34th Annual Salmonid Restoration Conference

April 6-9, 2016 at the Fortuna River Lodge

Salmonid Restoration in Working Watersheds

Conference Co-sponsors

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Welcome to the 34th Annual Salmonid Restoration Conference

Salmonid Restoration in Working Watersheds

Salmonid Restoration Federation (SRF), like the salmon restoration field, cultivates a "We Can Do It!" attitude when providing technical education for both scientists and on-the-ground restoration practitioners. This year the conference highlights efforts to restore ecological processes in productive watersheds that still retain a high level of ecological function.

The theme of this year's conference is "Salmonid Restoration in Working Watersheds" and the conference agenda features pioneering habitat restoration techniques in a landscape of legacy impacts and climate change. The agenda will also explore life-cycle modeling, fish physiology, and innovative recovery strategies.

Workshops will include Instream Flow Enhancement and Groundwater Recharge Planning, Design and Engineering of Off-channel Habitat and Large Wood Projects, Evolving Science and Policy to Restore Streams Using Instream Obstructions and Beaver Dam Analogues, and a workshop focused on tools for encouraging meaningful public input and participation to achieve recovery goals.

Field tours will include a tour of Arcata's Community-based urban/wildland restoration program; a tour of the Lower Mattole River and Estuary to see heliwood placement, riparian planting, and off-channel slough restoration; and a tour of upland restoration in the Headwaters Forest Preserve and tidewaters projects at Humboldt Bay National Wildlife Refuge. Additional tours include one of the Eel River Delta and Estuary, Lower Klamath and Redwood National Park projects, and fish passage and tidegates restoration in Humboldt Bay and the Mad River watershed.

Concurrent sessions include a biology track with sessions focused on life-cycle modeling, Eel River biology, salmonid health, and Spring-run Chinook salmon genetics. The habitat restoration track explores incised stream channels, off-channel ponds, floodplains, and beaver-influenced habitats. Additionally, a landscape track features sessions on climate change, Gold Country legacy impacts and restoration strategies, impacts of cannabis cultivation on fisheries, and a session on innovative approaches to understanding and improving salmon-habitat relationships.

Dana Stolzman,
SRF Executive Director
and Conference Agenda Coordinator

The Plenary session highlights the elements that comprise ecosystem function, including a keynote address by Mike Furniss entitled "Homage to the Interface: Coastal Deltas, Estuaries and Floodplains." Mary Power from UC Berkeley will present on "Drought, Floods, and Alternate States of Algal-based Food Webs in the Thirsty Eel." Merv George Jr., Forest Supervisor of Six Rivers National Forest, will make a presentation on "Ridges to River—Ecological Restoration," and renowned fisheries scientist Peter Moyle of UC Davis will present, "Climate Change, Drought, and the Future of California Salmonids."

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

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

Some SRF Board and staff members after our Board retreat.

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Session Coordinator: Patrick Higgins, Eel River Recovery Project

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Salmonid Health: Effects of Parasites and Pathogens

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

Saturday Morning Concurrent Session 2

Shelter in the Slow Lane: Off Channel Ponds, Floodplains, and Beaver Influenced Habitats

Session Coordinator: Eli Asarian, Riverbend Sciences

Saturday Morning Concurrent Session 3

Climate Change: Effective Restoration for a Warming World

Session Coordinator: Joshua Strange, Ph.D., Stillwater Sciences

Saturday Afternoon Concurrent Session 1

Incised Stream Channels: Causes, Environmental Impacts, and Practical Restoration Solutions

Session Coordinators: Thomas Leroy, Engineering Geologist, Pacific Watershed Associates, and John Green, Gold Ridge Resource Conservation District (RCD)

Saturday Afternoon Concurrent Session 2

Upper Klamath-Trinity River Spring-Run Chinook: Biology, Genetics, and Recovery

Session Coordinator: Tom Hotaling, Salmon River Restoration Council

Saturday Afternoon Concurrent Session 3

The Impacts of Cannabis Cultivation on Fisheries Recovery

Session Coordinator: Dougald Scott, Ph.D., Salmonid Restoration Federation, Board of Directors

This Conference Proceedings is dedicated to two great salmon warriors who dedicated their life and livelihood to protecting and advocating for wild salmon: Zeke Grader and Troy Fletcher.

Zeke Grader, a renowned defender of fish, fishing communities, the Bay-Delta Estuary and the public trust, passed away on September 7, 2015 at the age of 68. Grader retired in June of that year from the San Francisco-based Pacific Coast Federation of Fishermen's Associations and the Institute for Fisheries Resources. He directed the federation since its formation in 1976 and he headed the institute, an offshoot organization he founded in 1992.

Zeke worked to assure sustainable fisheries, including measures to protect against overfishing, decreasing bycatch, rebuilding depleted fish stocks, and protecting and restoring fish habitats. As a result of his work promoting sustainable fisheries and the protection of habitat, Grader was the recipient of numerous commendations and awards during his illustrious career, including the 1998 U.S. Department of Commerce Environmental Hero Award. His wit, congeniality, and dedication to the small boat fishing fleet cannot be replaced.

Upon hearing of the news of Zeke's death, Restore the Delta announced: "It is with a very heavy heart that we share with our followers the passing of Zeke Grader. Zeke, the Executive Director for Pacific Coast Federation of Fishermen's Associations, was a 40-year leader dedicated to protecting the Bay-Delta estuary, Northern California rivers, fisheries, coastal communities, and fishermen. He was brilliant, kind, brave, and always morally centered. Working with him was a complete honor. He will be missed."

Troy Fletcher, longtime executive director of the Yurok Tribe and one of the initial linchpins in the original Klamath Basin Restoration Agreements, passed away unexpectedly on November 20, 2015 at the age of 53. The following tribute is excerpted from a press release from the Yurok Tribe:

"We are all devastated by the passing of our friend, brother and colleague," said Susan Masten, who was the Yurok Tribe's Vice Chair at the time of his passing. "Troy dedicated his life and put his heart and soul into his effort to protect and restore the Klamath River. He will be greatly missed by all."

Fletcher, a tenacious Tribal advocate, accumulated a long list of history-making accomplishments, such as sowing the seeds that started the Tribe's natural resource protection programs, during his time working for the Tribe. While the truly humble human being would never take the credit, Fletcher was responsible for ending a generations-long conflict between many competing Klamath River-based interests, including: farmers, commercial fishers, a power company, environmental groups and other Tribes. Turning this group of fierce, former adversaries into a cooperative coalition, focused on removing four Klamath dams and creating a plan for equitable water use was just one the many achievements in his storied career.

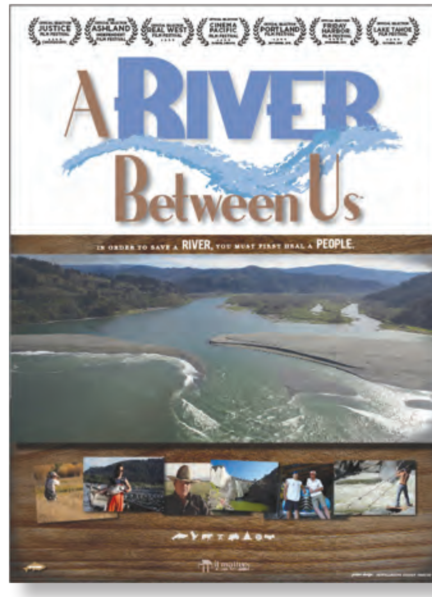
"Troy's integrity and innate leadership skills made him a magnet to all," said Dave Hillemeier, the Yurok Fisheries Program Manager. "We have lost a beloved friend, father, son, husband, mentor, leader, boss and a person respected by those from all walks of life."

As a descendent of the Jump Dance House at Pecwan, Fletcher was a strong supporter of the Tribe's culture and traditional value system, which is based on achieving balance in all things.

Conference Events

Thursday, April 7

SRF Annual Membership Meeting 5:30 - 6:30pm
SRF Membership and Supporter Dinner 6:30pm
Screening of *A River Between Us* 8pm



Thank you to our exclusive beer sponsor!

Friday, April 8

Poster Session and Reception 7 - 10pm

Saturday, April 9

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

The 2015 Restorationists of the Year awards.

Dance to Casey Neill and the Norway Rats Saturday evening at the banquet!

Evolving Science and Policy to Restore Streams Using Instream Obstructions and Beaver-Dam Analogues

Wednesday, April 6

Workshop Coordinator*: Eli Asarian, Riverbend Sciences*

Instream structures, such as beaver dams, wood jams, living vegetation, and other obstacles that slow the downstream movement of water and sediment, are essential to the restoration of streams. These obstructions can be used to accelerate the development of "stage zero" channels (Cluer and Thorne, 2013), which are increasingly recognized as having intrinsically high value because of the multiple and synergistic ecosystem goods and services that such systems provide. Stage-zero channels have well connected floodplains with elevated water tables, spatially-variable hydrologic regimes, and structurally-complex aquatic and riparian habitat. As such, they provide incredibly valuable habitat for a suite of terrestrial and aquatic taxa, including several Pacific salmonid species that are in decline.

This workshop will provide a state-of-the-science overview of recent innovations in the construction of instream obstructions in California and their use in stream restoration, particularly for building stage-zero fluvial ecosystems. Presentations will include the following topics:

- Recent advances in stream-restoration theory,
- Emerging tools available to build complex stream habitat, including beaver dam analogs and constructed wood jams,
- Fish passage at channel-spanning structures,
- Case studies of restoration projects in California that utilize instream obstructions, including channel-spanning Post-Assisted Woody Structures (PAWS) in the Scott Valley,
- Opportunities and challenges within the current regulatory framework for using instream obstructions to accelerate the recovery of dynamic, high-value fluvial ecosystems.

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

Streams Evolve, and Habitat and Ecosystem Benefits Accrue

***Brian Cluer, Ph.D. (Presenter)**, Regional Geomorphologist, NOAA Fisheries, and **Colin Thorne**, ESA*

While channel evolution models (CEM) provide an organizational structure for considering river channels and their complex response to disturbances (i.e., changes in base level, channelization, levees, or alterations to the flow and sediment regimes), physically and ecologically streams comprise more than their channel. We present a revised model, updated in light of several decades of research and practical experience, including realization that the single-thread, meandering-channel form may not represent the natural or pre-disturbed state, or the potential evolutionary end-state, an assumption implicit to CEMs. The new Stream Evolution Model (SEM) includes precursor and successor stages featuring floodplain interactions and multi-threaded channels, and stream evolution as a cyclical phenomenon within which natural channels evolve.

The SEM links habitat and ecosystem benefits to the hydrologic, hydraulic, morphological, and vegetative attributes of each evolutionary stage, highlighting the interactions between physical and biological processes. Consideration of the links between stream evolution and ecological services leads to improved understanding of the ecological status of modern, managed rivers compared to their unmanaged, natural counterparts. The potential utility of the SEM, with its interpretation of habitat and ecosystem benefits, includes improved river management decision making with respect to future capital investments in river conservation, restoration, and species recovery. The most abrupt difference in hydro-geomorphic attributes habitat and ecosystem benefits between adjacent stages is that from Stage 1 (single-thread channel) to Stage 2 (channelized stream), where scores drop from nearly 75% to less than 25%, due primarily to floodplain disconnection. Most habitat restoration projects target marginal improvements without altering a stream's fundamental attributes (i.e., Stage). The SEM model suggests that much greater benefits may be achieved by implementing projects that attempt to alter sediment and water dynamics sufficiently enough to evolve the stream into a different Stage.

This presentation adds original, new capabilities to the version of the Stream Evolution Model published in 2013 in the Journal *River Research and Applications* (Cluer and Thorne, 2013). The new version considers space-time substitution to account for the effects of upstream propagation of nickpoints and downstream delivery of excessive sediment loads, together with implications for habitats and ecosystems, and their conservation or restoration.

Using Ecologically-Functional Dams and Other Instream Obstructions to Restore Complex-Fluvial Ecosystems

Michael M. Pollock, Ph.D. (Presenter), *NOAA Fisheries, Northwest Fisheries Science Center;*
Brian L. Cluer, Ph.D., *NOAA Fisheries, West Coast Region - California Coastal Office;*
and ***Rocco Fiori****, Fiori Geosciences*

Instream structures, such as wood jams, living vegetation, beaver dams, certain geomorphic features, and other obstacles that slow the downstream movement of water and sediment, are essential to the restoration of streams. In particular, such ecologically functional dams or obstructions can accelerate the development of "stage zero" channels. The stage zero channel (sensu Cluer and Thorne, 2013) is increasingly recognized as having intrinsically high value because of the multiple and synergistic ecosystem goods and services that such systems provide. Stage-zero channels have well-connected floodplains with elevated water tables, spatially-variable hydrologic regimes and structurally-complex aquatic and riparian habitat. As such, they provide valuable habitat for a suite of terrestrial and aquatic taxa, including several Pacific salmon species that are in decline. In this presentation, we provide an overview of how ecologically functional dams can be built to create stage-zero channels. We compare the structure and function of stage-zero channels to more traditional channel restoration targets. We conclude that new approaches to stream restoration are needed that take into account society's economic and ecological imperatives to create resilient, structurally-complex, and dynamic systems, and that the spatial scale of restorative actions should be expanded where possible to better recognize and integrate the interdependent nature of longitudinal, lateral, and vertical linkages in stream systems.

Post-Assisted Woody Structures —Implementing California's First Beaver Dam Analogues

Betsy Stapleton, *Scott River Watershed Council*

This presentation will give an overview of the implementation of California's first Beaver Dam Analogues (BDA) in rural Scott Valley, Siskiyou County by the Scott River Watershed Council (SRWC) and federal cooperators, NOAA and U.S. Fish and Wildlife Service. This type of restoration is designed to restore geo-fluvial function rather than create a specific restoration feature; what does that mean for all those involved? Post-Assisted Woody Structures (PAWS) function differently than accepted restoration features, requiring a long-term relationship between restoration practitioner, landowner, restoration features, and regulators. The current regulatory system does not have mechanisms to easily accommodate this type of restoration. The complications of permitting a new restoration technique will be discussed, using the PAWS project as a case study. Additional lessons learned about BDA construction in California's environmental conditions, as well as design, placement, and landowner communication will be shared. Monitoring results from the first year of the project with be presented, including information about fish use, ground water impacts, and geomorphic changes.

A Demonstration of the Carbon Sequestration and Biodiversity Benefits of Beaver and Beaver Dam Analogue Restoration Techniques

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

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

This project seeks to evaluate the installation of BDAs as a restoration technique in Childs Meadow, a heavily-grazed meadow in the Cascade Range that is representative of low-gradient meadows across northern California. Using a before-after-control-impact study design, the study tests the impacts of two restoration techniques (willow planting with cattle exclusion, willow planting without cattle exclusion, and BDAs) on carbon sequestration, hydrology, and sensitive species. Results will be compared with measurements in an unrestored section of the meadow that currently supports an active beaver population and two imperiled species, Cascades Frog and Willow Flycatcher. Specific project objectives include 1) quantify and evaluate changes in above- and below- ground carbon storage following habitat restoration actions using BDAs and changes in grazing management; 2) compare the within meadow results to carbon sequestration values in existing restored and unrestored mountain meadows across the Cascade range; and 3) measure the response of hydrogeomorphic conditions (e.g., groundwater, temperature, habitat) and Cascades Frog and Willow Flycatcher to restorative actions. Initiated in summer 2015, thus far we have established the study reaches and collected the first year of pre-treatment data. In the fall of 2015 we installed the cattle exclosures and planted willows. The permitting process to install the BDAs is underway and is expected to be completed by spring 2016. Installation of the BDAs is planned for fall 2016 and three years of post-implementation monitoring will be performed to assess impacts of the treatments. Here, we will review our sampling design, preliminary results, and lessons learned about partnerships and permitting.

Fish Passage at Natural and Constructed Channel-Spanning Obstructions—Preliminary Observations from Klamath Basin Tributaries

Rocco Fiori (Presenter), Fiori GeoSciences; Jim Faulkner, Sarah Beesley, Scott Silloway, and Andrew Antonetti, Yurok Tribal Fisheries Program; Will Harling and Charles Wickman, Mid-Klamath Watershed Council; Erich Yokel and Peter Thamer, Scott River Watershed Council

Beaver dams, log jams, and man-made analogues provide a wide range of ecosystem goods and services, including enhanced floodplain connectivity; increased surface and groundwater exchange and storage; prolonged base flow; and created resilient, nutrient-rich, low-velocity, deep-water habitats. These ecosystem benefits are needed for fish and other terrestrial and aquatic species to avoid extirpation and by society to contend with drought and climate change. The perception that these features can be barriers to fish migration presents design and regulatory challenges for restoration actions that have a goal of restoring these ecosystem benefits. While fish passage at culverts and other hydraulic control structures (i.e., dams and weirs) has been well studied, research and guidance information is needed for managers and practitioners to properly evaluate barrier status of natural channel obstructions (beaver dams and log jams) and to effectively design and maintain man-made analogues.

I will present an overview of design and maintenance considerations, with a focus on fish passage, based on our preliminary assessments at channel spanning obstructions located in different geomorphic settings within the Klamath Basin. In general, during low flows juvenile fish passage at beaver dams and channel-spanning log jams (natural and analogues) occurs via several different types of flow paths, including orifices, gaps, and side-channels. We hypothesize that juvenile fish passage success is greatest when all of these flow paths are available. Beaver dams and beaver dam analogues (BDAs) in coarse-grained alluvial streams tend to be relatively permeable and require maintenance to sustain the inundated area, flow-through gaps, and side channels. Beaver dams located in streams underlain by fine-grained sediments tend to have lower permeability, orifice flow is less prevalent, and water levels can be sustained with less maintenance. When beaver are present, water levels tend to be controlled through their constant construction and maintenance activities, which increases water retention and preferentially promotes gap and side-channel flow and decreases flow through basal orifices. A stewardship approach that has scientists, practitioners, and regulatory agency staff cooperatively engaged in ecosystem recovery is needed to develop effective design guidelines and streamline the permit process.

Beaver Restoration in the Sierra Nevada —U.S. Fish and Wildlife Service Applications

Damion Ciotti, U.S. Fish and Wildlife Service

Restoring aquatic habitat complexity along low-gradient stream reaches is a priority for U.S. Fish and Wildlife Service restoration programs in the Sierra Nevada ecoregion. Beavers provide the opportunity to work with ecological process at reach and catchment scales. Integrating beaver and beaver dam analogue structures (BDA) within the planning, permitting, and design process is discussed for two projects. Site one has beaver present and active beaver dam building within a leveed stream channel. Constriction by floodplain levees results in beaver dam blowouts during annual peak flow events. BDAs are used to help beaver maintain existing dams and encourage dam expansion along a stream reach where levees will be breached in 2016. Site two is a stream channel with migrating head-cuts into a meadow and no beaver present. Design and permitting for BDAs and other actions are in process for this site. BDAs may aggrade the stream channel in parts, but there is uncertainty in this application for restoring longer-term meadow function. BDA use at this meadow must be coupled with beaver reintroduction in the catchment and installation of a properly-sized culvert or bridge that will stabilize the meadow stream channel.

The Beaver Restoration Guidebook: Are Beavers Too Good to be True for Stream Restoration?

Gregory Lewallen, MEM (Presenter), *Portland State University;* ***Michael Pollock, Ph.D.,*** *and* ***Chris Jordan, Ph.D.,*** *NOAA National Marine Fisheries Service;* ***Janine Castro, Ph.D.,*** *U.S. Fish and Wildlife and National Marine Fisheries Service; and* ***Kent Woodruff, Ph.D.,*** *U.S. Forest Service*

Are beaver adversaries or partners in stream restoration? Is beaver restoration and the positive impact on fish too good to be true? Researchers have been studying these questions and the restoration potential of beaver for decades, yet, in just the past few years, beavers have gained broad acclaim among restoration practitioners and some much deserved credit for restoration of aquatic systems in North America. Are beavers at the leading edge of salmon recovery? The recently released Beaver Restoration Guidebook does not directly answer all of these questions, but does shed some light on what beavers can do for you. Developed by an interdisciplinary team of researchers from NOAA National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Forest Service, and Portland State University, the Guidebook addresses the use of beaver (*Castor canadensis*) in stream, wetland, and floodplain restoration and discusses the many positive effects of beaver on aquatic ecosystems. The Guidebook is a scientifically-rigorous, yet accessible, practitioner's guide that provides a synthesis of the best available science for using beaver to improve ecosystem functions. Divided into two broad sections—Beaver Ecology and Beaver Restoration and Management—the Guidebook focuses on the many ways in which beavers improve habitat, primarily through the construction of dams that impound water and retain sediment and nutrients. In Beaver Ecology, we open with a discussion of the general effects that beaver dams have on physical and biological processes, and we close with "Frequently Asked Questions" and "Myth Busters". In Restoration and Management, we discuss common emerging restoration techniques and methods for mitigating unwanted beaver effects, followed by case studies from pioneering practitioners who have used many of these beaver restoration techniques in the field. The lessons they have learned will help guide future restoration efforts. We have also included a comprehensive beaver ecology library of over 1,400 references from scientific journals, "grey" literature, websites, legislation, regulations, and presentations. In summary, the Guidebook supports beaver restoration underpinned by science, such that a more comprehensive, evidence-based understanding of beaver ecology, restoration, and management emerges.

How to Streamline Permitting of Restoration Projects that Makes Streams Less Streamlined

Gordon Leppig*, Senior Environmental Scientist Supervisor, California Department of Fish and Wildlife*

Instream structures such as beaver dams, human-made beaver dam analogues (BDAs), and wood jams reconnect rivers and streams with their floodplains and help restore, protect, and enhance riverine habitats and the species that depend upon them. California's regulatory landscape, however, is as diverse and complex as the habitats they are intended to protect. Thus, ironically, environmental regulations, which are primarily intended to protect sensitive species and habitats, are often viewed as having the effect of slowing, impeding, and obstructing restoration projects that are typically supported by regulatory agencies and the restoration community. This session, focusing on California Fish and Wildlife Code, will discuss some of the complex environmental review and permitting issues related to proposed BDAs and other restorative, instream-channel habitat improvement projects. Insight and guidance are provided to increase the likelihood that proposed instream restoration projects will be efficiently permitted and approved.

Regulatory Challenges to Restoring Complex Fluvial Ecosystems in California—The Federal Perspective

Michael M. Pollock, Ph.D. (Presenter), *NOAA Fisheries, Northwest Fisheries Science Center;*
Brian L. Cluer, Ph.D., *NOAA Fisheries, West Coast Region, California Coastal Office;*
Mark Cookson, *U.S. Fish and Wildlife Service, Habitat Restoration Branch;*
and ***Janine Castro,*** *U.S. Fish and Wildlife Service*

Complex fluvial ecosystems are increasingly recognized as having intrinsically high value because of the multiple and synergistic ecosystem goods and services that such systems provide. Complex fluvial ecosystems have well-connected floodplains with elevated water tables, spatially-variable hydrologic regimes and structurally-complex aquatic and riparian habitat. In this presentation, we examine regulatory frameworks governing stream restoration actions and the regulatory challenges inherent in permitting the restoration of complex fluvial ecosystems and process-based restoration in general. We compare these regulatory challenges to the challenges facing simpler stream restoration projects that tend to be less effective in creating salmon habitat. We also discuss the concept of ecological risk assessment in the context of regulating stream restoration projects. We conclude that restoring complex fluvial habitat will face considerable regulatory hurdles until State and Federal laws intended to protect the environment (i.e., National Environmental Policy Act, Endangered Species Act, Clean Water Act, the California Environmental Quality Act, The California Endangered Species Act, California Streambed Alteration Agreements, and fish passage guidelines) better focus their "Adverse Effects Analyses" over longer time frames, larger spatial scales, and at the species-population level, as opposed to the more traditional regulatory paradigm of focusing on small-scale effects over short time frames and at the scale of individuals within a population.

Let's Get Connected—Tools for Getting Meaningful Public Input and Participation

Wednesday, April 6

Workshop Coordinators***: Natalie Arroyo,*** ***Redwood Community Action Agency (RCAA) and Eureka City Council Member, and*** ***Anna Halligan,*** ***Trout Unlimited***

Many of us in the world of watershed work find ourselves needing public input. It may be a grant requirement, or perhaps it is key to implementing a project with public support. Often, we don't have the best tools to describe our work to the general public, receive feedback and ideas, and get buy-in from the people who are affected most. This workshop will help define the issues many of us face, provide guidance about how to reach the public with an emphasis on the hardest-to-reach audiences, provide demonstrations of helpful facilitation techniques, and give you a chance to practice them. At the beginning of the workshop, we will use a real-world scenario as practice. We will get up, move, talk to one another, and hear each other's ideas, all while practicing and modeling effective public process. You'll come away with techniques for broadly spreading the word and handling the challenges of "talking fish" (or insert your specialty here) with total strangers!

What's Up with People in Our Watersheds? Defining the Issues that Reduce Public Participation in Recovery Efforts

Natalie Arroyo (Co-presenter), *Redwood Community Action Agency,*
and ***Anna Halligan (Co-presenter),*** *Trout Unlimited*

This presentation and facilitated group discussion will kick-off the workshop by helping define where and why we are coming-up short in outreach efforts and why this matters so much. We'll discuss how we use the public's concerns and feedback to truly inform our work, what barriers exist to communicating effectively, and why everyone isn't at the table in the beginning. The workshop will include a facilitated exercise in sharing what participants' challenges are in their own work. These challenges will be used as opportunities for learning throughout the day.

Compassionate Communication

Steph Wald, *Watershed Projects Manager, Central Coast Salmon Enhancement*

Steph Wald has been the Watershed Projects Manager at Central Coast Salmon Enhancement (CCSE) since 2003. Her passion is helping CCSE think like a watershed by accomplishing completion of watershed management plans with partner agencies along the Central Coast. Steph also coordinates and facilitates the Tri County Fish Team, a multi-stakeholder, fisheries restoration group that spans across San Luis Obipso, Santa Barbara, and Ventura counties. When not working at CCSE, Steph is busy with the Carrizo Plain Conservancy and living at Tierra Nueva Cohousing. Steph has extensive practice in facilitation, and her presentation will focus on compassionate communication skills. Her presentation will be closely aligned with the primary workshop components:

(a) Defining the Issue: Why is public outreach important? Where do we go wrong? How do we use people's concerns and feedback to truly inform our work (or do we)? What are your specific challenges?

