daunting task. However, the development of exciting new innovative tools and technology is enabling collaboration and iterative planning at this level of detail.

This presentation will provide real world examples of how land users, planners, and ecologists are combining the ALCES landscape simulator, hydrologic modelling, and scenario planning to help develop and implement land management frameworks for busy working watersheds and outline opportunities for using this approach in California. Specific examples will include a look at how indigenous groups are working with western scientists and a range of land use stakeholders to compare and evaluate scenarios like "Business As Usual" with "Climate Change" and exploring opportunities for restoration and/or maintenance of salmon habitat in multiple use watersheds in British Columbia. The approach enables an integrated, holistic planning perspective by assessing the cumulative effects, both benefits and liabilities, of overlapping land uses and ecological processes on environmental and socioeconomic variables. Utilizing web-based tools, planning groups are able to take advantage of land-use simulation, geospatial data analysis and integration, and data visualization to understand the key drivers of change in their landscape and explore virtual what-if scenarios for the future together.

Restoring the ecological health and function of rivers and their floodplains will require a coordinated effort across the range of land users that directly influence the condition of the watershed that supplies them. Rivers and floodplains are essentially a product of the combined effects of watershed land use, groundwater and climate. Working forward together in a busy working landscape like the Central Valley will require a common understanding of the cumulative effects of all the different land uses together with climate and groundwater to understand what actions can move us closer to our desired future—and those that won't. The collaborative evaluation of a range of options and growth plans that consider all land uses as well as mother nature will enable a convergence of many perspectives to create synergies where innovative solutions can and will emerge.

Building on CMP Monitoring Efforts to Document Insufficient Stream Flow as a Bottleneck to Salmonid Survival in Tributaries of the Russian River, CA

***Sarah Nossaman Pierce (Presenter), Mariska Obedzinski,** and **Andrew Bartshire,** University of California Sea Grant; **Gregg Horton,** Sonoma County Water Agency; **Nick Bauer,** University of California Sea Grant; and **Aaron Johnson,** Sonoma County Water Agency*

Limited stream flow over the summer months has, for years, been suspected to be a limiting factor to the survival of endangered coho salmon and threatened steelhead populations in the Russian River basin, but quantifying the impacts is challenging. Many stream reaches commonly become dry or intermittent by late summer, with surface flows dropping to only hundredths of a cubic foot per second, especially during drought years.

In order to document the wetted habitat conditions that rearing juveniles experience during the driest time of the year, spatial data was collected in late summer to map where high priority coho recovery streams were wet, intermittent or dry. This wetted habitat data was then related to snorkel and spawner survey data collected during Coastal Monitoring Program (CMP) efforts; late summer wetted habitat conditions were overlaid with redd observations from the previous winter and juvenile count data from the early summer months. The resulting data allowed us to quantify the length of stream habitat where rearing juveniles had no chance of surviving the dry season. In many streams, particularly those that were further from the ocean, the majority of spawning and juvenile rearing was concentrated in stream reaches that went dry later in the season, confirming low summer stream flow as a bottleneck to salmonid survival. Outcomes from this study underscore the need to address insufficient stream flow over the dry season as a critical step towards achieving species recovery.

Assessing Salmonid Habitat Conditions and Management Actions in the Garcia Watershed Using the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP-West) and the California Surface Water Ambient Monitoring Program (SWAMP)

Jonathan Warmerdam (Co-presenter), *North Coast Regional Water Quality Control Board, and* ***Jennifer Carah (Co-presenter),*** *The Nature Conservancy*

Like most salmonid-bearing watersheds of the North California Coast, the Garcia River in Mendocino County is impaired from excess sediment and elevated water temperatures due to legacy impacts from activities such as industrial logging, agriculture, grazing, road building, and gravel mining. And the numbers of native, ocean-run salmon and trout species, including coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Oncorhynchus mykiss*) in the watershed are greatly diminished from historic numbers. However, based on results from a quantitative monitoring program to assess salmonid habitat conditions and progress towards water quality and watershed management goals, it appears that implementation of elevated standards for land-use practices and other regulatory programs are improving conditions for salmonids in the watershed. Established in 2007, the Garcia River Monitoring Program (GRMP) follows U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP-West) and the California Surface Water Ambient Monitoring Program (SWAMP), and includes quantitative measures of physical, chemical, and biological variables. Those data are used to calculate metrics useful in assessing salmonid habitat conditions and progress towards management goals. Results from the initial years of the program indicate that the health of the watershed is improving. Although conditions in the Garcia River mainstem are still below desirable conditions, the tributaries are improving and in some cases are now meeting numeric targets set for multiple physical, chemical, and biological metrics. In this presentation, quantitative sampling protocols used in the GRMP will be described, and results from baseline and trend monitoring, as well as assessment of restoration actions will also be covered.

What Does Habitat Monitoring Data Mean to Salmonids? Creating Status, Trend, and Recovery Information from Field Data

Sean P. Gallagher, California Department of Fish and Wildlife

Recovery management requires information on key habitat metrics generated from design-based monitoring where data are collected in the field, converted into metrics, and these metrics used to generate information. The information generated as high-level indicators of salmonid habitat condition can be viewed as the raw material of knowledge necessary for informed management. Commonly used salmon habitat assessment procedures provide a great deal of specifics about what habitat variables to measure and how to measure them, yet are less informative on what the results mean for fish. Current habitat sampling methods accomplished this by comparing habitat variables from stream surveys to generalized ratings or legally-defined threshold values which are based on professional judgement and use qualifiers such as desirable and undesirable as criteria. It is difficult to estimate status or monitor the trends in categorical qualifiers. Therefore, there is a need for quantitatively-derived indicators of salmonid habitat. I will discuss various approaches to developing information and high-level indicators of salmon habitat with examples from our current work in coastal Mendocino County, California.

Real-Time Monitoring and Management of Watersheds Using the PWA Telemeter

Brad Job, P.E. (Presenter), William Weaver, Ph.D.,
and Danny Hagans, Pacific Watershed Associates (PWA)

Ongoing drought conditions, cumulative effects of past land use practices, increased diversion of surface water, and the effects of climate change have resulted in decreased summer and fall low-flow conditions in many west coast trout and salmon streams. The State of California has been adapting regulatory and restoration programs to address these worsening threats to healthy aquatic ecosystems. The policy efforts include the Policy for Maintaining Instream Flows in Northern California Coastal Streams, Assembly Bill (AB) 2121, Senate Bill (SB) 88, and the Sustainable Groundwater Management Act of 2014, as well as new regulatory programs addressing cannabis cultivation in the state. As a result, it has become very apparent that fundamental changes in human behavior will be necessary if threatened and endangered populations of anadromous fish are to be conserved.

Fortunately, advancements in technology can now allow watersheds to be managed "smartly," similar to the "Smart Grid" for electricity. The user-friendly Arduino microcontroller platform was released onto the market in 2006 as an open-sourced low cost programmed logic controller. Arduino-like microcontrollers are simple enough for do-it-yourself assembly and programming of robot like devices that can gather sensor data, evaluate results, and perform actions in response to environmental variables. In 2016, PWA began developing the PWA Telemeter, a cellular-connected microcontroller that senses water quantity, water quality, and other environmental variables to automate, simplify, and facilitate real-time data acquisition and management of surface water diversions. Data is collected at specified time intervals, uploaded to the cloud, and available for reporting or for actuating water controls such as pumps, siphons, or valves.

In summer 2016, several field devices were deployed in the Sacramento Delta in order to validate the data they collect and evaluate their performance in real-world conditions. In this field trial, we measured stream stage and water temperature adjacent to similar but much larger and more expensive instruments owned and operated by the California Department of Water Resources. The initial field trials were concluded in December 2016, with very favorable results. The devices are small, field robust, and collect reliable real time environmental data. The PWA Telemeter can coordinate operation of water diversions within a watershed so they operate asynchronously, in balance with the availability of water for diversion, and maintain diversion records to demonstrate compliance with regulations, like bypass flow.

Our smart diversion device can not only assure that water rights holders are complying with regulations and greatly simplify water rights reporting, but can also collect other water quality data like pH, dissolved oxygen concentration, and conductivity. Even a relatively sparse network of PWA Telemeters could greatly increase the spatial resolution of ambient water quality monitoring in California's streams and rivers at relatively low cost. Moreover, the devices could be configured to transmit passive inductive transponder or almost any low-power water quality sonde that generates an analog or digital signal. Initial discussions with the State Water Resources Control Board indicate that data from properly installed and calibrated PWA Telemeters will meet the Board's requirements for water measurement and reporting.

Evaluating Sediment Effects and Utilizing Sediment Budget Elements to Prioritize Watershed Scale Salmonid Habitat Recovery to Reduce Cumulative Impacts

***Danny Hagans (Presenter)** and **William Weaver, Ph.D.,** Pacific Watershed Associates*

The emphasis of salmonid recovery strategies and funding by federal and state fisheries managers has experienced dramatic shifts over the last 4+ decades. In the 1970s and 1980s, habitat improvement efforts myopically focused almost exclusively on anadromous stream reaches through instream actions such as riparian restoration, manipulating woody debris and small-scale, bank erosion stabilization efforts. This was partially influenced by the lack of access to many private watershed areas where upland erosion processes were occurring, but equally by an inadequate understanding of the nature and magnitude of upland erosion, the links between those watershed processes, and the resulting instream habitat loss in downstream anadromous stream reaches.

In the 1990s and 2000s, accelerated upland sediment production was widely recognized as a major limiting factor affecting salmonid populations and habitat recovery in high-value watersheds. As a result, west coast recovery strategies shifted to a more complete watershed view of cumulative effects that involved a significant effort at normalizing sediment production rates and processes, as well as simultaneously addressing in-stream recovery actions. In the 2010s, largely influenced by the continued dwindling numbers of salmonids, habitat recovery efforts have largely shifted back to a heavy focus on in-stream actions in specific watersheds supporting listed species (e.g., coho), with less emphasis toward on-going upland watershed threats and region-wide salmonid habitat restoration.

Depending on the differences in physical characteristics of a watershed (geology, topography, hydrology, etc.), this presentation proposes that increases in salmonid populations are critically linked to a balanced approach at addressing all limiting factors to salmonid habitat protection and recovery: including both upland threats and instream limiting factors. Accelerated land-use related erosion and sediment delivery to a watershed's streams affects the quality of virtually all in-stream parameters needed for biologically properly functioning watersheds. Controlling accelerated, man-caused erosion and downstream sedimentation is commonly identified as a major factor influencing (1) the quality and quantity of in-stream habitat, (2) an improving long-term trend in habitat conditions, and (3) eventual recovery of salmonid populations.

This presentation will review and discuss (1) the role of accelerated land use-related sediment production and its significant persistent effects on the quality of in-stream habitat metrics, such as temperature, spawning and rearing habitat quantity, invertebrate production, and turbidity; (2) the spatial and temporal nature of watershed processes, residence times of channel stored sediment by stream order, and linkages to anadromous stream habitat recovery; (3) how an analysis of individual watershed limiting factors and sediment budgets inform a more comprehensive and reality based programmatic salmonid habitat recovery strategy; and (4) example strategies for prioritizing and implementing sediment source normalization activities in the context of protecting and accelerating the restoration and recovery of salmonid habitats.

Characterizing Stream Channel Corridors to Inform Habitat Improvement Projects

Thomas H. Leroy and Eileen Weppner (Co-presenters), Pacific Watershed Associates

Most watershed-scale restoration activities require, by their nature, a planning document or characterization of the existing conditions to target our limited restoration funds most cost-effectively. Examples of such assessments include evaluation and prioritization of road systems and fish passage barriers throughout a watershed. Conversely, adding wood to impaired fluvial systems with the overall goal of improving fisheries is rarely based on a comprehensive evaluation and watershed-scale prioritization scheme. Because adding large woody material is becoming an increasingly popular restoration technique that is being employed throughout the Pacific Northwest by professionals and restorationists with varying backgrounds and skill sets, we have developed an assessment protocol that impartially examines riparian and geomorphic conditions and facilitates planning and prioritizing selected stream reaches for wood loading and riparian enhancement.

We focused our initial evaluation on 40 miles of anadromous streams, all tributary to the South Fork Eel River, in the Usal Redwood Forest managed by the Redwood Forest Foundation. This area was chosen because (1) it was repeatedly subjected to almost complete ground disturbance over the last 70 years, (2) the CDFW habitat inventory reports for the area indicated the channels were suffering from a lack of woody debris, and (3) based on observations of in place tree stumps we had a good idea of pre-disturbance riparian conditions and stream base-levels. The assessment methodology augments CDFW habitat reports and provides more detailed rationale for selecting specific wood loading sites throughout a fish-bearing stream, but also served as a snapshot of current geomorphic and riparian conditions, on average 25 to 35 years after the latest land management activities.

During the assessment we characterized, among other stream corridor attributes: Channel bed materials, channel grade and geometry, riparian tree composition and size, residual pool depths, and percent pool cover. Furthermore, we developed a procedure to identify and characterize all existing wood jams in the surveyed reaches based on their "key" log dimensions relative to the bankfull width and depth at the jam site. Finally we examined the logistical aspects of potential wood loading projects throughout the inventoried reaches, such as accessibility and material availability, which helped refine the appropriate wood loading technique (e.g., heavy equipment or hand labor, imported or locally derived wood material, etc.).

The Usal Forest assessment identified, located, and characterized 1,676 wood jams in the 40 miles of surveyed riparian corridor. All of our data was compiled in a GIS format and examined along with other factors including: long-term transportation planning, observed fish distribution and densities, and long-term management plans to develop action plans on a sub-watershed scale. In general, the scope of the prioritized projects will be to combine the implementation of streamside road decommissioning with wood loading in the adjacent reaches, and accelerate conifer recruitment to the riparian zones. The top priority projects were based on cost-effectiveness and were determined by consultation with regulatory agencies and local fisheries biologists.

Finally, we employed LiDAR de-trending techniques to identify and prioritize for further evaluation, potential off-channel habitat improvements in the same areas. The combination of these techniques, employed with other watershed surveys (such as road erosion assessments), will allow land managers to focus their limited restoration dollars to areas that will provide the most cost-effective results and address the most significant limiting factors. Employing unbiased evaluation methodologies for all watershed and habitat elements enable landowners, biologists, and restoration funders to make well-informed restoration and protection decisions to benefit salmon.

Identifying and Prioritizing Off-channel Habitat Restoration Opportunities through Assessment of Valley Bottom Geomorphology, Flow Inundation, and Floodplain Connectivity

Jay Stallman, PG, Stillwater Sciences

Exchange of flow, sediment, and wood between the bankfull channel and adjacent floodplains during high flow events creates and maintains off-channel salmonid habitat within low-gradient reaches of coastal watersheds. Past anthropogenic disturbances typically reduce connectivity between the bankfull channel and floodplain through channel incision and confinement associated with flood control and hydraulic mine tailings. High suspended sediment concentrations and sedimentation rates associated with elevated supply can also impair floodplain habitats. Resource managers and restoration practitioners now widely recognize the importance of floodplain connectivity to salmon and steelhead survival and growth; particularly at the fluvial-estuarine transition, in coastal plain reaches, and in relatively low-gradient reaches of steep watersheds that otherwise offer little low-velocity habitat for refuge or rearing. Various techniques are commonly used to evaluate flood inundation and channel-floodplain connectivity, ranging from simple hydraulic geometry relationships and surface de-trending techniques to more complex one-dimensional and two-dimensional hydraulic and sediment transport modeling. Drawing from three case studies, this portion of the workshop focuses on application of these techniques to understanding hydrodynamic processes on valley floors in support of habitat restoration planning, prioritization, and design. The three case studies from rivers with varying channel sizes and geomorphic settings demonstrate different approaches depending on type and quality of data sources, spatial scales, and project objectives: (1) lower Ten Mile River in coastal Mendocino County, where channel incision has reduced the availability of critical floodplain habitats at the fluvial-estuarine interface; (2) Elk River, a large tributary to Humboldt Bay, where an understanding of channel-floodplain interactions is critical to planning for recovery of sediment-impaired conditions in coastal plain reaches; and (3) Salmon River, a major inland tributary to the Klamath River in western Siskiyou County, where hydraulic gold mining pervasively altered floodplain morphology and reduced the availability of floodplain habitats.

Stanislaus River Restoration Rafting Tour

Wednesday, March 29

Field Tour Coordinator*: J.D. Wikert,* *U.S. Fish & Wildlife Service*

The Stanislaus River has been degraded through dams and diversions resulting in an overly deep and wide armored channel plus large pits from gravel and gold mining resulting in substantial loss of habitat for salmonids. Several restoration projects have been implemented in an effort to restore spawning gravels, create channel complexity, and reconnect off-channel habitats. Tour participants will raft the river through much of the salmon spawning reach. Recent projects on the river have focused on reconnecting floodplains and side-channels through lowering off-channel elevations and adding screened coarse sediment back to the adjacent main channel. This holistic approach allows for both in and off-channel benefits while reducing project expense as well as the impacts from trucks hauling gravel long distances.

photo by JD Wikert

Yolo Bypass and Putah Creek Restoration Projects Tour

Wednesday, March 29

**Field Tour Coordinators*: Karin Young,* *Putah Creek Council,*
and ***Rich Marovich,*** *Solano County Water Agency*

Putah Creek flows east from Cobb Mountain in the Mayacamas Range to the Yolo Bypass on the Sacramento Valley floor. With guaranteed flows due to the Putah Creek Accord, it is one of only a few creeks that perennially flows east into the Sacramento Valley. Below Monticello Dam, it provides a rare riparian corridor in a landscape otherwise dominated by agriculture and cities.

After the landmark Putah Creek Accord in 2000, partner organizations and agencies have implemented riparian restoration projects on the 25+ miles of creek between the Putah Diversion Dam and its terminus in the Yolo Bypass. These projects have included channel realignment to improve hydrologic function with limited flows, installation of rock weirs, gravel scarification, erosion control, invasive weed removal, and planting efforts with large-scale community involvement.

This tour will begin at the Monticello Dam at the base of Lake Berryessa and work downstream through the cities of Winters and Davis before ending in the agricultural fields of the Yolo Bypass. Discussions will include the history of Putah Creek, which went dry in 1988, and how the Accord has directed restoration and management practices since 2000.

Since fall 2013 Putah Creek has experienced significantly higher than normal numbers of fall-run Chinook. While the run is expected to be largely hatchery strays, the potential for a naturalized run has galvanized community interest in local salmon and highlighted the need for ongoing habitat improvement projects.

photo courtesy of Putah Creek Council

Watershed Day at the Capitol, a Legislative Tour

Wednesday, March 29

Field Tour Coordinator*: Michael Wellborn,* *California Watershed Network*

The Legislative Tour will focus on building exposure and outreach opportunities with legislators and officials including a representative of the State Water Resources Control Board and a state senator, followed by visits to the Capitol with key legislators and/or their staff members. This tour is intended to be an opportunity for learning the processes and pitfalls of work in the Capitol as well as conveying information about our community projects to legislators, their staff, and administration officials.

The field tour will commence with a morning meeting at Cal-EPA. State Water Board Member Tam Doduc will discuss current regulatory challenges and opportunities facing restoration groups; and State Assembly Member Kevin McCarty (invited) will provide a legislator's perspective. The morning will conclude with a round-up of issues for community restorationists from A.L. Riley and Vern Goehring.

After lunch, the tour participants will visit the Capitol building and break up into groups to meet with key legislators and/or their staff members. There will be escorted visits primarily for those that have not visited the capitol previously, while those with some capital experience will be able to proceed on their own schedules and priorities. It is recommended that all participants bring photos and descriptions of their local project sites to leave with each legislator/staff member as a memento of their visits.

