38th Annual Salmonid Restoration Conference

March 31 – April 3, 2020 Santa Cruz, CA

2020 Vision for California's Salmonscape

Conference Co-Sponsors

Balance Hydrologics, Inc., Bear River Band of the Rohnerville Rancheria, Cachuma Operation and Maintenance Board, California American Water, California Conservation Corps, California Department of Fish and Wildlife, California Department of Water Resources, California State Coastal Conservancy, CalTrans, California Trout - North Coast, Cardno, cbec, inc., City of Santa Cruz-Water Branch, County of Santa Cruz, East Bay Municipal Utility District, Environmental Science Associates, Eureka Water Probes, FISHBIO, GHD, Green Diamond Resource Company - CA Timberlands Division, Guadalupe-Coyote Resource Conservation District, HDR, ICF International, KSN, Inc., Lyme Redwood Forest Company, LLC, Marin Municipal Water District, McBain & Associates, Mendocino County Resource Conservation District, Michael Love and Associates, Midpeninsula Regional Open Space District, Monterey Peninsula Water Management District, NOAA Fisheries, Northern California Council – Fly Fishers International, Northern California Water Association, Pacific States Marine Fisheries Commission, Pacific Watershed Associates, Prunuske Chatham, Inc., Redwood Forest Foundation, Inc. and Usal Redwood Forest Company, Restoration Design Group, Rincon Consultants, Inc., Samara Restoration, San Lorenzo Valley Water District, San Mateo Resource Conservation District, Solano County Water Agency, Sonoma County Agricultural Preservation and Open Space District, Sonoma Water, Stillwater Sciences, The Nature Conservancy, Trinity River Restoration Program, Trout Unlimited, Valley Water, Waterways Consulting, Inc., Westervelt Ecological Services, Wildlife Conservation Board, William Rich and Associates, WRA, Inc.

The Virtual 38th Annual Salmonid Restoration Conference

2020 Vision for California's Salmonscape

Dana Stolzman,
SRF Executive Director
and Conference Agenda Coordinator

Today is the day that the SRF Conference Proceedings would have been going to the printer in preparation for the 38th Annual Salmonid Restoration Conference in Santa Cruz. The Annual Salmonid Restoration Conference is one of the few conferences that still prints a conference proceedings to have something tangible to provide at the conference, to create a lasting resource, and to honor the presenters and coordinators who generously share their knowledge and expertise.

The theme of this year's conference is *2020 Vision for California's Salmonscape* with a focus on preserving California's wild salmon population with the acuity required for 2020 and beyond. In this surreal moment where we must indefinitely postpone the conference, perhaps we will have the time and space to cultivate a keener vision about viable recovery actions, and the delicate act of balancing human actions with community and watershed needs.

The coronavirus global pandemic threatens our health and social norms including the freedom to convene and strategize for our beloved salmon. A week ago cancelling our annual conference seemed unthinkable, and today we know it to be inevitable and the right thing to do given the gravity of this unprecedented pandemic. Our minds are flexible, we can adapt to new information and scientific input.

Adaptability—the predominant trait of the salmon and watershed restoration field. Salmon and steelhead survive through adaptation, and so will the restoration field. Protecting, conserving, and restoring California wild salmon and steelhead populations will require laser focus on restoration strategies that show a strong fish response. If our best thinking got us to this precipice of salmonid recovery, our way forward will require clarity and acuity beyond what we have practiced in the past decade.

The salmon restoration field intersects with many disciplines including science, engineering, communities, infrastructure, planning, food production, and land use practices. These intersections animate the lively debate and discussions about the most appropriate strategies and techniques to achieve restoration milestones. Nowhere is this more evident than the SRF Conference, where practitioners from many fields converge to address the very issues that are germane to salmonid recovery.

Like salmon, the SRF Conference has had to adapt to cataclysmic changes that limit our movement and pose risks to our health and collective wellbeing. Our movement is nothing if not resourceful and adaptive. SRF will reschedule the conference in Santa Cruz as soon as it is prudent and feasible to do so.

Producing the conference is a yearlong interactive process that engages SRF's Board of Directors, our co-sponsors, and our colleagues. We sincerely thank all of the field tour, workshop, and session coordinators who did an outstanding job of creating a dynamic agenda and were able to pivot and lead by example in this trying time. SRF greatly appreciates all of our co-sponsors who generously contribute their ideas, time, and resources to the production of the conference.

Thank you to all of the SRF members, presenters, and conference attendees who have showed compassion and patience in this unprecedented time.

We shall persist!

Table of Contents

Tuesday, March 31

Wednesday, April 1

Thursday, April 2

Thursday Afternoon Concurrent Session

Friday Morning Concurrent Sessions

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

Tuesday, March 31

ARTIFISHAL Film Screening and Panel Discussion 7:00pm

Patagonia Outlet Store, Santa Cruz

Wednesday, April 1

SRF Membership Soiree 6:00pm

Monterey Bay National Marine Sanctuary

Thursday, April 2

Lunch Membership Meeting

in Bay View Room

Poster Session 7-10pm

Cocoanut Grove

Edge of the West will play with Ray Troll at the SRF Banquet.

Friday, April 3

Banquet, Awards Ceremony, and Dance!

Doors open at 6:30pm

Cocoanut Grove Ballroom

Thank you to our exclusive beer sponsor!

Fish Passage Design for Road Crossings Workshop and Field Tour

Tuesday, March 31

Workshop Coordinators: ***Michael Love P.E.,*** *Michael Love & Associates, Inc.* *and* ***Ross Taylor,*** *Ross Taylor and Associates*

Field Tour Presenters: ***Steve Wiesner,*** *County of Santa Cruz, Department of Public Works* *and* ***Gary Kittleson,*** *Kittleson Environmental*

This two-day workshop will focus on fish passage design approaches and techniques for road-stream crossings and other low-head barriers. The course will be structured around Part XII—Fish Passage Design and Implementation—of the CDFW California Salmonid Stream Habitat Restoration Manual. The workshop is intended for participants with a variety of backgrounds, including engineers, biologists, geologists, planners, and project managers.

Covered topics include:

- Biological imperative of providing passage
- Assessing geomorphic risk for a fish passage project
- Pre-design and selection of project approach
- Stream simulation design and reference reach characterization
- Roughened channel design
- Use of boulder and log weirs
- Retrofits and technical fishways

The workshop will have participants work on sample problems taken from real projects, including analysis of thalweg profiles, developing designs for a stream simulation culvert crossing, and sizing material for a roughened channel. Participants should bring a calculator and a ruler. The second half of Day 2 will include a field tour to a range of fish passage sites within Santa Cruz's Corralitos Creek. Sites include full replacements and retrofits of stream crossings and a fish ladder, illustrating the various design approaches covered in the workshop and described in CDFW's California Salmonid Stream Habitat Restoration Manual Part XII.

The fish passage workshop will culminate with a field tour of local road crossings
By Kristen Kittleson

Assessing Ecological Risks from Streamflow Diversions in Coastal California Streams Workshop

Tuesday, March 31

Workshop Coordinators: ***Bill Trush,*** *Co-Director, River Institute, Department of Environmental Science and Management, Humboldt State University;* ***Valerie Zimmer,*** *State Water Resources Control Board; and* ***Katrina Nystrom, M.S. Student,*** *Department of Environmental Science and Management, Humboldt State University*

The riffle crest thalweg (RCT) is a familiar hydraulic feature offering an alternative diversion strategy in unregulated California streams. By restricting streamflow (Q) diversions to a relatively small percentage change in ambient RCT depth in unregulated streams, the necessary magnitude, duration, frequency, and timing of key ecological processes will be protected. The workshop (1) introduces basic RCT concepts, (2) connects stream hydraulics to stream ecosystem processes, (3) reviews recent RCT research/monitoring, and (4) prioritizes ample opportunity for discussion and hands-on data analysis. Valerie Zimmer provides an engineer's perspective, while Bill Trush provides that of a stream ecologist. Katrina Nystrom will present at RCT diversion risk analysis for Pacific lamprey ammocoete rearing habitat availability during the spring-through-summer recession hydrograph. Workshop participants will be shown how to quantitatively link stream hydraulics with stream ecosystem processes, then apply these linkages to practically and quantitatively evaluate ecological risks from streamflow diversion. Ecological performance' is how well a given instream diversion strategy protects a stream ecosystem's capacity for self-renewal. Quantitatively, ecological performance will be evaluated graphically as a percentage decrease in diverse baseline ecological processes (Y-axis) resulting from a percentage increase in ambient streamflow diversion (X-axis).

In short, with management prescription on the X-axis and remaining beneficial uses (less than the annual 100% baseline established at 0% diversion) on the Y-axis, many diverse ecological processes, each with their own unit of measurement, can be plotted on a single bar graph.

Restoring Processes—San Clemente Dam Removal and Floodplain Restoration, Carmel River Field Tour

Tuesday, March 31

Field Tour Coordinator: ***Tommy Williams, Ph.D.,***
NOAA Fisheries, Southwest Fisheries Science Center

Field Tour Leaders*: Brian Cluer, Ph.D.*, *NMFS West Coast Region California Coastal Office;* ***Amy East,*** *USGS, Pacific Coastal Marine Science Center;* ***Christy Fischer,*** *Santa Lucia Conservancy;* ***Tim Frahm,*** *Trout Unlimited; and* ***Rafael Payan,*** *Monterey Peninsula Regional Park District*

The focus of this field tour is on stream processes in the context of large-scale restoration—dam removal and floodplain restoration—with in-the-field examples from areas downstream of the former San Clemente Dam and reconnection of floodplain at the site of a former golf course.

The removal of San Clemente Dam on the Carmel River in 2015 was the third-tallest dam removed intentionally thus far globally. The morning will be spent with researchers from NMFS and USGS discussing stream channel response and sediment movement following dam removal and high flow events.

Moving downstream from the former dam location, the afternoon will be spent with staff from NMFS, USGS, Trout Unlimited, Santa Lucia Conservancy, and Monterey Peninsula Regional Park District in the lower portion of the Carmel River watershed where the Rancho Cañada Golf Course is being removed and habitat restoration efforts are underway.

Aerial of post-San Clemente dam removal. By Brian Cluer.

Los Padres Dam Removal and Fish Passage Tour

Tuesday, March 31

Field Tour Coordinator*: Brian LeNeve,* *Carmel River Steelhead Association*

Field Tour Leaders*: Brian LeNeve,* ***Carmel River Steelhead Association,*** ***Haley Ohms, Ph.D.,*** ***UC Santa Cruz & NOAA Southwest Fisheries Science Center, and*** ***Beverly Chaney,*** ***Monterey Peninsula Water Management District, Cal Am Dam Keeper***

The Los Padres Dam tour will focus on how to improve fish passage over and back down from an existing dam, along with habitat improvements below an existing dam and learning how steelhead use a dam. With co-presenters from NMFS, Monterey Peninsula Water Management District, California American Water, and the Carmel River Steelhead Association participants will learn about 40 years of work to benefit steelhead.

This tour will drive south to the Carmel River and visit the Los Padres Dam site 24 miles from the ocean. When Los Padres Dam was built there was no fish passage considered and as a consequence many projects have been built to allow steelhead to migrate up to the headwaters and back down as adults, resident rainbow trout, and juveniles.

To get fish over the dam, three different ladder and trap structures have been built and are still visible, from a wood ladder and trap to a metal and concrete ladder to the Alaska Slide ladder and concrete block trap used today. March will be prime steelhead migration time so if we are lucky one or more fish will be in the trap, and we can see them trucked over the dam.

To get fish downstream, boulders were blown up to prevent them from crashing into the spillway, a metal extension was added to the spillway to get fish past remaining boulders, a berm was installed on the spillway to channel water into a concentrated area, a "notch" was cut in the top of the spillway, and the most recent project, a 4.8 million dollar water slide and behavioral guidance system was installed. There is also evidence of gravel injections from several years ago, and more is planned in the future.

Your guides from the Carmel River Steelhead Association and California American Water will explain how each of these systems are working or have worked and a representative from the NMFS South West Science Center will talk about what we have learned about fish passage through the dam as a result of a study that was started last year.

Looking upstream to the end of the spillway of Los Padres Dam and seeing nearly complete downstream fish passage, start of ladder and trap, remains of gravel injection and extension of spillway.
By Brian LeNeve

It Takes a Watershed: Fisheries Recovery in the Butano / Pescadero Watershed Tour

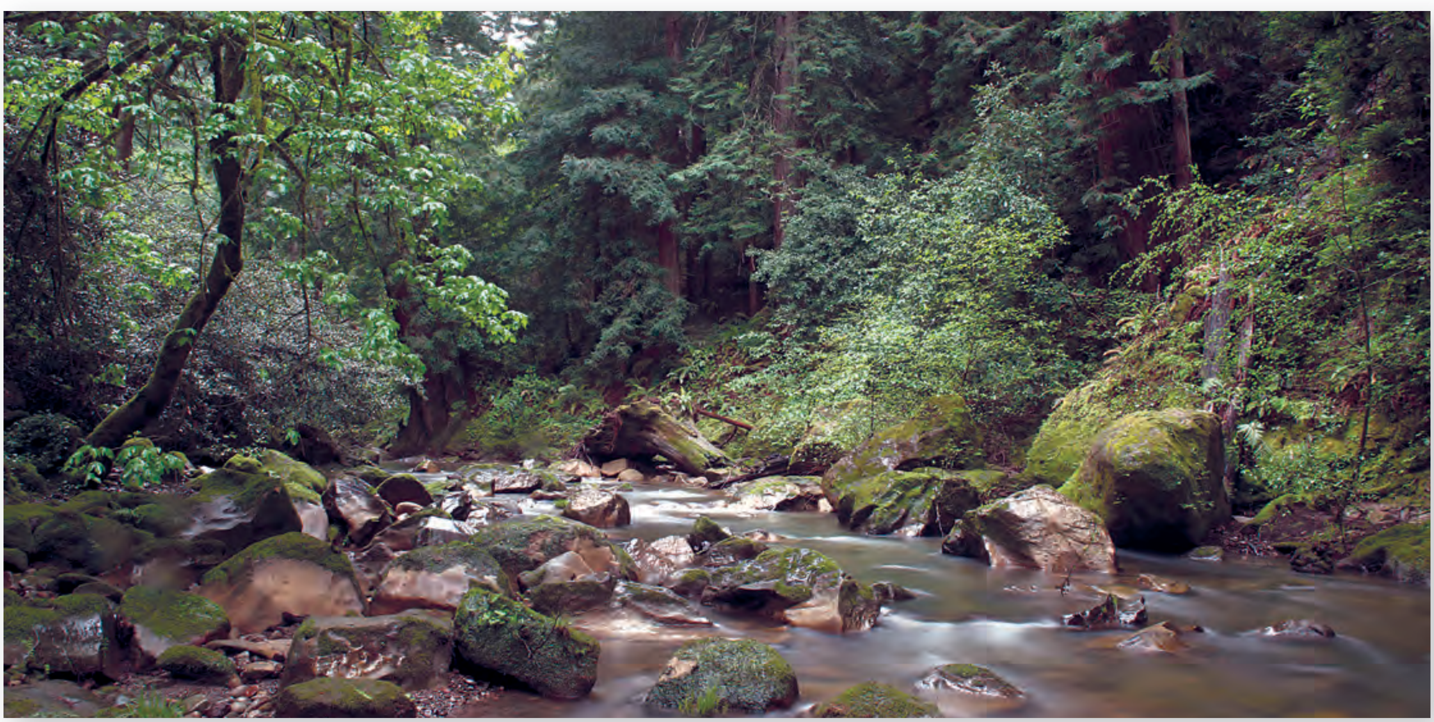
Tuesday, March 31 Field Tour

Field Tour Leaders*: **Jim Robins,** Alnus Ecological; **Joe Issel,** San Mateo Resource Conservation District; **Tim Hyland,** CA State Parks; **Joe Pecharich,** NOAA Restoration Center; **Jon Jankovitz,** CDFW; **John Klochak,** USFWS; and **Chris Hammersmark** and **Sam Diaz,** cbec, Inc.*

Pescadero Creek Watershed is a critical independent watershed for CCC Coho, is home to myriad special status species, and contains the Pescadero Marsh Natural Reserve which has been a management flashpoint for 30+ yrs. The tour will enable participants to learn about unique issues, technical solutions, compliance approaches, and partnerships necessary to complete an array of projects from headwaters to ocean including the marque Butano Reconnection project within the Marsh and much more.

The field tour will travel from Santa Cruz to Pescadero to tour the recently completed Butano Creek Reconnection and Resiliency Project with a short side trip to visit the natural stage-0 habitat upstream. The group will then travel to Native Son's Hall for a short presentation and lunch, to provide an overview of the watershed and context for the reconnection project.

Participants will tour POST's Butano Farms Property to discuss streamflow enhancement, soil health and the Butano Creek Floodplain Reconnection project site. The tour will visit the Butano Sediment Control project site and tour Butano State Park to discuss upstream habitat quality, stream flow improvement trade-offs and complexities, and forest health and resilience.



Pescadero Watershed By Trout Unlimited

Low-Tech Process-based Restoration with Beaver and Wood: Jump-Starting Structurally Starved Streams Workshop

Wednesday, April 1

Workshop Coordinators: ***Eli Asarian,*** *Riverbend Sciences;* ***Elijah Portugal,*** *California Department of Fish and Wildlife; and* ***Joe Wheaton, Ph.D.,*** *Utah State University*

The scale and severity of river impairment globally cannot be meaningfully addressed solely using traditional hard-engineering restoration approaches. This workshop will be an opportunity to share recent developments in the evolving science and practice of low-tech process-based restoration (LT-PBR) of riverscapes. LT-PBR is the practice of adding low unit-cost wood and beaver dams to riverscapes to mimic functions and initiate specific processes that improve river habitats. Dr. Joseph Wheaton (Utah State University) will lead the morning portion of the workshop, providing an introduction to the LT-PBR restoration approach and case study examples from recent and ongoing LT-PBR projects, primarily from outside of California. Afternoon presentations by scientists and practitioners will explore:

- Effects of LT-PBR on geomorphology, hydrology, hydraulics, habitat, water quality salmonids, and other organisms
- Updated case studies from restoration projects using beavers and wood
- Models and tools for prioritizing LT-PBR site selection
- Restoration implementation lessons learned
- Pathways for permitting LT-PBR projects and managing beavers in California

Following the afternoon presentations, there will be a panel/group discussion.

From *www.pacificsun.com*

Low-Tech Process-based Restoration with Beaver and Wood: Jump-Starting Structurally Starved Streams Workshop

Introduction to the Low-tech Process-based Restoration of Riverscapes Design Manual

Joe Wheaton, Ph.D., Utah State University

In this half-day day workshop, participants will be introduced to the principles underlying low-tech process-based restoration of riverscapes1. Participants will be introduced to cost-effective, low-risk techniques that can be implemented at large scales to meet riparian and instream habitat restoration goals including: partnering with beaver, beaver dam analogues (BDAs), post-assisted log structures (PALS), and other simple hand-built structures designed to facilitate process-based restoration of degraded riverscapes. This workshop will compliment afternoon talks and panel discussion on low-tech restoration of riverscapes.

1. http://lowtechpbr.restoration.usu.edu/

Temperature, Hydrological, and Fish-passage Impacts of Beaver-based Stream Restoration: Hypotheses, Models, Data, and the Way Forward with Low-tech Process-based Restoration

Chris Jordan, *NOAA Fisheries, Northwest Fisheries Science Center (Presenter) and Co-authors:* ***Carol Volk,*** *SouthFork Research Inc.;* ***Joe Wheaton, Ph.D.,*** *Utah State University; and* ***Nick Bouwes,*** *Quantitative Ecologist, EcoLogical Research Inc.*

Restoring natural hydrological and transport processes is a fundamental objective of beaver-based stream restoration practices. Returning the simplified stream reach state to a beaver dominated state means that the hydrological dynamics of a simplified, pre-restoration reach are altered to dramatically increase lateral and vertical connectivity. That is, groundwater elevation and extent and groundwater—surface water coupling are greater post-restoration, thereby strongly affecting surface water flow patterns and temperature. Although anecdotal evidence supports this process, few studies provide quantitative evidence of these altered dynamics associated with beaver-based stream restoration. From 2006 to 2017 we monitored water table elevation and temperature in two groundwater well fields on Bridge Creek, an incised tributary to the John Day River in northeastern Oregon, USA. In 2009, beaver dam analog (BDA) structures were installed to increase the number and lifespan of beaver dams adjacent to one well field, while the reach in the second well field remained untreated. Post-restoration monitoring measured large increases in surface water extent and water table elevation at the BDA-treated well field site relative to the untreated well field site. In addition, groundwater and surface water temperature patterns became more similar, a function of increased hyporheic exchange, post restoration relative to the pre-restoration conditions. To evaluate the biological impacts of the in-stream work on the target population of ESA-listed steelhead trout, we tagged adult and juvenile fish rearing and migrating in the system. Subsequent tag detections across the watershed confirmed that the patterns and timing of movement of these fishes were not impacted. Therefore, results demonstrate BDAs can be successfully utilized to raise groundwater tables and increase surface-groundwater exchange by altering the hydrological and transport processes that govern the movement of water through stream reaches. Results also showed that the construction of beaver dams, actual and analog, did not impede the up- and down-stream passage of migrating salmonids. These results will also be discussed in the context of observations and some data from other examples of process-based stream restoration based on beaver dam-like structures. A developing methodology for approaching low tech process-based stream restoration is emerging from practitioners across the northern hemisphere, but the acceptance in the scientific and management realm is lagging, so coordination, documentation, and collaboration is necessary within the restoration community to ensure the long-term viability of these methods.

Riparian Vegetation and Stream Channel Response to Meadow Restoration Using Synthetic Beaver Dams in Childs Meadow, CA

Kristen Wilson, Ph.D., *The Nature Conservancy, and Co-authors:* ***Tanushree Biswas, Ph.D.,*** *and* ***Andrea Craig,*** *The Nature Conservancy; and* ***Sarah Yarnell, Ph.D.,*** *UC Davis*

Cattle grazing in mountain meadows may limit willow *(Salix)* growth and beaver *(Castor canadensis)* dam building along streams. In Childs Meadow, landowners and researchers developed a restoration plan to try and improve habitat for two threatened species, Cascades frog *(Rana cascadae)* and Willow flycatcher *(Empidonax traillii)*. In 2016, three sections of the meadow along the stream channel were treated with different restoration actions: planting willows in all three sections, fencing cattle out of two sections, and constructing synthetic beaver dams on one section. To assess the effectiveness of this restoration effort, we evaluated the change in willow cover, groundwater levels and its relationship with biomass, and stream channel complexity, important determinants of habitat for the two threatened species, using aerial and satellite imagery and groundwater measurements through 2019. We compared these three metrics to a negative control site with cattle grazing and a positive control site with natural beaver dams. Results will be presented at the conference.

California's First Beaver Dam Analogues (BDAs) —What Half a Decade Has Taught Us

Charnna Gilmore, *Executive Director, Scott River Watershed Council*

Recent studies have highlighted the benefits of beaver pond habitat and how creating man-made beaver dam analogues (BDAs) can help provide critical habitat for endangered salmonids. In 2014, the Scott River Watershed Council partnered with NOAA, USFWS, and CDFW to construct a series of BDAs in the Scott River, a tributary to the Klamath River watershed. This session will focus on management issues, restoration strategies and monitoring results.

Looking Back: Four Years of Process-based Restoration at Doty Ravine

Damion Ciotti, U.S. Fish and Wildlife Service

A process-based restoration approach was applied to Doty Ravine Creek starting in 2016. This presentation will discuss the design approach taken and implementation and outcomes for fish and wildlife habitat. Important process-based design criteria will be discussed that help the practitioners correct human disruptions to natural process and apply a minimum dose approach to set a stream on a recovery trajectory. Doty Ravine also provides an interesting case study because conventional restoration actions such as wetland construction were attempted prior to PBR techniques, including wood structures and working with beaver.

Shinn Ranch: PBR the Hard Way

***Kevin Swift**, Swift Water Design*

This presentation will be about a 2019 process-based build I did on Shinn Ranch near the Nevada border, under difficult conditions and requiring some ingenuity. We built 175 structures, and added two miles of stream to a 5.5 mile system, for less than $90,000. I'll present lessons learned, some thoughts about how to streamline implementation, and a couple of interesting structures using less-common materials. Hopefully, folks will come away with a sense of what's possible even in remote, materials-limited systems. This will offer some California-based examples of PBR on the ground.

Some sample topics:

Plan/Design:

Blitz design—build your 30% plan in a day, solo, with just a phone and a drone. A lot of the money spent on design could be spent on fixing our streams. Here's how to get more for your money.

Happy S.A.D.—Stream Aided Design, and use of pre-existing jams, anchors, etc. Let the water do the work… of designing your build, and harvest efficiency at scale.

Build:

Miles of smiles—How to get more built faster, even with limited materials. Discover the joys of rabbit brush felt, the Glooshy Roll, and testing the weight limits of cheap trailers.

Ninja builds—make a difference with 3 people, 2 shovels and 1 electric chainsaw. How we recruited huge old-growth cottonwoods, after dinner, for a few thousand bucks.

Wicked Wicker—we're not building furniture here, people. Let's adopt faster techniques to get more done sooner.

Carbon:

Use of the Beerometer—track and get ruthless about carbon, joyfully. If you're using more diesel than beer, you're not doing it right, so here's how to fix your builds and have fun doing it.

Source Problems:

Cattle Are Not Sacred—Why it's so important to get cattle out of your build, and ideas about how to stop them wrecking your structures.

Care and Feeding of the Crew:

Thoughts on employee relations, from Cowboy and Dotty, our HR department and Security staff (both dogs). Also, the importance of waffles and what people really want for Christmas.

I've got a few other ideas floating around, but the basic gist is rapid implementation—be faster, lighter, cheaper, and have more fun than everybody else.

Beaver Dam Analog Design, Construction, and Performance on the Trinity River, California

John H. Bair, McBain Associates

Beaver Dam Analogs (BDAs) provide physical, hydrological, and ecological benefits, are easy to construct and maintain, and are inexpensive. A BDA was used at Bucktail, a rehabilitation site on the Trinity River in northern California to increase groundwater recharge, seasonal wetland area, and juvenile Chinook and Coho salmon rearing habitat. The BDA was constructed in 2016 as part of a larger physical restoration effort. The Bucktail site was an abandoned gravel mine that had left behind a small ponded area that was connected to the mainstem Trinity River through hyporheic exchange during low flow periods, and by surface flow during runoff events of greater than a 1.5-year recurrence (i.e., 170 cm). A side channel was constructed as part of the Bucktail project that routed water from the mainstem Trinity River through the historic gravel mine and existing pond during fall baseflows (8.5 cms). A BDA was added at the downstream end of the existing ponded area, controlling the outflow routed back to the mainstem. The upright piles in the BDA were set using a large excavator in less than a half day. Over the course three days, six people harvested willow and cottonwood poles and weaved them between the BDA's upright piles and placed mud and straw along the toe. Once complete, the BDA allowed high winter and spring flows to pass without significant hydraulic obstruction while damming water at fall baseflows. The completed BDA structure at Bucktail was 26 m long and 1.0 m to 1.5 m in height above the thalweg. The BDA raised the upstream water surface height one meter, resulting in expansion of the existing ponded area from 2,785 m2 to 8,360 m2, increased groundwater recharge and, over a longer time period, accrual of seasonal wetland area. Maintenance of the BDA structure has occurred twice since 2016 and included collecting willow poles from nearby plants and weaving them between the upright poles, as well as using straw to plug small holes. The results of the BDA construction were immediate; beaver occupied the pond and began to utilize inundated vegetation for forage. Within 30 days after construction, Chinook salmon were spawning in the outflow channel at the base of the dam and jumping over the dam.

Beaver Restoration Planning and Implementation in California: Tools and Case Studies

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

Over the past decade, the Occidental Arts and Ecology Center (OAEC) has been working with agencies, academia and conservation organizations to help land managers determine what role beaver could play in supporting recovery riparian and meadow function, as well as recovery of listed salmonids and other RTE species. Thanks to the efforts of many advocates, agencies, restoration practitioners and landowners, awareness of and interest in beaver's benefits to California has grown.

Sharing results from several case studies, OAEC will describe the approach and suite of tools it uses for restoration planning and the partnerships it relies on to help land managers identify, prioritize, fund, and implement both passive and active restoration. It starts with conserving the beaver we currently have.

Passive actions include trapping restrictions and rule changes, co-existence strategies to prevent depredation, and grazing regime changes. These low-cost, zero-disturbance actions can enhance and expand the benefits beaver have on riparian and montane meadow systems.

OAEC will describe recent California policy change efforts that could help beaver, a non-listed species, gain better protection and greater recognition for their role in providing critical habitat to listed species. In areas with human/beaver conflicts, there are many low-cost ways to mitigate beaver damage while continuing to receive their habitat modification benefits. OAEC will share some co-existence success stories.

Active beaver restoration actions for existing colonies or recruitment to new areas can include planting desirable food species, reinforcing ephemeral dams, installing instream structures (including BDAs) to support beaver persistence/establishment, and other approaches.

OAEC will share how, in partnership with others, it is using historic/current distribution data, ground-truthing, focal species surveys, the Beaver Restoration Assessment Tool (BRAT), and other tools to assist land managers and owners in prioritizing beaver restoration. By identifying each reach's capacity to support various beaver-based restoration actions, these tools can guide meadow/stream restoration and focal species recovery.

Given California's unique confusion about beaver's native range and CDFW's policy prohibiting relocation, restoring beavers to appropriate areas currently lacking them requires creative planning. OAEC will describe how its work with tribes, ranchers and conservation organizations from the Southern Cascades/Sierra to the coast is supporting beaver recruitment, and setting the stage for future beaver relocation should that become possible.