(b) Demonstration of Dynamic Facilitation Techniques and Practice: Learning different ways to elicit and record ideas.

(c) Facilitation and Communication with People Who Don't Speak Our Language: Tips for presenting information to people that is understandable, including those who don't speak "technicalese", who speak a language other than English, and who don't respond to our language because of a cultural divide.

(d) Diversity and Our Outreach Efforts: Why isn't everyone at the table? What can we do to change that?

(e) Using All the Input: How to effectively use input, ensure that people feel heard, and benefit from both positive and negative feedback.

Sense Making: How to Use Graphic Communication to Convey Ideas and Increase Understanding

Keytra Meyer, *Strategy Manager, Humboldt Area Foundation*

Graphics can be an excellent tool to help people prepare for meetings, feel heard at meetings, organize thoughts and ideas, and convey outputs and next steps. This presentation will demonstrate tools and provide examples of how graphics can be used prior to, during, and following meetings and public input. In addition, participants will have a chance to practice some graphic recording skills and walk away with knowledge of helpful resources to dive deeper into the (exciting!) world of graphic recording and facilitation.

Effective Communication: Designing Meetings for Meaningful Collaboration

Miriam Volat, Facilitator, Policy Project Manager and Soil Scientist, Occidental Arts and Ecology Center

This is an experiential workshop designed to give participants skills in planning, designing, and facilitating meetings that lead to effective collaboration with diverse partners and the general public.

You will get a chance to practice process design methods that lead to lasting results and build community capacity for change. We will explore facilitation techniques for working with stakeholders with different agendas, different backgrounds, and varying levels of privilege to develop buy-in and commitment to common interests. Much of the effectiveness of any public engagement process stems from how it was prepared for and how it is facilitated. From agenda development, to in-person meetings, to online participation, to follow-up, there are opportunities to ensure constructive communication and a deeper understanding of complex issues. We will look at how each of these stages in a public engagement process can lead to better decisions and collaborative environments while discussing specific methodologies you can employ in your projects.

The Mattole Field Institute—An Incidentally Novel Approach to Engaging the Public in a Rural Watershed

Flora Brain, Mattole Restoration Council

The Mattole Field Institute provides hands-on training and exploration of restoration and related topics for adult students. We are partnered with professors in Humboldt State University's (HSU) Departments of Environmental Science & Management, Forestry, and the interdisciplinary Environment & Community Social Sciences graduate program. We currently offer a five-day immersion course in Watershed Restoration, as well as a five-day, graduate-level field course focused on the Socioeconomics of Natural Resources in the Mattole Basin.

This presentation focuses on the benefits derived from connecting HSU graduate students in Environment & Community Social Sciences with local community members, landowners, and restorationists in the Mattole River watershed in the Fall of 2015. The primary goal of this field course was to provide a deep and nuanced exposure to socio-economic forces in a rural watershed; the anticipated chief benefit was for the university students. However, we discovered that in connecting these students with community members, locals also realized significant benefits from the opportunities to gather and share perspectives with the student group. In discussing community issues with a keenly interested yet detached group of social science researchers, locals found a unique space to reflect on challenges close to home. We conclude that such field courses connecting local community members with graduate-level university students can create multiple benefits: providing tomorrow's restoration and social science professionals with watershed-based experiential education, as well as empowering community members in those watersheds through opportunities for group discussion, reflection, and realization of shared local goals.

In rural, salmon-bearing watersheds like the Mattole, limited resources pose challenges for ecological restoration and human communities alike. We look forward to future Mattole Field Institute courses where socioeconomic, political, and cultural issues will be further integrated with ecological concerns, and local community members will be more deeply engaged. We believe that only by studying and attending to our culture and our environment together can we create a resilient future home for ourselves and the salmon native to this place.

Bridging the Divide Between Policy and People

Jennifer Savage, California Policy Manager, Surfrider Foundation

The Surfrider Foundation maintains 84 U.S. chapters and is fueled by a powerful network of activists dedicated to the protection and enjoyment of our world's oceans, waves, and beaches. The organization's success depends on grassroots volunteers having the motivation and understanding to take action; translating policy documents into language people outside the political world can understand is imperative.

As California Policy Manager, Jennifer Savage works with the 20 California chapters to support a variety of campaigns with the common threads of beach access, adaptation to climate change, clean water, and a healthy ocean. This workshop will provide attendees the opportunity to practice converting wonk-heavy reports into real-world messaging.

How Service Programs Create a Legacy of Stewardship

***Jennifer Catsos**, Program Manager, AmeriCorps Watershed Stewards Project*

For over 20 years, the Watershed Stewards Program (WSP) has been engaged in comprehensive, community-based watershed restoration and education throughout coastal California. As an AmeriCorps program, we engage developing natural resource professionals in a ten-and-a-half month service term. These Members are placed with natural resource organization placement sites throughout California to assist communities and organizations with habitat restoration for salmonids (Chinook salmon, coho salmon, and steelhead trout). Additionally, WSP Members provide watershed education and outreach in high-needs communities, engage in volunteer recruitment efforts to increase the capacity and reach of partner organizations, and receive trainings to help themselves develop into the next generation of natural resource professionals.

This presentation will examine the transformative power of service and how we can connect this to restoration efforts and the environmental movement. We will explore how to build stewardship through engagement in long- and short-term service, while sharing some success stories from our 20-year program history.

Building Trust Within a Project Area Through Meaningful Public Engagement and Outreach

Sara Schremmer, *Program Manager, Salmonid Restoration Federation*

To improve water security for rural families and stream flows for salmon, Salmonid Restoration Federation has been engaged in three years of community outreach and low flow monitoring that are part of a collaborative effort called the Redwood Creek Water Conservation Project, which aims to build capacity for water conservation implementation projects on the South Fork of the Eel River near Redway, California. This presentation will include a case study of the innovative outreach and engagement strategies that have been used to build trust among hard-to-reach populations within the project area, combined with practical information about best practices for survey administration, conducting focus groups, analyzing quantitative and qualitative data, and making that data accessible to local stakeholders.

Involving Multiple Landowners in a Large-Scale Restoration Project

Doreen Hansen, Watershed Coordinator, Humboldt County Resource Conservation District

Have you attempted to implement a restoration project that spans properties owned by multiple landowners? Did it seem like you were juggling opposing interests? Was it challenging to bring everyone to consensus?

The Salt River Ecosystem Restoration Project is one of the largest restoration projects on the Pacific Coast of North America. The Project will excavate seven miles of the Salt River, which has aggraded with sediment for a majority of its length, and restore 330 acres of a former organic dairy back to an estuary. This project addresses chronic flooding and fish and wildlife habitat impacts across a coastal watershed. Over 40 private landowners and land managers are involved across the project footprint.

Initially, this project was brought forward by the community seeking flood relief. Over the past 30 or so years, the Salt River became hydrologically dysfunctional due to the severe amount of sediment aggradation delivered from the upper watershed. Though the community had agreed that there needed to be a watershed-wide solution to widespread flooding, once the project planning began to move forward, landowners realized they may be impacted by the project in unanticipated ways. As the project gained more and more partners, fish and wildlife habitat issues needed to be considered along with flooding concerns.

The Humboldt County Resource Conservation District is the lead agency for the Salt River Ecosystem Restoration Project. We are the landowner liaisons and coordinators for the project designs and implementation. We are happy to share our successful, and unsuccessful, approaches and methods for landowner outreach.

Rollout of the Southern Oregon/Northern California Coast (SONCC) Coho Salmon Recovery Plan—the Vision and Lessons Learned

Julie Weeder, Southern Oregon/Northern California Coast Coho Salmon Recovery Coordinator, NOAA Fisheries

Recovery plans provide the "roadmap to recovery" that all entities can follow in order to recover Endangered Species Act-listed species. During preparation of these plans, there is a necessary step of providing a draft to the public to review. Meetings to explain this draft and encourage participation in the review process are critical to the review process working properly.

In 2012, NOAA Fisheries released the public review draft of the Southern Oregon/Northern California Coast (SONCC) Coho Salmon Recovery Plan. This plan addresses a species that ranges across seven-million-acres and 20 counties. Five public meetings were held to raise awareness of the plan and explain the public review process. This presentation will discuss the goals of these meetings, how they were advertised, how they played out, how we considered public input, and lessons learned that were applied during rollout meetings for the final recovery plan in 2014 and 2015.

Headwaters to Bay: Tour of Arcata's Community-Based Urban and Wildland Restoration Program

Wednesday, April 6

Field Tour Coordinators*: Mark Andre* and ***Julie Neander,*** *City of Arcata;*
and ***Dan Gale,*** *U.S. Fish and Wildlife Service*

The City of Arcata is situated on Humboldt Bay, one of the most important estuaries on California's coast. To implement a host of city environmental policies, goals, and adopted plans, a large number of habitat restoration projects have been conducted in the City's five watersheds since 1984. This field tour focuses on lessons learned from aspects of some of the older projects, as well as the progress of recent projects conducted in the lower estuaries of anadromous watersheds. Restoration actions have included "daylighting" creek segments in downtown areas, decommissioning upland community forest roads in headwater areas, developing large-scale estuarine and salt marsh projects, installing fish-friendly tide gates to restore fish passage, reestablishing floodplains connected to altered watercourses, implementing Low Impact Design (LID) features into urban development, setting back or breaching levees, and establishing riparian cover.

The goal of Arcata's restoration program is to modify disturbed ecosystems so that they closely resemble a desired condition. The desired condition usually is one matched to a reference condition or by retrospective work looking at historic maps and photos. A key to the success of the habitat restoration effort in Arcata is having a wealth of local, scientific expertise to draw upon, as well as involvement of the citizenry in restoration efforts. Participation in restoration projects helps bring the community together and creates a social identity, sense of place, and local pride in their community. The social dimensions of restoration close to population centers also provide opportunity for education and for building a constituency that will support restoration efforts in the future.

The tour will begin in the forested uplands and work downstream to the urbanized, middle-reach stream segments and then down to the lower-gradient coastal agriculture and salt-marsh estuary zone.

Lower Mattole River and Estuary: Heli-wood Placement, Riparian Planting, and Off-Channel Slough Restoration

Wednesday, April 6

Field Tour Coordinators*: **Sungnome Madrone** and **Nathan Queener,** Mattole Salmon Group; **Dave Fuller,** Bureau of Land Management; **Conor Shea, Ph.D.,** U.S. Fish and Wildlife Service; and **Cassie Pinnel,** Mattole Restoration Council*

Decades of road building and timber harvesting on steep, erodible slopes, combined with floods and naturally high rates of rainfall, has resulted in a generally filled-in and simplified habitat in the Mattole Lower River and Estuary area. A major planning and implementation effort is underway in this area with the Bureau of Land Management leading an ambitious program of large-wood loading, riparian planting, and treating terrace margins as an approach to diversifying these previously-simplified habitats.

Over the past couple decades we have seen an evolution of large-wood loading techniques here in the Mattole and elsewhere. Utilizing whole trees acquired through native prairie restoration for placement in the river and estuary has led to the development of a Heli-wood project type here in the Mattole. Heli-wood is helicopter-placed wood that allows for placement of whole trees, including their limbs, boles, and root wads.

On this tour we will walk to heli-wood placement sites and Engineered Log jam Structures (ELJ). We will talk about the logistics of this type of work with helicopters, lessons learned, costs, and other factors that help make this type of work feasible and well-integrated. We will see extensive riparian planting sites of varying ages, including deeply trenched willow baffles.

The Mattole is rare in that its estuary area is subject to many earthquakes and the Triple Junction earthquakes of 1992 uplifted the estuary area some three-to-four feet overnight. This uplift disconnected a complex set of off-channel sloughs from the river. This tour will visit the site of recent slough excavation that has seen extensive salmonid use immediately after completion. We will spend time at the slough observing wildlife and talking about fish use in the slough as compared to nearby riverine and estuary locations.

Salmon Creek Watershed, from Headwaters Forest Reserve to Humboldt Bay National Wildlife Refuge

Wednesday, April 6

Field Tour Coordinators*: **Mitch Farro**, Pacific Coast Fish Wildlife and Wetlands Restoration Association, and **Chris Herbst**, Pacific Watershed Associates*

This field trip will visit sites both in the Headwaters Forest Reserve and Humboldt Bay National Wildlife Refuge. Salmon Creek is the third largest tributary to Humboldt Bay and has received increasing attention due to the development of a watershed-wide, fisheries-restoration efforts including public and private lands. An overview of both the watershed setting and the scope of the restoration efforts from the headwaters to the tidelands in Salmon Creek will be presented.

The 7,400-acre Headwaters Forest Reserve, publicly acquired in March 1999, is managed for conservation by the U.S. Bureau of Land Management (BLM) and the California Department of Fish and Wildlife (CDFW). The Reserve includes approximately 3,000 acres of old-growth redwood forest and an additional 4,400 acres of second-growth forest that had been logged and roaded prior to public acquisition. In 2004, the BLM and CDFW completed a management plan for the Reserve which calls for the removal of almost all the remaining roads throughout the Reserve, along with forest restoration and development of recreational trails.

The BLM, in partnership with the Pacific Coast Fish Wildlife and Wetlands Restoration Association (PCFWWRA), began removing roads and other sediment sources in the headwaters of Salmon Creek in 2000 and has continued this work through 2015. Participants will hike to representative road-decommissioning project areas to discuss sediment-source inventories, project prioritization, techniques, equipment, costs, effectiveness, and monitoring.

The Humboldt Bay National Wildlife Refuge (NWR) at the mouth of Salmon Creek was established in the early 1970s primarily as a way to provide important coastal habitat for migrating shorebirds and waterfowl. In 1988, over 1,000 acres of former tidelands along lower Salmon Creek and adjacent areas was acquired by the U.S. Fish and Wildlife Service for inclusion in the Refuge. Several efforts to improve instream habitat conditions have taken place over the last decade in lower Salmon Creek.

The field trip will visit the location of the major tidegate replacements, salt-marsh restoration and new tidal-channel excavations, and off-channel ponds constructed on Humboldt Bay NWR. The trip will provide the opportunity to explore the issues involved in the design, permitting, construction, and monitoring of this tidal salmonid habitat project.

Restoring Complexity: Design of Large Wood Structures and Off-Channel Habitats

Thursday, April 7

Workshop Coordinators*: Michael Love, P.E.,* *Michael Love & Associates, Inc.,* *and* ***Steve Allen, P.E.,* *GHD*

Many of our streams and rivers have become over-simplified through removal of large wood and stream encroachment and confinement, often resulting from pressures to reduce flooding at the expense of biological diversity. This trend commonly results in the disconnection and loss of complex backwater habitats and deep pools that once provided productive nurseries for rearing salmonids. This workshop focuses on developing and constructing projects aimed at restoring geomorphic processes that create and maintain channel complexity while working within current-day constraints. Presentations will describe approaches to identify and characterize site suitability for restoring off-channel habitat and creating high-flow and thermal refugia; available tools and analyses to support design development; use of large-wood structures (LWS) to create desired geomorphic responses; approaches to mitigate potential project risks; and engineering and construction techniques for installing LWS and connecting off-channel habitat. The workshop will include instruction on these various topics and presentations of example projects.

Geotechnical Characterization and Construction Techniques for Creating Off-Channel Habitats and Post-Assisted Wood Structures

Rocco Fiori, Fiori GeoSciences

Over the past decade, efforts to recover salmonid populations in California have begun to shift focus from projects intended to reduce instream sediment inputs from upslope sources to projects with the objective to increase habitat complexity, quality, and quantity directly within the fluvial corridor. This trend includes the innovative use of unanchored wood in 3rd to 5th order wildland streams; the integrated use of constructed or engineered wood jams and off-channel features in 3rd order and larger streams; and the use of beaver dam analogues, water banking, levee setback, floodplain reconnection, wetland creation, and improving estuary function where possible. This trend demonstrates a top-down approach to habitat restoration lead by the work of researchers and practitioners.

The technical requirements to stay current in this field necessitate an interdisciplinary collaborative approach that builds on information and techniques developed in low-risk (to life and property) settings and from well-funded, research-level projects. The ability to incorporate proven techniques into low-cost projects is possible, but only when practitioners, regulators, and landowners recognize and understand the potential risks and are able to balance data collection and analysis tasks in accordance with identified hazards and associated levels of risk. This can be accomplished through the use of reconnaissance level study, supporting literature, and the application of rational professional judgment.

An overview of techniques and lessons learned from a suite of low-cost, process-based restoration projects will be presented. Topics will include site characterization, design approach, factor of safety analysis, and performance outcomes. Following a recent channel-resetting event (with high flow and significant sediment inputs), this suite of projects demonstrates a transition from site to reach scale effects with a trend toward self-maintenance and resiliency.

Constructed Wood Jams and Off-Channel Habitats on the Trinity River, California

Aaron Martin, DJ Bandrowski, Kyle DeJuilio, and Andreas Krause (Presenters), Yurok Tribe

Since 2005, the Trinity River Restoration Program has built over 25 large restoration projects in the 40 miles below Lewiston Dam. Constructed wood jams and off-channel habitats have played an increasingly important role in restoration design and habitat response. A variety of case studies from the Trinity River will be presented to showcase a selection of wood jams and off-channel habitats that have been utilized to accomplish different design objectives. The physical and biological responses of the structures will be discussed. A brief overview of the benefits of wood, basic design considerations, and the new National Wood Design Manual will be presented.

Installation of Large Woody Debris (LWD) from a Contractor's Perspective

Mark Cederborg, Handford ARC

This workshop presentation will be a discussion of LWD installations, including methods of construction for a variety of design types, installation parameters and specifications, performance standards, and site conditions. The presentation will include an interactive discussion with the audience. A focus of the discussion will be on potential failure points during installation (e.g., log splitting, mushroom tops); mitigation measures to avoid installation problems; problem solving between the designer, owner, and contractor; how to get creative to achieve design parameters given various site conditions, access, and environmental restrictions; and what to do when a contractor says, "that's impossible." The presentation will also include a discussion of the types of equipment used for log structure installation and pros and cons of the pieces chosen for installation.

Large Wood Structure (LWS) Construction Considerations for Publicly Bid and Contracted Restoration Projects

Steven Allen (Presenter) and Jeremy Svehla, GHD

This presentation will focus on the construction of large-wood projects to create specific hydraulic conditions desired by the project design. During the design process, various hydraulic design criteria are used to design a desired hydraulic condition when the project is completed. Large wood is a great construction material and, like most construction materials, it has its challenges when working with it in the field. Specifically, it can be a challenge to construct large wood structures to meet stringent hydraulic conditions. This presentation will focus on the design and construction contracting of large wood structures for publically bid restoration projects. The design approach, selection/availability of materials, measurement/payment, testing, bidding, and implementation will be discussed in the context of several public works projects.

Integrating Off-Channel Estuary Slough Restoration in the Mattole, with Riparian Revegetation and Terrace Margin Treatments for Climate Change Resiliency

Sungnome Madrone (Presenter), *Executive Director,* ***Drew Barber,*** *Project Coordinator, and* ***Nathan Queener,*** *Project Coordinator, Mattole Salmon Group*

The importance of off-channel slough habitat in estuaries will only increase for salmon in a warming world. High-quality estuary habitat has the potential to be used by all out-migrating fish from a watershed and, during drought years, it is particularly important for juveniles, especially when low flows restrict spawning adults' access to large portions of the watershed.

This presentation will discuss the planning, permitting, design, and engineering elements that went into a recently completed project in the Mattole River estuary. We will share lessons learned in integrating this slough restoration work with riparian revegetation and terrace margin treatments. The integration provided a cost-effective and fully-integrated approach to restoring several habitat types while focusing on reinforcing estuary processes instead of just implementing site-specific treatments.

The Mattole Project is a collaborative partnership between the Bureau of Land Management (BLM), which manages much of the estuary area, and other adjacent landowners, including: the Mattole Salmon Group, the Mattole Restoration Council, the Department of Fish and Wildlife, the State Coastal Conservancy, the National Fish and Wildlife Foundation, The Nature Conservancy, the Department of Water Resources, NOAA, and the U.S. Fish and Wildlife Service.

A five-year estuary restoration plan was prepared by BLM working directly with its many partners listed above for the project area. This plan was then permitted and now we are implementing multiple elements of the plan. Our presentation will walk us through this effort with a focus on the off-channel slough restoration and its role in climate change resiliency.

The water quality in this new slough habitat is good with excellent hyporheic flow as well as tidal mixing at the upper end of the tidal zone. The advanced riparian forest that was retained during the excavation provides excellent shade and food sources. The in-channel vegetation has grown and the placed woody debris provides excellent cover. The first summer after construction, nearly 15% of the observed summer steelhead population were utilizing the new slough. Fish use of the slough and nearby habitats was monitored throughout 2015, and very high densities of juvenile steelhead and Chinook were observed in the slough, although our understanding of the causes of the observed patterns and seasonality of fish use remains incomplete.

Jacoby Creek Off-Channel Ponds: Site Characterization, Design, and Construction

Michael Love (Co-presenter) and Antonio Llanos (Co-presenter), Michael Love & Associates, Inc.

Jacoby Creek is a tributary to Humboldt Bay that supports coho, Chinook, steelhead, and coastal cutthroat trout. It drains into a broad, low-gradient valley before reaching tidewater. Remnant and abandoned meander bends, side channels, and backwater ponds are found throughout the valley, but nearly all of them have become disconnected from Jacoby Creek due to historical land-use practices, thus eliminating salmonid access to these once productive habitats. In 2012 the non-profit organizations Jacoby Creek Land Trust and Pacific Coast Fish, Wildlife, and Wetlands Restoration Association partnered to restore fish access and improve habitat quality for two historical off-channel ponds located on Land Trust properties.

Michael Love & Associates (MLA) developed designs for the restoration work. Initial activities included a thorough hydrologic and geologic characterization of the site. Pacific Watershed Associates (PWA) conducted borings to characterize the soil stratigraphy and installed a monitoring well. MLA installed water-level loggers in the adjacent creek, ponds, and monitoring well, and collected water quality data from fall through late spring. Water level data was correlated to records from a long-term flow gage operated upstream of the project, allowing for evaluation of water levels in both wet and dry water years. Inflow to the ponds from local drainages was characterized in terms of water quantity and quality during the study period. All of this information proved essential in designing the connection channel and depth of the ponds.

A channel was constructed connecting each pond to Jacoby Creek. These connections consist of a streamside alcove and channel with log steps designed to provide access for juvenile salmonids during winter base flow. The connection to the creek is at an acute angle to utilize the sweeping velocities of the creek and minimize sedimentation at the mouth of each alcove. The alcoves were excavated deep enough to offer year-round habitat and provide a place for fish to stage as they prepare to ascend the steps and enter the pond. The pond level is controlled by the upstream log weir. During frequent higher flows in Jacoby Creek, the weirs become fully backwatered, providing swim-in access to the ponds. The bottom elevation of the pond was set to ensure it would dry during the summer and early fall, thus preventing colonization by invasive bullfrogs. Three types of large wood structures were constructed and anchored using log piles: weirs, habitat features, and grade control sills.

The project was constructed in October 2015 and both physical and biological monitoring will be ongoing for three years. Time-lapse cameras, photopoints, and annual topographic surveys are used to monitor sedimentation and erosion, while California Department of Fish and Wildlife (CDFW) biologists monitor fish usage.

This presentation will cover pre-design site characterization, design development, construction techniques, and preliminary post-construction findings for the two pond sites. Lessons learned from this project are intended to help inform future off-channel habitat enhancement projects.

Channel Surfing by Juvenile Salmonids: Fish and Water Quality Responses to Off-Channel Habitat Restoration Projects in the Stream-Estuary Ecotone of Humboldt Bay

Michael Wallace, ***California Department of Fish and Wildlife***

There has been a growing appreciation of the importance of the stream-estuary ecotone (SEE) to juvenile coho salmon (*Oncorhynchus kisutch*) which has resulted in numerous habitat restoration projects being planned and completed in this habitat throughout northern and central California. The California Department of Fish and Wildlife is assessing restoration project performance and working with the restoration community to help design and improve future restoration projects. This talk will illustrate fish use and water quality conditions of off-channel habitat restoration projects in the SEE of Humboldt Bay tributaries. The presentation will also explore patterns in juvenile salmonid movement between stream and SEE habitat and mainstem and off-channel habitat. It will also present patterns of water quality conditions in constructed off-channel habitat.

Coho, Cows, and Collaboration: Creating Coho Rearing Habitat in an Anthropogenic Landscape

Charles Wickman (Presenter), Will Harling, *and* ***Mitzi Wickman,*** *Mid Klamath Watershed Council;* ***Toz Soto,*** *Karuk Tribe; and* ***Rocco Fiori,*** *Fiori Geosciences*

Coho salmon and humans share a preference for wide, low-gradient, cold-water river valleys. Historically, this meant meandering, beaver impounded coho incubators. For the last 150 years though, the Klamath River and its tributaries have seen extensive gold mining, logging, ranching, and small-scale parceling of these landscapes, all at the expense of these delicate fish and their less-than-hardy needs. Since 2010, the Mid Klamath Watershed Council, the Karuk Tribe, and other partners have constructed several off-channel coho rearing habitat projects on tributaries to the middle section of the Klamath River, largely on private land, building unlikely but sensible relationships with landowners, contractors, and naysayers. This presentation will explore the nuts and bolts and successes of developing a project in an unlikely environment, and what it takes to sustain and enjoy collaborative relationships over time and through these drought years.

