30th Annual

Salmonid Restoration Conference

April 4-7, 2012, Davis, CA

30 Years of Fisheries Restoration— Focusing on a New Generation of Watershed Recovery

2012 Conference Co-sponsors

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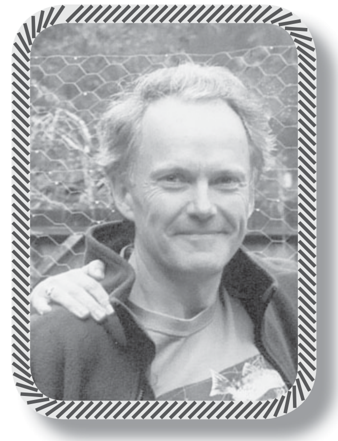
Thirty Years of Fisheries Restoration —Focusing on a New Generation of Watershed Recovery

By Don Allan, *SRF Board President*



Fisheries restoration has come a long way since the first salmon conference in 1983. Truly a whole new generation has come and a number of the restoration "pioneers" have gone in that time. Many of today's restorationists grew up in an era with a growing public awareness and concern over the state of our streams and our fisheries. Salmon in the classroom, painting storm drains with a "drains to creek" message, and outdoor education helped raise the awareness of salmon and watershed issues so they became topics of conversation around the dinner table. The public and our legislators became more aware of the plight of salmon, largely as a result of the work done by the restoration community, and the result was public support for the programs that support the work we do. The increase in public awareness and application of a more methodical and scientific approach to fisheries restoration are encouraging. We've gone from a scatter-gun approach of treating symptoms caused by old-style resource extraction and a lack of understanding of watershed science, to developing a systematic approach for collecting and analyzing data, assessing watersheds, identifying critical issues, and formulating watershed plans to address the critical issues.

As we have developed and grown in the art and science of watershed restoration, we have overcome some of the old challenges and see new challenges arising. Some of the old challenges seem simple looking back—now we take for granted that we should start with a watershed assessment before we develop a watershed restoration plan and start implementing projects, but that wasn't necessarily how things were done in the early days of fisheries restoration. Partly we were hampered by the funding restrictions of the day, and partly we were still working out a systematic approach for assessing and prioritizing watershed issues. SB 271 in 1997 was landmark legislation that added new categories for funding under the California Department of Fish & Game's Fisheries Restoration Grants Program. Watershed planning, upslope erosion control, organizational support, and monitoring became new funding categories under the FRGP. We expanded our understanding of the importance of high-flow refugia, estuary habitat, and the impacts of floodplain development. Assessing and replacing fish-barrier culverts rose to the highest of priorities. In the first decade of the 21st century we had the luxury of numerous opportunities for funding and in response we saw an expansion in the number of watershed groups, professional consultants, and engineering firms working in fisheries restoration, and the number of watershed plans developed and projects implemented.

As we embark on the next generation of watershed recovery, it is interesting to see the evolution of the fisheries restoration movement over the past 30 years. With global warming and shrinking government funding new factors in the equation, we have more evolving and adapting to do. SRF has been a facilitator in the evolution of watershed restoration, bringing the restoration community, scientists, funders, and land managers together to share advances in science and approaches to restoration. SRF strives to achieve, and attain, a more robust scientific approach to watershed restoration, and provide a forum for discussion where all can engage in open discourse. So what are the new challenges we need to address and what will the new generation of watershed recovery look like? I will leave that as a question, but I do expect that the conference will facilitate the discussion and that many of the people at this conference will guide the next generation of watershed recovery.

Welcome to the 30th Annual Salmonid Restoration Conference entitled "30 Years of Fisheries Restoration—Focusing on a New Generation of Watershed Recovery." The restoration field is at a critical turning point with how we prioritize fisheries restoration and advance towards restoring natural processes and recovering functioning watersheds. SRF has a diverse and wide-ranging conference agenda to match our watershed view of the future of restoration.

This year the conference will feature workshops on pressing fisheries topics including Fish Passage and Protection, Analytical Measures to Determine Instream Flow Needs for Salmonids, Restoring Floodplain Processes to Increase Salmonid Populations, Community Partnerships to Promote Restoration, and Integrated Population Monitoring in California. Field Tours will look at important concepts like restoring the natural hydrograph and meander in Putah Creek, tidal marshland restoration in the Yolo Bypass, floodplain restoration at the Cosumnes River and the McCormack Tract, and Suisun Marsh Fish Habitat Restoration followed by a tour of the UC Davis Center for Aquatic Biology and Aquaculture.

The Plenary session features keynote addresses by John Laird, California Secretary for Natural Resources and Chuck Bonham, the newly appointed Director of the California Department of Fish and Game. Other esteemed keynote speakers include fisheries scientist Jim Lichatowich, the author of *Salmon Without Rivers,* and Xanthippe Augerot, the author of the *Atlas of Pacific Salmon*.

Concurrent sessions focus on biological, physical, and environmental issues that affect salmonid restoration and recovery. Biological sessions will specifically look at the genetic effects of hatcheries on Chinook salmon, using existing fish tagging data to guide restoration planning, monitoring, and evaluation; and steelhead restoration and recovery. Physical sessions will focus on the role of coastal lagoons and oceans, geomorphological frontiers in river restoration, and floodplain processes. Timely environmental issues will include dam removal, conservation hatcheries, managing the Bay Delta for water and fish, and restoring the San Joaquin River.

SRF is excited to be hosting the conference in Davis, California, because of its proximity to some of the largest fish-think tanks in the state including the UC Davis Wildlife, Fish, and Conservation Biology Department as well as state and federal agencies focused on fisheries conservation, developing monitoring protocols, and implementing recovery actions for salmonids. The conference serves as a venue to share newly adopted protocols, learn about pioneering restoration techniques, and engage in constructive discourse about fisheries recovery strategies.

The production and coordination of the annual conference is a collaborative and dynamic process that engages Salmonid Restoration Federation's Board of Directors, co-sponsors, and colleagues. I want to thank all of the field tour, workshop, and session coordinators who have helped to build an exceptional agenda as well as all of the dedicated presenters who are sharing their expertise and experience.

SRF appreciates all of our co-sponsors who generously contribute their ideas, time, and resources to the production of the conference. I would like to specifically thank our long-time co-sponsor the California Department of Fish and Game for their conference agenda input and continued support.

SRF acknowledges all the conference participants who travel from near and far to participate in the largest salmon restoration conference in California. Lastly, I want to applaud all of the work-trade participants who work tirelessly to help the conference run smoothly. Your dedication to public service gives us hope for the future of the fisheries restoration field.

In addition to the conference, SRF will also be offering a host of other technical education trainings in the next year including the 6th Annual Spring-run Chinook symposium and the 15th Annual Coho Confab on the Trinity River in August, a Humboldt Wildlife Refuge and Off-channel habitat symposium in November, and a Fish Passage Design and Engineering Workshop in Southern California.

Please join us in our efforts to enhance the art-and-science of restoration and ultimately recover wild salmon and steelhead populations.

Dana Stolzman

Agenda Coordinator & Executive Director
Salmonid Restoration Federation

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Creating and Managing a Seasonal Floodplain for Native Fish Habitat and Passage—A Tour of Northern Yolo Bypass

Tour Coordinators*: Ted Sommer* and *Dennis McEwan,*
California Department of Water Resources

The 56,000-acre Yolo Bypass is the largest floodplain of the Sacramento River. In addition to its recognized value for flood management, agriculture, and wildlife, studies over the past 15 years have shown that the floodplain represents one of the most important areas in the region for fish passage and juvenile rearing. Severe declines in Chinook salmon and other native fishes in the region have led to a major effort to restore and enhance Yolo Bypass. Hence, Yolo Bypass has been included as a major focus of regulatory actions (e.g. National Marine Fisheries Service Biological Opinion) and planning efforts (e.g. Bay Delta Conservation Plan). This tour of the northern Yolo Bypass is designed to provide an introduction to the ecology of the floodplain for Chinook salmon and highlight some of the major issues for habitat restoration. Key stops will include: 1) Fremont Weir where restoration planning focuses on improved floodplain connectivity with the Sacramento River for fish passage and habitat; 2) Knaggs Ranch, a pilot salmon habitat project conducted by a consortium of NGOs and agencies; and 3) Yolo Bypass Wildlife Area to show an example of how current land uses are being balanced in the floodplain.

The afternoon portion of the tour will focus on tidal habitat restoration in the Lower Yolo Bypass and Cache Slough Complex. Habitat restoration in the Bypass affords a unique opportunity to resurrect a suite of interconnected habitat types that have been greatly diminished in the lower Sacramento River watershed. Restoration in the lower Yolo Bypass and Cache Slough complex is focused on freshwater tidal marsh and associated sub-tidal habitat and is primarily being driven by requirements of the federal biological opinions on State Water Project operations. The biological opinions require, in part, the Department of Water Resources to restore 8,000 acres of tidal habitat. The primary objectives of the restoration program are to: 1) enhance productivity and food availability for native Delta fishes; 2) restore processes that will promote primary and secondary productivity and tidal transport of resources to enhance the pelagic food web in the Delta; 3) increase the amount and quality of salmonid rearing and other habitat; and 4) increase through-Delta survival of juvenile salmonids by potentially enhancing beneficial migratory pathways. Tour participants will learn about overall restoration plans and objectives and view several planned restoration sites (Calhoun Cut Ecological Reserve, Prospect Island) as well as areas where unplanned levee breaches have led to significant naturally-restored habitats (Liberty Island).

Suisun Marsh Fish Habitat Restoration and UC Davis: From Fish Physiology and Habitat Needs to On-the-ground Habitat Restoration

Tour Coordinator*: Paul Garrison,* *California Department of Water Resources, and* ***Lisa Thompson, PhD,*** *Wildlife, Fish and Conservation Biology Department, UC Davis*

Suisun Marsh is the largest contiguous brackish water marsh remaining on the west coast of North America and is a critical part of the San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta) estuary ecosystem. The Marsh encompasses more than 10% of California's remaining natural wetlands and provides important habitat for more than 221 bird species, 45 mammalian species, 16 reptile and amphibian species, and more than 40 fish species.

Over 60 UC Davis researchers are affiliated with CABA, the Center for Aquatic Biology and Aquaculture. UC Davis researchers work across a wide range of aquatic specialties, with results that inform the management of California ecosystems like the Sacramento-San Joaquin Delta and Suisun Marsh. For example, current research projects on Delta smelt include long-term population trends, bioenergetics, genomics, Delta habitat, water quality requirements of smelt, predator-prey interactions, development of techniques for improved field tracking of smelt distribution and movement, development of conservation broodstock, and breeding for further research studies.

After the Suisun MArch Tour participants will visit the UC Davis CAB Lab.

Community Partnerships for Restoration Workshop

Wednesday, April 4

Workshop Coordinator*: Lisa Hulette,* *CA Salmon Initiative Project Director, The Nature Conservancy*

Restoration and conservation in 2012 is highly integrated and reliant on multiple partners for success. Ecological restoration professionals know the value of using a science-based approach as the underpinning of a successful salmon habitat recovery program, while at the same time acknowledging the usefulness of sustained, strategic partnerships. However, a more formal recognition needs to be made at both the policy and grassroots level that there are both social and physical impairments toward achieving salmon recovery in California. Communities come in many shapes and sizes, whether they be the community of agencies that help you work through permitting challenges, or the landowners who allow conservation work to occur on private property—they are all infinitely important if Coho Salmon recovery is to be realized in our lifetime. The presenters during this workshop all carry the battle wounds of working deep in communities, and know how heightened the sense of achievement is when triumph is shared. Our identity as people concerned about the plight of salmon, and the ecological implications of their demise, tightly binds us together, no matter what our job title. It is this unique sustained kinship that will help determine what the future of salmon is California and the Northwest. I invite everyone to listen and learn from people who know what working in the trenches means, and participate in a lively discussion about how we can continue to work together.

The North Coast Coho Project: Twelve Years of Collaborative Partnerships Working to Restore Coho Salmon Habitat

Lisa Bolton, Trout Unlimited

Trout Unlimited (TU) implements a simple conservation framework in California—*to protect, reconnect, restore, and sustain*. We are dedicated to solving problems not perpetuating conflict; and we have a track record to build upon.

TU's North Coast Coho Project (NCCP) falls within the *restore* frame of that simple conservation framework. The mission of the North Coast Coho Project (NCCP) is to restore wild coho salmon and steelhead populations to a viable, self sustaining level in northern California's coastal watersheds through coordinated efforts with landowners, local, state, and federal agencies, and community watershed groups, while utilizing the best available science and management practices and stimulating local and regional economies through watershed restoration projects. The NCCP is an innovative, entrepreneurial effort to restore entire coastal watersheds and return coho salmon to their historical habitat in Northern California. The NCCP is uniquely based on partnerships between TU, private enterprises, local, state, and federal government agencies, and private contractors. The NCCP has been and continues to be successful in its ability to identify projects, secure funding, and implement restoration activities.

The NCCP began in 1998 when the Mendocino Redwood Company (MRC) purchased Louisiana Pacific's California holdings and became the largest private landholder in Mendocino County. TU approached MRC about launching a joint project to restore its new lands, and in an unprecedented agreement between a conservation organization and a forest products company, TU and MRC joined forces to restore beleaguered coho salmon and steelhead populations on California's north coast.

Since its beginnings in 1998, NCCP has expanded to include a multitude of collaborative partners within Mendocino and Humboldt Counties including several of the largest land managers in Mendocino County including Campbell Timberland Management, Jackson Demonstration State Forest and California State Parks as well as smaller landowners. Partnership projects target forest road upgrading and decommissioning, fish passage barrier removal and instream habitat enhancement through installations of large woody material.

With coho salmon populations on a steep decline, restoration in these core coho watersheds is critical to their survival. The North Coast Coho Project partnerships work towards restoration of these watersheds on the landscape scale restoring miles and acres at a time. Over the last twelve years of the North Coast Coho Project, much has been accomplished and much has been learned. In this presentation, we'll review a brief history of the North Coast Coho Project and then discuss what has worked and what hasn't worked in the last decade of restoration partnership along the North Coast.

Partnerships to Demonstrate Cost-efficient Restoration Techniques for Rapidly Increasing Wood Cover and Habitat Availability in California Coho Streams

Chris Blencowe (presenter), *Blencowe Watershed Management,* ***Jennifer Carah,*** *The Nature Conservancy,* ***Dave Wright,*** *Campbell Timberland Management, and* ***Lisa Bolton,*** *Trout Unlimited*

Coho salmon, *Oncorhynchus kisutch*, are in deep trouble in California, with trends indicating that most or all populations in California coastal streams will disappear in next 25-50 years in the absence of serious intervention. Adding large woody material [LWM] to streams is identified as a priority restoration action in federal and state coho recovery plans due to its ability to positively influence channel form by increasing pool frequency and depth, increasing the availability of nesting gravel and over-wintering habitat, and increasing cover from predators. It is important that this and other key coho recovery actions be implemented widely and quickly, yet the current pace and scale of LWM augmentation is not meeting the urgent need. For example, nearly 80% of priority focus watersheds have been identified as having poor LWM volume in the National Marine Fisheries Service's draft 2010 *Recovery Plan for Evolutionarily Significant Unit of Central California Coast Coho Salmon*. Many previous LWM augmentation efforts involved engineering wood jams and anchoring woody materials in place. While appropriate in many situations, these techniques can be labor intensive, time consuming, expensive, and often fail to meet LWM restoration goals at a watershed or regional scale.

Environmental non-profits, private timber companies, non-industrial landowners, local restorationists, and state and federal agencies have partnered at multiple sites in Mendocino County, California to investigate new techniques for LWM augmentation that can be implemented widely, rapidly and cheaply. Since 2008, Campbell Timberland Management, Hawthorne Timber Company, Trout Unlimited, The Nature Conservancy, The Conservation Fund, California State Parks, Weger Associates, California Department of Fish and Game, the National Oceanic and Atmospheric Administration, and Blencowe Watershed Management have treated over 30 miles of priority coho streams in Mendocino County with unanchored large wood. We have used two techniques—direct falling of riparian trees into streams, and cutting/salvaging trees outside of the riparian zone and using logging equipment to place woody material unanchored in the active channel. Our costs for placing LWM have varied depending on the placement method, proximity and availability of LWM materials, site accessibility, and channel morphology. The average cost was about $250 per piece, and could be as little as $80 per piece. Our results suggest that these techniques may offer a competitive advantage to more traditional restoration methods in appropriate watersheds that have consolidated ownerships, significant available timber, and little risk to downstream infrastructure. Since it is many of these very watersheds that are key to recovering coho in coastal California and the Pacific Northwest, these techniques represent an important tool to rapidly and efficiently target restoration activities on a small number of ownerships for maximum effect on coho habitat at a watershed scale.

Tools to Promote Restoration of Both Communities and Anadromous Habitats in the Shasta River and Beyond

Amy Hoss, Klamath Project, The Nature Conservancy

The Nature Conservancy recently acquired two adjacent cattle ranches to help increase salmon populations in the Shasta River Watershed, a critical tributary for Klamath River salmon. These properties encompass 6,238 acres, include 19 cubic feet/second water rights to cold spring sources, and take in more than seven miles of prime salmon spawning and rearing habitat. Our primary objectives with these acquisitions are to: 1) implement significant stream restoration projects and 2) develop and promote solutions to problems associated with irrigated agriculture that have contributed to the decline of salmon populations.

As we developed this restoration project we assumed: 1) the threats associated with irrigated agriculture must be abated if we are to meet long-term conservation goals for salmon and other freshwater species; 2) irrigators in the Shasta Basin, and throughout the West, can reduce the amount and improve the timing of their water application to help meet fisheries restoration objectives; 3) landowners will be motivated by economics and regulatory pressure to adopt new irrigation methods or strategies; and 4) landowners would be amenable to provide water instream to benefit anadromous fish if they are provided with the flexibility in their agricultural operations (both mechanically and economically) to do so, and they have the assurance that their contribution will not result in the permanent loss of their water right.

To test these assumptions, TNC has initiated several restoration projects on Shasta Big Springs Ranch. When restoration projects have met these assumptions, TNC has then worked to demonstrate how these tools could be used locally and potentially state-wide by private landowners in restoring salmonid habitats. These projects include: 1) exercising CA Water Code §1707 to add fish and wildlife as a beneficial use to TNC-owned water rights so that the water can be used at critical times of the year for the benefit of anadromous fish, while at other times of the year utilized for irrigation; 2) experiment with the use of drought tolerant pastures grasses on irrigated pasture lands to test their applicability in a high-desert environment to analyze if they can tolerate little to no irrigation water during critical times of the year when cold water is needed for fish instream; and 3) identify simple, cost-effective ways for landowners to reduce the amount of tailwater returning from their lands to improve water quality in adjacent waterways.

Eating Totem Salmon: Exploring Extinction and Collaborative Restoration in a Coastal California Watershed Community

Flora Brain, ***Humboldt State University, Mattole Salmon Group***

Successful restoration strategies must take into account the human communities that coexist with and affect salmonid populations. Understanding the spectrum of people's interactions with salmonids, and their motivations for those interactions, is one key aspect. The decline of native salmonid populations below depensation levels highlights an intensified need for community restoration groups and agencies to address poaching where it is a concern. This presentation focuses on fisheries restoration from both a policy and community engagement perspective, presenting challenges with regulatory enforcement and areas for increased citizen involvement to address the taking of adult fish. The major goal of this research is to provide a place-based exploration of poaching and its associated political, institutional, and socio-cultural ramifications. Focused in Northern California's coastal Mattole River watershed, it reveals and unpacks some of the broad social, cultural, and philosophical challenges embedded in salmon recovery. Numbers of threatened wild Chinook and coho salmon in the Mattole River merit concern for extirpation of these runs. No harvest of these species from the river is permitted by law, but it does occur. Regulations prohibiting poaching in the geographically remote watershed are ineffectually enforced; this qualitative study explores people's perceptions of the situation and their ideas for resolution. It draws upon in-depth interviews with community members, recreational steelhead fishermen, poachers, and salmon restorationists. Poachers expressed diverse motivations and justifications for taking adult fish. Distrust of local restoration efforts suggests that traditional education campaigns may not be sufficient. Interview data will be presented as a means to understand the present situation, taking a hard look at local perspectives in order to inform effective responses. Strategies are offered for addressing poaching and engaging citizens in the Mattole. Such strategies are likely to be useful in other watersheds facing similar issues. Along with increased awareness of and responsiveness to local attitudes and behaviors in salmon restoration programs, this study calls for increased interdisciplinary collaboration in salmonid restoration as a whole. While extensive research is devoted to biological and ecological aspects of salmonid restoration, there is a concurrent need for social science research to illuminate the complex relationships among fish and humans, and to address socio-cultural and political impediments to lasting recovery.

Bringing Back Beaver: Integrating Beaver into Community-Based Salmonid Recovery Efforts

Brock Dolman, *Occidental Arts and Ecology Center*

For anyone involved with salmonid recovery efforts it can be daunting when you realize that, in order to achieve recovery, one must take the entire watershed into consideration and address all land use practices from ridgeline to rivermouth. This "Basin of Relations" awareness becomes critical as collaborative community organizing is considered key to recovery success of salmonid populations over time. Yet, building community consensus and publically organizing groups of humans is not what many of us field biologists were seemingly trained for. Despite this challenge, our movement has steadfastly adapted and integrated many diverse tools from multiple disciplines towards the goal of re-creating community conditions conducive for Totem Salmon. One ecologically astute opportunity at this time is to expand our collective definition of "community" and perceived "partnerships" beyond the bounds of that which is solely human. We must reach out to other life forms with ecological architecture skills equal to and at times greater than our own to form pragmatic interspecies partnerships. With a goal of watershed health and salmonid recovery in mind, the first keystone species that I propose we renew our relationship with is beaver—*Castor canadensis*! This talk will invoke some rationales for why this ecologically-based "community partnership" with beavers as managers of 'keystone processes' can plausibly enhance our fishery goals with speedier results at less cost while enhancing the overall climate disruption preparedness and resiliency of our shared Basins of Relations. The primary community organizing challenge here is not physical per se, but rather political and educational within the broader Ego-System to find beneficial ways of co-habitating watershed by watershed with this critical recovery partner. Aldo Leopold reminds us that: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." Can we envision the biotic beauty of beaver as "right"?