Beaver (*Castor canadensis*) of the Salinas River: A Human Dimensions-Inclusive Overview for Assessing Landscape-Scale Beaver-Assisted Restoration Opportunities

Stuart Suplick, B.S. *(Presenter); and Co-author:* ***Yiwen Chiu, Ph.D.****; California Polytechnic State University, San Luis Obispo—Natural Resources Management and Environmental Sciences Department*

Across the western United States, researchers are increasingly working with beaver *(Castor canadensis)* for process-based stream and watershed restoration. One recently developed geographic information system-based tool, the Beaver Restoration Assessment Tool (BRAT), analyzes opportunities for beaver-assisted restoration (BAR) at a landscape-scale. However, this tool benefits significantly from human dimensions-inclusive, basin-centralized beaver knowledge for proper interpretation. Unfortunately, this information is scattered or absent in most semi-arid and arid southern California basins. This study thus sought to gather and produce this information through an explorative, benefits-maximizing approach to landscape-scale BAR opportunities assessment in one of these basins, the Salinas River. 49.2 km of beaver dam field surveys, an emailed survey and interviews completed by 39 riparian organizations and residents, and a BRAT model run produced: an ANOVA-driven statistical determination of beaver damming hotspot areas, a beaver damming consistency range map, seven computer-assisted qualitative data analysis themes, and BRAT dam capacity and management outputs. When combined, these products revealed basin beaver dam dynamics, population behavior, ecosystem impacts, and human dimensions information that, despite their high-level nature, improved the quality and applicability of assessment recommendations. Ultimately, this study demonstrates how integrating a qualitative data component in landscape-scale BAR assessments is valuable for understanding basin-specific BAR opportunities and considerations, especially for basins without extensive prior beaver research efforts. Study findings also support literature that suggests the current BAR field's focus on beaver damming, and not other beaver activities, may be too restrictive for maximizing its potential in California basins similar to the Salinas River. Perhaps most interestingly, study findings suggest that beaver may be more prevalent in southern California Rivers and their tributaries than has been commonly understood. That beaver extensively utilize the Salinas River basin warrants further research efforts in this basin, in addition to surveys and studies in other major southern California basins, to better understand their prevalence and potential ecosystem tradeoffs within these hydrologic regions. To this point, in these basins where beaver need no reintroduction, California beaver advocacy groups may better promote proactive beaver management by adjusting education and communication strategies to emphasize these potential tradeoffs. In doing so, they have an opportunity to impart a healthier understanding among human communities of local ecosystem complexities.

Accelerating Coho and Steelhead Recovery Workshop

Wednesday, April 1

Workshop Coordinators*: Matt Clifford, JD,* *Trout Unlimited, and* ***Monty Schmitt,*** *The Nature Conservancy*

In the more than two decades that various coastal California populations of steelhead and Coho salmon have been protected under federal and/or state endangered species acts, a great deal of effort has gone into studying how to recover these species. Federal recovery plans have been completed for all three populations of coastal California steelhead, and both federal and state recovery plans have been completed for both populations of coastal California Coho. But although both the regulatory and restoration branches of the California Department of Fish and Wildlife and the National Marine Fisheries Service have been working for years to implement various actions called for in those plans, populations of both species have continued to decline. This workshop will focus on efforts to re-assess the approaches the agencies and the larger restoration community are taking to recover these species. Topics include: methods for prioritizing specific restoration projects at the watershed level to guide grant funding, more effective implementation of regulatory authority over water diversion and stream alteration, more efficient permitting of habitat restoration projects, and more effective monitoring of populations of both species.

State of Salmonids

Curtis Knight, *Cal Trout*

In 2017, Cal Trout and UC Davis Center for Watershed Sciences released State of the Salmonids II: Fish in Hot Water—an in-depth report that details the status of California's 32 types of native salmon, steelhead, and trout. The report underscores the need to accelerate salmon restoration on the North Coast and elsewhere in California because if we don't act, we risk losing 45% of California salmonids in the next 50 years.

The presentation will discuss the findings of the report, including an analysis of key threats to the survival of each species, starting with the overarching threat of climate change, which is likely to reduce the availability of cold-water habitat that salmon, steelhead, and trout all depend on for survival. It also highlights various other human-induced threats, such as dams, agriculture, estuary alteration, urbanization, and transportation. Strategies for recovering salmonids throughout California will also be discussed, including prioritizing protection and restoration efforts in three general areas:

Protecting the most productive river ecosystems remaining in California, such as the Smith and Eel Rivers, must be a priority. These strongholds, among others, have the capacity to support diversity and abundance because they retain high quality habitat and are not heavily influenced by hatcheries, thus supporting the persistence of wild fish.

Increasing focus on source waters will keep more water in streams and reduce stress on fish during drought, buffering the effects of climate change. Sierra meadow restoration, springs protection and progressive groundwater management all contribute to this effort.

Restoring function to once productive—but now highly altered—habitats can greatly improve rearing conditions for juvenile fish, especially floodplains, coastal lagoons, estuaries, and spring-fed rivers.

Twenty Years of Recovery Planning and Project History with the Pacific Coastal Salmon Recovery Fund: Washington, Oregon, Idaho, and California Case Studies

Keith Wolf, Ph.D., *Cardno*

For over twenty years, the states of Washington, Oregon, Idaho, California and Alaska have developed programs and supported local and technical organizations to fund salmon, steelhead, bull trout, and other listed and non-listed, species restoration and protection programs. The states, tribes, local organizing groups and project sponsors have undertaken over 13,700 projects, resulting in significant changes in salmon habitat conditions and availability since 1998. The benefits to fish populations and their habitats is demonstrable, but the value of these investments for recovering threatened and endangered species is poorly articulated and not always integrated at the watershed and/or ecosystem levels. As of October 2019, access to nearly 1.1 million acres of spawning and rearing habitat has been restored and protected for salmon, and access to over 10,900 miles of previously inaccessible streams has been re-established. How did we accomplish this and how will we maintain our momentum? How will we protect the funding streams and expand grant-source programs? We present case studies from Washington, Oregon and Idaho to this California audience. The authors have a combined 100 years of experience in ecosystem recovery planning, project development and grant-source fund assistance.

Implementing Priority Recovery Actions for Coho Salmon in the Central California Coast

Stephen Swales, *Fisheries Branch, California Department of Fish and Wildlife, and* ***Erin Seghesio,*** *NOAA Fisheries (Co-presenters)*

Coho salmon in the Central California Coast Evolutionarily Significant Unit are listed as Endangered under both the State and Federal Endangered Species Acts. While most populations are declining, some are already extirpated. California Department of Fish and Wildlife and NOAA Fisheries collaborated in initiating and developing a joint agency program entitled 'Priority Action Coho Team' (PACT). Members of the State Coho Recovery Team and other stakeholders participated in several meetings and their input was incorporated into the PACT priorities. The agencies have recently released a PACT progress report.

The main aim of this program is to prevent further extirpations of Coho salmon populations in central coast streams through identifying and implementing priority short-term recovery actions. The PACT recovery actions include; captive rearing/fish rescue, habitat restoration/protection, instream flow conservation, improvements in permitting/ regulations procedures and outreach/education. In this presentation, we will outline the structure and function of the PACT program, and discuss measures that can be taken to prevent the further extirpation of CCC Coho salmon. In addition, we will highlight some recovery efforts that have been completed.

The North Coast Salmon Project: A Synergistic Approach to Coho Salmon Recovery

Jonathan Nelson, California Department of Fish and Wildlife

The California Department of Fish and Wildlife has launched a new initiative called the North Coast Salmon Project to enhance the recovery of CESA-listed salmonids on the North Coast of California. In the first phase of this project, efforts will be concentrated on Coho salmon. The Project is guided by a leadership team made up of partner organizations and Department representatives with the goal of evaluating the effectiveness of past recovery efforts and identifying actions that will expedite and improve future Coho recovery methods. The Department will collaborate with local stakeholders and the restoration community to identify high priority recovery actions and develop locally driven conservation efforts. Approaches will focus on reach-specific restoration priorities utilizing the Salmonid Habitat Restoration Priorities (SHaRP) process as an initial framework. Other aspects of recovery, such as Department grant programs, population and habitat monitoring projects, and permitting for habitat restoration, will be evaluated for their efficacy, resulting in meaningful recommendations for improvement. Project efforts have been initiated in four focus watersheds: Lower and South Fork Eel River, Mendocino Coast streams, Russian River tributaries, and Lagunitas Creek. We will present on our progress made to date, next steps in developing a recovery framework, and expected outcomes from Project objectives.

How to Use the Salmon Habitat Restoration Priorities (SHaRP) Process to Enhance Inclusion and Support in On-the-ground Restoration Planning

Julie Weeder, *NOAA Fisheries, and* ***Allan Renger****,*
California Department of Fish and Wildlife (Co-presenters)

Our agencies have developed a process to engage partners in reach-level recovery implementation planning that builds upon the existing recovery plans of the two agencies. This effort, called Salmon Habitat Restoration Priorities or SHaRP, is an open, transparent, inclusive process which is nearing completion in the pilot watershed—the South Fork Eel River. SHaRP starts with identification of the best sub-watersheds within the larger basin to focus on. People with history or local expertise in the sub-watershed (e.g., local NGOs including RCDs, biologists, geologists, and hydrologists from NOAA Fisheries, NOAA Restoration Center, CDFW, other state and federal agencies, academia, and landowners) are invited to participate in a 2-day meeting for each of these sub-watersheds. By the end of each meeting, participants have agreed upon an on-the-ground restoration plan for the sub-watershed which identifies, to a reach scale, what actions should be undertaken in the next ten years to best address the habitat limitations, and threats most affecting salmon and steelhead there.

A Scientific Framework to Guide Salmonid Recovery Prioritization, Implementation, and Monitoring

***Darren Mierau,** North Coast Program Director, California Trout*

The scope and scale of efforts to restore salmon and steelhead populations has steadily expanded in California over the past several decades, in response to the listing of 10 distinct population units state-wide as threatened or endangered. Early restoration practitioners pioneered innovative methods to address habitat and water quality impairments, and restoration efforts focused opportunistically on small-scale on-the-ground actions: upgrading and decommissioning forest roads, removal of culverts and other migration barriers, placement of large wood into stream channels, and recently, water storage and instream flow management. Project phases of planning, engineering design, regulatory compliance, construction implementation, and monitoring have all become highly structured and refined, and practitioners have adapted to the business aspects of state and federal grant administration.

In short, we've developed a successful industry focused on recovering our native salmonids.

Standing on this pillar of success, however, there is also a growing acknowledgement among many restoration practitioners that we need to do more, better, and faster. Funding resources have expanded considerably in the last decade, now reaching upwards of $100 million annually being spent toward watershed, river, and habitat restoration. Yet a cohesive scientific framework to guide salmonid recovery prioritization, permitting, implementation, and monitoring is clearly lacking. In response to this deficiency, several nascent efforts have sprung up to bring more scientific structure and regional prioritization to restoration efforts. The PACT or *Priority Action Coho Team* has identified top-priority actions for CCC salmon. The SHaRP or *Salmon Habitat Restoration Priorities* is developing a template for basin-wide priority planning, focusing on the South Fork Eel River. A recent effort by the California Advisory Committee (CAC) has assisted CDFW and NMFS to identify priority CMP monitoring programs as a first step to secure consistent and adequate funding for population monitoring statewide. And in 2019, CDFW launched the North Coast Salmon Project to bring agency staff and stakeholders to the table to discuss restoration efforts.

These efforts need to continue, become better coordinated, and integrate more thoughtful experimental designs into restoration actions to ensure our investments are achieving measurable outcomes.

Accelerating Steelhead and Coho Recovery Using the Habitat Restoration and Enhancement Act and Other Programmatic Permits

Katie Haldeman *and* ***Erika Lovejoy,*** *Sustainable Conservation (Co-presenters);*
and Co-Author: ***Madeleine Wieland,*** *California Department of Fish and Wildlife*

Sustainable Conservation's Accelerating Restoration team collaborates with agencies and restoration proponents to create policy and regulatory incentives that save time and resources on project implementation. These actions are essential to help restore habitat at the pace and scale necessary to recover species. Our flagship initiative focuses on developing "programmatic permits" and other efficient permitting mechanisms that seek to expedite implementation of projects, while ensuring essential environmental protections are in place. By creating a separate regulatory pathway, there is also greater opportunity for restoration project proponents and regulatory agencies to partner on common goals and achieve critically needed environmental outcomes.

In 2014, Sustainable Conservation sponsored the Habitat Restoration and Enhancement Act (HREA) and created an alternative, expedited permitting pathway for the California Department of Fish and Wildlife (CDFW) for restoration projects 5 acres or less. More than 45 projects have been approved using HREA and the program can provide a major boost for restoration proponents trying to get steelhead and Coho projects implemented more quickly. The process works in coordination with an existing State Water Resources Control Board programmatic permit for small-scale projects. Along with highlights of approved projects, a primer will be provided on the HREA program, application requirements, and how to best partner with CDFW to successfully utilize the process.

Sustainable Conservation will also provide a brief update on complementary efforts with other state and federal agencies (e.g., Army Corps, NOAA, U.S. Fish and Wildlife, State Water Resources Control Board) to develop expedited permitting pathways for aquatic and riparian restoration projects across the state.

Effectiveness Monitoring of Coho and Steelhead Habitat Enhancement in Lagunitas Creek

Gregory Andrew, M.S., *Marin Municipal Water District*

The goals of the Lagunitas Creek Winter Habitat and Floodplain Enhancement Project have been to increase the winter carrying capacity for Coho salmon *(Oncorhynchus kisutch)* and steelhead *(O. mykiss)*, produce more and larger smolts, reconnect Lagunitas Creek to its floodplain, and improve water quality to benefit the cold water fishery. I will be presenting three years of effectiveness monitoring of the project. The monitoring has focused on documenting how the project has enhanced habitat conditions at the project sites, including: the flow conditions under which targeted floodplain channels become activated; floodplain channel geomorphology; instream habitat; wood racking; and some water quality monitoring. Fish population monitoring has been ongoing within the Lagunitas Creek watershed for all freshwater life stages of Coho and steelhead, with smolt surveys being the most informative to habitat enhancement. Only limited surveys at the project sites have been conducted, so the linkages between populations and habitat enhancements continue to rely on long-term population trends.

The two phases of restoration construction were completed in 2017 and 2019. Large wood structures/ engineered log jams as Bar Apex Jams (BAJs), Log Debris Retention Jams (LDRJs), and Log Diversion Vanes (LDVs) were installed at eight project sites; and a 1,000-foot floodplain channel was excavated through the riparian corridor at a ninth site. The project has enhanced habitat through a 3-mile reach of Lagunitas Creek and reconnected almost a half-mile of floodplain habitat.

While the adjacent floodplain of Lagunitas Creek becomes inundated at winter storm flows reached during the annual or 2-year storm event, this project is meant to engage the floodplain on a more regular and prolonged period during moderate winter base flows. Flow monitoring during the first three years of the project has been conducted using stage gage data recorders and time-lapse camera photography. The stage gages are being used to monitor water surface elevations pre- and post-construction, both in the main stem channel and floodplains. Time-lapse cameras have captured flooding during winter storm events. Data from both devices is compared with stream flow recorded at the USGS stream gages in the creek. Other monitoring has included observations of sediment accumulation and floodplain channel changes; the amount of woody debris to rack up on the engineered log structures and within the floodplain channels; and an as-built topographic survey to establish the elevation of the streambed along the stream thalweg, by a longitudinal survey running through the segment of the stream channel where the engineered log structures were installed.

Annual Coho and steelhead smolt population estimates have been conducted since 2006 so there is considerable pre-construction population data on Lagunitas Creek. The long-term trends in smolt outmigration will be ongoing to help identify any linkages to this habitat enhancement work.

The Roles Engineers and Geologists Can Play in Accelerating Salmonid Recovery

Marjorie Caisley, P.E., *Senior Hydraulic Engineer, California Department of Fish and Wildlife*

Often in restoration projects, engineers and geologists are considered to play a role in design and implementation of the project. However, integrating engineers and geologists into watershed planning and post-project monitoring would likely accelerate stream restoration and salmonid recovery efforts. Prior watershed planning efforts like the North Coast Watershed Assessment Program have included geologists in the multi-disciplinary teams doing watershed planning. However, the role of the geologist was primarily in assembling geologic and geomorphic data for the plan. More input is needed from geologists and engineers in watershed plans to assess risk, determine the feasibility of restoration techniques, and do cursory cost-benefit analyses. These additional tasks in the watershed planning phase would result in identifying low risk areas and standardized restoration techniques for fast track implementation, and prioritize the remaining more complex restoration according to biologic benefit, cost benefit, and feasibility. Post-project monitoring would also benefit from the participation of engineers and geologists. Measuring the success of restoration projects involves measuring physical parameters of the stream. In-depth knowledge of stream processes is necessary for developing meaningful monitoring of physical parameters. Additionally, engineers bring a specialized skill set for producing repeatable topographic and velocity measurements. Assessing success and failures of restoration projects from a multi-disciplinary perspective will produce meaningful lessons learned that can be quickly turned around for use in future restoration. The ultimate goal of involving geologists and engineers in the whole restoration process is to prioritize restoration projects more effectively and to inform the design approach to reduce the need for design changes and accelerate implementation.

Coho Salmon Flow Initiative (CFI): A Watershed-scale Approach to Instream Flow Issues Based on Conservation Priorities

David Hines, California Department of Fish and Wildlife

The Coho salmon Flow Initiative (CFI) is a proposal to provide an objective framework for the California Department of Fish and Wildlife, Bay Delta Region (CDFW) to target the most important threats to instream flows without being arbitrary or unfair to stakeholders. Given the endangered status of Coho salmon, their distribution and their ability to function as an umbrella species for freshwater ecosystems, it is appropriate to select them as the focal species for this effort. Watersheds serve as logical work units because they are self-contained hydrologic systems and because biologists have generally defined Coho salmon populations at this scale. The proposed pilot watershed is Green Valley Creek, tributary to the Russian River due to its importance to the recovery of Coho salmon and its compromised instream flows. CDFW will begin by identifying restoration and agency partners. These may include other agencies, non-governmental organizations and local stakeholders. Then, a watershed-wide resource assessment will be conducted that will include evaluation of water supply, flow/habitat relationships and water demand analyses. These will become the technical foundation for watershed-wide flow restoration efforts.

Specific approaches have not yet been defined but, the following concepts are intended to lead toward watershed-wide solutions. First is a comprehensive outreach program designed to raise awareness, enhance working relationships and direct interested parties to relevant resources. Next is to prioritize existing restoration funding to promote voluntary water storage and increase stakeholder satisfaction. This will be followed, as needed, by regulatory solicitations, compliance surveys and, if necessary, enforcement actions.

We also recommend a watershed-wide monitoring program to evaluate the effectiveness of these efforts in re-establishing and/or maintaining sufficient flows for Coho salmon. Partners can measure their success by the degree to which stream flow meets criteria established by methods published and/or approved by CDFW and the State Water Resources Control Board. Agencies can also use the monitoring results to determine whether it becomes necessary to continue with permitting solicitations, compliance or enforcement actions. If we approach management of instream flows in this comprehensive way, we can substantially improve our ability to restore flows in select Coho salmon watersheds and improve water security for local residents.

How Water Diversion Laws Can Deter Voluntary Participation in Streamflow Restoration Projects, and Some Potential Fixes

Matt Clifford, *California Water Project Attorney, Trout Unlimited*

Low summer baseflows are a factor that limits Coho recovery in many coastal California watersheds, and in many of these watersheds, water diversions are a significant component of the problem. In several areas, restorationists are attempting to address this problem by convincing diverters to participate in voluntary projects to switch the timing of their existing diversions from the dry season to the wet season, enabled by the installation of small-scale offstream storage in the form of tanks or ponds. This model, while promising, has not yet been adopted on a widespread scale. One reason for this is that state laws governing the diversion of water—primarily the Water Code (as applied under the North Coast Instream Flow Policy) and Section 1602 of the Fish and Game Code—are sometimes applied in ways that can unintentionally create disincentives for dry season diverters to participate in such projects. This presentation will briefly describe the existing regulatory landscape governing small-scale water diversion on the North Coast, explain how those laws can deter water users from participating in voluntary streamflow improvement projects, and suggest alternative concepts for permitting and enforcement that could reduce these disincentives and spur broader participation in streamflow restoration.

Building Local Capacity: An Overlooked Element in the Implementation of Habitat Restoration

Steph Wald, *Creek Lands Conservation and Co-authors:* ***Matt Clifford,*** *Trout Unlimited, and* ***Kellyx Nelson,*** *San Mateo Resource Conservation District*

Federal and state plans for achieving the recovery of endangered salmon and steelhead populations call for extensive voluntary habitat restoration measures to be implemented, predominantly on private land, over the next several decades. The success of these recovery plans depends directly on whether this implementation takes place.

Neither the state nor the federal government has proposed undertaking habitat restoration using their own personnel. Instead, both assume non-governmental entities, primarily locally-based NGOs, will take the lead role in planning, designing, permitting, and implementing restoration projects, using funding awarded on a competitive basis from public grant programs. This model calls upon local organizations to take on a very broad array of complex tasks: developing project ideas, nurturing relationships with private landowners and obtaining legal permission, creating engineering designs, navigating multiple state, federal, and local permitting processes, and hiring and supervising consultants and contractors, all while administering the grant funds themselves in keeping with the detailed requirements of various granting agencies, on strict timelines. While organizations capable of meeting these challenges exist in some regions of California salmon and steelhead country, in others they are essentially nonexistent. This limits the ability to put effective restoration projects on the ground.

Given the central role that locally-based organizations play in current salmonid recovery plans, more attention needs to be paid to the ways in which public grant program policies affect the ability of these entities to undertake habitat restoration projects on a sustainable basis. This presentation will examine the effects of existing policies regarding overhead, budgeting, grant amendments, permitting, and other topics have on the capacity of local organizations, and how those policies could be improved to help give rise to a healthier community of restoration partners capable of implementing habitat restoration across the geographic range of California salmonids.

18 Years of Managing Mountain Bikes, Sediment, and Legacy Logging, to Improve Salmonid Habitat Field Tour

Wednesday, April 1

Tour Coordinators: ***Aaron Hébert,*** *Midpeninsula Regional Open Space District* *and* ***Jonathan Owens,*** *Balance Hydrologics*

Since 2001, the Midpeninsula Regional Open Space District and Balance Hydrologics Inc. have been working to reduce and monitor sedimentation from 24 miles of roads and trails in a popular mountain biking open space preserve. Threatened salmonid species are present in the creek system downstream, which was historically impacted by forestry activities in the preserve location. Monitoring the effectiveness of road and trail improvements has been performed through V* sediment pool monitoring, as well as stream- and sediment-gaging. Baseline conditions were measured from 2004 through 2007, and were re-measured during 2018 and 2019. Aaron Hébert, Water Resources Specialist and Craig Beckman, Maintenance Supervisor at Midpeninsula Regional Open Space District; and Jonathan Owens, Principal and hydrologist and Chelsea Neill, P.G. hydrologist, at Balance Hydrologics Inc. will be the presenters

The day will start with 1.5 hours of presentations and workshop, providing project overview and data methods and analyses. The field tour will head tov the San Gregorio watershed and the El Corte de Madera Creek Open Space Preserve. Participants will hike the roads, trails, and bridges that Midpen rebuilt to reduce sedimentation, enter the mainstem of El Corte de Madera Creek, and learn about stream gaging, sediment sampling, and the basic techniques of V* field data gathering that were used. Topics will include discussions of legacy logging, large-wood jams, sediment rating curves, and natural vs. human-influenced sediment sources.

Chelsea Neill of Balance Hydrologics and Aaron Hebert of Midpen gather V data at a pool in El Corte de Madera Open Space Preserve (2019).*
By Morgan Williams

Salmonid Recovery in the San Lorenzo River Watershed: Water, Wood, and Working with Neighbors Field Tour

Wednesday, April 1

Tour Coordinators: ***Kristen Kittleson,*** *County of Santa Cruz* *and* ***Chris Berry,*** *City of Santa Cruz*

This tour will visit sites in the San Lorenzo River Watershed that showcase current salmonid recovery actions, including lagoon and water management, stream wood enhancement and working within residential neighborhoods to preserve natural wood recruitment and enhance riparian corridors. The tour will include lunch at the beautiful Quail Hollow County Park.

Logs and rootwads installed for the Upper Zayante Creek Stream Enhancement Project. By Kristen Kittleson

Scotts Creek Field Tour:
A Three-Pronged Approach to Coho Recovery

Wednesday, April 1

Tour Coordinators: ***Joe Issel,*** *Santa Cruz Resource Conservation District,* ***Brian Dietterick, Ph.D.,*** *Cal Poly's Swanton Ranch, and* ***Joseph Kiernan, Ph.D.,*** *NOAA Fisheries*

Scotts Creek is the only watershed south of the Golden Gate Bridge that continues to support all three cohorts of CCC Coho. This watershed is critical to Coho recovery in the Santa Cruz Mountains Diversity Strata. As Coho struggle to keep a foothold south of the Golden Gate, a unique collaboration of scientists, restoration practitioners, geneticists, transportation planners, and farm managers are working in tandem to keep this population from going extinct. The field tour will showcase the three major efforts underway by partners: ecological restoration, monitoring, and hatchery efforts. Tour participants will get an inside view of habitat restoration projects, new science being developed through NOAA's Science Center, and the challenges and achievements of the watershed's Coho recovery hatchery.

The Scotts Creek tour will visit the lagoon, conservation hatchery, and Cal Poly's Swanton Ranch. By Walter Heady, TNC

The Making of California Salmonscape: Science, Art, and Seafood

Ray Troll *and* ***Sarah Mesnick, Ph.D.,*** *Southwest Fisheries Science Center*

From the Sierra Nevada to the Golden Gate, California is a salmon state. Yet, we are challenged to conserve and manage these magnificent fish if the vast majority of the public is unaware they live in our waterways or how their actions affect salmon and salmon habitat. NOAA Fisheries and artist Ray Troll created "California Salmonscape" to share the diversity and importance of salmon and their habitats throughout the Golden State. California is home to Chinook and Coho salmon, steelhead, and coastal cutthroat populations that range from the Klamath River in the north to the Tijuana River in the south. The circular pattern emphasizes the continuous flow of seasonal salmon runs, while the detailed illustration shows the different life stages of salmon, the many dimensions of human activities the fish encounter throughout their lives, and the landscape through which they travel—from Sierra Nevada mountain streams to the sea—and back again. Together, the images depict the connectivity of people, salmon, and the marine, estuarine and freshwater habitats upon which we all depend. The plenary presentation will tell the story of the long-time collaboration between the artist and scientists at NOAA Fisheries' Southwest Fisheries Science Center and will highlight Ray Troll's renowned humor and artistic storytelling. Ultimately, our shared goal is to share the art and "salmonscape" concept with a wide audience in support of the conservation and management of Pacific coast salmonids.

Sharpening Our Vision for California's Salmon Restoration Approaches

Chuck Bonham, J.D, *Director, California Department of Fish and Wildlife*

California is the nation's most populous state and home to more diverse species and ecosystems than anywhere in the United States. It is a global biodiversity hotspot, but that biodiversity is also disappearing at one of the highest rates. Like California is the international leader on climate change, so too can we be the international leader on biodiversity, conservation, and climate resiliency for natural resources.

One problem is that the scale and pace of restoration is not matching the increasing threats from climate change, wildfire, drought, flooding, escalating human-wildlife conflict over habitat and water, and ultimately species extinction. Permitting, including the permits issued by the California Department of Fish and Wildlife (Department or CDFW), exists in a regulatory framework that avoids risk but results in piecemeal conservation. It needs to change so environmental permitting is not a barrier to environmental projects. It is time to reframe from a focus on risk avoidance to a focus on the imperative for restoration action at a larger scale, at a faster pace.

The Department is pursuing an integrated strategy to change this paradigm, involving reforms to its internal processes, grant making, and organization of its programs to optimize engagement with the salmon restoration community.

The Director's presentation will walk through these reforms and lay out a vision for California's salmon restoration with a renewed commitment to partnerships.

Protecting and Restoring California's Ocean Ecosystems

Margaret Spring, J.D., *Chief Conservation and Science Officer, Monterey Bay Aquarium*

The health of our ocean and coast is under threat. A range of unsustainable practices on land and at sea have resulted in fishery declines, ocean pollution and habitat destruction—all exacerbated by climate change. Fortunately, we have tangible examples of how to reverse impacts, and nations are working together to tackle these problems. The Monterey Bay Aquarium is bringing success stories to the public, policymakers, businesses and world leaders, urging them to make decisions for a healthy ocean.

For example, the United States is the world leader in sustainable conservation and management of marine fisheries. The 2006 federal reforms to the Magnuson-Stevens Fishery Conservation and Management Act worked not only to end overfishing and rebuild stocks, but also to protect habitats just off our shores.

California has led the way in addressing ocean threats: establishing a network of marine protected areas in state waters, leading the way to curb the emissions responsible for climate change and ocean acidification, and taking action to curtail ocean plastic pollution. The Monterey Bay Aquarium works with the Monterey Bay Aquarium Research Institute (MBARI) to bring new science and technology to the solution space.

Conservation and recovery of salmonids are a part of this story. These resilient fish connect the land with the ocean through their anadromous migrations, playing an essential role in riverine and ocean ecology, as well as supporting human livelihoods. But many populations are still declining, especially along the southern extent of their North American range.

As the impacts of climate change accelerate, the threats to salmonids in their freshwater habitats are top of mind for resource managers in drought-prone California. But we know less about salmonids' oceanic life phase, due to limitations in the collection and retrieval of data using conventional and acoustic tagging technologies. Without this critical understanding, we are poorly positioned to project how changing ocean conditions and processes will affect salmonids in the future.

Pop-up satellite archival tags have recently enabled Aquarium researchers to track steelhead (*Oncorhynchus mykiss*) movements along the Pacific Coast of North America and transmit temperature, depth and light data to satellites. For the first time, we are able to document steelhead oceanic movements and environmental preferences, providing a more comprehensive understanding of steelhead life history. With MBARI, we are also using environmental DNA to monitor and measure the population abundance of both salmonids and other aquatic fauna. We hope these efforts with NOAA Fisheries will help resource management agencies understand the status and trends of marine resources and define more effective conservation strategies for interconnected coastal ecosystems.

Of Salmon and People: Tending to Nature, Tending Ourselves

Rene Henery, Ph.D., California Science Director, Trout Unlimited

Exploring our ability to recover healthy salmon populations, amidst a rapidly changing world, invites the questions: What do we mean by "recover"? What do we mean by "healthy"? And, how can healing occur? As our collective understanding of salmon species evolves, it continues to reveal the extent to which salmon are reflections of their environment. Their recovery, consequently, hinges on the reconnection and repair of the landscapes, dynamics, and processes they exist within and rely upon. The condition of those landscapes, in turn, reflect the condition of the people who inhabit them, of our individual and collective histories, and of our complex relationships with the environment and each other. Our ability to support the diverse expression, adaptive capacity, and resilience of salmon populations, in this sense, hinges on our individual and collective capacity to express those attributes ourselves. This awareness invites a reorientation in our pursuit of salmon recovery towards a new, broader suite of questions including: How are human relationships in need of healing and repair? How can tending to our own condition support the health of natural systems? And perhaps most importantly, how do we heal?