The field tour will culminate at the Governor's office lobby for photo opportunities with the bronze bear before returning to the vans and the ride back to Davis.

photo by Michael Wellborn

State of Beaver Restoration in California

Thursday, March 30

Workshop Coordinator: *Eli Asarian, Riverbend Sciences*

This workshop will provide an overview of current efforts to restore streams in California using beavers and beaver dam analogues. Presentation topics will include:

- Effects of beavers, beaver dams, and beaver dam analogues on geomorphology, hydrology, habitat, and salmonids in stream ecosystems
- Updated progress reports on case studies of restoration projects utilizing beavers and beaver dam analogues, including in the Scott Valley, Trinity River, Sierra Nevada, and Columbia River Basin
- Informational resources and guidelines for beaver restoration and co-existing with beavers
- The evolving framework for permitting beaver dam analogues and managing beavers in California

Following the presentations there will be in-depth group discussions about how restorationists and permitting agencies can move forward together to improve beaver management and the process for permitting innovative and adaptive restoration projects in California.

photo by Eli Asarian

The Physical Process Foundation for Stream Ecosystems: Why Restoring Beaver Dams Is Important

Brian Cluer, Ph.D., *NOAA Fisheries, West Coast Region*

Watershed development to facilitate expanding agriculture has stressed habitats critical to many aquatic organisms that are now endangered. The general ag-land development approach is characterized by some form of channel improvement to expedite runoff and drain the upper aquifer, followed by water diversion upstream to supply irrigation to the drained land. Drainage of floodplains and wetlands has been an honorable and relentless endeavor throughout civilization's history. Today, most catchments have very little wetland habitat, and even less accessible to salmonids.

The science community supports process restoration, but habitat construction and land stabilization remain the norm in "habitat" restoration practice. In addition, agency fish passage codes and guidelines tend to impede channel-spanning restoration projects even in settings where raising the stream bed-storing sediment, and elevating the water table is the goal of process restoration.

A recently published stream evolution model (Cluer and Thorne 2013) created a conceptual framework for a typical watershed that identifies the types of streams naturally forming in the usual process domains categorized by sediment dynamics: supply, transfer, and deposition zones. The framework also describes the processes and commonly found channel conditions for alluvial streams as they evolve or respond to disturbances. More importantly, the paper links habitat and ecosystem benefits to the different process domains and stream evolutionary stages. The model shows (1) that streams [stage 0] with a high degree of floodplain interaction are significantly richer in habitat and ecosystem benefits, more resilient to climate and disturbance, and are ubiquitous features historically found in alluvial valleys, and (2) that incised streams [stages 2-4] are the least ecologically valuable and least resilient type of stream, and adding complexity features to incised streams does not restore ecological function, because the physical processes appropriate to the domain are not restored. This daylights the problem of incised stream channels, and highlights the importance of restoring incised streams to a high degree of floodplain interaction in order to regain significant ecosystem benefits and habitat for salmonids.

Beaver historically played a significant role in alluvial valley processes and ecology, either by enhancing deposition processes or reversing channel incision following a disturbance, thus buffering natural disturbances and over time maintaining stream habitat at a high value. With beaver extirpation followed by land development schemes, the high value streams vanished and the incised channel became the new norm. The science of life cycle modeling is showing us that salmonids will not recover without some stage 0 stream habitat in several key watersheds. Therefore, restoring incised channels in alluvial valleys is the highest benefit restoration action, and in the right locations can also be the lowest cost alternative. Beaver dams (natural or mimics) are an important tool for addressing the incised channel problem that is pervasive in the historical range of salmonids.

Lessons Learned from a 15-Year Beaver Dam Analogue Restoration and Monitoring Project—Applying Results to Other Watersheds

Michael M. Pollock, Ph.D., NOAA Fisheries

A long-term restoration and monitoring project in the Columbia River Basin in eastern Oregon was initiated 15 years ago to examine the biological and physical effects of high densities of beaver dam analogues on fluvial ecosystem recovery, and in particular, their effects on a population of ESA-listed steelhead. After years of pre-project monitoring, over 100 beaver dam analogues were installed at four separate treatment reaches within the lower 30 kilometers of Bridge Creek beginning in 2009. Monitoring continues through the present. The effects of this project on beaver populations, steelhead populations (including movement), riparian vegetation, groundwater, temperature, and fluvial geomorphology are discussed. The applicability of these results to other watersheds in different ecoregions and different hydro-geomorphic settings as well as the lessons learned from this project are discussed. Spatial and temporal considerations of scale in the context of process-based restoration to facilitate population-level recovery of salmonids are also discussed.

Do Beaver Have a Role in the Recovery of California Coho Salmon?

Stephen Swales, Ph.D. (Presenter), *Fisheries Branch, California Department of Fish and Wildlife, and* ***Michael M. Pollock, Ph.D.,*** *NOAA Fisheries, Northwest Fisheries Science Center*

Coho salmon populations are in severe decline throughout many coastal watersheds in northern and central California and are listed under both the federal and state Endangered Species Acts. The loss and degradation of suitable spawning, rearing and overwintering habitat through human-related land and water resource developments are thought to be the primary causes of these declines. Overwintering habitat, in particular, has been shown to be lacking in many California coastal watersheds, largely due to floodplain development for agriculture, forestry and urbanization. Beaver are thought historically to have been widely distributed and abundant in many coastal watersheds, and their historic and current distribution often overlaps with that of coho salmon. The shallow off-channel ponds created through beaver activity have been shown to provide valuable overwintering habitat for juvenile coho salmon and other salmonids. Recent state and federal coho salmon recovery plans suggest the potential role of beaver in coho salmon recovery warrants further investigation. In this presentation we will discuss the relationship between beaver and coho salmon and will examine the possible role of beaver in coho salmon recovery.

Scott Valley Beaver Dam Analogues: Year 3

***Betsy Stapleton (Co-presenter)**, Scott River Watershed Council, and **Michael M. Pollock, Ph.D. (Co-presenter)**, NOAA Fisheries, Northwest Fisheries Science Center*

The first beaver dam analogues in California were installed in 2014 in the Scott River Watershed. Scott River Watershed Council, along with federal collaborators, NOAA Fisheries and U.S. Fish and Wildlife Service, have installed a total of eight Beaver Dam Analogues in widely divergent geo-fluvial conditions. As the first project to implement this innovative restoration technique in California, complex social and permitting challenges have been encountered. Beavers have interacted with the Beaver Dam Analogues, expanding project scope. A project overview, as well as successes and lessons learned will be described in this session. Monitoring results that show positive impacts on groundwater, in-stream conditions, riparian vegetation and fish production will be reviewed, as well as structure and function in the differing locations and conditions.

Bucktail Beaver Dam Analogue Construction Process and Near-Term Results

James Lee (Presenter), *Hoopa Valley Tribe and Trinity River Restoration Program, and* ***John H. Bair,*** *McBain Associates*

The Trinity River Restoration Program aims to restore salmon and steelhead populations in a dam-regulated river by creating complex aquatic environments and reestablishing natural physical processes that maintain habitat complexity. In summer 2016, Trinity River Restoration Program implemented the Bucktail Channel Rehabilitation Project on the Trinity River near Lewiston, CA. An important suite of features within this project was a side channel, wetland, and beaver dam analogue (BDA) complex that increased connectivity between the main channel and a mostly isolated floodplain. The Bucktail BDA was the first BDA that Trinity River Restoration Program constructed in the Trinity River riparian corridor.

The BDA took less time and materials to construct than project proponents anticipated. Within two weeks of BDA construction, beaver and salmon use of the area was detected. No potential hazards to humans or fish and wildlife habitat were evident after BDA construction. Short-term results of the Bucktail BDA indicate that future Trinity River Restoration Program projects should incorporate BDAs where appropriate physical and hydraulic conditions exist.

This presentation will focus on the site, timeline, methods, equipment, materials, and personnel used to construct the Bucktail BDA; and a qualitative assessment of fish and wildlife use of the structure and associated pond in the months following BDA construction.

Demonstration of Carbon Sequestration and Biodiversity Benefits of Beaver and Beaver Dam Analogue Restoration Techniques in Childs Meadow, Tehama County CA: Year 2 Update

Sarah Yarnell, Ph.D. (Presenter), *Center for Watershed Sciences, University of California, Davis;* ***Kristen Podolak, Ph.D.,*** *The Nature Conservancy;* ***Karen Pope, Ph.D.****, U.S. Forest Service,* ***Evan Wolf,*** *University of California, Davis; and* ***Ryan Burnett,*** *Point Blue Conservation Science*

In mountain watersheds, meadows and other wide floodplain and riparian areas represent only 25% of the river area, but store approximately 75% of the riverine organic carbon in floodplain sediment and coarse wood. Due to extensive livestock grazing and widespread removal of beaver and willows, headwater meadows have transformed from multi-thread channels with seasonally active floodplains into single thread, incised channels that store less carbon and are lower in habitat quality for a diverse suite of meadow-dependent wildlife. Meadow restoration techniques often include willow planting and cattle exclosures; however, few studies have rigorously tested the long-term efficacy of these methods or evaluated alternative restoration techniques such as reintroduction of beaver or installation of beaver dam analogues.

This project seeks to evaluate the installation of beaver dam analogues as a restoration technique in Childs Meadow, a heavily grazed meadow in the Cascade Range representative of low-gradient meadows across northern California. Using a before-after control-impact study design, the study tests the impacts of two restoration techniques (willow planting with cattle exclusion and willow planting with cattle exclusion and beaver dam analogues) on carbon sequestration, hydrology, and sensitive species. Results will be compared with measurements in an unrestored section of the meadow that currently supports an active beaver population and two imperiled species (Cascades Frog and Willow Flycatcher). Specific project objectives include (1) quantify and evaluate changes in above and below ground carbon storage following habitat restoration actions using beaver dam analogues and changes in grazing management, (2) compare the within meadow results to carbon sequestration values in existing restored and unrestored mountain meadows across the Cascade range, and (3) measure the response of hydrogeomorphic conditions (e.g. groundwater, temperature, habitat) and Cascades Frog and Willow Flycatcher to restorative actions. Initiated in summer 2015, thus far we have established the experimental study reaches, collected one full year of pre-treatment data, and installed six beaver dam analogues. Three years of post-implementation monitoring will be completed to assess impacts of the treatments. Here, we will review our preliminary pre-treatment results, present observations of changes immediately post-installation of the beaver dam analogues, and discuss lessons learned about partnerships and permitting.

Applications of Beaver Restoration Techniques in the Sierra Nevada

Damion Ciotti (Presenter) and Jared McKee, U.S. Fish and Wildlife Service

In lower order streams, research suggests beaver and their associated habitats result in improved habitat quality and increased complexity. The effects of beavers on stream fishes are variable and site dependent and concerns remain around the risks of these techniques to natural resources. In 2015 the US Fish and Wildlife Service started implementing, under an adaptive approach, various beaver restoration techniques at two project locations in the Sierra Nevada with the goal of restoring healthy ecosystem function and meeting species recovery objectives. The first site is an 80 acre high-elevation Sierra meadow with small (1'-2') migrating headcuts and no beaver present. The second site, in a smaller foothills drainage, has beaver present and active beaver dam building within a 0.5 mile leveed stream channel disconnected from a 40 acre floodplain. Beaver restoration techniques included ceasing beaver depredation, bolstering existing dams with a history of breaching, and installation of beaver dam analogue structures. Restoration strategies for these two projects are described including design criteria, implementation and recent results. Overall these techniques were low cost, low risk, and well suited for process based restoration in a fluvial system especially when addressing sediment or hydrologic site objectives.

Beaver in California: Creating a Culture of Stewardship

Kate Lundquist (Presenter) *and* ***Brock Dolman,***
Occidental Arts and Ecology Center WATER Institute

While beaver have created valuable aquatic habitat across California for centuries, this keystone species is still overlooked and often maligned. In this session the Occidental Arts and Ecology Center WATER Institute will discuss its statewide efforts to create a culture of beaver stewardship towards watershed restoration, salmonid recovery, and climate change adaptation. Learn about the recently released Beaver in California guidebook (*www.oaec.org/publications/beaver-in-california*) and how it can help landowners and resource managers mitigate potential damage while receiving the ecosystems services beaver provide. This publication discusses the historic legacy and current benefits of beaver to California's unique ecosystems; non-lethal management strategies and California case studies that promote co-existence and decrease the need for lethal management; beaver as a cost-effective tool for restoring mountain meadows, riparian rangelands, and endangered salmonid habitat; and offers recommendations to support the implementation of beaver coexistence and conservation policies. The WATER Institute will also discuss its work to conduct a pilot beaver restoration feasibility assessment process to help landowners determine how to best incorporate beaver into their restoration planning.

Adaptive Beaver Management Plans: A Tool for Mitigating Beaver Nuisance Behavior While Partnering with Beaver in a Restoration Context

Elijah Portugal, Natural Resources Services, Redwood Community Action Agency

Over the past several years, there has been a growing appreciation in both the scientific community and the restoration and conservation communities about the importance of beaver as a keystone species in the long-term sustainable management of natural resources associated with riverine and riparian systems. As keystone species, beaver exert strong control over the riverine environment through their dam building activities. In the human built environment beaver dam building can pose problems through flooding, blocking of culverts and unwanted harvest of planted riparian vegetation. Adaptive beaver management plans are a tool to provide mitigation techniques ('Living with Beaver Strategies') for beaver nuisance behavior while allowing the beaver to remain in place and continue to provide the ecosystem services necessary for a healthy dynamic river. Plans typically include identification of likely conflict areas, specific mitigation recommendations, simple monitoring frameworks, and a transparent logical structure to arrive at a specific management action. Case study examples from two adaptive beaver management plans will be discussed.

Permit Guidance for Beaver Dam Analogues (BDAs) in the North Coast Region

Jonathan Warmerdam, ***North Coast Regional Water Quality Control Board***

Implementation of a new experimental restoration technique known as beaver dam analogues (BDAs), has begun in California. BDAs are channel-spanning features intended to mimic or reinforce the natural functions of beaver dams. Like natural beaver dams, BDAs are biodegradable, temporary features on the landscape with functions that change in response to the effects of flowing water, sediment, and beaver activity (Pollock 2012).

BDAs have a longer history of implementation and experience in other parts of the Pacific Northwest, but due to their experimental status in California, there are a number of unique permitting considerations and requirements that must be incorporated into projects. Coordination between state and federal regulatory agencies, restoration practitioners, and environmental non-profits has helped identify the expected level of project information, allowable material use, adaptive management methods, and appropriate environmental protection measures required for BDA projects. Additionally, the most-appropriate permitting pathways for BDA authorization are continuing to evolve and mature.

North Coast Regional Water Quality Control Board staff will provide preliminary guidance to restoration practitioners seeking state-level water quality certifications to develop BDA projects in the North Coast Region.

Practical Permitting Guidance for Beaver Dam Analogue Restoration Projects

***Curt Babcock** and **Michael Harris (Co-presenters)**, California Department of Fish and Wildlife*

Beaver dam analogues are a relatively new type of instream restoration method for California. The Department is very interested in the benefits they may provide for stream stabilization, habitat complexity, and coho salmon recovery. However, the Department believes more information is needed regarding siting and design to maximize the habitat restoration objectives, including providing fish passage. The regulatory landscape is complex and changing in California. Historically, all projects, including restoration projects, received the same scrutiny and process as development projects. This has changed with the recent passage of the Coho HELP Act and the Habitat Restoration and Enhancement Act, which provide for streamlined permitting pathways for small habitat restoration projects. This presentation, focusing on California Fish and Game Code and the Department's role and authorities, will discuss some of the complex environmental review and permitting issues related to proposed beaver dam analogue habitat improvement projects. Guidance is provided to increase the likelihood that proposed instream restoration projects will be efficiently permitted and approved.

Fish Passage: Tidewater to the Sierra

Thursday, March 30

Workshop Coordinators*: Michael Love, P.E., Michael Love & Associates, Inc.;*
Mike Garello, P.E., HDR Engineering, Inc.; and **Ross Taylor,** *Ross Taylor & Associates*

This workshop will be a day-long course and discussion focused on taking a broad perspective to address stream and downstream fish passage challenges. This will involve the examination of migration barriers from a watershed perspective and understanding how they are inter-related rather than focusing on one barrier at a time. The workshop will also discuss the various technologies and approaches available to address barriers, lessons learned from previous projects, and future challenges ahead.

The morning will focus on a range of fish migration challenges that arise at road-stream crossings, low-head dams, and other infrastructure that impede movement of fish. These include inventory and ranking of barriers for remediation while working with multiple ownerships, identifying channel incision that creates fish barriers, conducting geomorphic risk assessments to avoid creating new upstream barriers, and how to select the best fish passage solution for a site.

In the afternoon the workshop will focus on upstream and downstream passage over high-head dams. Here, we will examine what has worked in the Pacific Northwest, lessons learned, and the similarities and differences in the challenges we face in California. Topics will include volitional versus non-volitional upstream passage, guidance and collection systems for out-migrants, thermal barriers and temperature control, and the successes and failures of reservoir transit, among others.

Two panel discussions will present various viewpoints on the use of volitional and non-volitional passage at high head dams as well as on the applicability of lessons generated in the Pacific Northwest for use in California. The panel discussions will be interactive. All workshop attendees will be encouraged to engage in all topics. Topics of discussion are anticipated to include:

- **Panel Discussion:** Upstream passage: When is volitional passage the right option for fish passage?
- **Panel Discussion:** Downstream passage: Are lessons learned in the PNW applicable to California high dams and reservoirs?

Status of Fish Passage Assessments and Prioritization in California

Ross Taylor (Co-presenter), *Ross Taylor and Associates,*
and ***Anne Elston (Co-presenter),*** *Pacific States Marine Fisheries Commission*

Fish passage through stream crossings and over dams is an important factor in the recovery of depleted salmonid populations throughout the Pacific Northwest. Although most fish-bearing streams with culverts at stream crossings tend to be relatively small in size with only a couple of miles or less of upstream habitat, thousands of these exist and the cumulative effect of blocked habitat is quite significant. The numerous dams that impede fish passage in California range from small diversion structures several feet in height up to high-head dams of heights greater than 100 feet.

One of the challenges in opening up significant reaches of blocked habitat is that many streams within a watershed are bisected by multiple crossings and dams, often owned and managed by a variety of entities. Thus, standardized assessment and prioritization methodologies, as well as inter-agency planning and coordination are vital to achieving comprehensive fish passage on a watershed scale.

This presentation summarizes the status of fish passage assessments and prioritizations in California, identifies data gaps and discusses tools to close these existing gaps. Recent updates to the Passage Assessment Database (PAD) will also be presented.

One Size Does Not Fit All—Tools and Approaches to Addressing Stream Crossing Barriers

Michael Love, P.E., Michael Love & Associates, Inc.

Part XII of the California Department of Fish and Wildlife's Salmonid Stream Habitat Restoration Manual summarizes contemporary design approaches and implementation techniques for providing fish passage at existing and replacement stream crossings, small dams, and other in-stream structures. This portion of the workshop will provide an overview of the manual and will be divided into three sections.

The first section will include a review of the important steps in the pre-design and geomorphic evaluation phases of a project. The discussion will include approaches for developing and interpreting stream profiles, identifying incised channels and knickpoints that may create fish barriers, and importance of assessing risk associated with working in incising channels.

The second section will review the various approaches available to improve fish passage and their applicability. This will include an overview of the stream simulation approach, baffles for culvert retrofits, and grade control techniques, including boulder and log weirs, geomorphically-based roughened channels, and pool and chute fishways. The presentation will use project examples to illustrate the different approaches, while focusing on lessons learned.

The third section will be interactive, with participants utilizing annotated channel profiles and other provided geomorphic information to identify a suitable design channel profile along with the low and high vertical adjustment potential for the profile, and develop recommendations for the design approach.

Fish Passage at High Dams: Modern Challenges and Solutions to Addressing Uncertainty

Michael C. Garello, P.E., *HDR Engineering, Inc.;* ***John Hannon,*** *U.S. Bureau of Reclamation;*
Jonathon Mann, P.E., *California Department of Fish and Wildlife;*
and ***Rick Wantuck,*** *NOAA/National Marine Fisheries Service*

High-head dams are known barriers to the upstream and downstream migration of fish. In the Pacific Northwest there is over a century of experimentation, failure, success, and lessons learned for fish passage at high-head barriers. Technologies for upstream fish passage have advanced to a significant degree over the years while the state of the art for downstream fish passage continues to evolve. Some systems are proving to be very effective; others are still working towards improved performance. Several new technologies are also under development for both upstream and downstream fish passage. Facility owners, fisheries resource agencies, researchers, and designers are eager to learn lessons from field experience and apply that knowledge to their existing or future facility. Do the lessons learned at other locations apply to California High Dam reintroduction projects? Is California the next melting pot for development of high-dam fish passage technology?

This afternoon presentation will be given by multiple speakers and provide a broad overview of fish passage at high-head dams with an emphasis on the lessons learned from the Pacific Northwest and the specific challenges of California. The presenters will cover available technologies, the design process, case-studies, and lessons learned from existing facilities. The presentation will help attendees understand the full suite of technical and environmental challenges associated with these structures, why solutions are so site specific, and how they must be tailored to individual conditions and project constraints. These presentations will provide a framework for the panel discussions that will follow.