Partnerships for Restoration

Maura Eagan Moody, *NOAA's National Marine Fisheries Service,*
and ***Carl Morrison,*** *President, Morison & Associates, Inc.*

Federal Recovery Plans are required under the Endangered Species Act (ESA) to guide actions needed to bring threatened and endangered species to the point where they no longer need the protections of the ESA. These Plans are guidance documents, not regulatory hammers, and their success depends upon collaboration form a variety of stakeholders. NOAA's National Marine Fisheries Service North-Central California Coast Office is in the process of developing Recovery Plans for four threatened and endangered salmon and steelhead species. These species range from Redwood Creek in Humboldt County south to Soquel Creek in Santa Cruz County, and includes the San Francisco Bay Region. The region has a mosaic of land managers and complex land uses.

With leadership from the Sonoma County Water Agency, the Zone 7 Water Agency, and NOAA's Fisheries Service, an innovative Statements of Understanding (SOU) was developed to facilitate information exchange and development of specific recovery actions between local agencies and NOAA's Fishery Service. The local knowledge, extensive data sets, and targeted recovery actions presented by the agency partners were valuable in the recovery planning process for NOAA Fisheries Service. Agency partners benefit from increased competitiveness for grant funding and co-manager status for early review and comment on draft plans.

The SOU partners now include 21 water agencies, flood control districts, counties, resource conservation districts, and others, all invested in creating sound planning documents and implementing recovery actions within their jurisdictions.

The effort has built trust and improved communication as local and Federal representatives work together to better understand the recovery planning process and the opportunities and constraints each stakeholder presents. We expect that, with local agency support, implementation of recovery actions will provide greater benefits, and sooner, to listed species. We also expect that early collaboration and watershed restoration will benefit local communities in the form of grant funding, restoration jobs, and improved water and habitat quality.

Salmonid Restoration through Partnerships in Salmon Creek, Sonoma County, California

John K. Green, *Lead Scientist and Project Manager, Gold Ridge Resource Conservation District*

Ongoing work in Salmon Creek, a small coastal watershed in Sonoma County, highlights the potential for salmonid habitat restoration and protection through partnerships. Over the past 10 years, collaborative efforts among partners that include the Salmon Creek Watershed Council, Gold Ridge Resource Conservation District, Prunuske Chatham Inc., Occidental Arts and Ecology Center, private landowners and public agencies have been successful in improving instream and riparian habitat conditions, as well as instream flows for salmonids. This collaborative group has conducted a variety of watershed studies to establish a scientific basis for restoration efforts, including an Integrated Coastal Watershed Management Plan, a study of estuary and lower mainstem conditions, and a watershed-wide inventory of road-related erosion. These studies, and the cooperative relationships developed with landowners in the watershed, have led to a series of on-the-ground restoration and habitat protection projects primarily funded by public agencies. Over the past five years, the Gold Ridge RCD and our partners have implemented multiple instream habitat improvement projects; worked to increase riparian canopy cover and species diversity throughout the watershed, thus improving stream shading and providing a future source of large woody debris; undertaken extensive erosion control efforts, including a comprehensive program to reduce the road-related delivery of fine sediment; and planned and constructed both large agricultural and small residential rainwater catchment projects to reduce extractive pressures on summer streamflow. These efforts continue to be embraced by the local community because of the trust we have built through intensive outreach efforts and a record of beneficial projects. Successful restoration work in the Salmon Creek watershed demonstrates that resource conservation projects benefit not just salmon, but the community as a whole.

Risk-Based Approach to Road Assessment and Mitigation of Road-Related Sediment Delivery

Jeremy Wright, ***Green Diamond Resource Company***

Sediment delivery from roads on industrial timberland properties is currently the focus of significant mitigation efforts in order to reduce the impacts to salmonids and associated habitat. Contemporary methods of identifying road-related sediment delivery on Timber Management Zone (TPZ) properties has focused on quantification of potential sediment volumes and treatment concurrent within the lifespan of a Timber Harvest Plan (THP). Under the Aquatic Habitat Conservation Plan for Green Diamond Resource Company (GDRCo) a new approach was undertaken in 2010 to identify high-risk sediment sources and schedule treatment within a year of THP approval or within three years if identified in a Non-THP, Routine Maintenance Area. This risk-based approach focuses on specific elements of watercourse crossings and erosion sites to determine whether sites qualify as a potential "Imminent Risk of Failure" source rather than waiting for THP utilization on road segments. Under this assessment and treatment regime GDR Co mitigation of sediment sources is occurring on a watershed scale which treats the highest risk sites first. Data management and monitoring requirements for all identified sediment sources also supplements adaptive management strategies in the continued efforts to reduce sediment inputs from road networks.

Building Trust—The Key to a Successful Watershed Restoration Program

Lauren Hammack, *Senior Geomorphologist/Principal, Prunuske Chatham, Inc*

Most of us in the ecological protection and restoration field are scientists or engineers. We are fascinated with, and fully immersed in, the technical aspects of our academic field of choice. We've been trained in how to do "sound science" or apply "standard practices". We largely work in agencies, organizations, and companies that focus on conserving our natural resources and native species. For the most part, we understand what can be done and are working diligently with our peer scientists and engineers to figure out how. Amongst ourselves, we speak the same language. The challenge to affecting changes that will markedly improve conditions for salmonids or other species often lies not in our ability to know what to do, but rather in our ability to communicate effectively to the public. Important habitat improvement projects get stalled or even scrapped when the landowner or the community at large suddenly gets cold feet. What happens? While each situation is unique, we often fail to communicate ecosystem science and restoration design fundamentals to the public in a way that is understandable, engaging, and non-threatening. Unintentionally we end up fostering confusion, fear, and distrust by the words we use and the ways in which we communicate. In this talk I will delve into the subject of trust building as a key to successful restoration program development. Using examples from 10 years working with individuals and communities in Sonoma and Marin Counties, we will explore the communication of salmonid restoration science and implementation through the eyes of the public; seeing where we, the restoration community, can perhaps make strides in building greater trust and participation.

Watershed Stewards and Watershed Workers—Improving California's Watersheds with the California Conservation Corps

John Griffith, *California Conservation Corps,*
and ***Carrie Lewis,*** *Project Director, Watershed Stewards Project*

The California Conservation Corps is a workforce development program that hires young adults between 18 and 25 to spend a year engaged in conservation and restoration work throughout California. During their tour in the Corps, CCC corpsmembers develop a strong work ethic and marketable job skills while learning responsibility, self-discipline, teamwork, self-care, and good work habits. Corpsmembers also reap the rewards of becoming part of something bigger than themselves, achieving a sense of commitment to community and responsibility to society as a whole. In the process, the CCC improves the ecology of California's lands and rivers.

Typical CCC restoration projects include modifying fish passage barriers , planting trees in riparian zones, reducing upslope sediment sources, stabilizing stream banks through bioengineering and log/boulder structures, building livestock exclusion fences, constructing instream habitat structures for pool development and spawning gravel retention, and installing logs and root wads that serve as cover structures. Restoration work is focused on streams and watersheds with the greatest ability to increase salmonid populations over the long term.

Since 1980, CCC corpsmembers have completed the following restoration tasks:

- Over 1,500 stream miles improved
- Modified over 1,250 fish passage barriers
- Stabilized over 48,880 feet of stream bank
- Installed more than 6,500 fish habitat structures
- Improved over 326,500 sf of fisheries habitat
- Planted over 2,000,000 trees

The AmeriCorps Watershed Stewards Project (WSP) is a comprehensive, community-based, watershed restoration and education program of the CCC. Established in 1994, WSP was created by biologists and educators to fill critical scientific information and education gaps. The WSP mission is to conserve, restore, and enhance anadromous watersheds for future generations by linking education with high quality scientific practices. In collaboration with private landowners, timber companies, fishing industry representatives, teachers, community members, non-profit organizations, and public agencies, WSP revitalizes watersheds that contain endangered and threatened species by using state-of-the-art data collection and watershed restoration techniques.

Each year, WSP places 55 AmeriCorps members at 25 placements sites which range from Yreka south to Ventura in California's coastal watersheds. During their 10.5 month term, the majority of WSP member time is directly related to the assessment and recovery of anadromous watersheds and salmonids (i.e. assessments, data collection, data analysis, data compilation, monitoring and restoration). The remainder of their service time is spent participating in AmeriCorps training, National Service community service days, and engaging students, community members and volunteers in service learning education, and hands on stewardship of their local watersheds.

Since 1994, WSP Members have:

- Surveyed 23,804 stream and watershed miles
- Generated more than 2,418 scientific reports and databases
- Developed 1,451 watershed restoration projects and completed 123,722 hours of service toward watershed restoration
- Instructed 34,172 students using Real Science
- Shared scientifically based salmon and watershed restoration information with 164,077 community members and more than 7,778 natural resource professionals
- Engaged 19,321 community volunteers to restore watersheds and educate watershed residents

Nine Years and Counting—A Stakeholder's Journey to Try to Restore Steelhead in a Local Creek

Sally Kruger, *Member of Pismo Creek Watershed Forum,*
and ***Steph Wald,*** *Central Coast Salmon Enhancement (CCSE)*

West Corral de Piedra Creek (WCDPC) is the main tributary of Pismo Creek in San Luis Obispo County. Historically, this creek has had well-documented steelhead migration to pristine spawning grounds at its headwaters. In the 1960s a dam was erected on WCDPC to capture 551 acre feet (AF) of water for agricultural use as allowed under permits from the State Water Resource Control Board (SWRCB). In 1990, a 4th permit for another 400 AF was issued and the size of the dam was doubled. Although a fish ladder was constructed, it is only functional when the reservoir overflows.

In 2002, some of the landowners downstream of the dam approached Central Coast Salmon Enhancement and the Pismo Creek Watershed Forum group was formed. In 2004, 12 landowners filed complaints with the SWRCB regarding the lack of flow, possible permit violations and lack of protection of a public trust resource. After an inspection by SWRCB, the complaints were not addressed until November 2006 when someone was assigned the case. Although the issues addressed in the complaints have not been resolved, SWRCB is more carefully monitoring the situation. In 2009, the Watershed group released a watershed management plan. Some of the issues that have led to lack of water and degradation of steelhead habitat include:

- In 2006 the dam owners expanded their agriculture into an adjacent parcel that is in a different watershed. All of the water for these new plantings, is transported from deep wells in the WCDPC watershed. Laden with boron, this water is pumped into the reservoir to dilute it, and then transported. When the water level in the reservoir is low, the amount of boron found in the outfall is known to be harmful to steelhead (Birge and Black, 1977). Our efforts to get this stopped have so far been unsuccessful.
- In 2008, the dam owner filed a permit to build an agricultural cluster of six homes on this property. Again, the water for these homes would be pumped from the WCDPC watershed to the site. Thankfully the application for this agricultural cluster was eventually withdrawn.
- In December of 2009, a week of rain precipitated a mud slide from a recently plowed field that totally filled two large pools downstream with sediment. An additional 630 AF of water coming downstream after this slide event failed to clear the pools.

In the last nine years, I and other downstream users have worked with seven NOAA employees; six DFG representatives, and four staff from SWRCB, and have contacted the California Sportsfishing Alliance, Trout Unlimited, American Rivers, and the Sierra Club. This talk will detail the efforts of trying to ensure an adequate flow downstream of a private dam. How can we, given older SWRCB issued permits, apply new knowledge of what it takes to protect steelhead and leverage the limited resources of State/Federal monies and personnel in order to rectify this situation?

Methods for Monitoring Fish Passage Structures

Joey Howard (Presenter), Brian Wardman, *and* ***Jimmy Pan,*** *Northwest Hydraulic Consultants*

This presentation discusses the hydraulic characteristics of a constructed roughened channel measured using mobile Large Scale Particle Image Velocimetry (LSPIV) methods and an Acoustic Doppler Velocimeter (ADV). The roughened channel was constructed in October of 2011 as part of an irrigation diversion screen facility. The roughened channel slopes at about 4% and is about 70 feet long. It is composed of large rock buttresses spaced at about 25 feet with engineered stream bed material between buttresses. The objectives of monitoring hydraulic characteristics along the roughened channel include quantification of spatial variability of velocity, depth, and turbulence; comparison of microhydraulic characteristics with numerical model estimates; and assessment of microhydraulics as they relate to California Department of Fish and Game (CDFG) fish passage criteria. LSPIV and ADV measurements were collected concurrently at the site during winter flows. LSPIV provided surface velocity measurements at many points in an area, while the ADV provided detailed velocity measurements at particular points and depths. NHC compared the LSPIV measurements with the ADV measurements to assess the ability of LSPIV to characterize the velocity field. Using the LSPIV measurements, NHC calculated the average velocity at specific cross sections and compared the cross section average velocity with velocities measured at discreet locations along the cross section. Results from one and two-dimensional models were compared with the measured velocities and differences between the computed and measured velocities were documented. The measured and modeled hydraulic characteristics were used to compute the energy dissipation factor (EDF), a proxy for turbulence. Measured and modeled velocities, depths, and EDF were compared with CDFG fish passage criteria

Two Approaches to Improving Fish Passage on the Cosumnes River: Restoring Connectivity on an "Undammed River"

Donald Ratcliff (Presenter), *U.S. Fish and Wildlife Service—Anadromous Fish Restoration and National Fish Passage Programs; and* ***Trevor Kennedy*** *and* ***Kari Burr,*** *Fishery Foundation of California*

While the Cosumnes River is often referred to as the California Central Valley's only undammed river, it is unfortunately not devoid of barriers to fish migration. Groundwater pumping, water diversions, channelization, and alterations in surface runoff have increased historic periods of disconnection from the Sacramento-San Joaquin Delta in most years and reduced passage at diversion and groundwater recharge dams when the system is connected. The current situation has led to an increased importance on unimpeded passage for migratory aquatic species that use the river. In 2010 and 2011, the last two major non-natural barriers to migration were addressed to improve fish passage. At Rooney Brothers Dam, a series of four boulder weirs were constructed in 2010 and adult Fall-run Chinook salmon were documented freely passing the site less than 48 hours after the river connected. This site is also now passable at substantially lower flows and over a much wider range of flows. The North Granlees Diversion Dam is one of two relatively large (15′) diversion dams on a split channel that have been in place in several forms since 1921. Both dams had outdated fish ladders that provided only limited passage. The south ladder was rebuilt in 2002 but deposition in that channel over the next several years moved the majority of the flow to the north channel. The north ladder was rebuilt in 2011 and post implementation surveys show a marked improvement. A summary of design and implementation, performance criteria, and biological data for both projects will be presented to illustrate the approach used at each site and initial estimates of overall passage improvement. While serious issues remain regarding water supply and availability in the Cosumnes watershed, these recently completed improvements to fish passage will greatly benefit migratory species when the river is connected.

Budiselich Flashboard Dam Fish Passage Improvement Project: A Rock Ramp Roughened Channel Fishway in the Calaveras River System

Randy Beckwith (Presenter), Trevor Greene** and **Colin Hanley,
California Department of Water Resources

A milestone for restoring fish passage in the Calaveras River system was passed when the first fish passage project was constructed in the fall of 2011. The Department of Water Resources' Fish Passage Improvement Program (FPIP) has been working on fish passage issues in the Calaveras River system for approximately 10 years. In 2007, FPIP staff completed the *Calaveras River Fish Migration Barriers Assessment Report* (available at *www.water.ca.gov/fishpassage*), which detailed the assessment of fish passage at 97 instream structures, including low-water crossings, dams, and culverts, from New Hogan Dam downstream to the confluence with the San Joaquin River. In late 2008, the Calaveras River Fish Group, a stakeholder group including Stockton East Water District (SEWD), State and federal agencies, consultants, University of the Pacific, and environmental groups, assembled and voted on the priority fish passage projects in the lower watershed. Budiselich Flashboard Dam, located in the Stockton Diverting Canal just upstream of Highway 99, was determined to be the number one fish passage priority in the lower Calaveras River system.

The 100-foot-wide concrete dam foundation was a significant barrier to upstream migration of Fall-run Chinook salmon and steelhead during lower flows, because of shallow flow depths and the riprapped, steep slope (approx. 12%) downstream of the dam. To improve passage, FPIP staff designed a 250-foot-long rock ramp roughened channel with a 3% slope. An Engineered Streambed Material mix, which consists of a gradation of cobbles down to fine-grained material, is the primary component of the rock ramp. The design also included seven buried boulder weirs within the ramp to provide grade control. The most upstream boulder weir (just downstream of the dam), is designed to backwater the dam foundation by one foot at low flows, providing enough depth for fish passage. A 10-foot-wide low-flow channel extends throughout the length of the project, and is designed to provide at least one foot of depth at flows greater than 30 cubic feet per second.

The fish passage project was endorsed by SEWD's agricultural customers and urban contractors (California Water Service Company, City of Stockton, and San Joaquin County), and approved by numerous regulatory agencies. Since the project is located in a flood control channel, it had to be endorsed by San Joaquin County and approved by the Central Valley Flood Protection Board. To gain support from each agency, detailed hydraulic modeling was completed to ensure the project had no significant impact on water surface elevations for the 100-year and 200-year flows.

The project was constructed in September of 2011 and hydraulic monitoring of the project is planned for late-fall 2011. Discussion of the barrier and its impact on fish passage, design process, modeling, project construction, hydraulic monitoring results, as well as lessons learned, will be presented.

Lessons Learned from the Design and Construction of Five Low-Water Crossings on Tajiguas Creek, Gaviota Coast, California

Rachel Shea, P.E., (Presenter), Michael Love and Associates; Erin Brown, (Presenter), South Coast Habitat Restoration

This project included the removal of five low-water or "Arizona" crossings that were migration barriers for the federally endangered steelhead trout, installation of one free-spanning bridge, creation of a geomorphically functioning stream channel, and restoration of the stream banks within the project area using biotechnical methods of bank stabilization.

Rancho Tajiguas, owned by MAZ Properties, is a private property that encompasses the entire 6.2 square mile watershed of Tajiguas Creek on the Gaviota Coast near Santa Barbara. After implementation, completed in November, 2011, the project will restore approximately three miles of spawning and rearing habitat.

This presentation will discuss the stages of project development and implementation as well as lessons learned. This unique opportunity allowed for the coordination of multiple barrier removals during a single construction season. Project highlights included a design approach that relied partially on construction and partially on natural channel process to reduce implementation costs, construction of a willow wattle fence and other biotechnical slope stabilization methods, and coordination with the activities and infrastructure constraints of a large operating ranch.

The project was result of the collaboration between the property owner, Michael Love and Associates, South Coast Habitat Restoration and California Department of Fish and Game. Michael Love and Associates is an engineering firm specializing in fish passage, fluvial geomorphology and water resources engineering. South Coast Habitat Restoration, a project of Earth Island Institute, works to restore habitat in Santa Barbara and Ventura Counties.

Willow Slough Weir and Fish Ladder Replacement: Removing the Last Barriers on Lower Butte Creek.

Harry Spanglet and Nancy Snodgrass (Presenters), California Department of Water Resources

The East Borrow Canal (EBC) of the Sutter Bypass is one of two channels that represent the remnant of Lower Butte Creek, which is a migratory route for one of the largest naturally-reproducing populations of Spring-run Chinook salmon in the Central Valley as well as Fall-run Chinook salmon and Central Valley steelhead. Willow Slough Weir is an earthen weir owned and operated by the California Department of Water Resources (DWR) that controls flows into Willow Slough by impounding water in the EBC to maintain an elevated water surface elevation for irrigation diversions and releasing water through 60 inch culverts. The weir is an impassable barrier to anadromous fish, so the original weir included a 90 cfs Denil fish ladder, which was ineffective for upstream fish passage due to poor design and placement paired with little to no attraction flow. DWR replaced the weir in 2010 and installed a 270 cfs modified pool-and-chute fish ladder to improve upstream fish passage, and additional culverts to increase the flow capacity so that the EBC could drain faster, reducing the amount of pumping at the DWR pumping plant located upstream in the EBC. Completion of the project was complicated by the need to maintain water surface elevation and fish passage during construction, the site's location in an area under both US Army Corps and Central Valley Flood Protection Board jurisdiction, and the presence of State and Federally listed species. A 32-foot temporary wooden Denil fish ladder was constructed to maintain passage during construction, and a sheet pile cofferdam was used to maintain impoundment elevation. The new ladder, which was completed in October 2010, provides diverse passage routes for upstream migrants over a wide range of flows, allows more water through the fish ladder thus improving attraction flows, and is largely self-cleaning. With the planned replacement by 2012 of one more upstream weir on the EBC (Weir No. 2) all major barriers to fish passage in Lower Butte Creek will have been removed.

Georgiana Slough—Bio Acoustic Fish Fence

Jacob McQuirk (Presenter), *California Department of Water Resources;* ***Mark Bowen, PhD,*** *U.S. Bureau of Reclamation;* ***Chuck Hanson, PhD,*** *Hanson Environmental, and* ***Jon Burau, PhD,*** *U.S. Geological Survey*

In the spring of 2011, the Department of Water Resources (DWR) conducted a pilot study of a non-physical fish barrier utilizing Bio Acoustic Fish Fence (BAFF) technology. The study was conducted at the divergence of the Sacramento River and Georgiana Slough, close to the town of Walnut Grove. The motivation for conducting this study came from the 2009 National Marine Fisheries Service (NMFS) Biological Opinion on the long term coordinated operations of the State Water Project and Central Valley Project. This study supported the NMFS Reasonable and Prudent Alternative to Jeopardy (RPA) action IV.1.3 which requires an evaluation of engineering solutions to prevent emigrating juvenile salmonids from entering the Georgiana Slough and other paths into the interior Delta. The BAFF technology was previously used at the Head of Old River and proved effective in the deterrence of salmon smolts entering Old River from the San Joaquin River.

The BAFF technology is non-physical, which allows it to deter fish while minimizing the obstruction of flow and boat passage. The BAFF uses three different types of stimuli in order to effectively deter fish. Lights, sound, and a bubble curtain are the components that make up the barrier. The frames of the barrier were comprised of light bars, speakers, and perforated hoses. It is strategically aligned and submerged at the divergence of the two waterways. The theory behind this technology is that the stimuli provided by the BAFF will guide the fish away from the dangerous waters and keep them in their safest environment.