Coho Salmon Utilization of Constructed Off-Channel Habitats along Seiad Creek and other Middle Klamath Tributaries

Toz Soto (Presenter), Karuk Tribe; Will Harling and Charles Wickman, Mid Klamath Watershed Council; Michelle Krall, Humboldt State University; and Larry Lestelle, Biostream Environmental

The Karuk Tribal Fisheries Program (KTFP) is leading efforts to study coho salmon utilization and performance within constructed off channel habitats along the middle Klamath River and its tributaries. The KTFP has conducted coho salmon ecology studies in the Klamath River since 2007 and, more recently, began planning and constructing off-channel habitats with partners from the Mid Klamath Watershed Council, beginning in 2010. Key findings of our work include a better understanding of habitat needs for juvenile coho salmon rearing and specific limiting factors that can be address by constructing habitats to fit coho-specific needs. The use of Passive Inductive Transponder (PIT) tags has shown diverse habitat utilization patterns for juvenile coho salmon, including natal and non-natal use of constructed off-channel habitat, residency time and movement patterns, abundance, and growth rates.

Results indicated that coho salmon are seeking out constructed off-channel habitats for winter rearing opportunities and summer rearing opportunities when cold water is available. Klamath River juvenile coho were found to migrate long distances in search of winter-rearing habitat during the onset of winter high flows and, similarly, it is common for juvenile coho salmon to migrate long distances seeking out cold-water refuges during the onset of summer high temperatures.

A wide range of climatic conditions, wet and dry years, have occurred in years following construction of off-channel habitat. This provides an opportunity to compare coho utilization between different water year types and the reality that habitat utilization is dynamic, with some sites being productive while others are not.

Coho salmon utilization was found to be variable between all constructed off-channel habitats examined, but specific habitat characteristics, including groundwater connectivity and fish accessibility, are key factors in determining the rate of utilization and performance of coho salmon. PIT tag technology can be an important tool to better understand specific needs of juvenile coho salmon and to design off-channel habitats with maximum benefits.

The Effectiveness of Large Wood Enhancement in Lagunitas Creek over 15 Years

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

Between 1998 and 2013, the Marin Municipal Water District (MMWD) installed 59 large-wood structures in a six-kilometer reach of Lagunitas Creek in Marin County, California, primarily to increase the complexity of summer rearing habitat for juvenile coho salmon. Since 2000, MMWD has monitored the effectiveness of these structures by collecting data on stream depths and salmonid abundance at these enhancement sites. Monitoring was conducted prior to construction and afterwards for a period of three to fourteen years (mean = 8.6 years).

Maximum pool depths at enhancement sites increased an average of 26 cm, although some designs produced greater increases in depth. Prior to wood addition, juvenile coho salmon densities at enhancement sites were less than 40% of those in control pools. One year after construction, absolute densities had increased by 450% and were more than double those in control pools. Higher densities at enhancement sites continued for over a decade.

Large-wood enhancement may be partly responsible for recent increases in coho fry survival in the spring and summer. In the next few years we will install an additional 26 large-wood structures that are designed to reconnect Lagunitas Creek to its floodplain and increase coho survival through the winter.

Design and Implementation of Instream Woody Material for Juvenile Salmonid Habitat

Brian Wardman, P.E., Northwest Hydraulic Consultants

This presentation discusses the design and implementation of instream-woody material (IWM) at a habitat restoration project on the American River in Sacramento, California. The levees along the lower American and Sacramento Rivers limit accessibility of the floodplain to out-migrating juvenile salmonids. Shallow-water habitat on the floodplains provides a rest stop with food, cover, and respite from higher instream velocities. The project lowered an elevated-floodplain bench within the levee corridor to provide shallow-water conditions during typical water levels when juvenile salmon and steelhead are present. The lowered floodplain will be planted with native vegetation. IWM was placed along the riverside edge and within the excavated floodplain to provide erosion protection and habitat until planted vegetation is able to mature. The selection and placement of the IWM was based on the Sacramento Area Flood Control Agency's IWM Installation and Monitoring Guidance Manual, as well as qualitative observations of the on-going performance of IWM at previously constructed nearby sites. The design of the IWM anchoring and layout was constrained by the site's urban environment. This presentation provides an overview of the criteria used to select the IWM, a discussion of the installation methods, and outlines the unique features of the site to be monitored as the site matures.

Models for Cranberry Bog Stream and Wetland Restoration

Caitlin Alcott (Presenter), Martin J. Melchior, and Nick Nelson, Inter-Fluve, Inc.

The Eel River Restoration Project is the first example of active cranberry bog restoration in Massachusetts. Prior to restoration, the Eel River headwaters had been in cranberry culture for over 150 years. The stream was dammed and former sloped fens were converted to cranberry culture through the application of sand and management of dikes and water control structures. Design of the restoration project began in 2005 and construction was completed in July 2010. The Eel River Project included restoration of 40 acres of Atlantic white-cedar swamp and minerotrophic fen habitat, sphagnum moss restoration, fish and wildlife passage culvert replacements, removal of small dams, raptor perch habitat construction, 8,000 feet of new stream channel construction, over 1,000 pieces of large woody habitat, and stormwater detention and infiltration ponds. Habitat for salter brook trout, Bridle Shiner, and Eastern Box Turtle, a Massachusetts special concern species, were constructed.

The Tidemarsh Farms restoration site is a 400-acre retired cranberry bog. Construction started for 250 acres of wetland restoration and 20,000 feet of stream-channel restoration, including fish-passage restoration for blueback herring, American eel, and alewife. This project incorporates the Living Observatory, a collaboration among the project owners, Massachusetts Division of Ecological Restoration, MIT, various universities, and project partners in which remote-sensing techniques will be incorporated into visitor experience to both monitor ecological recovery and educate the public regarding cranberry-bog restoration.

Over three-thousand acres in Coos and Curry County in Southern Oregon contribute to the national cranberry production. As cranberry bogs are retired in the U.S., alternatives to traditional passive revegetation and restoration approaches are valuable. This talk examines the design and construction challenges faced in developing a repeatable template for large-scale cranberry bog stream and wetland restoration.

Instream Flow Enhancement and Groundwater Recharge Planning

Thursday, April 7

Workshop Coordinators*: Lisa Hulette,* *The Nature Conservancy,*
and Tasha McKee, Sanctuary Forest

Coho salmon in California are on the brink of extinction, and if current trends continue, Chinook salmon and steelhead trout are close behind. Dependent largely on the small-forested tributaries of the Coast Range for spawning and the first year of their lives, salmon populations have been significantly reduced by the devastating effects of logging, agriculture, and urbanization. Populations of coho salmon in the state have fallen from more than 500,000 fish to fewer than 5,000 in less than a century.

Water scarcity issues now pose the single biggest threat to salmonid recovery. Drought, land use impacts, and human water use are all contributing factors. With climate change and prediction of future droughts, we are urgently called upon to restore ground and surface water hydrology and develop conservation programs to reduce human use impacts.

This workshop will address streamflow and groundwater recharge science, including project implementation, resource management challenges, and new policy directions designed to provide salmon and steelhead the best chance for survival across their freshwater life cycle. Presenters will discuss strategies for increasing instream flow from state-wide action plans to water conservation and transaction programs to restoration of ground and surface water hydrology. Several different approaches to groundwater recharge will be presented in different settings such that participants will walk away with a broad understanding of techniques and their application. An interactive groundwater planning exercise will take participants through the steps of preliminary assessment and planning of groundwater recharge projects. Two contrasting project types will be used for the exercise and participant teams will be assisted in the preparation and sharing of a groundwater recharge project. Permitting for groundwater recharge projects will also be addressed, including the new Water Quality Certification for Small Habitat Restoration Projects.

California Water Action Plan: Enhance Water Flows in Stream Systems Statewide

Daniel Worth, *State Water Resources Control Board*

The California Natural Resources Agency, the California Environmental Protection Agency, and the California Department of Food and Agriculture developed the California Water Action Plan (WAP), which was signed by Governor Edmund G. Brown Jr. and released to the public on January 22, 2014. The WAP's fourth action, Protect and Restore Important Ecosystems, contains a sub-action (see page 12 of the WAP) that states the following:

"The State Water Resources Control Board and the Department of Fish and Wildlife will implement a suite of individual and coordinated administrative efforts to enhance flows statewide in at least five stream systems that support critical habitat for anadromous fish. These actions include developing defensible, cost-effective, and time-sensitive approaches to establish instream flows using sound science and a transparent public process. When developing and implementing this action, the State Water Resources Control Board and the Department of Fish and Wildlife will consider their public trust responsibility and existing statutory authorities such as maintaining fish in good condition."

Through a coordinated effort between the Department of Fish and Wildlife (DFW) and the State Water Resources Control Board (SWRCB), five priority stream systems have been identified as a starting point for the WAP effort. The five stream systems identified are the Shasta River, South Fork Eel River, Mark West Creek (Tributary to Russian River), Mill Creek (tributary to Sacramento River), and Ventura River.

This WAP action calls for a suite of tools to enhance and establish flows. This effort potentially involves a variety of work including, but not limited to, science to inform flow studies and potential actions; education and stakeholder engagement; enforcement, grant funding and outreach; development and implementation of flow requirements; instream flow dedications; and cooperative agreements. The WAP contains a goal of "over the next five years, the actions … will move California toward more sustainable water management by providing a more reliable water supply for our farms and communities, restoring important wildlife habitat and species, and helping the state's water systems and environment become more resilient."

Policy Analysis and Implementation of the Sustainable Groundwater Management Act (SGMA)

Pablo Garza, *Associate Director of External Affairs & State Policy, The Nature Conservancy*

The acute drought, increased ground subsidence, and leadership of Governor Brown and the Legislature enabled the passage of landmark legislation, the Sustainable Groundwater Management Act (SGMA), in 2014. The legislation establishes a framework for the management of California's precious groundwater resources. While protections for ecosystem values in SGMA was a low priority for many stakeholders, environmental NGOs hung together to ensure SGMA contained important provisions to protect public trust values. How was this achieved? What are these protections? And what needs to be done to realize these gains as SGMA is implemented over the next few decades?

The Nature Conservancy's Associate Director of External Affairs & State Policy, Pablo Garza, will provide his account of how it all went down and what the Conservancy will be doing as SGMA is implemented.

Providing Flows for Salmonids in Drought Years and Beyond

***Daniel Schultz,** State Water Resources Control Board, Division of Water Rights, Public Trust Unit*

In spring of 2014 and 2015, the State Water Resources Control Board (State Water Board) adopted emergency regulations for Curtailment of Diversions due to Insufficient Flow for Specific Fisheries (California Code of Regulations, title 23, § 877—879.2) (Regulations). The Regulations established drought-emergency minimum-flow requirements for the protection of specific runs of federal and state listed anadromous fish in Mill Creek, Deer Creek, and Antelope Creek. The Regulations included a provision that if diverters entered into Voluntary Agreements with California Department of Fish and Wildlife (CDFW) or National Marine Fisheries Service (NMFS) to provide flows necessary to allow for adult and juvenile fish migration and those Voluntary Agreements represented substantially all of the water diverted in the watershed, then the flow requirements in the regulations would not go into effect for the watershed.

The ongoing drought emergency has placed juvenile Central California Coast (CCC) coho salmon (coho salmon) and CCC steelhead (steelhead) in Russian River tributaries in a perilous situation. Low flows, already a problem before the drought, have been made worse by the extremely dry conditions. Use of surface and groundwater during these dry conditions reduces instream flows and results in disconnected stream systems. Isolated pools, resulting from this disconnected stream system, contain low oxygen levels and elevated temperatures that stress and kill fish and threaten coho salmon with extinction.

The Russian River Tributaries Emergency Regulation (California Code of Regulations, title 23, § 876) went into effect on July 6, 2015 and is designed to help protect federal and state listed anadromous fish in four priority Russian River tributary watersheds (Dutch Bill Creek, Green Valley Creek, Mark West Creek, and Mill Creek). The emergency regulation consists of two elements:

Enhanced Water Conservation Measures: Users of water diverted from the critical portions of the four watersheds, including both surface water and groundwater, are required to implement enhanced water conservation measures.

Information Order Authority: The State Water Board is authorized to collect information on surface and groundwater use in the four watersheds. This information is needed to accurately estimate the total water demand and the uses of water in these four watersheds to inform additional actions to protect federal- and state-listed anadromous fish, if needed in the future.

Drought conditions could potentially extend into next year and similar actions may be necessary to ensure drought emergency flows are implemented for protection of specific fisheries in high-priority watersheds. It is important that we use this opportunity to look back and evaluate the successes and shortcomings of the Regulations and Voluntary Agreements in Mill, Deer, and Antelope Creeks; implementation and compliance with the Russian River tributaries emergency regulations; discuss additional potential watersheds that may be in need of drought emergency minimum flows; and the benefits and constraints of the different paths forward to establish minimum flows for this drought period, future droughts, and other water-year types in the future.

South Fork Eel River Water Conservation Program —Sproul Creek Instream Flow Study

Darren Mierau (Presenter), *North Coast Director, California Trout,*
and ***William Trush, Ph.D.,*** *Humboldt State University, River Institute*

CalTrout and several project partners are conducting water resource investigations in Sproul Creek, tributary to the South Fork Eel River (SFER), Humboldt County, CA, as part of the South Fork Eel Water Conservation Program. This Program has two purposes: 1) demonstrate the application of ecologically sound and regionally appropriate methodologies for conducting site-specific instream flow studies that identify annual streamflows protective of native salmon and steelhead populations, and 2) propose watershed-scale water diversion methods and guidelines for SFER watersheds that protect public trust resources while allocating adequate water supplies for people's domestic needs.

We present seven habitat criteria that, if met, would provide ample streamflow to meet the life-history needs of juvenile and adult salmonids. Habitat criteria are thresholds used to determine if specific streamflow magnitudes sustain beneficial conditions for water quality and instream aquatic habitat. The Sproul Creek flow study will recommend flow criteria (instream flow needs) for the spring streamflow recession (April and May), through the summer low-flow period (June through September), and into onset of the rainy season (October or November). Juvenile salmonids are particularly vulnerable to excessive water diversions during this period of the hydrograph.

Our analyses and flow prescriptions rely prominently on unimpaired annual hydrographs as a basis for interpreting the functional relationships between streamflow, hydraulic habitat conditions, and biological/ecological responses. Unimpaired hydrographs suggest appropriate streamflow ranges in magnitude, frequency, timing, and duration within and across different water year types, and are important baseline targets for protection and recovery of streamflows. The degree of departure from the unimpaired flow regime is correlated with environmental risk.

South Fork Eel River Water Conservation Program —A Variable Diversion Rate Strategy for Coastal Watershed Management

William Trush, Ph.D. (Presenter), Humboldt State University, River Institute,
and Darren Mierau, North Coast Director, California Trout

North Coast California streams in a mediterranean climate experience a predictable spring through early autumn receding hydrograph each year. Naturally receding streamflows elevate stress on juvenile salmonids as water temperatures warm significantly, overall stream productivity drops, prime rearing habitats become scarce, and dewatered riffles eventually isolate one pool from the next. Each stressor changes in magnitude, duration, rate, and timing as spring becomes summer and then autumn. A primary objective of the Sproul Creek Instream Flow Study, as part of CalTrout's South Fork Eel Water Conservation Project, is to scientifically demonstrate how a Variable Diversion Rate strategy would be more protective of a stream ecosystem's and anadromous salmonid populations' capacity for self-renewal, or health, than bypass flow, modified bypass flow, or percentage-of-flow diversion strategies. If properly executed, juvenile salmonids will be stressed, but to no significantly greater extent than they would experiencing the naturally, unimpaired receding hydrograph. If properly executed, residential water users can be permitted year-round while minimizing potential cumulative diversion effects. Each step in permitting a residential water right, using a Variable Diversion Rate strategy, will be reviewed quantitatively (i.e., not conceptually, but with real numbers required of a permit). We will demonstrate how unimpaired annual hydrographs are necessary for quantifying instream flow needs (IFNs) of unregulated, small-stream ecosystems and anadromous salmonid populations. The ecological performance and annual water yield reliability will be contrasted between diversion strategies now being applied to California streams. Last, recommendations will be provided for standardizing recent and ongoing instream flow study methodologies applied in coastal watersheds, to ensure their scientific veracity.

Effect of Water Transactions on Water Quality and Adult Fall-Run Chinook Salmon in the Shasta River

***Amy Campbell (Presenter)**, The Nature Conservancy, and **Ann Willis**, University of California, Davis, Center for Watershed Sciences*

In 2012, a record number of adult fall-run Chinook returned to the Shasta River during a time when the majority of water is diverted for agricultural use. This presentation will summarize the effect that water transactions in the Shasta River had on addressing water quality limitations for these returning fish. Water transactions are becoming an increasingly used approach to provide instream flows during periods when there are competing water uses. Water transactions are often used to achieve ecological objectives, but their water quality or biological effects are rarely quantified. The effects of a water transaction implemented in the Shasta River were evaluated by using a spreadsheet model to quantify changes in dissolved oxygen conditions as they relate to discharge, pool volumes, holding habitat capacity, and potential dissolved oxygen demand by holding fish. The results indicate that water transactions may mitigate potential water quality impairments by decreasing the residence time in holding habitat, and are particularly effective during periods when flows are low, holding habitats are near carrying capacity, and dissolved oxygen demand by fish is elevated.

Aquatic Habitat is More than Skin Deep—Linkages Between Human Activities, Reduced Groundwater Abundance, and Aquatic Ecosystem Health

Brad Job, *Civil Engineer, Pacific Watershed Associates*

In northern California, even in dry years, it's the timing as much as the total annual volume of precipitation that tightly constrains groundwater resources. Because of the long dry seasons, low flow water in rivers and streams is almost entirely comprised of groundwater that has discharged to surface water. Steep hill slopes, fine-grained soils, malleable bedrock, and high stream-channel gradients conspire to naturally reduce the rate at which groundwater can be recharged and limit the volume that the Coast Range geological landscape can yield.

Human activities have changed aspects of the hydrologic cycle over the past 150 years and significantly reduced groundwater recharge, storage, and dry-season stream flows. These activities include compaction and erosion of surface soils; construction of impervious surfaces; road and trail construction; deep road cuts; destruction of wetlands; irrigated agriculture; even-aged forest stand management; wildland fire suppression; climate change; stream clearing and inadequate wood loading; and linearizing and simplifying watercourses.

At its most fundamental level, impaired hydrology is a transport problem. But, unlike traffic problems, the restorationist's objective should be to increase raindrops' commute time between hillslopes and stream channels and slow the transport of water out of watersheds. Restoration techniques going forward should put speed bumps into unnaturally accelerated flow paths, add complexity to stream networks that have been diced with roads, and support environmental education that links increased valuation of aquatic ecosystems with the mutual health of ourselves, our lifestyles, and our planet.

Reconnecting Hillslope Hydrology—Road Run-Off and Infiltration

Joel Monschke, P.E. Engineering Geomorphologist, *Stillwater Sciences*

Conventional road systems collect and convey ground and surface water through ditches and culverts to streams and rivers, resulting in a significant loss to groundwater infiltration and storage, translating to lower streamflows in the months with no rainfall. This presentation will include a review of best management practices for infiltration of road run-off. The purpose of these practices is to restore the natural hydrology and groundwater infiltration that has been interrupted by the road system. For roads in use, best management practices include a combination of detention and infiltration systems. The greatest benefit comes from maintained, permanent structures that begin close to the source of run-off. Detention structures include check dams and detention ponds and are used to slow run-off and store it until it can soak into the ground. Infiltration structures include gravel infiltration trenches with or without perforated pipe, seepage cisterns, infiltration basins, and bio-infiltration swales. These structures directly infiltrate surface flow into the ground. They are sized to infiltrate a two-year storm and are usually installed in combination to achieve the infiltration needed. Reduced erosion and sediment delivery to streams is an added benefit of road run-off infiltration systems.

Meadow and Floodplain Restoration and Active and Passive Groundwater Recharge

Eric Ginney (Presenter) and Carlos Diaz, P.E., Environmental Science Associates (ESA)

While all component parts of our watersheds should be considered important "sponges" that soak up precipitation and route it as groundwater for delivery to streams, meadows and floodplains are low-gradient landscape features that might also be considered as important "piggy banks," slowly dispersing their currency at the low point in the seasonal water budget. These lower-gradient landscape features may serve to recharge and store significant volumes of groundwater.

This presentation begins by establishing a context for the nature, importance, and organization of meadows, floodplains, shallow and deep groundwater, and hyporheic flow via a brief primer on surface and subsurface hydrology. The presentation outlines anthropogenic impacts to these natural systems and then summarizes conservation and restoration options for meadow and floodplain ecosystems, and considers the dynamic interplay of surface and ground waters supporting unique vegetation, streamflow, and aquatic habitat conditions. It summarizes the importance of meadows, floodplains, and another unique landscape feature (alluvial fans) as areas of potentially critical groundwater recharge. The presentation closes with an overview of opportunities to increase groundwater recharge via passive and active methods, at a variety of scales and on multiple landscape positions, and illustrates with project examples.

Quantifying Groundwater Recharge and Storage Increases from Meadow Restoration in the Sierra Nevada

David Shaw, P.G., ***Principal Hydrologist / Geologist, Balance Hydrologics, Inc.***

The current drought and the specter of climate change have been catalyzing interest in how sub-alpine and alpine-meadow restoration may benefit groundwater recharge and storage, but limited work has been carried out to quantify these benefits. We have used flow, groundwater, and salinity monitoring techniques to examine groundwater recharge, storage, and release associated with two types of channel-and floodplain-restoration project approaches, during both the design phase and after restoration implementation. As part of planning for a small-scale inset floodplain restoration, the temporal and spatial variation in baseline surface-groundwater relationships was documented by collecting local stream stage, flow, and groundwater data. Based on these ambient surface-groundwater relationships and the proposed restoration design, post-project recharge is projected to increase tenfold, from approximately 0.2 to two acre-feet per year. At a larger scale, a 'plug-and-pond' approach was applied to a 700-acre montane meadow in an effort to increase the duration of floodplain inundation and raise groundwater levels. Groundwater monitoring and streamflow gaging before, during, and after implementation indicate that shallow groundwater storage increased by approximately 100 acre-feet, corresponding to a calculated increase in storage of approximately 0.6 acre-feet per acre of restored meadow. In this system, release of stored groundwater has the potential to increase late-season downstream flows by five to six cubic feet per second, or approximately ten percent. Careful assessment of effects of restoration projects on the groundwater system should become a part of nearly all restoration plans, both to understand project sustainability during drought and to meet our collective social goal of storing additional water in mountain meadows and other alluvial valleys in the Sierra Nevada to adapt to evolving climatic conditions.

Restoring an Incised Coastal Stream—Groundwater Recharge Outcomes

Tasha McKee (Co-presenter), *Sanctuary Forest;* ***Brad Job (Co-presenter)****, Civil Engineer, Pacific Watershed Associates; and* ***Sam Flanagan,*** *Geologist, Bureau of Land Management*

Sanctuary Forest, Bureau of Land Management, NOAA Fisheries, U.S. Fish & Wildlife Service, and the Mattole Salmon Group implemented a collaborative, streamflow-enhancement pilot project at Baker Creek in the Mattole Watershed in 2012—2015. The project aimed to restore an 1,800 foot reach of incised stream with the objectives of reconnected floodplains, increased summer and winter juvenile pool habitat, increased groundwater storage, and improved summer flows. This presentation will focus on the groundwater recharge objectives and outcomes of the project and include a discussion of the pilot project approach with development of hypotheses, desired outcomes, and pre- and post-project monitoring. Additionally, challenges to achieving the outcomes will be shared. Project assessment is underway and the groundwater recharge results are highly instructive with regard to the limitations associated with bedrock streambeds and the scale of floodplain reconnection needed to confer drought resilience.

Interactive Groundwater Planning Exercise

Joel Monschke (Co-presenter), *Stillwater Sciences;* ***Eric Ginney (Co-presenter),*** *Environmental Science Associates (ESA); and* ***Tasha McKee (Co-presenter),*** *Sanctuary Forest*

Restoring groundwater hydrology is perhaps the most important work to be done, yet most of us know very little about groundwater concepts or where to begin. This presentation and exercise aims to empower participants with the basic approaches for preliminary assessment and planning of groundwater recharge projects. We will focus on two project types—restoring incised streams and earthen ponds built along terraces and upland swales. The process for determining the most suitable project type begins with review of topography maps to identify low-gradient areas (less than five-percent slope), followed by field scouting to confirm gradient and to assess water holding potential through vegetation type. Once an area is selected, additional mapping is often needed to refine the topography into one- or five-foot elevation changes. Groundwater monitoring or test wells will also need to be installed to determine depth to bedrock, existing water levels, and soil type layers. For instream projects, ecological factors are very important and sites are selected to optimize habitat benefits, including connection to side channels and alcoves. For terrace and swale-pond projects, runoff calculations can be used to determine optimum pond sizes and locations. This interactive exercise will be informed by actual projects that are currently being planned by the presenters.

Permitting Groundwater Recharge Projects —Permit Pathways and Lessons Learned

Tasha McKee (Co-presenter), *Sanctuary Forest,*
and ***Joel Monschke (Co-presenter),*** *Stillwater Sciences*

Groundwater recharge projects are currently not included in the California Department of Fish and Wildlife Fisheries Restoration Program and most other funding sources place the permitting burden on the project applicant. In order to facilitate restoration of groundwater hydrology and address statewide drought, improved permitting pathways will need to be developed for watershed-scale projects. This presentation will focus on existing permit pathways utilized by the presenters for small, groundwater-recharge projects. State permitting will include a discussion of the Categorical Exemption 15333 and the State Water Resources Control Board 401 Water Quality Certification for Small Habitat Restoration Projects, along with new simpler permitting opportunities under the 2014 Habitat Restoration and Enhancement Act/AB 2193. Federal permitting will include a discussion of National Marine Fisheries Service (NMFS) and the U.S. Army Corps of Engineers. Lessons learned from the permit process will be highlighted, along with permitting resources, agencies, and organizations that provide guidance.