Approaches for Management and Restoration of Central California Coastal Lagoons

Thursday Afternoon Concurrent Session

Session Coordinator*: Dane K Behrens, Ph.D., P.E., Environmental Science Associates*

Coastal lagoons are a vital part of the California coastline, acting as links in the sediment supply chain that form sandy beaches along the shoreline and as critical habitat for native species. Because of their location, they are frontlines for climate change impacts from both the coastal side (sea-level rise) and from the upstream side (increased runoff variability). Climate change is anticipated to create extensive change to the long-term function and fate of these systems. At the same time, the historical backdrop includes a host of legacy impacts to the hydrograph and sediment supply, as well as development encroachment within the floodplain. While this is the reality for most of coastal California, there is a particular urgency in central California, where a small number of coastal lagoon systems have disproportionate importance as homes for threatened and endangered species, such as the California Central Coast steelhead, California Central Coast Coho salmon, and tidewater goby.

This session will showcase novel approaches for restoration, monitoring, and long-term management that are being developed in central California. Speakers will include restoration practitioners and biologists that will highlight recent efforts to improve habitats, recent advances in monitoring methods and how they are being implemented in the field, and the long-term evolution of planning approaches to meet the challenge of climate change. This session will integrate with site tours of local sites, including the Scotts Creek and Pescadero Creek watersheds.

Considerations for Management of the Mouth State of California's Bar-built Estuaries

Kevin O'Connor, *Moss Landing Marine Labs (Presenter); and Co-authors:* ***John Largier,*** *UC Davis, Bodega Marine Lab and* ***Ross Clark,*** *Central Coast Wetlands Group*

There are numerous small bar-built estuaries (lagoons) along the coast of California that provide important habitat function for endemic species including salmonids listed under the Endangered Species Act (ESA). At many of these estuaries there are ongoing conflicts among landowners, community stakeholders, agencies, and organizations regarding sandbar management and favorable habitat function. More than 25 of these bar-built estuaries are mechanically breached under state and federal permits. Agency staff struggle to determine if, when, and how breaching can occur and how permit conditions can best help to manage the resource and protect the various species and environmental services. The National Marine Fisheries Service (NMFS) and other federal and state agencies currently address these conflicts on a case-by-case basis in response to a proposed breaching action or in response to restoration proposals for individual systems. NMFS West Coast Region provided grant funding to develop considerations for regulatory agencies to improve management, restoration, and protection of coastal lagoons in California when breaching actions are needed. This pilot project has investigated the utility of existing data to document changes in environmental parameters and functions within systems under varying bar management regimes. The report provides an evaluation of how various breaching techniques may affect lagoon species and services and makes recommendations regarding selection of enhanced monitoring strategies that better document changes in the resulting condition. The analysis is intended to better inform future regulatory oversight and support a more consistent, state-wide, science-based approach to management of California lagoons.

Butano Marsh Channel Reconnection and Resilience Project

Jai Singh, *cbec, inc. eco engineering (Presenter); and Co-authors:* ***Kellyx Nelson,*** *San Mateo RCD;* ***Jim Robins,*** *Alnus Ecological; and* ***Chris Hammersmark, Ph.D., P.E.,*** *cbec eco engineering*

This multi-objective project addressed critical fish passage, water quality, and flood risk challenges affecting Butano Creek, Pescadero Marsh, and the surrounding community of Pescadero in unincorporated San Mateo County. Anthropogenic disturbances to the watershed significantly increased sediment delivery to Butano Creek and the Pescadero Marsh. Prior to project implementation, the creek channel was no longer discernible for over a half mile length due to sediment accumulation that had filled the channel to the top of its banks and subsequent establishment of vegetation. The resulting condition was nearly impassable for anadromous fish and other native fish species. These issues were of particular concern for populations of endangered Central California Coast Coho salmon (*Oncorhynchus kisutch*) and threatened Central California Coast Steelhead (*Oncorhynchus mykiss*). Compounding these challenges were the regular development of high levels of anoxia in Butano Marsh which had caused devastating annual fish kills in Pescadero Lagoon during natural breaching events in late fall and early winter. The loss of Butano Creek's conveyance capacity also contributed to chronic flooding of Pescadero Creek Road, disconnecting the town from its main access route and emergency services following even moderate rain events.

While the issues of fish passage, water quality, and flooding have been the source of controversy and enmity across stakeholder groups for decades, the five years leading up to the project saw a tectonic shift in collaboration and cooperation amongst key stakeholders. While this shift can be attributed to myriad factors, several key mechanisms appeared most significant: (1) an RCD-led effort to identify solutions to flooding along Pescadero Creek Road at Butano Creek; (2) scientific research on the mechanisms, drivers, and impact of anoxia on aquatic resources; and (3) a realization that the loss of a defined creek channel through Upper Butano Marsh was a common variable contributing to water quality degradation, lack of escape habitat, and fresh water inflows during episodes of poor water quality, and chronic flooding of the road. Moreover, with significant flooding in the winter of 2017 and documentation of a massive anoxia-driven fish kill in 2016, the planning paradigm shifted from a focus on the risks associated with action to the risks associated with inaction. This shift resulted in a unique opportunity for collaboration among disparate interests in developing an actionable plan to address these long-standing problems.

Project construction was completed in October 2019 and included excavation of accumulated sediment from the Butano Creek stream channel to reestablish fish passage between the estuary and the watershed and to reduce flooding of Pescadero Creek Road during low-magnitude, frequently-occurring flood events. This sediment was beneficially reused to selectively aggrade Butano Marsh, filling in relic ditches, borrow pits, and other man-made low spots that generated anoxic conditions and allowed anoxic water to rapidly drain from the marsh into the lagoon following breaches. These actions restored salmonid access to the watershed's spawning habitat, enhanced refuge during times of poor water quality in the marsh, and ameliorated the conditions that create anoxic water and drive fish kills.

Scott Creek Lagoon and Marsh Restoration Project

Dane Behrens, *ESA, (Presenter); and Co-authors:* ***Jim Robins,*** *Alnus Ecological,*
and ***Lizzy Eichorn,*** *RCD Santa Cruz*

Scott Creek is a small coastal watershed terminating in a perched-bar-built estuary 12 miles northwest of Santa Cruz. The site is critically important for several federally listed threatened and endangered species, including California Central Coast Coho salmon, California Central Coast steelhead, and tidewater goby. The existing Highway 1 Bridge and embankment bisects the lagoon, historically separating the beach from the marsh, and confining the main lagoon channel within a series of training berms. The bridge is at the end of its design life, and will need to be modified to account for the threats of coastal erosion under extreme events and with future sea-level rise. This project provides a unique opportunity to combine a Highway 1 upgrade project with a restoration of the back-barrier lagoon and marsh, and may provide an example of what future sea-level rise adaptation could look like on the Central Coast.

A major innovation of this project is its coordination process with Caltrans and various state, federal, and local resource agencies. Rather than designing the highway upgrades and then identifying impacts to natural resources, this collaborative process has focused on developing a shared understanding of the ecological structures and functions of the lagoon and marsh and then developing designs that restore/enhance the ecosystem. This understanding of the ecosystem and its potential for improved resilience and enhancement has been used to guide design and assessment of the appropriate highway improvements.

A central goal of the Scott Creek Lagoon and Marsh Restoration Project is to support the enhancement of ecological functions and wetland and lagoon habitat quality for native species through restoration of geomorphic processes, while providing for sustainable (long-term and low maintenance) transportation infrastructure. This project is being led by an Integrated Watershed Restoration Panel Technical Advisory Committee (TAC) and is a collaboration between Caltrans, RCD Santa Cruz, ESA, Cal Poly, and a number of public agencies and technical experts.

This talk will showcase a number of experimental approaches used to understand future restored conditions, including time-lapse photography, 2D modeling of a lagoon breach event and creek floods, and sediment chronology to help understand the response of the site to future sea-level rise. The talk will also highlight preliminary aspects of the design that have come from the collaborative approach.

Santa Clara River Estuary Habitat Restoration and Enhancement Project

Chris Hammersmark, *cbec, inc. eco engineering (Presenter); and Co-authors:* ***Mike Podlech,*** *Podlech Environmental Consulting and* ***Mike Josselyn,*** *WRA, Inc.*

Located at the base of the 1,623 square mile Santa Clara River watershed and nestled between Oxnard and Ventura, the Santa Clara River Estuary and surrounding areas provide habitat for several endangered species, including Southern California steelhead, tidewater goby, western snowy plover, and California least tern. Adjacent to the estuary is the McGrath State Beach Campground, which at times is inundated and closed due to high water levels in the estuary resulting from effluent discharged from the Ventura Water Reclamation Facility. This project examined the feasibility of restoration and/or enhancement actions to the Santa Clara River Estuary, particularly within the 25-acre area currently occupied by the campground, which would be relocated further to the south. Through an open and collaborative stakeholder brainstorming process, two alternatives were developed and refined. In the development of alternatives and consideration of the needs of the native biota, a variety of habitat types including tidal slough and marsh complexes, fluvial side channels, seasonally inundated floodplains, open water lagoon, and back dunes were considered. The alternatives and subsequent iterations of the alternatives were evaluated with multi-dimensional hydrodynamic, sediment transport, circulation, temperature, and habitat suitability models. Conditions evaluated included various flood events, open berm tidally dominated conditions, as well as closed berm conditions. Following the initial alternative evaluation and refinement, a preferred alternative was selected and a set of 30% complete construction plans was developed. At present, design and hydrodynamic modeling are underway to inform the design of the relocated campground, while additional funding is pursued in order to complete the planning, design, permitting, and implementation phases of the restoration and campground relocation project.

Logging, Leather, Lime, and "Lost Boys"— Reducing Limiting Factors for Anadromous Salmonids in the San Lorenzo River Lagoon, Santa Cruz County

Chris Berry, *City of Santa Cruz Water Department (Presenter); and Co-authors:* ***Shawn Chartrand,*** *Balance Hydrologics;* ***David Revell,*** *Revell Coastal;* ***Jeff Hagar,*** *Hagar Environmental Science; and* ***Scott Ruble,*** *City of Santa Cruz Public Works Department*

The San Lorenzo River watershed has a long history of anthropogenic influence as well as the distinction of formerly being one of the healthiest anadromous salmonid fisheries south of San Francisco. While significant water development from the watershed goes back to the mission days of the late 1700s, the post-Gold Rush era was characterized by substantial land use and water development activities that substantially impacted the watershed. During the latter half of the 20th century, the growth of upper watershed communities, legacy impacts of 19th century land uses, and flood control activities in the lower watershed have also strongly influenced the watershed's ability to support Coho and steelhead populations due to channel simplification, water diversion, groundwater overdraft, riparian vegetation removal, streambed sedimentation, water quality degradation, and related issues.

However, flood control planning for the lower San Lorenzo River and lagoon was among the first in the state to include requirements for retention of riparian vegetation and recommended instream flows for the protection of anadromous salmonid rearing and other beneficial uses of water. In recent years, the City of Santa Cruz (in partnership with the California Department of Wildlife and the National Marine Fisheries Service) has developed and implemented instream flows which are substantially higher than have been present historically and which directly benefit the lower San Lorenzo River and lagoon functions. Greater effort has also gone into management of the sandbar at the mouth of the San Lorenzo River recently and plans are currently underway for installation of a water level control structure that will provide greater lagoon stability and enable further improvement of the habitat there. These management actions have been informed by a long-term water quality and fisheries monitoring program that is amongst the most robust of California coastal lagoon monitoring programs.

Concurrent with this work, the City has also partnered with numerous community groups on a variety of activities ranging from invasive plant removal to regional water supply planning. These activities aim toward improving the overall conditions of the watershed—understanding that a well-aligned, watershed-wide restoration effort is necessary in order to provide conditions for anadromous salmonid recovery success as well as protection of other beneficial uses. This effort will not only benefit anadromous salmonid rearing in the San Lorenzo River lagoon but also protect other important beneficial uses such as municipal water supply and recreation from headwater tributaries near Skyline all the way to the San Lorenzo River lagoon where the river enters the Pacific Ocean at the Monterey Bay National Marine Sanctuary.

With a long-term commitment to fisheries conservation, including dedicated funding for monitoring and restoration ultimately being enabled by the City of Santa Cruz Anadromous Salmonid Habitat Conservation Plan, science-based management of the San Lorenzo River and its lagoon will be supported into the future—providing hope that the river may once again reclaim its position as one of the state's most important anadromous salmonid watersheds.

Balancing Flood Risk and Habitat Enhancement on the San Lorenzo River Estuary

Ben Snyder, P.E., WRA Environmental Consultants

Repeated flooding of the City of Santa Cruz, built in the former estuary and floodplain of the lower San Lorenzo River, led to the construction of a flood damage reduction project by the U.S. Army Corps of Engineers in 1959. Excessive sedimentation and maintenance costs led to redesign and reauthorization of the original project. The Corps and the City raised the levees, constructed floodwalls, replaced bridges, and implemented aquatic and riparian habitat enhancements from 1999 to 2004 (USACE, 2014). A flood risk performance evaluation was prepared by the Corps in 2014, taking into account the potential for bed degradation and aggradation, uncertainty in bed geometry, channel roughness, downstream boundary condition, and long-term sea level rise. The Corps concluded that the estuary and transitional reaches have considerably greater freeboard and greater assurance of containing the 1% annual chance event than required by FEMA for levee accreditation under the National Flood Insurance Program (Performance Evaluation for the San Lorenzo River Flood Damage Reduction Project, USACE, 2014). This represents a truly golden opportunity for salmonid habitat restoration in the Lower San Lorenzo. Central California Coast Coho salmon have been nearly extirpated from the San Lorenzo River in Santa Cruz, CA (Recovery Plan for the Evolutionarily Significant Unit Central California Coast Coho salmon, NOAA Fisheries, 2012). Over 80% of the historic extent of the San Lorenzo River estuary has been lost due to urbanization and levee construction. Restoration of cover, large wood structures, and scour pools have been identified as action items in the species recovery plan (NOAA 2012). We provide an overview of the mobile boundary hydraulics, sediment transport, and risk analysis used in the Corps study and present a conceptual design for enhancement of the San Lorenzo River estuary using large wood structures that could be implemented while still providing flood risk reduction to the City of Santa Cruz consistent with the project's original intent.

Lagoon Management of the San Lorenzo River, Santa Cruz California: Using Sand to Balance Ecological Function and Social Demands

David Revell, Ph.D., Revell Coastal

The City of Santa Cruz faces substantial challenges managing the mouth of the bar built estuary on the San Lorenzo River. The river and lagoon support sensitive species including steelhead, Coho salmon, and tidewater goby which rely on the seasonal opening and closure dynamics as a critical part of their life cycle. Aside from water quality concerns, the nearby federal historic landmark—the Santa Cruz Beach Boardwalk amusement park, low lying neighborhoods, and the City's central business district face flooding hazards even during droughts when the barrier beach closes and lagoon waters rise. The barrier beach, Main Beach, is one of the busiest in Central and Northern California, receiving tens of thousands of visitors on a busy summer weekend. With a high wave exposure, lifeguards are frequently dealing with multiple life safety incidents, including broken backs, drownings, and hypothermia.

In 2014, the City of Santa Cruz started managing this lagoon and river mouth to balance all of these competing objectives. This presentation will briefly discuss the competing objectives, regulatory complexities, historical evolution of the lagoon, with specific focus on the last five summers of lagoon mouth management to balance the competing flooding, life safety, and natural resource objectives. Varying levels of watershed discharge, wave conditions, and river morphology have provided a wide range of challenges and experiences in managing this heavily monitored bar-built estuary for sensitive species. Lessons learned from sand management activities, temporary outlet channels, low flow berm-crest notches, and pipe experiments will be shared to support others in lagoon management in California and around the country.

Understanding Historical Context to Inform Current Salmonid Recovery Planning

Thursday Afternoon Concurrent Session

Session Coordinator: ***Jay Stallman,*** *Stillwater Sciences*

Aquatic habitat restoration projects typically require a historical perspective to help elucidate unimpaired conditions, the type and effects of past disturbance, and system trajectory. Providing historical context is an essential early step in developing restoration goals, objectives, and appropriate design approaches. Historical context also provides a common reference for landowners, resource agencies, and other stakeholders to determine what conditions are attainable and sustainable within existing constraints. While many types of historical analyses commonly apply to landscape-level changes in physical habitat, the concept of historical ecology equally applies to understanding bottlenecks in salmon and steelhead population dynamics and shifts in the life history strategies of these species resulting from habitat degradation and other stressors. The session will focus on key components of historical analysis, approaches appropriate to different settings, and applications to fisheries habitat restoration planning and design.

What Ancient Salmon Bones Can Teach Us About Recovering California's Salmon Populations

Malte Willmes, *UC Santa Cruz, Institute of Marine Sciences (Presenter); and Co-authors:* ***Rachel Johnson, Ph.D.,*** *NOAA Fisheries and UC Davis;* ***Anna Sturrock,*** *National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center;* ***Jeff Rosenthal,*** *Far Western Anthropological Research Group;* ***Jelmer Eerkens,*** *UC Davis Department of Anthropology;* ***Lewi S. Levis*** *and* ***James A. Hobbs,*** *UC Davis Department of Wildlife, Fish, & Conservation Biology*

Chinook salmon *(Oncorhynchus tshawytscha)* populations in California are in decline due to the combined effects of habitat degradation, water diversions, and shifting climate regimes. Conservation and management of Chinook is dependent on our understanding of their life history variability and their ability to adapt to future changes. Surveys and geochemical tools have provided crucial insights for modern salmon populations in California. However, these data were collected only after significant population declines and extirpation from a large fraction of historic habitat had occurred. Here we contrast our findings from modern (2002-2010, n=755) and historic (~1840 CE, n=49) salmon otoliths (fish ear stones) from the lower Feather River. Specifically, we investigated the age and size of fall-run Chinook and reconstructed natal origins and rearing habitat utilization using strontium isotope ratios (87Sr/86Sr). Modern wild spawned Chinook on the Feather River showed generally younger and more truncated ages (age-2 and age-3 dominated), while their historic counterparts showed generally older ages (age-3 and age-4 dominated) and a wider age distribution. In modern salmon we identified a significant shift from wild-spawned to hatchery-origin fish on the lower Feather River, after the stock collapse in 2008-2009, indicating that the population recovery in 2010-2012 was largely driven by hatchery fish. For the historic Chinook we identify natal origins and rearing habitats that suggest that a diverse range of habitats were used and that variable life history strategies were successful on the lower Feather River just prior to the gold-rush period (~1848-1855). This study presents the first step at unlocking the potential of historic fish bones to better understand salmon populations in California's past and to apply this knowledge for future salmon conservation, management, and recovery.

Yuba River Salmon Impacted Since the Gold Rush: An Analysis to Modify Aging Infrastructure, Restore Volitional Passage and Remove Mercury from the Aquatic Environment

Carrie Monohan, Ph.D., *The Sierra Fund and California State University Chico (Presenter); and Co-author:* ***Allan James, Ph.D.****, University of South Carolina*

The Yuba River was one of the most extensively hydraulically mined watersheds on earth. The use of hydraulic mines was developed in this watershed prior to any regulation on the industry and the impacts were devastating and are still the number one cause of ongoing degradation. The Yuba River, a 1,345 square mile watershed, has 80 significant (>5 acres) hydraulic mines totaling over 8,000 acres. The largest hydraulic mine in the watershed is Malakoff Diggins which releases a ton of suspended sediment each year, almost half of which is delivered during one or two large storm events. With this suspended sediment comes the associated particulate bound mercury which was brought over from the coast range and used in both hard rock and hydraulic mining operations. Of the 26 million pounds of mercury brought to the Sierra Nevada, 10-30% was lost to the environment and remains a threat to public health through sport fish consumption to this day. The largest ongoing impact to the fish are the debris control dams that were built to hold back hydraulic mining debris after the Sawyer Decision of 1884. The Sawyer Decision is often cited as the first environmental regulation in California's history and the debris control dam is the reason that fish can no longer reach their natal waters in the Yuba River. The largest debris control dam that was built was Englebright, which was built by the California Debris Commission in 1941 so that hydraulic mining could resume after WWII. Englebright is blocking spring run and fall run Chinook from 60-150 miles of habitat. The Yuba River was designated as critical habitat for spring run Chinook by NOAA fisheries in 2012. There are currently 23 million cubic yards of sediment behind Englebright. An engineering evaluation and analysis to lower Engleblight to 460ft elevation would allow for a 1,500 ft. fish ladder to be constructed and still allow the local water agency to use it as an afterbay for the larger New Bullard's Bar Reservoir. Lowering Englebright would expose the sediment deposit in the upper reaches of the reservoir and allow for removal of the sediment from the aquatic habitat. The cost of doing nothing has reached a tipping point, not just for the salmon, but for the infrastructure as well. If nothing is done Englebright will fill up and lose all capacity to retain flows in less than 200 years, and the recovery of salmon runs returning to the Yuba watershed may cease to be viable much sooner than that.

Novel Physical Evidence of the Historical Nativity of Chinook Salmon (*Oncorhynchus tshawytscha*) in the Guadalupe River Watershed of Santa Clara County, California

Richard B. Lanman, M.D.*, Guadalupe-Coyote Resource Conservation District and Institute for Historical Ecology (Presenter); and Co-authors:* ***Linda Hylkema, M.A.****, RPA, Santa Clara University;* ***Cristie M. Boone, Ph.D.****, Albion Environmental, Inc.;* ***Brian Allée, Ph.D.****, South Bay Clean Creeks Coalition;* ***Roger O. Castillo****, Salmon and Steelhead Restoration Group, Inc.;* ***Stephanie A. Moreno, B.A.****, Guadalupe-Coyote Resource Conservation District;* ***Mary Faith Flores****, University of Oklahoma;* ***Upuli DeSilva****, University of Oklahoma;* ***Brittany Bingham, B.S.****, Department of Anthropology, University of Oklahoma; and* ***Brian M. Kemp, Ph.D.****, Department of Anthropology, University of Oklahoma*

Chinook salmon spawning runs peak every November-December in the Guadalupe River mainstem and its primary tributaries, Los Gatos and Alamitos Creeks. These runs approached 1,000 adult fish in the late 1990s but were nearly extirpated after major anthropomorphic alterations to the mainstem to mitigate flooding in the early 2000s constructed by the Army Corps of Engineers and Santa Clara Valley Water District. Historical observer records of salmon spawning in the creek may not be reliable as large steelhead trout (*Oncorhynchus mykiss*) have always been extant and may be confused with salmon. Although initial mitochondrial DNA studies of salmon carcasses in the 1990s found haplotypes consistent with both Central Valley fall-run Chinook (CV) and Russian River Chinook, later studies using more extensive microsatellite DNA analysis suggest that the salmon are most likely hatchery strays from the CV stocks. The size of the runs until the late 20th century and their continued persistence in the last several years, despite extreme drought conditions, suggest that the Guadalupe River watershed may provide suitable spawning and rearing habitat for Chinook salmon, raising the question as to whether they were historically native. We utilized ancient DNA sequencing of salmonid vertebrae identified by ichthyozooarchaeological analysis of excavations at the historic Mission Santa Clara to answer this question.

Archaeological excavation of the Native American Rancheria associated with Mission Santa Clara de Asís was conducted by Albion Environmental and Santa Clara University from 2012-2013. The study site was situated within 2.5 km of the Guadalupe River mainstem, likely along its Mission Creek tributary in Santa Clara County, California, and dates from 1781 to the 1850-60's. Ancient DNA extracted from 55 vertebrae samples identified as salmonids were sequenced at the Laboratories of Molecular Anthropology and Microbiome Research (LMAMR) Ancient Lab at the University of Oklahoma to resolve specific *Oncorhynchus* species type.

Fish remains were analyzed from multiple projects, reaching 17,288 total identifiable fish specimens (NISP). Freshwater fishes comprised 79-95% of the assemblages based on NISP, with the majority of remaining specimens representing indeterminate freshwater/euryhaline species. Less than 1% of specimens were from marine fishes. To date 52 specimens are confirmed rainbow/steelhead and 3 specimens are confirmed Chinook salmon.

This study provides the first physical evidence that Chinook salmon were historically native to the Guadalupe River watershed, the southernmost major metropolitan area hosting salmon runs in the United States. Nativity to the watershed is consistent with apparent habitat suitability and persistence of salmon spawning runs, despite recent extreme drought years and major flood control-related concretization of the river

Years in Their Ears: What do Fish Earbones Tell Us About Spring-run Chinook Salmon Success?

Flora Cordoleani, Ph.D., *UC Santa Cruz and NOAA Fisheries (Presenter); and Co-author:* ***Corey Phillis, Ph.D.***, *Metropolitan Water District;* ***Anna Sturrock, Ph.D.***, *UC Davis;* ***George Whitman***, *UC Davis; and* ***Rachel Johnson, Ph.D.***, *NOAA Fisheries and UC Davis*

The Central Valley spring-run Chinook (CVSC) Environmentally Significant Unit (ESU) was once a major component of the annual salmon runs and occupied the headwaters of all major Central Valley river systems where natural barriers were absent. Now self-sustaining CVSC populations persist only in three tributaries of the Sacramento River: Mill, Deer, and Butte creeks, and the ESU is listed as threatened under the federal Endangered Species Act. One of the objectives of the Southwest Fisheries Science Center is to identify the management actions that could help recover the ESU.

Life history diversity is thought to buffer salmon populations to environmental variability, such as drought and poor ocean conditions, resulting in greater stability of the population or stock through time. CVSC express unique juvenile rearing plasticity characterized by a wide range of size, timing, and age at which they outmigrate from their natal tributaries and to the ocean. However, describing the relative success of these life history strategies under different environmental conditions is challenging because so few juveniles are captured, marked, and recovered as adults. To further describe the juvenile life history diversity in CVSC we used strontium isotopes to reconstruct the juvenile life-history strategies from adult otoliths collected in Mill, Deer, and Butte creeks between 2003 and 2018. The goal was to identify 1) the successful life-history types within the CVCS populations and among years, and 2) potential factors that might influence the expression of a given life history type.

We identify three distinct juvenile life-history types among successful spawners in Mill and Deer creeks characterized by their early-, intermediate-, or late-outmigration strategy from their natal stream. Among Butte Creek spawners, however, only early- and intermediate-outmigrants were observed. In all three populations the relative contribution of each life-history strategy varied between years, perhaps due to variable selection pressures in the freshwater or marine environment. Additionally, we found evidence that an individual's outmigration strategy was correlated with growth in the weeks following exogenous feeding. Our findings are a necessary step toward identifying the management strategies that will protect and promote expression of life-history diversity that contributes to population recovery and stability in California's variable environment.

Using Historical Context to Understand Altered Watershed Processes and Appropriate Restoration in Salmonid Habitat Restoration Prioritization (SHaRP)

Chris Loomis *and* ***Seth Ricker,*** *California Department of Fish and Wildlife*

Within the collaborative Salmonid Habitat Restoration Prioritization (SHaRP) planning process, we use a watershed's history to guide the development of watershed restoration plans that aim to reinstate habitat-forming processes. The SHaRP planning process, currently underway in tributaries of the South Fork of the Eel River, incorporates the human history of a watershed along with all the available watershed data, expert opinion, and scientific literature into a restoration plan to form a conceptual model of the relative state and trajectory of watershed processes affecting fish habitat. Drawing upon the collective knowledge of agencies, researchers, restoration practitioners, watershed residents, and landowners, we seek to understand how salmonid spawning and rearing habitat has degraded through time as a result of land use and disturbance and provide recommendations to change the trajectory of that habitat. Historical data on fish ecology and population dynamics is generally less available, but by constructing a complementary conceptual life history model that corresponds in space and time to salmonid habitat requirements within a watershed, the SHaRP process intends to address limiting habitat factors in the context of dynamic watershed process. Perspectives gained from historical fisheries data are also motivating the downstream migration of the SHaRP planning process. Comparing contemporary tributary smolt production to historical counts of returning adult Coho salmon suggest that tributary production alone will not likely meet restoration recovery criteria. Using our knowledge of Coho salmon habitat use and movement through other watersheds as a model, we hope to understand juvenile Coho salmon habitat use of mainstem habitats, including the South Fork Eel River and the Eel River estuary, and the implications for restoring salmon populations closer to historical counts.

Understanding Patterns and Processes That Supported Salmon in the Sacramento-San Joaquin Delta Historically

April Robinson, *San Francisco Estuary Institute (Presenter); and Co-authors:* ***Alison Whipple, Letitia Grenier,*** *and* ***Robin Grossinger,*** *San Francisco Estuary Institute*

The Sacramento-San Joaquin Delta is a highly modified system that has undergone large-scale transformation from landscapes dominated by wetlands to those dominated by agriculture. This loss of wetland habitats—freshwater emergent wetlands, willow-fern swamps, networks of small tidal channels—is an overriding stressor in the Delta ecosystem. As wetland habitats were lost, alongside increasing flow alteration, degrading water quality, and introduced invasive species, the ability of the Delta to provide essential habitat for migrating salmon declined dramatically. Understanding how the Delta functioned historically can provide valuable insights for how restoration and conservation can increase support for salmon and other species. Improving this understanding was the goal of the Sacramento-San Joaquin Delta historical ecology study, completed by San Francisco Estuary Institute (SFEI) in collaboration with the CA Department of Fish and Wildlife. The study used GIS and conceptual models to piece together numerous disparate historical sources (e.g., maps, textual accounts, photographs) to reconstruct the patterns and character of the Delta's habitat types and to document associated physical processes. Historical Delta landscapes were complex and dynamic and reflected broad physical gradients and landforms. These landscapes offered abundant food resources and opportunities for salmon to meet life history needs. This heterogeneity meant that the Delta could provide valuable habitat across a wide range of variability in the timing and location of salmon rearing and migration in the Delta.

Building on this historical ecology work, SFEI has quantified landscape metrics to capture aspects of the historical landscape that were important for supporting salmon, other species, and ecological functions. These metrics include flooding patterns, proportion of wetlands, riparian adjacency, and channel characteristics. Metric evaluation provides a more defined description of change in conditions and can be used to help develop goals and expectations for rehabilitating functional Delta habitats. Given the nature and scale of the historical transformation, as well as expected future changes such as climate change, the goal is not to recreate the Delta of the past. Rather, the objective is to understand how we can re-establish or mimic certain natural processes, in an altered system, in order to provide desirable ecological function now and into the future.