The BAFF's effectiveness was analyzed through acoustic telemetry mark-recapture methods. Juvenile salmon were surgically implanted with acoustic telemetry tags that weighed 0.65 grams. 1,500 study fish were released approximately six miles upstream from the study site. Releases occurred continuously day and night for about 45 days in the months of March, April, and May. The study site was instrumented with tag tracking technology (hydrophones) in order to develop fish positions in three dimensions and evaluate their response to the barrier. Approximately 50 predatory fish were also acoustically tagged in order to observe their interaction with the experimental fish and BAFF.

Fish tracks were developed and various methods were used to determine the BAFF's effectiveness. The studies preliminary results show that the BAFF was effective in deterring juvenile salmon. DWR, along with consultants and the assistance of other State and Federal agencies, are currently analyzing the collected data in more detail. Results of the 2011 study are also being used to refine the proposed 2012 study.

Developing Successful Fish Screen Projects: Lessons Learned

Les Perkins, *Farmers Conservation Alliance*

FCA has been designing and implementing fish screen projects all over the West over the past six years. Development and implementation of projects has lead to an accumulation of "lessons learned" which has in turn lead to the development of a detailed process for implementing fish screening projects.

Learning comes in many forms, however, quite often the most valuable lessons are those learned when things don't go as planned. FCA has experienced a few of these "learning" projects that have lead to some of the most valuable insights in to how to develop projects the right way. An analysis of difficult projects, the issues that arose, the cause of those issues, and the eventual remedies that resulted will be used as a basis for understanding what can and will go wrong with fish screening projects.

Figuring out how to make a difficult project function the way it was intended is only half of the story. The other half entails what is done with that knowledge going forward. The lessons learned in project development lead to a purposeful and detailed process for developing fish screening projects the right way. In conjunction with the Fish Screening Oversight Committee of the Columbia Basin Fish and Wildlife Authority, FCA has developed a method for thoroughly analyzing a project to design a fish screen that fits that particular site and which all project partners have a clear understanding of what to expect and who is responsible for each project component.

Finally, no project is truly complete without monitoring. Fish screening projects require specific monitoring activities. Consistent and clear data gathering is essential to properly evaluate the success of a particular screen project.

Fish Protection at the Red Bluff Diversion Dam Emergency Pumping Plant

Darryl Hayes, P.E., Intake Screens, Inc.

The Red Bluff Diversion Dam (RBDD), located on the Sacramento River, is a large, seasonally operated, gated barrier whose primary purpose is to gravity divert up to 2,500 cfs into the Tehama-Colusa and Corning Canal systems. Although the RBDD was initially operated to provide year-round diversions, the annual "gates-in" period has been reduced to less than a three-month period to improve juvenile and adult fish passage of several endangered salmonid species and green sturgeon through the area. In 2009, the National Marine Fisheries Service mandated that the gates could only be operated between June 15 and August 31, forcing the Canal Authority to construct a 500 cfs emergency pumping plant to provide critical agricultural deliveries to their users during the spring and fall "gates-out" period. The emergency pumping plant (EPP) consists of ten 350 Hp vertical turbine pumps spaced on 15-foot centers and located in a shallow area along an existing sheetpile wall area downstream of the RBDD. Each pump intake was adapted to draw its water through a 14-foot diameter brush-cleaned cone-shaped fish screen. Each screen's large surface area allows the pumping plant to operate at full capacity in as little as three feet of water. The majority of the facility components were built off-site and then installed on driven piles to reduce construction related impacts. The entire EPP and fish screen system was designed, fabricated, constructed, and operational within a three-month period and in time for spring 2009 water deliveries. The cone-shaped fish screens have successfully protected fish while allowing critical water deliveries and fish passage to continue until the permanent fish screen and pumping facility (currently under construction) is completed in late 2012. This presentation will describe the facility design and construction details as well as some of the fisheries monitoring and screen testing completed at the EPP site.

The Need for Fish Passage Above Rim Dams in the Central Valley

Alice Berg, *Southwest Region ESA Specialist, National Marine Fisheries Service*

Extensive extirpation of historical populations has placed Sacramento River winter-run Chinook salmon, Central Valley Spring-run Chinook salmon, and Central Valley steelhead in danger of extinction. The proximate problem afflicting these species is that their historical spawning and initial rearing areas are largely inaccessible due to the presence of large dams. For example, 15 of the 18 or 19 historical populations of Central Valley Spring-run Chinook salmon are extinct, with their entire historical spawning habitats behind various impassable dams. In addition to habitat loss, substantial habitat degradation also contributes to the dire status of these species, and anthropogenic climate change is expected to exacerbate conditions. Climate models for the Central Valley are broadly consistent in that temperatures in the future will warm, total precipitation may decline, the variation in precipitation may substantially increase (i.e., more frequent flood flows and critically dry years), and snowfall will decline. Because many anadromous salmonid populations have been extirpated in the Central Valley due to dams, and climate change is expected to further constrain the ability of resource managers to provide suitable water temperatures and flows downstream of the dams, NMFS believes it is necessary to work with co-managers and stakeholders in pursuit of reintroducing Winter-run Chinook salmon, Spring-run Chinook salmon, and steelhead to historical habitats upstream of some dams. The Central Valley Technical Recovery Team recommends just such an effort: "*To recover Central Valley salmon and steelhead ESUs, some populations will need to be established in areas now blocked by dams or insufficient flows. Assuming that most of these dams will remain in place for the foreseeable future, it will be necessary to move fish around the dams.*" This presentation will cover why salmon and steelhead reintroductions are needed, the priority watersheds for reintroductions and some of the primary issues associated with reintroductions.

Fish Passage Feasibility Evaluation at Shasta and Folsom Dams

John Hannon, *Fisheries Biologist, U.S. Bureau of Reclamation—Bay Delta Office*

The U.S. Bureau of Reclamation's 2009 Central Valley Project water operations biological opinion from NMFS includes a suite of actions that will evaluate and, if determined feasible, then reintroduce Winter-run and Spring-run Chinook salmon and steelhead into historic habitats upstream of Shasta and Folsom dams. An interagency steering committee, formed pursuant to the BO, and subcommittees are in the process of developing and implementing an initial pilot fish passage plan for Shasta Dam on the Sacramento River. The initial goal of the program is to determine the feasibility of providing long-term anadromous salmonid passage at Shasta Dam. The program is proceeding in phases which include 1) habitat assessments to characterize the habitat for listed species upstream of the dam, 2) fish passage studies testing reach and lifestage specific survival rates and ecological interactions and facilities evaluations testing potential juvenile downstream passage and adult upstream passage options, and 3) pilot reintroduction which would reintroduce listed species into the upstream habitats with pilot facilities in place to enable a determination regarding the feasibility of a long-term fish passage program.

Ongoing habitat evaluations are focusing on prioritizing between the McCloud and upper Sacramento rivers, the main tributaries with sources of cool water during the summer, for the initial pilot testing. Engineering aspects of downstream juvenile salmonid passage options are being evaluated for the pilot testing phase with a preference given to volitional passage options. A variation on an option for sustaining Chinook production that was identified before Shasta Dam was constructed will be evaluated. Primary tests needed to assess likelihood of biological success include adult collection and transport survival to release, spawning success, juvenile production (emigrants per spawner), and juvenile passage/collection efficiency. The success of the program will depend on the cooperative efforts of resource management agencies with jurisdiction over the species and habitats and collaboration with local stakeholders. The presentation will provide an update on the current status of the program.

Fish Passage and Reintroduction Opportunities in the Yuba River

Rick Wantuck, *Regional Supervisor, Fisheries Bioengineering and Hydropower Programs, NOAA/National Marine Fisheries Service*

The Yuba River watershed has been the subject of intensive study in recent years for the purpose of conserving existing anadromous fish populations in the lower Yuba River, as well as examining reintroduction potential for anadromous fish in the upper Yuba River watershed. At present, the upstream extent of fish passage is blocked by the Narrows-Englebright hydropower complex at River Mile 24. Upstream of this complex, opportunities exist for reintroduction of Chinook salmon and steelhead based on documentation of favorable existing habitat conditions, or projections of productive habitat conditions that can be restored through reasonable water management and infrastructure modifications.

Because of the existence of numerous hydropower and water diversion developments in the upper watershed, most of the pristine habitats and unimpaired hydrologic regimes of the pre-dam era have been altered. Therefore, reintroduction plans must account for actual habitat-based potential, as well as the engineering opportunities and challenges associated with specific fish passage programs and project-related facilities. NMFS promotes a phased, adaptive management program for anadromous fish reintroduction in the upper Yuba watershed, featuring a comprehensive program that can be implemented in stages: 1) Study, Planning, and Permitting Phase; 2) Pilot Reintroduction Phase; 3) Short Term Reintroduction Phase; 4) Long Term Reintroduction Phase.

This presentation will focus on the synthesis of habitat-based studies with fish passage engineering development, along with potential project modifications required to support various options. Conceptual fish passage strategies, facilities design alternatives, habitat assessment modeling, and generic elements of a comprehensive reintroduction plan will be discussed.

Volitional Up and Downstream Fish Passage at a Reregulating Reservoir In Oregon

Andrew Talabere, Eugene Water & Electric Board

The Eugene Water & Electirc Board (EWEB) signed a Settlement Agreement in 2008 that provides for the construction of volitional fish passage at Trail Bridge Dam. Trail Bridge Dam and Reservoir is the reregulating facility for the Carmen-Smith Hydroelectric Project on the upper McKenzie River, Oregon. EWEB chose volitional passage after evaluating numerous possible options for both up and downstream passage. Factors involved in choosing volitional passage include, 1) upfront capital investment vs. ongoing operational and personnel costs of assisted passage, 2) dam safety and associated construction risks, 3) impacts to aquatic and recreational resources, 4) public pressure on our elected board, and 5) constraining the risk of meeting survival standards for non-volitional passage. The decision process was iterative and different factors prevailed at the different decision points. The first decision point for upstream passage was clearly between a ladder and trap and haul. Decisions made after this point were much more nuanced and involved numerous factors and feedbacks. The entire process for downstream passage was less clear cut but quickly resolved to a fully volitional system. Providing volitional passage at a 90 foot tall earthen dam that fluctuates up to 12 feet per day presented several challenges. The final ladder design climbs a total of 85 feet using 9" steps in a vertical slot configuration. The ladder exit structure consists of 16 exit gates that will automatically open and close to track changing reservoir elevation. Downstream passage consists of a floating double V-screen that delivers fish-free water to the penstock and an approximately 3500 foot bypass pipe carrying 25 cfs of fish-filled water to the McKenzie River below the Project. Hydraulic and biological monitoring and evaluation of all passage facilities for Chinook salmon, bull trout, and other native migratory species is planned.

The New Selective Water Withdrawal and Fish Passage Facilities at the Pelton Round Butte Project on the Deschutes River in Central Oregon

Don Ratliff, *Portland General Electric Company*

After ten years of concept, modeling, pre-studies, and design, and two years of construction, the Round Butte Dam Selective Water Withdrawal and Fish Transfer Facility began operation in December 2009. The federal licensees for the Pelton Round Butte Hydro Project, Portland General Electric and the Confederated Tribes of the Warm Springs Reservation of Oregon constructed the new selective intake as partial fisheries and water quality mitigation under terms of the new federal license issued in June 2005. This new facility is the keystone to a major effort to reintroduce summer steelhead, and Spring Chinook salmon, and develop an anadromous sockeye run from kokanee in the Metolius, Middle Deschutes, and lower Crooked rivers upstream of the Pelton Round Butte Project. The new intake system screens the entire normal flow of the Deschutes River. The surface intake and fish facilities are designed to capture downstream-migrant juvenile salmonids from Lake Billy Chinook for transport to the lower Deschutes River. The first 6,000 cfs of surface flow created by power generation enters through two large V screens which concentrate the water flow with fish down to 60 cfs. Tertiary screens reduce the flow further to 12 cfs. The remaining 12 cfs and fish are pumped from the intake structure to the Fish Transfer Facility. There, dewatering screens and in-line bar separators sort fish by size into holding raceways. All juvenile salmonids transported downstream are being physically marked so upon adult return, only fish originating above Round Butte Dam will be passed upstream. A secondary function of the new selective water withdrawal intake system is to manage discharge into the lower Deschutes River to the approximate temperature it would be if the hydro project was not in place. This is being done by selectively withdrawing surface water during winter and spring, but mixing cold hypolimnic water at increasing amounts from July 1st through October. Initial fish-passage operation is encouraging as juvenile Chinook and sockeye/kokanee migrants are being captured and separated by size with no observed injury. Reintroduction of Spring Chinook and steelhead by Oregon State and Warm Springs Tribal Fish Managers is being done with annual distributed fry releases. Yearling wild kokanee are being passed downstream in an attempt to reestablish an anadromous sockeye run in the Deschutes Basin to take advantage of both historical habitat in Suttle Lake, and new habitat created by the hydroelectric reservoirs. Approximately 100,000 smolts were passed downstream in 2010, and 260,000 in 2011. The majority of these were yearling “sockeye”.

The Response of Spring Chinook Salmon Inhabiting the South Fork McKenzie River, Oregon Following the Construction of Cougar Dam

Greg Taylor, ***U.S. Army Corps of Engineers***

The U.S. Army Corps of Engineers (USACE) operates and maintains a system of 13 dams and reservoirs within the Willamette River basin of northwestern Oregon. The USACE completed construction of Cougar Dam on the South Fork McKenzie River on September 24, 1963. Facilities were included for passing upstream and downstream migrating Spring Chinook salmon (*Oncorhynchus tshawytscha*), the only indigenous anadromous fish spawning upstream of the dam. After two years of evaluation a multi-agency steering committee recommended discontinuing passing salmon at Cougar Dam due to serious problems identified with the adult collection and juvenile downstream passage facilities. The USACE mitigated for lost production above the dam with construction of McKenzie Hatchery. In 1993, the Oregon Department of Fish and Wildlife began outplanting hatchery Spring Chinook salmon upstream of dams in the Willamette Basin to provide nutrient enhancement, a prey base for native resident fish, and later as a means of supplementing natural production of Spring Chinook salmon. The National Marine Fisheries Service (NMFS) listed Upper Willamette River Chinook salmon on March 24, 1999. NMFS completed a biological opinion for the continued operation of the Willamette Project on July 11, 2008. The opinion identified specific actions to be completed at Cougar Dam including: operating a new temperature control tower, constructing a new adult upstream passage and juvenile downstream passage facility. This presentation is a case study that examines the response of the Spring Chinook salmon population inhabiting the South Fork McKenzie River, OR following construction of Cougar Dam.

Putah Creek: Restoring a Natural Hydrograph Tour

Thursday, April 5

***Tour Coordinators: Libby Earthman,** Putah Creek Council*
*and **Jacob Katz,** Moyle Fisheries Lab, UC Davis*

In the summer of 1989, the Putah Creek Council published the following passage in a newsletter:

"An environmental tragedy is unfolding on the outskirts of Davis. Because of bureaucratic confusion about water rights and inadequate water releases below Lake Solano dam into the natural stream, the lower six miles of Putah Creek have been dry for over two weeks.

Countless fish and aquatic life have been lost, cottonwood and willow trees are beginning to die out, and numerous species of wildlife have abandoned the riparian and wetland habitat they rely on for survival . . . Beaver dams and lodges sit exposed in the sweltering heat and thousands of dried carcasses of fish, tadpoles and crustaceans are imbedded in the drying mud of the creek's disappearing potholes."

The news of a dry stream bed spurred community action to save Putah Creek resulting in the Putah Creek Council, UC Davis, the cities of Winters and Davis, Yolo County, and local famers all jointly filing suit against Solano County Water Agency to ensure legally protected perennial flows. Citing specific state laws pertaining to the Public Trust Doctrine, the suit argued that the state had an obligation to present and future generations to protect the stream flow in Putah Creek and the aquatic and riparian wildlife dependant upon it. Specifically, section 5937 of the California Fish & Game Code requires dam operators to maintain fish below dams in "good condition." The thousands of fish carcasses embedded in the mud of the dry creek served as a powerful demonstration of why such a law had been enacted.

Protections for Putah Creek: the Putah Creek Accord

The result of the 10-year lawsuit was an amicable settlement called the Putah Creek Accord. The accord ensures habitat protection and in-stream flows designed specifically to favor native fishes, perpetual wildlife monitoring, and funds a Putah Creek Streamkeeper.

Putah Creek is a highly altered stream system: it has been straightened, dammed, mined for gravel, levied, and had its banks denuded for flood water conveyance. Yet, Putah Creek still supports a great diversity of native fish, wildlife, and bird species. According to Andy Engelis, curator at the UC Davis Museum of Wildlife and Fish Biology, "Putah Creek is a thin ribbon of habitat supporting over 1/6th of the bird diversity of the state." The creek is also home to a vibrant native fish assemblage which is flourishing thanks to the flow schedules provided by the Accord which more closely resemble native hydrology, including increased flow in spring for spawning natives and autumn attraction flows for salmon.

Current Projects to Enhance Wildlife and Salmon Habitat

The local restoration community continues to further Putah Creek restoration. Field tour participants will hear Dr. Peter Moyle recount the history and central place of the Putah Creek Accord in state-wide efforts to provide ecological stream flows and visit large-scale current projects designed to: increase functional floodplains; facilitate up stream salmonid migration; enhance gravel mobilization within the channel; and increase salmonid spawning habitat, shading, and dissolved oxygen.

Participants will learn about the history of restoration efforts along Putah Creek and tour the largest-scale project to date—the $2.2 million project in summer 2011 to narrow the channel along much of one mile of creek in order to create functioning floodplains where none existed, enhance spawning grounds, and increase public access. Participants will also have an opportunity to walk to an adjacent project of similar design that was completed in 2005.

Tour participants will also visit a potential massive-scale restoration site where the lowest extent of the Putah Creek channel may be moved into a tidally influenced channel in the Yolo Bypass. The site would enhance salmonid migration into Putah Creek, and would restore the current channel to a (likely) historic connection to the Bay-Delta.

Cosumnes River and McCormack Williamson Floodplain Tour

Thursday, April 5

Tour Coordinators*: Carson Jeffres,* *University of California, Davis, and* ***Leo Winternitz,* *The Nature Conservancy*

California's Central Valley freshwater ecosystems are highly productive and diverse, providing invaluable ecosystem services, yet are highly impacted and at risk of continued anthropogenic degradation. Perhaps most impacted are the floodplain and riparian habitats that have been reduced to approximately 5% of their historic distribution. The Cosumnes River is the only major river on the west slope of the Sierra Nevada without a major dam, thereby leaving its flow regime largely "natural" and intact during winter and spring seasons. It is for this reason that the Cosumnes River—and restoration of its seasonal floodplains—has become a primary research location to better understand the natural flow regime, differential benefits of seasonal floodplain access by native fishes (and especially Fall-run Chinook), and potential applicability to other locations throughout the Central Valley. Our continued study of the effects of process-based restoration, wherein levees are breached to create productive shallow water habitat, have resulted in a number of insights that now provide the scientific basis for many of the actions now being proposed to simultaneously meet water delivery, flood protection and fishery enhancement goals. Our tour of the Cosumnes River will highlight the effects of floodplain habitat restoration efforts with an emphasis on witnessing hydrologic flows and connectivity among various habitat types. We will visit several areas either restored or in the process of being restored, with direct access determined by magnitude of spring snowmelt and rain fed floodwaters at the time of the tour.

The Cosumnes River tour will also highlight the effects of floodplain habitat restoration efforts with an emphasis on witnessing hydrologic flows and connectivity among various habitat types. We will visit several areas either restored or in the process of being restored, with direct access determined by magnitude of spring snowmelt and rain fed floodwaters at the time of the tour. The tour will culminate at the McCormack-Williamson Tract (owned and managed by TNC). Because of its location and elevation, the tract has been viewed as a prime site for restoration of fresh water marsh, seasonal wetlands and riparian forest.

McCormack-Williamson Tract is a 1,631 acre "island" farm located in the north Delta downstream of the confluence of the Cosumnes and Mokelumne Rivers. The tract was purchased in 1999 by The Nature Conservancy using CALFED Ecosystem Restoration Program (ERP) funds. Because of its location and elevation, the tract has been viewed as a prime site for restoration of fresh water marsh, seasonal wetlands and riparian forest.

McCormack-Williamson plays a key role in north Delta hydraulics. Because its levees are lower than adjacent islands by court decree, McCormack Williamson has flooded seven times since the late 1930's. The property typically floods by overtopping at the northeast end during large flood events and then breaches downstream in an uncontrolled fashion, causing stress on and failure of adjacent levees and local marina moorings.

The intent of restoration on McCormack-Williamson is to implement flood control improvements in a manner that benefits aquatic and terrestrial habitats, species and ecological processes. Because the tract's topography varies from roughly minus four feet to plus five feet above sea-level, the tract provides an ideal landscape gradient for a continuum of habitat types that provides for ecosystem benefits. The flood control/ecosystem restoration project is well supported by area landowners who have been affected by the catastrophic nature of flooding on McCormack-Williamson for years.

A Science Panel chaired by Dr. Jeff Mount (UC Davis) and consisting of academics from several disciplines was convened four times from 2003 – 2005 to review the ecological restoration conceptual ideas for the tract. Historical and current hydro-geomorphic conditions were evaluated, sediment regime, aquatic and riparian resources were assessed, and design and engineering of restoration alternatives were evaluated. Results from this work have been incorporated into the current planning process for restoration of this tract. Restoration is scheduled to start in late 2013 after all planning has been completed and permits acquired.