Voyage of the Argonauts: Returning Habitat, Economic Prosperity, and Navigability to the Eel River Delta

Thursday, April 7

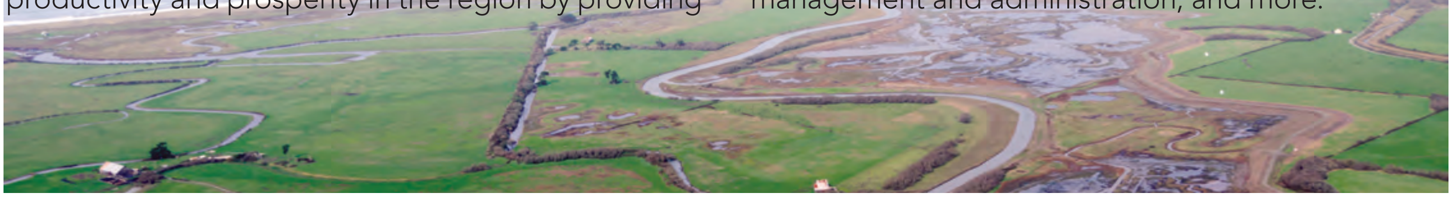
Field Tour Coordinators*: Michael Bowen, State Coastal Conservancy; Jeremy Svehla, P.E., GHD; Emily Afriat-Hyman, MA, The Wildlands Conservancy; and* **Doreen Hansen,** *Humboldt County Resource Conservation District*

Inhabited by humans for thousands of years, the Eel River estuary is one of the most important and sensitive estuaries on the west coast, with 8,700-acres of tidal flats, both perennial and seasonal wetlands, and about 75-miles of river channels and tidal sloughs. The Eel River Delta provides habitat for many aquatic and terrestrial species, and supports flourishing agricultural communities. Long before the "farm to table" movement, the Eel River Delta, and Ferndale in particular, supplied California markets with some of the world's finest dairy products. The Eel Delta still produces high-quality dairy and beef products, while also hosting one of California's major salmon and steelhead runs. However, flooding, sea level rise, and other issues challenge the viability of some agricultural operations and infrastructure, such as roads and waste treatment facilities. Balancing ecosystem restoration with the promotion of high-quality agriculture and infrastructure in the coastal zone is challenging, but several key projects illustrate the importance and success of this approach.

Although nearly 60% of the estuary has been lost due to the construction of levees and dikes; 10% of salt marsh habitats remain today. Restoring the estuary is a key component towards recovery of salmon, and other sensitive and listed species. Ecosystem restoration in the Eel Delta also affords unprecedented opportunities to improve drainage and infrastructure for the agricultural communities around the Delta. The Salt River Ecosystem Restoration Project and the Eel River Estuary Project, two of many projects within the Eel River Delta, seek to restore ecological integrity to reclaimed areas, while also enhancing agricultural productivity and prosperity in the region by providing land management options for landowners that support enhanced business security, stability, and ecological integrity. Hydrologically intact and functional channels tend to improve drainage for farmers. These channels also ensure a complex and diverse estuary, with suitable cover of deep channels and sloughs connected to productive brackish wetlands that will help increase the size and fitness of juvenile salmon prior to entering the ocean, and ultimately improve overall marine survival for adults.

Numerous landowners, as well as local, state, and federal agencies, industry representatives, and nonprofit organizations, are working together to ensure the Eel River Delta is a working landscape that can support sustainable agriculture and other land management practices while providing healthy fish and wildlife habitats. The Eel Delta provides an historic opportunity to enhance coastal agricultural productivity while ensuring the long-term recovery of Eel River salmon stocks capable of supporting the regional fishing economy of California's north coast.

Tour participants will have an unusual opportunity to tour key restoration sites within the Eel River Delta, some of which are located on private land or are otherwise inaccessible for viewing. The tour will include the 444-acre Riverside Ranch, the Port Kenyon reach of the Salt River channel, and much of the 1,200-acre Eel River Estuary Preserve, site of a proposed effort to restore historic Centerville Slough and its freshwater tributaries. Focal topics for the tour will include project challenges, lessons learned, biological responses to project features, construction management and administration, and more.



Lower Klamath and Strawberry Creek Field Tour

Thursday, April 7

Field Tour Coordinators*: Rocco Fiori,* *Fiori Geosciences,*
and ***Mitch Farro,*** *Pacific Coast Fish Wildlife and Wetlands Restoration Association*

The tour will include the Strawberry Creek restoration project within Redwood National Park and adjacent private lands. This project, constructed in 2014, restores a section of backwater habitat connected to the Redwood Creek estuary. The project used an aggressive approach to control invasive reed canary grass and other invasive aquatic plants by constructing planting mounds within the wetland, and then covering them with fabric, thick mulch, and dense riparian planting to shade the open water. Post-project monitoring shows improved water quality and the return of rearing coho salmon to this reach of Strawberry Creek.

The Lower Klamath portion of the tour will focus on restoring complexity and resiliency to instream and off-channel habitats to support self-maintaining salmonid populations. The Yurok Tribal Fisheries Program and its restoration partners have been using a bio-geomorphic approach that promotes the geomorphic processes necessary to form and maintain productive instream and off-channel habitat features. These techniques include: 1) excavations that mimic or enhance naturally occurring valley landforms such as side-channels, alcoves, remnant oxbows, and wetlands; 2) constructing log jams that provide cover, promote pool scour, sediment sorting and metering, and induce favorable hydraulics and connectivity to off-channel features; 3) constructing infiltration galleries to facilitate surface and groundwater exchange that enriches dissolved oxygen levels in constructed off-channel features; and 4) bioengineering that integrates the use of willow and other riparian plants to add root cohesion, hydraulic roughness, and vertical and horizontal vegetative structure and diversity to the site. On-going monitoring indicates that natal and non-natal juvenile and adult fish utilize these habitats as soon as they are available. Case examples from four different hydro-geomorphic settings will be presented that illustrate design considerations and constraints, and provide associated biological and physical monitoring results.

Fish Passage and Tidegates Projects in the Humboldt Bay and Lower Mad River Watersheds

Thursday, April 7

Field Tour Coordinators*: Ross Taylor,* *Ross Taylor & Associates*
and ***Leah Mahan,*** *NOAA Restoration Center*

Tributaries to Humboldt Bay and the lower Mad River support spawning and rearing populations of coho salmon, Chinook salmon, steelhead, coastal cutthroat trout, Pacific lamprey, and other native fish species. Prior to 1998, access into many of these tributaries was severely limited due to migration barriers caused by culverts on roads, as well as tide gates around Humboldt Bay. Initial passage assessments were focused on county-maintained road crossings, followed by CalTrans and the City of Arcata. Since 2001, numerous fish-passage projects have been completed using a variety of design techniques. Ongoing project monitoring has documented a range of successes, as well as valuable "lessons learned."

This field tour will start with at the River Lodge with a brief PowerPoint presentation that will provide an overview of the sites to be visited, including site-specific constraints that influenced design selection. The tour will provide an overview of a wide range of solutions to restore fish passage, including replacement with stream bed simulation, replacement with hydraulic design option, replacement with bridge, retrofit of existing structure, muted tide gate, and engineered fishway.

At each site, people involved with project planning, engineering, construction, and monitoring will be present to discuss the completed project.

Homage to the Interface: Coastal Deltas, Estuaries, and Floodplains

Michael J. Furniss, *U.S .Forest Service, Redwood Sciences Lab (retired) and MJ Furniss & Associates*

Everything seems to come together where saltwater meets fresh, where terrestrial meets aquatic, where fish, birds, and humans must co-exist, and where a warming climate and growing human populations have the most immediate impacts on our precious biota. These interfaces are now seen as keystone habitats for many taxa. These are our greatest challenges and most fertile opportunities.

In the early years of salmonid restoration, we largely avoided these places: they were usually on private land, complicated and expensive, and their biological importance under-appreciated. In recent years, ambitious collaborative efforts have restored many of these coastal habitats, such as at the nearby Salmon Creek, Arcata's McDaniel Slough, and the innovative Nigiri Project on floodplains of the Sacramento, among many others. Restoring these long-lost and much-needed keystones is very likely to amplify all of our efforts and bolster the resilience of salmonid populations. Much remains to be done and we are becoming adept at doing it.

Drought, Floods, and Alternate States of Algal-Based Food Webs in the Thirsty Eel

Mary Power (Presenter), Keith Bouma-Gregson, Jack Sculley, Stephanie Carlson, Suzanne Kelson, Gabe Rossi,* and *Phil Georgakakos, University of California, Berkeley

Alternative states of algal-based food webs assemble during the summer low flow season in the Eel and similar rivers under the Mediterranean climate seasonality along the California North Coast. These states depend on antecedent winter and current summer flow conditions. Blooms of the attached green alga *Cladophora* follow winters with one or more bed-mobilizing floods, which scour away over-wintering, predator-resistant grazers. Large armored larval caddisflies (*Dicosmoecus*) abound after winters without flood scour, and they sequester early summer growths of *Cladophora* and diatoms, reducing supplies feeding vulnerable grazers and therefore higher trophic levels, including fish. If winter floods release spring algae from large grazers, however, *Cladophora* proliferates over the summer low-flow season, and becomes overgrown with highly-edible epiphytic diatoms. Salmonids and other predators are then supported by prey built of epilithic- and epiphytic-algal carbon, but only if scouring-winter floods are followed by sustained summer base flow. If prolonged drought (or human water extraction) reduce flows enough to disconnect and warm mainstem pools, cyanobacteria, some toxic, can proliferate and cover both rocky substrates and the *Cladophora*-diatom assemblages. If these cyanobacteria are toxic, as some have proven to be for dogs along North Coast rivers, they may be the apex of one-link food chains. Twenty-five years of observation, five field experiments, and diatom frustule counts in an 84-year-stratigraphic record from the Eel's marine canyon help link year-to-year variation in hydrology to the three contrasting summer food web states: with scouring floods and sufficient summer base flow leading to 3-4 link chains that support salmon; flood-free winters leading to 2-link food chains with algal energy sequestered by predator resistant grazers if base flows keep main-stem reaches hydraulically connected; and the recently seen, concerning development that under severely reduced summer base flows, a one-link food chain may develop, capped by cyanobacteria. We have more to learn about how these concerning proliferations affect other consumers in riverine- and nearshore- marine food webs. Agency, academic, and citizen scientists are now collaborating to monitor and study conditions that flip river food webs from salmon supporting to cyanobacterially dominated states, and to learn more about the fates of algal production in river- and coastal- food webs. More eyes are needed on the Eel river, as well as other on the North Coast watersheds, to track critical flow-driven ecological changes, and to steward these rivers and their watersheds through the prolonged droughts and other altered hydrologic regimes that lie ahead for the region.

Ridges to River—Ecological Restoration

***Merv George, Jr.**, Forest Supervisor, United States Forest Service—Six Rivers National Forest*

The Six Rivers National Forest is implementing an "all hands all lands" approach to ecological restoration. This means landscapes across jurisdictional boundaries and from the ridge tops to the rivers. Because many areas have had fire excluded from the landscape for many years, there is an inventory of vegetation fuel that is now posing a major risk to watersheds and aquatic species. With ladder fuels posing major potential risks to forests overgrown with drought and disease stricken dead trees, there is a need to manage these fuels in order to save the precious watersheds from the next high-intense fire. As the forest implements ecological restoration, the goal is to prepare our forest to be resilient from fire and disease so that our communities and all forest-life forms can be safe.

Climate Change, Drought, and the Future of California Salmonids

Peter B. Moyle (Presenter), *Center for Watershed Sciences and Department of Wildlife Fish and Conservation Biology, University of California, Davis;* ***Robert A. Lusardi,*** *Center for Watershed Sciences, University of California, Davis and California Trout; and* ***Jacob Katz,*** *California Trout*

California supports a remarkable diversity of salmonid fishes, most endemic to the state. Unfortunately, when the status of the 32 native salmonids in California was evaluated as of 2010, 78% were found to be either extinct or likely to be extirpated from the state within 100 years. Here, I present preliminary results of a re-evaluation of the status of these species as well as the status of five non-native species, based on new information on climate change and other factors. The re-evaluation is based on the updating of species accounts that is currently underway, a project sponsored by California Trout. The decline of many species appears to have accelerated since our last evaluation because of drought, competition for water, and other factors. Survival of California's native salmonids will require major societal involvement and action in their conservation. This means developing and implementing a systematic, statewide conservation strategy focused on long-term persistence under rapidly changing conditions.

Life-Cycle Modeling to Inform Conservation, Restoration, and Recovery Planning

Friday Afternoon Concurrent Session 1

Session Coordinators: ***Thomas Williams, Ph.D.,*** *NOAA Fisheries, Southwest Science Center and* ***Brian Cluer Ph.D.,*** *NOAA Fisheries, NMFS West Coast Region*

The Right Side Channel, at the Right Time: Using Life-Cycle Analysis & Interdisciplinary Design to Build Resilient Side Channels on the Clackamas River

John Esler (Presenter), *Portland General Electric;* ***Lon Mikkelsen, Mike McAllister, Mike Brunfelt, RG, Emily Alcott, CE, MES,*** *and* ***Mackenzie Baxter,*** *Inter-Fluve, Inc.*

In 1877, a U.S. Fisheries Commission report wrote of the Clackamas River, "probably no tributary of the Columbia has abounded so profusely with salmon in past years as this river" (Stone and Livingston, 1877). Since then a 130-year history of over-harvesting, loss of suitable habitat and increased temperatures driven by timber clearing, gravel mining, agricultural conversion, and hydroelectric development have greatly reduced salmon and steelhead populations in the Clackamas.

Portland General Electric (PGE) has constructed and operated hydroelectric facilities on the Clackamas River since the early 1900s, including seven dams and four powerhouses to deliver power to Portland and surrounding communities. PGE's fishery management efforts began with construction of a wooden fish ladder on the Cazadero Dam in 1902. Besides maintaining upstream and downstream fish passage systems at its dams, PGE is funding the construction of side channels, gravel augmentation programs, restoring riparian revegetation, and placement of large wood jam installations that the river is no longer creating on its own. As technology and science have improved over the years, these efforts have included life-cycle modeling to help identify appropriate design criteria for fish habitat enhancement projects.

This presentation will detail how life-cycle modeling was used in concert with geomorphic and hydrologic analyses to select appropriate locations for side-channel projects aimed at improving habitat for endangered salmon. These efforts funded by PGE, were founded on the recognition that life-cycle suitable habitat types developed within the context of contemporary geomorphic and hydrologic conditions are the key to developing effective projects that improve habitat during the time of year and flow stages most critical and limiting to endangered salmon and steelhead. This presentation will describe the Milo McIver Park Fish Enhancement project. Two 700-foot-long side channels have been designed to increase salmonid production by providing cold-water summer rearing habitat and high-flow rearing/refuge habitat for juvenile coho, Chinook, and steelhead. Presenters will discuss preliminary monitoring data and initial performance of the project.

Coho Life-History Modeling in Coastal Northern California

Gabe Scheer (Presenter) *and* ***Darren Ward, Ph.D.,*** *Humboldt State University;*
and ***Seth Ricker,*** *California Department of Fish and Wildlife*

Historic land use practices and associated habitat degradation have led to large declines in coho salmon populations across California. With limited budgets, and high costs of salmon recovery efforts, it is important to prioritize restoration and recovery actions where they will have the highest potential for population response. Population modeling offers a powerful tool in understanding salmonid population dynamics as a function of management actions, and habitat restoration efforts. One challenge in developing population models is obtaining parameter estimates specific to the population of interest. As part of the California Coastal Salmonid Monitoring Plan, Life Cycle Monitoring (LCM) stations provide a promising source of population-specific metrics for this effort. This project utilizes 14 years of life-stage specific survival and movement data collected on Freshwater Creek LCM in Humboldt County to build and parameterize a stage-structured, life-history model. Subsequent analysis evaluates sensitivity and population response to various restoration and management scenarios. Questions this model addresses are: How do changes in juvenile survival and life-history composition affect coho salmon population growth and stability? What management regimes will maximize population viability? What are the projected population responses for coho under various restoration scenarios?

Illuminating Population Consequences of Disparate Survival and Behavior Between Hatchery- and Wild-Origin Chinook Salmon: The Role of Salmon Life-Cycle Models

Michael P. Beakes, Ph.D. (Presenter), William H. Satterthwaite, Colleen M. Petrik, Eric Danner, and Steve Lindley, NMFS, Southwest Fisheries Science Center

In past decades there has been a heavy reliance on the production of hatchery-reared fish to supplement declining population numbers of Pacific salmon. In some cases, the benefits of hatchery supplementation have been negligible despite concerted long-term stocking efforts. The management and conservation of depressed salmon populations, via hatchery practices or otherwise, can be improved by expanding our understanding of the dissimilarities between hatchery and wild salmon and how each interacts with the environment. In this study we use a stage-structured salmon life-cycle model to explore the population consequences of disparate survival and behavior between hatchery and wild-origin, fall-run Chinook salmon (*Oncorhynchus tshawytscha*) in the California Central Valley. We couple empirically based statistical functions with deterministic theoretical models to identify how environmental conditions (e.g., water temperature, flow) and habitat drive the survival and abundance of both hatchery and wild salmon as they integrate across riverscapes and cross marine and freshwater ecosystem boundaries during their life cycle. This study aims to identify if hatchery practices can lead to dissimilar interactions between hatchery and wild salmon and the environmental conditions they experience. As well, this study aims to assess if population dynamics of fall-run Chinook salmon in the California Central Valley are partly dependent on the composition of individuals that make up their populations. In doing so, this study seeks to improve our ability to conserve imperiled salmonids by identifying mechanistic linkages between the natal origin of salmon, survival and behavior, and the environment salmon experience at spatiotemporal scales relevant to salmon populations and fisheries management.

When are Population Models like Blimps? How to Avoid Fatal Flaws by Proper Model Selection

Frank Ligon (Presenter), Peter Baker, Ethan Bell, Abel Brumo, Jody Lando, Dirk Pedersen, and Joshua Strange, Stillwater Sciences; and William Dietrich, University of California, Berkeley

An old joke says that criticizing a population model is like shooting at a blimp—every shot is a hit and every hit is fatal. One of the reasons for the occasional skepticism regarding the usefulness of population models is that in some cases the models used were not appropriate for the questions being asked or the amount or quality of available data. We present case studies demonstrating the circumstances under which different modeling approaches may be more appropriate than others in guiding the development of salmon restoration and management programs. The life-cycle models that we discuss all attempt to identify the sources of mortality that historically and currently limit the size of a salmon population (i.e., limiting factors). The case studies include quantitative conceptual models, state-space models, individual-based models, and models that focus on addressing limiting factors through restoration of geomorphic processes. Case studies of two types of multi-stage, stock-production models are presented: first, for small watersheds where all life stages essentially use the same reaches and it is feasible to do a complete inventory of all available freshwater and estuarine habitat; and second, for larger watersheds where migration is more important (e.g., migration of fry from spawning reaches to downstream rearing habitat) and where it is infeasible to inventory all the available habitat, making it necessary to link the life-cycle population model to a physical (e.g., digital terrain-based) model to predict the distribution, quantity, and quality of habitat for each life stage. With these case studies, we will attempt to demonstrate why a particular model or modeling approach is unlikely to be the best choice in every case and what the best choices are. While there are many reasons that a population model may seem to have limited utility, selecting the appropriate model greatly reduces the possibility of fatal criticisms and can lead to defensible results that support effective salmon restoration and management.

The Black Box for Salmon Survival: Changing Perspectives on Marine Survival and Implications for Life-Cycle Models

Cyril Michel (Presenter) *and* ***Ann-Marie K. Osterback, Ph.D.,*** *University of California, Santa Cruz and National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center (SWFSC); and* ***Sean Hayes,*** *NMFS-SWFSC*

Numerous salmon life-cycle models are being developed for different salmonid populations throughout the west coast of the United States. These models depend on the accurate estimating of survival through the various life stages of the salmon life-cycle so as to better identify population bottlenecks which will in turn inform management actions.

The efficacy of these models in this application depends on accurate parameterization of key life-stage transitions such as marine survival. Where little information is known we are forced to make assumptions about how certain life-stage transitions should be parameterized, and these assumptions can have profound impacts on the inference that can be taken from these models. For example, the marine component of the salmon life-cycle is undoubtedly the life stage for which we know the least. Survival of salmonids during their marine residency has long been thought to be relatively low compared to the other life stages, however empirical evidence of this is limited. Likely, this hypothesis came from incorrectly parsing survival in combined measures of smolt outmigration, marine, and return adult migration survival (i.e., the smolt-to-adult return rate).

In more recent years, new tagging technologies have allowed us to more accurately estimate smolt outmigration survival, and as a result, parse out marine survival. Using the examples of two very different case studies (Central California steelhead from a small coastal creek, and late fall-run Chinook salmon from the Sacramento River), we demonstrate that outmigration survival in the river may be lower than originally believed, suggesting that marine survival is therefore higher than the literature may indicate. Furthermore, these studies have revealed higher than expected variation in year-to-year outmigration survival, varying up to a half order of magnitude. Many models attempting to explain marine survival using environmental indicators suffer from large amounts of unexplained variation in some years; we posit this may also be variation in outmigration survival incorrectly attributed to ocean survival. It is possible that if we start accurately partitioning outmigration and marine survival, we may ultimately identify different population bottlenecks requiring different management solutions.

Incorporating Life-History Diversity into Estimates of Skagit River Chinook Salmon Production

Corey Phillis, Ph.D. (Presenter), *NOAA Fisheries contractor—Ocean Associates, Inc.,*
and ***Correigh Greene, FE,*** *NOAA Fisheries, Northwest Fisheries Science Center*

Understanding how various habitat features influence production and carrying capacity of watersheds, and how life-history variation of outmigrants responds to these habitat factors, is critical for setting escapement levels and meeting population recovery goals. Here we illustrate how these concepts can be applied to improve conservation efforts using Skagit River Chinook salmon, a population with a history of extensive monitoring at multiple life stages and complementary watershed habitat data. Long-term monitoring reveal five juvenile life-history types (LHTs) are expressed in proportion to available LHT-specific rearing habitat (i.e., density-dependent migration) and migrate to sea at different ages and sizes. We integrate estimates of LHT-specific habitat capacity with size-specific variation in marine survival to predict outmigrant production and adult returns under a range of spawner abundance. We show that current juvenile rearing capacity is met at moderate spawner abundance, above which there is an increasing expression of fry migrants, the small fish that bypass the riverine and estuarine habitats and consequently experience low marine survival. Thus, fry migrants increasingly reduce adult returns as spawner abundance increases, yet the reduction in return rates are not predicted by outmigrant production when life-history variation is ignored.

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

Assessing Legacy Impacts of Hydraulic Mining in the Sierra Nevada —a 20-Year Perspective

Jennifer A. Curtis, ***U.S. Geological Survey, California Water Science Center***

Gold-bearing sediments were hydraulically mined throughout the Sierra Nevada during the unregulated California Gold Rush of the mid-to-late 1800s and during a protracted period of licensed mining in the early 20th century. Liquid mercury was used for gold recovery and more than eight million pounds of mercury was lost and conveyed into downstream watersheds. Hydraulic mining was developed in 1853 to excavate auriferous sediments located on ridgetops high above the modern channel. This required an intricate water diversion, transfer, storage, and delivery system. Debris tunnels were drifted up through bedrock valley walls into the bottoms of hydraulic mines and were used to deliver mine tailings to adjacent water courses. As a result, the mines were transformed into internally drained pits and tailings were washed into adjacent watercourses where as much as 46m of aggradation occurred. In 1884, due to adverse downstream effects, large-scale hydraulic mining was ended by court injunction. In order to comply with the Rivers and Harbors Act of 1880, which protected navigable rivers, the injunction prohibited the dumping of mining sediment into tributaries to the Sacramento and San Joaquin Rivers. The Camenetti Act was passed in 1893 and allowed small-scale licensed hydraulic mining under the supervision of the California Debris Commission until the 1950s. The license application for operating a hydraulic mine required emplacement of a debris retention structure and monthly reports of the volumes of excavated sediment. The largest of these debris dams was Englebright Dam built in 1941 on the lower Yuba River. The Yuba River, a tributary to the Sacramento River, historically supported both fall-run and spring-run Chinook salmon but access to much of the area historically used by spring-run Chinook was blocked by Englebright Dam. Flow diversions were retained and incorporated into the modern water supply and hydropower network. Erosion of abandoned mine pits and remobilization of tailings from aggraded tributary channels represent primary sources of sediment and mercury under modern conditions. This presentation will present findings from studies conducted in the Bear-Yuba watersheds since 1996. Assessments include the reconstruction of historic sedimentation histories and sediment budgets, assessments of sediment and mercury transport, and investigations of upland erosion rates and fine sediment sources.

Gravel, Gold, and Fish—Reclaiming California's Gold Fields

Rocko Brown, Ph.D. (Presenter), *and* ***Jason White, M.S.****, Environmental Science Associates (ESA);*
Joseph Merz, Ph.D., *and* ***Jesse Anderson,*** *Cramer Fish Sciences*

The legacy of human impacts to aquatic and terrestrial flora and fauna has left deep scars on landscapes and habitat forming and maintaining processes. Restoration, rehabilitation, and enhancement of degraded landscapes has shown to be effective in restoring habitat for riparian and riverine species. Compared to other settings, historic mine tailings from gold dredging operations provide a unique opportunity for habitat restoration because prior to restoration, these areas have little to any functional value to society in their current state. For example, floodplain restoration in urban and agricultural environments is often limited by the amount of space that can be nested in the river corridor. Since remnant gold fields are more abundant than current State aggregate needs these lands are opportune environments for ecosystem restoration. This talk discusses the potential for the restoration of river channels and floodplains associated with historic dredger mine tailings. Some example projects that have successfully turned otherwise degraded landscapes into key patches of ecosystem diversity are discussed. Lastly, key opportunities and constraints for dredger mine tailing restoration in California are also discussed.