Legacy Effects of Timber Harvesting on Salmonid Habitat at Caspar Creek and Avenues for Improving Habitat During Future Timber Harvests

Paul Richardson, Postdoctoral Fellow, *USDA Forest Service Pacific Southwest Research Station (PSW) (Presenter); and Co-authors:* ***Diane Sutherland,*** *Geomorphologist, USDA Forest Service PSW;* ***Joe Wagenbrenner,*** *Research Hydrologist, USDA Forest Service PSW; and* ***Sue Hilton,*** *Hydrologist (retired), USDA Forest Service PSW*

Most forests in the United States have been logged, often multiple times. Consequently, these prior timber harvests have dramatically altered channel morphology and habitat. There is a strong need to understand the consequences of prior timber harvesting and to continue refining best management practices to restore salmonid habitat. At Caspar Creek, located in the Jackson Demonstration State Forest in northern California, downed wood and stumps in or near channels were often removed to aid floating cut old-growth logs to mills during splash dam releases before ~1905. Removal of wood led to decreased channel morphological complexity that negatively impacted salmonid habitat. In addition, old-growth logging contributed to channel incision, terrace development, and substantial gullying which produced headcuts that are still prevalent and can limit fish passage. With this timber harvesting legacy and almost 60 years of monitoring, the Caspar Creek Experimental Watersheds are excellent sites for assessing the consequences of timber harvest and developing and testing best management practices. Here we focus on how large downed wood and bed load transport have influenced stream habitat. Experimental timber harvesting occurred in the South Fork catchment from 1971 to 1973 and then in the North Fork catchment from 1985 to 1992. The quantity of in-channel wood in the North Fork remained low following old-growth logging until the 1990s when a series of blowdowns along recently exposed buffer strips dramatically increased the amount of downed wood in the North Fork channel. This created a fortuitous, semi-natural experiment to investigate the consequences of increasing the quantity of in-channel wood. To aid this investigation, we reconstructed an annual record of bed load yields for the North Fork catchment from 1962 to 2017. We compared these yields to annual bed load yields predicted by a bed load transport model to identify major departures between the predicted and reconstructed yields. We found that decreased bed load yields, which are associated with gravel aggradation along the North Fork main stem, occurred shortly after the blowdowns occurred. The aggradation is likely the direct consequence of increased in-channel wood and new in-channel storage space created by logjams. The quantity of wood has remained stable following the last of the major blowdowns in 1995. Ultimately, the blowdowns led to gravel aggradation and the development of pools and logjams, which increased channel habitat complexity along the North Fork. Continued monitoring of in-channel wood is necessary to fully assess the long-term consequences of the blowdowns on stream habitat and the mass balance of in-channel wood, which is controlled by the input rate of new in-channel wood relative to the rate of physical weathering, decay, and downstream transport of existing in-channel wood. The results of this semi-natural experiment suggest that adding large wood to channels during timber harvests may improve salmonid habitat and help restore channels to conditions that existed prior to old-growth logging.

Sediment: Management Challenges and the Foundation of Habitat

Thursday Afternoon Concurrent Session

Session Coordinators***: Eric Ginny,*** *Environmental Science Associates*
and ***Brian Cluer,*** *NOAA Fisheries*

Fine sediment is a critical component of the river ecosystem; important for sustaining key riparian regeneration processes, maintaining soil moisture and water table; holding, processing and delivering nutrients; and many other processes vital to a functioning ecosystem. In dam-impaired systems its role is highly overlooked and even misunderstood. On restoration projects, the fear of "muddying the waters" has often led to increased regulatory requirements for in-water work and monitoring, leading to sometimes exorbitant added costs without a clear linkage to benefits. Thus the regulation of sediment hinders the restoration of better ecosystem function. This session explores the role of fine sediment in foundation ecosystem processes and examines the regulation of turbidity (a proxy for fine sediment entrainment into the water column) on restoration projects. The tradeoffs and costs-benefits of omitting fine sediment in restoration projects and similar requirements for in-water work and monitoring will be explored through case study scenarios and a panel discussion.

Implementation of the Yuba River Canyon Salmon Habitat Restoration Project—Water Quality Permitting Challenges, Constraints, and Utility

Justin Gragg, *Environmental Science Associates (Presenter);*
and Co-author: ***Eric Ginney,*** *Environmental Science Associates*

Fine sediment is rarely explicitly considered or incorporated into salmonid river restoration projects and, to the contrary, is often discouraged by means of often abstract water quality or other permitting requirements. As a result, the actual impacts of fine sediment are seldom weighed against either potential benefits or in the context of existing background conditions. By nature, many river restoration projects involve a substantial amount of in-water work with large equipment and the cost of full compliance with existing water quality and permitting requirements is not measured in the context of the actual benefit of compliance, which we argue may not be well understood or rationalized. Further, such projects are already typically highly constrained by seasonal work-window limitations which, again, are not factored in or "discounted" from the day-to-day water quality permit requirements. Without site- or system-specific context, and/or more specific temporal and spatial components to the criteria (e.g., duration of water quality exceedance, location of measurement with regards to hydraulics), there is no clear basis for the "benefits" of regulatory measures and subsequently no real basis for the additional cost of compliance. We present a case-study based on sediment and water quality data collected during construction of a spawning habitat restoration project on the Lower Yuba River, just downstream of Englebright Dam, during the summer of 2018. Englebright Dam, completed in 1941 with the purpose of eliminating the downstream transport of hydraulic mining debris, completely cutoff the supply of gravel to the Lower Yuba River and substantially reduced the supply of finer sediment (e.g., sand and silt). Our project involved the excavation (degrading) and sorting of material from a highly armored bar and placement of material within the river for spawning riffle construction at concurrently widened sections. We discuss the rationale and implications of water quality regulations in the context of our project and the potential benefits and assumed impacts of fine sediment. For example, under natural conditions we would expect recruitment and storage of fine sediment to be important for long-term viability of vegetation on areas of the bar and river banks. Further, downstream of the hydraulic mining-impacted areas of the Sierra Nevada, the presence of mercury contaminated sediment seems almost ubiquitous and, we suggest, that context must also be considered in asserting the utility of water quality permitting requirements. We suggest our case study, and those like it, illuminate bigger picture challenges associated with incorporating fine sediment into restoration design and implementation, and we consider an alternative water quality permitting framework for similar river restoration projects.

Blue River Fish Barrier: 2D Numerical Hydraulic and Sediment Transport Modeling

Caroline Ubing, M.S., P.E. *and* ***Michael Sixta, M.S., P.E.,*** *U.S. Bureau of Reclamation, Denver, CO (Co-Presenters)*

Steady-state two-dimensional (2D) numerical hydraulic and sediment transport modeling simulations were performed on a fish barrier located on the Blue River, approximately 0.5 miles upstream of its confluence with the San Francisco River in east central Arizona. The fish barrier structure and downstream jetty were constructed in 2012 to prevent upstream movement of non-native fish. In September of 2013, a large storm event deposited approximately 2.3 feet (ft.) of sediment on the structure's apron on river left, potentially allowing upstream migration of non-native species. To prevent upstream passage and the impact of future sediment deposition, four alternatives were analyzed: 1) no action, 2) remove jetty, 3) increase the entire barrier height by 4 ft., and 4) increase a portion of barrier height upstream of the current depositional area by 4 ft. The objective of the numerical modeling was to evaluate if the hydraulic conditions at the structure prevent upstream movement of non-native fish species and the sediment aggradation and degradation upstream, at, and downstream of the structure. The numerical model applied to this study was SRH-2D, a 2D mobile bed hydraulics and sediment transport model for river systems (Lai, 2008).

Each alternative was analyzed to determine if it is a physical barrier (drop in bed elevation of 4 ft. or depths < 0.25 ft.) or a velocity barrier (magnitude > 6 ft./s across the barrier). Assuming a stationary bed, upstream fish passage is possible under the "no action" alternative during the 2-yr. and 5-yr. flood events. Removing the jetty (Alternative 2) only allowed upstream movement during the 2-yr. flow event. The mobile bed analysis evaluated structure stability and depositional potential downstream and at the structure. Model results show a depositional feature forms downstream of the structure along the right bank for all alternatives, with the greatest deposition occurring during the 2-yr. event. The hydraulic conditions surrounding the fish barrier were again analyzed to determine if there is a physical/velocity barrier to prevent upstream movement of non-native fish species after maximum deposition. Model results show that Alternative 3, a 4-ft. increase over the entire barrier length, was the only alternative that maintained a physical or velocity barrier for all flow events.

Mobile-bed sediment transport modeling is subject to several uncertainties associated with the incoming sediment load, the sediment transport equation(s) applied, and other model parameters. The evaluated sediment transport capacity methods include: Parker's (1990) bed load transport equation; Wilcock and Crowe's (W/C; 2003) bed load transport equation; Wu (2000) total load sediment transport equation; and Parker's (1990) bed load transport equation applied to gravel and larger particles combined with Engelund and Hansen (E/H; 1967)'s transport equation for sand. Results indicate that erosion can range from 0.1 to 2.8 ft., while deposition ranged from 0.1 to 2.0 ft. The Parker (1990) transport equation produced the lowest range in erosion and depositional values, while the Wu (2000) equation produced the largest range in values.

Assessing the Effectiveness of Restoration in Changing Sediment Deposition Patterns on Floodplains

Preston Brown, ***Salmon Protection and Watershed Network***

Exceedingly high levels of fine sediments in the bedload of salmonid streams cause problems for egg survival, benthic macro-invertebrate production, and can lead to redd scour. For decades addressing the sources of fine sediments has been the focus of much work to improve water quality and reduce fine sediment loading. These efforts have attempted to reduce the volume of fine sediment runoff from relic timber roads, urban and agricultural runoff, and other ground disturbances- particularly in headwater drainages. While addressing the sources of excessive fine sediment runoff can be worthwhile, another component of addressing excess fine sediments in salmonid streams has been overlooked. That is the role depositional zones play in metering, sorting, and attenuating fine sediments. Only in recent years has a shift in managing excess fine sediments begun to utilize floodplains as a mechanism to mitigate and manage the level of fine sediments in the watershed.

Like many coastal drainages, Lagunitas Creek, Marin County, continues to suffer from impacts of excess fine sediment runoff. Channel incision caused by dams, rural development, and unmaintained dirt roads are the primary drivers of fine sediment loading in the watershed. In an effort to mitigate the impacts from fine sediment loading, the Lagunitas Sediment Total Maximum Daily Load (TMDL) implementation plan calls for the creation and enhancement of floodplain habitats and installation of large woody debris to help sort, meter, and attenuate fine sediments through the watershed.

Recent projects on Lagunitas Creek have aimed to address the problem of excess fine sediment loading through means of floodplain creation and reconnection. Restoration projects that have created multi-stage alluvial channels, undulant topography, and large woody debris structures have shown promising results in metering, sorting, and attenuating sediments through the riparian corridor.

Results of these project have demonstrated accumulations of enormous volumes of fine sediments being deposited on floodplains, while course sediment sorting and metering have resulted in expansive channel bar formation and retention of coarse bedload.

These projects have demonstrated that managing fine sediments in a watershed should include improving the function of floodplains as depositional zones where sediments can naturally sort and attenuate. Many alluvial valleys no longer perform this function, yet headwater streams will continue to produce sediments. Therefore, when managing fine sediments in a watershed, it's important to shift the focus away from a source-only perspective to include enhancing the function and performance of depositional floodplain zones.

Not Just a Steelhead Passage Project: Removal of the Upper York Creek Dam for Restoration of Sediment Transport After Over 100 Years of Aggradation

Jenn Hyman, P.E., *Director of Engineering, EKI Environment & Water Inc. (Presenter); and Co-authors:* ***Erica Ahmann Smithies, P.E.,*** *Director of Public Works, City of St. Helena; and* ***Brian Bartell,*** *Restoration Designer, WRA*

The City of St. Helena's (City's) Upper York Creek Dam is an earthen dam 140 feet wide and 50 feet tall and is a total barrier to fish passage. The dam is completely filled in with sediment that has accumulated behind the dam for over 100 years. The presence of the dam and lack of sediment has caused incising of the creek bed downstream and associated bank instabilities. York Creek is one of the most significant spawning and rearing streams in the Napa River watershed for Central California Coast ESU steelhead. Removal of the dam, currently scheduled for the fall of 2020, is expected to open up about 1.5 miles of steelhead spawning habitat upstream of the dam and improve habitat in reaches below the dam by reintroducing sediment sufficient for spawning.

The Upper York Creek Dam Removal Project has been in the planning stages for about 15 years and is currently on track for implementation in the fall of 2020. Like many complex and expensive projects, this one has been stalled over the years due to personnel and consultant changes. It is interesting to compare the evolution of the design approach for the dam removal project, starting in 2005, when the first designs were prepared, to today (2019), when new updated plans are in preparation.

65% design documents prepared by Prunuske Chatham Inc. (2006) called for the removal of nearly all of the dam material and aggraded sediment. As was the state of the art at the time, the creek restoration was heavily engineered with nearly the entire 1200 ft. length channel sinuous and lined with imported boulders and logs for creation of step pools and weirs. The landscape restoration plan called for the planting of many trees.

The updated design in preparation this year by WRA takes a regenerative approach intended to keep sediment in the watershed and allow nature to guide the evolution of the creek's morphology. Sediment will be allowed to be washed downstream and accumulate with the help of wood structures placed downstream of the dam, where the creek has been starved of sediment over the last century. Trees will be allowed to revegetate naturally. There are advantages to the more natural approach in terms of lower cost and complexity. The disadvantage is that it relies on a heavy storm or storms to create the new creek channel and floodplain, with associated high levels of turbidity, which the permitting agencies acknowledge may be detrimental to steelhead. Long-term monitoring and adaptive management are required to confirm that project goals will be met.

Sediment, Dam Removals, and Other Restoration Projects: Issues & Challenges

Eric Ginney, *Environmental Science Associates (Presenter)*
and Co-author: ***Justin Gragg,*** *Environmental Science Associates*

From time immemorial, the Klamath Tribes have inhabited the upper Klamath River watershed. Early Euro-American accounts describe these peoples as primarily dependent on fishing, rather than hunting, with the harvest of ocean-going salmon in the Klamath River a prominent part of tribal culture and subsistence. In April 2016, stakeholders signed an amended Klamath Hydroelectric Settlement Agreement that asked the Federal Energy Regulatory Commission to order the decommissioning of the lower four dams on the Klamath River and restore salmon migration to their historical habitat. Presently, the Klamath River Renewal Corporation (KRRC) is part of the cooperative effort to re-establish the natural vitality of the Klamath River so that it can support all communities in the basin. KRRC's job is to take ownership of four PacifiCorp dams—JC Boyle, Copco, No. 1 & 2, and Iron Gate—and then remove these dams, restore formerly inundated lands, and implement required mitigation measures.

Reservoir sediments (~15 million cubic yards) are approximately 85% silt, clay, and organic material that is 80 to 90% water by volume and highly erodible. The remaining material is mostly sand with a relatively small amount of gravel, with concentrations in tributary arms considered important for salmonids after dam removal.

Dam removal assumes simultaneous drawdown of all reservoirs and the erosion of impounded sediment by the river and tributaries for downstream transport. Silt and clay will be quickly mobilized during drawdown and transported downstream in suspension, temporarily impacting water quality. Most of the fine sediment will be eroded and transported to the Pacific Ocean during the period of concurrent drawdown of the four dams which will last from January 1 to mid-March of the year of drawdown. Downstream effects on the river's morphology and habitat are anticipated to be limited, with deposition of coarser sediment expected to primarily occur between the reservoirs and the confluence of the Shasta River. Sediment transport from dam removal would not be expected to have a significant effect on the bed downstream of Shasta River.

Residual sediment after drawdown in the footprints of the former reservoirs is the focus of this presentation. Within those areas it is assumed that the Klamath River would most likely re-occupy its historical active channel almost immediately in most places and is expected to have a similar width to pre-dam conditions. The sediment that is left behind in the reservoirs is anticipated to form raised surfaces above pre-dam conditions; as a result, some floodplains within the former reservoirs may be inundated less frequently than typical floodplains elsewhere in the basin. The extent to which this outcome may be mitigated depends on potential actions taken during and after drawdown. This presentation provides an overview of the current disposition of sediment in the reservoirs and focuses on the likely evolution of impounded sediment during and after dam removal. The authors opine on the cost, impact, and habitat benefits and tradeoffs of actively assisting sediment evacuation during drawdown compared with grading and further modifying in-channel and floodplain areas in the years after drawdown.

Opportunities for Community Involvement to Address Common Urban Stream Management Issues

Thursday Afternoon Concurrent Session

Session Coordinators*: Ann Riley* *and* *Jackie Van Der Hout,*
California Urban Streams Partnership

This session will focus on addressing community involvement in some of the most pressing issues facing urban streams, highlighting why community engagement in urban areas is crucial to successful long-term restoration and management. Speakers will focus on engaging diverse communities in stream stewardship, including homeless populations, landowners, the urban and rural divide, and under-served urban populations. How can we forge and maintain collaborative relationships to steward our shared resources? How can we learn from our past mistakes in urban stream management to create more inclusive and comprehensive collaborations? We will examine how urban stream management can benefit both human populations and stream ecosystems through holistic flood management, steelhead recovery, trash management, and more.

Coalition and Community-based Endangered Steelhead Recovery in Southern California

Sandra Jacobson, Ph.D., *California Trout, Director—South Coast Region (Presenter)*
and Co-author: ***Russell Marlow,*** *California Trout, Program Manager—South Coast Region*

Due to the complexity of threats that face endangered salmonids and the precariously few populations left particularly in Southern California, a coalition approach is needed to engage a wide range of partners in the recovery process. This opens the door for community participation in a way that can effectively align agency and community goals. CalTrout leads two steelhead coalitions in Southern California, one based in San Diego, the other in Ventura. These coalitions engage the community at multiple levels—with the strategy to integrate fisheries conservation and recovery efforts for steelhead into existing regional conservation efforts in the South Coast Region through actions that are consistent with Recovery Plan objectives. The coalition operates according to a strategic plan. This focuses effort to ensure maximum efficiency and positioning for funding, and to ensure a pragmatic and economically feasible approach to accomplish the goals. Examples of projects underway will be presented that remediate large and complex fish passage barriers on high priority rivers, remove non-native species to benefit native fish, and improve irrigation efficiency to benefit tribal communities water resources and local agricultural technical capabilities while supporting native trout habitat. Overall, these projects chart a new path to integrate natural processes into urban landscapes—creating resource management solutions that support wildlife and communities.

A Summary of Building Community Capacity in Southern California Urban Stream Management

***Michael Wellborn**, President, California Watershed Network*

We will examine the evolution of two urban stream programs that originated in the 1990's in southern California. The first is the Aliso Creek Watershed Group formed in southern Orange County; and the second is the Santa Ana River Watershed Group that traverses San Bernardino, Riverside and Orange Counties. We will compare the two watersheds including the jurisdictions, local community engagement, regulatory challenges, issues that helped or hindered the programs, and current status.

Community-Based Ecological Solutions to Reduce Risk of Flooding in the Rheem Creek Watershed

***Anne Bremer,** Education and Community Programs Manager, The Watershed Project*

In western Contra Costa County, the Rheem Creek watershed faces many challenges, including dense development, which have led to highly degraded ecosystems and problems such as flooding, particularly in the Rollingwood neighborhood. For over 20 years, this community has suffered from flooding related to creek overflows. The Rollingwood reach of Rheem Creek has long been neglected and is choked with invasive vegetation, leading to sediment build up, obstructed channels, and worsening flood conditions. Climate change is expected to increase flood frequency and unpredictability. The City of Richmond, American Rivers, The Watershed Project, Restoration Design Group, the State Coastal Conservancy, and Contra Costa College have partnered on a multi-phased project to restore ecological function to the Rheem Creek watershed while reducing the risk of flooding to nearby residents. The project aims to implement nature-based solutions placed throughout the watershed, benefiting people, wildlife, and the economy by restoring and enhancing riparian habitat, providing open space and educational opportunities, and improving the watershed's ecological function, all of which will build climate change resilience. Phase I of this project consists of community engagement and agency coordination, site-specific restoration planning, and advancing restoration efforts throughout the watershed. By working together, residents, public agencies, and environmental groups can improve the health of Rheem Creek while alleviating long-standing flooding issues.

Community engagement and agency coordination are critical for this collaborative project. The project began with a door-to-door household survey to obtain historical flood information and involve the most impacted communities from the beginning. The project will also include community design charrettes, neighborhood workdays, and coordination with local agencies and municipalities as this project lies within multiple jurisdictions. The Watershed Project is creating relationships within the community to establish a long term community-based maintenance and monitoring plan. By collaborating with partner organizations, agencies, and community members, the project partners are hopeful that their collective efforts will be successful in surmounting the challenges that the Rheem Creek watershed has faced for many years, increasing the community's climate resilience, and providing a better quality of life for the people who live there.

Addressing Property Owner Fears of Creeks

Emanuel Peterson, *Project Manager, California Urban Streams Partnership*

The California Urban Streams Partnership (CUSP) works to address stream management needs to protect the environment in urban and rural private properties throughout Contra Costa Country through the Streamside Management Program for Landowners (SMPL). SMPL has made it simple for homeowners to understand solutions, permitting requirements, and best ecological practices available to address their property-creek issues. Property owners who fear that they have problems relating to stream bank stability, stormwater, and flooding are referred to CUSP by the county Public Works Department, towns, and cities in the county. In addition to providing site assessments, CUSP, in partnership with the Contra Costa County Resource Conservation District, has provided on-site stream restoration assistance to property owners.

Contra Costa County has a population of approximately one million and 40% of the county is public space, while 60% is held privately. The county acreage is contained within an urban growth limit boundary containing 43% of the acreage. Many of the streams are habitat for anadromous fish and other species of concern. Within this context, CUSP works to help residents understand how to be stewards of their watersheds, while solving conflicts between property and stream boundaries.

Due to lack of knowledge and fear of stream management, many property owners revert to environmental damaging riprap, concrete, gabions, and channelization. SMPL provides landowners with information to face their fears around streams to manage their streams with environmentally sensitive strategies that achieve the results they need. We will discuss the common reasons property owners ask for assistance through SMPL and what practices are used to address common issues. Many common requests for assistance are due to erosion, stormwater, flooding, invasive plants, vegetation management, fire management, and fear of unknown hazards. Additionally, we will explore how this program helps participants understand stream-related regulations, as well as more about streams systems and watersheds. This education has empowered SMPL participants to accomplish installation of inexpensive remedies to address their property concerns and enhance their creeks, all while dispelling their fear and stress about stream environments.

CUSP has partnered with the County Public Works Department to make the SMPL program possible while reducing workload for the county staff. Additionally, SMPL operates in compliance with the California Department of Fish and Wildlife and the San Francisco Bay Regional Water Quality Control Board by pre-emptively educating property owners on how to avoid regulatory issues through mismanagement.

Working with Homeless Populations to Reclaim and Restore Urban Coastal Habitat

Herman Garcia, *Founder and Executive Director,*
Coastal Habitat Education and Environmental Restoration

CHEER (Coastal Habitat Education and Environmental Restoration) is a non-profit founded in 2003 to restore coastal ecosystems in a manner that safeguards resource-based local economies. CHEER's work is centered in cooperation across various interests, and in working to create living steams and ecosystems, has brought building community partnerships for watershed recovery to the forefront. The first step in CHEER's work is habitat reclamation. The habitat reclamation policy CHEER has adopted as a first step to restoration has been foundational for much of their work- before an ecosystem can be restored to its functioning state, it needs to have garbage and trash removed. In order to achieve habitat reclamation goals, CHEER partners with volunteers and organizations to remove an average of over 2,500 pounds per day from creeks and watersheds. This November, CHEER removed over 21,000 pounds of garbage in one week.

CHEER's habitat reclamation system is built around a seamless system of watershed care which has since been adapted by large non-profits focused on restoration and conservation, such as the Nature Conservancy and the Sierra Club. Through organizing clean-ups through a strength-based approach and using strategic partnerships, large scale improvement and watershed recovery becomes possible.

Partnerships provide the crucial foundation of this work and make possible the sustainability of watershed scale habitat reclamation for entire ecosystems. CHEER has developed partnerships across the spectrum of communities with many different relationships to the watersheds they live and work in. Partnerships range from federal programs such as the EPA and NOAA, to establishing relationships with people experiencing homelessness in San Jose.

During this talk, CHEER's methods of creating and establishing ongoing partnerships will be discussed, with a focus on a case study of partnerships with homeless populations. Looking at the successful cleanup of a stretch of Coyote Creek in partnership with unhoused residents of "The Jungle" along Coyote Creek, methods of developing trust and long-term relationships with community partners will be discussed. Through an emphasis on building reciprocal relationships and establishing trust, CHEER has been able to create partnerships with individuals and groups for Habitat Reclamation projects that equally benefit disadvantaged human communities.

Engage, Educate, and Empower: Motivating Communities to Get on Board with Restoration in Their Backyards

***Sarah Phillips**, Marin Resource Conservation District*

Getting residents on board with restoration can prove challenging, especially in urbanized watersheds. There are many hurdles a watershed faces while navigating through an urbanized landscape, including the people. Yet it is people that can make a difference. Luckily, there is a multitude of ways to engage the communities around you in order to see the change we need to see in our impacted waterways. This presentation will cover a series of strategies used by Marin Resource Conservation District's Urban Streams Program Manager, Sarah Phillips, who carries out such efforts throughout Marin County's watersheds, including both rural and urban watersheds, as the two require differing messages and at times, varying approaches. It all starts with making a personal connection, followed by education, then finding the motivation that will entice the community to join in with ways to improve the watershed that they live in. In some cases, it's a matter of providing incentives and in other cases, it can be as simple as taking people out to observe juvenile salmonids up close and personal so that their hearts swell to the point of caring, and inspiring them to change behavior and improve habitat conditions in whatever ways possible. It is monumental to teach communities about salmonids and the crisis their populations face today and even more monumental to provide the people with the tools they need so they don't feel hopeless, but instead become empowered to do their part. This presentation will take a hard look at the successes and lessons learned since the Urban Stream Program was initiated in September, 2014, so that others may gain knowledge on key elements that have worked and have not. Lastly, this presentation will also touch on ways in which the practice of facilitation and mediation may prove very crucial when used at the right time in the right place.

Seascape Ecology Session I: Overview, Current Events, and Movement and Migration

Friday Morning Concurrent Sessions

Session Coordinators*: **Cynthia Le Doux-Bloom, Ph.D.,** Humboldt State University, Department of Fisheries Biology; and **Nate Mantua, Ph.D.,** NOAA, Southwest Fisheries Science Center*

Although many factors may be responsible for the declines in anadromous salmonid populations, this circumstance is commonly linked to the ocean conditions present during the marine life cycle phase, which remains unstudied compared to riverine and estuarine life phases. Upon ocean entry, salmonids display a wide range of growth and survival rates and display a variety of movement and migratory behaviors, both tied to ocean productivity which influences the foraging conditions these individuals encounter across space and time.

These sessions will feature innovative and novel studies focused on understanding the ocean life cycle phase of Pacific salmonids, including:

(1) An Overview of Seascape Ecology
and Current Events;

(2) Movement and Migration;

(3) Survival and Growth; and

(4) Foraging Conditions in the California Current.

Individual-based Models as a Tool for Predicting Juvenile Salmon Growth and Mortality Under Changing Ocean and Climate Conditions

Jerome Fiechter, Ph.D., *University of California at Santa Cruz (Presenter);*
and Co-author: ***Brian Wells, Ph.D.,*** *NOAA Fisheries*

Spatially explicit individual-based models (IBMs) can provide a mechanistic insight into physical and biological processes controlling the population dynamics of forage and predatory marine species and their expected response to varying ocean and climate conditions. Here, we present an ecosystem model framework comprised of an ocean circulation submodel, a nutrient-phytoplankton-zooplankton submodel and a salmon IBM to describe the effects of environmental conditions and coastal upwelling variability on the growth of juvenile Chinook salmon in central California coastal waters. The model results generally indicate that years favorable for juvenile salmon growth off central California are characterized by particularly intense early season upwelling (i.e., March through May), leading to enhanced krill concentrations during summer near the location of ocean entry (i.e., Gulf of the Farallones). Seasonally averaged growth rates in the model are mainly consistent with observed values and suggest that juvenile salmon emigrating later in the season (i.e., late May and June) achieve higher weight gains during their first 90 days of ocean residence. We also discuss how the ecosystem model framework can be extended to include mortality from various predators based on their respective feeding strategies (e.g., central place vs. migratory predator), as well as opportunities to include regional downscaling of global climate models to generate long-term projections of juvenile salmon population variability in California coastal waters. Finally, we provide examples of how results from the IBM can be used to inform hatchery practices, such as time of release or size at ocean emigration.

Seascape Behavior and Distribution of Acoustically Tagged Salmon along the Washington Coastal Shelf

Brian Wells, Ph.D., *NOAA Fisheries (Presenter) and* ***Joe M. Smith,*** *Northwest Fisheries Science Center, Estuary and Ocean Ecology Program, Fish Ecology Division, NOAA Fisheries*

We primarily base our current understanding of the distribution and behavior of salmon on methods that provide the origin (e.g., coded wire tags, genetics, chemical signatures) and capture location (e.g., ocean surveys, commercial fishing, recreation fishing) of a fish. These techniques are dependent on when and where we chose to sample, thus giving us a limited understanding of where and when salmon spend time in the ocean. Our goal is to obtain an individual-based understanding of how the variation in variables associated with the California Current influence the distribution and behavior of salmon. To do this, we need individual-level information that is independent of sampling. To further this goal, we deployed 115 acoustic receivers along the northern coast of Washington State in a 4.5 km grid. We tagged 146 Chinook salmon (mean = 349 mm, SD = 112 mm) and 31 Coho salmon (mean = 484 mm, SD = 141 mm) in the spring and summer of 2019. Tagged Chinook salmon were mainly fall-run type Chinook that were hypothesized to remain over the coastal shelf during their ocean residence. However, many spring-run (West Cascades and Willamette stocks) Chinook were captured and tagged over the coastal shelf as well. We downloaded the acoustic receivers in the first week of September. We detected 126 unique Chinook salmon (86%) on 111 receivers with a total of 51,170 detections, and 22 unique Coho salmon (71%) on 72 receivers with a total of 2,572 detections. Salmon visited many receivers (Chinook mean = 13, max. = 47; Coho mean = 7, max = 19). Tags are projected to last two years, so we expect more detections from these tags. We will summarize various salmon movement/residence metrics and discuss them in the context of an important salmon predator, the southern resident killer whale.