Restoring Floodplain Processes to Increase Salmonid Populations Workshop

Thursday, April 5

Workshop Coordinator*: Eric Ginney,* *Floodplain Restoration Program Manager, ESA PWA*

Rivers and their floodplains are among the most productive and diverse ecosystems on Earth. In California, particularly its Central Valley, they are also one of the most-altered ecosystems. Water supply and flood management systems generally overlay the network of natural waterways that are host to habitats and species that have been dramatically affected by human change—in some cases pushed to near-extinction or beyond. There is increasing recognition of the importance of rivers and creeks being connected to their floodplains in supporting key ecosystem functions that can increase the number of successfully out-migrating smolts and sustain key in-channel habitats such as pools and riffles. While physical, institutional, and legal constraints on transportation, water supply, and flood management systems create enormous challenges in restoring river-floodplain connectivity, there are also new drivers at work: recognition of species dependence on functional floodplains; deficiencies in existing infrastructure systems to meet societies needs; and the need to rethink society's infrastructure—particularly our flood management and water supply systems—in light of ongoing climate change.

In this workshop, we explore the functions of, and linkages between, the channel and its floodplain. We examine how fishes use floodplains, and how rivers and creeks interact with floodplains relative to the fluvial geomorphic process that create and maintain the habitat necessary for sustaining salmonid populations. We also explore strategies and design criteria for restoring floodplain habitat that benefits salmonids. Lastly, we touch on how these restoration techniques provide other benefits to society, chiefly increased options for safely managing floodwater, especially when changes in climate are considered.

Floodplain Ecology and the Role of Floodplains in the Aquatic Ecosystem

Alexander Fremier, PhD, College of Natural Resources, University of Idaho, Moscow

In recent decades river restoration has become a billion dollar undertaking (Bernhardt et al. 2005). Restoration and rehabilitation of rivers and floodplains is considered a vital step in efficient environmental management, as they are valuable multifunctional landscape features. Specifically, river systems support unique and rich species assemblages of native species with extreme cultural significance (namely salmonids). The ecosystem services provided by naturally functioning river systems are unmatched; they regulate water quality and water supply (Tockner and Stanford 2002, Opperman et al. 2009). However, restoration of dynamic but resilient ecosystems is no small task, especially when many large-scale ecological processes have been heavily altered.

River systems are highly connected across spatial and temporal scales, and the abiotic and biotic processes are tightly coupled (Fremier and Strickler 2011). Restoration practitioners must understand how to design projects that address not only the processes that create and maintain the physical habitat template of key species but also the production of food resources for key life histories, all within the constraints of heavily modified landscapes. In this workshop, speakers will present their work on floodplain restoration from a range of ecosystems and projects goals throughout California to illustrate particular restoration solutions to common floodplain problems. The goal of the workshop is to learn from ongoing restoration projects how to improve ecosystem functioning through targeted restoration.

Salmonid Ecology in the River Ecosystem: Salmonid Use of Pool, Riffle and Floodplain Habitats

***Joseph Merz, PhD**, Principal Scientist/Restoration Ecology, Cramer Fish Sciences*

Salmonids, including Pacific salmon and trout, are an important component of ecological function and economy for western North America. Salmonids not only play a key character in western folklore but an integral role in many societies throughout the Northern Hemisphere.

Salmon and trout of the Pacific Coast have evolved with natural disturbances such as floods, drought, fires, volcanoes, wind-throw, and disease. These influences have maintained the characteristics of habitat favorable to salmonids and created a diversity of life history patterns that help maintain the resilience of each species. Natural disturbances tend to be relatively severe but are localized, allowing for ecosystem recovery. However, human-caused disturbances may have a magnitude so great that irreversible changes to the aquatic community occur or they may increase the severity of impacts from natural disturbances (e.g. flooding) with both acute and chronic impacts to salmonids. Human activities can also cause such widespread gradual changes across the landscape that the recovery potential of an ecosystem is altered. Therefore, habitat must not only allow an organism to survive but thrive and successfully reproduce. Creation and maintenance of a diverse habitat mosaic through natural stream processes, such as hydrograph variability, sediment budgets and development and maintenance of commensal relationships between the stream and its biota are paramount to healthy salmonid populations. In this workshop, we will discuss important components of stream conditions that affect salmonid habitat, including spawning, incubation, emergence, rearing, feeding, predator avoidance and migration.

What's a Floodplain without the Flood? How Different Flood Types Influence Floodplain Function

Eric Ginney, ESA PWA

In both impaired and natural river and creek ecosystems, understanding the hydrology of the watershed is a major factor in determining the hydro-geomorphic and ecologic processes that create and maintain healthy salmonid habitat. Indeed, while many restoration projects seek to reconnect rivers and creeks to their floodplains through manipulation of the physical floodplain template, if the stream's hydrology and the role of flood flows are not considered, a successful outcome is unlikely.

This presentation describes how certain types of flow events (specifically examining the differences in timing, duration, magnitude and frequency) drive key hydro-geomorphic processes that form floodplains and channels, sustain terrestrial and aquatic habitats, and ultimately foster the dynamic habitats within which salmonids evolved.

Restoring Floodplains in Incised and Confined Rivers

Andrew Collison, PhD, *Fluvial Team Director, ESA PWA*

While the benefits of reconnecting rivers to their floodplains are widely recognized, many of California's rivers and creeks are incised or otherwise disconnected from their floodplains. In some cases it is not feasible to fully restore the historic channel-floodplain connection due to flood control needs, adjacent land uses or channel incision. In these systems we need instead to develop ways to maximize restoration of channel and floodplain processes within a tightly constrained corridor. These corridors include levee setbacks and incised 'inset floodplain benches'. This presentation describes some of the processes that have disrupted channel-floodplain connectivity in rivers in California, and outlines emerging approaches to restoring floodplains in constrained corridors.

Floodplain Activation Floods: The Floodplain Activation Flow (FAF) Concept as a Restoration Metric and Design Tool

Elizabeth Andrews, P.E., *Principal, ESA PWA*

Low-magnitude, high-frequency events historically inundated floodplains along the lowland alluvial rivers of California. California has experienced a dramatic loss of floodplain that experiences this type of "activation" flow (Floodplain Activation Flow, or FAF), due to such human interventions as flow diversion, flow regulation, levee construction, and channel and floodplain modification. During these floodplain "activation" periods, physical and biological elements interact in a way so as to significantly contribute to the food web and to create and support habitat conditions that are beneficial to many native California species, including fish. Because such flow events—and such floodplains—represent a minimal threshold for a range of inundation conditions that support ecological processes across a range of flood magnitudes, they are a central focus for current restoration efforts. This presentation will broadly review our current understanding of these processes and how they interact with floodplain conditions, including river-floodplain connectivity and the inundation regime.

Can we effectively use this information to guide restoration? Approaches to applications will be briefly described, with particular focus on methods to design or assess the floodplain inundation regime and determine how well targets such as inundation seasonality, duration, and intra-annual frequency have been met.

What Makes Good Floodplain Habitat for Salmon? Insights from Long-term Studies in Yolo Bypass

Ted Sommer, California Department of Water Resources

Progress on floodplain research over the past decade has led to a major effort to create and enhance Central Valley floodplain habitat. However, there is no recognized set of floodplain design criteria for juvenile salmon habitat. Here, I use long-term research from the Yolo Bypass to propose a basic suite of habitat features that may promote salmon rearing success. Positive features include long duration flooding, high flow levels, moderate temperatures, invertebrate seed banks, and velocity refuges. Specific types of substrate and cover do not appear to be critical features. Detrimental features include man-made structures (e.g. weirs, ditches) and perennial ponds. I discuss the large number of caveats with this suite of characteristics including the need to maintain substantial variability rather than relying on a single "optimum" habitat type.

High Elevation Floodplains and Fish: Opportunities for Native Trout Recovery through Mountain Meadow Restoration and Enhancement

Rene Henery, PhD, *California Science Director, Trout Unlimited*

Meadow ecosystems are critical for California's inland native trout as well as many other native fishes. The vast majority of meadow systems in California's Sierra Nevada and Southern Cascades ranges have experienced more than a century of degradation resulting in their diminished ability to support the critical functions of water filtration, flood attenuation, biodiversity promotion, and water storage.

In many cases, properly functioning mountain meadows not only support critical aquatic and riparian species, but act as high elevation reservoirs regulating discharge downstream. With the anticipated loss in high elevation snowpack as a function of climate change, and the associated potential for altered timing, magnitude, and duration of runoff, meadow rehabilitation is increasingly being explored as an approach to buffer impacts on downstream systems. Over the past twenty years, a wide range of approaches to meadow restoration, often hinging on the enhancement of channel floodplain connectivity, have become increasingly common. In many cases, however, these efforts primarily target improved hydrologic function, with only the assumption that fish and other aquatic and riparian biota will also benefit from the restoration action.

This presentation will review attributes of meadow ecosystems critical to California's eight native trout species, as well as examples of meadow degradation and associated potential impacts on native fishes. In addition, the presentation will examine a suite of specific restoration projects, discuss their relative benefit for trout and other fishes, and highlight some of the principle opportunities, risks, and unanswered questions in the emerging science of meadow enhancement.

Establishing Salmon and Steelhead Monitoring Programs in California

Thursday, April 5

Workshop Coordinator*: Kevin Shaffer,* *California Department of Fish and Game*

Commencing in 2010, the Department of Fish and Game is releasing a series of documents and initiating field projects to establish comprehensive, scientifically sound, inter-agency monitoring programs for salmon and steelhead in coastal and Central Valley watersheds. This workshop is to present the foundation, science, statistics, and objectives of the programs. The Fish Bulletin describing the coastal monitoring program and Department Administrative Report describing the Central Valley steelhead program will be distributed at the workshop.

Overview of the CMP: Managing a New Program, Its Goals and Activities, and the Role of Collaboration

Kevin Shaffer, California State Department of Fish and Game

Since 2004, the Department has worked to develop a program to comprehensively monitor coastal populations of salmon and steelhead, from the Southern California steelhead Distinct Population Unit in the south to the Southern Oregon-Northern California coho salmon Evolutionary Significant Unit in the north. Beginning with a conceptual plan for developing a program, completed in 2004, to the recent Fish Bulletin describing the scientific foundation of a program founded in monitoring the status and trend of coastal populations of anadromous salmonids, the Department has collaborated with the National Marine Fisheries Service to establish this program. The Service's Protected Resource Division and Science Center in Santa Cruz have partnered in this effort. The Department has initiated projects (e.g., Mendocino Coast, Humboldt Bay, Redwood Creek) to begin building the program. Several other projects have or will commence across the entire coast. Once status and trend monitoring has been established, other important elements (e.g., fisheries, hatchery efficacy; restoration effectiveness) shall be integrated. The two agencies have technical (i.e., field science, GIS, data management) and management teams to initiate this program, and in 2012, the Department will work to build an interagency advisory team to aid in implementing and maintaining a program for California.

Also commencing in 2004, the Department began developing steelhead and Chinook salmon monitoring plans for the Central Valley. In 2011, the Department released the interagency plan for steelhead; the Chinook salmon plan is still being developed and is set to be finalized in 2012. This workshop is to discuss the science, planning, and future of both the coast and Central Valley with organizations, agencies, scientists, and restoration professionals interested and likely to be active partners in monitoring salmon and steelhead in California.

The Foundation of a Strategic Plan and Key Elements that Drive CMP's Plan.

Peter Adams (Presenter) Retired, *National Marine Fisheries Service, Southwest Fisheries Science Center,* ***L.B. Boydston,*** *Fisheries Consultant,* ***Sean Gallagher, Michael Lacy,*** *and* ***Kevin Shaffer,*** *California Department of Fish and Game, and* ***T. McDonald,*** *West Inc.*

Decisions are being made everywhere in California about the status of salmonids or on actions that intended to help recover these fish. These decisions are being made without the kind of monitoring information needed to evaluate these decisions. Without this monitoring, we cannot know what condition salmonid populations are in and how effective our actions are at helping these populations. The California Coastal Salmonid Population Monitoring Plan (CMP) will create a state-wide approach for monitoring coastal salmonids condition and their recovery. The plan divides California into Northern and Southern areas with a boundary north of the Pajaro River based on species composition and abundance. The CMP uses the Viable Salmonid Population concept; abundance, productivity, spatial structure, and diversity; as a framework for monitoring goals. In the Northern Area, adult abundance will be estimated through expanded redd surveys selected in a random, spatially-balanced way, and in the Southern Area, adults will be counted at fixed stations. This difference is due to low abundance and episodic migration in the Southern area. Productivity is calculated as the change in adult abundance. Spatial structure will be monitored using juvenile summer-fall snorkel surveys. Diversity traits are locally different, and will need to be examined using local diversity monitoring plans. Finally, life-cycle monitoring stations will be used to estimate marine and freshwater survival. These stations would have an adult counting station, redd surveys above the counting station, and outmigrating trapping station which would provide "fish-in, fish-out" estimates. The plan also outlines the important infrastructure functions of data management, data reporting, and monitoring performance review.

The Statistical and Sampling Foundation of the CMP Plan

Trent McDonald (Presenter), *Western EcoSystems Technology, Inc.;* ***Peter Adams, Retired****, National Marine Fisheries Service, Southwest Fisheries Science Center;* ***L.B. Boydstun,*** *Fisheries Consultant; and* ***Michael Lacy,*** *California Department of Fish and Game, Fish Division*

The California Monitoring Program (CMP) for coastal salmon and steelhead populations proposes adult, life cycle, and juvenile monitoring programs in both a Northern and Southern monitoring area. To conduct this monitoring, the locations at which monitoring takes place (stream segments) should be selected in a statistically rigorous way that prevents bias and promotes efficiency in final program estimates. The purpose of this talk is to describe the statistical foundations of the CMP from sample unit definition through panel rotation. I describe the sample units envisioned by the CMP, the stratification envisioned, the sample frames, sample selection via a generalized random tessellation stratified (GRTS) procedure, and rotation of field effort designed to spread sampling among years and streams. Information necessary to construct the sampling frames and specific procedures for selecting the GRTS sample will be described.

Status and Trend Evaluation Using Data from the California Coastal Monitoring Plan

Michael Lacy (Presenter), California Department of Fish and Game, and Thomas Williams, National Marine Fisheries Service, Southwest Fisheries Science Center

The California Coastal Monitoring Plan (CMP) will provide data necessary to evaluate the status and trend of Chinook salmon, coho salmon, and steelhead populations in coastal basins of California. The CMP has been designed to provide information relevant for monitoring Viable Salmonid Population parameters (abundance, productivity, spatial distribution, and diversity). The CMP uses Generalized Random Tessellation Stratified (GRTS)—based sample site selection to ensure spatially explicit and balanced sampling. In the northern area, GRTS - based sampling will be used to estimate spawner abundance and juvenile distribution. This sampling design enables regional (e.g., ESU-level) estimation, while still providing sufficient flexibility to address larger or smaller spatial groupings by combining data or adjusting sampling intensity. In the southern area, status and trend evaluations will depend on direct counts of returning adult steelhead and GRTS-based sampling to assess juvenile distribution. Included in the CMP are permanent life-cycle stations that will provide estimates of freshwater productivity/survival and ocean survival and escapement. Estimates of freshwater and marine survival are critical for assessing whether population trends are in response to changes in freshwater productivity or shifting ocean conditions. The CMP will provide data that are consistent with analytical formats used by National Marine Fisheries Service and California Department of Fish & Game to evaluate status and trend.

The Mendocino Coastal Monitoring Project: The Prototype for CMP

Sean P. Gallagher (Presenter), *California State Department of Fish and Game,*
and ***David W. Wright,*** *Campbell Timberlands Management*

California's coastal salmon and steelhead populations are listed under the California Endangered Species Act and the Federal Endangered Species Act. Both listings require recovery plans and monitoring to provide measures of recovery. Since 2004 the California Department of Fish and Game and NOAA Fisheries have been working to develop a plan for monitoring California's coastal salmonids (the California Coastal Salmonid Monitoring Plan – CMP). Between fall 2005 and spring 2009 we perfomed pilot work in Mendocino County, California to evaluate methods and metrics for monitoring the status and trends of salmonids in context of the CMP. Beginning in fall 2009, we applied the results of our previous pilot studies to estimate salmonid escapement for the Mendocino coast region, the first implementation of the CMP in the state. For the CMP, data to evaluate adult population status are collected in a rotating panel using a spatially balanced probabilistic design (e.g. Generalized Random Tesselation Stratified – GRTS). Under this scheme, we use a two-stage approach to estimate regional abundance. Regional redd surveys (stage 1) are conducted in stream reaches in a GRTS sampling design at a survey level of 15% or ≥ 41 reaches, which ever results in fewer reaches, of available habitat each year. Spawner: redd ratios, derived from smaller scale census watersheds (stage 2) where "true" escapement is estimated using capture-recapture methods, are used to estimate regional escapement from expanded redd counts. The second stage census watersheds, referred to in the CMP as Life Cycle Monitoring Streams, are places where we estimate adult, parr, and smolt abundance; make connections between life stage abundance and abiotic factors; and should serve as focal points to foster ancillary research. Here we present the findings of this prototype monitoring effort and discuss how our work can inform implementation of salmonid monitoring throughout coastal California.

Overview of the Central Valley Adult Chinook Salmon Escapement Monitoring Plan

Alice Low, California Department of Fish and Game

Accurate estimates of the numbers of adult Chinook salmon migrating from the ocean to spawn in CV streams (escapement) and harvested in freshwater are critical to sound management of ocean and inland harvest and monitoring the recovery of listed stocks. Adult escapement data are currently used for several key management purposes:

- Providing a basis for assessing recovery of listed stocks,
- Monitoring the success of restoration programs,
- Evaluating the contribution of hatchery fish to CV populations, and
- Sustainably managing ocean and inland harvest.

Estimates of the number of Chinook salmon returning to spawn in the Central Valley have been made since the early 1950s, and in some cases since the 1940s. Programs have evolved over the years, and vary in methods used, intensity of sampling effort, and reliability of estimates.

In the development of the Central Valley Adult Chinook Salmon Escapement Monitoring Plan, a thorough statistical review was conducted of existing survey methods. Sampling designs were reviewed and recommendations were made for improvement of the field and analytical methods used in the monitoring programs. The most appropriate survey/monitoring technique (i.e., mark-recapture carcass surveys, redd surveys, snorkel surveys, and fish device counters) was identified for each watershed.

Costs of the recommended CV monitoring programs were estimated for existing and new programs. To improve data management and reporting, an online database was reorganized and updated to provide a centralized location for sharing CV Chinook salmon escapement estimates and annual monitoring reports.

Revised Statistical Techniques for Development of Central Valley Adult Chinook Salmon Escapement Estimates

Ryan Nielson, West, Inc.

In the development of the Central Valley Adult Chinook Salmon Escapement Monitoring Plan, a thorough statistical review was conducted of existing survey methods. Sampling designs were reviewed and recommendations were made for improvement of the field and analytical methods used in the monitoring programs.

In particular, analytical methods to estimate escapement from mark-recapture carcass survey data were reviewed. Various population models have been used to estimate escapement from mark-recapture carcass survey data, without measures of precision and bias. The pooled Petersen, modified Schaefer, and Jolly-Seber models are currently used in the Central Valley. Based on a review of the available mark-recapture models and simulation modeling, the monitoring plan recommends replacement of the models currently used with the super-population modification of the Cormack-Jolly-Seber (CJS) model. Use of this model should significantly improve the accuracy of escapement estimates from the Central Valley mark-recapture carcass surveys. In addition, methods to estimate escapement using redd survey and fish device counter data were developed.

Development of Abundance Estimates from Juvenile Chinook Salmon Monitoring Data

***Trent McDonald, PhD, (Presenter),** Western EcoSystems Technology, Inc.; **Douglas Threloff,** U.S. Fish and Wildlife Service; **Michael Banach,** Pacific States Marine Fisheries Commission; **Connie Shannon,** Pacific States Marine Fisheries Commission; and **Karen Wilson,** Pacific States Marine Fisheries Commission*

Since 1993, rotary screw traps (RSTs) have been used to monitor the production or abundance of juvenile Chinook salmon at 37 locations in the Central Valley of California. Despite the expenditure of over $45,000,000 to operate these traps, there has been no standardized, unified effort to store, analyze, and report RST data in the Central Valley. We are developing an integrated data base and analysis systems to house, check, display, analyze, and report RST data in a standardized manner. The system will facilitate data entry, house existing RST data from different Central Valley watersheds, compensate for operational differences when possible, and produce standardized passage estimates by life stage. The standard analyses built into the system will, when necessary, utilize generalized additive models to interpolate estimates of capture probabilities and catch to days where one or the other parameter is missing. The procedure will then inflate daily catch numbers by daily capture probabilities to arrive at total passage. Confidence intervals will be produced by bootstrapping. The analysis procedures are programmed in R and utilized in a way that is easy to update when new or better analyses are discovered. This talk describes the data base and analysis systems, but dwells on the statistical procedures being used in the system. Examples of inputs and outputs of the nearly complete system are provided.

Overview of the Central Valley Steelhead Monitoring Plan

Russell Bellmer, *California Department of Fish and Game*

A Comprehensive Monitoring Plan for Steelhead (*Oncorhynchus mykiss*) in the California Central Valley is a science based collaborative approach to collect steelhead population data. A result of requests from fisheries resource managers and resource federal and state agencies leadership, the development of this plan was funded by the CALFED Ecosystem Restoration Program with additional funding support from the California Department of Water Resources and the United States Bureau of Reclamation. This plan identifies the actions needed to fill knowledge gaps and collect baseline information on population abundance and distribution, which will help assess the recovery of California Central Valley steelhead populations using a statistically rigorous approach. It also contains recommendations for continued juvenile steelhead monitoring and the development of new technologies/methods to improve the understanding of life history traits and population dynamics. The goal of this monitoring plan is to provide the data necessary to assess the restoration and recovery of steelhead populations by determining the distribution, abundance, and population trends of these fish. The objectives of the plan include: estimate steelhead population abundance with levels of precision; examine trends in steelhead abundance; and identify the current spatial distribution and assess changes. The plan includes recommendations for the development of a centralized database and a coordinated reporting system to be utilized by all Central Valley steelhead monitoring programs.