Restoration Progress and Opportunities for the Yuba River Goldfields

Gary Reedy (Presenter), Rachel Hutchinson, *and* ***Chris Friedel,*** *South Yuba River Citizens League*

Extensive hydraulic mining in the Sierra Nevada during the late 1800s resulted in a massive influx of sediments that filled the lower river valleys and profoundly changed the physical character of the Yuba River. Dredger mining activity during the early 1900s directly impacted 24 miles of the Yuba River and transformed floodplain areas into mine tailings known as the Yuba Goldfields. As a result of these historic impacts and the construction of upstream dams, the lower Yuba River is limited in shaded riverine aquatic habitat and high-quality floodplain rearing habitat. The Hammon Bar Riparian Enhancement Project involved planting 6,500 large cottonwood and willow cuttings in 2011 and 2012 to increase vegetation cover, structural complexity, and, ultimately, local production of large woody material to enhance salmonid habitat. Project results suggest that this is an economically feasible method of establishing additional riparian forest. Other projects in the planning stages would involve floodplain lowering in collaboration with aggregate mining operations, riparian planting, and placement of large woody structures. Meanwhile, participants in the FERC (Federal Energy Regulatory Commission) relicensing process are evaluating potential flow modifications that would enhance floodplain rearing habitat and natural riparian tree recruitment. Also, the Army Corps of Engineers is conducting a feasibility study for Yuba River Ecosystem Restoration that could lead to federal funding and support for large-scale restoration. This presentation will include a vision for the maximum extent of potential floodplain restoration on the lower Yuba River.

Gold Mining, Extreme Floods, and Geomorphic Context of the Trinity River, California

Andreas Krause, M.S., Yurok Tribe

Major human and natural impacts have shaped the Trinity River, a large, energetic gravel-bed river in the Klamath Mountains of northern California. Hydraulic mining introduced very large sediment inputs that have left two measurable and persistent sediment waves. Dredger mining affected large extents of the valley-bottom sediment, mechanically mixing stratigraphic layers and leaving large deposits that are difficult for the river to rework. Large floods reworked broad swaths of valley-bottom sediment, developed valley-scale bars, and converted branched channel segments into a single thread channel planform. Logging introduced large amounts of fine sediment. Flow regulation reduced sediment transport competence and capacity; and promoted vegetation encroachment and natural levee formation that narrowed and stabilized the pre-dam planform. Restoration increased flow releases and large restoration projects can only make minor changes to the valley bottom and channel geomorphology as compared to previous impacts.

Each disturbance caused successive valley-bottom and channel changes. In each case, channel recovery is incomplete. Each disturbance modifies the recovery from a previous disturbance, and the previous disturbance acts to structure subsequent channel geometry and dynamics. This complex history of disturbance and response defines the geomorphic structure of the Trinity River and must be understood to inform effective restoration actions. The Trinity River also serves an important new case study on dynamics of hydraulic mining sediment waves as the unique history and geography offers contrast to the better studied examples in the Sierra Nevada Mountains.

Riparian Area Rehabilitation After Gold Mining

John H. Bair, McBain and Associates

Gold mining irreparably altered riparian areas and many methods have been demonstrated to successfully rehabilitate riparian areas in the Central Valley and intermountain regions. Riparian areas are transitional areas with gradients of nutrient and water availability that vary with distance and elevation from water. Surface and subsurface hydrology connect aquatic biomes with adjacent uplands within riparian areas (Natural Research Council, 2002, "Riparian Areas: Functions and Strategies for Management"). Riparian areas include the region between the aquatic biome and uplands, wetlands, and portions of uplands that significantly influence the conditions or processes of aquatic areas (California State Water Resources Control Board, 2012, "California Wetland and Riparian Area Protection Policy"). Riparian areas provide high-flow refugia, shade, cover, large wood, and nutrients to the aquatic biome (i.e., riparian services). Gold mining hydrologically disconnected streams and rivers from their adjacent floodplains. Soil moisture characteristics, inundation frequency, and ground surface interaction with shallow hyporheic groundwater changed permanently. Large wood and vegetation was removed. Following gold mining, levees, dams, gravel mining, and urbanization further limited recovery and reconnection of streamflows, groundwater, and riparian areas. On Clear Creek, Trinity, the Lower Tuolumne, the Yuba, and Merced rivers, mined areas have been found to be exceptionally difficult places to recover riparian services. Therefore, a primary goal for restoring riparian areas has been to quickly reestablish vegetation and the riparian services that were lost to the aquatic biome. Successful rehabilitation has required that soils, streamflow, groundwater, and topography be evaluated to identify the types of opportunities and methods that could be combined to recover self-maintaining riparian areas. Physical restoration combined with revegetation has been used successfully to promote recovery and facilitate riparian plant recruitment from locally available seed sources. Lowering tailings has created variable ground surfaces that inundate more frequently and are close to shallow groundwater. Sand, silt, and organic mulch have been added to graded ground surfaces to increase soil moisture retention and improve plant survival and growth. The first sites revegetated on Clear Creek, the Yuba River, and the Trinity River were revegetated using hardwood pole cuttings. Survival of pole cuttings planted on the Trinity River ranged from 0% to 100%, depending on where a patch was located, depth to groundwater, and the species. *Arroyo* willow had the highest survival, black cottonwood and shiny willow generally had a 50% survival rate, and red willow performed the worst. For the last three years on the Trinity, nursery container stock has been used and supplemental irrigation provided. Additionally, plant protectors were installed to help plants grow above deer or elk browsing levels, and plantings were mulched to reduce weed competition and local soil moisture loss. Current survival trends on the Trinity have been similar to earlier projects, but growth rate and ground coverage has increased.

Quantifying Legacy Impacts on Summer Stream Temperatures and Potential Riparian Reforestation Strategies

Rosealea M. Bond (Presenter) *and* ***Andrew Stubblefield, Ph.D.,*** *Department of Forestry and Wildland Resources, Humboldt State University; and* ***Robert Van Kirk, Ph.D.,*** *Department of Mathematics, Humboldt State University, and Henry's Fork Foundation*

Legacy impacts from historic land-use practices continue to be observed in California's streams. In this study we investigate a "hotspot" of the Salmon River, the second largest tributary of the Klamath River. It is a region of steep mountains and diverse conifer forests. Historical land uses, including logging, flow diversions, and hydraulic gold mining, have resulted in altered sediment transport regimes, diminished riparian cover, and reduced large woody debris. These in turn have altered the thermal regime of the river. Summer stream temperatures commonly exceed *Oncorhynchus spp.* temperature thresholds. Thermal dynamics of a one-kilometer reach of the North Fork Salmon River was quantified using distributed temperature sensing fiber-optics (DTS) and Heat Source modeling. DTS observations revealed nearly uniform warming over the study reach (July 2012), a diel heating cycle of 5°C, and a Maximum Weekly Maximum Temperature (MWMT) of 23°C. Habitat inventory of the study reach indicated poor salmonid habitat quality with low-habitat complexity and no large woody debris or instream cover, potentially reflecting hydraulic mining practices in the area. Heat Source modeling included the stream's thermal responses to future warming scenarios, as well as potential riparian reforestation simulations to estimate benefits of reforestation. Current stream temperatures were reduced by 0.11 °C/km under simulated partial reforestation of riparian buffers and 0.26 °C/km with full reforestation. Full reforestation augmented climate warming in all but the most extreme warming scenario—a 6 °C temperature rise combined with 71.0 % flow reduction. Reforesting areas, such as denuded gravel bars and areas with little vegetation, not only improves stream temperature related to current conditions but could reduce impacts from future warming conditions under constant boundary conditions. Land managers should consider reforestation as a tool for mitigating both current warming in legacy hydraulically mined areas, as well as future warming conditions.

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

The Progress and Promise of the Timber Regulation and Forest Restoration Program to Implement Planning Watershed Pilot Projects

Richard Gienger, *State Coho Recovery Team Representative, California Sierra Club,*
and ***Russell Henly, Ph.D.,*** *Assistant Secretary of Forest Resources Management,*
California Natural Resources Agency

Logging operations have gone through a sea change since the modern California Forest Practice Act of 1973, the application of the California Environmental Quality Act (CEQA), and implementation of water quality and endangered species statutes. The Board of Forestry and Fire Protection and CAL FIRE have the ability to require restoration measures to be implemented as part of their regulatory authority. Some important restoration activities have become part of the forest regulatory process, especially in regard to roads. Other important areas for fisheries and watershed recovery have had less progress.

The Timber Regulation and Forest Restoration (TRFR) Program was established in 2012 under Assembly Bill 1492. The bill provides a program funding stream via a one-percent assessment on wood products sold at the retail level. Its intent is to improve transparency and efficiency in the state's timber harvest regulation programs, provide for development of ecological performance measures, enhance the integration of species recovery into the regulatory process, and establish expanded forest restoration grant programs.

In embarking on its first Planning Watershed Pilot Project, the TRFR Program can help to improve the cumulative impacts evaluation and response process that will provide a "blueprint" and implementation measures for recovery from legacy logging impacts. A basic part of this is careful examination of actual Planning Watersheds. Calwater 2.2 Planning Watersheds, which usually range in size from 5,000 to 10,000 acres, and are almost always the scale at which cumulative watershed impacts are considered for harvesting plans.

Up to four representative Pilot Project Planning Watersheds will be evaluated for the adequacy and utility of information developed in timber harvesting plans, along with other available information. Multi-stakeholder and multidisciplinary teams ("Pilot Project Working Groups") will make findings and recommendations that will include, but not be limited to: adequacy for evaluation and response to cumulative impacts; suitable templates for information that facilitate and meet the needs of plan writers and reviewers, whether they be private, public, or agency stakeholders; and, ways to better identify and implement restoration opportunities. It should be noted that the 2004 California Coho Recovery Strategy makes similar findings and recommendations.

The TRFR Program and the foundational Pilot Projects need full public participation at every level to ensure success in their work to improve California's forests. The Pilot Project Working Groups will be an important part of this public participation.

Life on the Edge: Recovering Steelhead Southern California

Mark H. Capelli, *South-Central/Southern California Steelhead Recovery Coordinator, NMFS—West Coast Region*

The National Marine Fisheries Services (NMFS) in 1997 listed a distinct sub-population (DPS) of steelhead (*Oncorhynchus mykiss*) within the southern half of coastal California at the southern extent of their range in North America; in 2002, the range of the southern sub-populations was extended from the Malibu coast south to the U.S.-Mexico border.

NMFS Technical Recovery Team (TRT) for Southern steelhead has divided the Southern California Steelhead DPSs into five Biogeographic Population Groups (BPGs), characterized by a distinguishing suite of physical, climatic, and hydrologic features. Recovery of the southern steelhead DPS will require the restoration of a minimum number of populations within each of the five BPGs. The core watersheds identified in this biological strategy are geographically dispersed across the recovery planning area to preserve the existing diversity of life-history forms (ranging from anadromous to resident) and their evolutionary trajectories. This presentation focuses on the southernmost eight populations within the Santa Catalina Gulf Coast extending to the U.S. Mexico Border. This biological strategy is indented to minimize the likelihood of extirpation of individual populations within each BPG by natural perturbations (including periodic droughts, wildfires, and longer-range climatic changes), and preserve the potential natural dispersal of fishes between watersheds.

The Recovery Plan for the Southern California steelhead DPS identify a series of recovery actions intended to address the threats currently facing the species, as well as future threats posed by climate change and related habitat transformations. Additionally, a long-term research and monitoring program is proposed to address a number of key issues (such as the relationship between anadromous and resident forms) and refine the population and DPS-wide viability criteria developed by the TRT. The ecosystem restoration strategy, which focuses on restoring natural riverine and estuarine functions and features, will also serve to benefit the suite of native species, including other federally and state listed species which these watersheds historically supported.

P.A.C.T.—A Trans-Agency, Trans-Discipline Program to Prevent Coho Salmon Extirpation in the Central California Coast

Stephen Swales, Ph.D. (Presenter), *Fisheries Branch, California Department of Fish and Wildlife, and* ***Charlotte Ambrose,*** *NOAA Fisheries*

Coho salmon in coastal watersheds throughout the central California coast are severely depleted and many populations are either extirpated or approaching extirpation. Since 2005, coho salmon in the Central California Coast Evolutionarily Significant Unit (CCC ESU) have been listed as Endangered, under both the federal and state Endangered Species Acts (ESA and CESA). More recently, in 2015, CCC coho salmon were listed as a national '*Species in the Spotlight*' by the National Oceanic and Atmospheric Administration (NOAA). This designation seeks to highlight species which are most at risk of extinction and to target efforts vital for stabilizing populations and preventing extinction. In response to the declining status of coho salmon in the CCC ESU, in 2013 the California Department of Fish and Wildlife and NOAA Fisheries established a joint recovery program entitled *Priority Action Coho Team* (PACT), with the aim of preventing further extirpation of coho salmon in CCC coastal watersheds. In this presentation we will outline the structure and function of the PACT program and discuss measures which can be taken to prevent the further extirpation of CCC coho salmon, and which may contribute to the eventual recovery of viable populations throughout the ESU.

The Effects of Early Sandbar Formation on the Ecology and Population Dynamics of Steelhead and Coho Salmon in the Scott Creek Lagoon

Ann-Marie K. Osterback, Ph.D. (Presenter), Cynthia H. Kern, Ph.D., and Joseph D. Kiernan, Ph.D., NOAA Fisheries, Southwest Fisheries Science Center

Recent drought conditions have affected the dynamics of seasonal bar-built estuaries along the central California coast and thus the availability of critical rearing habitat and migration corridors for ESA-listed steelhead and coho salmon. In Scott Creek (Santa Cruz County), the sandbar at the mouth of the creek typically opens in late fall (~November) with the first major rainfall event and closes in the summer (~July) due to decreased stream flow and increased sediment deposition from coastal wave action. In 2014, however, the sandbar did not open until February and closed early (late May), providing only four months of connectivity between the stream and the Pacific Ocean for adult entry and juvenile (smolt) outmigration to occur. While early winter rains opened the lagoon at a more typical time the following winter (December 2014), little rainfall throughout the subsequent winter and spring again resulted in very early bar closure in May 2015. In both years, early sandbar formation effectively 'trapped' significant numbers of coho salmon smolts in the freshwater lagoon, requiring them to reside in freshwater for an additional year until given the opportunity to outmigrate the following winter as age-2 individuals. Whereas the benefits of lagoon rearing have been well documented for juvenile steelhead in Scott Creek, the fate of coho salmon rearing in the Scott Creek lagoon is poorly understood. In June 2015, we initiated an intensive field study to investigate the ecology and population dynamics of steelhead and coho salmon in the Scott Creek lagoon. We conducted monthly sampling to quantify the abundance, growth, and condition of lagoon-rearing steelhead and coho salmon, and also assess resource use (e.g., habitat, prey items) and overlap between the two species. We also collected data on key abiotic factors (i.e., temperature, dissolved oxygen, salinity, pH, and turbidity) to examine how each variable influenced fish distribution, abundance, and movement. We found that both coho salmon and steelhead were able to persist in the Scott Creek lagoon despite remarkably high water temperatures and low dissolved oxygen concentrations during some sampling events. Although both species experienced positive growth during lagoon residence, growth was generally greater for steelhead than for coho salmon. Importantly, our study demonstrates that juvenile coho salmon rearing in the Scott Creek lagoon can successfully over-summer a second year in freshwater before ocean entry during years with low stream flows and early sandbar formation. Ongoing research is working to assess the viability of this alternative life history strategy and whether lagoon-reared coho salmon ultimately experience enhanced marine survival.

Effects of Staggered Release Timing of Hatchery Coho Salmon Smolts on Subsequent Adult Returns to Scott Creek, California—Spreading Risk to Cope with Variable Ocean Conditions

Brian Spence (Presenter), Joseph D. Kiernan, Ph.D., *and* ***Erick Sturm,*** *NOAA Fisheries, Southwest Fisheries Science Center, Fisheries Ecology Division*

Precipitous declines in the abundance of coho salmon in watersheds south of the Golden Gate led to the establishment in 2002 of a captive brood program intended to prevent extinction and help rebuild these highly endangered coho stocks. This program, which is cooperatively run by NOAA Fisheries and the Monterey Bay Salmon and Trout Project, has produced smolts primarily for release in the Scott Creek watershed, Santa Cruz County. In the spring of 2013, we initiated a five-year study to examine whether survival of smolts released from this program might be improved by altering the release strategy from the historical practice of releasing all smolts in mid-to-late March to a release schedule that more closely matched the outmigration timing of naturally produced smolts in local streams, which typically lasts two months or more and peaks in late April or May. In spring of 2013, 2014, and 2015, batches of coded wire and PIT-tagged smolts were released at weekly intervals beginning in mid-March and ending in early May in order to determine whether subsequent survival varied among release groups. For the 2013 release group, we found that return rate varied with time of release. Return of three-year old adults from smolts released between April 9 and May 9 was more than twice that for smolts released from March 19 to April 2. Return rates of jacks from this same brood year also showed two-to-four fold variation among release groups, though the seasonal pattern was less clear. For the 2014 release group, jack return rates were again about 1.7 times higher for smolts released after April 6 than for smolt released prior to March 30. Overall, we estimate that 163 (± 12) adult and jack coho salmon returned to Scott Creek in the 2014-2015 spawning season, making this the largest return of coho salmon to the watershed in a decade. Though preliminary, the results suggest that staggering smolt releases may temporally spread ecological risk associated variable and unpredictable conditions in the marine environment, which are driven by the timing and intensity of coastal upwelling.

Assessing the Impact of Brown Trout on the Trinity River, CA

Justin Alvarez (Presenter), Hoopa Valley Tribal Fisheries,
and Darren Ward, Ph.D., Humboldt State University

Brown Trout were introduced to the Trinity River in the 1890s in two separate efforts, each time with the intent of establishing a self-sustaining population. This effort was successful, as is demonstrated by the healthy population over 100 years later. However, Brown Trout introduction is another example of managing our rivers fish populations with imperfect knowledge. River management now frequently includes undoing practices of the past, such as returning wood to the channels where it was removed to aid fish passage and assessing the impact of non-native species on the systems where they were introduced for a host of reasons.

Until recently, Brown Trout in the Trinity River were only investigated incidentally during surveys targeting Chinook and coho salmon and steelhead trout. These studies have suggested that the Brown Trout population is growing, and with this observation there has been increased motivation to conduct a study to quantify their numbers and gather baseline information. The Hoopa Tribe, in collaboration with Humboldt State University and with the cooperation of the California Department of Fish and Wildlife and National Marine Fisheries Service, is evaluating the status of Trinity River Brown Trout and its impact on the native fishes. We have found that the spatial distribution of the Brown Trout varies with time of year and location of prey. The diet of the Brown Trout varies by individual and across time, with some fish specializing on specific prey items but all taking advantage of prey pulses when they occur. The information being brought forth will be used in the creation of a Brown Trout management plan in the coming year.

Session Coordinator*: Patrick Higgins, Managing Director, Eel River Recovery Project*

The Distribution of Anadromy Versus Residency in *Oncorhynchus mykiss* in the Eel River

***Bret Harvey (Presenter)** and **Rodney Nakamoto,** U.S. Forest Service, Redwood Sciences Lab; and **Christian Zimmerman,** U.S. Geological Survey, Alaska Science Center*

Understanding the distribution of anadromy and residency in the steelhead / rainbow trout *Oncorhynchus mykiss* is valuable for the management and conservation of the species. We investigated this issue in the Eel River of northwestern California by seeking to relate the occurrence of anadromy versus residency with environmental factors known to influence the distribution of anadromy in *Oncorhynchus mykiss* in other places. We determined the maternal life history of 106 juvenile *O. mykiss* using strontium isotope analysis. Fish were collected from 52 broadly distributed sites covering a range of stream size and distance from the ocean. Sixty-three of 93 fish sampled below barriers had anadromous mothers, while one of 13 fish sampled above prospective barriers had an anadromous mother. We did not detect any influence of stream size or distance from the ocean on the occurrence of anadromy. Fish with resident mothers were found at 22 of 47 sites below barriers. The importance to population dynamics of maintaining suitable year-round freshwater conditions for adult resident fish is suggested by the broad distribution of their progeny.

Eel River Biology: Salmonids, Sturgeon, Lamprey, and Multi-species Planning

Life History, Distribution, and Ecology of Pacific Lamprey in the Eel River

***Abel Brumo (Presenter)**, Stillwater Sciences; and **Stephen Kullmann, Tim Nelson,** and **Eddie Koch,** Wiyot Tribe Natural Resources Department*

The Pacific lamprey plays a key ecological role in river systems across the Pacific Northwest and is a culturally important species for the Native American tribes that have always depended on it as a plentiful and energy-rich food source. Available evidence suggests that the species' abundance has declined substantially, both rangewide and in the Eel River, which received its English name due to the fact that it once contained large numbers of Pacific lampreys—commonly referred to as eels. The Wiyot Tribe is renewing its traditional role as active stewards of the natural resources in its ancestral territory, and in recent years has conducted several projects aimed at researching, monitoring, and restoring Pacific lamprey populations in the Eel River. Drawing from the Tribe's recent work and that of others studying the species, we will describe the current state of knowledge on life history, distribution, and ecology of Pacific lamprey in the Eel River basin. We will then present a life-history-based conceptual model as a framework for identifying the factors likely limiting Pacific lamprey abundance in the basin. Finally, we will describe key data gaps in our understanding of these limiting factors and discuss the research and monitoring—some of which is currently underway—needed to address them.

Green Sturgeon of the Eel River

Eddie Koch (Presenter), Stephen Kullmann, *and* ***Tim Nelson,*** *Wiyot Tribe Natural Resources Department; and* ***Joshua Strange, Ph.D.,*** *Stillwater Sciences*

Anadromous North American green sturgeon (*Acipenser medirostris*) occur in the coastal waters of western North America from the Aleutian Islands, Alaska to Ensenada, Mexico. However, the only documented contemporary spawning aggregations occur in the Rogue River of southern Oregon and adjacent Klamath River of northern California (northern Distinct Population Segment [DPS]—species of special concern), plus the Sacramento River of California's Central Valley (Southern DPS -threatened). Green sturgeon in the Eel River comprised one of the most prominent data gaps for North American green sturgeon given that the Eel River is one of the larger rivers in California and had an apparently robust and important historic spawning run and yet ambiguity persists in terms of the current status of green sturgeon in the Eel River. Officially, the Eel River spawning run is considered to have been lost and is designated as part of the northern DPS without direct evidence (critical habitat for southern DPS starts south of the Eel River), and yet sightings still occur annually. As recently as the late 1990s, adult green sturgeon were seen over one-hundred-kilometers upstream, consistent with a spawning run. For whatever green sturgeon that still spawn in the Eel River, it's important to determine if they are indeed northern DPS, or rather southern DPS, or even a mix. All possible outcomes would be significant: 1) if they are northern DPS then this would add a third spawning river to that population besides the Klamath and Rouge rivers; 2) if they are southern DPS then that would add a vital second spawning population besides the Sacramento River, with important implications for resiliency; and, 3) if they are a mix, then it would be the first documented mixed spawning run. We are conducting an ongoing project to resolve this ambiguity and document the current status of green sturgeon in the Eel River. Here we present on the first two years of results, including findings to date for: 1) assessment of habitat availability and limitations; 2) adult sturgeon presence and enumeration survey on the mainstem Eel River using a mobile DIDSON sonar camera; 3) tagging of adults in the Eel River with ultra-sonic telemetry transmitters; 4) monitoring movements of tagged adults, tagged in the Eel River or elsewhere, through a sonic receiver detection network at strategic sites in the marine, estuarine, and riverine migration corridor; and 5) identifying population(s) of origin using genetic analysis of tissue samples obtained from tagged adult green sturgeon. This is project is the first systematic study of green sturgeon in the Eel River and is already producing significant results.

Gauging Eel River Fall Chinook Abundance Through Citizen-Assisted Monitoring

***Patrick Higgins**, Managing Director, Eel River Recovery Project*

The Eel River Recovery Project (ERRP) has collected data on Eel River fall Chinook salmon returns since 2012, using a combination of dive surveys in lower Eel River index pools and documentation of mass migrations and spawning concentrations by citizen monitors throughout the watershed.

Dives begin after low flow angling closures on October 1, and are not held when flows rise above 300 cfs and angling re-opens. Methods are similar to those employed by the California Department of Fish and Wildlife and the U.S. Forest Service in northern California for summer steelhead and spring Chinook in the Klamath, Trinity, and Sierra foothill tributaries. Dive team members spread across a pool and swim in a line downstream, counting fish as they pass upstream. Lower Eel River pools are challenging because of shallow depth and algae, but consistent methods provide a useful index of abundance. Surveys are also conducted in index pools between Dyerville and Scotia, when conditions permit.

In some years it is possible for volunteers to do timed observations of Chinook salmon mass migrations from bridges that span the Eel River at various locations, where volunteers may also video and photo- document runs. ERRP follows-up on leads by traveling to areas of fish sightings to assess the number of holding fish or spawner densities. During low flow conditions in 2013-2014, ERRP used kayaks and canoes to do redd and carcass counts. Volunteers also join surveys of tributaries, when flows drop sufficiently during spawning season.

While runs were thought to be depleted, ERRP has found numbers to be re-building with estimates from 10,000 to 50,000 fish annually since 2012. Early October counts in index pools in and below Fortuna may be a few hundred or in the low thousands, with later counts increasing to a maximum ERRP one-day census of 5,962 Chinook salmon on November 8, 2012. ERRP is always experimenting to try and improve precision of dive counts and to decrease stress on the fish. Dive formations that funnel, not push the fish, are being implemented and more extensive use of video cameras by scuba divers is planned to either substitute for counts or to help verify results.

Chinook population estimates by ERRP are similar in magnitude to U.S. Fish and Wildlife Service estimates made from 1955-1958. The reasons for Chinook salmon recovery in the Eel River appear to be: 1) no take by anglers in river; 2) restricted ocean fishing from 2007-2009; 3) mostly good ocean feeding conditions from 1995-2012; 4) high rainfall and flows in winter and spring in the same time period allowing high survival of downstream migrants; 5) diminished pikeminnow abundance due to colder water and higher flow and possibly otter predation; and 6) improving habitat conditions in the Eel River estuary.