Fins, Feathers, Farms and Floodplain Fecundity: Multi-Use Floodplain Projects in the Lower Sacramento Valley Tour

Thursday, March 30

Field Tour Coordinators*: Jacob Katz, Ph.D., California Trout, and* ***Eric Ginney****, ESA*

Multi-benefit projects are designed to reduce flood risk and enhance fish and wildlife habitat by allowing rivers and floodplains to function more naturally. These projects create additional public benefits such as protecting farms and ranches, improving water quality, increasing groundwater recharge, and providing public recreation opportunities. This tour will visit diverse floodplain projects in Yolo Bypass, Sutter Bypass and the Colusa basin, where farmers, water districts, conservationists and agencies are collaborating to integrate current ecological science into the management of tens of thousands of acres of agricultural floodplain in ways that benefit both fish and people. Come see how the same agricultural fields can grow food for people in summer and produce food and habitat for native fish and wildlife in the winter offseason.

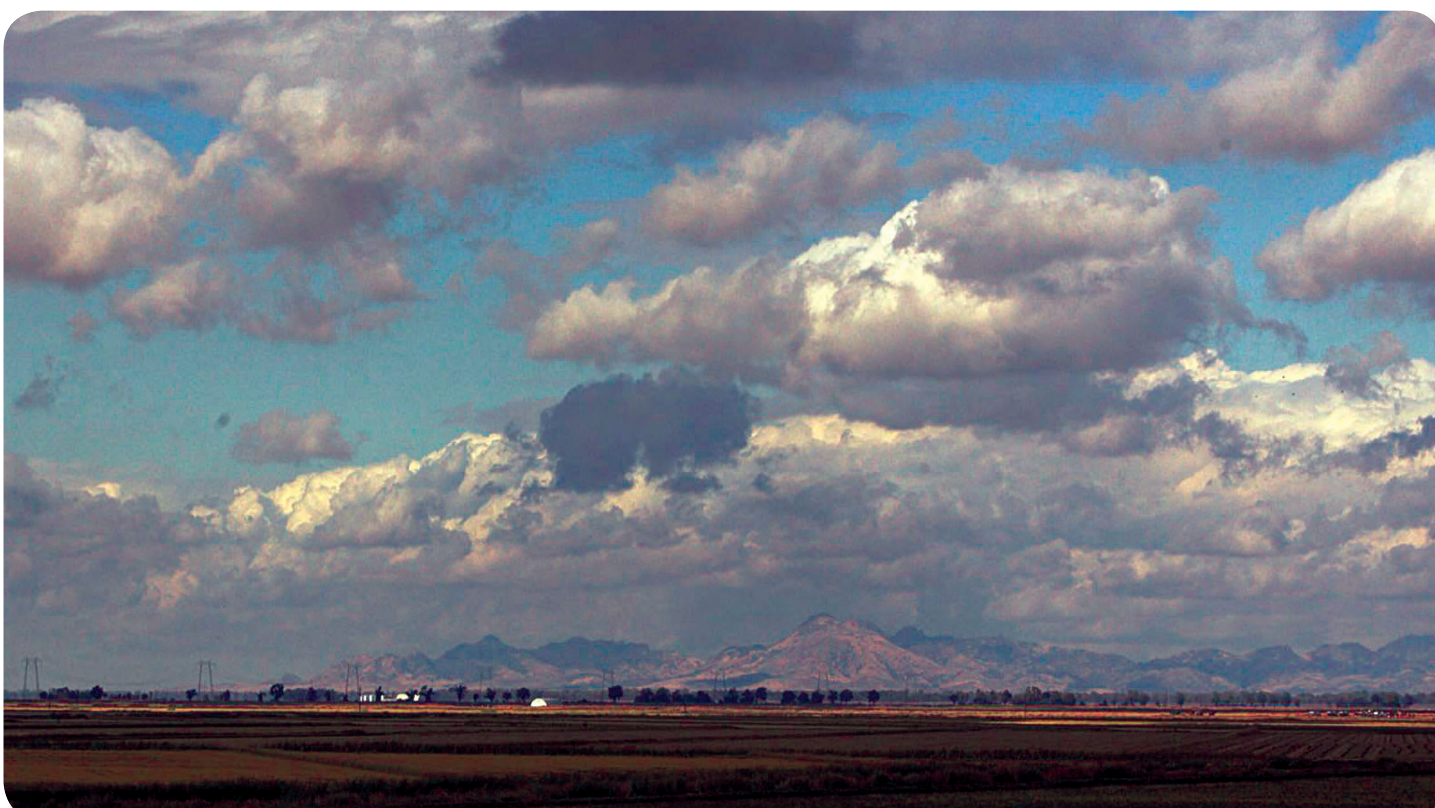
photo by Jacob Katz

American River Gravel Augmentation and Floodplain Restoration Sites Tour

Thursday, March 30

Field Tour Coordinators*: Chris Hammersmark, Ph.D, P.E.,* *cbec eco engineering, and* ***Joe Merz, Ph.D.,* *Cramer Fish Sciences*

The Lower American River is the crown jewel in the Sacramento region's rich legacy of environmental stewardship. Nearly five million people flock to the spectacular river parkway each year to enjoy its unique ecological resources and recreational opportunities.

The river has had a long history of anthropogenic impacts including mining, urbanization of historic floodplains, flow management and water development. With 43 fish species, including many invasive species and endangered steelhead trout and struggling Chinook salmon, the river also provides important habitat for the anadromous fisheries of the Sacramento River Basin. It is also home to a rich diversity of wildlife and waterfowl. These natural attributes have made the lower American River the only urban waterway to be designated a "Wild and Scenic River" by state and federal governments.

Today, stakeholders, including the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, California Fish and Wildlife and the Sacramento Water Forum have been working together to rehabilitate the Lower American River focusing on spawning, incubation and rearing habitat of Chinook salmon and steelhead. The field trip will visit recently restored sites. Historical impacts, and project design, implementation and monitoring will be discussed.

Salmon Restoration and the Re-engineering of Water in California

***Jay R. Lund, Ph.D.**, Director, Center for Watershed Sciences, Professor of Civil and Environmental Engineering, University of California, Davis*

The restoration of salmon in California must occur with a landscape crowded with human activities. Water management in California is being re-engineered, in a fashion, to better support environmental purposes along with traditional human economic uses. This talk looks at the historical evolution of human water development in California and how it relates to maintaining salmon populations. It then looks at promising directions for maintaining viable salmon populations in California and how systematic and policy analysis might help in sustaining salmon.

Friday, March 31

If Salmon Could Talk…

***Felicia Marcus**, Chair, State Water Resources Control Board*

With big decisions related to the Bay and Delta pending, there are an array of voices arguing about what the science says about salmon's needs. Chair Marcus will talk about the challenge of wading through the battlelines, and the big feelings on all sides, to find solutions. Due to *ex parte* rules, Chair Marcus cannot discuss the pending WaterFix water rights petition proceedings, and will instead focus on the Board's update of the Water Quality Control Plan for the Bay-Delta.

The Epic California Drought as Viewed from Space: Drought vs. Chronic Water Scarcity and Implications for Sustainability

Jay Famiglietti, Ph.D., NASA Jet Propulsion Lab, and UC Irvine

The California drought may well be over but the state's water woes will continue to plague its residents for the foreseeable future. In this presentation I will review satellite observations of the epic drought and what they have revealed about California's unquenchable thirst. From El Nino to La Nina, wet years vs. dry years, drought vs, flooding, and urban water use vs. agricultural, I will discuss the last 15 years of satellite observations of changing snowpack, groundwater depletion, and land subsidence. I will make the point that agricultural water use drives chronic water scarcity in California, so that as long as the state attempts to maintain food production at current levels, identifying sufficient water resources for irrigation will become increasingly challenging. As such, classic groundwater 'sustainability' is likely dead and must give way to more realistic management strategies that explicitly measure and control rates of depletion.

Estimating Juvenile Salmonid Survival Across Diverse Spatiotemporal Scales

Friday Afternoon Concurrent Session 1

Session Coordinator*: Cynthia Le Doux-Bloom, Ph.D.,* *AECOM*

Estimating juvenile salmonid survival is one critical factor for assessing recovery. During outmigration, juveniles encounter threats to survival such as native and non-native fishes, avians, aquatic mammals, agricultural and municipal water pumps, tidal gates, and other man-made structures. Route selection plays an important factor in survival due to differences in threat levels. Identifying habitat areas with high mortality provides opportunities to direct restoration activities and recovery efforts.

Survival and Movement Rates of Wild Chinook Salmon Smolts from Mill Creek through the Sacramento River, Sacramento-San Joaquin River Delta, and San Francisco Bay, 2013-2016

Jeremy Notch (Presenter) and Flora Cordoleani, Ph.D., NOAA Southwest Fisheries Science Center and University of California, Santa Cruz; Arnold Ammann, NOAA Southwest Fisheries Science Center; Matt Johnson, California Department of Fish and Wildlife; and Alex McHuron, NOAA Fisheries, Southwest Fisheries Science Center and University of California, Santa Cruz

Populations of wild spring and fall-run Chinook salmon in California's Central Valley once numbering in the millions have dramatically declined in recent years to all-time low numbers. Dam construction, habitat degradation, predation, water diversions, and introgression with hatchery salmon have decimated populations of wild spring-run Chinook in the Central Valley. Currently, just a few populations of spring-run Chinook persist in the remaining un-dammed tributaries to the Upper Sacramento River Basin. Mill Creek is one of these tributaries, which offers some of the most pristine spawning and rearing habitat currently available to Chinook salmon in the Central Valley. Despite this pristine habitat, its populations of spring and fall-run Chinook salmon have declined in recent years, with spring-run escapement reaching a low of 127 adults in 2015. In order to address this issue and study the survival rates of out-migrating smolts from Mill Creek, we used Juvenile Salmon Acoustic Telemetry System (JSATS) acoustic tags surgically implanted into migrating smolts captured with a rotary screw trap. Acoustic receivers placed throughout the migration corridor allow us to track reach-specific survival and movement rates from Mill Creek to the Pacific Ocean. After four years of data collection (2013-2016), we have applied acoustic tags to 330 smolts during their spring out-migration. The smolts experienced extreme drought conditions in 2013-2015, followed by a wet year in 2016. The data suggests survival for smolts emigrating from Mill Creek during drought conditions is very poor, with the majority of them dying in Mill Creek and the Upper Sacramento River. In 2016 these smolts experienced high-water conditions that should lead to higher survival rates. Continued acoustic tagging studies on these stocks will allow us to better manage the dwindling populations and focus restoration efforts in key locations.

Sacramento River Reach-Specific Movement and Survival Rates of Hatchery-Origin Winter-Run Chinook Salmon Juveniles

Arnold J. Ammann (Presenter), *NOAA Southwest Fisheries Science Center,*
and ***Jason L. Hassrick,*** *ICF International*

From 2013 through 2016, we used the Juvenile salmon Acoustic Telemetry System (JSATS) to estimate reach-specific survival rates for hatchery-origin winter-run Chinook salmon. Winter-run juveniles produced at the Livingston Stone National Fish Hatchery were released into the Sacramento River in Redding and tracked during out-migration by receivers placed every 10-50 river kilometers throughout their 550 km migration to the ocean. Each of the four years had different flow conditions after release and different migration and survival patterns were observed among years. In all years we observed some fish holding for varying lengths of time in an area between Red Bluff and Knights Landing. The percent of fish exhibiting holding behavior varied from 100% in 2013 to 30% in 2015. Overall survival to the ocean ranged from 2 to 13% and correlated strongly with travel time and flow after release. Higher flows generally resulted in faster travel times and greater survival. Median travel time through the river varied among years, from up to 45 days in 2013 to less than 10 days in 2015. Survival through the River and Bays was the most variable among years while survival through the Delta was the least variable. This research provides much needed data on survival and movement of the juvenile out-migration life stage. This information is critical for improving fisheries and water management, restoration efforts, and life cycle modeling.

Movement and Survival Rates of Spring-Run Chinook Salmon Juveniles from the Sutter Bypass to the San Francisco Bay

Flora Cordoleani, Ph.D. (Presenter) *and* ***Arnold J. Ammann,*** *NOAA Southwest Fisheries Science Center;* ***Jeremy Notch,*** *NOAA Southwest Fisheries Science Center and University of California Santa Cruz; and* ***Alex Mc-Huron,*** *NOAA Southwest Fisheries Science Center*

Acoustic tagging studies have become a well-established tool in estimating movement and survival rates of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in California's Central Valley. While these studies have focused on hatchery smolts that are easily tagged and released in large groups, little is known about the survival and movement rates of the remaining wild salmon in the Central Valley. Managers have been limited to inferring wild salmon survival and movement dynamics from hatchery fish data; a tactic that has been criticized because the two are different in many ways.

Spring-run Chinook salmon were once a major component of the Central Valley Chinook stock, with annual catches of over a half-million fish in the 1880's. Today, wild populations of spring-run Chinook thought to be self-sustaining survive only in three tributaries of the Sacramento River: Mill, Deer, and Butte Creeks, and are state and federally listed as a threatened species (Lindley *et al.*, 2007; Yoshiyama *et al.*, 1998). In 2015 and 2016 we implemented an acoustic tagging experiment in the Sutter Bypass with the objective to tag wild Butte Creek spring-run Chinook salmon juveniles and to provide information on movement rates and locations of high mortality during their migration to the ocean. This study also aimed at comparing the results obtained from this experiment and a similar study performed the same years on Mill Creek spring-run juveniles that didn't have access to the Sutter Basin floodplain to rear. Moreover, these data collected in a range of water years will allow the assessment of the role of the floodplain to freshwater survival, especially during dry years when the Sacramento River conditions are shallower, warmer, and predation rate may be greater.

We will present the results and discuss the implications for juvenile Chinook salmon survival in the Central Valley.

Factors Affecting Delta Survival and Route Selection of San Joaquin River Fall-Run Chinook Salmon, 2010 - 2013

Rebecca Buchanan, Ph.D. (Presenter), *University of Washington;* ***Pat Brandes,*** *U.S. Fish and Wildlife Service; and* ***Josh Israel, Ph.D.,*** *U.S. Bureau of Reclamation*

Delta survival of juvenile fall-run Chinook salmon migrating from the San Joaquin River has been very low in recent years (at most 10% since 2010). Understanding the factors that influence Delta survival is key to successfully managing this population. Acoustic-telemetry data from juvenile outmigration studies in 2010—2013 were analyzed in a multi-year analysis using covariates that reflect fish condition and environmental and operating conditions to identify important factors in determining route selection and survival. Covariates included fish size, barrier status at the head of Old River, export rates, river flow, water velocity, water temperature, and salinity (X2). Route selection at the head of Old River is primarily determined by the presence of a rock barrier, and secondarily by river flow, with more fish selecting the San Joaquin River route when flows are high. However, low survival in both routes limits the benefits of route manipulation on overall through-Delta survival. Survival through the upper reaches of the study area (upstream of Turner Cut in the San Joaquin, and upstream of the water export facilities or Highway 4 in Old River) was primarily associated with salinity (X2) and flow, with some effect of exports; however, consistently low survival in downstream reaches reduced overall survival to Chipps Island. Overall, through-Delta survival from the head of Old River to Chipps Island was related to water temperature and water exports in the San Joaquin River route, and to water exports and Old and Middle River flow in the Old River route. Findings suggest that fish are responding to water quality (e.g., salinity, temperature) as well as water quantity. The complex relationships among the covariates make it difficult to identify driving factors and suggest a flexible management approach that incorporates regular monitoring of fish performance in response to management actions.

Do Barriers for Deterring Juvenile Salmonids Away from High-risk Migration Pathways Affect Survival at Important Channel Junctions in the Sacramento-San Joaquin Delta, California?

Marin Greenwood, Ph.D., ICF

California's Department of Water Resources is mandated to investigate engineering solutions to reduce juvenile salmonid migration into the low-survival interior Sacramento-San Joaquin Delta. To this end, various barriers have been investigated at important channel junctions. Predation risk near such barriers could increase because of the predator habitat provided by the in-water structures or because of changed juvenile salmonid behavior. The present study investigated survival of acoustically tagged juvenile salmonids at the San Joaquin River-Head of Old River (HOR, 2009-2012) and Sacramento River-Georgiana Slough (GS, 2014) junctions. Predation probability of juvenile Chinook Salmon (CS) at HOR was significantly greater with a bio-acoustic fish fence (BAFF) turned on (2009/2010) and a rock barrier (2012) in place than with the BAFF turned off, largely because the barriers guided the CS, as intended, away from the low-survival route, but inadvertently toward a predator-dense ambush location. In addition, predation probability was positively related to ambient light level, perhaps because visual predators were more successful by day. The estimated proportion of juvenile CS that were preyed upon at HOR ranged from 0.10 in 2011 (high flow, no barrier) to 0.39 in 2012 (lower flow, rock barrier). Bioenergetics modeling illustrated that the potential proportional consumption of CS entering HOR by Striped Bass could have been greater in 2012 (~0.17) than 2011 (<0.005) because 2012 had higher predator density, lower prey density, and higher temperature. At GS, predation probability was not related to the operation of a floating fish guidance structure, but was negatively related to turbidity, possibly because visual predators were more successful in clearer water. The present study illustrates that site-specific considerations are key because barriers and other factors can affect survival at important channel junctions. Additional studies with true no-barrier control conditions are essential to define potential barrier effects on predation.

Estimating Relative Survival and Adult Return Rates of Coho Salmon that Rear in Stream and Estuary Habitats

Darren M. Ward, Ph.D. (Presenter), *Humboldt State University Department of Fisheries Biology;* ***Seth Ricker*** *and* ***Mike Wallace,*** *California Department of Fish and Wildlife;* ***Gabe Scheer,*** *Humboldt State University Department of Fisheries Biology; and* ***Nicholas Van Vleet,*** *California Cooperative Fish and Wildlife Research Unit, Humboldt State University*

Cohorts of Coho Salmon (*Oncorhynchus kisutch*) rearing in the Freshwater Creek watershed separate into different rearing habitats during the course of their juvenile rearing period. One goal of the life-cycle monitoring program on Freshwater Creek is to determine which types of habitat produce fish with the highest probability of contributing to the adult spawning population by estimating life-stage-specific survival rates for individuals from different habitats. Estimating survival rates requires juvenile tagging efforts followed by recapture or detection of tagged individuals as they transition between life stages and habitats. Individuals that move into the stream-estuary ecotone for an extended rearing period as juveniles presented a challenge for this monitoring effort. Because they use habitats downstream of much of the sampling infrastructure on Freshwater Creek, these estuary-rearing fish do not necessarily pass by a final recapture point before entering the marine environment. We will review a variety of approaches that can give different types of information about the relative performance of fish that use estuarine and stream habitats as juveniles and make recommendations for future monitoring efforts.

Central Valley Recovery Planning and Restoration

Friday Afternoon Concurrent Session 2

Session Coordinator*: Charlotte Ambrose, NOAA Fisheries*

In the summer of 2014, a federal recovery plan was released for Central Valley salmon and steelhead that laid a framework to restore the region's historically abundant wild fish runs. This recovery plan complemented the California Department of Fish and Wildlife's Ecosystem Restoration Conservation strategy. Millions of wild salmon and steelhead once returned each year to spawn in the foothill and mountain streams surrounding California's Central Valley. Fed by rainfall, snowmelt, and coldwater springs, these streams fostered diverse and abundant Chinook salmon and steelhead runs. The mid-1800s ushered in sweeping changes to the landscape that led many species to the brink of extinction, including: Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. Gold mining, dam construction, water and hydropower development, and other land uses hindered fish populations from thriving in the Central Valley. By 1989, Sacramento River winter-run Chinook was listed under the Endangered Species Act as a threatened species, but was soon reclassified as endangered in 1994. Central Valley steelhead and spring-run Chinook followed suit in 1998 and 1999, respectively, becoming federally listed as threatened species.

Today, there is a path to recovery. A concerted effort among NOAA Fisheries, California Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, additional agencies, and the public culminated in NOAA Fisheries' development and release of a federal plan to recover Central Valley's listed salmon and steelhead runs. The plan provides a road map to recover these species with the goal of removing them from the Endangered Species List. With science at its foundation, the plan identifies clear priorities to guide recovery efforts in the Sacramento-San Joaquin Delta and its watersheds. It also provides a framework for targeting conservation efforts and modifying on-the-ground actions based on new science and changing circumstances.