Integration of Steelhead Population Monitoring into Comprehensive Life Cycle Investigations

Joshua Israel, PhD, U.S. Bureau of Reclamation

Comprehensive monitoring strategies for imperiled species should develop information pertinent to the species' demographics as well as gain insight into the relationship of these characteristics to limiting factors. Both aspects of monitoring strategies are critical, otherwise interpretation of results may not reflect information about the status and dynamics of the species. *A Comprehensive Monitoring Plan for Steelhead (Oncorhynchus mykiss) in the California Central Valley* was developed to collect steelhead population data. In the 2009 NMFS Biological Opinion for the Long-term operations of the CVP and SWP, Reclamation and DWR were requested to design, implement, and fund the *Comprehensive Monitoring Plan*. This plan was to include adult and juvenile direct counts, red surveys, and escapement estimates in CVP and SWP- controlled streams, and develop better estimates on juvenile production. This information is important since it serves as a basis for incidental take limits, and this provides necessary information to calculate biological triggers for operational actions. While there are numerous efforts already underway and others planned as part of the Comprehensive Monitoring Plan, these efforts lack a mechanism for integrating them into a meaningful representation of the steelhead dynamics and relationship to management actions. As part of the CVP and SWP operational and mitigation activities, steelhead are propagated at multiple hatcheries, salvaged at export facilities, and also are the focus of instream flow releases and habitat restoration. Envisioning a comprehensive monitoring program that is centered on a life cycle model allows us to incorporate spatially explicit information about species demographic and operational and mitigation actions. As part of a federal Near Term Science Strategy, Reclamation is funding genotyping of all Central Valley steelhead hatchery broodstocks, which will allow for identification of any Central Valley juvenile hatchery steelhead (adipose fin clipped) to hatchery (and family) or origin. A mark-recapture framework may be useful for using these genetic tags to estimate a number of currently unknown demographics for each different steelhead stocks in the Central Valley throughout their life cycle. Genetic tagging of these broodstocks can be applied to evaluating a number of other demographics on the population including stock-specific harvest rates and salvage rates. Undertaking a large-scale mark-recapture investigation will require coordination between anglers, DFG creel biologists, hatchery biologists, and monitoring study program biologists. This kind of coordination was critical to the last Sacramento River comprehensive monitoring effort spearheaded by Richard Hallock in the 1950's. This talk with review Hallock's (1957, 1961) approach to life cycle investigation, describe some strategies for using genetic tagging as an effective tool a comprehensive steelhead monitoring program, and include some ideas about why I think monitoring programs require linking management actions and observations.

Analytical Approaches to Determine Instream Flow Needs for Salmonids and River Ecosystems

Thursday, April 5

Workshop Coordinator: ***Darren Mierau,*** *California Trout*

Instream flow studies share many common traits, the first of which is the need to identify streamflows that protect basic ecological attributes (e.g., processes, populations) of rivers and streams. In the face of competing demand for water resources, instream flow studies are often contentious and highly scrutinized. Studies typically involve some level of data collection to quantify instream conditions (e.g., water temperature) and relationships between physical conditions and water quantity (e.g., habitat-flow curves), evaluation of water supply availability, and often negotiation to establish instream flow requirements. Perhaps the most challenging step in developing instream flow recommendations is the *analysis and integration* of disparate data sets to identify a flow regime that balances competing ecological attributes (e.g., fluvial processes, riparian ecology, water temperature, and physical habitat structure). The integration stage of instream flow analysis often must address spatial and temporal variability in flow and habitat conditions, and consider habitat capacity (spatial habitat factors), biological productivity (growth rates, inter-specific competition, survival), and life history diversity (phenotypic and genotypic). Additionally, flow studies must conduct this analysis in a transparent manner that allows non-technical stakeholders to participate in decision-making. Ultimately the instream flow needs must be weighed against diversion needs and hydrograph manipulation necessary to meet existing and future water demand. Currently numerous instream flow studies or programs are being implemented in California, several of which have employed new approaches to data analysis and integration. Setting aside the often-debated topic of instream flow *methods,* this workshop will (1) offer a set of principles to guide flow study data analysis and integration, (2) describe several flow studies currently being implemented or just completed that utilize different analytical approaches, and (3) allow instream flow practitioners and others an opportunity to discuss concepts and approaches that may contribute to improving the application of study results.

Determining Streamflow Requirements Under the North Coast Instream Flow Policy

Brian Johnson, *California Director, Trout Unlimited*

Thousands of streamflow diversions throughout the North Coast region of California currently operate without adequate safeguards to ESA-listed salmonid fish species. A.B. 2121, signed into law in 2004 by then Governor Arnold Schwarzenegger, was needed to sharply reduce the backlog of water rights applications in coastal streams from the Mattole River to San Francisco, while protecting instream habitat and water quality. On May 4, 2010 the State Water Board adopted its policy titled "Policy for Maintaining Instream Flows in Northern California Coastal Streams," referred to as the North Coast Instream Flow Policy. Three pathways for securing a water right application under the new policy are: application of standard Regionally Protective Criteria, site-specific studies, and a "watershed approach." The policy contains principles and guidelines for maintaining instream flows, including: (1) limits to the season of diversion; (2) allowable diversions only when streamflows are higher than those needed to maintain fish habitat; (3) diversion rates to protect natural flow variability; (4) measures to minimize on-stream dam effects; and (5) measures to minimize cumulative effects caused by multiple diversions. Trout Unlimited was the main stakeholder pushing for the legislation, and were involved at all stages of policy development. In fact, large parts of the policy resulted from collaborative discussion with representatives from the wine industry. However, significant issues remain with the water right permit processing. For example, the "regional criteria" are conservative enough that most applicants have a powerful incentive to pursue site-specific studies. While a number of approaches exist, better and less costly methods for conducting site-specific studies are needed. Trout Unlimited will continue to work to resolve questions about policy implementation, and make recommendations for practitioners.

Identifying Hydraulic Habitat Thresholds to Protect Summer Low-Flows in the Mattole River Headwaters, CA

Gabe Rossi, *Hydrologist and Engineering Technician, McBain and Trush, Inc.*

Integrating habitat abundance, temperature and productivity is often the central challenge of an instream flow study. Hydraulic Habitat Thresholds (HHTs) can be used to quantify ranges of flow that create habitat abundance and promote ecosystem productivity. Recognizing streamflows where HHTs for habitat and productivity overlap with good temperature conditions is a core step in identifying viable life history tactics and the instream flows that support them. The HHT approach relies on direct field-measurements of stream hydraulics at monumented locations to identify streamflow thresholds for abundance and quality of multiple habitat types (spawning, fry and juvenile rearing, benthic invertebrate productivity etc.). The HHT method was applied to identify streamflow thresholds and respective allowable rates of diversion on the Upper Mattole River. This talk will focus on how HHTs for habitat abundance, and ecosystem productivity where integrated with respect to potential life history tactics to identify instream flow needs and allowable diversion rates.

Real-Time Management of a Watershed's Instream Flow Needs with Multiple Dispersed Water Users

Tasha McKee, *Co-Executive Director, Mattole River Sanctuary Forest*

In the Mattole River headwaters there is no municipal water system and it is up to each landowner to develop and operate their own water diversion and water system. Over the last decade, several low flow years have underscored the need to change the timing of diversions and to develop a community approach for managing cumulative impacts. Sanctuary Forest developed the Mattole Headwaters Storage and Forbearance program in response to the severe low flows of 2002 and outcomes from community meetings. This voluntary, incentive based program helps landowners change their water use for the benefit of the river, fisheries and wildlife. Participating landowners forbear from exercising their riparian water rights during the low flow season, and receive a water storage system and water management guidelines to ensure an adequate water supply. Over the last five years, 750,000 gallons of storage have been installed along with 12 forbearance agreements and measurable improvements in streamflow. This presentation will focus on the challenges of developing and managing a program that serves multiple dispersed water users. In the Mattole the development phase began with a feasibility study to determine if the program would be effective. The next steps included development of fisheries protection criteria, forbearance agreement, landowner outreach and education, and agency collaboration and permits. Ongoing implementation includes forbearance and storage installation along with effectiveness and compliance monitoring. Management of the program involves low flow season monitoring along with landowner notices and technical support needed to ensure forbearance. The program has been very successful, with increased water security for people and increased streamflow for salmonids. Education and outreach have fostered community appreciation and pride in the program with many households practicing conservation and installing some storage on their own.

Developing Interim Instream Flows for the Shasta River Big Springs Complex and Shasta Canyon

Bill Trush, *River Ecologist, McBain and Trush, Inc., and Institute for River Ecosystems*

An instream flow program began in the Shasta River in 2006, with the goal of developing instream flows adequate to maintain fish in good condition pursuant to Fish and Game Code Sections 1603, 5901 and 5937. The first phase of this study identified interim instream flow needs in the Big Springs Complex of the Shasta River, including several stream reaches below Dwinnell Reservoir, to protect critical habitat associated with the cold water springs and mainstem reaches for coho salmon summer rearing. The second study phase will identify instream flow needs for the 7.8 mile Shasta Canyon located above the confluence with the Klamath River. The Shasta Canyon is gatekeeper to the Shasta Basin. All upstream migrating salmon/steelhead adults and outmigrating smolts must pass through the Canyon. The Ocean Protection Council (OPC) provided funding to identify instream flow needs for the Shasta River Big Springs Complex and the Shasta Canyon as part of an overall strategy for recovering basinwide anadromous salmonid populations. Seven ‘guidelines’ directed our analytical strategy for identifying instream flow needs for the Shasta River. In this workshop, each guideline will be explained and quantitatively incorporated into estimating baseflow instream flow needs for Shasta River Canyon as a demonstration for applying these guidelines elsewhere.

Stream Ecosystem Flows for Geomorphic, Riparian, and Fisheries Recovery and Maintenance in Mono Basin Tributaries, CA

Ross Taylor, *Fisheries Biologist, Ross Taylor and Associates*

The California State Water Resources Control Board (SWRCB) must balance how water is allocated to meet the needs of citizens and natural resources. In 1941, the Los Angeles Department of Water and Power (LADWP) began exporting water from the Mono Basin to the City of Los Angeles. Over the next five decades, water exports caused significant negative ecological changes to Mono Lake and its tributary streams—primarily Rush and Lee Vining creeks. In 1998, the SWRCB established interim instream flows (called Stream Restoration Flows or SRFs) in Mono Lake tributaries to promote the recovery of Mono Lake, the stream channels, and the non-native but naturally reproducing trout populations. Two independent scientists (the Stream Scientists) were appointed by the SWRCB to monitor the recovery of the stream channels and the fisheries, evaluate the interim flows, and recommend adjustments to these interim flows. As twelve years of monitoring unfolded, the Stream Scientists, with assistance from LADWP, California Department of Fish and Game (CDFG), the Mono Lake Committee, and CalTrout, identified these primary 'how to' changes: (1) prescribe more reliable Lee Vining Creek diversions and eliminate potential negative impacts; (2) accelerate recovery of the Lee Vining Creek ecosystem by encouraging Southern California Edison's (SCE) assistance in bypassing higher peak snowmelt runoff events; (3) reduce SCE's elevated winter baseflows in Lee Vining Creek to improve winter trout holding habitat; (4) actively manage for a more reliably full Grant Lake Reservoir (GLR), by diverting Lee Vining Creek streamflow throughout most of the runoff year, to increase the magnitude, duration, and frequency of GLR spills and to provide cooler summertime dam releases into Rush Creek from a deeper reservoir; (5) adjust the Rush Creek SRF streamflows to better achieve desired ecological outcomes and processes and to improve the reliability of their release; (6) accelerate recovery of the Rush Creek ecosystem by encouraging SCE and US Forest Service (USFS) to assist in releasing higher peak snowmelt runoff events that reservoir spills managed only by LADWP cannot re-create; (7) provide a shallow groundwater environment during snowmelt runoff necessary to promote riparian vegetation recovery on contemporary floodplains; and (8) recommend baseflow changes to the SRFs that will shift the brown trout populations toward a more varied age-class structure that includes older and larger fish by increasing adult habitat and improving growth rates. In April of 2010, the Stream Scientists' Synthesis Report recommended changes to the interim flows. This presentation will highlight the strategies and data analyses used by the Stream Scientists to develop their recommended stream ecosystem flows (SEFs). The presentation will describe how watershed-specific differences and existing infrastructure within Rush and Lee Vining creeks influenced flow recommendations. The presentation will also allow workshop participants the opportunity to debate the merits of the analytical approach used to develop flow recommendations, and provide suggestions to further improve the Stream Scientists' recommendations.

Instream Flow Analysis in the FERC Relicensing of PG&E's McCloud River Project

Scott Wilcox, *Senior Fisheries Biologist, Stillwater Sciences*

The McCloud River watershed is located northeast of Redding, CA and has its headwaters on the slopes of Mt. Shasta. The geology of the area is dominated by porous volcanic deposits forming a large aquifer that provides a steady supply of cold spring water to the upper McCloud River. That water supply, and other aspects of the remote and protected watershed, has supported a renowned trout fishery. The water supply is also used for hydroelectric power generation as part of PG&E's McCloud-Pit Project. Competing flow demands in the lower McCloud River led to extensive evaluation of flows during the recent relicensing of the hydro project. Several instream flow assessment methods were considered during planning for the lower McCloud River relicensing studies. They included 1-D and 2-D PHABSIM methods, habitat mapping approaches, and biological models. The stakeholder group ultimately decided to use Habitat Criteria Mapping (HCM) and Individual-Based Model (IBM) tools for instream flow assessment. A 1-D PHABSIM model supplemented the data analysis process for the other two methods. The results of the different assessments were quite similar with regard to relationships between flow and physical habitat, and the IBM predicted that the trout population would respond well to a flow regime that approximated current hydrologic conditions and that produced high physical habitat index values. Proposed flow recommendations were made based on an incremental, multidisciplinary, matrix-based approach that considered different resource and life stage needs, priorities, and timing, using data derived from the various site-specific studies. The process was kept transparent by providing stakeholders with the underlying study results for each resource, conclusions regarding seasonal flow implications of those results, and identifying competing flow needs at different times of the year. A graphical representation was made of current flow conditions throughout the year, and of the seasonal resource constraints and opportunities, and a "walk-through" of the rationale and tradeoffs behind a proposed flow regime provided to stakeholders. This proposal, as refined by stakeholder discussion, formed a platform from which other regulatory options were considered, including the possible reintroduction of anadromous fish into the watershed.

The process of flow regime analysis and recommendation for the McCloud River reinforced several conclusions from a recent review of approaches to instream flow assessment. First, there is a "tipping point" beyond which more data will not necessarily lead to better or more efficient decision-making; several studies pointing to the same conclusion may, or may not, have a greater weight in the decision-making process. Second, the art and science of using the data for decision-making is at least as important, or more so, than the science of generating it in the first place; high quality results can otherwise get lost in a cloudy decision-making process. Third, it is helpful to appropriately match the level of study effort and use of analytical tools to the value and risk status of the resource, and to management goals and options. A mismatch of effort, priorities, or management options can negatively affect the utility and cost effectiveness of flow decisions.

California Department of Fish and Game Statewide Instream Flow Policy on Development of Flow Recommendations

Robert Holmes, *Water Branch Instream Flow Program, California Department of Fish and Game*

The California Department of Fish and Game (DFG) is conducting an instream flow study on the Big Sur River (Monterey County) to identify habitat and instream flow relationships for south-central steelhead. The Big Sur River is among the larger watersheds south of San Francisco Bay currently supporting south-central steelhead and is considered a stronghold for steelhead on the Central Coast. The flow study includes investigation of south-central steelhead spawning, migration, and juvenile rearing. Analytical approaches used as part of the Big Sur River flow study will be presented. DFG's policy for development of instream flow recommendations is to use the Instream Flow Incremental Methodology (IFIM). The IFIM is a structured multidisciplinary and collaborative process that provides incremental results and techniques to interpret, understand, and negotiate instream flow recommendations. A primary benefit of using the IFIM approach is data defensibility, a necessary foundation for fulfilling DFG's interest in assuring that water flows within streams are maintained at levels which are adequate for long-term protection, maintenance and proper stewardship of fish and wildlife resources. The IFIM process has five phases including: 1) Problem Identification and Diagnosis; 2) Study Planning and Objectives; 3) Study Implementation; 4) Analysis of Alternatives; and 5) Problem Resolution. The IFIM process addresses components that are important aspects of flow regimes including: hydrology, biology and habitat, geomorphology, water quality (including temperature), and connectivity. Flow recommendations are the final product of the IFIM process, describing the magnitude, duration, frequency, and timing of the recommended flows. DFG is mandated through Public Resources Code (PRC) §10000-10005 to identify priority streams and rivers throughout the State needing instream flow assessments, and to develop stream flow requirements for protection of fish and wildlife on those streams. DFG identified a list of twenty-two priority streams for instream flow assessments in 2008. DFG's Instream Flow Program is currently involved with investigating the relationships between flow and available stream habitat for several of those streams throughout the State, including the Big Sur River. DFG will submit the flow recommendations developed through the IFIM process under PRC §10000-10005 to the State Water Resources Control Board.

Salmon, People and Place: the Search for Salmon Recovery

Jim Lichatowich, *Author of* **Salmon without Rivers**

130 years ago we bought into the myth that salmon-sustaining ecosystems could be replaced by industrial production systems or fish factories as hatcheries were called in their early years. Adhering to this myth led to habitat destruction, over harvest and the extinction of salmon in forty percent of their natural range and massive listings under the Endangered Species Act. I will describe some steps that we need to take to expose the myth and put salmon on a path to recovery.

Salmon: Past, Present, and Future and What the California Department of Fish and Game Can Do

Chuck Bonham, *Director, California Department of Fish and Game*

California began managing its fisheries resources in 1870. The Department of Fish and Game has existed since the first decade of the twentieth century. Management and protection of the State's anadromous resources has been one of the department's most crucial responsibilities. Declines in fish populations, ocean and inland, and declines in department staff and programs have combined to make for a challenging end of the twentieth century. Director Bonham will share how the department is planning for the 21st Century and those things necessary to ensure healthy salmon and steelhead populations for future generations of Californians.

Managing the Delta for Fish and People

John Laird, Secerety of California Natural Resources Agency

One of the largest habitat restoration projects in the United States sits right in our backyard, and it is good for both fish and people.

Watershed Recovery from the Perspective of the North Pacific

Xanthippe Augerot, PhD, *author of* Atlas of Pacific Salmon

Pacific salmon are distributed widely across the North Pacific, from the Korean Peninsula to California. Small populations of non-anadromous Pacific salmonids are found even further south, in Taiwan and Baja California. The major salmon jurisdictions of the North Pacific have each evolved their own practice and culture of salmon management. Differences and similarities in salmon management and culture will be highlighted, with the intention of sharing lessons relevant to living with salmon in our home watersheds.

River Assessment, Management, and Rehabilitation Using "Near-Census" Data and Models in the 21st Century

Greg Pasternack, PhD, *Department of Land, Air, and Water Resources, University of California, Davis*

Process-based fluvial geomorphology is undergoing a paradigm shift in which new scientific discoveries increasingly stem from "near-census" maps of rivers and river change along with comparably detailed and expansive predictive models of hydrodynamics and morphodynamics. "Near-census" analysis involves the use of densely gridded data at ~1-m resolution over long river segments (~10-100 km) as opposed to the traditional standard of limited statistical sampling with transects or intensive reference-site analysis. Near-census, sub-meter physical data that are rapidly emerging at low cost include color aerial imagery, airborne LiDAR of terrestrial bare earth, water surfaces, and plant-canopy tops, survey-grade bathymetric echo-sounding, boat-based surface velocity tracking, image-based extraction of bed material particle size distributions on terrestrial land and through clear water, and image-based extraction of stream wood deposits. Near-census data may be used to drive 2D and 3D hydrodynamic models that yield near-census predictions of flow patterns with reasonable accuracy. Together, data and model results can be analyzed using emerging methods to map and uncover the complex patterns of river-corridor landforms at different spatial scales. Then, geomorphic processes and ecological functions (including habitats for specific species' life stages) can be analyzed relative to the landforms at each scale. The end result is a comprehensive assessment of the status of the flow-dependent aspects a river with tools in hand to answer specific management questions and guide engineering design of technical solutions to identified problems. These topics will be illustrated with examples. To support academic and professional training in near-census analysis, a new textbook titled "2D Modeling and Eco-hydraulic Analysis" is now available.

Should Streams be Managed as Drainage Networks or Habitat Networks?

Michael M. Pollock, PhD, (Presenter) and Tim Beechie, NOAA, Northwest Fisheries Science Center

Many hydraulic engineers and fluvial geomorphologists have historically viewed stream systems as drainage networks that if functioning properly, should efficiently route water and sediment downstream. In this view natural instream obstructions such as wood, rocks or beaver dams are not desirable because they may create unpredictable changes in channel morphology that would impact the movement of sediment and water and may affect stream stability. This view has extended to the science of stream restoration and the regulatory environment that guides restoration projects, where channels must often be engineered to remain vertically and laterally stable and to move sediment and water at the rate designed over the life of the project. If instream structures are included in a restoration project, they must often be designed to be stable and to not substantially impede the downstream movement of sediment or water. We argue that this view is outdated and that instream obstructions that dynamically alter both the vertical and horizontal position of the stream are essential to the recovery of salmon habitat. We further hypothesize that there are spatial patterns to the numerous types of instream obstructions that historically existed in watersheds and that the ecological functions provided by a particular type of obstruction depends on watershed position. For many types of obstructions, key to creating habitat beneficial to salmon is the ability to substantially decrease the sediment and water transport capacity of a stream, and to do so both stochastically and dynamically. From this perspective, salmon-sustaining streams are recognized as a network of dynamic habitat patches that move in three dimensions.

Ecological Meaningful Flows in Restoration: Examples from California Salmon Streams

Joseph Merz, PhD, (Presenter), University of California, Santa Cruz, **Rocko Brown**, *ESA PWA,* *Carson Jeffres, University of California, Davis, and* **Clark Watry,** *Cramer Fish Sciences*

Hydrologic analysis has made significant contributions to our understanding of river dynamics, flood control, channel maintenance, and riverine ecology. The origins of this science are rooted in engineering applications aimed at predicting maximum or worst case scenarios for water supply infrastructure and public safety. For example, the calculation of peak flood magnitudes are typically based on daily peak flows or even monthly statistics and are concerned primarily with annual statistical predictions. However, extrapolation of these techniques to rehabilitation of riverine ecosystem recovery can have resounding effects on management decisions; particularly evident when differences between estimated long-term physical and ephemeral biological responses are critiqued. One of the primary issues in defining meaningful flows is that hydrologists and ecologists discuss hydrology in fundamentally different ways. For example, hydrologists tend to use statistics such as monthly or annual averages and flood frequency distributions to characterize stream conditions. Ecologists, on the other hand, are concerned with the duration of annual flood pulses or low flow extremes, timing of those conditions, rates at which water levels rise or fall and in turn, connectivity of secondary habitats during periods that are meaningful for the flora and fauna of the riverine system. Identifying measurements of the hydrograph that are useful to both practitioners of river form and ecological function are therefore important undertakings that would greatly benefit restoration efforts throughout the world.