The Influence of Natural Barriers on the Distribution of Steelhead and Rainbow Trout in Tributaries of the South Fork Eel River

Suzanne J. Kelson (Presenter) *and* ***Stephanie M. Carlson,*** *University of California, Berkeley; and* ***Michael R. Miller,*** *University of California, Davis*

Oncorhynchus mykiss have long been appreciated for their life history diversity, including partial migration, in which some individuals migrate to the ocean (steelhead) while others remain in freshwater (rainbow). Steelhead are listed as federally threatened along the northern coast of California, but rainbow are not. Longitudinal (upstream-downstream) zonation of the two life-history forms has been noted throughout their range, with residents tending to dominate in upper headwaters. Here we focus on how natural, small barriers (waterfalls) and hydrology interact to determine the longitudinal distribution of resident and migratory fish. We predict that small waterfalls can be an impediment to upstream-moving migratory adults, particularly during dry winters, which may contribute to the longitudinal zonation of the two forms.

To determine the longitudinal distribution of steelhead and rainbow trout in relation to small barriers, we are using a combination of methods. First, we have captured approximately 2,400 and 1,500 *O. mykiss* across two years (2014, 2015) in two tributaries of the South Fork Eel River: Elder and Fox Creek, respectively. In both systems, we sampled from the mouth to the uppermost reach with fish (covering seven and two km of stream in Elder and Fox, respectively). At capture, we took a tissue sample for genetic analyses. We then used SNPs (Single Nucleotide Polymorphisms) on the Omy5 region of the genome to assign each fish (n = 2400) to a migratory or resident genotype (Pearse et al., 2014). In addition, we PIT-tagged each fish. Fish that were captured at stationary antennas located near the mouth of each creek were assigned a migratory phenotype, while fish that were recaptured upstream or were large at initial capture (> 180mm) were assigned a resident phenotype. Finally, we surveyed every waterfall for location, height, and angle, including the largest waterfall located 2 km from the mouth in Elder Creek. Here we present preliminary analyses from Elder Creek, focusing on the importance of the largest waterfall.

We found that the largest waterfall on Elder Creek (3.1 m high) influences the distribution of resident and migratory life histories. Resident genotypes dominated above the waterfall in Elder Creek (72% resident above vs. 44% below). Additionally, we were more likely to recapture tagged fish upstream of the largest waterfall suggesting a tendency towards residency in this region. Adult steelhead have been observed ascending the largest waterfall in flows over 60cfs (Trush, 1991). Analyses of historical hydrograph data (1967 - 2014) revealed that there is considerable variation in the frequency of flow events of this magnitude, from 0 - 78 days per year between December and May. Our results suggest that partial barriers can select against migratory fish, particularly during dry winters, which might suggest even stronger zonation of the two forms during drought conditions. We plan to repeat our sampling in summer 2016, following a predicted wet winter.

There are clear conservation applications to understanding how natural barriers influence life history diversity. Understanding the extent to which the resident and migratory form spatially overlap, and potentially interbreed, where they naturally co-occur could have implications for the level of protection that each life history receives.

Wild Fish of Southern Humboldt and Mendocino—What the Coastal Monitoring Program Partnership has Learned from Five Years of South Fork Eel River Coho Spawning Abundance Surveys

***Brian Starks (Co-presenter)**, Pacific States Marine Fisheries Commission,*
*and **Allan Renger (Co-presenter)**, California Department of Fish and Wildlife*

The Eel River Watershed, located In northern California's Humboldt, Mendocino, Trinity, and Lake Counties, supports an entirely wild-spawned population of State and Federal Endangered Species Act(s) (ESA) listed coho salmon, and monitoring of the Eel's coho population is an essential measure of ESA coho recovery plans (CDFW, 2004; NOAA, 2014). In 2011, the California Department of Fish and Wildlife (CDFW) and National Oceanic and Atmospheric Administration (NOAA) published the California Coastal Salmonid Population Monitoring Plan (CMP) (Adams et al., 2011). Extensive spawning ground surveys (SGS) are the primary survey method in the northern California monitoring area and form the foundation of the CMP approach to track status and trends of adult salmonid abundance for ESA recovery monitoring. Coho SGS have been conducted annually since 2010 on the South Fork Eel River by a project partnership (S.F. Eel Coho Project) that includes CDFW, NOAA Fisheries, Pacific States Marine Fisheries Commission (PSMFC), Americorp Watershed Stewards Program (WSP), and California Conservation Corps (CCC), and this monitoring is consistent with CMP methods, data analysis, and data-base compatibility. SGS are conducted on a randomly selected 20% of the total 201 reaches making up the South Fork Eel River coho sampling frame annually from November to March, and an estimate of total coho redds constructed in the sample frame is developed from these sample reach observations. In the November to March 2010/11, 2011/12, 2012/13, and 2013/14 survey years, we estimate coho salmon constructed 1630, 1312, 1568, and 879 redds respectively in the South Fork Eel River.

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

Presence and Prevalence of Parasites and Pathogens in Pacific Northwest Salmonids

Cynthia Le Doux-Bloom, Ph.D., ***AECOM***

Anthropogenic and environmental habitat changes can shift host and parasite and/or pathogen relationships, resulting in heightened transmission and amplification rates, which may lead to disease outbreaks resulting in mortality across wide spatiotemporal scales. Fish under acute and/or chronic stressors have the highest incidence of parasite and/or pathogen infection.

Considerations of endemic parasite and/or pathogen presence and prevalence should be incorporated into watershed restoration planning and project implementation to facilitate increased across life-stage salmonid recovery. This session will present an overview of the most prevalent viral, bacterial, and parasitic pathogens found in anadromous salmonids inhabiting select California watersheds. Additionally, methods to reduce stress on fish (e.g., handling), to identify potential infection or infected behavior, to decrease transmission, and to incorporate fish health testing into restoration planning will be presented.

An Outbreak of *Ichthyophthirius multifiliis* (ich) in the Klamath and Trinity Rivers in 2014 with Updated 2015 Results

Michael Belchik, ***Yurok Tribal Fisheries Program***

In September 2014, an outbreak of *Ichthyophthirius multifiliis* (ich) occurred in the Klamath and Trinity Rivers in migrating adult salmonids. The Yurok Tribal Fisheries Program monitored the progress of this parasitic-disease organism throughout the time and space of the fall-migration period in the lower 44 miles of Klamath River and at the Iron Gate and Trinity River Hatcheries. Ich levels climbed until they reached high levels, however no mortality event was observed in the Klamath or Trinity Rivers, nor was a diseased state observed in these fish. Salmon observed at hatcheries at the upper end of the migration range within the Klamath and Trinity Rivers had almost no ich on them. The evidence collected in 2014, as well as the known biology of ich and the migrating adult salmonids, indicate a strong likelihood that increased flows reduced the severity of this outbreak. Preliminary results from 2015 sampling will also be presented and a discussion of the implications for water flow management and other management options, such as dam removal.

Ceratomyxa shasta: Timing of Myxospore Release from Juvenile Chinook Salmon

Scott Benson (Presenter), *Humboldt State University, Sponsored Programs Foundation, and* ***Gary L. Hendrickson,*** *Professor emeritus, Department of Fisheries Biology, Humboldt State University*

Ceratomyxa shasta is a myxozoan parasite of salmonid fishes. It is endemic to several river systems in the Pacific Northwest of North America. It has a two-host life cycle involving the freshwater polychaete *Manayunkia speciosa*, so direct transmission from fish to fish is not possible. In the lower Klamath River, California, *C. shasta* has caused significant losses of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) during summer outmigration for more than a decade. Population dynamics of fall-run Chinook salmon in the Klamath are affected by *C. shasta*. My study investigates the timing of *C. shasta* myxospore release from juvenile Chinook salmon. It will help determine what role juvenile Chinook salmon play in perpetuating the infectious cycle in the river, and it will also provide insight into *C. shasta* production in spawned adult Chinook salmon carcasses. During the summers of 2010 and 2011, juvenile Chinook salmon from Iron Gate Hatchery were held in cages in the Klamath River for three days, and then reared at the Humboldt State University Fish Pathology Laboratory. Water samples were collected from the holding tanks and tested for *C. shasta* DNA with Quantitative Polymerase Chain Reaction (QPCR). Parasite DNA was mainly detected around the time of death and one week after death, when the carcasses tended to break open during decomposition. Observations suggest the parasite is released passively from fish. A cohort of out-migrating juvenile Chinook salmon may be capable of producing about 500 billion myxospores, but migration timing may place the spores at an area low enough in the river that they do not contribute directly to subsequent infections in other juvenile Chinook salmon.

Ceratonova shasta: Disease Impacts on Juvenile Chinook Salmon in the Klamath River Basin—Perspectives from a Ten Year Fish Health Monitoring Program

Kimberly True (Presenter), Anne Bolick, *and* ***Scott Foott,*** *U.S. Fish and Wildlife Service California-Nevada Fish Health Center*

The U.S. Fish and Wildlife Service (USFWS) California-Nevada Fish Health Center has monitored myxozoan infections (*Ceratonova shasta* and *Parvicapsula minibicornis*) in juvenile Chinook salmon *(Oncorhynchus tshawytscha*) in the Klamath River basin for over ten years. The Klamath River Fish Health Monitoring Program (KRFHMP) focuses on assessing annual *C. shasta* prevalence of infection (POI) in natural and hatchery-origin Chinook salmon during peak emigration (April to August) and estuary residency. Weekly monitoring of parasitic infection prevalence in juvenile Chinook salmon occurs in four major reaches of the Klamath River, beginning with natural juvenile Chinook salmon in upper reaches in early Spring and then hatchery Chinook salmon migrating downstream. Prevalence of *C. shasta* infection and disease severity (quantity of parasite DNA) are assessed using sensitive molecular tools (Quantitative Polymerase Chain Reaction—QPCR), histopathology, and additional diagnostic methods. Coded-wire tagged (CWT) hatchery Chinook salmon provide known exposure period for individual fish and allow an assessment of *C. shasta* exposure duration as it relates to disease (enteronecrosis) development using a Weeks at Large (WAL) metric.

Ceratonova shasta life cycle, fish pathology, and environmental factors that influence both the fish host and the alternative invertebrate host (polychaete *Manayunkia speciosa*) will be discussed. Fish host-pathogen dynamics (polychaete abundance, infectious actinospore release timing, and fish migration rate) that influence overall fish health in natural and hatchery juvenile Chinook salmon will be presented for specific monitoring years and across variable environmental year types. Recent trends in *C. shasta* prevalence of infection and disease severity under drought conditions in California will be emphasized.

A Conceptual Plan to Remedy Major Fish Pathogens in the Klamath-Trinity Basin

Joshua Strange, Ph.D.,* *Stillwater Sciences

Ecological degradation has led to significant pathogen-host imbalances and synergistic stressors in the Klamath-Trinity basin resulting in chronic and episodic salmon mortality. This fish disease-related mortality appears to be having substantial population level impacts, which is suppressing salmonid abundance and undermining habitat restoration efforts. Unless effective solutions are implemented that meaningfully improve the status quo, disease mortality will become more severe and increasingly frequent with the acceleration of global warming. Despite focused research and management attention for over a decade, success at minimizing and mitigating fish disease impacts has been limited, and the last two years can be considered the worst years on record for disease incidence and severity in the basin. Drawing upon my extensive experience in salmon biology, freshwater ecology, the relevant fish pathogens, and the Klamath-Trinity basin, I will summarize the primary contributing factors of the present pathogen-host imbalances and present a conceptual plan to remedy the major fish pathogens in the Klamath-Trinity basin. This plan is designed specifically to remedy episodic adult salmon mortality from *Ichthyophthirius multifiliis* and chronic elevated juvenile salmon mortality from dual infections with *Ceratonova shasta* and *Parvicapsula minibicornis* but is anticipated to have other benefits to fish health. This plan is feasible, practical, achievable, and can be implemented within an adaptive management framework relying on existing monitoring programs.

Shelter in the Slow Lane: Off Channel Ponds, Floodplains, and Beaver Influenced Habitats

Saturday Morning Concurrent Session 2

Session Coordinator*: Eli Asarian, Riverbend Sciences*

Fast Life In The Slow Lane —Or How Flooding Facilitates The Floodplain Fatty Feeding Frenzy

***Jacob Katz, Ph.D. (Presenter),** California Trout, and* ***Carson Jeffres,** University of California, Davis–Center for Watershed Sciences*

The simple act of sunlight falling on floodplains is the foundation of the river food web. Sunlight makes sugar; sugar makes bugs; bugs make fish. In essence floodplains are solar panels that store energy as plant and algae carbohydrates. This carbon fuel source (either algal or detrital) was the primary engine of productivity that supported the once-prolific numbers of fish and waterfowl in the pre-development Central Valley. But the carbon is only made available to aquatic food webs when rivers flood. Over the last century, construction of levees has cut-off 95% of the Central Valley's floodplains from river channels. Today, Central Valley aquatic ecosystems no longer receive the solar energy needed to support a robust aquatic food web and sustain abundant fish and wildlife populations. This means recovery of endangered fish populations will be impossible without first recovering the ecological processes which once supported historic abundances. Put more simply, levees starve salmon.

This presentation will report on research that demonstrates that restoring ecological function is possible even in intensively managed landscapes, like the Central Valley, when we mimic natural floodplain processes on working agricultural lands. I will also report on multi-stakeholder efforts, supported by both farmers and fisherman, underway to inundate over 18,000 acres in the Colusa and Yolo Basins.

Slowing Down Fast Traffic—Adapting a Levee System Built For Speed to Provide a Bit of Comfort (and a Fatty Feeding Frenzy)

Eric Ginney, Environmental Science Associates (ESA)

We know that levees starve salmon, robbing the river ecosystem of the very basis of its food web. With only 5% of the Central Valley's floodplains left connected to rivers, it's no surprise that river and flood management planning efforts are examining ways to expand floodways to increase available floodplain. We understand how to change the levee system to allow rivers to flood, and when that isn't possible, we are learning how to mimic natural floodplain processes on working agricultural lands to provide the ecological processes necessary to grow fat fish.

The Central Valley levee system is documented as being inadequate of providing public safety and protecting assets, let alone of providing adequate habitat to recover and sustain endangered populations of salmonids. Under a changing climate scenario, stress on the flood management system is estimated to increase. The level of investment in the flood management system estimated to best meet California's needs is approximately $20 billion in the next 20 years and is ultimately more than $100 billion. For comparison, the recent 2014 Water Bond (Proposition 1) was just $7.5 billion.

Where and how can we adapt our limited investment in flood infrastructure to yield a resilient system that provides public safety benefits as well as the important hydrogeomorphic processes that we know are necessary to support a robust aquatic food web and sustain abundant fish and wildlife populations? In those locations where those investments cannot be made at this time, where and how can we identify opportunities to provide surrogate habitats (e.g., managed winter flooding for fish and waterbirds) that mimic these natural processes?

This presentation describes the physical and chemical processes that occur when Central Valley rivers flood. It reviews the pre-Euro-American configuration of floodplains and flood basins and briefly touches on the presence of beaver in the valley and on the changes that construction of the flood and sediment management system has had on key physical processes. Within this context and based on dominant, landscape-scale characteristics represented by historical conditions, I consider locations where there are opportunities to adapt portions of the flood system to increase key hydrogeomorphic processes via changes to levees and water management infrastructure—much of which is presently inadequate or past its design life. These opportunities are founded on the results of hydraulic and ecological modeling and other geospatial tools. I also consider opportunities for mimicking ecological processes within and adjacent to the flood system to support conditions conducive to generating Floodplain Fatties. In many instances, these opportunities include the inherent benefit of increased agricultural water-use efficiency, increasing conservation of the Central Valley's most precious resource while increasing salmon habitat.

Creating Off-Channel Coho Rearing Habitat in the Middle Klamath River Subbasin: A Status Review of Constructed Projects (2010-2015)

Will Harling (Presenter), Charles Wickman, Mitzi Wickman, *and* ***James Petersen,*** *Mid Klamath Watershed Council;* ***Toz Soto,*** *Karuk Tribe; and* ***Michelle Krall,*** *Humboldt State University*

Since 2010, the Mid Klamath Watershed Council, Karuk Tribe, and other partners have been constructing off-channel coho rearing habitat on tributaries to the middle section of the Klamath River. Observations from these projects, including reflections on site selection, permitting, design, implementation, and monitoring provide valuable information for other restorationists interested in constructing similar projects. Historic photo analysis, groundwater monitoring, past flood history, interviews with old-timers, fluvial geomorphic analysis, and reach-specific coho habitat-use observations are considered in identifying potential project sites. Permitting off-channel projects has been an ongoing process with regulatory agencies. Design options that address permit requirements while allowing for flexibility to address site-specific conditions during construction are critical to project success. Lessons learned from constructing off-channel habitats in variable locations, from bedrock confined sites to alluvial deltas, to the Klamath floodplain, will be discussed. Performance of these sites, including water quality, coho abundance through the year and between years, resilience to disturbance, maintenance and monitoring needs, invasive species, and evolution over time will also be covered. Finally, recommendations will be offered for off-channel habitat monitoring protocols, sharing information between organizations implementing these types of projects, and the current and future role of constructed off-channel habitats in restoring coho salmon in the Southern Oregon Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU).

The Influence of Habitat Characteristics on Juvenile Coho Salmon Abundance and Growth in Constructed Off-Channel Habitats in the Middle Klamath River Subbasin

Michelle Krall (Presenter) *and* ***Darren Ward,*** *Humboldt State University;* ***Will Harling,*** *Mid Klamath Watershed Council; and* ***Toz Soto,*** *Karuk Tribe*

Humans have altered low-gradient stream reaches in the Klamath River basin, disconnecting floodplains and decreasing the amount of available rearing habitat for juvenile coho salmon. In response, numerous off-channel habitats have been constructed in tributaries of the middle and lower Klamath basin to provide both summer and winter rearing habitat for juvenile coho salmon and to help mitigate their declines. These habitats can provide seasonal refuge from high-winter flows and also suitable summer habitat when water temperatures increase in the main stem Klamath River. Previous research in the middle Klamath has shown that these constructed habitats perform similarly to natural habitats. Juvenile coho salmon growth rates, abundance, and retention in constructed sites were not significantly different from natural sites; however, they were significantly different between individual sites. It is not clear what mechanisms are responsible for the differences in performance among the constructed habitats. Though these habitats are typically constructed for winter rearing, juvenile coho salmon are utilizing these habitats in the summer as well. This study investigated the effect of accessibility to the restoration sites on the abundance of juvenile coho salmon within nine off-channel habitats of the middle Klamath River basin. I also tested whether habitat characteristics and food availability within the habitats impact abundance, retention, and growth of juvenile coho salmon utilizing the sites. Densities of juvenile coho salmon in these habitats were better predicted by habitat characteristics of average depth, maximum weekly maximum temperature, and average dissolved oxygen rather than accessibility to the site. However, accessibility throughout the year is important in order for coho salmon to move in and out of the site depending on habitat conditions and migration timing. Available benthic prey items and zooplankton varied between study sites with a positive effect of the density of *Cladocera* per cubic meter on retention through the summer. Availability of *Hemiptera*, *Ephemeroptera*, and *Diptera* had a positive effect on specific growth rates of juvenile coho salmon. Constructed off-channel habitats may be of increasing importance during the summer as temperatures continue to rise and the need for thermal refuge increases. With suitable habitat conditions and the availability of nutritious prey items, constructed off-channel habitats can hopefully support sufficient abundance and growth of coho salmon to contribute to increased survival and recovery.

Physical and Biological Monitoring of Beaver Dam Analogues in the Scott River Watershed

***Erich Yokel (Presenter)**, Scott River Watershed Council; **Michael M. Pollock, Ph.D.**, NOAA, Northwest Fisheries Science Center; and **Mark Cookson**, U.S. Fish and Wildlife Service—Habitat Restoration Branch*

The Scott River Watershed Council, NOAA Fisheries, Northwest Fisheries Science Center, and the U.S. Fish and Wildlife Service—Habitat Restoration Program installed six beaver dam analogues (BDAs) (also known as Post Assisted Woody Structures, or PAWS) in the Scott River and Sugar Creek in fall 2014 and two BDAs in Miners Creek in fall 2015. A monitoring program to document the effect on biological and physical parameters was designed to demonstrate the ecological response to the structures.

A major ecological benefit of BDAs is the creation of low-velocity, deep-water impoundments that increase local water surface elevation and potentially increase hyporheic flows and groundwater recharge. The deep, slow water habitats associated with BDAs create high-quality, year-round habitat for all salmonids and increase the carrying capacity of over-wintering coho salmon in areas with limited slow-water habitat due to legacy channel alteration. Biological and physical monitoring documents the desired ecological effects of the BDAs while insuring that any undesired effects (e.g., limitations to fish passage or water quality impairments) are quickly mitigated through adaptive management.

The documentation of volitional adult and juvenile fish passage through the structures and the utilization by juvenile salmonids of the deep, slow-velocity habitats created by the structures are performed throughout the year. Biological surveys, in conjunction with structure manipulation, are utilized to insure adult fish passage of Chinook (*O. tshawytscha*) and coho salmon (*O. kisutch*) past the structures. Juvenile direct-observation surveys, in conjunction with mark (Passive Inductive Transponder (PIT) tags) and recapture efforts, document the abundance and condition of rearing salmon and trout (*O. mykiss*) in the habitats affected by the BDAs. Establishment of PIT tag detection stations in association with the structures documents juvenile fish passage.

A network of groundwater and surface water elevation stations were established to document the BDAs effect on local water surface elevations. Stream water quality (temperature and dissolved oxygen) is monitored above and below the BDAs. A Slow Water Habitat characterization survey is performed above the BDAs to quantify the volume of available habitat and document velocities and fish cover elements during different seasonal flow regimes. Photo monitoring and topographic surveys document the changing stream and riparian conditions in the treated reaches.

The compilation and analysis of the monitoring efforts demonstrates the effect on the physical environment and the fishery of the BDAs in the Scott River. Continuation of the monitoring over five years will document BDA function and ecological response in the main stem and tributaries of the Scott River.

The Role Beavers Have in Creating Salmonid Rearing Habitats in Coastal California Streams Lacking Perennial Beaver Dams

***Marisa Parish (Co-presenter)**, Humboldt State University and Smith River Alliance, and **Justin Garwood (Co-presenter)**, California Department of Fish and Wildlife*

The ecological engineering activities of the North American beaver (*Castor canadensis*) provide beneficial salmonid rearing habitats, primarily through beavers building and maintaining channel-spanning dams that typically result in complex, slow-water habitats. Intense winter storms and widely-fluctuating river flows prevent beavers from damming most coastal streams and rivers of northern California. However, based on recent surveys, we found beaver populations are widespread in many streams, including the Smith River, Klamath River, Trinity River, Redwood Creek, and the Mad River despite these rivers having a lack of permanent beaver dams. Through snorkel surveys, we discovered beavers construct and maintain bank lodges with elaborate underwater tunnels containing openings usually surrounded by densely packed, small woody debris. These structures provide complex habitats for salmonids in stream reaches that otherwise lack persistent cover. Data assessing any benefits of beaver along banks of coastal rivers is lacking.

A substantial beaver population resides in and utilizes bank lodges in the main stem and coastal tributaries of the Smith River. This distribution overlaps almost exclusively with the current distribution of Federal and State Endangered Species Act (ESA) listed coho salmon in the Smith River. Our study was designed to assess how juvenile salmonids are seasonally distributed relative to beaver lodges. We conducted surveys for beavers during the summer of 2014 to assess distribution of bank lodges and current beaver activity in the Smith River coastal plain. We documented beaver activity at 34 lodges across 58 kilometers (km) of stream representing 83% of habitable stream throughout the coastal plain. Average distance between lodges was 1.1 km (0.1 - 3.9 km). During the winter of 2014-15, we found the distribution of beaver activity increased 1.8 km through colonization of small tributaries which had been dry during the summer months.

With the use of snorkeling and minnow trap surveys, we evaluated multi-season occupancy parameters of rearing juvenile coho salmon at a subset of habitats with lodges and without lodges throughout the main stem of the Smith River during the summer 2014 and winter 2014-15. We established 24 survey sites (half with lodges, half without lodges) throughout the main stem Smith River. During each season, we visited all sites on four occasions to estimate seasonal salmonid occupancy. During the summer we found beaver activity at 19 of 24 sites with an average of 32% of available aquatic cover (cubic meters, m^3) created by beavers. We estimated the occupancy rate of coho salmon ranged from 0.69 to 0.85. In contrast, we found beaver activity in the main stem decreased during the winter with activity only present at 14 of 24 sites. An average of 14% of available aquatic cover across sites (square meters, m^2) was created by beavers. We estimated the occupancy rate of coho salmon ranged from 0.26 to 0.34. Similar to beaver, we detected coho salmon utilizing small intermittent coastal streams during the winter.

We suggest the role of beavers in shaping habitats within coastal rivers is largely underappreciated as most beaver-salmonid interaction studies have focused on the benefits of lentic habitats formed by beaver dams.

Session Coordinator*: Joshua Strange, Ph.D.,* *Stillwater Sciences*

When It Rains It Pours, but Not Very Often; Implications for Climate Change Considerations for Southern California Steelhead Restoration

Stacie Fejtek Smith (Presenter) *and* ***Bob Pagliuco,*** *NOAA Restoration Center*

Restoration and monitoring of steelhead will become increasingly complicated with climate change. Southern California's streams are already subject to infrequent and flashy storm events. Under climate change scenarios, increased durations of droughts and more intense storm events are anticipated. This talk will discuss climate change considerations in the context of steelhead restoration from headwaters to ocean, focusing on small dam removal and wetland restoration. Small dam removals often utilize "blow and go" techniques that rely on flow events to remove sediment once trapped behind the small dam. Addressing concerns of sediment bleeding after small dam removal and evaluating fish passage restoration success is difficult under drought conditions and requires adapting restoration design and monitoring strategies to ensure projects are indeed beneficial to the species. This talk will also describe best management practices for incorporating climate change into southern California coastal wetland restoration and management that pertain to steelhead protection. Wetlands must incorporate climate change considerations on two fronts: fluvial inputs (change in precipitation) and ocean inputs (sea-level rise). The monitoring methods used in southern California coastal watershed projects also require creative strategies, both in the light of climate change and funding fluctuation. Utilizing partnerships such as the NOAA/California Conservation Corps Fisheries Veterans Program is just one creative solution.