The Salmonid Restoration Federation Conference highlights key themes that are critical for the recovery of these Central Valley salmonids: reintroductions, hatchery reform, habitat and floodplain restoration, science and monitoring, and others. This session will provide the background of the recovery plans and the context of how specific recovery actions are necessary in specific locations to shift Central Valley salmon and steelhead from extinction to recovery.

Recovering Central Valley Chinook Salmon and Steelhead

Brian Ellrott, *National Marine Fisheries Service*

Millions of wild salmon and steelhead once returned to spawn in the foothills and mountains of California's Central Valley. Streams fed by rainfall, snowmelt, and cold water springs encircled the valley, fostering unmatched diversity of Chinook salmon and steelhead. However, the mid-1800s ushered in sweeping changes to the landscape that ultimately led to declines in the abundance, distribution, and diversity of these fish.

Gold mining, dam construction, water and hydropower management, and other land uses hindered fish populations from thriving in the Central Valley. By the 1990s, three of the valley's salmon and steelhead species were close to extinction and listed under the federal Endangered Species Act (ESA): Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. Today, only a few of the historic populations remain, but a new ESA recovery plan provides a framework for recovering Central Valley's iconic fish.

In July 2014, the National Marine Fisheries Service released a plan to recover Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. This recovery plan sets goals and prioritizes actions for the Sacramento-San Joaquin Delta and its watersheds, laying out steps to achieve the species' recovery. The goal of this recovery plan is to improve the biological status of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead so they can be removed from the list of federally endangered species. The basic recovery strategy for these three species focuses on enhancing existing populations and reintroducing populations into their historical habitats.

Although NMFS is responsible for implementing the recovery plan, achieving the ESA goal of species delisting is beyond the scope of any one agency or group and will not happen without cooperation among fishing, water, and environmental stakeholder groups, and public agencies at all levels of government. We all need to work together in order to attain the ESA delisting goal as well as the broader goal of restoring the Central Valley's salmon heritage and protecting it for future generations.

This presentation will: (1) cover key aspects of the Central Valley Chinook Salmon and Steelhead Recovery Plan; (2) announce the results of a recent status review for winter-run Chinook salmon; and (3) highlight NOAA Fisheries' Species in the Spotlight Initiative including opportunities to recover winter-run Chinook salmon that are identified in a recently released 5-year action plan.

Salmon Recovery NGO Experience

John McManus, ***Golden Gate Salmon Association (GGSA)***

It's well-documented that California's Central Valley once had plentiful salmon and great habitat. Some might think the call for more science and monitoring efforts suggests we don't really know enough to act, which is wrong. We may not have perfect knowledge but we certainly know enough to act to recover Central Valley salmon, lest we end up with the best-documented extinction event in history.

GGSA has been working for six years on a suite of recovery projects in the Central Valley that break down into two categories: those aimed at habitat restoration and those aimed at securing more water for fish. Most or all of the GGSA recovery projects dovetail with recovery recommendations for salmon from NMFS.

GGSA and others are pushing for actions to reverse damage done by putting dikes and levees on the river banks, filling the side channels, straightening the river, and rip-rapping the banks (among other things). We need to reverse or mitigate modifications to the river channel by manmade structures that seem to create perfect predator habitat. Far too little of this work is getting done. When it comes to habitat restoration, bureaucracy and regulations thwart permitting and thus actions on the ground. One of the biggest recovery needs is to act with a sense of urgency and move rock and dirt. The regulations slowing recovery were all born of good intent and most specifically designed to prevent a bad action and outcome, but they've become an enemy of restoration along with a focus on what seems like perpetual research that displaces true recovery actions. Those who destroyed Central Valley salmon habitat, going back over 100 years, largely did so with zero permits and regulation. Something like programmatic permits are needed to allow widespread, prompt, landscape-level restoration of the valley floor for salmon.

In addition, we need to re-balance water allocation to supply more water for salmon, particularly for out migrating juveniles. But who has the political will to re-allocate one of California's most precious natural resource—water? At least until now, not the politicians who appoint the water managers. In a world of Citizens United, where unlimited money can be spent to tip elections, any politician who seeks to take water from those who have it and instead give it to salmon are likely to find a very well-financed opponent in the next political race running on a platform of maintaining the status quo.

Accelerating Salmonid Recovery: Expediting Permitting of Habitat Restoration in the Central Valley

***Eric Ginney (Co-presenter),** Environmental Science Associates; **Ruth Goodfield (Co-presenter),** NOAA Restoration Center; **Erika Lovejoy (Co-presenter),** Sustainable Conservation; **Chris Fitzer,** Environmental Science Associates; and **Katie Haldeman** and **Erik Schmidt,** Sustainable Conservation*

Frequently, the most challenging aspect of a restoration project in the Central Valley of California is not the technical work that goes into the planning, design, and implementation, but instead addressing the complex web of environmental regulations. There is significant new restoration funding available in the Central Valley and we anticipate an increase in projects, however, the agencies granting funding generally do not provide permitting or permit funding assistance for applicants.

To address this situation, Sustainable Conservation is working with the National Oceanic and Atmospheric Administration's (NOAA) Restoration Center (NOAA RC), the U.S. Army Corps of Engineers (Corps), and Environmental Science Associates to develop a programmatic Biological Assessment (BA) for habitat restoration projects in the Central Valley. The BA will be jointly submitted to NOAA's National Marine Fisheries Service (NMFS) by the Corps and NOAA's Fisheries Restoration Center. NMFS would then complete a programmatic Biological Opinion (BO) under Section 7 of the federal Endangered Species Act for approximately 20 habitat restoration project types. If an applicant proposes restoration actions that are covered in the programmatic BO, the project can receive incidental take authorization much more quickly and easily than through an individual project BO. Programmatic Section 7 consultation can significantly accelerate the regulatory approval of restoration projects, allowing for more expedited implementation, which will aid in the recovery of anadromous fish species throughout the Central Valley.

Expedited authorizations and permits for restoration activities can reduce a project's permit approval timeline by several months or more, as well as cut applicants' permitting costs significantly. For agencies, programmatic approvals reduce staff workload and help meet key goals for resource protection, species recovery, and delivery of funds. NMFS' salmon and steelhead recovery plans recognize efficient permitting of priority restoration projects as an important step in helping implement the plans and get needed projects constructed. Restoration proponents and regulatory agency staff should take advantage of these tools for faster regulatory approval of environmentally beneficial projects. However, it is important to understand the detailed project description, environmental and species protection, size limitation, and other requirements of these frontloaded permits, and be willing to communicate early with regulatory agencies in a cooperative relationship.

When completed (scheduled for 2018) this newly available programmatic BO will be available for project proponents including federal, state and local governments, special districts and NGOs, giving them the opportunity to plan, design and implement restoration projects more quickly and with more resources for on-the-ground work.

Funding Opportunities for Fisheries and Watershed Restoration Projects

Matt Wells, California Department of Fish and Wildlife

An ongoing challenge in salmonid fisheries and watershed restoration is the development of strategies to address various geographic regions and species with sufficient funding and resources. Add to this challenge a five-year drought, and the situation demands a closely coordinated and concerted effort across public agencies and stakeholders. This presentation will outline the objectives and priorities of relevant California Department of Fish and Wildlife (CDFW) grant programs and distinguish the unique characteristics of each and how potential applicants can best pursue funding through these programs.

CDFW administers two overarching grant programs directly targeting fisheries and watershed enhancement and restoration. The first, the Fisheries Restoration Grant Program (FRGP) funds projects to address rapidly declining populations of wild salmon and steelhead trout and deteriorating fish habitat in California. The second and more recently established, the Proposition 1 Restoration Grant Programs, developed in response to the 2014 water bond measure is focused on statewide watershed restoration and water quality and ecosystem restoration in the Delta. Together these grant programs are working both separately and together to fund critical fisheries and watershed restoration and protection efforts statewide.

CDFW is committed to furthering the statewide restoration objectives while maintaining transparent and open processes in close coordination with its public stakeholders. This presentation will discuss the FRGP Proposition 1 Restoration Grant Programs, and will outline CDFW objectives and efforts to coordinate closely with stakeholders to develop better solicitations, resulting in stronger proposals, grant agreements, and projects that will deliver quantitative and qualitative improvements to fisheries habitats and watersheds.

Conservation Banking 101

***Hal Holland** and **Greg DeYoung**, Westervelt Ecological Services*

Conservation banking is a tool that can be effectively deployed to help recover species. It typically involves the acquisition, restoration, and long-term protection of land with sensitive resources. Each proposed conservation bank is reviewed by regulatory teams prior to being assigned mitigation credits that may be used to offset impacts within a prescribed geographical area. The tool has been employed for a quarter century in California and is gaining momentum nationally through a suite of policy initiatives, including the National Marine Fisheries Service, West Coast Region's Conservation Banking Guidance.

This presentation is an overview of conservation banking. It will begin with a brief history of its origins and uses, move to the methods of conservation bank establishment and operation, and then cover the status of governing policies.

Salmonid Conservation Banking: Two Central Valley Case Studies

***Gregg Sutter** and **Mark Young**, Westervelt Ecological Services*

Conservation banking for salmon and steelhead began in the last century and has continued to evolve as laws and policies are refined. This presentation reviews two salmonid conservation banks in the Central Valley, one that is within the legal Delta, the Cosumnes Floodplain Mitigation Bank, and another that is located directly on the Sacramento River, the Bullock Bend Mitigation Bank. The two banks address the needs of different runs of salmon, but use the shared strategy of floodplain reconnection. The presentation will give an overview of the design, review, and permitting of the banks. It will also review the projects' ecological results to date.

Swirling in Sediment and Slowing Fisheries Recovery

Friday Afternoon Concurrent Session 3

Session Coordinators*: Brian Cluer, Ph.D., NOAA Fisheries, West Coast Region and Michael Pollock, Ph.D., NOAA Fisheries, Northwest Fisheries Science Center*

We have a funny relationship with sediment. Sediment is considered by fisheries resource agencies as harmful to spawning beds and for filling over-summering pools. Water quality jurisdictions regulate sediment as a pollutant, and yet there is no salmonid habitat that is not created by sediment. For example, two common sediment condition evaluation methods are V* and embeddedness, where V* is a measure of fines in pools and embeddedness is a ratio of fine vs. coarse sediment on the streambed. Typically, neither measure is applied in context to watershed sediment delivery, sediment transport modes and grain sizes, seasonal cycles of sediment transport, or linked to the physical processes that are reflected in the evaluations that are only a snapshot in time. Also, there are language barriers between disciplines; at the particle scale, fisheries managers consider small gravel and sand to be fines, while engineers and geologists classify fine particles as silt and clay. There are understanding barriers too; at a site or channel-width scale the processes governing the mode of sediment transport (bedload, suspended load, and wash load) are significantly different for different grain sizes, although sediment typically is managed as a whole. Geomorphic process domains are important but underutilized: source areas are distinct from sorting and transfer areas, which are distinct from deposition zones, although sediment continuity is applied regardless of geomorphic context or geologic history, making every site a transfer zone. Land development in general created transport zones out of former deposition zones, losing the significant ecosystem richness that deposition zones support. Natural channel design approaches assume sediment continuity is a goal, and sometimes continuity is a regulatory or grant requirement. But sediment continuity, and bank stabilization projects, in deposition zones retards restoration and species recovery. Sediment TMDL's for fines are considered inconsistent with beach replenishment and coastal sand management. This session will explore some of the common misunderstandings of sediment, modes of sediment transport, seasonal and decadal cycles, and how sediment and habitat interact.

Engineering Is the Easy Part

***Jim Robins (Presenter)**, Alnus Ecological; **Kelly Nelson**, San Mateo Resource Conservation District; and **Chris Coburn**, Resource Conservation District of Santa Cruz County*

Regulatory frameworks must be effective in protecting natural resources while also minimizing burdens for those wishing to implement voluntary restoration projects that benefit protected species. The restoration community has developed a number of innovative approaches to address the time, cost, and complexity of navigating local, state, and federal permitting that has posed significant barriers to fisheries recovery. These approaches range from permit coordination programs to legislative measures to programmatic biological opinions and inter-agency consistency determinations. While we have made headway in addressing some of the barriers to voluntary restoration, the nearly singular focus on shovel ready projects and the disconnect between funding realities and regulatory frameworks can result in additional difficulties implementing cost-effective and time-sensitive restoration projects. This presentation will discuss the benefits as well as the true costs and on-the-ground realities of existing efforts to address these constraints as they have been experienced in the Central Coast region. The presentation will also make clear how existing efforts affect the pace and scale of implementing fisheries restoration projects in our region. Finally, we will discuss significant regulatory barriers that remain and potential ideas on improving the path forward.

Incorporating Geomorphic Processes and Sediment Dynamics into Salmonid Habitat Restoration Design

Jason Q. White (Presenter), Aaron A. Fulton, and Jorgen A. Blomberg, Environmental Science Associates

Human impacts over the past century have altered natural geomorphic processes leading to degraded stream habitat and the decline of salmonid populations. Ideally, stream restoration would be achieved simply through removal of stressors, and the channel would be allowed to recover and evolve to an improved ecological condition. However, in reality many stressors are here to stay, certain stream management actions may prohibit channel evolution, or channel evolution and recovery may require decades to centuries—which is longer than struggling salmonid populations can endure.

Because of these realities, most stream restoration actions aim to create habitat that will immediately benefit salmonids through manipulating the landscape. Such actions are sought to function instantly, but also remain functional in perpetuity. In an effort to design functional and permanent features, restoration practitioners inevitably design stable and static elements that "mimic" desirable habitat that are unaffected by geomorphic processes. If these features experience significant sediment deposition or scour after a high-flow event, the resulting conditions is often considered a failure.

Environmental Science Associates (ESA) has taken a more natural approach to stream restoration design, one which embraces geomorphic processes and sediment dynamics. ESA's approach aims to create dynamic yet self-maintaining features that utilize incoming sediment. For this approach, sediment deposition and scour is a desired and intended outcome. Most importantly, the approach accelerates channel evolution to improved geomorphic and ecological function. ESA recently applied this geomorphic approach for the Dry Creek Habitat Enhancement and Napa River Restoration Projects in Northern California. For Site 2C of the Sonoma County Water Agency's Dry Creek Habitat Enhancement Project, ESA designed a perennial secondary channel aimed at providing summer rearing habitat for steelhead and coho salmon. ESA took a nested approach to secondary channel design that utilized sediment dynamics at various scales to create a self-maintaining feature under dynamic conditions. At the reach scale the secondary channel was designed to have similar sediment competence as the main channel, ensuring sediment deposits at the same rate in the secondary channel as the main channel. At the geomorphic unit scale, the entrance was designed to deposit sediment equally across both the secondary and main channel, keeps the secondary channel connected to the main channel, and pool-riffles were designed with geometric relationships that promote discharge-dependent velocity reversals, which will scour pools and deposit at riffles during high flows. At the habitat unit scale, large wood was placed strategically throughout the secondary channel to promote scour, deposition, and routing of sediment, enhancing the self-maintenance of the secondary channel. Napa County's Napa River Restoration Site 13 and 14 aimed to widen the incised corridor at locations along the reach to cause sediment deposition and maintain existing and ideally-spaced-constructed riffles. The widening was designed to reduce sediment competence at riffles sufficiently to cause deposition of ideal spawning-size gravels during high flows. Overall, ESA's design approach for the Dry Creek and Napa River Projects focuses on utilizing geomorphic processes and sediment dynamics to create self-maintaining high quality complex salmonid habitat.

Clear and Simple Connections Between Dirt, Fish, Entrenchment, and Recovery

Mike Napolitano (Presenter), Leslie Ferguson, and Setenay Bozkurt-Frucht, P.E.,
San Francisco Bay Water Quality Control Board

Channel incision is a widespread problem within the Central California Coast Range including all streams in the Bay Area listed as impaired by sediment[1]. Incised channels reflect a fundamental alteration of sediment supply, transport, and storage processes, and inter-related negative effects on channel habitat complexity and floodplain disconnection. Incised channels in the Central California Coast Range also suffer from a substantial chronic increase in the supply of sand and finer sediment contributed from unpaved roads and elevated episodic inputs of sand and coarser sediment contributed from land-use activities that destabilize steep slopes, channel heads, and topographic hollows.

Nevertheless, these sediment-impaired streams provide some of the best remaining fish and wildlife habitat in the Bay Area and elsewhere within the Central California Coast Range. Efforts to conserve listed fish populations, and more broadly native fish and aquatic wildlife communities that depend on these watersheds, require restoration of geomorphic processes at the watershed scale and active and passive approaches to river habitat restoration over very large scales.

Sediment Total Maximum Daily Load (TMDL) determinations provide an opportunity to promote and implement watershed-scale plans to restore geomorphic and hydrologic processes. In addition to the fundamental need to prepare scientifically rigorous analyses, there is the critical need to clearly communicate geomorphic concepts to biologists, engineers, planners working in government agencies, and the private sector, and most importantly to watershed residents and other interested stakeholders to develop the buy-in and support that is needed to successfully implement large-scale and long-term restoration efforts. In many cases, the actions that are needed to restore geomorphic and hydrologic processes also are needed to conserve and recover listed species and to help human communities adapt to climate change.

Three Bay Area sediment TMDLs are presented as case studies to highlight successes and failures in working to restore geomorphic and hydrologic processes at the watershed scale in the San Francisco Bay Area. Ultimately, more creative approaches to regulation, much more public education and outreach, and much greater funding for restoration are needed to support conservation of native fish and aquatic wildlife species in the Bay Area and elsewhere in California.

[1] These include Lagunitas Creek, the Napa River, Pescadero Creek, the Petaluma River, San Francisquito Creek, San Gregorio Creek, Sonoma Creek, and Walker Creek.

Sediment for Salmon in San Francisco Bay: What's Needed, What's Available, and What's Next?

Scott Dusterhoff (Presenter), Sarah Pearce, Lester McKee, and Robin Grossinger, San Francisco Estuary Institute, and Carolyn Doehring, Morro Bay National Estuary Program

San Francisco Bay tidal habitats used by salmonids have decreased dramatically in extent over the past 200 years. Considerable energy is being spent to restore tidal marsh habitats all around the Bay, with the ultimate regional goal of regaining approximately 100,000 acres of tidal marsh (i.e., one-half of the amount that existed in the mid-19th century). A large volume of sediment is needed not only for marsh restoration but also to ensure the long-term resilience of existing and restored marshes as Bay water levels rise and large coastal storm events become more frequent. Sediment delivered to and trapped within flood control channels that drain to the Bay can be a viable sediment source under management approaches that deliver sediment to marshes through natural processes and mechanical means (i.e., beneficial reuse of dredged sediment). This talk presents a regional sediment analysis of the major flood control channels at the Bay interface. The analysis focuses on the sediment supply to the channels (i.e., watershed sediment amount and interannual variability) and the sediment stored and removed (i.e., dredged amount, frequency, location) over the past 50 years. The analysis also includes an assessment of potential climate change impacts on future watershed sediment supply to tidal marshes around the Bay. The findings are intended to inform new multi-benefit management approaches that incorporate tidal habitat restoration and maintenance into flood risk management.

Mechanical Scarification of Gravel Beds to Increase Chinook Salmon Spawning Success—Field Experience in Lower Putah Creek

Ken W. Davis, Wildlife Survey & Photo Service

Interstitial spaces between stream cobble are essential microhabitat for many species of aquatic invertebrates, salmonid eggs, alvins, and juveniles. When the inter-cobble spaces are filled with sediment or fines, many benthic macroinvertebrate species and the early life stages of salmonids cannot survive. The degree to which fine sediments surround coarse substrates on the surface is referred to as embeddedness. Severe embeddedness can create a condition referred to as cementation where the cobble is essentially locked in place in some areas to a depth of six inches. A self-sustaining run of Chinook salmon on Lower Putah Creek is possible but is currently limited by cementation of potential spawning gravels. Scarification of the cemented gravels using a medium reach excavator appears to dramatically improve the condition of the gravel resources and the necessary habitat for much of the aquatic food web and coldwater fish. Trials of mechanical scouring began in 2013 at one location about a mile downstream of Putah Diversion Dam. Salmon spawned in the loosened gravel and not in adjacent reaches. Subsequently, in 2014 salmon spawned intensively in five mechanical scouring test sites each separated by untreated control sites where the number of redds and viability (as measured by depth of redds) was markedly reduced or non-existent. Chinook salmon are already returning to lower Putah Creek in record numbers. The 200 spawning salmon in 2014 was nearly three times the previous high of 70 spawners in 2003. In 2015 we had 800 spawners. It appears that active salmon in the system can, at least partially, maintain the open coble condition. Mechanical scarification is a relatively inexpensive method of improving spawning areas.