In this presentation we offer meaningful tools for assessing flow that are available to stream practitioners and river managers in an effort to focus appropriate science on important stream management decisions. Here, we contrast hydrologic analyses for engineering, geomorphic, and ecological applications in stream management and define the minimum fidelity needed in a hydrologic time series to capture ecological dynamics. Finally, we define quantitative indices used to represent flow variability by illustrating these tools on two large, California salmon streams that have varying hydrologic regimes and anthropogenic controls. While examples meaningful to Pacific salmonids are given, their utility is applicable to numerous issues, from aquatic macroinvertebrates to riparian vegetation.

Community Assemblage in a Riparian Community: Investigating Phylogenetic Patterns Across an Abiotic to Biotic Environmental Gradient on the Sacramento River Floodplain

Alex Fremier, PhD, (Presenter), *University of Idaho, Moscow,* ***David Tank,*** *College of Natural Resources, University of Idaho and Stillinger Herbarium, and* ***Simon Dufour,*** *Université, France*

The wealth of community ecology research to date has shown how abiotic conditions, disturbance and biotic interactions act collectively as environmental filters and selective forces in community assembly over ecological time and spatial scales. Despite awareness that ecological communities have evolution histories, rarely have studies included deep historical explanations for community assembly. In this study we investigate the relationship between phylogeny and plant community composition in the Sacramento River valley to understand how flood disturbance influences the plant community assembly. To investigate the influence of phylogenetic diversity across an environmental gradient, we compiled species composition and abundance data across four fluvially defined zones on the floodplain. These four zones represent a gradient ranging from strong abiotic control to strong biotic control and allow us to test the hypothesis that species composition would be phylogenetically clustered (i.e., species more closely related to each other than expected by chance) in abiotically controlled surfaces and phylogenetically over-dispersed (i.e., species more distantly related to each other than expected by chance) in less flood prone surfaces that are more heavily influenced by biotic interactions. We found strong species clustering among our physically-defined groups. More fluvially disturbed groups were significantly phylogenetically clustered with no relationship on higher riparian forest communities, as expected. Grassland communities showed significant phylogenetic clustering. Our results will help researchers better understand plant community dynamics on disturbance prone floodplains. One applied aspect of this work is the potential to analyze non-native species invasions across ecological disturbance gradients. A phylogenetic approach allows researchers to predict the invasibility of individual species and the most appropriate native species competitors. That is, invasive species more distantly related to the entire species pool has shown to be more invasive (Strauss et al. 2006); potentially, by restoring more closely related native species, managers can limit non-native invasions. Coupling these evolutionary and ecological processes will improve our understanding of community assembly and our ability to predict directional changes in species composition caused by altered environmental and biotic processes.

Synthetic River Valleys

Rocko A. Brown, *ESA PWA and University of California, Davis*

The description of fluvial form has evolved from anecdotal descriptions to artistic renderings to 2D plots of cross section or longitudinal profiles and more recently 3D digital models. Synthetic river valleys, artificial 3D topographic models of river topography, have a plethora of potential applications in fluvial geomorphology, and the earth sciences in general, as well as in computer science and ecology. Synthetic river channels have existed implicitly since approximately the 1970s and can be simulated from a variety of approaches spanning the artistic and numerical. The benefit of synthetic rivers to applied and theoretical river and stream engineering and management is that the simulation of synthetic channel geometry of prescribed conditions can allow systematic evaluation of the dominant relationships between river flow and geometry over vast spatial scales. A new model based on geometric modeling is presented that uses hierarchically scaled parametric curves in over-lapping 2D planes to create 3D synthetic river valleys in a completely flexible modular setting. The approach is able to simulate 3D stream geometry from paired 2D descriptions and can allow experimental insight into form-process relationships in addition to visualizing past measurements of channel form that are limited to two dimension descriptions. Results are presented that illustrate the models ability to simulate fluvial topography representative of real world rivers as well as how channel geometric elements can be adjusted. Methods for generating 3D models of river and stream topography could allow historical reconstruction of fluvial systems that have been altered far before emergent technology could capture their characteristics topographic characteristics. In addition, the consequences of river re-scaling can be explicitly re-evaluated to determine the efficacy of this paradigm in settings where natural riverine boundary controls exist. Lastly, synthetic rivers allow stream and river restoration designers to rapidly generate the full spectrum of reach scale topography in designs.

Tools to Improve Water Temperature Management on the Lower American River

Chris Hammersmark (Presenter), Chris Bowles and Chris Campbell, cbec eco engineering

The status of Chinook salmon and steelhead in the lower American River warrants investment in rehabilitation and management actions to improve the resiliency of the remaining populations. Recently, considerable effort has been invested into physical solutions to improve the quality and quantity of spawning and rearing habitat (e.g., side channel creation and gravel augmentation). However, the river's thermal regime may indeed be a greater stressor on the salmonid populations. To support improved fisheries management, two predictive temperature models have been developed. The first is the iterative Cold Water Pool Management Model (iCPMM), which is an evolution and improvement of the previous version of the model. iCPMM includes Folsom Reservoir as well as the lower American River and allows for annual temperature planning of reservoir operations and subsequent conditions in the river. This model includes application of the automated temperature selection procedure (ATSP) which determines the lowest (i.e., coolest) temperature schedule that is achievable with the initial reservoir conditions and the anticipated release hydrograph for any given year. The ATSP provides a suite of monthly temperature target curves which attempt to balance the needs of rearing steelhead, as well as those of spawning Fall-run Chinook salmon. The second model is a hydrodynamic and water temperature model developed within the HEC-RAS modeling platform which is utilized at a sub-hourly time step. The model domain extends from the base of Nimbus Dam to the confluence with the Sacramento River. This model can be used to evaluate various potential management scenarios, with results that are ecologically significant (e.g., daily maximum temperatures as opposed to weekly or monthly averages) both temporally and spatially. These two models provide the opportunity to improve temperature conditions, and therefore inform fisheries management in the lower American River.

Bay-Delta Recovery Efforts for Anadromous Fisheries: Will the State of California Delta Plan and the Federal HCP – Bay Delta Conservation Plan (BDCP) Actually Lead to Recovery of Salmon and Steelhead in the Central Valley of California?

Dr. Mark Rockwell, *Co-Vice President of Conservation, Northern California Council, Federation of Fly Fishers and the Endangered Species Coalition*

After nearly a decade of anadromous fishery collapse in the Central Valley of California, there are significant efforts being made to both stabilize water reliability for 24 million Californians, and recover the Delta's ecosystem. Dr. Rockwell has been engaged in planning efforts for both the legislatively mandated Delta Plan and the continuing efforts on the BDCP to find ways to balance the needs for water between people and the environment. Both plans are for 50 or more years, so the decisions being made have far reaching implications. Dr. Rockwell will try to speak to what appears to be helpful for fisheries and what is not. Although both plans involve the Delta and its fish and wildlife, both are very different in their intent. BDCP, as a Habitat Conservation Plan (HCP) under the Endangered Species Act (ESA) has been requested by the state water agency (DWR) and their contractors, and as such, is focused on water needs for people. The Delta Plan has the legislative mandates of reduced reliance on the Delta, and achieving the co-equal goals of ecosystem recovery and water system reliability. Dr. Rockwell will attempt to communicate where we are with both plans, and what is needed to ensure success for our anadromous fisheries.

A New Era of Governance—In 2009 the Legislature Passed Historic Delta Legislation: Why? And Where Are We Now?

Tina Cannon Leahy, *Principal Consultant, Assembly Water, Parks & Wildlife Committee*

The Delta has suffered from multiple crises for years—ecosystem, water supply, levee stability, water quality, politicized policy, and litigation. In 2006, the Legislature and the Governor initiated "Delta Vision", a process that utilized a Blue-Ribbon Task Force to help develop cabinet-level recommendations for policy changes. On January 3, 2009, those recommendations were delivered and immediately thereafter the Legislature took up the mantle holding informational hearings from Delta experts, Task Force members, and the Schwarzenegger Administration, as well as the public at large, and engaging in vigorous water policy discussions throughout much of 2009. When the Legislature adjourned in the fall without reaching agreement on a final set of bills, then-Governor Arnold Schwarzenegger convened the 7th Extraordinary Session, which culminated in the signing of a historic five-bill package addressing pending Delta and water issues. One of the keystones of that package was SB 1 (Simitian), which reformed Delta policy and governance. Ms. Leahy will provide a short overview of the history leading up to the passage of SB 1, the requirements in the bill that changed the way we manage the Delta and where we are at today.

The State of Freshwater Flows in the Bay Delta: an Overview and Reality Check for Delta Planning Processes

Christina Swanson, PhD, *Science Director, Natural Resources Defense Council*

The amounts, timing and patterns of freshwater inflow to an estuary are key physical and ecological drivers that define the quality and quantity of estuarine habitat, promote productivity and influence the abundance, movements and life cycles of fish and wildlife. In the San Francisco Bay estuary and its upstream Delta region, freshwater inflows have been highly altered by dams, levees and water diversions: there is broad scientific agreement that this altered hydrograph is one of the principal stressors on the ecosystem and its fisheries resources. As part of the San Francisco Estuary Partnership's (SFEP) comprehensive State of the San Francisco Bay report, we developed a multi-metric Freshwater Inflow Index and Open Water Estuarine Habitat and Flood Events indicators to measure the condition and trends in freshwater inflow and associated habitat and ecological processes in the estuary. Results were evaluated relative to SFEP's Comprehensive Conservation and Management Plan goals and the State Water Resources Control Board's 2010 Delta Flow Criteria. Using data from 1930 through 2010, the indicators all showed a significant decline in conditions since the 1950s, with conditions worsening to consistently "poor" during the last few decades. In 2010, indicator values were at or near record lows for the 80-year period of record. Based on our scientific understanding of the estuary and how it has changed in the past century: 1) current water diversions from the ecosystem are ecologically unsustainable, and 2) improving freshwater inflow conditions to restore key elements of the natural hydrograph offers an important approach for restoring habitat and ecological processes. However, despite the legislatively mandated co-equal goals for ecosystem restoration and a reliable water supply, this essential conservation action is currently receiving little meaningful attention in the ongoing Delta planning processes.

An Overview of the Delta Stewardship Council's Delta Plan from the Lead Scientist's Perspective

Peter Goodwin, PhD, *Lead Scientist for the Delta Science Program*

Dr. Peter Goodwin, an internationally-recognized expert in ecohydraulics (the impact of management on aquatic ecosystems), ecosystem restoration, and enhancement of river, wetland and estuarine systems, is the new Lead Scientist for the Delta Science Program.

In making the two-year appointment, DSC Chair Phil Isenberg said, "With his broad understanding of water-related science and engineering, and his background as a former CALFED Independent Science Board member, Peter will provide crucial knowledge and scientific leadership for the Delta Stewardship Program and the Delta Plan."

"I look forward to helping build the scientific community and to search for the common truths on the many critical issues that face the Delta," Dr. Goodwin said. "The development of the Delta Plan is clearly a project of critical importance to California that is helping set standards of how science can inform the making of policy."Managing the Bay Delta for Water and Fish—An Overview and Update on the Bay-Delta Planning Processes and Future Implementation

Delta Stewardship Council Bay Delta Conservation Plan

Karla Nemeth, California Natural Resources Agency

The Bay Delta Conservation Plan (BDCP) is being prepared through a collaboration of state, federal, and local water agencies, state and federal fish agencies, environmental organizations, and other interested parties. These organizations have formed the BDCP Steering Committee. The plan will identify a set of water flow and habitat restoration actions to contribute to the recovery of endangered and sensitive species and their habitats in California's Sacramento-San Joaquin Delta. The goal of the BDCP is to provide for both species/habitat protection and improved reliability of water supplies. *www.baydeltaconservationplan.com*

An Overview of the Sacramento-San Joaquin Delta Conservancy and Our Efforts to Balance Ecosystem Restoration with Economic Development

Campbell Ingram, *Executive Officer, Sacramento-San Joaquin Delta Conservancy*

Campbell became the first Executive Officer of the Sacramento-San Joaquin Delta Conservancy in March of 2011. The Conservancy is tasked with being a lead agency for ecosystem restoration in the Delta and supporting efforts that advance environmental protection and the economic well-being of Delta residents. Nearing the completion of a strategic plan that will define the role of the Conservancy and our objectives for the next five to ten years, Campbell will provide an overview of the planning process and how the Conservancy expects to work with local communities to balance ecosystem restoration and economic development in the Delta and Suisun Marsh.

Using Radio Telemetry to Assess Steelhead Use of Thermal Refugia: Inferring Location from Temperature

Kim Brewitt (Presenter), *University of California, Santa Cruz;* ***Steve Lindley,*** *National Marine Fisheries Service;* ***Kirstin Holsman,*** *Northwest Fisheries Science Center; and* ***Eric Danner*** *and* ***Andrew Pike,*** *University of California, Santa Cruz and National Marine Fisheries Service*

Elevated river temperatures can decrease both the quantity and quality of available fish habitat; fish tagging studies are integral to assessing how populations are responding to these changes in habitat. Summer water temperatures on the Klamath River can reach levels that are physiologically stressful to endangered and threatened salmonids. At the limits of their thermal tolerance, salmonids may behaviorally thermoregulate by moving to localized patches of colder water, or thermal refugia. The presence of these refugia may be key to salmonid survival, especially during periods of elevated mainstem temperatures when refugia may be the only usable habitat available. However, while fish obtain thermal benefits by using refugia, potential trade-offs include lower food availability, decreased growth rates, and increased risk of disease due to high fish densities. This study focuses on defining the mechanisms driving juvenile steelhead (*Oncorhynchus mykiss*) thermal refugia use and the implications refugia use has for steelhead growth and survival. However, it is difficult to quantify fish use of thermal refugia because it is necessary to monitor very fine-scale movement patterns—movements of as little as 3m can significantly alter a fish's thermal experience. This fine-scale monitoring can be challenging in a riverine environment where traditional acoustic telemetry techniques do not work due to noise interference from riffles. To address this challenge, we combine radio telemetry (Lotek temperature transmitter tags) and large arrays of water temperature loggers set in thermal refugia. By correlating fish temperatures with simultaneous water temperatures, we are able to infer fish location based on temperature. This novel approach allows us to monitor how individual fish are utilizing different thermal environments throughout the day, and across seasons, which is key to understanding how factors such as diurnal water temperature variations and heterogeneous food availability impact salmonid growth and survival. To place this research in the context of the larger river, we will integrate these data with a bioenergetics model and NOAA Fisheries river temperature model.

Downstream Migration of Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*Oncorhynchus mykiss*) Smolts in the Highly Modified Lower Sacramento River, California

***David Zajanc (Presenter),** and **Sharon H. Kramer,** H. T. Harvey and Associates; **Nadav Nur,** PRBO Conservation Science; and **Peter A. Nelson,** Collaborative Fisheries Research West*

Using acoustic telemetry methods on large numbers of tagged fish, we studied how the downstream migration of Chinook salmon and steelhead smolts could be related to habitat features and spatial and temporal variables on a highly altered section of the Sacramento River. We viewed downstream migration as a process in which fish transition between moving and holding states, and used a two-component Generalized Linear Model for analysis. The two components represent two aspects of holding: 1) probability of holding, and 2) holding time. For both species, the probability of holding increased when a fish was released in the study area rather than upstream of it. For Chinook salmon, the probability of holding increased as wood cover and fine substrates increased; holding time increased as wood cover increased. For steelhead, the holding time increased as large (i.e., cobble/boulder) substrate and wood diversity increased. We found support for three research and management implications: 1) release location influences the probability of holding and holding time for both species, and hatchery releases could potentially be managed to increase holding in areas with typically greater survival; 2) downstream migratory behaviors of Chinook salmon and steelhead smolts differ and conclusions regarding one species cannot necessarily be applied to the other; and 3) certain qualities of habitat features, such as high density and diversity of large woody material, should be incorporated into bank rehabilitation projects to increase cover from predators and provide velocity refuge, improving holding habitat and likely improving survival during downstream migration.

Using Radio-Telemetry to Determine Seasonal Habitat Preferences of Brown Trout in a Moderate-Gradient Stream in the Eastern Sierra Nevada Mountains

Ross N. Taylor (Presenter), *Ross Taylor and Associates;* ***Ken N. Knudson,*** *KNK Aquatic Ecology; and* ***Bradley B. Shepard,*** *Wildlife Conservation Society*

The California State Water Resources Control Board (SWRCB) must balance how water is allocated to meet the needs of citizens and natural resources. In 1941, the Los Angeles Department of Water and Power (LADWP) completed the construction of infrastructure to store and export water from the Mono Basin, on the east side of the Sierra Nevada Mountains, to the City of Los Angeles. Over the next five decades, these water exports caused significant negative ecological changes to Mono Lake and its tributary streams. In 1998, the Water Board established preliminary instream flows in Mono Lake tributaries to promote the recovery of Mono Lake, the stream channels, and the non-native, but naturally reproducing, trout fisheries. We were appointed by the SWRCB to study these fisheries and evaluate the 1998 ordered flows and to recommend adjustments to these preliminary flows.

The fisheries monitoring program was initiated in 1999. The subsequent 12 years of annual monitoring during various runoff year-types have shown that the numbers, biomasses and condition factors of brown trout have fluctuated somewhat from year-to-year, but have generally been within the ranges found on other Eastern Sierra trout streams, as reported by CDFG. Habitat typing and pool-quality surveys demonstrated that brown trout habitat has steadily improved within Rush Creek, with large deep pools being much more common in 2008 compared to 1991 or even 2002. However, large brown trout (>350 mm), which during the SWRCB hearings were reported to be fairly common in Rush Creek prior to 1941, were rarely captured during electrofishing or observed during snorkeling, even after significantly more large, deep pools were present following high runoff years in 2005 and 2006.

To better evaluate the SWRCB's minimum base flows and stream restoration flows we needed to accurately measure the physical characteristics of microhabitats utilized by brown trout in the 1.6% gradient,13.5 km reach of lower Rush Creek between Grant Lake Reservoir (elevation 2174 m) and Mono Lake. Our objectives were to quantify and compare macrohabitat types (pool, riffle, or glide) and microhabitat characteristics (water depth, water velocity, and cover) that were preferred by three size classes of brown trout during spawning, winter, and "other" (May through mid-October) seasons in lower Rush Creek.

We used previous studies of habitat requirements for river-dwelling brown trout, which we subsequently confirmed for Rush Creek using underwater observations and radio-tagged fish relocations of brown trout, to develop habitat criteria. Between September 2005 and September 2007, small radio transmitters supplied by LOTEK Wireless were surgically implanted into the abdominal cavities of 92 wild, resident brown trout from three size classes; 18 juveniles (197 to 206 mm; 72 to 95 g); 20 adults (244 to 304 mm; 151 to 298 g); and 54 large adults (314 to 518 mm; 317 to 1728 g). From October 2005 through March of 2008, these radio-tagged fish were relocated on a near monthly basis. When the holding position of a relocated fish was firmly established, we determined the macrohabitat type and collected detailed microhabitat information.

The criteria for preferred habitats were deep (> 30 cm) water with slow velocities (< 21 cm/s). Since most slow velocity habitats and larger brown trout we observed were located in relatively close proximity to the streambed, velocities were measured 15 cm above the streambed. We also included availability of cover as a requirement for preferred winter habitat. The minimum area of trout holding habitat was set 1.1 m2. Using these criteria, an instream flow study was conducted in which we measured and directly mapped all habitats that met these criteria at five different flow releases (15, 30, 45, 60 and 90 cfs) in four representative sample reaches of Rush Creek and compared the proportions of these preferred habitats provided by these different flows.

Results of the direct habitat mapping indicated that lower flows generally provided more habitats for large brown trout, primarily because lower flows reduced water velocities in this moderate-gradient stream. The results of the Rush Creek instream flow study were integrated with a water temperature model and geomorphic studies to recommend annual flow regimes that would maintain ecological functions, including channel forming high flows, periodic riparian area inundation, and fish habitat (preferred depths, velocities, and temperatures) under different water availability scenarios.

Using Acoustic Telemetry to Determine Movements, Behavior, and Critical Spawning Habitat for Green Sturgeon in the Sacramento River

Michael J. Thomas (Presenter), *Research Associate,* ***Matthew L. Peterson, Alex R. Hearn,*** *and* ***A. Peter Klimley,*** *Biotelemetry Lab, Wildlife, Fish & Conservation, Biology, University of California, Davis*

The green sturgeon (*Acipenser medirostris*) is one of two acipenserid fishes native to the Central Valley. On April 7, 2006 the Southern DPS, which constitutes the spawning population of the Sacramento River, was listed as "threatened" under the Endangered Species Act (ESA). Recent interest in green sturgeon behavior, habitat preferences, and migratory path ways has led us to develop a series of telemetric and hydrologic studies to identify and describe potential aggregate and spawning locations. Over the past five field seasons we have tracked green sturgeon both actively and passively within the putative spawning grounds. Using this movement data as a basis for identifying fidelity to specific habitat units, we have now begun mapping and describing the physical and hydrologic characteristics of known spawning locations. These studies will provide new information about habitat preference, and the availability of preferred habitat within the Sacramento drainage.