Spatial and Temporal Variability in Baseflow Magnitude and Dry Stream Channels in the Mattole River Headwaters: Implications for Salmonids and Restoration

Nathan Queener (Presenter), *Humboldt State University, Department of Forestry and Wildland Resources and Mattole Salmon Group, and* ***Andrew Stubblefield,*** *Humboldt State University, Department of Forestry and Wildland Resources*

Pronounced seasonality in rainfall and streamflow are natural components of a Mediterranean climate. Increases in human population, water use, and climate change have the potential to further increase water scarcity in regional watersheds. Multiple recent studies have identified declining minimum flows over the period of record for many stream gages in this region. Better understanding the processes that regulate the storage and release of water from catchments in the dry-season and the spatial distribution of dry channel throughout the stream network will help inform decisions intended to improve salmonid habitat.

This study used repeated synoptic measurements of streamflow and surveys of the extent of dry channel in small fish-bearing streams (drainage area less than 11 square-kilometers, km^2) in the southernmost 85 km^2 of the Mattole River watershed to characterize variability in base-flow and patterns of reach drying, and to explore correlations of discharge with landscape characteristics. A nearby continuously recording stream gage was used as an index gage to allow for the comparison of tributary flows measured on multiple dates.

Tributary unit-area streamflow within this physiographically homogenous area varied by over two-orders-of-magnitude. Losing reaches exhibiting downstream declines in both discharge and unit-area yield were common, even in streams with no water diversions. Basins with greater base-flow had steeper slopes, higher elevations, narrower valleys, more dissected topography, and more precipitation. The magnitude of difference in water yield among basins was much greater than the difference in precipitation, suggesting that flow differences were the result of the combination of differences in basin water inputs, storage capacity, and routing. The positive correlation between basin steepness and flow is likely attributable to the role of the thickness of the weathered bedrock layer in water storage, and more rapid bedrock weathering in steeper basins, resulting in greater storage capacity.

In some salmonid-bearing streams, riffles lacked surface flow for at least 25% of the year. The distribution of dry channels showed no clear tendency towards reaches "drying down" or "drying up", although flow going subsurface near the stream mouth early in the summer while upstream reaches subsequently maintained surface flows for months was common, eliminating the potential for downstream migration early in the dry season.

Extreme variability in summer base-flow can occur independently of diversions and consumptive water use. Conversely, streams with naturally low base-flows are particularly susceptible to water diversion. The summer-rearing potential of basins with naturally higher base-flow per unit area will have greater resiliency to climate change effects, and preserving and enhancing habitat in these basins should be a priority. These results also suggests that in similar geologies low-gradient streams essential for coho salmon rearing may be particularly susceptible to climate change or water diversions that reduce streamflow.

Differences in internal plumbing within these basins likely sets limits on their potential for base-flow increases resulting from management actions. However, the relationship between streamflow and the extent of dry channel in the study streams also demonstrates that even small changes in flow can lead to large changes in longitudinal connectivity of the channel network and habitat availability.

Availability of Thermal Stratification and Refugia in the Middle San Joaquin River System

Nathaniel L. Butler, Ph.D., University of California, Berkeley

Climate change is anticipated to impact salmonids in a multitude of ways with increases in stream temperatures that frequently limit suitable stream habitat. Thermal stratification in river pools becomes critical to providing the cold water habitat salmonids need as stream temperatures increase. A better understanding of thermal stratification is needed to quantitatively incorporate it into restoration projects. Vertical water temperature profiles were measured in six river pools in the middle San Joaquin River system during fall 2012 to identify the key processes forming thermal stratification and thermal refugia. Surface and subsurface water temperature were measured at these six sites every fifteen minutes for two to three weeks at the ten-centimeter (cm) scale to evaluate diurnal and weekly trends in thermal stratification.

Air temperature and the interaction of streamflow with pool geometry were dominant controls on the daily thermal stratification observed at all six pool sites instrumented. The daily maximum change in air temperature correlated with both the maximum daily thermal stratification and the volume of thermal refugia in a river pool. Air temperature correlated with thermal stratification because the nightly decreases in air temperature below pool water temperature caused convective mixing as the surface water cooled. The extent of convective mixing, the decrease in pool water temperature, and the resulting formation of cold water habitat at the pool bottom all corresponded to nightly air temperature. A multi-day moving average of the daily air temperature was able to estimate the percentage of pool volume below a water temperature threshold. Surface streamflow was an also important control on the availability of thermal refugia with streamflow and pool geometry determining mixing conditions in pools. Thermal refugia was observed to be eliminated in one pool with minimal complexity when streamflow increased from 0.3 cubic meters per second (m^3/s) to 1.6 m^3/s.

Use of GIS Technology to Prioritize the Restoration and Protection of Anchor Habitat Riparian Areas in the Rogue River Basin

Eugene Wier (Presenter), Denis Reich, and Gustavo Monteverde, The Freshwater Trust

The Freshwater Trust (The Trust) has increasingly utilized the latest in Geographic Information Systems (GIS) technology to scope and prioritize its freshwater conservation work. The Rogue River Basin in Oregon—home to two of The Trust's largest riparian and in-stream restoration programs—enjoys a strong conservation community responsible for a basin-wide cooperative planning effort, the Rogue Restoration Action Plan. The durability of salmonid anchor habitat has been an important driver for this process, including the ability of riparian areas to withstand climate change and increasing pressure from invasive species, such as Himalayan blackberry. In support, The Trust has successfully procured state technical assistance to refine its GIS assessment tools so as to identify and prioritize "neighborhoods" of restorable riparian areas associated with the most productive reaches for anadromy. Reforesting these areas would be seen as the most cost-effective approach for building resiliency into the basin's anchor habitat network.

In July 2015 the Riparian Extent and Status Tool (REST) began development over a 12-month period, with support from an eight-member advisory committee of Rogue restoration professionals. The REST tool creates a continuous series of adjacent, equal-area Riparian Assessment Units, or "RAUs", evaluating near-stream vegetation along both banks of the Rogue and its tributaries. Each RAU is scored based on vegetation "extent", or percent forested, measured as 16 feet or higher using Light Detection and Ranging (LiDAR). Additional layers for restorability based on geomorphological metrics are also included.

Additionally, a field survey component will expand on REST's assessment capabilities. While much of the overstory in the Rogue can present a healthy picture, under the canopy aggressive weeds such as Himalayan blackberry, reed canary grass, and poison-hemlock often out-compete natural recruitment of key native species. Field surveys will collect a series of coarse quantitative and qualitative measures from 20 to 40 sites covering a spectrum of degradation levels. These measures will help calibrate the LiDAR raster such that each RAU score also reflects some degree of understory condition, providing a more complete picture of riparian health than canopy coverage alone.

A "neighborhood" proximity analysis will then prioritize reaches with low degradation and high restorability for riparian restoration. These layers will then be overlapped with sub-watershed level priorities already generated by the Rogue Restoration Action Plan. The result is a tax-lot level ranked list of anchor habitat neighborhoods that fit the local conservation community's needs and preferences. Well-established per-acre rates for site preparation, planting, irrigation, and stewardship are then employed to develop budgets for reach-level restoration.

By summer 2016 the LiDAR-covered portions of the Rogue will be scoped for restoration that best helps secure landscapes with the highest ecological value, building insurance against future climate change impacts and weed encroachment. This is an ideal complement to similar efforts currently being directed by Rogue partners to prioritize fish passage augmentation, instream work, and uplands restoration. Together all will help to ensure the essential preservation of the Rogue River Basin as one of the Pacific Northwest's key salmon habitats and ecological treasures.

Thinking Like Planet Water for Rehydrative Resilience in a Time of Global Weirding

Brock Dolman, Occidental Arts and Ecology Center WATER Institute

Climate change studies for California generally forecast significant hydro-modifications to the behavior of the State's water cycle. Potential dramatic reductions in annual snow pack, increases in extreme run-off events, exacerbated flooding, rising sea levels, amplified drought events, warmer and reduced instream flows, decreasing ground water recharge and affected available water quality and quantity are but a few of the challenges that humans and non-humans alike will face in the near future. This literal 'Watershed Moment' for all of California deeply necessitates that we ponder for a moment how to Think Like Planet Water for rehydrative resilience. From Ridgeline to Rivermouth we will have to adeptly and astutely adapt how we re-pattern our settlements to be ecologically literate and climate responsive. Critical to re-tuning the resiliency of how our watershed communities could responsively function amidst changing climatic regimes will be how we enhance the integrity of our riparian and riverine corridors. Clearly defining, conserving and regenerating the environmental services of these keystone ecosystems and processes, originating with the incipient start of the smallest headwaters springs and seasonal creeks to the grand convergence with the ocean, California's water security and recovery of listed salmonids fundamentally depends on dynamic watershed health. Will we collectively rise to the challenge? As has been wisely noted by many: "planning is best in advance"—so what is the plan for adapting to Global Weirding in your watershed going to look like?

Survive, Thrive, or Die? Adapting California's Water Infrastructure to Help Salmon in the Face of Extreme Climate Change

Joshua Strange, Ph.D., Stillwater Sciences

The acceleration of climate change is consistently outpacing modeled predictions, the scale and speed of which effects all aspects of salmon conservation and restoration on some level. Increased flow variability, extreme weather events, changing ocean conditions, rising snow levels, decreasing soil moisture, and warming waters pose serious challenges to cold-water dependent fish species in California. Such challenges are compounded by the impacts of these same climate stressors on human populations and associated water demands. Successfully accounting for climate change in restoration and recovery planning and implementation requires, in part: 1) accurately anticipating climatic change impacts at sufficient resolution and broad time scales; and 2) having effective compensating and mitigating tactics and techniques. In terms of the second, California's water infrastructure and associated water management and policy will play a deciding role in the fate and productivity of many salmon populations. California's existing water infrastructure is poorly suited to meet these coming challenges, and if the human response to these increasing climatic stressors is reactionary and shortsighted, then outcomes for salmon populations will be poor. Conversely, with proactive, long-term planning and implementation, California's water infrastructure can be upgraded in a manner that will help to compensate and mitigate for accelerating climate change impacts on salmon populations, while also improving water management flexibility for consumptive uses. This presentation will explore ways this can be accomplished, including conceptual examples of water infrastructure and management upgrades to improve water quality, reduce fish diseases, create thermal refuges, manage floodplain rearing, ensure successful migration, protect pre-spawn holding habitat, and augment cold water flows. The degree to which this is accomplished could mean the difference between surviving, thriving, or dying for many salmon populations and runs in California over the coming centuries.

Incised Stream Channels: Causes, Environmental Impacts, and Practical Restoration Solutions

Saturday Afternoon Concurrent Session 1

Session Coordinators*: Thomas Leroy, Engineering Geologist, Pacific Watershed Associates, and John Green, Gold Ridge Resource Conservation District*

Stream Channel Incision and Salmonid Restoration in Coastal California

John Green, Lead Scientist, Gold Ridge Resource Conservation District

Stream channel incision is a widespread problem which has been closely linked to human activities, including past and ongoing land and stream channel management practices. Vegetation conversion, the proliferation of impervious surfaces, poor road drainage practices, and channel cleaning and straightening, among others, all act to increase the frequency of channel-forming flows and reduce channel roughness, resulting in downcutting. The impacts of channel incision include the concentration of increasingly larger flood flows within the incised channel, which can mobilize salmonid spawning gravels on a more frequent basis and limit velocity refugia for juvenile fish. Incised channels are sites of elevated sediment delivery through bank collapse and fluvial erosion, and the lowered base-level of an incised stream often triggers headcutting and further incision in tributaries, as well as gully formation. Channel incision can also lead to the degradation of alluvial aquifers, reducing summer baseflows that are critical to juvenile salmonid over-summer survival.

Coho salmon restoration efforts in coastal California streams have for decades focused on improving instream habitat and, more recently, on increasing critically-low summer baseflows. But in spite of its potential to negate these efforts, little direct attention has been paid to preventing or remediating stream channel incision. Because the causes of incision tend to be distributed over the landscape, addressing them will be expensive and will require a watershed- or landscape-scale approach, with efforts coordinated across a range of entities, including government agencies at multiple levels and restoration-focused, non-governmental organizations. Failure to address both the causes and impacts of stream channel incision introduces increased risk to the prospects for recovery of healthy, self-sustaining salmonid populations.

A Stream Evolution Model for Incised Stream Channels

Brian L. Cluer, Ph.D. (Presenter), *NOAA Fisheries-West Coast Region, California Coastal Office, and* ***Michael M. Pollock, Ph.D.,*** *NOAA Fisheries-Northwest Fisheries Science Center*

Channel evolution models (CEM) provide a framework for evaluating the geomorphic history and estimating the future trajectory of incised channels. The recently developed stream evolution model (SEM) (Cluer and Thorne, 2014) provides linkages to habitat and ecosystem benefits associated with the various stages of evolution. The SEM also expands the range of channel configurations to include multi-threaded braided and anastomosing wetlands, where channels become difficult to define.

The SEM framework shows that there are significant differences in habitat and ecosystem values between incised- and floodplain-connected streams. It follows that when floodplain stream are disconnected through natural or human actions, significant losses in habitat and ecosystem values ensue. Furthermore, enhancing channels once incised does not restore the habitat or ecosystem values of a former floodplain-connected stream; the biogeophysical processes are not restored. This has implications for stream conservation and restoration that would ideally be codified in restoration plans and grant programs.

The presentation will give an overview of the Cluer and Thorne SEM and supporting examples of functional restoration approaches, including floodplain reconnection and aquifer restoration to restore climate resilient watersheds and habitat.

The Evolution and Restoration of Incised, Lower-Order Stream Channels in Managed, Fish Bearing, Mountain Streams of North Coastal California

Thomas H. Leroy, *Engineering Geologist, Pacific Watershed Associates*

Many mountain stream channels in north coastal California have been subjected to one or more watershed scale anthropogenic disturbance events, including extensive logging and road building. Within these disturbed watersheds, many of the lower-order, fish-bearing streams now exhibit some degree of channel incision. Characterizing and understanding the evolution of an incised stream channel is a necessary first step in developing a cost-effective restoration project that either 1) addresses and mitigates the cause and symptoms of the incision; or 2) works within the existing local channel geomorphic context and designs restoration projects around the projected future trajectory of channel evolution.

Understanding the cause of observed channel incision is critical to developing a cost-effective restoration project to restore biogeophysical function. Observations from recent channel surveys along 50 miles of low-order mountain streams in northern California indicate there are two common channel evolution models that lead to channel incision. In the first, the observed channel incision is likely related to changes in the hydrograph caused by a combination of upslope logging (vegetation removal) and the subsequent removal of associated channel stored large woody debris. These two disturbances often result in larger, flashier storm runoff and increased stream velocities. In the second model, the observed channel incision is likely related to sediment aggradation in low-gradient reaches or reaches plugged by debris jams and followed by channel re-incision, perhaps through base lowering or normal re-incision through the flood deposits.

For example, if the first model of increased runoff and/or woody debris removal is thought to be the cause of the channel incision, a project that slows water down and encourages deposition within the affected stream reach may be fruitful. Alternatively, if the channel was re-incising through unnatural low-gradient flood deposits (model 2), then a project that facilitates lateral scour and resorting of channel-stored sediment may be more effective at accelerating the evolution of the channel to a configuration more consistent with natural conditions. Creating a restoration project that simply treats observed symptoms of channel incision (such as lack of habitat complexity or disconnection of floodplain habitat) without understanding the overall cause of the incision may result in an ineffective restoration project.

Morphologic Effects on Anthropocene Sediment Pulses on the South Fork Eel River of Northwestern California

Tim L. Bailey, Geology Department, Humboldt State University

Sediment dynamics in the South Fork Eel River watershed have become a significant public policy concern due to their impact on several populations of anadromous salmonids. The decline in suitable alluvial rearing habitat is of particular concern. The watershed consists primarily of highly erodible marine sediments and is undergoing rapid, though variable, tectonic uplift. The river alternates between bedrock, colluvial, and alluvial reaches. In the years after 1945, logging and road building activities accelerated substantially through much of the watershed. Accelerated land use related sediment delivery has continued into the present. In 1955, and then more dramatically in 1964, floods introduced substantial pulses of sediment into the fluvial system. In order to quantitatively measure changes in sediment storage and channel morphology, we have produced a time series of channel and floodplain topography with coverages from 1941 to 2009. Topography was generated using stereo photogrammetry, historically surveyed topographic cross sections, and an airborne LiDAR (Light Detection and Ranging) coverage. At a station, hydraulic geometry has been generated for each time step at 100 meter intervals for 81 km of the river. The floods disrupted in-stream wood structures and removed riparian forests from floodplains. The reduction in channel cohesion, increased fine sediment, and increased rates of channel migration resulted in significant adjustment to alluvial reaches. Pool frequency and size has been significantly reduced. Sedimentary deposits have been mapped using oblique structure from motion photogrammetry. Overbank deposits from the 1964 flood in excess of one-meter thickness are still widely distributed, however significant declines in stored sediment is evident. Laser particle size analysis has been conducted on sediment samples to determine hydraulic characteristics of the depositional environment. Channel incision and dissection of depositional surfaces observed since 1964 are compared to the persistence rates of older elevated terrace deposits. The Anthropocene sediment pulse has not resulted in either net aggradation or incision; however, total channel roughness has declined dramatically during the interval of the study. The current floodplain conditions are most likely the result of decline in coarse woody materials and are not likely be reversed without significant intervention.

Using Biogenic Structures to Restore Complexity to Incised Streams

Michael M. Pollock, Ph.D. (Presenter), *NOAA Fisheries-Northwest Fisheries Science Center,* *and* ***Brian L. Cluer, Ph.D.,*** *NOAA Fisheries-West Coast Region, California Coastal Office*

Biogenic features such as beaver dams, large wood, and live vegetation are essential to the maintenance of complex stream ecosystems, but these features are largely absent from models of how streams change over time. Many streams have incised because of changing climate or land-use practices and have limited ecological functionality. Because incised streams provide limited benefits to biota, they are a common focus of restoration efforts. Contemporary models of long-term change in streams are focused primarily on physical characteristics, and most restoration efforts are also focused on manipulating physical rather than ecological processes. We present an alternative view that stream restoration is an ecosystem process and suggest that the recovery of incised streams is largely dependent on the interaction of biogenic structures with physical fluvial processes. In particular, we propose that live vegetation, large wood, and beaver dams or beaver dam analogues can substantially accelerate the recovery of incised streams and can help create and maintain complex fluvial ecosystems. This understanding can help guide incised stream restoration efforts and focus restoration treatments on addressing the underlying causes of stream habitat degradation rather than the symptoms.

Addressing Channel Incision in the Mattole River Headwaters —It Takes a Valley

***Sam Flanagan (Presenter)**, Bureau of Land Management, and **Brad Job, P.E.**, Pacific Watershed Associates*

The Mattole River can be characterized as convex, rather than concave, in profile resulting in relatively low-gradient headwaters streams. Beginning near river mile 60, low gradient channels flow through relatively wide alluvial valleys. Incision to bedrock has created a network of mostly continuous strath terraces. Active floodplains and off-channel features are largely absent in this incised valley setting. A combination of historic wood removal and channel manipulation, coupled with active tectonics, presents a challenging setting for disentangling the causes of channel incision. Remnant, old-growth trees on terrace surfaces suggest paleo, or geologically-induced incision. In contrast, many of the smaller tributaries show remnants of more recent, human-influenced channel changes promoting incision. As a consequence, salmonid habitat, particularly for coho salmon, is limited. Access to floodplains and velocity refugia is lacking, and the lack of a deformable stream bed precludes the development of deeper, more complex pools. Exemplifying this is Baker Creek, a 4.5 square-kilometer (km^2) tributary to the upper Mattole. Beginning in 2012, large wood was placed over a 400 meter reach with the multiple objectives of increasing groundwater storage, improving instream habitat, and increasing floodplain and off-channel connectivity. The project was guided by a desire to rapidly create coho salmon habitat given the precarious state of the Mattole population while promoting a longer-term trend towards less incision. We review project challenges, including a) designing channel grade controls that satisfy regulatory criteria while providing access to historic floodplain features now disconnected from the lotic system; b) sealing log weirs to provide more continuous connectivity; and c) allowing for sediment loads that create self-maintaining structures. We discuss philosophical issues surrounding a) the need to restore reaches that may be geologically prone to incision rather than human-caused; b) creating a series of "hard-wired" engineered structures with targeted inundation depths versus more natural wood jams; and c) promoting increased sediment generation and transport through increased channel instability, rather than minimizing sediment inputs through stabilization. Finally, we present preliminary monitoring results. Specifically, pool depths and complexity have increased, off-channel habitat with consequent fish utilization has been observed, and increased lateral instability with beneficial sediment and wood inputs has been noted. Further monitoring is planned as the reach evolves.

Upper Klamath-Trinity River Spring-Run Chinook: Biology, Genetics, and Recovery

Saturday Afternoon Concurrent Session 2

Session Coordinator*: Tom Hotaling,* *Salmon River Restoration Council*

Spring-Run Chinook Salmon Recovery in the Klamath-Trinity Basin

Joshua Strange, Ph.D., ***Stillwater Sciences***

Spring-run Chinook salmon (stream-type) were once the predominant run in the Klamath-Trinity basin with populations numbering in the hundreds of thousands of spawners. Currently, remnant naturally spawning populations exist only in the Salmon and South Fork Trinity rivers with annual returns averaging well less than 2,000 spawners with minimums of less than 500, which is not sufficient for long-term population resiliency. Artificial production occurs at the Trinity River Hatchery but hybridization with fall-run Chinook salmon is occurring. The recovery of a robust, natural spring-run Chinook salmon meta-population in the Klamath-Trinity basin is a crucial goal. In the absence of an Evolutionary Significant Unit designation separate from fall-run and resulting listing under the Endangered Species Act, a voluntary and stakeholder driven approach to recovery planning is been used for spring-run Chinook salmon in the Klamath-Trinity basin. In this presentation we will summarize their current status, management, and restoration activities to date; existing limiting factors analysis and evidence; and outline the necessary recovery actions to preserve and restore naturally spawning spring-run Chinook salmon in the Klamath-Trinity basin.

The Evolutionary Basis of Premature Migration in Pacific Salmon Highlights the Utility of Genomics for Conservation Unit Delineation

Michael R. Miller, Ph.D. (Presenter), *Center for Watershed Sciences and Department of Animal Science, University of California, Davis; and* ***Daniel J. Prince*** *and* ***Sean M. O'Rourke,*** *Department of Animal Science, University of California, Davis*

In order to minimize the loss of variation within species, the Endangered Species Act (ESA) allows for the protection of 'distinct population segments' (DPSs). A population, or group of populations, that qualify as a DPS receive full species status under the ESA. Methods for quantifying the 'distinctness' of populations typically rely on overall genetic differentiation, and thus prioritize the protection of geographically isolated populations with the idea that this reflects their evolutionary importance. In addition to local adaptation and genetic differentiation, significant adaptive variation exists within population groups. A prime example of this is Pacific salmon run timing, which describes the seasonal timing of adult freshwater migration. Previous genetic studies have found little differentiation between populations with different run timings from the same location, suggesting that early run timing is evolutionarily plastic and can easily re-evolve from late run populations if lost. This has resulted in DPSs that group diminishing early run populations with relatively healthy late run populations and a lack of protection for a life-history trait which provides immense economic, cultural, and ecological benefits. Here, we conduct association mapping in steelhead and Chinook to identify regions of the genome contributing to the early run phenotype. Strikingly, we find that early run timing is completely explained by the same genomic locus in both species. Patterns of nucleotide variation at this locus show that the early run phenotype is the result of a single genetic evolutionary event occurring within each species that subsequently spread through straying and positive selection. This result strongly refutes the previous notion that early run timing can be easily re-evolved from late run populations. Thus, identifying and analyzing the genetic region responsible for early run timing produces opposite conclusions about the evolutionary basis and conservation priority of early run populations. These results provide a clear example of how grouping populations based on overall genetic differentiation is insufficient to protect intraspecific variation that is universally regarded as unique and important.

Ishyâat, Spring Salmon

Josh Saxon, *Karuk Tribal Council*

Tribal people living in the Klamath Basin still recognize the spiritual importance of *ishyâat*, spring salmon, as a connection to our past and the key to our spiritual health and well-being into the future. While modern practices have greatly influenced tribal harvest methods, many of the ceremonial practices led by families today tie the people to significant places, life-giving food sources and traditional management practices. The traditional diet of the indigenous people of the Klamath region relied heavily on salmon, with over half of their yearly protein needs met by fish. Even today when the first fish are brought to the elders, families look forward to putting away jars of smoked fish for the wintertime. The people relied on annual ceremony, time tested harvesting protocols, and communal generosity to prosper and be healthy.

The present condition of our *ishyâat* has prompted tribal fishermen, managing agencies, concerned community members, and scientists to focus our collective efforts on restoring this keystone run of salmon. Because the spring-run of salmon in the Klamath began the harvest season for all basin tribes, the importance of understanding their role in the short- and long-term restoration of the Klamath region has been elevated. These fish not only contributed the bulk of fat content needed by humans coming out of long winters, the spawned fish also contributed to fertilizing riparian vegetation and sustaining wildlife. The life cycle of our spring-run fish has been largely compromised, and if we lose this run the likelihood of negatively affecting a multitude of plant and animal species, as well as humans, who are reliant on *ishyâat* for spiritual balance and physical health increases.

Spring Chinook of the South Fork Trinity River

***Joshua Smith**, Watershed Research and Training Center*

The South Fork Trinity River is one of the largest tributaries to the Klamath River but is often overlooked. The longest undammed river remaining in California, it hosts one of the last remaining spring Chinook salmon populations in the State. The South Fork Trinity once had a thriving run of spring Chinook salmon but this run has declined precipitously in recent times. The typical land use practices of the 1950's followed closely by the 1955 and 1964 floods led to widespread degradation of the watershed and, in turn, led to population declines. Chinook populations have varied since those times but remained alarmingly low. Some academic debates about the genetic distinctions of these fish have kept the population from acquiring special status protections and meanwhile new types of land use continue to threaten these already vulnerable fish. There is hope, however, and this watershed is a place where we can make a difference in the recovery of these wild fish.