Impact of a Marine Heat Wave on Pacific Salmon Habitat

Steven Lindley, Ph.D. (Presenter); and Co-authors: Nate Mantua, Steve Munch, and Tanya Rogers, NOAA Fisheries

The distribution of Pacific salmon has frequently been described based on sea surface temperatures (SSTs), and the productivity of Pacific salmon populations is often related to fluctuations of sea surface temperature at regional or basin scales. Recently (2014-2016), the northeast Pacific was struck by an extensive and intense large marine heatwave, with SST 2-3 °C above normal, in an event so notable that "the blob" became a household name. At the time, fisheries scientists and managers feared that this heatwave would have severe negative effects on Pacific salmon, and that it might be a preview of how salmon and salmon fisheries would fare in a warmer future. The linkages between SST and salmon are not simple however, involving not only direct effects of increased temperature on the salmon themselves, but bottom-up effects from changes in stratification and top-down effects from changes in predator distributions. In this paper, we examine how the heat wave affected mixed layer depths, primary production, the distribution of SSTs favorable for the various species of Pacific salmon, and the return rates of select salmon populations that experienced the heat wave to evaluate its impact on salmon and to increase our understanding of how ocean warming might impact salmon populations in the future. The heatwave appears to have had negative effects on salmon using the Gulf of Alaska, but positive effects on salmon using the Bering Sea.

20 in 2020:
Twenty Years of Seascape and Salmon Studies on the Pacific West Coast

Nate Mantua, Ph.D. *(Presenter); and Co-authors:* ***David D. Huff , Brian J. Burke, Richard D. Brodeur, Jarrod A. Santora, John C. Field, Kate Richerson, Kurt L. Fresh, Michelle M. McClure, William H. Satterthwaite, Chris J. Harvey, Forbes Darby, Su J. Kim, Richard W. Zabel,*** *and* ***Steve Lindley,*** *NOAA Fisheries*

Two decades have passed since the initiation of National Oceanic and Atmospheric Administration's (NOAA's) research program aimed at advancing understanding of estuary and ocean ecology of U.S. West Coast Pacific salmon (*Oncorhynchus spp.*). In this review and prospectus, we summarize key findings from this program and describe a plan for better orienting it toward Ecosystem Based Management (EBM). Twenty years ago, the NOAA Fisheries West Coast Science Centers proposed a coordinated plan for ocean research on Pacific salmon (*Oncorhynchus spp.*) to elucidate the drivers of variation in salmon abundance. The research plan was designed to inform hatchery practices, to provide forecasts to inform harvest rules, and to consider ocean climate variability when evaluating restoration and recovery plans and actions. Each of the projects carried out under the ocean research plan focused on ecosystem components and how they affected salmon physiology/vital rates and salmon population dynamics. Successful outcomes include descriptions of coast-wide and local-scale distributions and distributional relationships to small-scale oceanographic features. Studies have also examined seasonal and inter-annual variations in diet composition, immature salmon growth rates and condition, diseases and parasites, salmon predators, environmental covariates of salmon presence or abundance, and correlates of marine survival. Our EBM approach will provide managers with information to improve resilience of West Coast salmon populations and the fishing and biotic communities that depend on them. Our path forward involves increasing our understanding of ecosystem processes in order to improve the dependability of scenario testing under novel conditions. Over the past two decades, we developed a conceptual model for how salmon are influenced by climate, predators, prey, fisheries, and human activities. Knowledge gaps that we identified from our conceptual model include limited understanding of salmon distributions, behavior, maturation dynamics, population dynamics, and salmon interactions with predators, competitors, and prey during winter. We consider emerging risks and vulnerabilities facing salmon and propose analysis frameworks for evaluating them. Increased marine predator populations coupled with climate change pose a significant risk to West Coast salmon and require new strategies and actions to mitigate their negative impacts on salmon, salmon-dependent fishing, and ecosystem components. We propose research to support the development of new decision-support tools for evaluating tradeoffs associated with alternative management strategies. Research is expected to develop decision-support tools and information to inform salmon and ecosystem management, and ultimately form a central part of the adaptive management system needed to improve resilience of salmon populations, salmon-dependent fisheries, and ecosystem components.

Ocean Movement and Behavior of Steelhead Revealed by Pop-up Satellite Archival Tags

Emily A. Miller, *Monterey Bay Aquarium (Presenter); and Co-authors:* ***Andrew C. Seitz*** *and* ***Michael B. Courtney,*** *University of Alaska Fairbanks, College of Fisheries and Ocean Sciences;* ***Matthew Catterson*** *and* ***Jeff Nichols,*** *Alaska Department of Fish and Game;* ***Joseph D. Kiernan****, NOAA Fisheries Southwest Fisheries Science Center;* ***John O'Sullivan, Alexander Norton, Kyle S. Van Houtan,*** *and* ***Andre Boustany,*** *Monterey Bay Aquarium*

Steelhead *(Oncorhynchus mykiss)* populations have declined along the southern extent of their North America range in the last century. While their freshwater life history is well-studied, their ocean ecology is largely unknown. Unlike most anadromous Pacific salmonids, steelhead are iteroparous (can complete multiple reproductive cycles over the course of its lifetime). Gaining insights to the oceanic phase of post-spawning adults, or kelts, is therefore critical for maintenance and management of this diverse life history strategy that ensures species persistence. Conventional and acoustic tag technologies have retrieval and data collection limitations in the ocean environment. Thus, in 2018 and 2019 we tagged out-migrating female kelts with pop-up satellite archival tags (PSATs) at opposite ends of the North American range—Scott Creek, CA and Situk River, AK. Here, we report tracks from five California and 16 Alaska tags that remained attached to steelhead for 3-172 days. Steelhead occupied an average depth of 8.6 ± 23.1 m and average temperature of 12.7 ± 1.1 °C off California, and 2.2 ± 2.5 m and 11.0 ± 1.3 °C off Alaska. The farthest distance traveled by an individual kelt was over 2,600 km, from Situk River, AK to the western end of the North American Aleutian Islands and into the southern edge of the Bering Sea. We describe steelhead migratory pathways, diving behavior, and environmental preferences across regions and years. These results provide valuable first steps to understanding steelhead ocean ecology across the Pacific coast.

Ocean Distribution of West Coast Chinook Salmon Inferred from Coded-wire-tags and Genetic Data

***Will Satterthwaite**, NOAA Fisheries Southwest Fisheries Science Center (Presenter);*
*and Co-Authors: **Ole Shelton**, NOAA Northwest Fisheries Science Center*

Information on the ocean distribution of West Coast Chinook salmon comes primarily from recoveries of coded-wire-tagged (CWT) fish, and more recently genetic sampling as well, in commercial and recreational ocean fisheries. Nearly 40 years' worth of CWT data are available at this point, recovered in comprehensive sampling from Alaska to California. CWT reveal fish age along with other information about juvenile fish at the time of tagging. However, CWT are largely limited to hatchery-origin fish. Genetic stock identification (GSI) can provide information on natural-origin fish, but individual stocks and populations are not always resolvable at the desired level, and age information requires additional work on scales or otoliths, which is often not done.

Some of the earliest analyses of total CWT recoveries by area established that in general Chinook from common freshwater regions have similar oceanic distributions, with stocks of more northerly origin often found further to the north in the ocean as well. Fall- versus spring-run stocks from the Columbia Basin appear to have substantial differences in their distributions whereas fall versus spring-run stocks from California and the Oregon Coast appear more similar. Refined models for California stocks accounting for seasonality and fishing effort revealed seasonal changes in distributions, including increased density near source rivers as the spawning season approached, as well as some variation across years in fine-scale distribution, possibly tracking ocean temperatures. For California stocks of particular conservation concern, both CWT and GSI data suggest that Sacramento winter Chinook are highly concentrated south of Point Arena and that Central Valley spring Chinook are distributed similarly to Central Valley fall Chinook. GSI data suggests broad similarity in the distributions of California Coastal and Klamath Chinook, with some divergence toward respective source rivers around August.

A recently developed state-space model reflects the most direct attempt to date at inferring area-specific ocean abundance of individual Chinook stocks and what factors might drive variation in distribution over time. Application of this model framework to CWT recovered from fall-run Chinook coast-wide has confirmed that ocean distribution depends strongly on region of origin, varies seasonally, and varies across years in ways that seem at least partially explained by ocean temperatures. Efforts are ongoing to extend this model to spring-run and natural-origin stocks by developing a unified statistical framework that can be applied simultaneously to CWT and GSI data while incorporating data from additional fisheries, such as salmon bycatch in groundfish trawl fisheries.

The Science Informing Salmonid Reintroductions

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

This session will bring together a variety of fields of experts that are involved in efforts to reintroduce salmon and steelhead to their historic freshwater habitats. The talks will discuss the state of knowledge in reintroduction science and cover projects throughout the state (and further afield) that are utilizing a variety of techniques, including dam removal, passage facilities, and trap & haul, and in various stages of completion, from successfully completed to early conceptual planning.

The Science Informing Salmonid Reintroductions

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

A surge in efforts to reintroduce salmon and trout to their historic habitat is the result of a confluence of different factors, including completed recovery plans, changes in attitudes regarding resource management, and advances in biological science. These efforts include projects in a variety of stages, from conceptual planning to post-dam removal ecosystem recovery.

I will present an overview of the science behind reintroductions of salmon and trout to their historic habitat, or in some cases novel habitat. I will draw primarily on experience from involvement in numerous projects in California, including the San Joaquin River, Yuba River, Carmel River, Battle Creek, Clear Creek, and the Klamath River. I will discuss how science factors into source stock selection, habitat restoration, release strategies, and population reconstitution processes. I will further discuss the paramount importance of careful monitoring of reintroduction projects to evaluate the performance of particular strategies and adaptively manage the projects for successful outcomes.

Genetic Monitoring of Reintroduction and Supplementation Efforts in Central California Populations of Endangered Coho Salmon

Elizabeth A. Gilbert-Horvath, NOAA Fisheries, Southwest Fisheries Science Center (Presenter); and Co-authors: Eric C. Anderson, NOAA Fisheries, Southwest Fisheries Science Center; Benjamin White, U.S. Army Corps of Engineers/Warm Springs Hatchery; Michael Reichmuth, National Park Service; Robert Coey, California Coastal Office, NOAA Fisheries, West Coast Region; Devon E. Pearse and John Carlos Garza, NOAA Fisheries, Southwest Fisheries Science Center

Populations of Coho salmon *(Oncorhynchus kisutch)* in central California are critically endangered as a result of human activity and environmental conditions during the past century. Habitat loss, drought, wildfire, and variable ocean conditions have adversely impacted this species, resulting in severe genetic and demographic consequences, including local extinctions, small effective population sizes, inbreeding, and low diversity. In many basins where Coho salmon persist, extinction risk is high and ever-present. In spite of an overall trend of declining numbers in rivers throughout California, some watersheds, such as Lagunitas Creek, continue to sustain populations with relatively high genetic diversity. Warm Springs Hatchery (WSH), a mitigation facility on the Russian River, operates a captive breeding program for Coho salmon, and is a hub for recovery and conservation efforts in Marin, Sonoma, and Mendocino counties. Genetic broodstock management techniques are employed in the hatchery setting (e.g., inbreeding avoidance and managed outbreeding) to produce juveniles for reintroduction and population supplementation in the Russian River and other area watersheds. This captive breeding is coupled with several recently adopted reintroduction strategies, including adult releases, rescue, rear and release programs, and streamside incubation of fertilized eggs. These methods are evaluated here using genetic parentage and sibling analyses to assess their efficacy. The adult release strategy involves WSH broodstock individuals being released as mature adults directly into spawning habitat. This strategy has been employed since 2004 in Salmon and Walker creeks, from which Coho salmon had been previously extirpated. Parentage analysis of wild-born juveniles revealed evidence of successful natural spawning by adults released there, as well as spawning by unsampled parents, presumably naturally spawned ocean returns. The presence of juveniles in Walker Creek in subsequent years, when no adults were released, suggests continued natural spawning by the descendants of the released adults and/or ocean returns. In Redwood Creek (Muir Woods National Monument), wild Coho juveniles from three consecutive brood years were rescued from drying habitat during California's 2012-2016 drought, reared to maturity at WSH, and released as adults back into their natal stream. Juveniles sampled in each of the following summers were found to be offspring of these released adults. Finally, a remote site incubator (RSI) was tested in the Russian River in 2019, and parentage results from initial post-release juvenile monitoring will be presented. By analyzing data spanning the past fifteen years of reintroduction and supplementation efforts in central California, we characterize efficacy, highlight key outcomes, and address how our findings might inform reintroduction approaches going forward.

Recolonization Potential for Coho Salmon in Tributaries to the Klamath River Above Iron Gate Dam

***Max Ramos, M.Sc. Student,** Humboldt State University (Presenter);*
*and Co-author: **Darren Ward, Ph.D.,** Humboldt State University*

Four major dams on the Klamath River are slated for removal in 2022, restoring access to hundreds of miles of potential habitat for anadromous fishes. The Coho salmon *(Oncorhynchus kisutch)* in the Klamath River are classified under the Southern Oregon/Northern California Coast evolutionarily significant unit as a threatened species. We are using physical habitat and biological features of low-order tributaries to the Klamath River above the dams to assess available habitat and its fundamental capacity to support Coho salmon post dam removal. The intrinsic potential (IP) modeling approach developed by the National Oceanic and Atmospheric Administration (NOAA) and the habitat limiting factors model (HLFM) developed by the Oregon Department of Fish and Wildlife (ODFW) will be utilized to assess habitat. In addition, we are developing an occupancy model using program "PRESENCE" and data from reference sites below the dam and from other watersheds to estimate the potential distribution and abundance of juvenile Coho salmon at the sites. Results from this analysis can be used to make management decisions for habitat restoration efforts and future Coho salmon population goals.

Dam, That Was a Wild Ride—Steelhead Passage Up, Down, and Around the Los Padres Dam in California

Haley A. Ohms, Ph.D., *Institute of Marine Science, UC Santa Cruz and NOAA, Southwest Fisheries Science Center (Presenter); and Co-Authors:* ***Gabriel T. Brooks,*** *NOAA, Northwest Fisheries Science Center; and* ***David A. Boughton, Ph.D.,*** *NOAA, Southwest Fisheries Science Center*

Fish passage is a concern at many dams in the U.S. and is one consideration when deciding whether to remove dams approaching the end of their useful lives. This scenario is currently playing out at the Los Padres Dam on the Carmel River in California. The Los Padres Dam has a trap-and-haul system for adult upstream passage and a newly installed floating-weir collector for downstream juvenile and adult passage. To test the effectiveness of the floating-weir collector, we tagged juvenile and adult steelhead and rainbow trout and monitored their movements through the reservoir and around the dam in the winter of 2018/2019. Only one adult moved downstream through the floating weir collector, while all other adults moving downstream used the spillway (n=60). More juveniles moved downstream using the floating weir collector (8%), however juveniles moving downstream were still twice as likely to use the spillway (17%). Additionally, 75% of all juveniles that entered the reservoir remained there, either through mortality or for rearing. These 'lost' juveniles could represent a life history that rears in the reservoir for a season before continuing downstream migration, but some may also represent predation by brown trout inhabiting the reservoir. Spillway passage survival was high for both adults (89%) and juveniles (95%), indicating that this route of passage may not represent a problem for survival. These preliminary results suggest that despite the new fish passage infrastructure, the spillway remains an active route of passage at the Los Padres dam and the reservoir still functions as either a mortality or behavioral sink for most downstream migrants. Additionally, and in terms of broader application, studying fish movements and life histories within a system prior to building expensive infrastructure is a worthwhile investment.

The Return of the King: Reintroduction of Chinook Salmon to the San Joaquin River

Anthony Clemento, Ph.D., *NOAA Fisheries SWFSC, Santa Cruz Lab and University of California, Santa Cruz, Institute of Marine Sciences (Presenter); and Co-author:* ***John Carlos Garza, Ph.D.,*** *NOAA Fisheries SWFSC, Santa Cruz Lab*

The San Joaquin River in California's southern Central Valley historically contained vast numbers of spring-run Chinook salmon. However, with the opening of Friant Dam in 1942, the population would rapidly disappear as a majority of the water was diverted to agriculture and irrigation. Now, some 65 years later, after a federal lawsuit and millions of dollars spent on habitat restoration and hatchery supplementation, spring-run salmon are once again swimming and spawning in the waters of the San Joaquin. In this talk we will review the multi-faceted approach being taken to reintroduce salmon to the river, with a particular focus on the utility of genetics in supporting the goals of the restoration program. This will include a look back at the factors considered in choosing a broodstock and then how genetic data is being integrated into the adaptive management of these fish at a variety of life-history stages. We will highlight the many challenges associated with implementing such a large and dynamic reintroduction plan and how genetic analysis is being used to monitor progress and define success. Finally, we will touch briefly on future goals and directions for the program.

Capacity of Two High Sierra Rivers in California for Reintroduction of Anadromous Salmonids

David A. Boughton, Ph.D., *NOAA Fisheries SW Fisheries Science Center (Presenter); and Co-Author:* ***Lee R. Harrison, Ph.D.,*** *NOAA Fisheries SW Fisheries Science Center*

Historically, anadromous steelhead and spring-run Chinook salmon used high-elevation habitats in the Sierra Nevada for a significant portion of their life-cycles, but are currently extirpated from most of these montane streams by impassable dams. Recovery plans for both species envision reintroducing them to some of their former montane habitats by establishing passage across dams and reservoirs for both upstream and downstream migrants. Passage, however, is only useful if the habitats above the dams possess the capacity to support viable populations of the two species. In this talk we describe how we used remote-sensing and habitat modeling to produce quantitative, high-resolution, dynamic estimates of habitat capacity for each species in the upper Tuolumne and Merced rivers in the central Sierra Nevada.

Head of Reservoir to Ocean; Innovations Connecting Restoration and Reintroductions for ESA Listed Salmonids

Stacie Fejtek Smith, D.Env., *NOAA Fisheries, West Coast Region, California Central Valley Office*

Completion of the hydropower projects on Battle Creek in early 1900's and Shasta Dam in 1945 cut off Sacramento winter-run Chinook from 100% of their historical holding, spawning, and rearing habitat. Shasta Dam and many of the Central Valley rim dams are recognized by the California Water Action Plan as "too integral to California's water infrastructure to consider removing, but, where feasible, passage around the rim dams may be necessary to recover salmon." Developing a methodology to transport juvenile fish from above rim dams is the last major technological hurdle for non-volitional fish passage above high-head dams throughout the Central Valley in order to prevent extinction and facilitate species recovery. No "head-of-reservoir" collection systems currently exist. However, while no rim dams in California's Central Valley currently provide passage for native California salmon, similar fish passage approaches are standard practice at many larger dams in Oregon and Washington. Many of the lessons learned from successful fish passage programs in Oregon and Washington will now be tested and evaluated for the first time as part of the Juvenile Salmonid Collection System Pilot Project (JSCS Pilot Project).

The JSCS Pilot Project is an ongoing effort to implement fish passage for Endangered Species Act (ESA) listed Sacramento River winter-run Chinook salmon above Shasta Dam in a step-wise science informed fashion. The pilot project provides an innovative experimental technology that accounts for the unique circumstances and environmental elements present above Shasta Dam. In order to move fish around the dams and reintroduce Chinook salmon to habitats that have been inaccessible for more than 70 years, a multi-agency and stakeholder working group determined that a key element for project success would be the ability to manage these ecologically significant headwaters for multiple uses. Therefore, in addition to answer key biological and engineering questions regarding collection of out migrating juveniles, this project also seeks to address important multi-benefit questions regarding resident-recreational fish migration, impacts to recreational resources during project implementation, and furthering engagement and education for local stakeholders and residents on the value of reintroducing winter-run Chinook to the McCloud River.

Challenges and Innovations in Salmonid Life Cycle Monitoring in Coastal Streams

Session Coordinator*: Jack Eschenroeder, FISHBIO*

This session will focus on the unique challenges of conducting life cycle monitoring in coastal streams, as well as approaches being implemented to overcome these challenges. This session will provide a forum for exchanging ideas and solutions to problems encountered with monitoring in systems typified by flashy hydrographs, high turbidities, and shifting substrates. Potential presentations will include the application of technologies, as well as explanations of how data are being used in restoration efforts.

Salmonid Monitoring in Turbid Coastal Streams: Learned Perspectives from Salinas River Adaptive Monitoring

Jack Eschenroeder, FISHBIO

The Salinas River steelhead population can be characterized as a depressed population predominantly supported by populations of resident rainbow trout within the headwaters of the Arroyo Seco River. The Salinas River itself is a large river system composed of several regulated tributaries and a single unregulated tributary, encompassing a large drainage basin that has highly variable and unregulated flow and a predominantly sand substrate. These conditions create an environment where it is challenging to use traditional methods to monitor small numbers of fish. Many approaches to life-cycle monitoring are insufficient or have limited capabilities under these conditions and adult steelhead information was historically very limited due to these monitoring deficiencies. In order to improve the quantity and quality of steelhead data, we chose to implement an infrared fish counter and portable resistance board weir monitoring station in the lower Salinas River. Lessons learned from the first year's successes and failures were used to adapt future years' monitoring structures and plans, such as adjustments and redesigns of the weir substrate rail to improve anchoring and reduce scouring of the sand substrate. Remote network connectivity was added to decrease data collection effort by increasing the time period between checks. An underwater camera was also added to improve silhouette identification certainty at lower turbidities and a camera tunnel was configured to improve the quality of the videos/photos, thereby further improving identification certainty. Configurations and dimensions of the infrared scanner were also adjusted to increase detection accuracy through a high range of turbidities. An air-filled chamber camera housing was configured to the Riverwatcher to improve the quality of video/photos during high turbidity events and changes were made to the Riverwatcher software to allow users to record videos/photos of downstream passages without the purchase of additional equipment. Potential future improvements include cloud-based software (Riverwatcher Daily) to help users share data more easily and provide a unique platform for individuals interested in public relations. Finally, passive inductive transponder (PIT) tag antennas are now integrated into the Riverwatcher so that for each PIT tag detected at the Riverwatcher, the size, sex, condition, and other information about that individual can also be gathered. Collectively, these changes have reduced the limitations of monitoring in the unique conditions of this coastal steelhead stream.

Long-term Southern Steelhead Monitoring in the Santa Monica Bay—Tools Used and Lessons Learned!

Rosi Dagit, *Senior Conservation Biologist, Resource Conservation District of the Santa Monica Mountains (RCDSMM)*

From 2001-2019, the RCDSMM implemented a systematic approach to documenting abundance and distribution patterns related to mainstem habitat and juvenile survival, as well as reproduction, recruitment patterns, and migration timing in creeks by conducting monthly snorkel and bi-weekly redd surveys during spawning season in three coastal streams in the Santa Monica Bay. Additionally, we managed a life cycle Monitoring Station in Topanga Creek from 2008-2018 that incorporated mark-recapture events, in-stream PIT tag array, weir trap, and DIDSON camera. Combining all of these elements was a unique opportunity to more fully understand the ecology of steelhead, *Oncorhynchus mykiss,* in small coastal creeks. Cumulatively, this long-term data set provides important information about abundance, spatial structure, diversity, and meta-population structure of *O. mykiss* in this region, as well as freshwater habitat condition. This kind of data is essential to the development of objective, measurable, population level recovery goals that accurately reflect both the complexity of the southern steelhead life cycle and opportunities to recover the population to the fullest extent possible.

However, even with coordinated implementation of all these methods for many years, it was a challenge to meet the standards outlined in the Coastal Monitoring Program (Adams et al. 2011). Those strategies were designed for systems where both flows and fish are more abundant and reliably present. Despite these limitations, we were still able to assemble important information that addressed key elements of a Viable Salmonid Population assessment including documenting abundance and productivity, spatial distribution including habitat preferences and freshwater habitat conditions, and contribute to understanding of regional genetic diversity.

What worked, what didn't work, and suggestions for handling equipment problems as well as adjusting the monitoring plan to better address conditions in Southern California going forward will be discussed.

Preliminary Results from the Redwood Creek Coho Salmon Jump-start Project; Preserving Coho Salmon for Future Generations

***Michael Reichmuth,** National Park Service (Presenter);*
*and Co-authors: **Darren Fong,** National Park Service*
*and **Elizabeth A. Gilbert-Horvath,** NOAA Fisheries, Southwest Fisheries Science Center*

The Redwood Creek watershed, located in Marin County, California, is the only Coho salmon *(Oncorhynchus kisutch)* bearing stream managed by Golden Gate National Recreation Area. The Coho salmon in Redwood Creek are part of the critically endangered Central California Coast Evolutionarily Significant Unit. Since 2004, the National Park Service has used a life cycle monitoring program to document changes in the population size and inform managers on potential limitations to survival. A major population crash was documented from 2006 to 2009 when escapement estimates were in the single digits. Over the last decade, the Coho population in Redwood Creek has not shown any significant improvements with occasional minor increases. Critically low population levels of Coho salmon within Redwood Creek triggered further action to prevent local extirpation of the species. Several large-scale restoration projects have been completed to improve habitat for Coho salmon in Redwood Creek, but those efforts have not led to any substantial increases in the population. With the population reaching dispensation levels, a restoration hatchery approach was initiated with the hope of rebuilding a once robust population of Coho salmon in Redwood Creek.

Starting in December of 2015, captive-reared adult Coho salmon (originally captured as wild juveniles) were released back into Redwood Creek for four consecutive winters to prevent extirpation of the population and ensure continued persistence of the species within the stream. The National Park Service Inventory and Monitoring Program, with support from the California Department of Fish and Wildlife and Golden Gate National Park Conservancy, performed surveys on these adults and their progeny to document the reproductive success of adult Coho salmon released and identify potential improvements to future release strategies. Since the first major release (over 100 adult Coho) during December of 2016, monitoring has been completed for two release groups using a mixture of adult visual surveys, juvenile snorkel surveys, and DNA parentage analysis from juvenile tissue samples. Although only two years of data have been analyzed (2017 and 2018), results have already informed managers on the use of this Coho restoration tool. Results suggest that the release of sexually mature adult Coho into Redwood Creek increased the juvenile population leading to higher Coho smolt production. Information such as spawning distribution characteristics, redd success rate, genetic diversity of family groups, and hydrologic requirements have been informative for planning future restoration efforts. This study serves as an example of how a multi-agency effort can be utilized to preserve our local biodiversity while maintaining scientific integrity.

Life Cycle Monitoring in the Russian River: Overcoming Obstacles and Challenges

Gregg Horton, Ph.D, *Sonoma Water (Presenter);*
and Co-Authors: ***Mariska Obedzinski, MS,*** *California Sea Grant;* ***Andrea Pecharich, MS,*** *Sonoma Water; and* ***Aaron Johnson, MS,*** *Sonoma Water*

Life cycle monitoring (LCM) is based on fish counts or population abundance estimates at key life stages. For example, in the context of the California Coastal Monitoring Program (CMP, Adams et al. 2011) abundance prior to ocean entry (smolts or "fish out") and upon return from the ocean to spawn (adults or "fish in") are necessary in order to inform status and trends and to obtain estimates of freshwater and marine survival. FB 180 outlines a general approach to obtaining such estimates that relies on operation of fixed traps and weirs. In some river systems, however, operation of smolt traps and adult counting weirs that target life stages that migrate during winter (e.g., steelhead smolts and adults) is not possible without significant infrastructure. Even where such infrastructure is present, however, high flows can make trap operation unsafe for both personnel and equipment which can, in turn, lead to data gaps resulting in biased estimates of abundance and survival. Although a smaller sub-basin within the larger watershed can be targeted for LCM, questions arise as to (1) how well that sub-basin represents the watershed as a whole and (2) the degree to which freshwater and marine survival can be decoupled from riverine and estuarine migration survival. Complements and in some cases alternatives to fixed trap operation include operation of multi-antenna Passive Inductive Transponder (PIT) arrays coupled with mark-recapture models. In the Russian River watershed, we are implementing LCM in multiple sub-basins containing Coho salmon and steelhead habitat using a combination of year-round smolt trapping in the spring, which encompasses the Coho smolt migration period, and strategically-located, year-round PIT antennas to detect PIT-tagged individuals as they emigrate from their stream of origin (steelhead smolts) or return to the Russian River to spawn (Coho and steelhead adults). The source of PIT-tagged fish includes: juvenile Coho and steelhead tagged during modified basin visual estimation technique (BVET) surveys in the fall, Coho releases from a captive broodstock program, and Coho and steelhead smolts tagged at outmigrant traps. Fall BVET surveys yield estimates of juvenile steelhead abundance which are used as inputs for a steelhead smolt abundance model that includes PIT antenna detections at the mouths of each stream during the entire steelhead smolt outmigration period and not just the tail-end when outmigrant traps can be operated. For Coho and steelhead adults, a PIT antenna array located at the upstream extent of the Russian River estuary is used to detect individuals as they return. Detections at the estuary array, which is located downstream of the sub-basins of origin, overcomes the problem of not being able to distinguish sub-basin fidelity from true marine survival as would be the case if we relied only on detections at sub-basin PIT antenna arrays.

Water Depth Monitoring at Riffle Crest Thalwegs Supports Juvenile Salmon Outmigration

Brian Kastl, M.Sc., *UC Berkeley (Presenter);*
and Co-authors: ***Mariska Obedzinski, M.Sc.,*** *CA Sea Grant,* ***Stephanie Carlson, Ph.D.,*** *UC Berkeley;* ***Sarah Nossaman Pierce,*** *CA Sea Grant; and* ***Ted Grantham, Ph.D.,*** *UC Berkeley*

The Mediterranean climate of coastal California presents unique monitoring needs for life cycle bottlenecks of migratory salmon. The endangered Coho salmon *(Oncorhynchus kisutch)* of California's Russian River face shallow water depths and low streamflow in spring and early summer, during the smolt outmigration from tributary streams. However, little is known about the flow conditions that smolts require to successfully outmigrate. This study uses a unique water depth monitoring approach—the riffle crest thalweg (RCT) method—to investigates how variation in hydrologic and geomorphic characteristics influence outmigration timing of Coho salmon. We measured water depths at 12 riffle crest thalweg sites, spread over 0.5—2 km-long reaches, at each of five streams throughout March—June 2018 and 2019. Next, we converted continuous stage gage data to continuous riffle crest thalweg depth estimates, which we analyzed in relation to observed smolt movement past passive inductive transponder (PIT) tag antennas from 2012 to 2019. Findings indicate that median RCT depths during outmigration are 6—23 cm and outmigration rates rapidly decrease at depths less than 4 cm. Years with greater RCT depths in May are associated with longer outmigration season durations, extending up to three weeks later in spring. Simultaneous discharge measurements and RCT measurements allowed us to develop a rating curve for each stream that describes how RCT depths change with incremental changes in discharge. Discharge required to reach commonly used minimum outmigration depth requirements varies by a factor of six among streams. Interannual stability of rating curves suggests that coastal salmon-bearing streams show sufficient geomorphic stability, so that rating curves can be used over numerous years to inform instream flow management. As human water use and climate change continue to threaten the outmigration of anadromous salmon, monitoring RCTs is a low-cost, informative approach for evaluating environmental flow needs.