Using Photogrammetric and Aerial Vehicle Technology to Support Salmonid Restoration Planning and Engineering

Friday Afternoon Concurrent Session 4

Session Coordinator***: Thomas H. Leroy,*** ***Pacific Watershed Associates***

Recent advancements in photogrammetric software programs and unmanned aerial vehicle technology (UAVs) has provided new and exciting tools for earth scientists to plan and design restoration projects to improve salmonid habitat. Innovative uses for these new tools include: rapid creation of topographic maps, particle size analysis, quantifying geomorphic and vegetation change associated with monitoring and implementation projects, and documenting as-built conditions at both the feature and site scale. This session will explore all of the pioneering efforts at incorporating this technology into restoring salmonid habitat.

State of the Art Geomorphic Monitoring and What It Tells Us About How Rivers and Streams Evolve

Michael Strom (Presenter) and Rocko A. Brown, Ph.D., Environmental Science Associates; Elke Ranke, Zone 7 Water Agency; and Andy Collison, Ph.D., Environmental Science Associates

Geomorphic monitoring of rivers is often based largely on repeated surveys of the thalweg profile and widely spaced channel cross sections, leading to limited and potentially ambiguous interpretations. The proliferation of photogrammetric and aerial vehicle technology has opened the door to high-coverage-three-dimensional morphological monitoring at relatively low costs. Not only are the immediate products of unmanned aerial vehicles (UAVs) visually striking, but they can be combined with other methods and techniques to provide a much more diagnostically revealing window into how rivers and streams work, and ultimately what this means for salmon and people. This talk discusses the use of UAV derived imagery and topography in analyzing topographic change in Arroyo Mocho, a regulated and ephemeral stream located in Livermore, California. We present results for two years of monitoring following a project by Zone 7 Water Agency that included the removal of fish passage barriers, installation of two roughened rock ramps for fish passage, and floodplain regrading and restoration. The results illustrate the range of adjustments that rivers and streams make in varying water years, including locations of geomorphic dynamism within a corridor of stable width as well as continued bank retreat, and highlight the opportunities and challenges for restoring channel complexity in a spatially-constrained urban setting. By mapping the system in three dimensions, much more insight has been gained into both local and reach scale geomorphic responses to restoration actions than would have been possible using traditional monitoring methods.

Ground-Based Application of Structure From Motion (SFM) to Quantify Gravel Storage in Response to Gravel Augmentation on a High Gradient, Mountainous Stream, with No Access to the Global Positioning System (GPS)

Mindi Curran (Presenter), *Humboldt State University, Geology Department and McBain Associates Applied River Sciences;* ***Melanie Michalak,*** *Humboldt State University, Geology Department; and* ***Geoff Hales, M.S.,*** *Humboldt State University, Geology Department and McBain Associates Applied River Sciences*

Digital Terrain Models (DTMs) generated in Agisoft Photoscan from the application of photogrammetry can provide a basis for quantitative analysis of geomorphic features at a resolution much greater than conventional techniques. The photogrammetric analysis used in this study is an attractive option for many types of researchers because data collection equipment and operator costs are low in comparison to analyses using drones or other aerial devices. It also provides a methodology for applying photogrammetry in a setting with no access to the Global Positioning System (GPS).

The Oak Grove Fork (OGF), located in northwestern Oregon, is one of the largest tributaries to the Clackamas River. Lake Harriet Dam was built on the OGF in 1924 as part of a hydroelectric development by Portland General Electric. The dam and diversion have decreased flow and sediment supply downstream, resulting in geomorphic changes and corresponding biological effects, including reduced salmonid habitat. As part of a program to help restore a portion of the natural sediment supply and improve salmonid habitat, a gravel augmentation program began in September 2016. This program introduced a total of 500 tons of gravel, 250 tons at the upstream extent of our reach and 250 tons downstream of our reach, to the OGF. Tracking the downstream movement of augmented gravels is necessary to establishing program success.

Four photogrammetric analysis sites along a one-mile stretch, downstream of the gravel introduction site, are actively being monitored. Our methodology includes photographing baseline conditions prior to introduction and then re-photographing the following spring and summer after the end of winter and snowmelt flows. The primary objective of this study is to differentiate baseline DTMs using DTMs created at subsequent time intervals after gravel introduction, in order to capture centimeter-scale streambed elevation changes at selected sites, as a way to quantify the amount of gravel routing downstream. The OGF is characterized by dense overstory vegetation and steep canyon walls, which prohibit the use of aerial photography and GPS. Due to this limitation, it was necessary to establish site-specific Ground Control Points (GCPs) and obtain their real space positioning (northing, easting, and elevation) using an alternative method. For this study, we used re-bar monumented with yellow survey caps as GCPs to provide necessary-permanent control for model comparisons between DTMs generated at different times over the course of the study. Elevation and coordinate control were established using a total station, auto-level, and surveying tape. GCPs were then used to spatially reference DTMs built for each site. Pilot testing on Redwood Creek in Humboldt County, CA, which shares similar channel characteristics, shows bed surface changes and centimeter-scale resolution can be captured using this methodology.

Identifying Salmonid Habitat Units Using High Resolution Imagery Acquired with a UAS in the Upper Eel River Watershed, California

Erik C. Kenas (Presenter), Alison O'Dowd, and James Graham, Humboldt State University; Darren Mierau, California Trout; and Dennis Ryan, Vertical Sciences

Northern California's Eel River has two dams in its upper watershed that are part of Pacific Gas & Electric Company's Potter Valley Project. These dams store and divert water to the Russian River, providing irrigation to farmers and a municipal water source for communities across Mendocino, Sonoma, and northern Marin counties. This storage and diversion impact anadromous salmonid populations of Coho, Chinook, and steelhead in the Eel River, with populations estimated between 1-3% of historic levels. The upcoming Federal Energy Regulatory Commission relicensing of Scott Dam has created a need for assessment of salmonid habitat and an estimation of potential stream carrying capacity for steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*O. tshawytscha*) beyond the impassable Scott Dam. An accurate understanding of existing habitat is necessary to evaluate potential salmonid populations and a stream survey is critical to the process. However, traditional stream surveys are labor intensive and time consuming. The introduction of consumer grade unmanned aircraft systems (UAS) offer an opportunity to collect high-resolution imagery at a lower cost than manned aircraft. This study explores the use of a UAS to acquire high-resolution imagery to separate stream habitat into habitat units. An eBee real time kinematics (RTK) UAS was flown by Vertical Sciences at an altitude of 50 meters above ground level along two separate one-kilometer transects of Smoke House Creek above Lake Pillsbury. The images produced were of sub-meter resolution. The imagery was used to identify habitat units and characterize them. Habitat units identified included pools, riffles, flatwater, and dry. The UAS data was compared to in-situ identified habitat units collected via a traditional ground-based stream survey. The comparison yielded a correlation in habitat units identified and their attributes. Additionally, the potential to identify stream habitat features such as wetted width and bank-full width exist in the aerial imagery. The collection of the UAS data, including producing RTK ground control points, along two kilometers of interest took a shorter amount of time in the field than the traditional stream survey techniques. The UAS aerial imagery data was also used to produce fluvial topographic information in the form of a digital surface model. These methods for research could inform the potential recovery management for native anadromous salmonid populations in the upper Eel River.

Automated Photogrammetric Particle Segmentation for Longitudinal and Temporal Sediment Surveillance of River Networks

Tim L. Bailey, Humboldt State University

Anthropogenic disruption of fluvial sediment regimes poses one of the most common stressors to anadromous fisheries and the freshwater habitats on which they depend. Salmonids are dependent on bio-geomorphic habitat envelopes that are profoundly linked to channel particle size distribution. Recent developments in photogrammetric methods offer a compelling vehicle for geomorphic change detection in fluvial environments. These techniques generate combined topographic and spectral point clouds at arbitrary spatial resolution. Most high-resolution topographic analysis has focused on volumetric change detection or digital elevation models of difference. Surface particle size distribution is one of the most responsive channel characteristics to changes in sediment dynamics from either restoration treatments or watershed degradation. Automated particle segmentation algorithms in conjunction with high-resolution photogrammetric point clouds can provide powerful quantitative analytical tools to characterize these aquatic habitats. This approach can significantly improve the statistical sensitivity of surface particle counts to detect changes in channel hydraulic conditions and reach sediment dynamics. In addition spatial and temporal sampling regimes can be responsive to experimental or management requirements.

In order to quantify the longitudinal trends in channel particle size distribution in the South Fork Eel watershed, seven reaches with upstream watershed areas between 670 km^2 to 1,700 km^2 were surveyed. For each reach photogrammetric point clouds with point densities between 5,000 and 25,000 points/ m^2 were generated for several hydraulic cross sections. Ground control points were surveyed using real time kinematic GPS. Subsurface samples were collected along with manual pebble counts. Dimensionless armoring ratios (q^*) were computed from the control samples and areal survey. As expected, this data set demonstrated progressive downstream fining from the cobble-dominated riverbed upstream of the Confusion Hill knick-point to a gravel-dominated regime near Garberville. Minimum particles sizes were observed in a sampled reach where the South Fork passes through Franciscan Melange. Particle size distributions rebound significantly in the lower 25 km of the river.

Similar methods were used to monitor the short-term temporal evolution of sediment dynamics in a 16 km^2 debris flow impacted watershed. Historical denudation rates since the 1965 aggradational maxima are estimated to be two orders of magnitude higher than the Holocene mean. The watershed remains an acute source of fine sediment. Point clouds of three hydraulic cross sections were collected in 2014, 2015, and 2016. This sequence of coverages observed an incision pulse advance upstream as a destabilizing knick-point. All three of the cross sections have coarsened significantly over the period of observation, indicating a decline in upstream sediment supply and decline in channel sediment storage. Extrapolating annual trends indicates that natural processes will require several more decades to return to reference particle size distribution. Photogrammetric methods provide the opportunity for small organizations to produce advanced sediment surveillance products tailored to their analytical needs. The larger applied watershed restoration community can benefit from quantitative methods to validate treatment approaches. In conjunction with synoptic intermediate scale remote sensing products, high-resolution photogrammetric methods provide vivid documentation and direct quantitative measurement of critical environmental conditions.

Improving Salmonid Restoration Efforts using Unmanned Aerial Systems and Structure-from-Motion Photogrammetry, Lower American River, California

Toby Stegman (Presenter), Ben Taber, P.E., *and* ***Chris Hammersmark, Ph.D., P.E.,***
cbec eco-engineering; and ***John Hannon,*** *U.S. Bureau of Reclamation*

The use of unmanned aerial systems (UAS) has exploded in the last several years. To even further accelerate the use of UAS within the private sector, the Federal Aviation Administration implemented new regulations for commercial UAS in the late summer of 2016. These streamlined regulations opened the door to new uses of the technology and a rapidly growing market. Recent advancements in Structure-from-Motion photogrammetry and the use of UAS holds great potential for salmonid restoration planning and monitoring. Here we present our use of UAS and Structure-from-Motion to support salmonid restoration along the Lower American River, CA. We employed this technology to develop a high-resolution existing conditions digital elevation model for use in project design and hydraulic modeling. During the project construction phase, sediment sorting operations were tracked using weekly UAS fights, where volumes of gravel stockpiles were calculated. UAS data was also used for interim grade check surveys to rapidly produce an elevation difference surface during side-channel and floodplain grading operations. Post-construction monitoring was accomplished using UAS and Structure-from-Motion, where we investigated and applied depth retrieval methods to generate bathymetric data. We implemented a recently published method of refraction correction for bathymetric returns in the Structure-from-Motion point cloud and assessed their accuracy with real-time kinematic global positioning systems survey data. We also tested a more conventional method of photogrammetric depth retrieval, using UAS ortho-images with limited field data. Obtaining an understanding of the limitations and opportunities of both terrestrial and bathymetric topographic UAS mapping in the riverscape will continue to advance the field of salmonid restoration, with significant potential cost savings related to design, implementation, and post-project assessment.

Integration of Structure for Motion (SfM) Technology—Using 3D Models to Inform River Restoration Designs and Basin Wide Planning

David (DJ) Bandrowski, P.E., Yurok Tribe

A new technology has been gaining utility in the restoration community for capturing 3D Point Clouds of existing ground topography and river features. This technology is called "Structure for Motion (SfM)", which is digital photogrammetry using computer algorithms designed to integrate overlapping photo images from off the shelf cameras and drones into 3D digital objects. The end product of this computer simulation is a seamless photo mosaic and true-scale models of various ground terrains or river features including large wood jams or detailed hydraulic structures. This process can be applied for aerial terrain mapping and 3D topographic Digital Terrain Models (DTM) of the existing ground surfaces. This process allows for streamlining the planning, design, and analysis of restoration projects without having to invest in high-dollar survey equipment or LiDAR flights. The most complicated surfaces that once were difficult or impossible to survey are now within reach through the SfM workflow.

The Yurok Tribe is embracing this technology and applying it at two very different geographic scales. The first application is a very detailed 3D modeling of existing large-wood jams recently constructed in the upper Trinity River. The application is being repeated at pre- and post-hydraulic events to capture three-dimensionally how the wood jams are evolving over time. This high-precision monitoring and analysis will help inform designers and engineers on how various types of wood architecture performs under specific hydraulic conditions and events. This monitoring effort will help inform large-wood design strategies, workflow, and appropriate risk factors on future projects.

The second application where this photogrammetry and 3D modeling technology is being integrated is on a basin-wide planning effort across a 20 mile reach on the largest undammed river in California—the South Fork Trinity River (SFTR). SfM is being used to develop 3D topographic maps of the river from photos that were captured from a low-aerial flight using a fix wing aircraft and detailed reaches using UAV Drone technology. Aerial mapping costs using this process are a fraction of traditional methods of ortho-photo and LIDAR flights. In addition, historic aerial photos are being applied to this technology to develop DTM's of the past topography that will be used for understanding three-dimensionally how the rivers geomorphology has evolved through time. Harnessing this technology is allowing more efficient and effective restoration design and planning process across various geographic scales.

Reintroduction of Salmon into their Historical Habitats, Part 1

Saturday Morning Concurrent Session 1

Session Coordinators*: Curtis Knight,* *California Trout,*
and Robert Lusardi, Ph.D., California Trout, and University of California, Davis

Climate change, aging water infrastructure, successive years of drought, and increasing demand for water resources has precipitated strong declines in salmonids throughout California. Compounding this, longitudinal and lateral disconnections from historical spawning and rearing habitat has triggered a loss of salmonid life history diversity, making species less resilient to change. As a result, reintroductions of salmonids to historical habitats has occurred or is proposed as a recovery strategy. Dam removal, trap and haul above high head dams, reintroduction of captive bred animals, and improving lateral connectivity to historical floodplain habitat are proposed methods to improve salmonid life history diversity, abundance, population redundancy and, ultimately, resilience to change. These presentations examine the methods, science, and policy implications of salmonid re-introductions to historical habitat.

A Collaborative Effort to Develop a Pilot Project and Assess the Feasibility of Reintroducing Chinook Salmon above Pardee Reservoir on the Mokelumne River, CA

Reuben Childress (Co-presenter), *Foothill Conservancy, and* ***Michelle Workman (Co-presenter),*** *East Bay Municipal Utility District Fisheries and Wildlife Division*

The reintroduction of a species into its historical habitat is often a complicated, lengthy, and expensive process based on the necessity to gain support, meet regulatory and permitting requirements, and fund efforts aimed at dam removal, habitat restoration, trap and haul efforts, and monitoring. We present a modest model to move a watershed closer to reintroduction through the development of a pilot project with goals and objectives that are achievable in an approximate five-year time frame and that address the concerns of the resource agencies up front. This effort is driven by a diverse group of watershed stakeholders, each with a unique vested interest and role, self named the Upper Mokelumne Salmonid Restoration Team (SRT).

The effort was spearheaded by the non-profit organization Foothill Conservancy, a long-time advocacy group in the Mokelumne River Watershed. The facilitated SRT is composed of state and federal regulatory agencies, environmental and industry-based organizations, corporations, water agencies, local tribes, and private property owners. The team has been meeting for approximately two years to develop a consensus-based process to produce a fall-run Chinook Salmon reintroduction pilot study and follow it through to implementation. The over-arching goal is to provide data to support a large -scale reintroduction effort in the future that is based on empirical evidence of potential success.

Salmon restoration above rim dams is not a new concept in the West. However, the SRT's approach on the Mokelumne River is far from regulatory or mandated mitigation. By bringing diverse groups together in a watershed, finding agreement on a step-wise process, and working towards a goal that can be accomplished in a short time frame, the group believes: 1) that there is value in collecting data, and conducting monitoring that would support a reintroduction, and 2) that they can produce results with limited funding that may be evaluated by the resource agencies and assist in achieving reintroductions on a broader scale than in the agencies' few prioritized watersheds.

We will present information on the process, the goals, objectives, and methods developed for the pilot study, data collected to date to support the effort, and next steps.

A Plan for Reintroduction of Winter-run Chinook Salmon to Battle Creek

James Lecky (Presenter), *ICF International;* ***Jason Roberts,*** *California Department of Fish and Wildlife; and* ***Willis McConnaha*** *and* ***Greg Blair,*** *ICF*

Sacramento River winter-run Chinook Evolutionary Significant Unit (ESU) has a life history uniquely adapted to cold, spring-fed streams in the upper Sacramento River above Shasta Dam and in Battle Creek. Historically, they returned to these streams in winter and spawned from late spring to mid-summer. Access to this habitat was blocked by the construction of Shasta Dam and adult passage barriers in Battle Creek. Consequently, winter-run Chinook now consists of a single population confined to the main-stem Sacramento below Shasta Dam where it is maintained by cold-water releases from Shasta Dam. The Sacramento winter-run Chinook ESU is listed as endangered under California and Federal ESAs. National Marine Fisheries Service concluded in their 2005 status review that the ESU is "in danger of extinction due to risks to the ESU's diversity and spatial structure."

The dire situation for winter-run Chinook has been exacerbated by the on-going California drought, which has jeopardized the ability to maintain suitable temperatures below Shasta Dam to support the population. In response, the State of California has supported development of a plan to reintroduce winter-run Chinook into historic habitat in Battle Creek using available state drought response funds. Battle Creek remains one of the few streams below Shasta Dam with conditions that could support the winter-run life history while providing temperature refuge as the climate warms.

The Battle Creek Winter-Run Chinook Reintroduction Plan was developed by an inter-agency committee with consultant support. The plan is a roadmap for reintroduction of the species in Battle Creek. It is based on the assumption that the Battle Creek Restoration Plan will be completed and will restore flows and passage to quality habitat in Battle Creek.

Reintroduction is structured around three phases that lead to establishment of a viable locally adapted population in Battle Creek. Phase 1 will use a mix of hatchery production and translocation of natural-origin juveniles from the mainstem to establish natural production of winter-run Chinook in Battle Creek with sufficient abundance to overcome founder effects and provide the basis for development of a self-sustaining, genetically diverse, and locally adapted population. Phase 2 will develop a locally adapted population by reducing transfers from the donor mainstem population, increasing use of Battle Creek natural origin in hatchery broodstock, and reducing hatchery production with evidence of sustainable natural production. In Phase 3, artificial hatchery production will be eliminated and the focus will be on long-term sustainability. Strategies in each phase are crafted to achieve goals specific to the phase and move the population into the next phase. Transitions through the phases are based on monitoring of natural production and abundance triggers based on number of natural origin adults returning to Battle Creek.

Pre-season run forecasts of natural and hatchery origin returns to the mainstem Sacramento and Battle Creek will be used to set annual program objectives for hatchery production, brood stock composition, and the translocation of natural juveniles. Adaptive management is a critical element of the Plan to evaluate progress, update key assumptions, review objectives, and modify strategies.