Restoration of Wild Spring-Run Chinook on the South Fork Trinity River —A Call for Action

David (DJ) Bandrowski, P.E., (Presenter), *and* ***Aaron Martin,*** *Yurok Tribe;* ***Josh Smith,*** *Watershed Research and Training Center; and* ***Rocco Fiori,*** *Fiori Geosciences*

The South Fork Trinity River (SFTR) is the largest undammed river in the State of California, federally designated as a wild and scenic river, and a keystone watershed within the Klamath River basin supporting one of the last remaining populations of wild spring-run Chinook salmon. This once abundant fishery is in peril, and the spring-run Chinook are nearing the brink of extirpation from this unique stronghold (SFTR Spring Chinook Subgroup, Trinity River Restoration Program, TRRP, Fish Work Group, 2013). The SFTR is southern exposed and flows ninety-two miles from the headwaters of the Yollo Bolly Mountains to the confluence with the main stem Trinity River passing through the Hyampom valley. This river is located in one of the most isolated and remote watersheds in California and flows through the largest epicenter of marijuana cultivation and illegal water diversion in the country. Ecosystem restoration action is urgent to improve watershed health in the face of climate change, cultivation, and water diversions that are destroying necessary water quality and quantity for migrating anadromous salmon species.

Currently there is a coordinated effort underway between the Yurok Tribe and the Watershed Research and Training Center (WRTC) of Hayfork to help restore this damaged river system and stabilize the existing population of spring-run Chinook salmon from extirpation. Strategic in-river restoration and rehabilitation, combined with existing upslope stabilization best management practices (BMP), is being planned for execution in the upcoming months. This in-river restoration is targeted at improving adult and juvenile salmonid habitats, restoring reach-scale physical geomorphic processes, and improving water quality related to thermal refugia.

Large wood restoration implementation has been targeted as the primary method for achieving the above goals. Due to the remote geographic setting of the SFTR, the Yurok Tribe and WRTC are planning to use helicopter-placed large wood at strategic locations across a fifteen-mile reach. The wood will be placed at key locations within proximity to cold water tributary confluences. The large wood will be transported from upslope timber harvesting zones by helicopter and placed in designed arrangements to interact with hydraulic forces to induce scour pools, create habitat complexity, provide instream cover, and promote floodplain connectivity. Large wood is a critical element and driver for the interplay between ecosystem health, in-stream habitat complexity, and geomorphic processes in the formation of deep pool habitats for cool water refugia. Strategic implementation of large wood log jams will help provide the necessary reach-scale thermal resiliency for wild spring chinook to migrate through and hold in the SFTR, as well as promote the habitat complexity required by juvenile spring chinook for successful rearing and emigration.

This presentation will provide updated details and analyze results for this upcoming restoration action on the SFTR. The Yurok Tribe is developing baseline watershed hydraulic analyses to evaluate historical trends and topographic evolution through new technologies in photogrammetry, remote sensing, and 2D eco-hydraulic modeling. The time to act is now; waiting for this population to rebound on its own is no longer an option.

Monitoring and Restoration Efforts for Salmon River Spring-Run Chinook and Their Relevance to the Planned Reintroduction of Salmonids in the Upper Klamath Basin after Dam Removal

Nathaniel Pennington (Presenter), *Spring Chinook Specialist, and* ***Thomas Hotaling,*** *Fisheries Program Coordinator, Salmon River Restoration Council*

This presentation will look at past, present, and future monitoring and recovery efforts for the Salmon River's spring-run Chinook. Data will be examined using various efforts, including juvenile out-migrant trapping, adult population surveys, and habitat usage and suitability. Although the Salmon River supports a small but stable run of naturally spawning spring-run Chinook, further recovery has been limited, mostly due to the adverse anthropogenic conditions in the Klamath River and the disappearance of historic spring-run Chinook meta-populations. Habitat restoration, fish passage, public awareness, and effectiveness monitoring has proven to be crucial to the recovery of Salmon River spring-run Chinook. This data will be used to examine the capacity of the Upper Klamath Basin to support a viable population of spring-run Chinook, and to suggest what future reintroduction, habitat restoration, and population recovery efforts might look like for this region.

Session Coordinator*: Dougald Scott, Ph.D.,*
Salmonid Restoration Federation Board of Directors

Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds

***Scott Bauer (Presenter), Jennifer Olson, Michael van Hattem, Linda Miller**, and **Gordon Leppig,** California Department of Fish and Wildlife; **Adam Cockrill;** and **Margaret Tauzer,** National Marine Fisheries Service*

Large-scale marijuana cultivation has proliferated in northwestern California since the mid-1990s. The environmental impacts of marijuana cultivation appear substantial, yet have been difficult to quantify because cultivation is clandestine. We interpreted high-resolution aerial imagery to estimate the number of marijuana cultivation sites, greenhouses, and plants in four watersheds in northwestern California. Low-elevation, fixed-wing aircraft flights and cultivation site visits in the region validated assumptions used in aerial imagery interpretation. We estimated the water demand of marijuana irrigation and the potential effect water diversions could have on streamflow patterns. According to our estimates, water demands from marijuana cultivation have the potential to divert substantial proportions of the flow in our study watersheds, with our least impacted watershed seeing a maximum potential flow reduction of almost 23%, and other streams predicted to dry up entirely under certain diversion scenarios. These predictions are supported by field observations in our study watersheds documenting diminished or non-existent flows during the summers in recent years. Diminished streamflow due to marijuana cultivation is highly likely to have lethal or sub-lethal effects on state and federally-listed fishes and further decline of sensitive amphibian species. Our paper entitled, "Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds," was published in the online journal *PlosOne* on March 18, 2015.

Cannabis and Coho

Hezekiah Allen, *Executive Director, California Growers Association*

In California, cannabis is many things. There are the small farms selling craft products to boutique dispensaries. There are criminal land crimes to Silicon Valley venture capitalists. The cannabis industry is big — multiple billions of dollars a year by any estimate and it is largely unregulated. Cannabis is a way of life, creating jobs for hundreds of thousands of Californians. In recent years it has grown to become a serious threat to some of the most vulnerable salmon runs in the state.

Prohibition has pushed much of the cultivation into the hills and wilderness. In the worst case this is egregious crimes on public lands but, even in some of the best cases, cannabis farms are often sited in important and sensitive watershed areas.

Additionally, cannabis cultivators do not have access to incentive and education programs, so worst practices like misuse of toxins, over fertilization, or unmanaged runoff are widespread. Without business licensing to distinguish between civil and criminal infractions, the criminal justice system is and has historically been overwhelmed. Law enforcement tactics have not been able to manage impacts.

However, 2015 has been a landmark year for cannabis policy in California. Bipartisan legislation, passed with strong support, will—for the first time ever—create a framework for issuing business licenses for the cannabis industry. This comprehensive legislation lays out a framework for a huge rulemaking process to take place between 2016 and 2018. In addition to this legislation, two of the regional water boards in the state passed orders relating wastewater discharge in the cannabis industry.

Through a lens of streamflow and salmon,
the presentation will look at:

- Whether new legislation signed by Governor Jerry Brown provides relief quickly enough to make a difference for coho salmon,
- Policy and funding challenges of working within the cannabis industry,
- Will regulatory programs be able to function as a stepping stone to comprehensive regulation,
- Efforts being made by the cannabis industry to protect and restore streamflow, and
- Opportunities for collaboration with existing restoration organizations and natural resource agencies.

Long-Term Streamflow Trends in the Eel River Basin

Eli Asarian, Riverbend Sciences

Using streamflow data from the U.S. Geological Survey, I assessed long-term (1953-2014) trends in streamflow in the Eel River Basin. I combined data from several nearby precipitation stations to calculate a time series of Antecedent Precipitation Index (API) for the watershed contributing to each streamflow site. API is a time-weighted summary of precipitation which provides high weight to recent precipitation and low weight to precipitation that occurred many months ago. I used a regression model of the relationship between API and streamflow to calculate "precipitation-adjusted streamflow", which statistically reduced the year-to-year fluctuations caused by variable precipitation and allowed evaluation of the underlying streamflow trend. The use of daily precipitation data is an improvement on recent regional analyses that relied on monthly precipitation data.

During the summer and early fall, streamflow and precipitation-adjusted streamflow have significantly declined in recent decades at most gages in the Eel River basin. With the exception of precipitation quantity, the methods used in this analysis do not allow individual quantification of the factors contributing to streamflow declines. However, the long-term streamflow gages include a diverse range of watershed and climate conditions. Thus, we can hypothesize about causal mechanisms by carefully examining the trends that have occurred in watersheds with different conditions/histories. Elder Creek, the most pristine gaged watershed within the Eel River Basin, had declining trends in streamflow but not precipitation-adjusted streamflow (i.e., recent streamflow declines can be entirely explained by precipitation). This suggests that streamflow decreases at other sites are more likely the result of increased water withdrawals and/or changes in vegetation structure/composition than climate factors other than precipitation quantity (e.g., decreased fog and increased air temperature).

California Department of Fish and Wildlife estimates for marijuana-related water use within five Northwest California watersheds range from approximately one to ten cubic meters of water per day per square kilometer of watershed area. In comparison, the total magnitude of the decline in precipitation-adjusted streamflows across the entire 62 year period (1953-2014) during the months of July–October in this study was in the range of 30 to 100 cubic meters of water per day per square kilometer of watershed area for most tributary sites, indicating that water diversions for marijuana cultivation likely explain only a relatively small fraction (i.e., roughly 1% to 33%) of the total declines. These results do not mean that water diversions for marijuana cultivation do not have serious, even catastrophic, effects on streamflows in many Eel River Basin streams, including those with the highest value salmonid habitats, it just means that these diversions are only a partial explanation for basin-scale declines in streamflow. Despite being responsible for only a portion of streamflow declines, recent increases in diversions are a key additional impact compounding with previous impacts. Furthermore, diversions are perhaps the only factor causing streamflow declines that could actually be substantively addressed in the near-term (i.e., water can be stored in tanks and ponds when it is abundant during winter and early spring, offsetting the need for summer diversions).

Regulating the Watershed Impacts of Pot: Assessing the Utility of New Regulatory Regimes for Commercial Marijuana Production on the North Coast of California

Scott Greacen, JD, Executive Director, Friends of the Eel River

Watershed impacts associated with widespread, large-scale, and rapidly increasing commercial marijuana cultivation on the North Coast have become a key focus for salmonid recovery. Critical impacts include loss of streamflows to dry-season diversions and increased pollution in watersheds already impaired by high sediment levels and temperatures.

Uncontrolled impacts from the hugely profitable but unregulated marijuana industry have compounded the severe impacts of the hottest, driest drought in California history. Entire year-classes of coho salmon have been lost in tributaries of the South Fork Eel River critical to species recovery across the Eel River basin and the larger region, rendering recovery of the Southern Oregon-Northern California Coho (SONCC) Evolutionarily Significant Unit (ESU) increasingly unlikely.

The stage is set for a dramatic change in how California's state and local governments and their respective agencies relate to marijuana producers. Anticipating a 2016 ballot initiative to legalize adult use of marijuana, the California legislature passed a package of laws in 2015 regulating the ostensibly 'medical' commercial marijuana industry and providing a framework for local rules. Congress, federal courts, and the Department of Justice have all stepped back from interventions that short-circuited previous attempts to regulate marijuana production. North Coast counties are hurrying to write local rules to meet a March 2016 deadline under state law.

The legal regime likely to come into effect over the course of 2016 and 2017 will thus add several layers to existing laws, including those governing water diversions, water rights, and site grading, which have previously applied to commercial marijuana operations in theory but have proven difficult to enforce in an outlaw industry. The new rules include requirements promulgated by the North Coast Regional Water Quality Control Board to control sediment discharges by permitted operations.

The specific requirements of such regulations will be important. However, the chronic lack of institutional resources and absence of political will necessary to effectively enforce any rules, much less an effective, comprehensive system that will rein in thousands of outlaws, remains the Achilles' heel of California marijuana policy.

In the absence of effective enforcement, new rules will only control, at best, the actions of growers who choose to sign up with underfunded regulatory agencies. Because the rest of the U.S. is unlikely to legalize and regulate marijuana in the near future, California's North Coast is likely to remain the locus of a substantial black-market export industry in the near future. Never has "just legalize it" seemed so comprehensively naïve an approach to eliminating the entirely unnecessary burden that marijuana production has placed on the backs of North Coast salmon.

Water Resource Protection Requirements for Cannabis Cultivators Informed by Decades of Watershed Restoration

Adona White, *Water Resource Control Engineer,*
North Coast Regional Water Quality Control Board

In light of the water resource threats associated with the number and size of cannabis cultivation sites in the north coast, the North Coast Regional Water Quality Control Board (North Coast Water Board) has developed a new regulatory program to address waste discharges and potential beneficial use impacts from cannabis cultivation on private lands. There are four major components of the regulatory program, including education and outreach, interagency coordination, regulatory order development and implementation, and enforcement.

The program is informed by decades of non-point source pollution control and watershed restoration strategies. It is consistent with implementation strategies for sediment and temperature Total Maximum Daily Loads (TMDLs). This order is anticipated to serve as a model for future non-point source waste discharge orders developed/adopted by the North Coast Water Board. Key requirements that the presentation will focus on include:

- A sequential approach for preventing and minimizing water resource impacts.
- Property-wide sediment load reduction strategies including erosion control and site maintenance to minimize erosion and the creation of new sediment sources and reduction in sediment loading from existing controllable sediment discharge sites associated with current and past activities.
- Riparian protections to prevent erosion, filter sediment and nutrients, and maintain shade and large wood recruitment on all watercourses.
- Minimize surface water diversions from May 15 – October 31. Water quantity and quality are inextricably linked, and summertime streamflows are necessary to support fisheries and other beneficial uses.
- Promote coordination amongst neighbors for road maintenance and water use planning.
- Monitoring and reporting to verify management measure effectiveness and build sub-watershed scale data.
- A mechanism for enforcement penalties to be used to implement restoration or education and outreach via supplemental environmental projects.
- Prioritization of enforcement efforts based upon threat to fisheries and other water resources.

The program strikes a balance between responding to water quality threats associated with the scale and style of cannabis cultivation sites on the north coast, promoting participation of an industry that has long been unregulated, and implementing even-handed requirements for industries throughout the north coast. The program establishes clear water resource protection requirements while also allowing for site-specific solutions and landowner innovation, with the backstop of progressive enforcement to ensure timely compliance. North Coast Water Board staff are partnering with numerous entities, including counterparts with CDFW, the State Water Resources Control Board's Division of Water Rights and Office of Enforcement, landowners, consulting professionals, non-profit fisheries and restoration groups, landowner assistance groups, and industry trade-groups.

Where Has the Water Gone? Is it the Trees or the Weed?

John G. Williams, Ph.D.

Low flows in North Coast streams have dwindled markedly in late summer and early fall in recent decades, and diversions for Cannabis cultivation have been a contributing factor. However, various lines of evidence indicate that the main factor has been a major expansion of the fir forest at the expense of chaparral, prairie, and oak woodland resulting from less frequent fire since the Anglo invasion. I present gage data from unregulated streams (Elder Creek and the Mattole River) and historical evidence to make the argument. Lines of evidence include historical evidence for a major increase in fir forest over the last about 160 years; decreased low flows in a stream without significant Cannabis cultivation and no significant logging in the basin (Elder Creek); an increase in low flows with the logging boom of the 1950s and 1960s, and a decrease thereafter (Mattole River); published estimates of burning by native Americans; a timing mismatch between agricultural demand and reduced flows; and anecdotal evidence for reductions in flow in springs and small streams as fir forest expanded. I briefly discuss other impacts of Cannabis cultivation on fisheries recovery.

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SRF Upcoming Trainings

8th Annual Spring-Run Chinook Symposium

July, 2016, Chico, CA

The 8th Annual Spring-Run Chinook symposium will highlight recent restoration efforts in Butte and Battle Creek, regional status reports on Spring-run populations, genetics, FERC relicensing, climate variability, and population trend monitoring. Field tours will include visits to the legendary spawning grounds in Butte Creek and projects in critical creeks including Mill, Deer, and Antelope Creek that have been prioritized for instream flow enhancement and fish passage projects.

19th Annual Coho Confab

August 26-28, Mendocino

SRF, in cooperation with the Trout Unlimited, Mendocino RCD, The Nature Conservancy, and other non-profits and fisheries agencies will explore coho recovery strategies and techniques. The Confab will feature tours of large-wood placement, water conservation efforts, streambank stabilization, and fish passage projects. This Confab will visit exemplary restoration sites in the Mendocino and Navarro watersheds.

Poster Session Presenters

Reclaiming a Former Gravel Mine:
Reconnecting Abandoned Habitat at River Island
Presented by Emily Alcott
Inter-Fluve, Inc.
ealcott@interfluve.com

Natural Resources Services
—a division of Redwood Community Action Agency
Presented by Don Allan
Natural Resources Services
of the Redwood Community Action Agency
don@nrsrcaa.org

Youth Development and Natural Resource
Conservation Elevate Both to New Levels
Presented by Mark Allee
California Conservation Corps
mark.allee@ccc.ca.gov

Restoration of Rural and Urban Landscapes
Presented by Steve Allen
GHD
steve.allen@ghd.com

Eel River Recovery Project 2015 Water Temperature
Monitoring Results and Trend Analysis
from 1993-2015
Presented by Eli Asarian
River Bend Sciences
eli@riverbendsci.com

Assessing Riparian Condition
in Four Central Coast Watersheds
Presented by Jenny Balmagia
Watershed Stewards Program
/ Central Coast Wetlands Group
jbalmagia@gmail.com

Assessment of Salmonid Habitat Restoration Designs
on the Lower Mokelumne River, California
Presented by Robyn Bilski
East Bay Municipal Utility District
rbilski@ebmud.com

The Confounding Factor of "Ghost" PIT Tags:
A Case Study from Scott Creek, CA
Presented by Rosealea Bond
Southwest Fisheries Science Center
lea.bond@noaa.gov

Conceptual Design Hanson Russian River Ponds,
Floodplain Restoration Project
Presented by Brian Cluer, P.hD.
NOAA Fisheries
brian.cluer@noaa.gov

Anatoxin-a Dominates Benthic Cyanotoxin
Production in a California River Network
Presented by Keith Bouma-Gregson
University of California, Berkeley
kbg@berkeley.edu

Round Valley Indian Tribes Environmental Protection
Agency—Protecting Reservation Waters and
Educating the Community
Presented by Eloisa Britton
Round Valley Indian Tribes
Environmental Protection Agency
ebritton@rvit.org

Modeling Daily Average Stream Temperature
from Air Temperature and Watershed Area
Presented by Nathaniel Butler, P.hD.
University of California, Berkeley
butler.nathaniel.l@gmail.com

Watershed Stewards Program
Presented by Jennifer Catsos
Watershed Stewards Program
jennifer.catsos@ccc.ca.gov

Controls on Coho Salmon Jacking Rates
Presented by Jenna Dohman
Russian River Coho Salmon Monitoring Program,
Sea Grant Extension Program, University of California
Cooperative Extension
Jenna.Dohman@ccc.ca.gov

California Conservation Corps
Presented by Andrea Garcia
California Conservation Corps
andrea.garcia@ccc.ca.gov

Monitoring Stream Channel Response to Large Wood
Structure Placement—One Year After Installation
Presented by Gayle Garman
CA Department of Fish and Wildlife
gayle.garman@wildlife.ca.gov

California Department of Fish and Wildlife Ocean Ranch Unit, Eel River Wildlife Area Estuary Restoration Planning
Presented by Michelle Gilroy
CA Department of Fish and Wildlife
Michelle.Gilroy@wildlife.ca.gov

Outmigration Behavior and Marine Survival as a Function of Rearing Habitat for Coho Salmon in the Shasta River, California
Presented by Molly Gorman
Humboldt State University
mpg130@humboldt.edu

2015-2016 Eel River Fall Chinook Monitoring Results
Presented by Patrick Higgins
Eel River Recovery Project
phiggins@humboldt1.com

Benthic Macroinvertebrate Distrubition and Diversity in Topanga Creek Lagoon
Presented by Dylan Hofflander
Watershed Stewards Program
dylan.hofflander@ccc.ca.gov

Upper Klamath-Trinity River Spring-Run Chinook: Biology, Genetics, and Recovery
Presented by Thomas Hotaling
Salmon River Restoration Council
fisheries@srrc.org

The Shasta River Jack Anomaly
Presented by Caitlin Jetter
Watershed Stewards Program
/ CA Department of Fish and Wildlife, Yreka
caitlin.jetter@ccc.ca.gov

California Department of Fish and Wildlife 2015 Summer and Early Fall Drought Monitoring Study in Northern California Salmonid Streams
Presented by David Kajtaniak and Jon Guczek
CA Department of Fish and Wildlife
david.kajtaniak@wildlife.ca.gov,
jon.guczek@wildlife.ca.gov

Transition Season Forecasts to Support NOAA's National Marine Fisheries Service in Northwestern California
Presented by Reginald Kennedy
NOAA / National Weather Service
reginald.kennedy@noaa.gov

Seasonal Distribution and Survival of Juvenile Coho Salmon in the Scott Creek Watershed
Presented by Joseph Kiernan
NOAA Fisheries
joseph.kiernan@noaa.gov

Napa River Watershed Stream Map
Presented by Jonathan Koehler
Napa County Resource Conservation District
jonathan@naparcd.org

Testing the Effects of Water Quality and Multiple Sub-Lethal Stressors on Juvenile Salmonid Swim Performance in the San Joaquin River Delta
Presented by Brendan Lehman
NOAA Southwest Fisheries Science Center
/ University of California, Santa Cruz
brendan.lehman@noaa.gov

Non-lethal Management Solutions for Beaver: A Case Study CASTOR Model: California Assessment Tool Optimizing Restoration
Presented by Kate Lundquist
Occidental Arts and Ecology Center WATER Institute
kate@oaec.org

Watershed Best Management Practices for Cannabis Growers and Other Rural Gardeners
Presented by Linda MacElwee
Mendocino County Resource Conservation District
deborah.edelman@mcrcd.org

Quantifying Salmonid Stream Habitat with CHaMP and Rapid Habitat Census: A Comparison of Scope and Efficacy
Presented by Elizabeth Mackey
Pacific States Marine Fisheries Commission
Elizabeth.Mackey@wildlife.ca.gov

A Riparian Shade Model for the Laguna de Santa Rosa
Presented by Emily McClintock
Watershed Stewards Program / North Coast Regional Water Quality Control Board
Emily.McClintock@ccc.ca.gov

Juvenile Coho Distribution in the Van Duzen and Lower Eel River
Presented by Isaac Mikus
CA Department of Fish and Wildlife / Pacific States Marine Fisheries Commission
imikus@wildlife.ca.gov

Ten Years of Stream Habitat Restoration Using Large Woody Debris on Mendocino Coast Streams (2005-2015)
Presented by Scott Monday
CA Department of Fish and Wildlife
scott.monday@wildlife.ca.gov

Long-term Monitoring of Coho Salmon (*Oncorhynchus Kisutch*) Smolts in Little River Watershed, Humboldt County, California
Presented by Matt Nannizzi
Green Diamond Resource Company
mnannizzi@greendiamond.com

Flume Analysis of a Vortex Pool-and-Chute Fishway
Presented by Cristina Olivares
Humboldt State University
clo20@humboldt.edu

Developing and Monitoring Off-Channel Habitat on Lawrence Creek
Presented by Bob Pagliuco
NOAA Restoration Center
bob.pagliuco@noaa.gov

Watershed-Scale Riparian Restoration Assessment and Implementation, Mattole River Watershed
Presented by Cassie Pinnell
Mattole Restoration Council
cassie@mattole.org

Fourmile Wetland Restoration Project
Presented by Katie Ross-Smith
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katie.ross-smith@cardno.com

Reintroduction and Recovery Potential of Coho Salmon (*Oncorhynchus kisutch*) in Walker Creek, Marin County, California
Presented by Elizabeth Ruiz
Watershed Stewards Program
Elizabeth.Ruiz@ccc.ca.gov

Building a Collective Water Conservation Model in Redwood Creek, South Fork Eel River
Presented by Sara Schremmer
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sara@calslamon.org

Tri-County Fish Team Technical Training
Presented by Katherine Strailey
Watershed Stewards Program
/ Central Coast Salmon Enhancement
katherine.strailey@ccc.ca.gov

A Watershed Approach to Restoring Wildcat Creek: an Urban and Wildland Comparison
Presented by Erik Stromberg
Restoration Design Group, LLC
erik@rdgmail.com

Post-Assisted Woody Structures (PAWS) —Site Selection and Construction
Presented by Peter Thamer
Scott River Watershed Council
pdthamer@gmail.com

Fish Response to Habitat Restoration Projects in the Stream-Estuary Ecotone of Humboldt Bay
Presented by Michael Wallace
CA Department of Fish and Wildlife
mike.wallace@wildlife.ca.gov

Designing Process Linked Stream Restoration in the Dynamic Reaches of the Lower Dry Creek Near Healdsburg, California
Presented by Jason White
Environmental Science Associates
jwhite@esassoc.com

Use of GIS Technology to Prioritize the Restoration and Protection of Anchor Habitat Riparian Areas in the Rogue River Basin
Presented by Eugene Wier
The Freshwater Trust
eugene@thefreshwatertrust.org

Adaptive Resource Management and the Central Valley Project Improvement Act —Putting Science into Action
Presented by Julie Zimmerman
US Fish and Wildlife Service
julie_zimmerman@fws.gov

SRF Mission Statement

The 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 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 the salmonids.
3. Advocate on behalf of continued restoration dollars, protection of habitat, enhanced instream flows, and recovery of imperiled salmonids.

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