The Efficacy of eDNA Sampling to Detect Presence of Endangered Coho Salmon in Santa Cruz Mountain Streams: Building Reasonable Expectations of an Emerging Method

Brian C. Spence, Ph.D. *(Presenter); and Co-Authors:* ***David E. Rundio,*** *NOAA Fisheries Southwest Fisheries Science Center;* ***Nicholas J. Demetras,*** *NOAA Fisheries Southwest Fisheries Science Center and University of California, Santa Cruz; and* ***Maryna Sedoryk,*** *Pacific States Marine Fisheries Commission*

Environmental DNA methods (eDNA) have emerged as a promising tool for detecting rare, invasive, or highly cryptic species of fish. In riverine systems, however, the efficacy of eDNA sampling relative to more traditional sampling methods depends on numerous interacting environmental factors that influence the transport and fate of DNA after it is excreted by the source organism. Consequently, understanding downstream eDNA transport distances and detection probabilities across a range of environmental conditions is critical for effective survey design where the goal is to establish species presence. We conducted two studies to evaluate new field-based eDNA sampling and analytical tools for detecting endangered Coho salmon *(Oncorhynchus kisutch)* juveniles in streams of the Santa Cruz Mountains during late summer and fall, when stream flows are at their lowest. The first study involved cage trials in which we collected and analyzed (portable PCR [polymerase chain reaction]) three replicate 5-L water samples at distances 10, 50, 100, 200, 300, 500 and 1000 m downstream of a live car containing known numbers of juvenile Coho salmon. Trials were repeated using different densities of fish. Although on one occasion we detected Coho salmon eDNA as far as 1000 m downstream, detection probabilities for an individual sample declined rapidly with distance, falling below 50% at 200 m for the higher density of fish (N=30) and at less than 100 m for the lower density of fish (N=15). In a second study, we conducted paired snorkel surveys and eDNA sampling for Coho salmon at twenty-one randomly selected 1-3 km reaches throughout the Santa Cruz Mountains. A protocol in which six 5-L water samples were collected and analyzed for each reach (3 at the bottom and 3 at the midpoint) yielded results that were perfectly concordant with snorkel surveys with respect to species detection. Coho salmon DNA was detected at all six sites where Coho were found during snorkeling, even at sites where total fish counts in the reach were low (as few as 3 fish). Occupancy models indicated that, where Coho were present, the probability of detection in a water sample ranged from 0.67 to 0.83 and the probability of detection in a PCR replicate ranged from 0.55 to 0.99. Both probabilities were positively related to density of fish. Collectively, our results indicate that eDNA sampling may be a useful tool for detecting rare stream fishes in watersheds with Mediterranean climates; however, the spatial resolution of sampling will likely need to be fairly fine—on the order of a kilometer or so—for eDNA methods to yield a high probability of detecting fish in streams during low-flow periods.

Slack-Loop Antennas: A Flexible PIT-Tag Antenna Design to Meet the Challenges of Monitoring Fish Movement in Coastal California Streams

Haley A. Ohms, Ph.D., *Institute of Marine Science, UC Santa Cruz, and NOAA Southwest Fisheries Science Center (Presenter); and Co-authors:* ***Gabriel T. Brooks,*** *NOAA Northwest Fisheries Science Center;* ***J. Vincent Tranquilli,*** *Oregon Department of Fish and Wildlife, Fish Research and Monitoring Program; and* ***David A. Boughton, Ph.D.,*** *NOAA Southwest Fisheries Science Center*

Have you ever listened to the rain on your roof and thought, oh no, there goes my antenna—again? We have, and it's an awful way to spend a winter. California's central coast is a notoriously difficult place to operate passive inductive transponder (PIT) tag antennas because streams are flashy and have highly mobile sediment. In an attempt to make a half-duplex antenna that would better handle these conditions, and thus give us a better night's sleep, we designed a flexible antenna to withstand high flows, debris, and mobile sediment. We call this design a 'slack-loop antenna'. It is a half-duplex, pass-through antenna that is attached only at a single point on each streambank, and has top and bottom wires that bow downstream with the current. The slack-loop antenna design has allowed us to maintain operational antennas during high flows, and, safely re-connect them at high flows after blow-outs, instead of being forced to wait until flows come down. Slack-loop antennas can be used with either Oregon RFID or Biomark readers. In this talk, we will describe how to build slack-loop antennas, how to pair them with Oregon RFID and Biomark equipment, and the pros and cons compared with more traditional static antennas.

The Influence of Food Webs on Salmonid Growth and Performance: A Forgotten Link to Species Resilience

Friday Morning Concurrent Sessions

Session Coordinator*: Robert Lusardi,* *Center for Watershed Sciences, UC Davis*

Efforts to conserve at-risk populations of anadromous Pacific salmon *(Oncorhynchus spp.)* often focus on the restoration of physical habitat features (e.g., water temperature, pool frequency and depth, large wood abundance, etc.) associated with enhanced juvenile production in freshwater. However, there is growing recognition that restoration and protection of suitable habitat must consider interactions between physical habitat features, ecosystem productivity, and fish performance. Recently, numerous scientists have called for a broader understanding of how prey availability and food webs affect the growth, persistence, and survivorship of juvenile salmonids. This session will examine the effects of food webs and aquatic habitat productivity on the growth of juvenile salmonids, particularly in productive ecosystems or where food webs strongly interact with physical habitat attributes to influence growth.

Food Webs and Juvenile Steelhead Behavior in Coastal California—Towards a Foodscape Perspective

Gabriel Rossi, *UC Berkeley (Presenter); and Co-Authors:* ***Mary Power, Stephanie Carlson, Ted Grantham,*** *and* ***Shelley Pneh,*** *UC Berkeley*

The seasonality of stream food webs exert a strong effect on the behavior, physiology, growth, and life history of rearing salmon and steelhead. This is especially true in Mediterranean streams—characterized by strong inter- and intra-annual hydrologic variability. However, the term "Mediterranean stream" encompasses a wide range of hydrologies from perennial to nearly arid systems. Here we present a study of how the foraging behavior, physiology, and life history of juvenile steelhead *(Oncorhynchus mykiss)* track food web and hydrologic phenology in two radically different Mediterranean streams—one perennial and the other intermittent. Late-spring growth potential was higher in the intermittent stream, but conditions favorable to growth declined sharply to an inhospitable, low oxygen environment with high fish mortality by mid-summer. In the perennial stream, late-spring growth potential was lower, but conditions suitable for growth increased through June, with positive growth and with low mortality even in late summer. The life history implication for anadromous salmonids between these streams are pronounced, with strong differences in growth, foraging phenology, apparent lipid allocation, and outmigration constraints.

The principles learned from studying tributary food webs can be expanded to the entire river network. Salmon are fed by different trophic pathways, varying both with season and habitat type along the river network. These different trophic pathways produce asynchronous pulses of growth potential for juvenile salmonids in time (winter, spring, summer, fall) and space (tributary, mainstem, floodplain, estuary). Life history diversity within and between species allows population of sympatric salmonids to exploit this shifting mosaic of growth potential, but human manipulation of the watershed affects both the productivity and exploitability of salmon rearing habitats. In the second part of this talk we will explore what we know and what we still need to learn to develop and apply a foodscape perspective on salmon recovery.

Abundant Prey Availability Improves Juvenile Coho Growth Under Warming Stream Temperatures

Robert Lusardi, Ph.D., *UC Davis Center for Watershed Sciences and California Trout Coldwater Fish Scientist (Presenter); and Co-authors:* ***Bruce Hammock, Ph.D., Carson Jeffres, Ph.D.,*** *and* ***Randy Dahlgren, Ph.D.,*** *UC Davis; and* ***Joseph Kiernan, Ph.D.,*** *NOAA Fisheries*

Despite its importance in bioenergetics, aquatic ecosystem productivity remains relatively understudied when compared to the effects of water temperature and physical habitat on the growth of juvenile salmonids. Productive aquatic ecosystems, however, may exhibit enhanced secondary production with important implications for salmonid growth. Using a series of in situ mesocosms, we show that prey availability is the predominant factor influencing age-0+ Coho salmon growth over a natural gradient of temperature and prey abundance during the summer low flow period. Coho salmon absolute growth rates peaked at a mean daily average water temperature of 16.6 °C and an associated maximum weekly maximum temperature (MWMT) of 21.1 °C. Juvenile growth under these thermal conditions was six-fold greater than the growth rates observed for conspecifics rearing in the coolest study reach (mean T = 13.0 °C; MWMT = 16.0 °C). Even at the highest rearing temperature (mean T = 18.1 °C; MWMT = 24.0 °C), growth rates remained positive and above the study-wide average, although overall survival was reduced. The results suggest that ecosystem productivity could help buffer the negative effects of elevated water temperature on fish growth with important implications for climate change.

Juvenile Chinook Salmon Growth Across a Diversity of Habitats in the Butte Creek and Sacramento River Watersheds

Flora Cordoleani, Ph.D., *UCSC & NOAA Fisheries (Presenter);*
and Co-Authors: ***Eric Holmes,*** *UC Davis;* ***Rachel C. Johnson, Ph.D.,*** *NOAA Fisheries & UC Davis;*
and ***Carson Jeffres, Ph.D.****, UC Davis*

California's Central Valley supports four runs of Chinook salmon that vary in their extinction risk with winter and spring runs imperiled and fall/late-fall supporting recreational and commercial fisheries. All runs of salmon are impacted by diminished juvenile rearing habitat due to channelization of rivers and loss of approximately 95% of floodplain and wetland habitats. In the Northern Central Valley of California, the Sutter Bypass and Butte Sink regions function as ephemeral floodplain habitat as the result of weir overtopping events in the Sacramento River, wetland management, and high flows in Butte Creek. The Butte Creek spring-run Chinook salmon population have been a relatively successful and stable population compared to other spring-run populations in the Central Valley and it has been suggested that perennial access to one of the last functional floodplain in the Central Valley plays an important role in their relative success.

We developed a multi-years foodweb and salmon growth study to investigate this role for Butte Creek spring-run Chinook salmon and other Central Valley juvenile salmonid populations. Salmon were placed within experimental enclosures at various locations in the Sacramento River and Butte Creek watershed in the winter of 2019 and 2020. Habitats included river channel, agricultural, and wetland floodplain. We investigated physical water quality parameters, primary producers, zooplankton abundance, and resulting growth of juvenile salmon in the experimental enclosures across the diverse landscape. We also collected juvenile salmon near enclosures using beach seines to determine the run (by size at date), condition, length, and diet content of wild fish in the same habitats. The findings from this study characterize how prey items and fish growth vary among diverse juvenile rearing habitats throughout the Central Valley, data critical to inform restoration needs to promote resilient salmon populations.

Lollipops and Lemons: Large Differences in Chinook Salmon Growth Among Tidal Marsh Sloughs of the Upper San Francisco Estuary, CA

Brett Harvey, Ph.D., *CA Department of Water Resources (Presenter); and Co-authors:* ***Jake Sousa, B.S.; Jason Hassrick, Ph.D.; Calvin Lee, M.S.***; *and* ***Lenny Grimaldo, Ph.D.***, *ICF Fish and Aquatic Science;* ***Michelle Nelson***, *CA Department of Water Resources and ICF Fish and Aquatic Science;* ***Miranda Tilcock***, *UC Davis;* ***Anna Sturrock, Ph.D.*** *and* ***Carson Jeffres, Ph.D.***, *UC Davis;* ***Rachel Johnson, Ph.D.*** *and* ***Steve Lindley, Ph.D.***, *NOAA Southwest Fisheries Science Center*

Estuarine habitat use by juvenile Chinook salmon (*Oncorhynchus tshawytscha)* migrating through the Sacramento-San Joaquin Delta and San Francisco Estuary, and the benefits that accrue from this habitat use, are arguably the most poorly understood aspects of juvenile salmon life history in California's Central Valley, yet this information is critical to building effective decision support tools to guide management of water resources and habitat restoration. As part of a three-year suite of studies to address these questions, known as The Tidal Parr Studies, we are conducting a juvenile growth study using enclosures located in shallow-water marsh and shoal habitats across Suisun Marsh and Bay. Results from the first year found clear and dramatic differences in somatic growth rate and survival of juvenile salmon among locations differing in marsh-upland connectivity, tidal exchange, water residence time, trophic resources, and proximity to trophic inputs from managed waterfowl ponds. Ongoing studies will further elucidate drivers of salmon growth to help guide effective marsh restoration.

Export of Invertebrate Drift from Fishless Headwater Streams: Implications for Downstream Trout Production

Jonathan M. Hollis, M.S., *CDFW (Presenter); and Co-Author:* ***Margaret Wilzbach, Ph.D.,*** *California Cooperative Fish & Wildlife Research Unit (emeritus)*

An understanding of ecological linkages between headwater systems and downstream habitats is needed to enhance management practices for aquatic conservation. I quantified and described the export of invertebrate drift from fishless headwater streams to assess its potential importance to downstream populations of Coastal Cutthroat Trout *(Oncorhynchus clarki clarki)* in the lower Klamath River in northern California. From June 2015 through April 2016, I sampled invertebrate drift in six fishless headwaters in the sub-basins of Tectah, Ah Pah, and Tarup creeks. Concurrently, I collected invertebrate drift and trout diet samples from adjoining fish-bearing streams. Drift export rates were lowest in October and greatest in April, and ranged from 98—1331 mg dry mass stream-1 d-1. Invertebrate taxa of aquatic origin dominated drift biomass in fishless streams on all four sampling occasions; the proportion of terrestrially-derived biomass was highest in October. Estimates of daily drift flux in fish-bearing streams exceeded the delivery of drift mass from fishless streams throughout the year. Trout diet samples demonstrated tremendous variability in invertebrate biomass among individuals within seasons. However, average biomass per diet sample differed strongly among sampling occasions and was greatest in April. Terrestrial taxa dominated the biomass of trout diets in June and October. Both drift and diet samples were taxonomically rich but exhibited little similarity to each other. I estimated drift exports from fishless headwaters could support a maximum of 37 g dry mass stream-1 year-1 of trout, theoretically accounting for one-tenth to one-quarter of the annual production of over-yearling trout in the study streams.

Puddle Power: Reactivating Floodplains and Reenergizing River Food Webs

Jacob Katz, Ph.D., *California Trout (Presenter); and Co-authors:* ***Jacob Montgomery,*** *California Trout;* ***Carson Jeffres*** *and* ***Eric Holmes,*** *UC Davis Center for Watershed Sciences*

Recovery of endangered fish populations will likely be impossible without first reinstating landscape-scale natural processes which create and maintain diverse aquatic habitats and power abundant river ecosystems. One such process in the pre-development Central Valley was annual flooding which seasonally created a vast mosaic of productive floodplain habitats inundated for months each winter and spring, and facilitated the incorporation of floodplain-derived carbon into aquatic food webs. Put simply, seasonal flooding of broad shallow floodplains was the engine of natural productivity that once attracted and supported one of the great wildlife migrations on earth where two million salmon and tens of millions of waterfowl returned to the Valley annually. Nineteenth and twentieth-century investments in a network of drains, dams, canals, and levees irrevocably altered the patterns of water flow across the landscape and transformed the Central Valley from one of the world's great wildlife landscapes into one of Earth's most productive agricultural regions. 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 robust aquatic food webs, create fish and wildlife biomass, and sustain abundant fish and wildlife populations. Put simply, modern water management starves river ecosystems and creates endangered fish populations.

Our research has demonstrated that the physical conditions which typified historical winter and spring flooding patterns–shallower depths, warmer water, longer residence times, and detrital carbon sources– can be mimicked on managed wetlands and winter-flooded agricultural fields. Floodplain habitats facilitate dramatically higher rates of food web production compared to the deeper, colder, swifter waters and algal-based carbon sources found in most contemporary leveed river channels. Nearly a decade of experiments in dozens of locations has demonstrated that juvenile salmonids foraging on ephemeral floodplain habitats can grow at rates many times faster than those in adjacent river channels.

This presentation will demonstrate how multi-species-multi-benefit land uses can cultivate ecological solutions on actively farmed agricultural landscapes by mimicking the historical flood patterns that restore the ecological functions to which California's native fish species are adapted. A proposal for a portfolio of landscape scale projects (totaling over 250,000 acres) focused on reintegrating floodplain function into Sacramento Valley water, fish, and farm management will be presented and discussed.

Isotopes and Fish Eyes: New Tool to Track Population-level Benefits of Floodplains for Chinook Salmon

***Miranda Bell Tilcock** (Presenter); and Co-Authors: **Carson Jeffres,** and **Anna Sturrock,** UC Davis and **Rachel Johnson,** NOAA Southwest Fisheries Science Center*

In the Central Valley, California (USA), floodplains, like the Yolo Bypass, are critical nursery habitat for juvenile Chinook salmon, yet few quantitative tools exist to estimate contributions of these habitats to Chinook salmon populations. Previous work has demonstrated across multiple years how juvenile Chinook salmon reared on the Yolo Bypass have reduced 34S/32S isotopic signatures in their diets ($\delta^{34}S$ = -3.467‰ ± 2.27) and tissues, relative to salmon collected in the adjacent Sacramento River ($\delta^{34}S$ = +2.32‰ ± 2.50). These isotopic signatures are permanently archived within the protein-rich eye lens and for the first time will be used to quantitatively estimate the survival benefits Chinook salmon receive from rearing on floodplains like the Yolo Bypass. This was done by identifying the $\delta^{34}S$ value in individual lens layers from Chinook salmon as both juveniles prior to ocean entry as well as those from the same cohort that returned to spawn. By looking at these individual lens layers and known $\delta^{34}S$ signature from the Yolo Bypass, we can identify which fish used the Yolo Bypass before migrating to the ocean and what proportion of those fish returned as adults to spawn.

Seascape Ecology Overview, Current Events, and Movement and Migration

Friday Afternoon Concurrent Sessions

Session Coordinators: ***Cynthia Le Doux-Bloom, Ph.D.***, *Humboldt State University, Department of Fisheries Biology; and* ***Nate Mantua, Ph.D.***, *NOAA, Southwest Fisheries Science Center*

Although many factors may be responsible for the declines in anadromous salmonid populations, this circumstance is commonly linked to the ocean conditions present during the marine life cycle phase, which remains unstudied compared to riverine and estuarine life phases. Upon ocean entry, salmonids display a wide range of growth and survival rates and display a variety of movement and migratory behaviors, both tied to ocean productivity which influences the foraging conditions these individuals encounter across space and time.

These sessions will feature innovative and novel studies focused on understanding the ocean life cycle phase of Pacific salmonids, including:

(1). An Overview of Seascape Ecology and Current Events;

(2). Movement and Migration;

(3). Survival and Growth; and

(4). Foraging Conditions in the California Current

Epipelagic Community Seascapes: Assessing and Predicting Species Composition in the Northern California Current

Caren Barceló, *Department of Wildlife, Fisheries and Conservation Biology, UC Davis (Presenter); and Co-authors:* ***Richard D. Brodeur,*** *NOAA, Northwest Fisheries Science Center, Hatfield Marine Science Center;* ***Lorenzo Ciannelli,*** *Oregon State University;* ***Elizabeth Daly,*** *Cooperative Institute of Marine Resource Studies, Oregon State University, Hatfield Marine Science Center;* ***Craig M. Risien,*** *College of Earth, Ocean, and Atmospheric Sciences, Oregon State University;* ***Gonzalo Saldías,*** *Departamento de Fisica, Facultad de Ciencias, Universidad del Bío-Bío, Concepción, Chile; and* ***Jameal Samhouri,*** *NOAA Northwest Fisheries Science Center*

Monitoring a community of marine species from space could provide an effective way of tracking higher trophic level changes in the ocean that can be of importance to different sectors of society. We relate the remotely sensed marine environment with a multi-species epipelagic fish and invertebrate community index, allowing for hind-casts and near real-time spatio-temporal predictions. MODIS Aqua 555 nm fields, which capture land-sea connections observable from space that can influence biology 10s to100s of miles offshore in the open ocean, were found to be a significant predictor of community differences in addition to surface temperature and sea surface height. From maps of community composition projected onto satellite data, we develop a new community-level, temporally and spatially explicit indicator that assesses variations in the epipelagic community (consisting of juvenile salmonid species, sardine, anchovies, herring, and other species). We propose that by coupling satellite data fields with multi-species community-level data, new remotely-sensed ecosystem state indicators could be used for regional ocean management.

Climate-related Variability in Zooplankton Indicators of Ecosystem Status in Coastal Waters off Northern California

Eric P. Bjorkstedt, *NOAA Fisheries, Southwest Fisheries Science Center and Humboldt State University (Presenter); and Co-Authors:* ***Roxanne Robertson*** *and* ***Blair Winnacott,*** *CIMEC at Humboldt State University*

Sampling along the Trinidad Head Line is conducted at approximately monthly intervals throughout the year to provide information on the state of the coastal plankton ecosystem off northern California in the context of hydrographic variability and climate forcing. The resulting time series of data resolves seasonal patterns in several assemblages, as well as cross-shelf structure in those taxa analyzed across the entire transect. Seasonal patterns in the euphausiid assemblage reflect combined effects of variability in reproductive output and advection-driven cross-shelf distributions. Moreover, the euphausiid assemblage exhibited strong, persistent changes in response to the marine heatwave of 2014-2016, including the detection of warm-water taxa not previously reported in our record. Similar shifts have been detected in assemblages of larval fish and larval cephalopods across the transect and in the copepod assemblage sampled at our mid-shelf station. Coincident with these changes in diverse plankton assemblages, we have observed a persistent shift in the mean size of adult Euphausia pacifica towards smaller individuals. Collectively, these time series provide strong evidence of changes in the plankton community off northern California in response to climate forcing, including shifts with potentially important implications for productivity throughout the broader ecosystem.

Can We Use an Ocean Productivity Model to Estimate Juvenile Salmon Early Ocean Survival?

Mark Henderson, *U.S. Geological Survey, California Cooperative Fish and Wildlife Research Unit, Department of Fisheries Biology, Humboldt State University (Presenter); and Co-authors:* ***Jerome Fiechter,*** *Department of Ocean Sciences, UC Santa Cruz;* ***David D. Huff,*** *Estuarine and Ocean Ecology Program, Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA; and* ***Brian K. Wells,*** *Fisheries Ecology Division, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA*

Early ocean survival of Chinook salmon, *Oncorhynchus tshawytscha,* varies greatly inter-annually and may be the period during which later spawning abundance and fishery recruitment are set. Therefore, identifying environmental drivers related to early survival may inform better models for management and sustainability of salmon in a variable environment. With this in mind, our main objectives were to: (1) identify regions of high temporal variability in growth potential over a 23-year time series, (2) determine if the spatial distribution of growth potential was correlated with observed oceanographic conditions, and (3) determine if these spatial patterns in growth potential could be used to estimate juvenile salmon survival. We applied this method to the fall run of the Central Valley Chinook salmon population, focusing on the spring and summer period after emigration into central California coastal waters. For the period from 1988-2010, juvenile salmon growth potential on the central California continental shelf was described by three spatial patterns. These three patterns were most correlated with upwelling, de-trended sea level anomalies, and the strength of onshore/offshore currents, respectively. Using the annual strength of these three patterns, as well as the overall growth potential throughout central California coastal waters, in a generalized linear model we explained 82% of the variation in juvenile salmon survival estimates. We attributed the relationship between growth potential and survival to variability in environmental conditions experienced by juvenile salmon during their first year at-sea, as well as potential shifts in predation pressure following out-migration into coastal waters.

The California Current Seascape Influences Juvenile Salmon Foraging Ecology at Multiple Scales

Megan C. Sabal, *UC Santa Cruz, Department of Ecology and Evolutionary Biology (Presenter); and Co-Authors:* ***Elliott L. Hazen, Steven J. Bograd, Isaac D. Schroeder,*** *Environmental Research Division, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA;* ***R. Bruce MacFarlane,*** *Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA and Institute of Marine Sciences, UC Santa Cruz;* ***Sean A. Hayes****; Kylie L. Scales Environmental Research Division, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Monterey and Institute of Marine Sciences, University of California Santa Cruz, Global Change Ecology Research Group, School of Science and Engineering, University of the Sunshine Coast;* ***Peter I. Miller,*** *Remote Sensing Group, Plymouth Marine Laboratory; and* ***Arnold J. Ammann, Jeffrey A. Harding,*** *and* ***Brian K. Wells,*** *Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Santa Cruz*

Juvenile salmon *(Oncorhynchus spp.)* experience variable mortality rates during their first few months in the ocean and high growth during this period is critical to minimize size-selective predation. Examining links between the physical environment and foraging ecology is important to understand mechanisms that drive growth. These mechanisms are complex and include interactions among the physical environment, forage availability, bioenergetics, and salmon foraging behavior. Our objectives were to explore how seascape features (biological and physical) influence juvenile Chinook salmon *(O. tshawytscha)* foraging at annual and feeding-event scales in the California Current Ecosystem. We demonstrate that forage abundance was the most influential determinant of mean salmon stomach fullness at the annual scale, while at the feeding-event scale, fullness increased with greater cumulative upwelling during the 10 days prior and at closer distances to thermal fronts. Upwelling promotes nutrient enrichment and productivity, while fronts concentrate organisms, likely resulting in available prey to salmon and increased stomach fullness. Salmon were also more likely to consume krill when there was high prior upwelling and switched to non-krill invertebrates (i.e., amphipods, decapods, copepods) in weaker upwelling conditions. As salmon size increased from 72 mm to 250 mm, salmon were more likely to consume fish, equal amounts of krill, and fewer non-krill invertebrates. Broad seascape processes determined overall prey availability and fullness in a given year, while fine- and meso-scale processes influenced local accessibility of prey to individual salmon. Therefore, processes occurring at multiple scales will influence how marine organisms respond to changing environments.

Interactions Between Environment, Forage Availability, and Predation on Salmon in the Central California Current

Brian K. Wells, Ph.D., *NOAA Fisheries (Presenter);*
and Co-authors: ***Whitney Friedman, Ph.D.,*** *National Center for Ecological Analysis and Synthesis and* ***Jarrod Santora, Ph.D.,*** *NOAA Fisheries*

It is believed that the first weeks or months at sea for salmon is a critical period during which the magnitude of recruitment is set. Recent work from the California Current demonstrates that variability in forage availability is related to early salmon survival through a synergistic relationship with regional predator behaviors. The composition of the prey assemblage along the coast is linked to broad seascape conditions such as early upwelling and preconditioning of the shelf ecosystem. Typically, reduced stratification and nutrient introduction in late winter leads to robust krill populations and abundant lipid-rich forage fishes (e.g., rockfishes) during spring when salmon emigrate to sea. The distribution of prey during spring is largely dependent on fine- and mesoscale processes such as those resulting from wind and transport dynamics interacting with coastal geography (e.g., upwelling shadows, fronts). Salmon foraging success and condition are dependent on the overall abundance and quality of forage as well as its local accessibility. Improved foraging opportunities increase salmon growth which may allow the salmon to escape predator gapes. Importantly, predation on juvenile salmon can have significant effects on recruitment especially during years when there is limited alternative forage. We provide a full life-cycle model that represents the sensitivity of recruitment of salmon to these dynamics.

Monitoring Juvenile Chinook Salmon Distribution and Habitat Use in the San Francisco Estuary Using Environmental DNA (eDNA)

Thiago Sanches, *UC Davis (Presenter); and Co-Authors:* ***Brett Harvey, Ph.D.,*** *CA Department of Water Resources;* ***Calvin Lee, M.S.*** *and* ***Jason Hassrick, Ph.D.,*** *ICF Fish and Aquatic Science;* ***Anna Sturrock, Ph.D.*** *and* ***Andrea Schreier, Ph.D.,*** *UC Davis*

Although tidal marsh restoration is planned or underway in numerous locations across the San Francisco Estuary, little is known about pre-smolt Chinook salmon distribution and habitat use for a large portion of this region. This is partly because catching pre-smolt salmon in tidal marsh is difficult using conventional survey methods, such as trawl and beach seine. As part of a suite of studies known as the Tidal Parr Studies, we designed a high precision, high throughput eDNA protocol optimized for estuarine waters to gain a better understanding of the limitations of these methods and a better understanding of Chinook salmon distribution and habitat association. We validated our approach in controlled conditions to estimate the detection radius for eDNA and limits of detection and quantification. We then compared eDNA estimates of juvenile Chinook salmon distribution with estimates from a parallel trawl survey conducted in shallow water habitat of the upper estuary from January to June in 2018 and 2019. We conclude that eDNA sampling is a more efficient tool than trawling for detecting occurrence of juvenile Chinook salmon in tidal marsh channels and shoals of the San Francisco Estuary, particularly when density of salmon is low. Within these habitats, higher turbidity and lower dissolved oxygen were the best estimators of Chinook salmon eDNA detection during "dry year" climatic conditions, while higher Chl-a was the best predictor during a "wet year". Comparison of salmon distributions with trophic resources is currently underway. We expect broader use of eDNA for assessing Chinook salmon occupancy will provide managers with more detailed and reliable information for making decisions regarding habitat restoration and resource management in general.