Using Acoustic Telemetry to Identify Predator Habitat and Route Preference of Sub-adult Striped Bass in the San Francisco Estuary Watershed

Jennifer Hemmert, *California Department of Water Resources;*
and ***Cynthia LeDoux-Bloom****, University of California, Davis*

Striped bass (*Morone saxatilis*) are anadromous, iteroparous, long lived (>30 years) and prefer water temperatures > 60F. They were introduced to the San Francisco Estuary Watershed (SFEW) in 1879 from the U.S. Atlantic Coast. Sub-adult striped bass (< 2 year old) are thought to be the largest cohort in the SFEW, thus are speculated to have the greatest piscivorous predatory impact in the SFEW. Both the sub-adult striped bass and juvenile Chinook population have declined over the past 40 years when gut content analyses indicated high predation rates by striped bass on juvenile Chinook in the spring and early summer. However, sub-adult striped bass behavior is poorly understood. Understanding sub-adult striped bass habitat preference and their preferred migration routes could guide the design of restoration projects that provide unfavorable habitat conditions for striped bass.

Sub-adult striped bass (n=100) had transmitters implanted into their inter-peritoneal cavity during the summer of 2010 and were tracked for 14 months via the >400 receivers operated by the California Fish Tracking Consortium. Data were temporally and spatially analyzed to determine behavior, habitat preferences and migratory routes through the SFEW. Trawl, seine, and hatchery releases were associated with known sub-adult striped bass presence. These studies provide information on movement, timing, and migration of sub-adult striped bass may aid in the recovery planning of threatened species such as juvenile Chinook salmonids.

Using Two-Dimensional Acoustic Telemetry along with Modeling Tools to Evaluate Fish Response to Habitat Features for Evaluating Project Design Alternatives

Brian M. Mulvey (Presenter), *U. S. Army Corps of Engineers;* ***David L. Smith****, U.S. Army Corps of Engineers Research and Development Center; and* ***Phil Sandstrom*** *and* ***Robert R. Abbott,*** *Environ*

The Sacramento River Bank Protection Project was authorized to protect more than 1700 kilometers of levees and flood control facilities. A key component of the levee repair work is the incorporation of environmental features that restore riparian and fish habitat function. Presently, the primary tool for planning the incorporation of these features is the Standard Assessment Methodology (SAM). SAM uses a combination of field data, riparian and geomorphologic models to assess proposed project impacts and benefits, but there still remains uncertainty regarding the function and value of the incorporated features for benefiting the target fish species.

To improve the assessment ability of SAM and better understand the benefits of the constructed habitat features and alternative planning objectives, we are collecting two-dimensional fish movement data using acoustic tags and developing models supporting the use of Eularian Lagrangian Agent Method (ELAM). The fish movement tracking data is used to calibrate and validate ELAM output, which can be used to model generalized results to produce site-specific habitat suitability curves that can be incorporated into the SAM and improve assessment and forecasting capabilities. The combination of the SAM with ELAM is a promising approach that could improve the planning and execution of ecological restoration projects.

Two-dimensional tracking presents some significant challenges, especially in a large river system with dynamic flows. To achieve successful two-dimensional results, our studies required the development of new tools and adaptive planning to respond to the changing system.

Southern California Steelhead Recovery Plan

Mark H. Capelli, ***South-Central/Southern California Steelhead Recovery Coordinator, National Marine Fisheries Service***

In 1997 the National Marine Fisheries Services (NOAA Fisheries) listed a Distinct Population Segment (DPS) of steelhead (*Oncorhynchus mykiss*) within southern California, from the Santa Maria River to Malibu Creek, as endangered. In 2002 a range extension of the Southern California Steelhead DPS was extended to the U.S.–Mexico border.

NOAA Fisheries Science Center and a Technical Recovery Team has characterized the historic populations of steelhead and developed viability criteria for the recovery of this DPS. The TRT developed several basic findings regarding the nature of the southern California populations of native *O. mykiss*: 1) pre-historic distribution of *O. mykiss* was widespread throughout the coastal drainages; 2) current distribution of *O. mykiss* is still wide spread (with the anadromous forms the most constricted); 3) anadromous runs of *O. mykiss* have been eliminated or depressed in about one-third of the historically occupied watersheds; 4) remaining occupied watersheds exhibit extremely depressed anadromous *O. mykiss* populations; *O. mykiss* above artificial barriers are most closely related to below barrier populations of *O. mykiss*; *O. mykiss* above artificial barriers are residualized decedents of anadromous *O. mykiss* runs, not planted, hatchery reared *O. mykiss*; 5) *O. mykiss* above artificial barriers are an integral component of the anadromous *O. mykiss* populations; and 6) *O. mykiss* populations above artificial barriers have the potential to resume an anadromous life cycle. Population and DPS viability criteria must address issues such as specific mean annual run size of individual populations; ocean cycles affecting marine survival and growth; spawner density; the anadromous and non-anadromous fraction of an *O. mykiss* population complex; the number of populations per biogeographic group; protection of drought refugia; geographic separation of populations within biogeographic regions; and preservation of life-history diversity (fluvial anadromous, freshwater resident, lagoon anadromous).

NMFS Technical Recovery Team for Southern steelhead has divided the Southern California Steelhead DPSs into five Biogeographic Population Groups, characterized by a distinguishing suite of physical, climatic and hydrologic features. Recovery of the Southern California Steelhead DPSs will require the restoration of a minimum number of populations within each of the five Biogeographic Population Groups. The core watersheds identified in this biological strategy are geographically dispersed across the recovery planning area (extending from the Santa Maria River to the U.S.-Mexico Border) to preserve the existing diversity of life-history forms (ranging from anadromous to resident) and their evolutionary trajectories. Additionally this biological strategy is intended to minimize the likelihood of extirpation of individual populations within each Biogeographic Population Group as a result of natural perturbations (ranging from periodic drought and wildfires to longer range climatic changes), and preserve the potential natural dispersal of fishes between watersheds.

The Recovery Plan for the Southern California Steelhead DPS identifies a series of recovery actions intended to address the threats currently facing the species, as well as future threats posed by climate changes, and related habitat transformations. The two most prominent threats are restriction of access to upstream spawning and rearing habitats as a result of physical blockages (dams, road crossings, etc.), and the modification of the natural seasonal pattern of flows necessary to support migration, spawning, and rearing during the freshwater phase of the *O. mykiss* life cycle. Loss of estuarine habitats and periodic poor ocean conditions also contribute to the decrease in the productivity of *O. mykiss*.

A long-term research and monitoring program is proposed to address a number of key issues and uncertainties (such as the relationship between anadromous and resident forms, inter-basinal dispersal rates, spawning density, etc.) and refine the population and DPS viability criteria developed by the TRT.

Steelhead recovery in Southern California will take place in a landscape which has been highly modified, and currently occupied by over 22 million people. Recovery will require re-integrating the listed sub-populations back into habitats in a manner which allows the co-occupancy of watersheds by both fish and people.

Restoration Opportunities Spurred by Steelhead Recovery in Southern California

Wendy Katagi (Presenter), *CDM, Inc.;* ***George Sutherland,*** *Trout Unlimited;* *and* ***Theodore Johnson*** *and* ***Brian Murphy,*** *CDM, Inc.*

Urban pressures and demands continue to strain resources of southern California's rivers, creeks, and estuaries. What can be done to improve watershed health? This session will look at how recovery of federally endangered Southern Steelhead Trout (*Oncoryhnchus mykiss irideus*) are spurring ecosystem restoration opportunities in southern California through integrated watershed approaches.

The State of California is implementing Integrated Regional Water Management statewide encouraging regional and watershed-based solutions to water shortages, impaired water quality, and degraded ecosystems. Concurrent with this statewide initiative is the National Marine Fisheries Service's program to recover endangered steelhead trout in southern California. Recovery of this target species focuses on identifying limiting factors to recovery and designing, engineering, and constructing improvements to streams and estuaries to provide suitable habitat for steelhead. Since steelhead habitat support multiple species and healthier ecosystems, southern California water managers and watershed leaders are discovering the benefits of working together to solve tough water and land management issues. Critical watersheds span the entire southern California coast from Santa Barbara to San Diego counties.

Framing Climate Change for Steelhead Recovery and River Restoration

David Boughton, PhD, *NOAA Fisheries*

For the foreseeable future, steelhead recovery must occur in an era of both rapid, accelerating climate change, and rapid human adaptation to climate change. This implies that the steelhead of the future will inhabit new kinds of river systems, an outcome of natural, cultural, and climatic processes that are now rapidly changing in novel and complex ways. One key to moving forward with river restoration and steelhead recovery is to frame this context as usefully as possible, to avoid confusing the risks and opportunities presented by climate change. Here I outline some general principles: 1) Reframe concepts to be explicitly forward-looking. 2) Anticipate the self-adjustment of fluvial systems to climate change, and put it to good use as a form of creative natural-capital. 3) Work to integrate the natural, technological, and social capital of fluvial systems into a single, robust system of habitats and hydrological services. 4) Look for points of leverage in natural fluvial processes, where the evolutionary trajectory of river systems can be influenced by relatively modest human efforts. 5) Identify robust strategies for river rehabilitation and steelhead recovery that perform well across the range of plausible futures predicted by climate models.

Population Trends of Southern Steelhead as They Relate to Restoration Project Completion and Environmental Variables on the Lower Santa Ynez River

Timothy Robinson (Presenter), Scott B. Engblom** and **Scott J. Volan,
Cachuma Project Water Agencies

The fisheries monitoring program and habitat enhancement effort initiated by the Cachuma Project Water Agencies on the Lower Santa Ynez River (LSYR) in Santa Barbara County have resulted in a modest increase in smolt production and returning adult southern steelhead (*Oncorhynchus mykiss*) over the past decade. Migrant trapping, snorkel surveys, and redd surveys are used to assess both the transient and over-summering population of fish within the LSYR basin. The data are also used as performance evaluation metrics for completed restoration projects. Enhancement projects are likely contributing to an overall increase in steelhead populations and subsequent observations, but other variables such as flow management, water year type, and monitoring effort can be used as a metric to determine if the population is responding to anthropogenic influences, natural cycles, or both. One of the key questions is the variation in annual population in the variable and flashy runoff regimes of Southern California, and the ultimate response of fish populations to watershed restoration efforts. In addition, managed flows from Cachuma Dam including year-round target flows and passage supplementation releases are also creating favorable conditions for a population response. A multivariate analysis was conducted to tease out relationships between the population response correlates of annual trapping and snorkel survey data to annual rainfall, flow, catch-per unit effort, number of restoration projects completed, among others over the duration of the monitoring program. The results are being used to help guide annual monitoring efforts and future research objectives.

Influence of Geology and Implications for Salmonid Habitat and Restoration: A Case Study on Sediment Loads and Bed Conditions from Two Adjacent Watersheds in the Santa Cruz Mountains, California

Brian Hastings (Presenter), *Geomorphologist, and* ***Shawn Chartrand,*** *Principal Geomorphologist, Balance Hydrologics*

Coastal Santa Cruz County, California is the southernmost range of Central Coast coho salmon, a species listed as endangered and on the verge of extinction; while Central Coast steelhead are listed as threatened and not much better off. As a result, there are many ongoing projects to improve and enhance salmonid habitat and extend their existing habitat south of the San Francisco Bay. However, it is not uncommon to find that some projects have gone forward without consideration of sediment load, and its potential impacts to successfully restoring or sustaining both spawning and rearing habitat for salmonids. In explicit acknowledgement for the soundness of process-based restoration science, we offer a case study documenting how two adjacent small coastal streams are characterized by significantly different sediment production processes, and resulting sediment loads and bed conditions. As a result, restorative or enhancement approaches in each basin must absolutely be tailored to their underlying nature. We suppose that given the highly complex geology of the west coast of North America, we believe that the case study watersheds serve as a touchstone to all as to the importance for explicit recognition of sediment loads in the restoration practice.

Total annual sediment loads were measured from two, adjacent coastal watersheds (Laguna and Majors Creeks) in the Santa Cruz Mountains over a four-year period (water years 2008-2011) representing varying year types (dry, average and wet). Regardless of year type, Majors Creek exhibited between 5 and 7 times more annual sediment load (per square mile and per acre-feet) when compared to Laguna Creek. Coincident with these measurements we evaluated bed conditions after major runoff events and found that sediment loads significantly reduced available pool and riffle habitat in Majors Creek relative to Laguna Creek. Both watersheds are characterized by similar climate, vegetation, elevations, slope, historical and current land-uses, but differ markedly in geology. Laguna Creek drains a 3.12 square mile watershed underlain, dominantly, by Cretaceous-aged igneous/metamorphic rocks. Conversely, Majors Creek drains a 3.78 square mile watershed underlain mostly by Tertiary-aged (Miocene), marine sedimentary rocks. Extensive landslides and bank failures have been mapped throughout the Santa Cruz Mountains and are typically associated with these marine sedimentary rocks. Historically, coho have been documented in Laguna creek, but largely absent in Majors Creek—where some argue restoration efforts should be targeted. We hypothesize that Majors Creek high sediment load (relative to Laguna Creek) is linked to its underlying geology and may have been and continues to be a significant limiting factor for sustaining salmonid spawning and rearing habitat. An understanding of sediment loads may be a critical first step when evaluating or prioritizing opportunities for salmonid habitat restoration along the west coast of North America.

Using DIDSON to Provide Adult Steelhead Escapement Estimates in a Small Coastal Drainage of Central California

Kerrie Pipal (Presenter), Jeremy Notch, Sean Hayes, *and* ***Peter Adams,*** *NOAA National Marine Fisheries Service Southwest Fisheries Science Center—Fisheries Ecology Division*

Steelhead (*Oncorhynchus mykiss*) in central and southern California are listed as Threatened and Endangered under the Endangered Species Act. Obtaining escapement estimates is critical for measuring progress of recovery planning. However, monitoring these fish presents difficult challenges since their abundances are so low that a complete census of these populations is needed. Dual-frequency identification sonar (DIDSON) is a promising new technology that could potentially be used to monitor steelhead runs in California streams and rivers under highly variable environmental conditions. DIDSON produces high-quality images in turbid water, which allows for detection and enumeration of fish, as well as estimation of fish size and swimming direction. We tested the feasibility of using DIDSON to estimate steelhead escapement in a low abundance setting in Scott Creek, a small coastal watershed in central California. We deployed the DIDSON in Scott Creek over three steelhead run seasons from 2008-2010 and compared the results to those from a floating resistance-style weir located 200 m downstream. The DIDSON estimates (153, 57, and 84) were approximately two to three times those from the weir (50, 23, and 40). The differences may have been due to differences in operation time, as the DIDSON remained operational during periods of high flow when fish were migrating and the weir was over-topped, allowing fish to pass through undetected. Our DIDSON sampling has also shown that steelhead behavior in the stream is fairly complex. Issues with fish behavior (i.e., milling) made image analysis difficult, especially later in the spawning season as small numbers of spawners were still heading upstream and large numbers of kelts were traveling downstream. Species differentiation can also be problematic when using DIDSON for this type of monitoring if species of similar body morphology or size are present over the same time period as the target species. The main advantages to using DIDSON for monitoring listed fish are that fish passage is not impeded and fish do not need to be handled to be enumerated. Our results indicate that DIDSON can be a useful tool in providing escapement estimates for steelhead in low abundance situations.

The Beneficial and Harmful Effects of the Pescadero Intermittent Estuary-marsh Ecosystem

***Eric R. Huber (Presenter)** and **Stephanie M. Carlson,** University of California, Berkeley*

Over 90% of California's coastal wetlands have been destroyed and only one third of the remaining area occurs outside the San Francisco Bay. The Pescadero estuary-marsh ecosystem in San Mateo County, itself, comprises 16% of the remaining coastal wetland habitat in California's Central Coastal region. It contains approximately 180 bird, 50 mammal 33 amphibian, and 22 fish species including three endangered species (red-legged frog, San Francisco garter snake, tidewater goby) and one threatened species (steelhead trout). Like most of California's estuaries, it is marked by seasonal closure at its mouth by a sandbar which leads to the formation of a closed lagoon. Here we review what is known about the quality of the Pescadero intermittent estuary as rearing habitat for juvenile salmonids and report the results of our recent preliminary sampling and ideas for future directions.

Previous work in this system has shown that the lagoon can be good or bad quality habitat for steelhead smolts, depending on the state of the system. During the open marine-dominated state, secondary production rates of Peracarid crustaceans (preferred trout prey items) are very high leading to excellent apparent steelhead growth rates (Smith 1990, Robinson 1993, Martin 1995). During the closed brackish state, trout apparent growth rates are very good due to the availability of both the euryhaline crustaceans and freshwater insects (Smith 1990, Robinson 1993, Martin 1995). However, an acute fish and invertebrate kill has been observed to occur at the time of lagoon breach in 12 out of the last 16 years, including every year since 2000, indicating that the Pescadero lagoon can, at times, be harmful habitat for steelhead and other organisms.

Beginning in July 2011, we have seined multiple locations within the estuary at monthly intervals. These data accord with previous results and suggest the Pescadero intermittent estuary can provide beneficial habitat for steelhead trout, as captured smolts were relatively large and exhibited strong apparent growth rates over the summer. We will discuss future research directions, purported reasons for the kill, and different management options currently being considered.

Bowling for Coho, Restoration of Large Wood Habitat and Floodplain Activation on Straightened, Homogenous Reaches of San Vicente Creek in Davenport, CA

Denis Ruttenberg (Presenter), *Stream Engineer, Natural Resources Conservation Service, and* ***Jim Robins,*** *IWRP Project Coordinator, Resource Conservation District of Santa Cruz County*

In the summer of 2011, after many years of planning and collaborative effort across state, local, and federal resources agencies, the RCDSCC and the NRCS successfully installed nine innovative large wood log structures along two reaches of San Vicente Creek in Davenport, California. This project represents a successful collaboration between the Resource Conservation District of Santa Cruz County (RCD SCC), the NRCS, NMFS, the NOAA Restoration Center, and CDFG to implement a key recovery action for the imperiled Central California Coast Coho salmon (*Oncorhynchus kisutch*). This project is considered to be the first true large wood placement project in Santa Cruz County for salmonid habitat and the first LWD project along this stretch of coast in nearly 20 years. Resource agencies have identified that San Vicente Creek provides a unique opportunity to "test" the recovery strategies described in the Federal Recovery Plan, due to a number of key factors including: (a) the lack of a lagoon and sandbar, facilitating year round ocean-stream access; (b) unusually good water conditions with high summer base flows and cool summer temperatures resulting from Karst geology and limited diversions; (c) proximity to the larger Scott Creek watershed; and (d) recent successful implementations of alcove, pond, and backwater restoration. San Vicente is near the southern extent of habitat for endangered CCC Coho salmon and is planned as a recipient for planting of Coho from the nearby Monterey Bay Salmon and Trout broodstock program. The project reaches are located between the two restored backwater alcoves. The stream bed resembles a "bowling alley" with straightened reaches of uniform bed material that creates high velocities and minimizes wood cover and pools, adverse habitat conditions for young coho and steelhead. The current bedform and floodplain appears to be a result of history human management including "push-up" dams, extensive in-channel livestock use, and vegetation clearing. By installing and anchoring large wood, the project will create local scour pools, create cover for salmonids, sort bed material, trap volunteer wood, and activate the low flood plain through deflection and channel obstruction. The project was collaboratively developed and designed through the Integrated Watershed Restoration Program (IWRP) with significant input from NMFS and DFG fisheries biologists. During construction, the NRCS design engineer and the SCC RCD staff worked closely with the contractor to optimize wood placement and anchoring, while minimizing impacts to the riparian corridor. Permitting was facilitated through a Permit Coordination program brokered by the RCD SCC. The site will be monitored intensively by the RCD SCC and NOAA's Southwest Fisheries Science Center for five and ten years, respectively. We hope for strikes, spares, and splits in the creek bed.

A Boulder and Log Moment Stability Analysis Toolkit for Channel Restoration and Design Elements

Mark Strudley, Balance Hydrologics

It should come as no surprise that large woody debris and boulders in natural channel settings have long been recognized as elements that afford local or reach-scale geomorphic stability. Because of this recognition, combined with applauded encouragement by resource agencies to both retain and utilize large channel-stabilizing habitat elements in channel repair or restoration activities, increasing importance has been placed on effective use of wood and boulders in geomorphic design work. Yet very little is known about hydraulic movement thresholds of wood in rivers. Additionally, a rigorous quantitative analysis of large-clast stability for boulder placement in channels is rarely applied because simple, accurate, and effective toolkits of this nature are generally not available to consultants and other practitioners of river science and rehabilitation.

Here I present a simple toolkit useful for analyzing the moment stability of boulders and logs under high flow events. The model performs a force balance of the pertinent forces acting on a boulder or log about a point (or center) of rotation defined by the downstream-most point of contact between the boulder or log and the stream bed. Alternatively, the point of rotation can be defined as a downstream pivot point for a boulder resting on other boulders, as in the placement of rip rap. Using simple but fair assumptions that still allow faithful representation of moment stability for bodies resting in cohesionless and undeformable materials, conservative calculations of stability can be performed with relative ease using a simple spreadsheet tool. The tool has been successfully applied to various geomorphic settings and for various problems, including log placement for bank stability in coastal montane streams, and for boulder stability in step-pool channels for the Carmel River re-route at the San Clemente Dam removal. The tool is especially important in showcasing somewhat counter-intuitive results that back-of-the-envelope calculations would miss. For example, in one case study, the critical burial depth required for a boulder increased for increasing drag force (impinging velocity), but was insensitive to boulder mass.

Further model refinement may include representation of suction force, the effect of underlying sediment deformation, and the incorporation of more complex shape representations for logs (to include changes in orientation relative to streamlines and to include root masses). More dynamic modeling of boulder and log stability could easily follow this initial work, resulting in more comprehensive predictive tools to be used for log and boulder transport through reaches rather than incipient instability at a discrete location.

Can Eleven Years of Coho Salmon Adult, Parr, and Smolt Abundance Data Help Guide Restoration Planning, Monitoring, and Evaluation?