Techno-Arrogance: Why Trap and Haul Fails to Recover Salmon & Watersheds

Matt Stoecker, Stoecker Ecological

California's rivers and wild salmon face a new and dangerous threat. Misguided and fossil-fuel-powered "fish transportation" and "enhancement" schemes, like trapping and trucking salmon around impassable dams, are being inaccurately advertised as "fish passage" and "recovery" solutions. Despite the ongoing failure of these projects in the Pacific Northwest, resource agencies are proposing to spend billions of tax dollars to import this flawed technology to California dams. The recent trap and haul push is strikingly similar in tone and perspective to the unsuccessful hatchery program that was sold over a century ago as a way to try and mitigate for lost habitat and salmon-blocking dams. California Department of Fish and Wildlife's Steelhead Restoration and Management Plan sums up the dangerous precedent that would be set if trap and haul projects are implemented in the state: "…the real danger with this philosophy is that it can divert attention, and forestall real, long-term solutions."

The performance record for existing trap and haul programs is also replete with problems. Mechanical failures, stress and mortality to fish, and even degraded water quality and macroinvertebrate populations downstream are among them. CDFW's own Steelhead Restoration and Management Plan cites "the history of failure of trap-and-truck operations," and features a paper from the journal Conservation Biology that calls the use of such technologies, "techno-arrogance." The Oregon Department of Fish and Wildlife has noted that trap and haul programs can cause long-term evolutionary and population persistence problems as they "impose an artificial selective force and generally reduce fitness."

Perhaps most troubling is that, by definition, trap and haul does not meet the criteria for recovery under the Endangered Species Act or support CDFW's goals for "wild" and "self-sustaining" fish populations. Guidance documents for implementation of the ESA make it clear that delisting (the official goal of recovery actions) requires adequate wild and self-sustaining populations.

Despite the clear obligation under state and federal environmental review policies, trap and haul proposals at dams on the upper Sacramento, Yuba, and other rivers in the state are failing to adequately consider alternatives that provide effective and self-sustaining fish passage and recovery solutions. Unlike trap and haul, volitional fish passage alternatives can also achieve long-term ecosystem restoration and climate resiliency goals for the impacted watershed and coastal areas downstream.

It is time for restoration practitioners and fisheries advocates to demand that our resource agencies withdrawal support of all trap and haul proposals in California and refocus efforts on projects that meet ESA recovery and delisting criteria and result in broad and long-term ecosystem, energy, water, and flood protection benefits. NOAA Fisheries salmon recovery documents correctly state that "allowing for volitional fish passage to the upper watershed is the only way to establish a self-sustaining population" and "priority will be given to measures that, once implemented, are self-sustaining." Trap and haul projects fail to achieve this recovery goal and ultimately fail California's rivers, fish, and citizens.

Achieving Reintroduction through the Federal Power Act

Steve Edmondson, *National Marine Fisheries Service*

In many California watersheds, such as the Sacramento and San Joaquin (Central Valley), dams block 95% of historic salmonid spawning habitat. Additionally, non-federal FERC-licensed dams account for approximately 40% of all surface water storage in the Central Valley. As a result, chinook salmon and steelhead are extirpated from approximately 5,700 miles of their historic habitat in the Central Valley. In most cases the habitat remaining is restricted to the valley floor where it was historically limited to seasonal migration use only. Remnant populations below these dams are now subject to intensive river regulation and to further direct and indirect impacts of hydroelectric operations. According to a 1994 study by the Department of Energy, there are more tall FERC-licensed dams in FERC's San Francisco Region (California) than any other region and fewer projects with fish passage facilities than any other region with anadromous fish. Therefore, by necessity, anadromous fish will become a major focus of many relicensing activities in California because FERC relicensing represents a significant (and largely one time) opportunity to contribute to recovery by restoring access to significant stretches of historic habitat.

In passing the Electric Consumers Protection Act of 1986 (ECPA), Congress sought to assure protection for fish and wildlife by giving fish and wildlife agencies explicit authority to provide mitigation for new and relicensed hydropower projects. Under section 10(j) NOAA Fisheries recommends to FERC license conditions for fish protection, mitigation, and enhancement. Section 18 of the FPA expressly authorizes the Department of Commerce to issue mandatory fishway prescriptions, stating that FERC must require construction, maintenance, and operation by a licensee at its own expense of such fishways as may be prescribed by the Secretary.

Over the next 10+ years, NOAA Fisheries has an opportunity to participate in FERC relicensing actions on an unprecedented number of dams that affect California salmonid species and their habitats. FERC is required to make licensing decisions on 50-year-old dams as if they were new projects, thus requiring compliance with current environmental laws. Concurrently, energy deregulation has resulted in market volatility and increased competition. As hydro projects approach the limits of financial viability, incentives are increasing to cut costs wherever possible, frequently targeting environmental protections.

Salmon in the Sierra: Reintroduction into the North Yuba River

***Chris Shutes (Presenter)**, California Sportfishing Protection Alliance,*
*and **Steve Rothert**, American Rivers*

Dams block salmon and steelhead from reaching more than 5,700 miles of historic spawning habitat in California's Central Valley watershed. The loss of over 90% of historic spawning habitat, in addition to loss of rearing habitat and hatchery effects, has precipitated the ESA listing of Central Valley spring-run Chinook salmon and steelhead. NOAA Fisheries' Central Valley Recovery Plan identifies the Butte Creek population as the only remaining viable population of spring-run Chinook salmon in the Central Valley. To recover spring-run and consider delisting the fish, three additional populations must also attain "viability." This means getting spring-run salmon upstream of Central Valley rim dams.

In an unprecedented collaboration, the Yuba Salmon Partnership has changed the question from whether salmonids can be reintroduced upstream of Central Valley rim dams to how and when (now as opposed to it may be too late) salmonids can be reintroduced. Once it confronted the new question, the California Department of Fish and Wildlife embraced a trap and haul program as a necessary means to achieve this promising reintroduction. The Yuba County Water Agency pushed aside the default "not in my watershed" approach and embraced reintroduction with the caveat that the Agency be able to build a partnership in the effort. Three non-government organizations with a longstanding interest in recovery are supporting this effort given the legal and practical realities in the Yuba watershed. NOAA Fisheries is supportive, given its mandate to pursue actions that will promote recovery of the species.

Since 2014, the Yuba Salmon Partnership has worked to constructively develop an agreement to reintroduce spring-run salmon, and possibly steelhead, to the North Yuba River. The Yuba Salmon Partnership also plans to enhance lower Yuba River salmonid habitat. Working together, the North Yuba reintroduction and the lower Yuba River habitat enhancement represent a reconnection to previously blocked habit and potential for establishing a new population that is spatially distinct from existing populations. Yuba Salmon Partnership representative(s) (to be determined) will present plans for reintroduction into the upper North Yuba and habitat enhancement actions in the lower Yuba River.

Two-Way Trap and Haul as a Conservation Strategy for Anadromous Salmonids

Robert Lusardi, Ph.D. (Presenter), *California Trout and University of California, Davis, and* ***Peter B. Moyle, Ph.D.,*** *University of California, Davis*

Trap and haul is a common strategy to get Pacific coast salmonids around dams, involving millions of fish each year. In such situations, adults or juveniles are typically captured and moved in one direction. More recently, however, there has been an interest in two-way trap and haul (TH2) programs where volitional passage of adults and juveniles is not possible, in either direction. Under such circumstances, adult salmonids are captured and transported to upstream recipient habitats and their juvenile progeny are trapped during outmigration and transported downstream of the dam. Most TH2 programs in the Pacific Northwest are in the early stages of development or are functioning experimentally. The Baker River program, however, has been around for nearly 60 years and is commonly cited as a successful TH2 program on which to model other programs. Here, we examine the Baker River program but also look at successes and failures associated with a more recent program on the Deschutes River. Specifically, we address the importance of environmental context, salmonid life history, experimental design, and the role of technology and hatchery production in such programs.

Visioning Salmon Recovery—Restoring Ecological Function in the Central Valley's Working Landscapes through Science, Collaboration, and Structured Decision Making

Saturday Morning Concurrent Session 2

Session Coordinators*: Rene Henery, Ph.D., Trout Unlimited and Jacob Katz, Ph.D., California Trout*

Real solutions for recovering salmon in the Central Valley will require fishermen and farmers, water suppliers, urban users, government agencies, and environmentalists to take a clear-eyed look at California's water systems, roll up our collective sleeves, and implement practical actions that advance common interests. Accomplishing this, however, will require development of: a) collaborative forums and processes, b) science based objectives that facilitate the design of actions, c) on-the-ground projects that demonstrate success by integrating the objectives of multiple user groups, and d) economic and regulatory incentives for collaborative multi-benefit actions that advance objectives. All of these crucial elements are currently being applied to salmon recovery in the Central Valley. Successfully reconciling urban, agricultural, and environmental water and land uses, however, will require a proliferation of and deeper commitment to this structural, science-based approach to collaborative engagement.

The session will culminate with a panel discussion focused on identifying specific opportunities and tangible next steps towards reconciling water supply, flood protection, and healthy, self-sustaining runs of wild salmon in the Central Valley.

Emigrating Salmonid Habitat Estimation (ESHE): A Modeling Framework for Estimating Habitat Needs for Outmigrating Juvenile Salmonids

Travis M. Hinkelman, Ph.D. (Presenter), *Cramer Fish Sciences;* ***Paul S. Bergman, M.S.***, *Environmental Science Associates; and* ***Joseph E. Merz, Ph.D.***, *Cramer Fish Sciences*

Systematic loss of seasonally-inundated rearing habitat has significantly hindered native aquatic species that rely on this habitat for rearing, spawning, or migratory purposes during part or all of their life history. To restore degraded stream corridors and develop large-scale, sustainable watershed strategies, it is essential for managers to consider the habitat requirements of keystone species and re-establish the amount and range of habitat features under which such species prosper. A wealth of recent evidence has identified seasonally-inundated floodplains as providing quality food production and rearing habitat for juvenile Chinook salmon. Because studies have found that individual Chinook salmon maintain exclusive feeding territories even when schooling, territory size is thought to limit the density and production of juvenile Chinook salmon. Therefore, providing an adequate quantity and quality of rearing territory during emigration can reduce the negative effects associated with competition for space on a population level. We describe a modeling framework, Emigrating Salmonid Habitat Estimation (ESHE), that overlays modeled river hydrology with simulated cohorts of juvenile Chinook salmon, allowing for calculation of benefits provided by seasonally-inundated floodplain habitats. By tracking the movement, growth, and survival of juvenile Chinook salmon in a simulated system, we can provide estimates of rearing habitat needs in time and space, helping prioritize floodplain restoration locations. We will demonstrate an application of ESHE at large spatial scales to estimate daily rearing habitat needed for the four runs of Chinook salmon throughout the Central Valley of California under restored habitat conditions, where populations exist at Anadromous Fish Restoration Program (AFRP) doubling goals and juveniles emigrate under the assumption of abundant rearing habitat.

A Vision for Salmon Restoration in the San Joaquin Valley: The Stanislaus River Example

Jon Rosenfield, The Bay Institute

Over the past half century, numerous laws and policies have required restoration of anadromous fish fauna in the Central Valley, as well as their riverine and estuarine habitats. Despite these policy accomplishments, the San Joaquin River and its tributaries continue to suffer from declining fish populations, stream health, and watershed condition. Too often, planning efforts to implement conservation policies begin and end with a suite of actions, without a clear definition of the problem that the actions are meant to solve and without adequate articulation of the desired outcomes of the planning process. A large group of stakeholders interested in resolving long-standing ecosystem and water management issues in the San Joaquin River Valley convened to develop a structured scientific basis for integrated conservation actions and planning across the various regulatory processes and settlement discussions in this watershed. The parties specifically assembled a team of scientists charged with: (1) establishing desired outcomes for this watershed, (2) describing the physical and ecological conditions necessary to achieve those outcomes, and (3) evaluating current conditions in the context of the desired outcomes to identify and prioritize the key stressors that prevent attainment of desired outcomes. Starting with the Stanislaus River (a major tributary to the lower San Joaquin), this team (the "SEP group") translated numerous Central Valley-wide policy goals into local outcomes that would represent the local expression of existing policy requirements. These watershed-specific goals were then articulated as a suite of specific, measureable, achievable, relevant, and time bound (SMART) biological objectives. Environmental objectives characterizing the physical blueprint necessary to support attainment of biological objectives were derived from a comprehensive literature review and the targeted application of habitat area models. Finally, the team evaluated current conditions in the Stanislaus River against environmental and biological objectives to identify and prioritize stressors that currently prohibit attainment of desired outcomes for each salmonid life stage. The complete vision includes desired outcomes for the full range of Viable Salmon Population (VSP) criteria for fall-run and spring-run Chinook salmon and both resident and anadromous *O. mykiss* on the Stanislaus River, as well as temporally- and spatially- defined physical characteristics that are needed to support each salmonid life stage. Most of these products are applicable to other tributaries of the San Joaquin River and other rivers throughout the Central Valley. Each element of the SEP group's products serves an essential function in the design, adoption, and adaptive management of a future conservation strategy and associated set of actions for the Stanislaus River watershed. This approach may serve as a model for restoration planning in riverine and estuarine habitats of the Central Valley.

The Development of a Structured Adaptive Approach to Prioritizing Conservation and Restoration of Chinook Salmon in the Central Valley

James T. Peterson, ***U.S. Geological Survey, Oregon Cooperative Fish and Wildlife***

The Central Valley Project Improvement Act Fisheries Program is employing structured decision-making to develop a framework that allows stakeholders and decision-makers to identify program objectives and guide planning of broad scale fisheries activities. Program stakeholders on the Science Integration Team (SIT) identified Chinook salmon (*Oncorhynchus tshawytscha*) population objectives and developed a coarse resolution model that was parameterized using a combination of expert judgment and empirical data. The coarse resolution decision support model was built to evaluate alternative restoration scenarios in Central Valley tributaries and the delta. The purpose of the model was to help the SIT identify the management actions that the greatest likelihood of achieving the population objectives. The model also helped SIT members identify the areas of greatest uncertainty regarding the dynamics of Chinook salmon populations and their habitats. We intend this as an adaptive framework, within which model components will be iteratively improved to gain better understanding of the mechanisms linking management actions to stream and estuarine characteristics and ultimately Chinook salmon populations.

Central Valley Spring-run Chinook Salmon and Steelhead Recovery and the Role of the Yuba River

Brian Ellrott, National Marine Fisheries Service

In July 2014, the National Marine Fisheries Service released a plan to recover Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. This recovery plan sets goals and prioritizes actions for the Sacramento-San Joaquin Delta and its watersheds, laying out steps to achieve the species' recovery. The goal of this recovery plan is to improve the biological status of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead so they can be removed from the list of federally endangered species. The basic recovery strategy for these three species focuses on enhancing existing populations and reintroducing populations into their historical habitats. This presentation will first describe what a recovered Central Valley spring-run Chinook salmon Evolutionarily Significant Unit and a Central Valley steelhead Distinct Population Segment look like and then will focus on the importance of the Yuba River in recovering those species.

The Central Valley Salmon Habitat Partnership

Jacob Katz, Ph.D. (Presenter), California Trout; Chris Unkel, Ph.D., American Rivers; and Rene Henery, Ph.D., Trout Unlimited

Central Valley salmonid recovery is critical for successful and sustainable water management in California. Until these and other native fish species are on a trajectory towards viable, stable, and self-sustaining populations, the turmoil over water use, quality, storage, flood safety, floodplain land use, and myriad other matters that have a direct effect on California's economy will continue unabated. Much work has been done but the Central Valley's salmon populations are still teetering on extinction, some more so than others. There remains no cohesive effort designed to map the course we collectively must take to benefit these fish; to integrate all the different plans; to link all the concerned parties—the public and private land and water managers, the wildlife agencies, the regulators, the Conservation NGOs, the commercial fishermen, and sports anglers—in a common recovery effort.

Now, CalTrout, in partnership with Trout Unlimited and American Rivers, has convened a science-based, multi-stakeholder forum of resource conservation and fisheries organizations, local, state, and federal agencies, and private sector partners. Modeled on the Central Valley Joint Venture, the Central Valley Salmon Habitat Partnership (CVSHP) will work together to advance recovery of spring-run, late-fall, and winter-run Chinook salmon and Central Valley steelhead populations and sustain commercially and recreationally viable numbers of fall-run Chinook salmon in perpetuity for the benefit of those species and the public.

The mission of the CVSHP is to protect, restore, and enhance salmon and steelhead populations, habitats, and ecosystem conditions by working collaboratively through diverse partnerships to achieve the science-based conservation objectives and prioritized actions identified in the CVSHP's Implementation Plan. Ratification of the CVSHP charter is planned for Spring 2017.

The scientific building blocks for recovery of listed salmonids such as spring-run Chinook and steelhead have been created. Plans to double fall-run Chinook have been published. But the next step—turning that information into specific, tangible, habitat objectives—has yet to emerge. The CVSHP will provide the venue to coalesce the many disparate plans into mutually agreed upon measurable salmon objectives and provide the prioritized, regional implementation framework needed to achieve them.

Developing a Multi-Objective Rehabilitation Strategy for the Coon Creek Watershed

***Jai Singh (Presenter)** and **Chris Bowles,** cbec eco engineering; and **Matt Wacker** and **Ken Lindke,** H.T. Harvey & Associates*

Most Central Valley watersheds suffer from a complex history of land-use and flow-management impacts that have inhibited physical processes and caused declines in anadromous salmonid populations. However, accurate assessment of the causal factors driving these problems in smaller basins and the subsequent development of watershed-appropriate rehabilitation and management strategies remains challenging. This presentation describes an interdisciplinary watershed assessment of Coon Creek, a stream draining a 101-square-mile catchment with its headwaters near Auburn and its outlet on the floor of the Central Valley. Competing objectives in the watershed include conservation and mitigation, agriculture, cattle ranching, flow management, urbanization, and other land uses. Despite land-use pressures and resulting declines in salmonid populations, the catchment remains one of the least developed watersheds in the area and is prioritized by Placer County for protection and restoration actions. We adopt a "spatially-nested" approach to generate a process-based understanding of the basin across multiple-spatial scales and to identify causal mechanisms of watershed impairment. A fluvial-audit assessment characterizes sediment supply and storage, vegetation influences, and river engineering at the sub-reach scale to establish an understanding of the system's geomorphic processes and controls. Hydrologic analysis and engagement with water agencies provide critical insights on water demand, flow management practices, and their influence on habitat conditions. Combining this work with anadromous fish surveys, habitat assessments and water quality monitoring facilitates an integrated understanding of physical and ecological functions and the effects of land use. This interdisciplinary methodology enables us to identify controlling factors for watershed health and declines in anadromous-fish populations. Integrating these findings with land manager and agency goals enables us to develop cost-effective and site-appropriate strategies for the multi-objective management and rehabilitation of the basin.

Hatchery Supplementation: Friend or Foe?

Saturday Morning Concurrent Session 3

Session Coordinator*: John Carlos Garza, Ph.D.,*
NOAA Fisheries, Southwest Fisheries Science Center, and UC Santa Cruz

The advent of salmon and trout hatcheries were initially touted as the remedy for the loss of habitat due to dams and water development in western rivers and streams. Nearly a century and a half after the first major salmon hatchery was established in the upper Sacramento River basin, it has become clear that hatchery supplementation is not a panacea for the woes of habitat loss. But do hatchery supplementation and hatchery fish have a role to play in salmonid restoration and recovery? How do hatchery fish differ from natural fish and are they inherently problematic? Can hatcheries be used to prevent extinction? This session will explore these topics and hopefully provide insight into the benefits and pitfalls of hatchery supplementation, in the context of salmonid conservation efforts.

Hatchery Supplementation: Friend or Foe?

John Carlos Garza, Ph.D., *NOAA, Southwest Fisheries Science Center, and UC Santa Cruz*

Salmon and trout hatcheries were initially touted as the remedy for the loss of habitat due to dams and water development in western rivers and streams. Nearly a century and a half after the country's first major salmon hatchery was established in the upper Sacramento River basin, it has become clear that hatchery supplementation is not a panacea for the woes of habitat loss. As the evidence accumulates that hatchery salmonids can differ from natural fish in a number of ways and can have negative effects on natural populations, many questions have arisen about whether these programs should continue and, if so, how to manage them. I will describe the major considerations in this debate and try to provide a balanced overview of the large range of outcomes that can occur with hatchery programs, from causing further population declines to preventing extinction of local populations. Understanding the ways in which domestication selection has produced differences in life history and fitness, through research and careful monitoring and evaluation, will allow greater understanding of how hatchery fish affect natural populations. In addition, for many salmonid lineages, a substantial portion of the ancestral genetic variation is now present partially or mostly in hatchery stocks and their invaluable genetic legacy will need to be reintegrated into natural populations to increase progress towards recovery and restoration goals.