Juvenile Salmon Distribution and Abundance in Tidal Marsh Habitats of the San Francisco Estuary

Jason Hassrick, Ph.D., *ICF Fish and Aquatic Science (Presenter);*
and Co-authors: ***Brett Harvey, Ph.D.,*** *Department of Water Resources;* ***Lenny Grimaldo, Ph.D., Jake Sousa, B.S.,*** *and* ***Calvin Lee, M.S.,*** *ICF Fish and Aquatic Science;* ***Joe Smith, Ph.D.,*** *NOAA Northwest Fisheries Science Center;* ***Rachel Johnson, Ph.D., Steve Lindley, Ph.D.,*** *and* ***Stuart Munsch, Ph.D.,*** *NOAA Southwest Fisheries Science Center*

The degree to which juvenile Chinook salmon use the upper San Francisco Estuary for rearing is currently one of the most poorly understood aspects of juvenile life history. Salmon parr have been haphazardly found in shallow marsh habitats in the upper estuary while sampling for other purposes but there is a critical data gap regarding the distribution and abundance of juvenile salmon within estuarine habitats. In other systems, shallow estuarine habitat is critically important for salmon refuge and growth, and faster growth is directly linked to increased survival. Current management efforts include developing salmon life-cycle models for analyzing the effects of complex water management, habitat restoration, and climate change scenarios on salmon populations. Life-cycle models lack spatially explicit empirical information on the use of different habitats by salmon throughout the Bay-Delta. Additionally, multiple agencies and non-governmental organizations are working on restoring marsh habitat within the Bay-Delta but little information is available regarding the degree to which salmon use these restored habitats. As part of a suite of studies, known as the Tidal Parr Studies, to begin to fill these knowledge gaps we have initiated a three-year survey of fish assemblages in shallow-water marsh and shoal habitat from the Delta to San Pablo Bay to determine juvenile salmon distribution, timing, and abundance in habitats of varying quality, as defined by the NOAA Fisheries Winter-run life cycle model. The immediate purpose of this study is to determine whether observed salmon responses match the assumptions and expectations of habitat suitability and life-cycle models currently guiding resource management and habitat restoration in the Bay-Delta Estuary, while at the same time supplying much-needed quantitative information to improve these models. Our broader purpose in improving these models is to contribute to more objective and accurate predictions of alternative management and restoration actions intended to recover Central Valley salmon populations.

Preliminary results from 2019 indicate that 101 juvenile salmon were caught below the Sacramento-San Joaquin confluence and San Pablo Bay in 233 tows. Twice as many salmon were captured in eastern Suisun Bay and Grizzly Bay relative to the other four regions, although salmon were observed in the upper reaches of Suisun Marsh. More than twice as many salmon were captured in distributary marsh channels relative to open shoals and terminal channel habitats. Juveniles were as small as 30 mm parr, averaging 59 mm fork length. Sampling began in early January but salmon were first encountered on February 8 below the confluence. Salmon were captured until late May, with the last observed catch in Grizzly Bay on May 30th, suggesting brackish bay and marsh habitats were being used by rearing salmon for four months. The spatial distribution of salmon was restricted to the bays once marsh habitats exceeded 19 degrees Celsius. In addition to a descriptive analysis, we apply multilevel modeling techniques to understand how measured water quality and zooplankton species collected concurrently with salmon trawls may be used to predict the extent of juvenile salmon habitat in San Francisco Estuary.

(Un)Dam it! Dam Removal and Fish Passage Projects in California

Session Coordinator*: Darren Mierau,* *CalTrout North Coast Director*

Throughout the United States, aging dams and fish barriers of all sizes represent an unprecedented opportunity for salmon restorationists. By removing barriers to migration, we can restore fish access to spawning and rearing habitat, as well as increase streamflows and reduce harmful temperatures and algal blooms. This session will explore the many facets and stages of successful and ongoing dam and fish barrier removal projects throughout California, from permitting and project initiation to decommissioning and river restoration.

Thermal and Habitat Suitability for Anadromous Salmonids in the Dammed and Inaccessible Upper Mainstem Eel River Sub-basin in the Eel River Watershed

Alyssa FitzGerald, Ph.D., *UC Santa Cruz, NOAA Fisheries affiliate, (Presenter); and Co-authors:* ***David Boughton, Ph.D.,*** *NOAA Southwest Fisheries Science Center;* ***Josh Fuller, Ph.D.,*** *NOAA West Coast Region Santa Rosa;* ***Sara John, Ph.D.,*** *UC Santa Cruz, NOAA Fisheries affiliate;* ***Lee Harrison, Ph.D.*** *and* ***Nate Mantua, Ph.D.,*** *NOAA Southwest Fisheries Science Center*

In the Eel River watershed, stream temperatures warm markedly in the summer, resulting in sub-optimal or even lethal temperatures in some reaches for economically important but declining anadromous salmonids. Cool water refugia therefore become incredibly important, and these refugia are even more important during prolonged drought years. Of interest is the Upper Mainstem Eel River sub-basin, which historically hosted populations of winter- and summer-run steelhead and fall-run Chinook, but is currently inaccessible to anadromous salmonids due to Scott Dam. For this project, we estimated the amount of habitat in the Upper Mainstem Eel River sub-basin that would be suitable for steelhead and Chinook during normal, wet, and dry years, and compared these amounts to suitability in other sub-basins to determine the relative value of the Upper Mainstem Eel River sub-basin to anadromous salmonids in the Eel River watershed.

To calculate the amount of suitable salmonid habitat, we determined if a reach was: 1) thermally suitable and 2) habitable based on stream type, for all ~10,000 river kilometers in the Eel River watershed. As these two data are sparsely measured throughout the entire watershed, we employed a spatial stream temperature model to estimate mean monthly stream temperature for every river kilometer in the watershed and defined geomorphic stream type by gradient. Next, we calculated the amount of suitable habitat within each sub-basin—including the currently inaccessible Upper Mainstem Eel River sub-basin—for steelhead winter-run, steelhead summer-run, and Chinook fall-run, based on phenology, thermal criteria, and habitat suitability specific to each run and life stage. We found that the Upper Mainstem Eel River sub-basin provided temperatures that were cooler than much of the rest of the watershed in normal and drought years and contained multiple habitat types that could be readily used by several life stages. Productive, thermally suitable habitat was present in the currently blocked Upper Mainstem Eel River sub-basin even for incubation beginning in the early fall during drought years. This sub-basin also had the lowest percentage of sub-optimal/lethal temperatures for juveniles rearing of all large sub-basins during summer drought months, indicating that in the summer the Upper Mainstem Eel River may provide a cool water refuge from predation and competition. Together, these results indicate that the Upper Mainstem Eel River sub-basin may provide an important cool water refuge in the Eel River watershed during drought years.

If It's Broke, Why Fix It? Crumbling Concrete Coming to a Small Hydro Project Near You

Chris Shutes, California Sportfishing Protection Alliance

Much of America's infrastructure is crumbling. Dams are no exception. In previous SRF sessions, the presenters have discussed how changing energy markets have decreased the value of many small hydropower projects. Projects that cannot add flexible generation to regulate the power grid can't compete with lower cost wind and solar generation of electricity. Small hydro's problem is made worse by old age and large footprints. Bad economics have contributed to deferred maintenance of aging dams, canals, tunnels, penstocks, and powerhouses. In 2020, as parts of these projects begin to fail, many utilities are choosing to send much of the old hydropower fleet to the scrapyard instead of the repair shop.

This session will provide a survey of both worn and worn out small hydropower projects in northern and central California. It will suggest ways that stakeholders, power companies, and state and federal authorities can work together to get in front of decomposing infrastructure on a planned and proactive basis. It will examine the different approaches that utilities have used to get these projects off their books. For projects that are worth fixing, it will suggest initiatives that can retain the non-power values of aging hydropower projects such as water supply, recreation, and fishery support. For projects that are not worth fixing, it will discuss more collaborative ways to develop removal plans.

Battle Creek Salmon and Steelhead Restoration Project

***Mary Marshall** (Presenter) and **Trang Nguyen**, USDOI, Bureau of Reclamation*

Battle Creek has the unique geology, hydrology, and habitat suitability to support threatened and endangered Chinook salmon and Central Valley steelhead. The Battle Creek Salmon and Steelhead Restoration Project, located in Shasta and Tehama Counties near Manton, California, is among the largest cold-water anadromous fish restoration efforts in North America. The project is restoring approximately 42 miles of habitat on Battle Creek and an additional 6 miles of habitat on tributaries to Battle Creek, while continuing hydroelectric power production at Pacific Gas and Electric Company's (PG&E's) Battle Creek Hydroelectric Project—Federal Energy Regulatory Commission (FERC) Project No. 1121.

The project is a partnership between PG&E, the Bureau of Reclamation, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the California Department of Fish and Wildlife. In addition, numerous stakeholders, including the Battle Creek Watershed Conservancy, the Greater Battle Creek Watershed Working Group, landowners, and funders have made and continue to make important contributions to the project.

Project implementation includes modification of Battle Creek Hydroelectric Project facilities located on North Fork Battle Creek, South Fork Battle Creek, and Baldwin Creek in three phases. By removing five diversions dams and constructing fish screens and ladders on three other diversion dams, the project is providing safe passage for anadromous fish to reach the cold water and habitat needed for them to successfully spawn and increase their populations. The project is also preventing false attraction by stopping the mixing of North Fork Battle Creek and South Fork Battle Creek waters, through the construction of powerhouse bypass and tailrace connectors; protecting a trout hatchery from diseases carried by anadromous fish, through the construction of a fish barrier weir; increasing instream flows; dedicating water rights for instream purposes at dam removal sites; and implementing adaptive management to ensure fisheries objectives are met.

To date, a dam and canal system have been removed; and, two fish screens and ladders, a powerhouse bypass and tailrace connector, and a fish barrier weir have been constructed.

Due to PG&E's intent to not renew their FERC license in 2026, the project is currently moving forward with removal work only.

The Eel River Potter Valley Project—Modernizing Hydro-Power Infrastructure in One of California's Wildest Rivers

***Redgie Collins**, California Trout (Presenter);*
*and **Curtis Knight** and **Darren Mierau**, California Trout*

The Eel River Dams—Scott Dam and Cape Horn Dam—are owned and operated by Pacific Gas and Electric (PG&E) as part of the century-old Potter Valley Project (PVP). Historically an important source of "clean" hydro-electric power and both domestic and irrigation water supplies to Southern Mendocino and Northern Sonoma counties, the PVP in the 21st C is at a critical infrastructure cross-roads. The power generation is marginal, and, unable to capitalize on the trans-basin delivery of 70,000+ acre-feet of water from the Eel to the Russian, PG&E has been incurring annual financial losses of $5-7 million. In 2018, facing millions of dollars in FERC relicensing costs and tens-of-millions in capital investments to enable fish passage for threatened fall-run Chinook salmon and winter-run steelhead, PG&E settled on a seldom-used license pathway—abandon relicensing the project. Only a few months later PG&E entered Chapter 11 Bankruptcy.

The Potter Valley Project has always been a regional project, and now it needs a regional solution. In a somewhat unprecedented step, five disparate stakeholder groups have stepped forward to lead the project through uncharted waters toward an undetermined outcome, defined only by individual interests and a pledge to pursue Congressman Huffman's mandate of a "two-basin solution". Those five groups: Sonoma Water, Mendocino County Inland Water and Power Commission, Humboldt County, the Round Valley Indian Tribe, and California Trout are bidding to find a feasible solution to the outdated PVP infrastructure, one that continues to provide critical water supplies to a burgeoning region while restoring the wildness to the Eel River and its once abundant salmon fisheries. A successful solution will require immense trust and cooperation among stakeholders, flexibility on the part of FERC, likely investment of public funding to complement millions of dollars eventually expected from PG&E, and a clear desire by political leaders, water users, and conservation organizations to abandon outdated conflicts and seek regional infrastructure solutions we can all support.

The Removal of San Clemente Dam—Lessons Learned and Questions Raised

Trish Chapman, *State Coastal Conservancy*

San Clemente Dam on the Carmel River in Monterey County is the largest dam removed to date in California. The 106-foot tall dam had the steepest fish ladder in the western U.S. and was a significant fish passage barrier. Between San Clemente Dam and the next major barrier were 25 miles of high quality steelhead spawning and rearing habitat. In the early 1990's, the Division of Safety of Dams determined that the dam was a seismic hazard and by the early 2000's the reservoir had sedimented in to the point that it was no longer serving a water supply purpose. San Clemente Dam was removed in 2015 as the result of a multi-year public-private partnership. It is the largest dam removed in California to date. Large restoration projects share many significant challenges to successful implementation such as funding, liability, regulatory hurdles, stakeholders, and challenging partnerships. The San Clemente Dam project also illustrates the challenges of design, construction, and regulatory oversight in a dynamic river system. This presentation will examine the San Clemente Dam Removal project and outline the key ingredients for success, some of the lessons learned, and the questions raised for future river restoration efforts.

Modifying Diversion Structures in the Shasta Valley to Improve Fish Passage and Enhance Flows

Andrew Braugh, *California Trout (Presenter) and Co-author:* ***Asil Donna,*** *Aquaterra Consulting*

The Shasta River is one of the most complex, unique, controversial, and potentially productive rivers in California. According to McBain and Trush (2013), factors affecting salmon recovery in the watershed include physical barriers (dams and weirs), flow alterations due to irrigation withdrawals and return flows (tailwater), degraded salmonid habitat, poor water quality (primarily temperature and dissolved oxygen), and loss of riparian vegetation, as major factors contributing to declining salmonid populations. This presentation illustrates examples of how California Trout builds relationships with private landowners to improve water management practices, including water diversions, throughout the basin. On-going restoration projects on the Hart and Cardoza Ranches demonstrate that constructive solutions exist for restoring fish passage to critical habitat by modifying water diversion structures and upgrading irrigation infrastructure.

Anadromous Salmonid Habitat Suitability Criteria

Friday Afternoon Concurrent Sessions

Session Coordinator*: Mark Gard,* *California Department of Fish and Wildlife*

This session will synthesize available information on spawning and rearing habitat and an analysis of what should be considered in the design process. The focus is the design of habitat restoration and water projects for anadromous salmonids in the Central Valley of California. The session is primarily focused on the intersection of biology and restoration strategies.

Large Scale Floodplain Rearing Habitat Rehabilitation: Southport Levee Setback

Chris Bowles, *cbec eco engineering (Presenter); and Co-authors:* ***Sam Diaz*** *and* ***John Stofleth,*** *cbec eco engineering and* ***Paul Dirksen,*** *West Sacramento Area Flood Control Agency*

Studies have hypothesized that there is very little remaining floodplain in California's Central Valley due to the combination of flow regulation, channel incision, and levee construction. Areas where floodplains can be restored should be high priorities for the restoration community, presenting the opportunity to increase essential ecosystem functions and provide anadromous fish habitat. The Southport Levee Improvement Project is one such opportunity. The multi-purpose project, situated along 5.6 miles of the right bank of the Sacramento River in West Sacramento, includes a major levee setback that is under construction. This project is an important step toward combining flood-risk reduction with significant ecological restoration.

The levee setback will create 150 acres of reconnected floodplain habitat. The restoration design creates riparian, perennial marsh, and floodplain habitat and accommodates compatible public recreation. The design will reduce habitat fragmentation, spatial/temporal losses, provide ecological uplift, and incorporate a watershed scale approach to ecosystem enhancement and flood protection. The establishment of ecological and physical design criteria are necessary to ensure creation of high-value habitat is maximized, species benefiting from restoration are maximized, and restoration design observes constraints of the Southport Project.

We will review the multi-disciplinary approach employed to integrate hydrodynamic modeling with ecological design to maximize the habitat enhancements of the restoration design. Our approach utilized a 2-dimensional hydrodynamic and morphological model as an analytical tool for assessing floodplain inundation dynamics to support restoration recommendations and optimization of ecological benefits. We will emphasize the benefits of using a 2-dimensional hydrodynamic model as a tool to describe hydrodynamic and ecological processes, inform restoration design, and satisfy ecological criteria and constraints.

We will also discuss how levee setback projects represent a significant opportunity for achieving increased flood protection and restoration of critical habitat for Delta and anadromous fish species and in turn, provide multiple benefits to society.

Review of Central Valley Anadromous Salmonid Habitat Suitability Criteria

Mark Gard, Ph.D., P.E., U.S. Fish and Wildlife Service

The presentation will provide an overview of methods and Habitat Suitability Criteria (HSC) for both Chinook salmon and steelhead spawning and juvenile rearing, as well as results of biological verification of the criteria. Seventeen sets of Central Valley site-specific HSC for Chinook salmon spawning, twelve sets of HSC for Chinook salmon fry rearing, ten sets of HSC for Chinook salmon juvenile rearing, five sets of HSC for steelhead spawning, and three sets of HSC for steelhead fry and juvenile rearing were identified. Biological verification was successful in ten out of thirteen cases. Differences between criteria were largely due to differences in methods used to collect data and develop the criteria.

Using Aerial Redd Survey Data and Two-dimensional Hydraulic Models to Construct a Temperature Dependent Spawning Resource Selection Function for Winter-run Chinook Salmon

Peter N. Dudley, *Southwest Fisheries Science Center, National Marine Fisheries Service and Cooperative Institute for Marine Ecosystems and Climate (CIMEC), UC Santa Cruz (Presenter); and Co-authors:* ***Sarah N. John*** *and* ***Milles E. Daniels,*** *Southwest Fisheries Science Center, National Marine Fisheries Service and Cooperative Institute for Marine Ecosystems and Climate (CIMEC), UC Santa Cruz; and* ***Eric M. Danner,*** *Southwest Fisheries Science Center, National Marine Fisheries Service, Santa Cruz, California*

Impassable barriers have cut off a great deal of historic salmonid spawning habitat. This habitat reduction has spurred efforts in spawning habitat restoration and modeling. These efforts require information on spawning site velocity and depth preferences, which may change as the environment changes. Gathering these data can be time-consuming and costly. This presentation uses available historic redd aerial surveys; 2D hydraulic modeling; and Bayesian, multivariate polynomial, logistic regression to calculate velocity and depth spawning resource selection functions and examine their interactions with temperature. Our methods result in univariate and multivariate resource selection functions, and find no interaction between velocity and depth preference, no interaction between depth preference and T, but a credible interaction between velocity preference and temperature. We find the best multivariate resource selection function is a model which includes temperature and interactions between depth, velocity, and temperature. According to the area under the curve metric for a receiver operating curve, this model is "useful". Finally, we apply this model in a web application to allow managers to visualize the resource selection function.

Mapping Salmon Rearing Habitat in the Delta

Gloria Desanker, *San Francisco Estuary Institute (Presenter);*
and Co-authors: ***Bruce DiGennaro,*** *The Essex Partnership and* ***Letitia Grenier, April Robinson, Micha Salomon, Sam Safran,*** *and* ***Alison Whipple,*** *San Francisco Estuary Institute*

The Sacramento-San Joaquin Delta, once a vast, productive support system for salmon populations, is now a high-risk area for rearing and migrating juvenile salmon. Numerous efforts are underway to restore wetland and aquatic habitats in the Delta to improve and expand rearing habitat. The extent of anthropogenic alterations, levees and diversions in the Delta, the high variability in life history strategies for migrating salmon, the many variables that affect habitat quality, and the major uncertainties in what constitutes good rearing habitat make achieving this goal challenging. There is a need to synthesize knowledge and data about conditions in the Delta to improve planning and implementation of restoration projects that benefit salmon.

As part of the Delta Conservancy's effort to improve restoration site selection and design, this project aims to define and map suitable rearing habitat for Chinook salmon in the Delta. Our approach was to summarize existing knowledge about what makes habitat good, map relevant parameters for which spatial data was available, and combine a selection of parameters to identify existing suitable habitat. We mapped suitable rearing habitat within the tidally influenced portion of the Delta. Criteria mapped included water temperature, water depth, a measure of connected wetland area, and wetland adjacency.

We also gathered input from local resource managers and stakeholders about areas in the Delta where existing habitat was thought to be suitable, areas that should be prioritized for restoration, and areas thought to be of high risk to juvenile salmon. Considerations identified by stakeholders included proximity of good habitat to tributaries, water diversions, and known predator hot spots that influence survival probability, proximity of good habitat along physical gradients such as temperature and salinity, and availability of opportunities for hedging across all life stages or size classes of salmon. Mapping data and stakeholder input were combined to highlight areas to be prioritized for conservation and restoration.

The maps created in this project provide landscape- and site-scale summaries of where rearing salmon are likely to be supported and where certain restoration actions might be appropriate. In addition, this effort identified key knowledge and data gaps related to improving conditions for rearing juvenile salmon in the highly altered Delta landscape.

Increasing Lateral Connectivity to Benefit Juvenile Salmonids on the Lower Yuba River: The Hallwood Side Channel and Floodplain Restoration Project

April Sawyer, *cbec, inc. ecoengineering (Presenter); and Co-authors:* ***Chris Hammersmark,*** *cbec, inc. ecoengineering;* ***Sam Diaz,*** *cbec, inc. ecoengineering;* ***Matthew Weber,*** *cbec, inc. ecoengineering;* ***Jon Parsons,*** *cbec ecoengineering, inc.;* ***Paul Cadrett,*** *United States Fish and Wildlife Service, Anadromous Fish Restoration Program;* ***Joe Merz, Kirsten Sellheim, Philip Colombano,*** *and* ***Michael Beakes,*** *Cramer Fish Sciences;* ***Rachel Hutchinson,*** *South Yuba River Citizens League; and* ***Paul Bratovich,*** *HDR Inc.*

Anthropogenic actions on the Lower Yuba River dating back to the Gold Rush altered geomorphic and hydraulic conditions and subsequently the available habitat for rearing juvenile salmonids. The Hallwood Side Channel and Floodplain Restoration Project was developed to address the United States Fish & Wildlife Service Anadromous Fish Restoration Program's goal to double natural production of anadromous fish in Central Valley rivers. Specifically, the Project was designed to restore and enhance ecosystem processes, focusing on juvenile rearing fall and spring-run Chinook salmon and California Central Valley steelhead. The Project is supported by numerous agencies and stakeholders and leverages relationships with aggregate mining landowners to facilitate economically efficient habitat enhancement. After several years of planning, design, permitting, and pre-project monitoring, Phase 1 began implementation in late summer 2019. The design process targeted increasing inundation frequency and duration during the rearing period in a network of perennial and seasonally inundated side channels and removing large, unnatural constraints separating the main channel from its floodplain. Focused riparian planting was paired with predictions for natural recruitment in an experimental setting. The full Project will proceed over 4 to 6 years and will create or enhance up to 157 acres of seasonally inundated floodplain habitat, 1.7 miles of perennial channels, and 6.1 miles of seasonal side channels and alcoves. Two-dimensional hydraulic models and habitat suitability indices were used to predict habitat benefits, including an increase in suitable acreage for rearing and wetted edge habitat. Due to a design based on restoring lateral connectivity and removing unnatural constraints, coupled with a robust monitoring program, the Project will provide a wealth of information regarding restoration success at a large scale.

Wanted: Project Site—A Framework for Evaluating Possible Restoration Sites

J.D. Wikert, U.S. Fish and Wildlife Service (Presenter);
and Co-authors: Rocko Brown, Ph.D. and Joseph Merz, Ph.D., Cramer Fish Sciences

Salmonid habitat restoration often occurs at locations that are available and accessible (low hanging fruit). In order for restoration to achieve larger watershed-scale goals, it is necessary to approach planning with a biological goal in mind (e.g., providing off-channel Chinook salmon rearing habitat in the spring). In addition, riverine landscapes are not random canvases. Even degraded river corridors follow basic gradients that need to be considered when planning habitat enhancement actions. Empirical or modeled data can enable a determination of how much habitat is necessary, when it needs to function, and how it needs to be distributed to maximize benefits. Logistical and efficacy considerations are also important factors as projects need to fall within available funding limitations and because increased budgetary efficiency can translate into greater amounts of restored habitats. Ultimately, restoration actions must be put into a context of ultimate goals for a population, watershed, or program to determine total effort needed, timelines, and track success. In this presentation, we will discuss the process used to evaluate restoration opportunities to enhance the migratory corridor for fall-run Chinook salmon and steelhead in the Stanislaus River, San Joaquin Basin, Central Valley, California and put it into the context of overall watershed restoration goals.

Quantifying Dynamic Floodplain Habitat for Juvenile Salmon Using a Hydrospatial Approach

Alison Whipple, Ph.D., *San Francisco Estuary Institute (Presenter); and Co-Authors:* ***Gloria Desanker,*** *San Francisco Estuary Institute;* ***Joshua Viers, Ph.D.,*** *UC Merced;* ***Ted Grantham, Ph.D.,*** *UC Berkeley;* ***Lisa Hunt, Ph.D.*** *and* ***Amy Merrill, Ph.D.,*** *American Rivers;* ***Jacob Katz, Ph.D,*** *CalTrout; and* ***Rene Henery, Ph.D.,*** *Trout Unlimited*

The restoration of floodplain functions is critical to the recovery of healthy salmon populations in the Central Valley and beyond. Seasonally inundated floodplains provide productive rearing habitat for juvenile salmonids, supporting their rapid growth and increasing the likelihood of survival on their journey to the ocean and within the marine environment. Achieving these salmon benefits, however, requires floodplain habitat restoration that considers the dynamic interactions of floodwaters and the landscape, which vary in space and time. Habitat quantification tools help scientists and natural resource managers evaluate the effects of land management, flow manipulation, and structural habitat improvements on the amount, quality, location, and timing of habitat available for target species. We used hydrospatial analysis—a spatially- and temporally-discretized approach that combines two-dimensional hydrodynamic modeling output with a daily flow time series—to evaluate physical metrics like depth and velocity, as well as inundation duration, timing, and connectivity, using juvenile Chinook salmon habitat suitability criteria. Habitat availability over a twenty-year period was quantified for several restoration sites within the Central Valley. Total annual habitat, measured in acre-day units, was summarized from daily spatially-resolved (grid-based) estimates of suitability. Results indicate where and when (within and across years) restoration sites may provide the greatest habitat benefits to salmon, as well as the sensitivity of habitat quantity to the suitability criteria applied. Results also reveal a high degree of variability in suitable habitat within and among sites and illustrate that flow-habitat relationships are non-linear and mediated by complex floodplain environments. This approach improves assessment of spatially- and temporally-variable floodplain habitat conditions and is being employed as part of the Chinook salmon Habitat Quantification Tool (HQT) of the Central Valley Habitat Exchange to guide the restoration and management of floodplains for salmon benefits.

Hydrologic Management Insights from Instrumented Watersheds

Friday Afternoon Concurrent Sessions

Session Coordinators*: Tim Bailey,* *Humboldt County Resource Conservation District; and* ***David Dralle, Postdoctoral Researcher,* *Eel River Critical Zone Observatory, Department of Earth and Planetary Science, UC Berkeley*

Successful watershed management requires a process-based understanding of the outcomes of management alternatives and treatments. Long-term ecological research sites and shorter-term intensively monitored sites both provide important insights into watershed hydrologic response to management strategies and natural variability. Well-designed experiments are needed to understand emerging management techniques. Data from all these approaches will be critical for formulating management responses to the myriad of ecological stressors faced by California's freshwater fisheries including declining summer baseflows. This session will be an opportunity to share data-driven insights into hydrologic responses to climate, disturbance and vegetation management (e.g., fire and timber harvest), restoration, and management interventions such as enhanced groundwater recharge.

Hyporheic Restoration: Lessons From Meacham Creek, OR

Byron Amerson, *Cardno, Inc. (Presenter); and Co-authors:* ***Geoff Poole, Scott O'Daniel,*** *and* ***Mike Lambert,*** *ESA*

In the summer of 2011, the Confederated Tribes of the Umatilla Indian Reservation restored a one-mile reach of Meacham Creek, a tributary to the Umatilla River in north central Oregon. The baseline channel was an incised, wall-based channel with a homogenous and coarse bed with a shallow alluvial aquifer. In contrast, the restored channel was more sinuous with increased depth and substrate heterogeneity. For over 5 years we monitored the effect of the restoration on both floodplain hydrology and temperature via a network of water level and temperature loggers installed in 19 wells throughout the floodplain. We also modeled floodplain hydrology and temperature using the water table elevation and temperature measurements for calibration. We found that post-restoration the alluvial aquifer depth had increased by an average of 1.5 m. Our modeling indicated that channel planform had a strong effect on floodplain hydrology, shown by a decrease in maximum residence time of floodplain hyporheic water from about 680 days to 380 days. Given the increase in the floodplain water table elevation, the hyporheic volume increased from 1.6 m3 to 1.95 million m3. This increase in storage of 345,000 m3 yielded an increase in hyporheic flux (total hyporheic volume per meter of valley length) of 436 m2 pre-restoration to 529 m2 post restoration. Furthermore, floodplain temperature heterogeneity increased concomitantly with channel planform and floodplain residence time. While residence time and temperature heterogeneity were altered by restoration, the mean temperature of upwelling water was similar pre- and post-restoration. Hence, the frequency of potential thermal refugia increased along the channel while mean channel temperature was essentially unchanged.

Effects of Flow Augmentation on Coho Salmon Smolt Passage in Porter Creek, a Tributary to the Russian River, California

***Sarah Nossaman Pierce**, California Sea Grant (Presenter); and Co-authors: **Mariska Obedzinski** and **William Boucher**, California Sea Grant; and **Mia van Docto**, Trout Unlimited*

Insufficient spring and summer streamflows have been identified as significant bottlenecks to salmonid recovery in tributaries to the Russian River. In low water years, many of the tributaries that provide critical Coho and steelhead habitat, including Porter Creek, disconnect during smolt emigration and extensive stream drying limits survival of rearing juveniles.

In collaboration with multiple organizations, a private vineyard company dedicated water from an off-channel retention pond to be released into Porter Creek, but guidance is needed to determine the best practice for distributing the limited quantity of water available over the spring and summer months. We developed a study to determine the amount of flow required to maintain stream connectivity through the smolt emigration season and to examine the effects of flow augmentation on smolt passage. Streamflow gaging, wet/dry mapping, and time-lapse cameras were used to document disconnection and combined with PIT-tag detection data to evaluate the effects of the augmentation on emigrating smolts at different flow release levels. In 2018, we estimate that 25% of the annual smolt run was provided passage as a result of implemented flow releases. We are continuing our investigation in order to provide long-term guidance as to the timing, quantity, and duration of releases that will most benefit fish populations in Porter Creek.

Advancing Voluntary Flow Enhancement Projects in California's Small Streams and Rivers

Amy Campbell, *The Nature Conservancy, Environmental Water Transaction Project Director*

The next decade will be critical in the fight against the impact of climate change on California's natural resources. The effects of rising temperatures are already occurring as evident in recent extreme droughts and floods across California. These types of events over the last decade have raised awareness that current approaches to managing California's water are increasingly failing to meet the needs of both people and nature and it's essential that we work to protect and enhance biodiverse strongholds across the State. Inadequate flows in California's unregulated and smaller streams are prevalent during the dry season, which are causing freshwater species populations to decline and increasing water supply insecurity for the people and communities which rely on freshwater. These smaller streams and rivers are home to over 80 percent of California's freshwater biodiversity, and in these systems, almost half of the native salmon, steelhead, and trout are predicted to be extinct in 50 years.