California Department of Fish and Wildlife Fish Hatcheries as Drought Safe Haven: Self-Contained Recirculating Aquaculture Systems for Fish Populations in Peril

Mark Clifford, Ph.D., California Department of Fish and Wildlife

As a result of unprecedented drought, California Department of Fish and Wildlife (CDFW) fish hatcheries and staff were employed to expand normal operations to provide a drought-safe haven for populations of fish listed as threatened, endangered, or of special concern. Drought-safe haven and other strategies were engaged as either subpopulations of these fish were in peril, or the entire population was in jeopardy of extinction due to unprecedented drought conditions. The lack of adequate precipitation in California between 2012 and 2016 resulted in the four driest consecutive water years since record keeping began in 1895, and 2015 was the warmest year on record. The California Governor's Emergency Declaration on January 11th, 2014 stated that, "The Department of Fish and Wildlife will evaluate and manage the changing impacts of drought on threatened and endangered species and species of special concern…." The continued lack of precipitation and snowpack by spring 2014 seemed certain to jeopardize the survival of several at-risk fish populations in the State. While in-basin relocation and other efforts were preferred and utilized, ultimately several species and populations of wild and listed fish were provided drought-safe-haven at CDFW hatcheries. Since both water supply and quality at several CDFW hatcheries were severely impacted by drought, and due to the risk of pathogen and/or aquatic invasive species transfer to hatcheries from wild populations (and vice versa), self-contained recirculating aquaculture systems (RAS) were engineered, procured, installed, and employed in expedited time. This presentation will describe the drought, the self-contained RAS deployed at specific locations throughout the State, infrastructure problems and solutions, the fish populations rescued and husbandry specifics, and fish releases back to wild (to date). Emphasis will be placed on the rescue and subsequent release of McCloud River Redband Trout.

Redband Trout: Fish Rescue Turned Conservation Hatchery Program

Jeff Rodzen, Ph.D., ***California Department of Fish and Wildlife***

In 2014, ongoing drought conditions in northern California prompted the California Department of Fish and Wildlife to perform a "fish rescue" of McCloud River Redband trout (*O. mykiss stonei*). Previous genetic analyses showed that McCloud Redband only exist in pure form in four small, isolated streams that faced immediate threats of desiccation. Large percentages of their existing populations were collected and moved to a hatchery for holding until habitat conditions improved. In 2015, they spawned in captivity and produced several families of hatchery-produced fish. As drought conditions improved in 2016, the remaining-rescued adults were reintroduced and hatchery progeny were out-planted. However, many adults were too large to return and several thousand fry were retained at the hatchery to avoid exceeding carrying capacities of the streams. The number of rescued adults, genetic structure, and hatchery facilities presented unique challenges for the holding, spawning, and rearing and tracking of family groups. We review the different challenges, metrics, and approaches used to maximize diversity, and considerations for the best genetic management of the hatchery stock for future conservation and recreational angling uses.

Evidence for Genetic Adaptation to Captivity and a Potential Mechanism to Account for Domestication in Hatchery-Reared Steelhead

Neil Thompson (Presenter), *Oregon State University;* ***Ben Clemens*** *and* ***Phil Simpson,*** *Oregon Department of Fish and Wildlife; and* ***Mike Blouin,*** *Oregon State University*

Adaptation to captivity (domestication) influences the reproductive success of hatchery-reared steelhead (*Oncorhynchus mykiss*), but the mechanism by which domestication occurs is not well understood. Size at release is positively correlated with probability of survival for hatchery-origin steelhead and viability selection after release is hypothesized to influence the effects of genetic adaptation to hatchery rearing. In this study we determined if family identity affects body size at release in multiple populations of hatchery-origin steelhead and assessed if size selective survival occurs after release from the hatchery. Using small-scale experiments and sampling from production cohorts we found significant-strong effects of family identity on body size at release for hatchery-origin steelhead from the Siletz and Hood River populations. We then assessed the potential for size-selective survival to occur by using scale analysis to back-calculate size at ocean entry for returning adults in the Hood River population. We compared the distributions of back-calculated sizes from returning adults to the same cohort at release from the hatchery. We repeated the size-selective survival twice in the Hood River. In one year weak-size-selective survival was observed (difference from mean smolt release size to mean smolt size for fish that survived was 1 cm) while in the second release year-strong size-selective survival occurred (difference of 4 cm). In the year with strong size-selective survival the average hatchery fish length at release was smaller (18.3 cm) than the year with weak-size-selective survival (20.7 cm mean fork length). Our results support the hypothesis that there is a genetic effect on body size at release and that size-selective mortality does occur after release, at least in the Hood River steelhead population. Determining the mechanisms by which genetic adaptation to hatchery rearing occurs may provide information to reduce unwanted domestication of hatchery-reared fish while potentially increasing the reproductive success of hatchery-origin steelhead spawning in the wild environment.

Can We Recover Central Valley Salmon and Steelhead Without a More Aggressive Approach to Management of Hatchery Produced Fish?

Brad Cavallo, Cramer Fish Sciences

Natural selection exerts tremendous pressure on animal populations. Salmon and steelhead have seemingly evolved to be particularly sensitive to these pressures. Behaviors, life history strategies, and innumerable other traits adapt relatively quickly to habitats and environmental conditions experienced at each phase of complex salmonid life cycles. Because selective pressures for spawning, egg incubation, and rearing in a hatchery differ from the natural environment, hatchery fish (and the progeny of hatchery fish) will tend to be less successful in spawning and rearing in the natural environment than fish with multiple generations of selection in that environment. The loss of traits adaptive to the natural environment is called domestication selection. Most artificial propagation programs devote considerable effort to minimizing it. Domestication selection becomes more severe with each successive generation spawned and reared in a hatchery environment. Available data indicates Central Valley salmonid hatchery programs have created conditions with a high likelihood of severe and harmful domestication selection. It is prudent to study and better understand these impacts, but it is also critical that we begin evaluating and implementing corrective management actions. Recovery of Central Valley salmon and steelhead cannot be achieved until these problems with hatchery impacts are addressed. My presentation will provide a vision for the kind of management actions which are needed, and describe how they might be implemented.

**Session Coordinators*: Curtis Knight,* *California Trout,*
and ***Rob Lusardi, Ph.D.,*** *California Trout and University of California, Davis*

Reconciliation and Reintroduction: A Community and Science-Based Recovery Plan for the Yuba River Watershed

Gary Reedy (Presenter), *Fisheries Restoration Consultant*
and ***Rachel Hutchinson,*** *South Yuba River Citizens League*

The Yuba River watershed received the brunt of California's gold-rush impacts more than a century ago, then the development of one of the most complex hydroelectric projects anywhere in the state. Astoundingly, the Yuba River watershed offers one of the best opportunities to recovery Central Valley salmon and steelhead, and yet the challenge is perceived differently by water and restoration interests, and among environmental groups. Narrow focus on priority actions and confidential negotiations among a few stakeholders do not serve a watershed community that is sensitive to local history and committed to a long-term view of restoration and sustainability. We propose a process that prioritizes reconciliation and effective salmonid recovery. This presentation will provide a vision for restoration that is specific to biological objectives, and a description of salmonid recovery projects that could be enthusiastically supported by the community. These include a long-term plan for volitional fish passage, and large-scale restoration of riparian and floodplain habitats in the Lower Yuba River that builds on several projects currently underway. More information can be found at *yubasalmonnow.org*.

Coalition-Based Steelhead Recovery Efforts in Southern California—South Coast

Sandra Jacobson, Ph.D., California Trout

The South Coast Steelhead Coalition implements the NMFS (2012) Southern California Steelhead Recovery Plan through a systematic process of identifying, prioritizing, and implementing steelhead recovery projects in high priority rivers of San Diego, Orange, and Riverside counties. The Coalition mobilizes federal, state, and local agencies, tribal nations, districts, and non-governmental organizations to move projects forward based on sound science, while utilizing the diverse technical and operational capabilities of Coalition participants. A large-scale genetic analysis of Southern California rainbow trout revealed two native populations within the Coalition area that are of Southern California steelhead descent. These populations are isolated in freshwater streams near remote headwaters of their native basins, and have adopted a completely resident life history. Concerted efforts to protect and expand these populations are in process; they are rare genetic resources that hold promise for contributing to future steelhead populations and for improving genetic diversity of fragmented native rainbow populations. Progress of the South Coast Steelhead Coalition will be discussed in the context of i) steelhead passage and habitat improvement projects underway that connect steelhead populations to support anadromy; and ii) efforts to expand geospatial distribution of native rainbow trout populations through a regional stream-based conservation breeding and rearing approach to support resiliency. Together these strategies will augment Southern California steelhead adaptive capabilities and promote their recovery by increasing population sizes and distribution; improving habitat quality, acreage and access; and increasing genetic diversity.

Estimating Potential Salmonid Habitat and Carrying Capacity in the Upper Mainstem Eel River, California

Emily Cooper (Presenter) and James Graham, Humboldt State University; Darren Mierau, California Trout, Ross Taylor, Ross Taylor & Associates; and Darren Ward and Alison O'Dowd, Humboldt State University

Anadromous salmonid populations in northern California's Eel River watershed are greatly impacted by two dams that are part of the Potter Valley Project. Current populations of coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*O. tshawytscha*), and steelhead trout (*Oncorhynchus mykiss*) are estimated to be between 1-3% of their historic populations. In response to the need for addressing the upcoming FERC relicensing of Scott Dam, this project provides an assessment of salmonid habitat and an estimation of potential stream carrying capacity for steelhead trout and Chinook Salmon in the Upper Mainstem Eel River watershed above the impassable Scott Dam. To determine potential distribution of each salmonid species, fish passage barriers upstream of Scott Dam were identified using the Intrinsic Potential (IP) Model from National Marine Fisheries Service and ground-based verification. Streams within the designated study area were stratified into reach types based on gradient and drainage area and were then subsampled for habitat assessment field surveys. A total of 20 wetted stream reaches totaling 13.2 stream km and 11 dry stream reaches totaling 6.3 stream km were surveyed during summer 2016. GIS and ground-based analyses determined 463 stream km (288 mi) available for potential steelhead spawner distribution, of which up to 333 stream km (207 mi) are available for potential steelhead rearing distribution. A total of 144 stream km (89 mi) were determined available for potential Chinook spawning and rearing distribution. These estimates include stream habitat currently inundated by Scott Dam's reservoir, Lake Pillsbury. Habitat survey data were summarized as they relate to species-specific densities to determine potential capacity for the respective capacity-limiting life stages of steelhead and Chinook. Two methods for modeling potential capacity for each species of interest were used. First, the Unit Characteristic Method provided reach-scale estimates using fish density values specific to habitat units (i.e. pools, riffles, glides), and the density values were then adjusted according to other habitat parameters (i.e. fish cover, depth, substrate, etc.) and how they deviate from average conditions within the study area. Habitat data characterization and capacity estimates respective to survey reaches were analyzed for variation across reach type categories while accounting for potential non-independence due to the clustering of sites into reaches. These results determined pooling of reach type strata for data extrapolation of capacity estimates from the reach to watershed scale for the entire study site. The second modeling method was an open-source, GIS-based capacity estimation model called Ripple, which estimates specific capacity for a given species for each life stage at simulated seasonal flow events using a 10m resolution digital elevation model. The results from these two approaches to estimating potential capacity were compared to each other and to estimates from past reports including the IP Model. This research has the potential to inform the relicensing of Scott Dam as well as recovery management for native anadromous salmonid populations in the Eel River.

Salmonid Fish Rescue and Reintroduction Strategies

Michael Dege, California Department of Fish and Wildlife

California's most recent drought has reminded us how environmental perturbations can add another layer of stress to native salmonids throughout the state. Such changes may become more frequent and extreme if projections of climate change are correct. In response to the most recent drought, the California Department of Fish and Wildlife (CDFW) has increased its monitoring effort of at-risk fish populations throughout the state. From this monitoring, fish recues and reintroductions have been implemented to reduce or prevent population level effects.

CDFW fish rescue and reintroduction procedures have evolved in recent years and include a more formalized approach of evaluating at-risk populations, protection options, implementation methods, and reintroduction strategies. To help implement these procedures, standardized protocols, and tiered options for evaluating at-risk fish populations has been created to help guide and direct CDFW staff. Today, CDFW fish rescue procedures do more than simply protect against fish loss, they evaluate population status, genetic structure, invasive species/disease introduction, species interactions, population stressors, and current/projected habitat conditions to better protect fish populations. Overall the goal is to provide long-term protection and conservation for at risk populations while implementing the best sound information and options available.

Beyond Boundaries—Restoring Habitat and Building Tribal Capacity in the Headwaters of the Klamath Basin—A Yurok Tribe Story from Limekiln Gulch

David (DJ) Bandrowski (Presenter) *and* ***Richard Nelson,*** *Yurok Tribe*

Over the past decade, the Yurok Tribe has played a key role in watershed restoration in the Klamath River Basin primarily near their reservation, but just recently their role has become more comprehensive and has increased geographically. The Yurok tribal reservation begins at the mouth of the Klamath River and extends approximately 40 miles upstream to confluence of the Trinity River. However, the Yurok Tribe recognizes that their responsibility in the stewardship and healing of the river extends much farther upriver beyond political boundaries. This is the story of Limekiln Gulch, an endeavor that was more than a restoration construction project, but rather a milestone and a transition as they embark on upper watershed efforts in helping restore the lifeblood of their people in the headwaters of the Klamath River.

In 2015, with a construction crew made up of all tribal members, the Yurok Tribe successfully took on the lead role in the implementation of the Limekiln Gulch Project. This large-scale project was over one hundred river miles upriver from the Yurok Tribe's reservation along the mainstem of the Trinity River. The project was funded by the Trinity River Restoration Program (TRRP) and was constructed entirely on federally managed lands by the Bureau of Land Management (BLM). The Yurok Tribe Watershed Department's work force, made up of heavy equipment operators, laborers, and technicians, transitioned quickly from its normal upslope projects to mainstem river restoration construction techniques. Building tribal capacity was a key part of the project, allowing tribal members to heal a part of the river that is upriver of their cultural home and ancestral lands. Over a six-month period, the tribe gained experience implementing over one mile of restoration elements including: complex side channels for juvenile rearing, floodplain and wetland habitats, large wood hydraulic features, and riparian revegetation components.

The Limekiln Gulch restoration was extremely challenging due to its remote and logistically isolated location along the Trinity River. Equipment, fuel, and supplies had to be staged several miles away from the construction area off steep confined mountain roads. Construction features were predominantly on the opposite side of the Trinity's mainstem from the projects access and therefore the river had to be forded many times per day by excavators, haul trucks, and dozers. The implementation team battled smoke from local wildfires, unusual summer heat, unforeseen bedrock excavation conditions, and high flows that compounded the logistics of construction. Fueled by their passion for the river, intense teamwork, and ingenuity the construction crew was able to overcome the challenges and implement the project successfully, meeting design goals, budget, and schedule.

Limekiln Gulch was much more than a restoration project, but rather the opening paragraph of a new chapter in the Yurok Tribe's story of restoring historic habitats and building tribal capacity. Beyond the boundary of a reservation, the Yurok Implementation Team is overcoming challenges upriver, preparing for even larger opportunities in dam removal and restoration actions across the Klamath Basin.

The Persistence and Characteristics of Chinook Salmon Migrations to the Upper Klamath River Prior to Exclusion by Dams

John Hamilton, ***U.S. Fish and Wildlife Service***

Knowledge of the historical distribution of anadromous fish is important to guide management decisions for the Klamath River, including ongoing restoration efforts and regional recovery of coho salmon (*Oncorhynchus kisutch*). Using various sources, we determined the historical distribution of anadromous fish above Iron Gate Dam. Evidence for the largest, most utilized species, Chinook salmon (*Oncorhynchus tshawytscha*), was available from multiple sources and clearly showed that this species historically migrated upstream into tributaries of Upper Klamath Lake. Available information indicates that the distribution of steelhead (*Oncorhynchus mykiss*) extended to the Klamath Upper Basin as well. Coho salmon and anadromous lamprey (*Lampetra tridentata*) likely were distributed upstream at least to the vicinity of Spencer Creek. A population of anadromous sockeye salmon (*Oncorhynchus nerka*) may have occurred historically above Iron Gate Dam. Green sturgeon (*Acipenser medirostris*), chum salmon (*Oncorhynchus keta*), pink salmon (*Oncorhynchus gorbuscha*), coastal cutthroat trout (*Oncorhynchus clarki clarki*), and eulachon (*Thaleichthys pacificus*) were restricted to the Klamath River well below Iron Gate Dam. This synthesis of available sources regarding the historical extent of these species' upstream distribution provides key information necessary to guide management and habitat restoration efforts.

Saturday Afternoon Concurrent Session 2

Session Coordinator*: Rhonda Reed,* *Fishery Consultant*

A large-scale restoration project focused on reviving one of California's largest rivers, the San Joaquin River, is currently underway. A legal settlement established a Restoration Goal and a Water Management Goal that drives the multi-agency efforts of channel modification, restoration hydrograph development, and reintroduction of Chinook salmon, *Oncorhynchus tshawytscha*. The Restoration Area, which begins at Friant Dam and continues downstream to the confluence of the Merced River, is approximately 153 miles long and historically maintained one of the largest spring-run Chinook salmon populations in California, with annual escapement ranging from 200,000 to 500,000 adult returns. However, completion of Friant Dam and subsequent diversions resulted in blocking salmon from portions of historic spawning and rearing reaches and ultimately dewatering large sections of the lower river. Extirpation of Chinook salmon occurred over 60 years ago with the last documented run of spring-run Chinook salmon consisting of 36 individuals in 1950. Restoration of the remaining anadromous portion of the river is a complex process involving implementing agencies, cooperating agencies, settling parties, a technical advisory committee and local stakeholders.

The goal of this session is to focus on the restoration program accomplishments to date, involving: spring and fall-run Chinook salmon introduction; model development; structural river channel improvements to allow for full restoration flow releases; and planning for large-scale fish passage and channel improvements.

Revised Draft Substitute Environmental Document for Flow Objectives on the Lower San Joaquin River and How It Benefits Fish

Daniel Worth, ***State Water Resources Control Board***

On Sept.15, 2016, the State Water Resources Control Board (State Water Board) staff released a draft proposal to update water quality requirements for salinity in the southern Delta and water flows in major tributaries to the San Joaquin River (the Stanislaus, Tuolumne, and Merced Rivers), which drains into the southern Delta. The refined salinity requirements reflect updated scientific information about salt levels that reasonably protect farming in the southern Delta. The new flow requirements for the San Joaquin River's major tributaries recognize the vital role upstream water flows provide for habitat and migratory signals for native fish species. In summary, the draft proposes increasing flows for fish and wildlife and adjusts the salinity requirements to a slightly higher level to reflect updated scientific knowledge.

The flow element of the proposed plan update would increase the required flows to be left in the rivers and would change the area currently protected by flow requirements by adding compliance locations on the Stanislaus, Tuolumne, and Merced Rivers, instead of only on the San Joaquin River at Vernalis. Scientific studies show that flow is a major factor in the survival of fish like salmon and that current flows are inadequate to protect many endangered and threatened species, as well as species relied upon by the commercial fisheries.

The revised draft SED for the first phase of the Bay-Delta Plan recommends an increased flow on the San Joaquin River and its tributaries to a range of 30 to 50 percent, with a starting point of 40 percent of unimpaired flow from February through June. Unimpaired flow represents the water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds. Historical median February through June flows from 1984–2009 in the Merced, Tuolumne, and Stanislaus Rivers were, respectively, 26, 21, and 40 percent of unimpaired flow. In other words, half of the time more than 60 or 70 percent of each river's flow is diverted out of the river during these months.

The unimpaired flow requirement is designed to mimic the cues of nature that species have evolved to respond to, but is not intended to be a rigid and fixed percent of unimpaired flow. It is intended to provide a quantity of water as a baseline, but the proposal provides for, and encourages, collaboration to use the flows as a block of water that can be "shaped" or shifted in time to provide more functionally useful flows that provide increased habitat, more optimal temperatures, or a migration cue. This type of targeted effort can provide more timely and efficient use of flows than a set regime.