To advance efforts to preserve and protect water in California in the most critical streams and rivers, the California Salmon and Steelhead Coalition, made up of The Nature Conservancy, Trout Unlimited, and California Trout, is developing a California Environmental Water Network (Network). The goal is to support the work of people and organizations working on-the-ground with building the technical skills and capacity needed to implement more voluntary and flow related projects across the State. Join the members of the California Salmon and Steelhead Coalition for an interactive session to learn more about the California Environmental Water Network and to provide feedback around this idea and how this Network might support your work on-the-ground.

Quantification of Water Storage and Non-perennial Runoff Dynamics in a Semi-arid Catchment

Amanda Donaldson, Ph.D. student, *UC Santa Cruz (Presenter);*
and ***Margaret Zimmer, Ph.D.,*** *UC Santa Cruz*

Although non-perennial streams only flow seasonally or during precipitation events, they provide important ecosystem habitats for many freshwater fish species' life cycles and deliver sediment, water, and solutes to downstream reaches. Our ability to manage and conserve these riverine systems hinges on a mechanistic understanding of the drivers of flow in non-perennial streams. At a 3.5-hectare oak woodland headwater catchment in the Blue Oak Ranch Reserve (coastal central CA), we investigated how the shallow soil properties and the degree of subsurface rock weathering influence catchment water storage capacity and the release of water to streamflow using a combination of hydrometric, isotopic, and geophysical approaches. We found that distinct antecedent wetness and subsurface critical zone characteristics influence the timing, magnitude, and duration of streamflow response to precipitation. This work highlights how the implementation of instrumented watershed-scale analyses can improve our scientific understanding and predictive power of non-perennial streams in the face of a rapidly changing world.

A Paired Watershed Comparison of Stream Condition: Disentangling Human Land Use from Natural Variability in Cannabis Producing Tributaries to the Headwaters of the Mattole River, CA

Elijah Portugal, M.S., *California Department of Fish and Wildlife (Presenter); and Co-authors:* ***Erin Ferguson, M.S., Jason Hwan, Ph.D., David Manthorne, M.S., Joseph Kermish-Wells, M.S.,*** *and* ***Kelly Souza,*** *California Department of Fish and Wildlife*

The California Department of Fish and Wildlife initiated a pilot study in 2018 to investigate hydrological and biological conditions in cannabis producing, Coho-bearing, naturally- intermittent tributaries to the upper Mattole River Watershed in northwestern California. A paired watershed design was used to attempt to isolate potential hydrological effects of water diversions for cannabis cultivation and other human uses from natural variability and impacts from legacy land use. We conducted hydrological and water quality monitoring (e.g., dissolved oxygen, temperature, and benthic macroinvertebrate community composition) during the outdoor cannabis growing season of May-Oct of 2018 and 2019 in three paired watersheds (two streams with cultivation and one without) and an additional seven unpaired watersheds in the region. 2018 cultivation sites were manually digitized using aerial imagery to make estimates of water demand using a hurdle model. Estimates of water demand (cannabis and non-cannabis human water use) were compared to measured surface water availability and watershed-specific unimpaired flow estimates and instream flow thresholds.

The Recession of Freedom— Investigating the Drivers of Within-reach Movement for Over-summering Juvenile Steelhead and Coho Salmon in a Drying Stream

Gabriel Rossi, *UC Berkeley (Presenter); and Co-authors:* ***Ted Grantham,*** *UC Berkeley; and* ***Mariska Obedzinski, Sarah Nossaman Pierce,*** *and* ***William Boucher,*** *California Sea Grant*

In coastal California, the spring-summer streamflow recession creates a seasonal pattern of habitat contraction that constrains the movement of juvenile salmon—but may also provide cues that guide salmon movement patterns. During the streamflow recession, water depth, water quality, and salmonid foraging profitability all decline rapidly and over-summering fish have a limited window of time to make movement decisions. Previous work suggests that such inter-pool movement decisions can have significant consequences for fish growth and survival. Human diversion and modification of streamflow has tended to create earlier and steeper streamflow recessions, which may further shorten the window of "freedom" for inter-pool movement by stream rearing salmonids. More research is needed to understand the environmental drivers and ecological consequences of juvenile salmon movement during the seasonal streamflow recession.

Porter Creek is a tributary to the Russian River in Sonoma County, which supports wild and hatchery-raised Coho Salmon, in addition to wild steelhead trout, and has been identified as a priority stream for salmonid recovery. Between May and October 2019, we monitored the inter-pool movement of Coho and steelhead in sixteen pools over four reaches of Porter Creek. In each reach, we monitored salmonid movement between sequential pools using PIT tag antennas placed over riffles. We also monitored multiple environmental parameters at the pool scale, including temperature, dissolved oxygen, riffle crest depths and widths, pool volume, and habitat indices. Using a random forest modeling framework, we tested our predictions that: (1) inter-pool movement decreases with declining riffle depths and widths, (2) movement ceases when water depths at the riffle crest fall below the average body depth of juvenile salmonids, and (3) before movement is constrained, juvenile salmon preferentially move into pools with greater depths, higher dissolved oxygen, and lower water temperature. The results of this study advance our understanding of the ecology and behavior of juvenile salmon and have implications for instream flow management and salmon recovery efforts in coastal California streams.

Hydrologic Insights From Comparing North Coast Stream Gage Data with Flow Estimation Methods and Geology

Valerie Zimmer, *State Water Board (Presenter); and Co-authors:* ***Bryan McFadin,*** *North Coast Regional Water Quality Control Board,* ***Thomas Gast,*** *Thomas Gast and Associates,* ***David Dralle, Ph.D.,*** *Sacramento State University,* ***Adam Weinberg,*** *State Water Board, and* ***Pat Higgins,*** *Eel River Recovery Project*

Tributary stream flows are often estimated using hydrologic modeling and stream-gage pairing, however, such methods can be highly inaccurate during the low-flow season. This may be attributable to unaccounted for environmental gradients, such as spatial variations in subsurface water holding capacity commonly encountered in geologically diverse landscapes, that nevertheless exert strong controls on processes that drive baseflow generation. Thus, spatially dense networks of streamflow gauges may be necessary to explain contrasting low flow behaviors between neighboring watersheds. We installed dozens of gages in the Eel River and other North Coast streams over the past 3 seasons, compared the flows against other methods of flow estimation, and analyzed the reasons for differences between measured and estimated flow. We present our hydrologic results and discuss the importance of accurate stream flow estimates for water management, eco-hydrology studies, and modeling.

Salmonid Restoration Federation

Board of Directors

Don Allan (President)
Restoration Consultant
donallan51@gmail.com

Michael Berry (Vice-President)
Dept. of Water Resources
Michael.Berry@water.ca.gov

Brian LeNeve (Treasurer)
Carmel River
Steelhead Association
brian@brianleneve.com

Sarah Phillips (Secretary)
Marin Resource
Conservation District
sarah@marinrcd.org

Eli Asarian
Riverbend Sciences
eli@riverbendsci.com

Anna Halligan (alternate)
Trout Unlimited
AHalligan@tu.org

Jennifer Hemmert (alternate)
CA Department
of Fish and Wildlife
ennifer.hemmert@wildlife.ca.gov

Cynthia LeDoux-Bloom, Ph.D.
HSU Department
of Fisheries Biology
cledouxbloom@gmail.com

Freddy Otte
City of San Luis Obispo
fotte@slocity.org

Katrina Nystrom
HSU Natural Resources
Graduate Program
katrinaclare@gmail.com

Elijah Portugal (alternate)
CDFW Fisheries Branch
elijahwp@gmail.com

Dan Resnik (alternate)
CA Department
of Fish and Wildlife
Dan.Resnik@wildlife.ca.gov

Dougald Scott, Ph.D.
Professor Emeritus
dougald@comcast.net

Staff

Dana Stolzman
Executive Director
srf@calsalmon.org

Maddie Halloran
Program Associate
maddie@calsalmon.org

Dian Griffith
Bookkeeper
dian@calsalmon.org

Nicole Nada
Project Assistant
nicole@calsalmon.org

SRF 425 Snug Alley, Unit D, Eureka, California 95501, (707) 923-7501

Presenter Directory

Byron Amerson
ESA
BAmerson@esassoc.com

Gregory Andrew
Marin Municipal Water District
gandrew@marinwater.org

Eli Asarian
Riverbend Sciences
eli@riverbendsci.com

Tim Bailey
Humboldt Resource Conservation District
watersheds.newforestry@gmail.com

John Bair
McBain Associates
john@mcbainassociates.com

Caren Barcelo
UC Davis
cbarcelo@ucdavis.edu

Miranda Bell Tilcock
UC Davis
—Center for Watershed Sciences
mirbell@ucdavis.edu

Chris Berry
City of Santa Cruz
cberry@cityofsantacruz.com

Eric Bjorkstedt
NOAA SWFSC and HSU
eric.bjorkstedt@noaa.gov

Chuck Bonham
California Department of Fish and Wildlife
Director@wildlife.ca.gov

David Boughton
National Marine Fisheries Service
David.Boughton@noaa.gov

Chris Bowles
cbec, inc.
c.bowles@cbecoeng.com

Andrew Braugh
California Trout
drewbraugh@gmail.com

Anne Bremer
The Watershed Project
anne@thewatershedproject.org

Preston Brown
Salmon Protection and Watershed Network (SPAWN)
preston@tirn.net

Amy Campbell
The Nature Conservancy
acampbell@tnc.org

Beverly Chaney
Monterey Peninsula Water Management District
beverly@mpwmd.dst.ca.us

Trish Chapman
State Coastal Conservancy
tchapman@scc.ca.gov

Damion Ciotti
US Fish and Wildlife Service
damion_ciotti@fws.gov

Matt Clifford
Trout Unlimited
mclifford@tu.org

Brian Cluer Ph.D.
NOAA Fisheries
brian.cluer@noaa.gov

Redgie Collins
Cal Trout
rcollins@caltrout.org

Flora Cordoleani Ph.D.
NOAA Southwest Fisheries Science Center
flora.cordoleani@noaa.gov

Ryan Cuthbert
FISHBIO
ryancuthbert@fishbio.com

Rosi Dagit
RCDSMM
rdagit@rcdsmm.org

Gloria Desanker
San Francisco Estuary Institute
gloriad@sfei.org

Sam Diaz
CBEC
s.diaz@cbecoeng.com

Amanda Donaldson
UCSC
amdonald@ucsc.edu

David Dralle, Ph.D.
UC Berkeley and Sacramento State University
dralle@berkeley.edu

Peter Dudley
NOAA Fisheries
pndphd@gmail.com

Amy East
USGS Pacific Coastal Marine Science Center
aeast@usgs.gov

Jack Eschenroeder
FISHBIO
jackeschenroeder@fishbio.com

Jerome Fiechter
University of California at Santa Cruz
fiechter@ucsc.edu

Christy Fischer
Santa Lucia Conservancy
cfischer@slconservancy.org

Alyssa FitzGerald
University of California Santa Cruz, NOAA Fisheries affiliate
alyssa.fitzgerald@noaa.gov

Tim Frahm
Trout Unlimited
timfrahm@hotmail.com

Herman Garcia
CHEER
Herman@CheerCentral.Org

Mark Gard
U.S Fish & Wildlife Service
Mark_Gard@fws.gov

John Carlos Garza Ph.D.
NOAA
carlos.garza@noaa.gov

Elizabeth Gilbert-Horvath
NOAA Fisheries, Southwest Fisheries Science Center
libby.gilbert@noaa.gov

Charnna Gilmore
Scott River Watershed Council
charnnagilmore@gmail.com

Eric Ginney
ESA
eginney@esassoc.com

Justin Gragg
Environmental Science Associates
jgragg@esassoc.com

Aaron Hebert
Midpeninsula Regional Open Space District
ahebert@openspace.org

Katie Haldeman
Sustainable Conservation
khaldeman@suscon.org

Chris Hammersmark Ph.D.
cbec, inc eco engineering
c.hammersmark@cbecoeng.com

Ben Harris
Monterey Bay Salmon & Trout Project
Director@mbstp.org

Brett Harvey Ph.D.
California Department of Water Resources
brett.harvey@water.ca.gov

Jason Hassrick
ICF
jason.hassrick@icfi.com

Mark Henderson
Humboldt State University / USGS
mark.henderson@humboldt.edu

Rene Henery Ph.D.
Trout Unlimited/ UNR
RHenery@tu.org

David Hines
CDFW
david.hines@wildlife.ca.gov

Jonathan Hollis
CA Department of Fish and Wildlife
jonathanmartinhollis@gmail.com

Gregg Horton
Sonoma County Water Agency
gregg.horton@scwa.ca.gov

David Huff
NWFSC NOAA
david.huff@noaa.gov

Tim Hyland
California State Parks
tim.hyland@parks.ca.gov

Jenn Hyman
EKI Environment & Water, Inc.
jhyman@ekiconsult.com

Joseph Issel
San Mateo Resource Conservation District
joe@sanmateorcd.org

Sandra Jacobson Ph.D.
California Trout
sjacobson@caltrout.org

Jon Jankovitz
CDFW
Jon.Jankovitz@wildlife.ca.gov

Chris Jordan
NOAA Fisheries
chris.jordan@noaa.gov

Brian Kastl
UC Berkeley
briankastl84@gmail.com

Jacob Katz Ph.D.
Central California Region, CalTrout
jkatz@caltrout.org

Kristen Kittleson
County of Santa Cruz
kristen.kittleson@santacruzcounty.us

Gary Kittleson
Kittleson Environmental Consulting
kittlesonenvironmental@gmail.com

John Klochak
US Fish and Wildlife Service
john_klochak@fws.gov

Curtis Knight
CalTrout
cknight@caltrout.org

Richard Lanman, Ph.D.
Institute for Historical Ecology
ricklanman@gmail.com

Brian LeNeve
Salmonid Restoration Federation
brian@brianleneve.com

Steve Lindley, Ph.D.
NOAA
steve.lindley@noaa.gov

Chris Loomis
CDFW
christopher.loomis@wildlife.ca.gov

Michael Love
Michael Love and Associates
mlove@h2odesigns.com

Erika Lovejoy
Sustainable Conservation
elovejoy@suscon.org

Kate Lundquist
Occidental Arts and Ecology Center
kate@oaec.org

Rob Lusardi Ph.D.
UC Davis —Center for Watershed Sciences
ralusardi@ucdavis.edu

Nathan Mantua, Ph.D.
NOAA/NMFS SW Fisheries Science Center
nate.mantua@gmail.com

Mary Marshall
U.S. Bureau of Reclamation
mmarshall@usbr.gov

Sarah Mesnick, Ph.D.
Southwest Fisheries Science Center, NOAA Fisheries
sarah.mesnick@noaa.gov

Darren Mierau
California Trout
DMierau@caltrout.org

Sky Miller
Cardno
sky.miller@cardno.com

Emily Miller
Monterey Bay Aquarium
emmiller@mbayaq.org

Carrie Monohan
The Sierra Fund
carrie.monohan@sierrafund.org

Jacob Montgomery
California Trout
jacob@caltrout.org

Jonathan Nelson
CA Dept of Fish and Wildlife
jonathan.nelson@wildlife.ca.gov

Sarah Nossaman Pierce, Ph.D.
CA Sea Grant
snossamanpierce@ucsd.edu

Katrina Nystrom
HSU River Institute
katrinaclare@gmail.com

Kevin O'Connor
Central Coast Wetlands Group
koconnor@mlml.calstate.edu

Haley Ohms, Ph.D.
NOAA Fisheries/UCSC
haley.ohms@noaa.gov

Laura O'Leary
Peninsula Open Space Trust
loleary@openspacetrust.org

Jonathan Owens
Balance Hydrologics, Inc.
jowens@balancehydro.com

Rafael Payan
Monterey Peninsula
Regional Park District
payan@mprpd.org

Joe Pecharich
NOAA Restoration Center
joe.pecharich@noaa.gov

Emanuel Peterson
California Urban
Streams Partnership
custreams@gmail.com

Sarah Phillips
Marin Resource
Conservation District
Sarah@marinrcd.org

Elijah Portugal
CA Dept of Fish and Wildlife
Elijah.Portugal@wildlife.ca.gov

Max Ramos
Humboldt State University
mmr37@humboldt.edu

Allan Renger
California Department
of Fish and Wildlife
allan.renger@wildlife.ca.gov

David Revell
ESA PWA
revellcoastal@gmail.com

Ann Riley, Ph.D.
California Urban
Streams Partnerships
rileywaterways@gmail.com

James Robins
Alnus Ecological
jrobins@alnus-eco.com

Tim Robinson, Ph.D.
Cachuma Operation and
Maintenance Board (COMB)
trobinson@cachuma-board.org

April Robinson
San Francisco Estuary Institute
april@sfei.org

Gabriel Rossi
UC Berkeley
rossfactor@berkeley.edu

Katie Ross-Smith, Ph.D.
Cardno
katie.ross-smith@cardno.com

Megan Sabal
UC Santa Cruz
msabal@ucsc.edu

William Satterthwaite
NOAA National Marine
Fisheries Service
will.satterthwaite@noaa.gov

April Sawyer
cbec ecoengineering, inc
a.sawyer@cbecoeng.com

Monty Schmitt
The Nature Conservancy
monty.schmitt@tnc.org

Erin Seghesio
NOAA Fisheries
erin.seghesio@noaa.gov

Chris Shutes
California Sportfishing
Protection Alliance
blancapaloma@msn.com

Jai Singh
cbec eco engineering
j.singh@cbecoeng.com

Mike Sixta
US Bureau of Reclamation
msixta@usbr.gov

Ben Snyder
WRA, Inc.
snyder@wra-ca.com

Brian Spence
NOAA Fisheries
brian.spence@noaa.gov

Margaret Spring
Monterey Bay Aquarium
mspring@mbayaq.org

Stuart Suplink
California Polytechnic State
University, San Luis Obispo
ssuplick@gmail.com

Stephen Swales, Ph.D.
California Department
of Fish and Wildlife
stephen.swales@wildlife.ca.gov

Kevin Swift
Swift Water Design
kevin@swiftwriting.com

Bill Trush
HSU River Institute
bill.trush@gmail.com

Caroline Ubing
USBR
cubing@usbr.gov

Steph Wald
Creek Lands Conservation
steph@creekland.org

Julie Weeder
NOAA Fisheries
julie.weeder@noaa.gov

Brian Wells
NOAA Fisheries
brian.wells@noaa.gov

Joseph Wheaton, Ph.D.
Utah State University
joe.wheaton@usu.edu

Alison Whipple
San Francisco Estuary Institute
alisonw@sfei.org

Steve Wiesner
County of Santa Cruz
steve.wiesner@santacruzcounty.us

J.D. Wikert
USFWS
John_Wikert@fws.gov

Thomas Williams, Ph.D.
NOAA Fisheries
tommy.williams@noaa.gov

Malte Willmes
UC Santa Cruz
mwillmes@ucsc.edu

Keith Wolf, Ph.D.
Cardno
keith.wolf@cardno.com

Valerie Zimmer
California State Water Resources Control Board
valerie.zimmer@waterboards.ca.gov

23rd Annual Coho Confab

September 11-13, 2020, South Fork Eel River

Join SRF, California Department of Fish and Wildlife, Eel River Watershed Improvement Group, Cal Trout, Eel River Critical Observatory, Pacific Watershed Associates, Trout Unlimited, and other restoration partners in this exciting Confab on the banks of the South Fork Eel River. This Confab will feature fish passage projects, upslope sediment remediation, large wood projects, and a suite of other techniques that are implemented or are being planned in this critical watershed.

South Fork Eel River By Pernel S. Thyseldew

Poster Session Presenters

Making Sense of Sacramento
Presented by Michael Wellborn
California Watershed Network
michael@watershednetwork.org

Spawning Surveys Provide Insight Into The Mating System Of Sympatric Anadromous and Resident Oncorhynchus mykiss
Presented by Dereka Danielle Chargualaf
NOAA Southwest Fisheries Science Center / UC Santa Cruz
dereka.chargualaf@noaa.gov

Steelhead Abundance Following Invasive Species Suppression Efforts in a Small Coastal Stream
Presented by Matt McKechnie
Stillwater Sciences
mmckechnie@stillwatersci.com

Physics Versus Biology: Implications for Predation on Juvenile Salmon
Presented by J.D. Wikert
US Fish and Wildlife Service
john_wikert@fws.gov

Calculating Large Wood Densities Along Salmonid Streams
Presented by Derek Acomb and Desiree Dela Vega
California Department of Fish and Wildlife
derek.acomb@wildlife.ca.gov

Coho Response to Fire in the Russian River Watershed
Presented by Adrienne Chenette and Shayda Abidi
Russian River Salmon & Steelhead
Monitoring Program
adrienne.chenette@ccc.ca.gov

Quantification of Instream Flow in North Coast Streams and Water Use Estimates
Presented by Emmy Anzalone and Jordan Garcia
Watershed Stewards Program and North Coast Regional Water Quality Control Board
emmy.anzalone@waterboards.ca.gov
jordan.garcia@waterboards.ca.gov

You Only Leave Once: Use of the Yolo Bypass by Out-Migrating Juvenile Chinook Salmon
Presented by Nicole Kwan
Department of Water Resources
Nicole.Kwan@water.ca.gov

Sink or Swim: Fates of Steelhead in the Pescadero Intermittent Estuary
Presented by Pat Samuel and Jon Jankovitz
California Trout and California Department of Fish and Wildlife
psamuel@caltrout.org

The Synchrony of Native Fish Movements: Synthesis Science Towards Adaptive Water Management in the Central Valley
Presented by Gabriel Singer
UC Davis
gsinger@ucdavis.edu

The San Joaquin River Restoration Program's Long-Term Monitoring Program for a Reintroduced Spring-run Chinook Salmon Population
Presented by Lauren Yamane
US Fish and Wildlife Service
lauren_yamane@fws.gov

Restoration Opportunities of Aging Flood Infrastructure in an Urbanized SF Bay Watershed
Presented by Jennifer Natali
UC Berkeley
jennifer.natali@berkeley.edu

Land Use and RipRAM Assessment of San Lorenzo Watershed
Presented by Alex Johanson and Maya Vavra
Watershed Stewards Program at Central Coast Wetlands Group, RCD of Santa Cruz, and Santa Cruz County Office of Environmental Health
ajohanson@mlml.calstate.edu

Southern Mendocino Coho Salmon Capture and Supplementation Program
Presented by Mandy Ingham
NOAA Fisheries
mandy.ingham@noaa.gov

Walker Creek Conceptual Life Cycle Model
Presented by Sterling Meus
Watershed Stewards Program and Marin Municipal Water District
smeus@marinwater.org

Juvenile Coho Winter Diet and its Effect on Their Survival Through the Winter
Presented by Elizabeth Deluca
Watershed Stewards Program and Marin Municipal Water District
edeluca@marinwater.org

Is There a Relationship Between American Dipper Density and Salmonid Density?
Presented by Emma Sevier and Alexander Brown
Watershed Stewards Program and CDFW Arcata
emmasevier@gmail.com

Living with Beaver
Presented by Fran Recht
PSMFC
franrecht@gmail.com

Beaver Restoration Planning for Salmonid Streams, Riparian Rangelands and Montane Meadow in California
Presented by Kate Lundquist
Occidental Arts and Ecology Center WATER Institute
kate@oaec.org

About CUSP
Presented by Jackie Van Der Hout and Emanuel Peterson
California Urban Streams Partnership
outreachcusp@gmail.com

Watershed Hydrologic Modeling for Habitat Restoration and Flow Enhancement Prioritization
Presented by Matthew O'Connor
Coast Range Watershed Institute
mattoconnor@sonic.net

Wallace Weir Fish Rescue Facility - Pilot Year Successes and Lessons Learned
Presented by Hailey Wright
California Department of Water Resources
hailey.wright@water.ca.gov

Variation in Coho Salmon (*Oncorhynchus kisutch*) Smolt Outmigration Size and Timing Across Sub-Basins in Lagunitas Creek, Marin County
Presented by Rachael Ryan
University of California, Berkeley
rachael_ryan@berkeley.edu

Wallace Weir Fish Rescue Facility
Presented by Elisabeth Beckensten
KSN
ebeckensten@ksninc.com

Beaver Dam Analogues (BDAs) and Juvenile Salmonid Passage
Presented by Chris O'Keefe
Humboldt State University
cokeefe@humboldt.edu

Matilija Dam Removal and Southern Steelhead Recovery
Presented by Mark Capelli
National Marine Fisheries Service
mark.capelli@noaa.gov

Striped Bass Predation of Steelhead on a Central California Stream
Presented by Brian LeNeve
Carmel River Steelhead Association
brian@brianleneve.com

Fox Hollow Rainwater Harvesting Project
Presented by Melanie McMillan
City of San Luis Obispo
Melanie.Mcmillan@CCC.CA.GOV

Fish Monitoring Efforts in San Luis Obispo Creek for Steelhead and Pacific Lamprey
Presented by Grace Willett
City of San Luis Obispo
Grace.Willett@CCC.CA.GOV

Going with the Flow: Discharge Drives Diversity
Presented by J.D. Wikert
US Fish and Wildlife Service
john_wikert@fws.gov

Watershed Stewards Program
Presented by Sienna Streamfellow, Leanne Pearl, and Alex Torres-Tarver
Watershed Stewards Program
sienna.streamfellow@ccc.ca.gov

Restoring Coastal Lagoons and Wetlands on California's Scenic Highway 1
Presented by Katherine Brown
Caltrans-District 5, Landscape Architecture, San Luis Obispo
katherine.brown@dot.ca.gov

Fish Passage Improvements at the Fremont Weir
Presented by Jeff Jenkins
State of California: Department of Water Resosurces
jeff.jenkins@water.ca.gov

Ancillary Restoration Services
Presented by Warren Mitchell
SHN
swoo@shn-engr.com

Constituents of Emerging Concern in the Environment
Presented by Michael Dirks
The Water Research Foundation
mdirks@waterrf.org

20 Years of Fish Screens on the Sacramento River
Presented by Nadine Bailey
Family Water Alliance, Inc.
Nadine@familywateralliance.com

Distribution of Fish and Invertebrates from Summer Salmon Surveys in the Central California Current System
Presented by Jeff Harding
NOAA SWFSC Fisheries Ecology Division
jeff.harding@noaa.gov

Reintroduction of Coho Salmon
Presented by David Hines, Manfred Kittel, and Libby Gilbert-Horvath
CDFW
david.hines@wildlife.ca.gov

Large Wood Restoration Effectiveness for Salmonids in Pudding Creek, CA: A Before-After-Control-Impact Experiment
Presented by Natalie Okun
Pacific States Marine Fisheries Commission and Humboldt State University
nbo3@humboldt.edu

Sacramento River Restoration Update
Presented by Ian Smith
Reclamation
ismith@usbr.gov

Construction of Log Jam Habitat Enhancement Structures in Zayante Creek, Santa Cruz County, CA
Presented by Matt Koozer and John Dvorsky
Biohabitats and Waterways Consulting, Inc.
mkoozer@biohabitats.com

WRA, Inc. Exhibitor Table
Presented by Angela Robinson, Brian Bartell, Ben Snyder, Steward DesMeules, Nicholas Brinton, Erik Schmidt, and Andrew Smith
WRA, Inc.
angela.robinson@wra-ca.com

Heritability of Traits in Hatchery Steelhead (*O. Mykiss*) in the California Russian River Revealed by Genetic Analysis
Presented by Anne Beulke
UCSC
abeulke@ucsc.edu

Assessing Microhabitat in West Fork Sproul Creek
Presented by Katherine Stonecypher
Watershed Stewards Program
katherine.stonecypher@wildlife.ca.gov

Pacific Lamprey Ammocoetes as Water Quality Improvers
Presented by Parker Kalan
California Polytechnic University
parkerkalan@gmail.com

Water Stewardship in the Mattole River Headwaters
Presented by Brandon Craig, Tasha Mckee, Walker Wise, and David Sopjes
Sanctuary Forest, Inc.
brandon@sanctuaryforest.org

Relevant and Relatable: Engaging Youth in Fisheries Across the World and in Our Own Backyard
Presented by Katelyn Wilcox
US Fish and Wildlife Service
katelyn_wilcox@fws.gov

10 Years of Adult Coho Salmon Population Monitoring on the SF Eel River
Presented by Monty Larson and Jon Guczek
CDFW
monty.larson@wildlife.ca.gov

Optimization of Restoration for Non-natal Rearing Habitats Using a Population Dynamic Model (WRHAP) for Winter Run Chinook Salmon Along the Sacramento River
Presented by Francisco J. Bellido Leiva
UC Davis
fjbellidoleiva@ucdavis.edu

Children's Books: "Big Fish Dreams" and "I am the Elwha"
Presented by Lori Peelen, Jon Peelen, and Joel Peelen
Creeklands in San Luis Obispo
lori.peelen@gmail.com

Monterey Bay National Marine Sanctuary
Presented by Lisa Uttal
NOAA's Monterey Bay National Marine Sanctuary
lisa.uttal@noaa.gov

Central California Traction RR Bridge Fish Passage Project
Presented by Randy Beckwith, Matt Meyers, Austin Hall, and Jacob Kollen
California Department of Water Resources
Randy.Beckwith@water.ca.gov

Lessons Learned from a Flashy Coastal Watershed: Assessing the Effectiveness of Off-Channel Habitats that Function from the Top to the Bottom of the Hydrograph
Presented by Ayano Hayes|
Turtle Island Restoration Network - SPAWN (Salmon Protection and Watershed Network)
ahayes@tirn.net

Differences in Ground Cover in the Upper Matilija Basin Before and After the Thomas Fire
Presented by Taylor Pantiga
Watershed Stewards Program
taypantiga@gmail.com

10th Spring-run Chinook Symposium

July 2020, Salmon River

SRF and Salmon River Restoration Council will host the 10th Spring-run Chinook symposium in the Salmon River watershed to highlight genetic, recovery, and restoration efforts to enhance Spring-run recovery. This symposium will be directly following the annual Salmon River dives and will tour restoration projects in the Salmon, Trinity, and Scott River. Dates TBA soon.

Spring-run Chinook salmon in the Salmon River
By Scott Harding

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.**

Salmonid Restoration Federation, 425 Snug Alley, Unit D, Eureka, California 95501

info@calsalmon.org *www.calsalmon.org*

Graphic Design & Layout
by Jeri Fergus of Trees Foundation
www.treesfoundation.org