Managing Precocious Maturation in Chinook Salmon (*Oncorhynchus tshawytscha*) Captive Broodstock

Paul Adelizi (Presenter) *and* ***Brian Erlandsen,*** *California Department of Fish and Wildlife, and* ***Jamie McGrath-Castro,*** *California State University, Fresno*

The San Joaquin River Restoration Program (Program) is working to reintroduce a self-sustaining population of spring-run Chinook Salmon to the San Joaquin River. However, the ESA designation of the Central Valley population greatly reduces the availability of donor fish for restoration. A captive breeding program was initiated to obtain sufficient numbers of broodstock without adversely impacting donor populations. The broodstock program amplifies the small numbers of salmon removed from the threatened populations by rearing them to adulthood in captivity and using their offspring for restoration.

One of the challenges with raising Chinook salmon broodstock is an increased incidence of early maturation, particularly in males. These "precocious" fish are often excluded from breeding programs to avoid over-representing the trait in offspring, which has the unintended result of reducing the genetic variability within the population. An experimental group of brood year (BY) 2010 fall-run Chinook Salmon reared at the facility exhibited early maturation in 15% of the yearling males, 84% of age-two males, and in 10% of age-two females. In response to the high levels of precocity, the Program initiated a growth modulation strategy, where feed levels were reduced in effort to slow male growth rates. Despite early use of this technique, precocity increased to 33% in BY 2012 spring-run Chinook yearling males. As a result, in subsequent years, a more aggressive feed reduction schedule was implemented, particularly between the months of September through January, which is recognized as a maturation decision window. The more aggressive growth modulation strategy reduced the percentage of age-two precocious BY 2012 males from 84% to 26%. In addition, precocity was reduced to just 7% in BY 2013 males, nearly one-fifth of the precocious yearlings observed the previous year. The observed reduction in early maturation as yearlings appears to be due to the aggressive reduction in feed rates and lowering of the rearing temperatures during incubation and early rearing.

Spawning Behavior and Habitat Selection of Chinook Salmon (*Oncorhynchus tshawytscha*) within the San Joaquin River, California

Andy J. Shriver, California Department of Fish and Wildlife

Recent studies have found that salmonid spawning habitat selection is related to fish size of the female spawner. Current scientific literature suggests that this, along with the tendency of salmon to return to their natal stream to spawn, may support genetic diversity and population resilience through reproductive isolation by limiting the successful spawning to a particular size of fish. Therefore, observations of the spawning behavior and habitat selection of female Chinook salmon (*Onchorynchus tshawytscha*) as related to fish size is beneficial in evaluating present conditions within San Joaquin River in determining future population success of a reintroduced species. Using acoustic and passive integrated transponder telemetry, individual females from the 2013 through 2016 fall-run trap-and-transport efforts on the San Joaquin River were linked to the specific redds they created without the presence of imprinted natal cues. This linkage allows for each female's spawning behavior to be independently observed and analyzed based on the characteristics (e.g., size, date and location of capture/release, age, stream of origin, genetic signature) of that female. When combined with data from other studies (e.g., trap and transport, redd and carcass surveys, stationary acoustic receivers), it is possible to determine, for each individual female, the time from release to spawning, the distance traveled between release to the selected spawning site, and the approximate time spent to construct, spawn in, and guard their redd. Additionally, linking individual females of a known size to specific redds allows detailed exploration of the relationship between fish size and habitat preference, such as substrate composition (e.g., D16, D50, D84 particle sizes), threshold particle size (i.e., largest particle moved during redd construction), redd size, egg pocket depths, and hydraulic conditions (i.e., flow and depth). These attributes provide insight to spawning behavior and habitat selected without the presence of imprinted natal cues, and its physical limitations to spawning success as a function of fish size. This work could inform what type of spawning habitat variability is required, if future spawning habitat improvement actions are performed, to ensure that a reintroduced population maintains a variation in fish size and genetics through time.

What if it Doesn't Flood? Excavating Salmonid Rearing Habitat and Possible Management in the Tuolumne and San Joaquin Rivers

***Gerald Dion, MS, MBA, (Presenter),** River Partners, and **Heyo Tjarks, MS,** River Partners*

If it floods every year at the right time, then hundreds to thousands of acres of floodplain are available for juvenile salmonids. However, the system is now designed to reduce flooding. What options are there for improving salmonid rearing with management actions? Is expanding the floodable area by excavation the only option for passive use? Maybe there are other options to alter and manage floodwaters on public and private lands.

Restoration and Salmon Reintroduction in the Southern San Joaquin Basin: Exploring the Regulatory Framework

Jeff Abrams, National Marine Fisheries Service, San Joaquin River Branch

The San Joaquin River Restoration Program aims to restore habitat and reintroduce Chinook salmon populations in the Southern San Joaquin River Basin. The Restoration Program is a direct result of a 2006 legal Settlement that ended an 18-year legal dispute involving the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority. One of the two principal Settlement goals was to, "to restore and maintain fish populations in 'good condition' in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish." The goal is simple enough, but the various actions required to implement the Restoration Program, including ensuring the soundness of the regulatory framework involved, are quite complicated. The San Joaquin River Basin was the historic heartland of spring-run Chinook salmon, but operations of Friant Dam and other rim dams led to their extirpation in the basin for over 50 years. Spring-run Chinook salmon was listed as an Endangered Species Act (ESA) listed threatened species in 1999 to protect the remaining populations in the Sacramento River Basin. To reintroduce this species required not just the creation of a conservation hatchery facility, the reevaluation of flow regimens, and the collection of broodstock from protected populations, but also the designation of an Experimental Population under Section 10(j) of the ESA. This presentation focuses on the details of the regulatory framework for fisheries reintroduction, restoration, and monitoring in the San Joaquin River Restoration Area and shares some "lessons learned" for salmon reintroductions elsewhere.

If You Build It Will They Come? A Perspective on 25 Years of Salmonid Restoration in the San Joaquin River Basin and the Future

Rhonda Reed, Fishery Consultant

Tens of millions of dollars have been invested in salmonid restoration projects in the San Joaquin River basin over the last 25 years, yet salmonid population levels have shown little response. This presentation will summarize these restoration investments and review the shifts in the scientific paradigms that have occurred over this time, to give a closing perspective on some restoration lessons learned and thoughts for a brighter future for salmonids of California's second largest river.

Protecting, Connecting, and Re-imagining Floodplain Habitat: Strategies for Restoring the Benefits of Floodplains to Juvenile Salmon

Saturday Afternoon Concurrent Session 3

Session Coordinators: ***Corey Phillis, Ph.D.***, *Metropolitan Water District, and* ***Brian Cluer, Ph.D.***, *NOAA Fisheries, West Coast Region*

Floodplain habitats provide growth and survival benefits to juvenile salmon and are identified as critical for recovery of California's Central Valley Chinook salmon and steelhead populations. However, development for other benefits, including farming, waterfowl, and flood control has left 98% of riparian and floodplain habitat in the Central Valley and Delta inaccessible to juvenile salmon. Therefore, restoring floodplain habitat on the landscape will require creative solutions that identify and align social and ecological benefits. This session will feature two interrelated themes: 1) Presenting the range of floodplain restoration strategies that exist, including maintenance and protection of existing floodplains, reconnecting rivers to existing floodplain, and novel strategies that attempt to mimic floodplain processes through water management; and 2) identifying where on the landscape these different strategies are most likely to successfully align the social and ecological benefits of floodplains.

Protecting, Connecting, and Re-imagining Floodplain Habitat: Strategies for Restoring the Benefits of Floodplains to Juvenile Salmon

Brian Cluer, Ph.D., *NOAA Fisheries, West Coast Region*

Few catchments on Earth are as extensively hydromodified, and modified as rapidly, as California's Central Valley. The San Joaquin River doesn't even flow in most years. Vast inland lakes and wetlands once measuring in the millions of acres are now miniscule and isolated from their watercourses. Watershed development to facilitate expanding agriculture has stressed habitats critical to many aquatic organisms that are now endangered. The general land development approach was some form of "channel improvement" (levees, channelization, dredging, etc.) to expedite runoff and drainage improvements to lower the upper aquifer, followed by water storage and diversion upstream to supply irrigation to the drained land. Drainage of floodplains and wetlands has been viewed as an honorable endeavor throughout much of civilization's history. Today however, most catchments have very little wetland habitat remaining, and even less that is accessible to salmonids.

California ranks with the upper Mississippi states in percentage of wetland drained. Prior to the mid-1800's, California's Central Valley floodplain wetland was estimated to be about four million of the valley's 13 million acres. Today, floodplain wetland is measured at about ¼ million acres.

This presentation will show the temporal and spatial history lines of floodplain wetland losses. The historic importance to aquatic dependent species such as salmonids will be discussed along with results from analysis of habitat quality and quantity, to put in perspective the habitat capacity of the modern Central Valley.

Although there remain large areas of wetland in the Central Valley, nearly all are hydrologically isolated and inaccessible to native fishes under all but the wettest of conditions. The presentation will conclude with some ideas for areas that might be re-configured for fish access, and some estimates of the habitat and ecosystem benefits that would result.

Mimicking Hydrologic Process to Restore Ecological Function

Jacob Katz, Ph.D., California Trout

Floodplain-sourced carbon is made available to aquatic food webs when floodplains activate as rivers flood. Today, levees cut off 95% of the Central Valley's floodplains from river channels. So that Central Valley aquatic ecosystems no longer recruit the carbon (stored solar energy) needed to support a robust aquatic food web and sustain abundant fish and wildlife populations. Put simply, levees are starving salmon and smelt.

Recovery of endangered fish populations will likely be impossible without first recovering the ecological processes which once supported historic abundances. Each winter and spring flooding in the pre-development Central Valley created a vast mosaic of productive floodplain habitats teeming with fish and wildlife. Nineteenth and twentieth-century investments in a network of dams, canals, and levees transformed the Central Valley into one of the world's most productive agricultural regions. This transformation has also led to the threatened and endangered status of numerous species.

This presentation will explore how managing floodplains to create prolonged shallow inundation mimics the Central Valley historical flood patterns to which California's native fish species are adapted. The presentation will synthesize five years of results from the Nigiri Project which seasonally manages for the creation of floodplain habitat for native fishes and waterbirds during winter and spring on floodplain agricultural fields that remain in agricultural production in summer and fall. The presentation will demonstrate how multi-species, multi-benefit land uses can cultivate ecological solutions on working agricultural landscapes while sustaining biodiversity and fostering resilience to climate change.

Rescaling Central Valley Rivers: Reconciling Theory with Practice

Rocko A. Brown, Ph.D., Environmental Science Associates

In regulated rivers flow hydrology is often modified, removing or diminishing peak floods that drive channel change and the maintenance of aquatic habitats. The temporal aspect of flow re-regulation has gained considerable traction over the past two decades, with environmental flows being increasingly adopted for the management of aquatic organisms. The spatial synchronicity associated with the newly managed river corridor is often addressed through specification of newly scaled peak flows, which are designed to occur with similar timing and have similar shapes to pre-regulation floods. While, it is understood that both environmental and channel maintenance flows are necessary for managed flow regimes, often river corridors have a plethora of impacts associated with flow regulation and land use development, necessitating active restoration of river corridor geometry and topography so that the physical template of the river corridor is more synchronous with newly prescribed flows. While the idea of re-scaling river corridor geometry is recognized as important, there are few case studies that illustrate the challenges and opportunities in re-scaling river geometry in human modified landscapes. This goal of this talk is to illustrate the challenges and opportunities associated with re-scaling river corridor geometry in human modified settings. Examples from California's Central Valley are used to illustrate how flow scaling is performed in practice.

Taking it Down a Notch: Entraining Juvenile Salmon Over Fremont Weir onto the Yolo Bypass Floodplain

Brett Harvey, Ph.D., California Department of Water Resources

The Yolo Bypass floodplain provides improved survival and growth opportunities for juvenile salmon relative to the adjacent Sacramento River channel. However, migrant juveniles cannot access the floodplain unless the Sacramento River overtops the Fremont Weir, an infrequent event that does not always coincide with peak migration periods. An ongoing multi-agency effort may result in the installation of a gated notch on the Fremont Weir in order to increase the frequency of flooding and the number of juvenile salmon entrained onto the Yolo Bypass floodplain. Alternative designs for notch location and configuration are under review, with a key consideration being maximization of juvenile entrainment within the constraints of notch flow. Studies are currently in progress to monitor and model hydrodynamics and concurrent fish movements in the Sacramento River adjacent to the Fremont Weir. These studies are expected to inform selection of notch design, and if constructed, notch operation.

A Contractor's Prospective for Successful In-Stream Habitat Enhancement and Restoration Projects

***Dena McCullough** and **Macky McCullough (Co-presenters)**, McCullough Construction Inc., and **Reg Elgin**, Elder and Cultural Monitor from the Dry Creek Rancheria*

From the beginning of the project to the conclusion of the project, create an environment for success so that projects remain on time and within budget with the general contractor. Create an atmosphere of teamwork that includes mutual respect and utilizes the expertise of the contractor to build a project that meets the goals of all stakeholders and values the opinions of all.

Methods, techniques, and equipment used to build the Dry Creek Habitat Enhancement Project – Phase II and Phase III in Sonoma County for the Sonoma County Water Agency. Excavating channel, LWD, pile driving snags, securing boulders to logs using cabling and bolts, bank treatments, and root wad placement. Successful dewatering techniques used to build two large backwater channels along side of Dry Creek will be discussed and illustrated as well.

Restoring the Mattole Estuary with Heliwood Whole Trees, Stream Barbs, and Riparian Plantings—An Anatomy of a Heliwood Project from Start to Finish

Sungnome Madrone, *Mattole Salmon Group*

Restoring floodplain connectivity is a complicated process. In the Mattole this is further complicated by active tectonics that create major uplift in combination with sea level rise. This uplift has cause significant off-channel habitat to become dis-connected from the river and has also aggraded mush of the estuary area. To tackle this difficult problem we have worked with our partners Bureau of Land Management (BLM), California Department of Fish and Wildlife (CDFW), US Fish and Wildlife Service (USFWS), NOAA Fisheries, The Nature Conservancy, National Fish and Wildlife Service, Department of Water Resources, SCC local landowners, and the Mattole Retsoration Council to develop an estuary restoration plan. With the plan in hand and a long history in the Mattole with effective implementation we were then poised to proceed.

This presentation will discuss tree acquisition and landowner concerns, needs, and benefits from this activity. Tree tipping and staging will be explained and the logistics of hiring a helicopter, picking the right type of air machine, costs, and benefits will be presented. The details of flight days, ground crew, data collection, and public relations will be shared and other lessons learned will de detailed.

We will explain how the trees were placed, types of structure completed, any anchoring that was done, and exactly how the stream barbs were constructed, including the planting of deep trenched willow baffles. Cleanup and restoration of the tree donor site will be described.

We will complete our presentation with a quick overview of the monitoring program established for this work. This monitoring includes PIT tagging all placed trees, GPS locations, and getting tree diameter at breast height and length and complexity. The placed trees are then surveyed into a total station survey of the entire treatment reach that documents existing conditions at the time of placement. We then resurvey every 3-5 years and can document changes in the thalwag, pool locations, size, and depths and the association of these channel features with placed large wood.

To complete this monitoring we do fish dives both in the river and nearby off-channel habitats to document fish use and these dives are done at night and during the day.

We will provide an anatomy of a heliwood project from start to finish.

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20th Annual Coho Confab August 24-26, 2017

Mattole River, North Coast, California

SRF, in cooperation with the CA Department of Fish and Wildlife, Mattole Restoration Council, Mattole Salmon Group, and Sanctuary Forest, will offer workshops and tours of off-channel slough restoration, forest and fuels reduction projects, water conservation practices, stream bank stabilization, large woody debris, and a tour of groundwater recharge planning projects. The Confab will specifically include a tour of Mattole estuary off-channel slough excavations, riparian restoration, Heliwood procurement, placement, designs, logistics, monitoring, and pool creation results. This year, we are also excited to feature a Prosper Ridge meadow reclamation and fuels reduction tour on BLM property and private land meadow reclamation and forest edge treatments. Additionally, we will explore water conservation projects in the Mattole headwaters and innovative groundwater recharge planning projects.

Confab participants will have an opportunity to explore new restoration projects at the Mattole estuary, the westernmost point of the continental United States. Photo courtesy of Mattole Salmon Group

Poster Session Presenters

Fox Hollow Rainwater Capture Project
Presented by Freddy Otte
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NOAA Fisheries
Presented by Charlotte Ambrose
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"Ghost" Pit Tags and Living Fish Have More in Common Then You Might Expect: A Case Study of Watershed-Scale Modeling of Tag Fate Over Multiple Winters
Presented by Rosealea Bond
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Variation in Juvenile Chinook Salmon Invertebrate Prey Abundance & Composition in the San Joaquin Restoration Area
Presented by Karen Boortz
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Stream Flow Enhancement Funding Opportunity
Presented by Brian Cary
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Tidal Wetland Connection in the Columbia River Estuary
Presented by Rowyn Cooper-Caroselli
Wolf Water Resources, inc.
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Sticks and Stones: Habitat Response to Concrete Structure Removal and Large Wood Addition
Presented by Gayle Garman
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Mill Creek Dam Fish Passage Project, Russian River
Presented by Lauren Hammack
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Assessment of Spatial and Temporal Variance of Macroinvertebrate Community Structure, Little Creek, Davenport CA
Presented by John Hardy
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Auburn Ravine—Small Stream, Big Potential
Presented by James Haufler
Friends of Auburn Ravine
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Territorial Site Selection and Growth Rate of Juvenile Steelhead Trout Under the Influence of a Dominance Hierarchy
Presented by Suzan Homsombath
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California Department of Fish and Wildlife Coastal Watershed Planning and Assessment Program 2016 Drought Monitoring Project
Presented by David Kajtaniak
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Illuminating Life Histories of Salmonids in Coastal California Watersheds
Presented by Emerson Kanawi
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Using Treatment Wetlands to Reduce Nitrates in Agricultural Run-off
Presented by Blair Libby
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Beaver in California: Creating A Culture of Stewardship
Presented by Kate Lundquist
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Heliwood in Action
Presented by Sungnome Madrone
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Sacramento Valley Salmon Recovery Program
Presented by Todd Manley
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Dry Creek Habitat Restoration Projects 2016
Presented by Dena McCullough
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Using Acoustic Telemetry to Determine Adult Fall-Run Chinook Salmon Migration Outcomes in the Yolo Bypass Toe Drain
Presented by Keiko Mertz
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Parent Based Tagging in Central Valley Chinook
Presented by Michelle Pepping
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Links in the Chain—Coordinating Restoration of Channel and Floodplain Reaches and Watersheds
Presented by Katie Ross-Smith
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katie.ross-smith@cardno.com

Trends in Non-Salmonid By-Catch at the Red Bluff Diversion Dam
Presented by Elizabeth Ruiz
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What Information Do We Have About Lamprey Ammocetes and Macropthalmia in the Sacramento-San Joaquin Delta?
Presented by Anji Shakya
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Progress Towards the Development of a Coho Marine Survival Forecasting Model for Lagunitas Creek
Presented by Katherine Strailey
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Delta Boundary Conditions: Plankton Communities and Water Quality in the Sacramento River and its Tributaries
Presented by Lisa Thompson
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Stream Enhancement Using a Large Helicopter
Presented by Jack Thornburg
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Mill Creek Dam Removal
Presented by Monica Tonty
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WSP Overview
Presented by Jody Weseman
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It's Alive! Creating Living Wood Structures
Presented by Jason White
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Reconstructing Life History of Chinook Salmon Across Time Using Modern and Fossil Otolith From the Feather River, California
Presented by Malte Willmes
Department of Wildlife, Fish, & Conservation Biology, UC Davis
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Mendocino Coast Large Woody Debris Restoration Projects 2005-2016, Funded by Fisheries Restoration Grant Program and Other Funding Programs
Presented by Angela Cruz
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Flow for Fish: Large-scale Rainwater Catchment for Agriculture
Presented by John Green
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Muddy Waters: Addressing Sediment and Side-Channels in the Interdam Reach of Putah Creek
Presented by Stephen Karr
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Comparison of Stream Simulation to Hydraulic Design Approaches for Constructing Fish Passage Channel Segments in Central California Coastal Streams: Challenges, Opportunities, and Lots of Large Rocks
Presented by Jeff Peters
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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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