Sean P. Gallagher (Presenter), California Department of Fish and Game
and David W. Wright, Campbell Timberlands Management

We evaluated an eleven-year (2001 to 2012) coho salmon adult, parr, and smolt abundance data set from three census watersheds in coastal Mendocino County, California to determine how this information can provide a scientific basis for directing life stage specific stream restoration activities. The three census watersheds: Caspar Creek, the South Fork Noyo River, and Pudding Creek, called Life Cycle Monitoring Streams (LCS), are part of the California Coastal Salmonid Monitoring Plan. These LCS streams are places where we estimate adult, parr, and smolt abundance; make connections between life stage abundance and abiotic factors; and serve as focal points to foster additional watershed and salmon research. Adult and smolt abundance was estimated using capture-recapture methods where fish were marked with either batch marks or individual identifiers and we estimated parr abundance with depletion sampling. Since 2006, we have applied PIT tags to all parr and smolts > 70mm and used this data to estimate abundance, growth, and survival. We used these data to calculate marine and freshwater survival, estimate carrying capacity of the three streams, and investigate the relationship between survival and abiotic factors (stream flow, turbidity, and temperature). We present the findings of this analysis and our results in relation to habitat census evaluations conducted following the Columbia Habitat Monitoring Program's scientific protocols during summer 2011. Finally, we relate our findings to specific potential population limiting habitat factors and discuss how the set of LCS streams provide an ideal setting for a BACI experiment for scientifically determining the efficacy of future habitat enhancements.

Restoration of a Small Southern California Coastal Creek and its Potential for Improved Habitat and Southern Steelhead Population Recovery

Rosi Dagit (Presenter), *and* ***Jenna Krug,*** *Resource Conservation District of the Santa Monica Mountains*

Despite their endangered status and ongoing challenges from urbanization, few studies have been completed on the feeding habits and life history of southern steelhead trout (*Oncorhynchus mykiss*). The O. mykiss population in Topanga Creek, California has been monitored for over ten years. Topanga Creek drains a 47-km2 watershed and is the third largest watershed in the Santa Monica Bay. *O. mykiss* are found to occur within a six km reach stretching from the ocean to the town. In this talk, we will review the restoration of the Rodeo Grounds Road Berm in Lower Topanga Creek and how it has impacted fish passage opportunities, habitat availability, and southern steelhead recovery. We will also touch on the potential future restoration of the Topanga Lagoon and how this might influence the recovery of the *O. mykiss* population in Topanga Creek.

In 1969, the Rodeo Grounds Road Berm, 1000 feet long and 40 to 100 feet wide, was built directly in the channel of Topanga Creek to protect rental homes built in the floodplain. The berm was augmented several times with asphalt and fill materials from various road-building projects. After the property was purchased by the California Department of Parks and Recreation in 2001, a multi-agency partnership convened to fund and implement a berm removal and creek restoration project. Planning for the project began in 2001 and most of the on-the-ground restoration activities took place from 2005 to 2009. Berm removal resulted in 3000 linear feet of connectivity critical for migrating steelhead trout, as well as invasive species removal and establishment of native wetland and riparian communities on over 12 acres of floodplain.

Natural re-alignment of the creek channel in response to storm events, re-adjustment of the channel bed as accumulated sediments are naturally entrained, and natural recruitment of riparian species have occurred since the restoration took place. Volunteer seedlings of mulefat (*Baccharis salicifolia*), giant rye (*Leymus condensatus*), and sycamores are abundant. When enough precipitation permits, the channel through the Berm area is fully connected to the ocean. Post-restoration snorkel surveys revealed trout ranging from five to eight inches using newly formed pools in the restored channel.

Restoration is supporting evolution of a more natural creek channel, floodplain and hydrology. Restored above surface creek flow provides additional summer rearing habitat, as well as improved over-winter habitat and critical passage links for endangered southern steelhead trout between the upper watershed of Topanga Creek and the ocean.

2D Hydrodynamic Modeling in the Yolo Bypass to Support Habitat Evaluation

***Chris Campbell (Presenter), April Sawyer** and **Chris Bowles**, cbec, inc.;*
***Marianne Kirkland,** DWR-Division of Environmental Services;*
*and **Ted Sommer,** DWR-Aquatic Ecology Section*

The Yolo Bypass is a major seasonal floodplain in the Central Valley and the Delta that provides rearing habitat and serves as a migratory pathway for juvenile Chinook salmon and splittail. In support of the Central Valley Flood Protection Plan (CVFPP) Restoration Opportunity Assessment (ROA), two-dimensional (2D) hydrodynamic modeling is being performed using MIKE 21 FM to predict seasonal inundation patterns in the Yolo Bypass under a range of flows to understand habitat conditions for juvenile Chinook salmon and splittail. Prior habitat use studies in the Yolo Bypass (e.g., Sommer et. al., 2005) have shown the importance of sustained inundation in the Yolo Bypass, resulting in increased fish residence time. However, the hydrology of the Yolo Bypass is complex with inundation possible from multiple sources with varying degrees of alteration and timing. As such, the aim of this analysis is to investigate habitat evaluation criteria in the Yolo Bypass under a range of flow conditions and in years when spatial and temporal trends in juvenile Chinook salmon use were monitored. Historical hydrology for two high performing years and two low-performing years for juvenile Chinook salmon and splittail will be simulated and used to test and/or improve existing habitat evaluation criteria and identify differences in high and low performing years.

Application of Width Variation in Floodplain Design

Jason White (Presenter) and Andy Collison, ESA PWA

As river restoration design engineers, we are frequently presented with systems confined by land use practices. Levees that provide flood control, incised channels due to increased runoff and decreased sediment supply, mining tailings from historic gold mining, to name a few, have all been observed in our practice to confine rivers. Often these rivers lack the qualities to promote a thriving fluvial ecosystem. These systems become armored, homogeneous channels that lack the desired morphologic units and winter flow refugia to sustain anadromous fisheries. We are challenged to improve these conditions through in-channel and floodplain restoration designs that are sustainable and work within constraints such flood control and land ownership. In natural systems, point bars, meander bends, boulders, large wood, and canyon walls have all been observed to be associated with channel heterogeneity. Studies have implied that channel bedform and substrate heterogeneity is a result of the variable flow hydraulics created by these features. Flume and synthetic studies have demonstrated the hydraulic mechanism causing varying bedforms. Recent research, on the confined gravel-bed Yuba River upstream of Parks Bar, directly tested the question of varying confining width controls on bedform. This research demonstrated that variable confinement can be linked to morphological-scale heterogeneity. Further research on this reach demonstrated the mechanism behind this linkage as being varying flow hydraulics due to the varying flow confinement at different stages. We believe this research has practical application in confined systems. Through the utilization of variable confinement width, it is possible to vary hydraulics, which in turn could vary sediment transport and channel morphodynamics. Varying confinement also creates the needed space to create floodplain benches that provide winter flow refugia, critical to a viable anadromous population. By utilizing the natural process of varying flow hydraulics, we believe this approach has the potential for high sustainability. We have applied this principle on the leveed, incised Napa River, and intend to apply this on Feather River and West Weaver Creek, both systems confined by hydraulic mine debris. Hydraulic modeling results of the Napa project are good, with the promise of improved application in future projects through iterative hydraulic modeling and design.

Hypothesis Driven Ecohydraulic Channel and Floodplain Design: Merced River, CA

Rocko Brown (Presenter), *ESA PWA and University of California, Davis;* ***Joseph Merz*** *and* ***Clark Watry,*** *Cramer Fish Sciences; and* ***Michelle Workman,*** *U. S. Fish and Wildlife Service and AFRP*

The Merced River in California has been severely impacted through gold dredging in the early 19th century. Typical of many California Rivers below dams, the channel is a physically monotonous and low energy environment that is poor habitat for native fish species, especially salmonids. Looking to the future, stakeholders seek to restore and enhance the altered river corridor for salmonid species through floodplain excavation of tailings and in-channel placement of excavated coarse sediment. The success of rehabilitation actions on physical environments, however, is highly dependent on society's ability to incorporate past lessons learned and allow future generations to do the same. Hypothesis driven design frameworks allow society to frame physical manipulation of the natural environment in a truly scientific fashion, hopefully facilitating objective decision making on our most valuable natural resources now and into the future. For this project, a hypothesis driven framework was utilized in conjunction with cutting edge design techniques for joint channel and floodplain rehabilitation. Post dam hydrology was assessed using ecological criteria related to the magnitude, frequency, and duration needed for defined functions related to the life history of target salmon. Notably, riffle-pool units were designed with the concept of both velocity reversals and flow convergence. This talk will highlight how a hypothesis-driven design phase, with emergent concepts from ecohydrology and riffle-pool sustainability, was implemented and what initial physical monitoring has revealed to date.

Trials and Tribulations: The Rocky Road of Restoration Implementation, A Case Study

*J.D. Wikert (Presenter), U. S. Fish and Wildlife Service;
and Jesse Anderson and Clark Watry, Cramer Fish Sciences*

While obtaining funding to accomplish restoration can be daunting, project implementation can provide an even more difficult challenge. We will discuss the trials and tribulations associated with successful implementation of a small scale side-channel restoration project on private property to restore salmonid rearing habitat on the Stanislaus River, CA. Project hurdles included recalcitrant permitting agencies, hostile local residents, property foreclosures, and a full reservoir.

Restoring Floodplain Processes on the Sacramento River and Deer Creek, Tehama County, CA: Hyporheic Flow and Sediment Transport Implications of Enhanced River Corridor Complexity Associated with Restored Floodplain Connectivity

Mark Tompkins (Presenter), Paul Frank, Anthony Falzone, and Jeremy Thomas, NewFields

Many of the rivers draining California's Central Valley have been disconnected from their floodplains by levees. This has resulted in elimination or degradation of natural processes that create and maintain dynamic river environments. Two important impacts of floodplain disconnection are reduced in-channel complexity and associated hyporheic exchange potential, as we found in lower Deer Creek near Vina, CA, and altered sediment transport dynamics, as we evaluated on the Sacramento River near Red Bluff, CA. On lower Deer Creek, we deployed a network of surface and subsurface water temperature loggers to measure effects of hyporheic exchange on diurnal water temperature fluctuations at sites of varying topographic relief in lower Deer Creek. Comparing hourly temperature of upwelling hyporheic water with downwelling surface water we observed up to 7.19°C reduction in amplitude of daily temperature fluctuation, up to 3.5°C reduction in daily peak temperature, and lag times between downwelling and upwelling peaks of up to 19 hours, all of which were strongly correlated with elevation difference between downwelling and upwelling sites. On the Sacramento River, we conducted historical geomorphic analyses, developed bedload and suspended sediment transport rating curves based on sampling at a range of high flows, and conducted 2-D hydraulic and sediment transport modeling in support of the design for a mitigation habitat site in East Sand Slough adjacent to the Sacramento River being implemented as part of the Red Bluff Diversion Dam Fish Passage Improvement Project. Our proposed mitigation design included enhancement of two existing inlets between the slough and the Sacramento River to connect them and provide aquatic and riparian habitat at lower flows. Our 2-D modeling, sediment transport sampling, and pre- and post-peak flow geomorphic investigations of East Sand Slough provided validated predictions about sediment transport dynamics and patterns of erosion and deposition likely with the enhanced connection between the river and the slough and the permanent removal of the Red Bluff Diversion dam gates.

Colonization and Assemblage Structure of Aquatic Invertebrates in Seasonal Floodplain Habitat of the Lower American River, California, USA

Steven Zeug (Presenter), Ben Rook, Clark Watry, *and* ***Joe Merz,*** *Cramer Fish Sciences*

The importance of periodic floodplain inundation to the productivity of lowland rivers is well recognized. However, translating the general framework of conceptual models into flow management and restoration actions is complicated by a lack of quantitative information on the spatiotemporal scale of biotic responses to flooding. During spring 2010, we surveyed benthic macroinvertebrates at the leading edge of rising water associated with habitat enhancement on the Lower American River, California. Stations continued to be surveyed bi-weekly to obtain samples at a variety of inundation durations and to track assemblage dynamics through time. Our study goal was to examine species relative abundance and the trajectory of invertebrate density and biomass in newly inundated habitats. We discuss these results in the context of designing restoration flows and habitat inundation to benefit anadromous salmonids and recommend future research directions.

Realistic Expectations for Hatchery-mediated Recovery: Can Hatcheries Help Us Restore Salmonid Populations?

Michael K. Lacy, *California Department of Fish and Game*

Hatcheries are increasingly called upon to aid in recovery of listed stocks of salmon and steelhead. Although traditional hatcheries have been used for decades to supplement salmonid populations, declines have continued, in some cases to alarmingly low levels. This talk will explore what hatcheries can realistically be expected to do in aid of recovery. Hatcheries can demonstrably increase local abundance and in many cases may be able to preserve genetic diversity, at least over short time scales. However, there is less certainty about whether hatcheries can preserve genetic diversity over the long-term, or improve prospects for long term viability. Effective programs will incorporate conservation elements that typically require modification of facilities and operations, increased staff training, and extensive in-hatchery and in-river monitoring. Good quality habitat in sufficient amounts is essential for optimal positive hatchery impact on recovery. Predictive methods can be used to explore the potential for using artificial propagation techniques to restore a declining or extirpated population.

Background and Recent Information on the Livingston Stone National Fish Hatchery's Role in Assisting in the Recovery of Endangered Winter Chinook Salmon in the Sacramento River

Laura J. Mahoney, *U. S. Fish and Wildlife Service*

Winter Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River were listed under the Endangered Species Act as threatened in 1989 as a result of a severe decline in population abundance. The listing was downgraded to endangered in 1994 when abundance was estimated at 184 adults. Since 1991, in response to the declining population of winter Chinook salmon, a hatchery propagation program has been operated at the Livingston Stone National Fish Hatchery to augment natural spawning in the Sacramento River and assist in population recovery and delisting. The Winter Chinook propagation program operates under strict guidelines intended to reduce negative effects that have been associated with historical salmon hatchery propagation programs, while increasing the abundance of the natural spawning population. In this presentation, we will discuss the operational guidelines that have been established for this program, as well as, the metrics that have been used to evaluate the program.

Fin Clips: Implementation of Parentage Based Tagging at the Feather River Hatchery, CA

Anthony J. Clemento, National Marine Fisheries Service

Hatcheries in California release millions of juvenile salmon and steelhead into the wild. This production is intended to mitigate for the loss of natural spawning and rearing habitat due to the construction of large dams throughout the state. In some years, these hatchery fish are thought to compose from half to 90% of the commercial fishery catch. Parentage based tagging (PBT) was proposed in 2005 as a novel genetic method for tracking the origin and cohort of these hatchery salmon. PBT is implemented simply by collecting tissue samples from the broodstock during spawning. DNA is extracted, the samples are genotyped and the information is entered into a parent database. When a hatchery fish is subsequently recovered in fisheries or at spawning, it is genotyped and compared to the parent database, providing age and source population—the same information currently obtained from coded wire tags (CWTs). By genotyping a single pair of parents, 100% of their offspring are "tagged", permitting much higher tagging rates than is currently feasible with CWTs. Additionally, PBT allows managers to track the fate of individual families of salmon, and therefore investigate important evolutionary questions about the inheritance of life history traits, variance in reproductive success, the occurrence of domestication selection in hatcheries and the effects of inbreeding on fitness. Due to the large amount of genotyping required, it was suggested that single nucleotide polymorphism (SNP) markers would be the most cost-effective genetic markers with low enough error-rates for this purpose. At the time, however, there were neither the appropriate number of SNPs available, nor the statistical tools needed to implement a large-scale PBT program. Over the last six years, we have endeavored to change that situation and breathe life into PBT for California salmon. A large multi-species SNP discovery effort in our lab has doubled the number of available SNPs for Chinook salmon. Combined with other SNPs from the literature and our collaborators, we have assembled a panel of 95 SNP loci with appropriate power for PBT. We have also developed new statistical algorithms, which increase the speed, accuracy and efficiency of locating an individual's correct parents in a database potentially containing millions to billions of possible parent pairs. This talk will review the SNP discovery efforts in our lab and the statistical foundations of a PBT analysis. We will also present the initial results of reconstructing multigenerational pedigrees of Feather River Hatchery spring Chinook salmon collected from 2006-2011. Finally, we will demonstrate the recovery of Feather River Spring Chinook in 2010 and 2011 ocean fisheries.

The Role of Artificial Propagation in Restoring Spring-run Chinook Salmon to the Upper San Joaquin River, CA

***Molly R. Stephens (Presenter), Karrigan S. Bork, Melinda R. Baerwald, Mariah H. Meek, Kat M. Tomalty,** and **Bernie May,** University of California, Davis*

Hatcheries' negative impacts on salmonid populations are well-documented. But artificial propagation can also serve as an important species-recovery tool. Central Valley Spring-run Chinook salmon experienced severe population declines over the past 50 years due in large part to dams that cut off upstream spawning habitat and thus contracted the species' range. Reintroduction deadlines mandated by a legal settlement, alongside concerns about the broader Spring-run Chinook ESU status, lend a sense of urgency to the restoration process. We developed a Hatchery and Genetic Management Plan as part of the regulatory process to permit species reintroductions for the San Joaquin River Restoration Program. We also authored a broader Genetic Management Plan for the reintroduced population, addressing potential genetic issues related to the reintroduction and to the monitoring of the newly formed population and the source populations. Here, we present guiding genetic principles for founding a new population, managing hatchery practices to minimize the use of introgressed stocks, and avoiding artificial selection and other negative hatchery effects. Uncertainty surrounding source stock availability and environmental variables in the river habitat restoration area requires adaptive management and flexibility in reintroduction timelines, while also attempting to meet recovery targets. Careful monitoring can allow us to learn about the relative reintroduction success of the source stocks and release strategies, providing lessons for future reintroduction efforts.

Preventing Extirpation of Coho Salmon in the Central California Coast ESU

Manfred Kittel, California Department of Fish and Game

Catastrophic declines in many coho salmon populations of the Central California Coast Evolutionarily Significant Unit (CCC ESU) over the past few years have prompted regulatory agencies to engage in integrated efforts to prevent the extirpation of local coho populations. These efforts span the spectrum from habitat restoration to captive rearing. Both approaches are essential to coho recovery in California, and their effects are complementary. To be most effective, captive rearing programs should be implemented strategically and supported by prioritized habitat restoration and other supportive efforts such as regulatory changes, law enforcement and educational programs, if necessary. Captive rearing programs should be tailored to a specific location and continue until specific abundance targets or alternative measure of success have been achieved. Habitat restoration projects competing for limited funding should focus on factors critically limiting natural production. All captive rearing programs should include adequate monitoring programs to evaluate their success and signal their termination.

The Use of a Captive Broodstock Program to Prevent Extinction and Assist in the Recovery of Coho Salmon (*Oncorhynchus kisutch*) Runs in Scott Creek, Santa Cruz County, CA

***Erick A. Sturm (Presenter), R. Bruce MacFarlane**, and **Sean Hayes,** National Marine Fisheries Service*

Coho salmon (*Oncorhynchus kisutch*) historically ranged from the Kamchatka Peninsula in Russia and across the Bering Sea from Alaska to central California. The southernmost populations in central California have been declining for some time with only one remaining continuous run south of the Golden Gate—the Scott Creek stock in Santa Cruz County. This run has been listed by both state and federal governments as Endangered. In an attempt to assist in the restoration of this run, a joint captive broodstock program was created between the National Marine Fisheries Service, Southwest Fisheries Science Center Fisheries Ecology Division and the Monterey Bay Salmon and Trout Project, a local non-profit organization dedicated to the restoration of native salmonids in the Monterey Bay area. This partnership has been rearing coho salmon in both sea and freshwater environments since 2002 with varying degrees of success.

Captive broodstock are used by this program to prevent the extinction of the southernmost run of coho salmon in North America. The captive broodstock fish are the ultimate insurance policy in case few or no wild fish return to spawn. This program also optimizes genetic diversity of surviving fish by using a spawning matrix to maintain stock heterogeneity including rarer alleles. Fish that are related at the half sibling level or higher cannot be mated. Moreover, to improve reproductive synchrony with wild fish, captive broodstock are injected with Ovaplant®, a synthetic gonadotropin releasing hormone analog, under an INAD (Investigational New Animal Drug) with the Federal Drug Administration. Additionally, in years when hatchery production exceeds the carrying capacity of Scott Creek, the captive broodstock program reintroduces coho salmon into local streams that historically had coho salmon runs and currently has appropriate rearing habitat, but currently do not contain coho salmon.

Monitoring Coho Salmon in the Russian River

Paul G. Olin, PhD, (Presenter), Mariska Obedzinski, Nicolas Bauer, Sarah Nossaman-Pierce, and Henning Fett, University of California Sea Grant Extension Program

Coho salmon populations have declined historically in the Russian River. In 2001, with three consecutive year classes thought to survive in only one stream, a decision was made by the California Department of Fish and Game to initiate a captive broodstock program wherein wild juveniles would be captured, and raised to maturity and spawned at the Don Claussen Warm Springs Hatchery on Lake Sonoma. The resulting offspring are then planted in select tributary streams using a variety of different stocking strategies.

Early on there were a number of questions being asked to enable adaptive management and improve the likelihood that resources and efforts being expended would have a successful outcome. It also became clear that a monitoring program was essential to collect data that would provide for science based decision making as the program evolved. Data on over-summer and over-winter survival, stream temperatures, flows, habitat conditions, and how these factors relate to overall survival were critical pieces of information.

To enable fish to acclimate to stream conditions, the initial strategy entailed juvenile stocking in the spring and fall with documentation of seasonal survival and outmigration of smolts using downstream migrant traps. Based on information provided from this effort, the stocking strategy evolved with fewer fish being stocked in the spring and more in the fall. Spring stocking of smolts began in 2009. The first stocking occurred in 2004 when 6,000 juveniles were planted in the fall. The number of fish planted over the years steadily increased and in 2010-2011 over 150,000 juvenile fish were released.

Initially, the program relied on Russian River genetic stock but in 2008 Olema Creek fish were included in the spawning matrix to enhance genetic variability. One challenge in creating a monitoring enterprise is tracking different release groups, multiple release locations, and different genetic cross types to evaluate the relative success of different strategies and improve the program. Unique single and multiple locations for coded wire tags proved sufficient initially, but the number of unique groups being stocked required an increasing reliance on PIT tag technology with antenna arrays to track fish throughout the system. This approach has provided valuable information to guide the program and produce reliable estimates of adult returns which were unattainable using up-stream adult migrant traps. From 2000 to 2009 less than seven adult coho per year are thought to have returned to the system. In 2009-2010, at least 19 fish returned and in 2010-2011, there were 92 documented adult returns. Estimates made possible through PIT tag data put the number likely to have returned in 2010-2011 at 181 adults.

Field monitoring of coho salmon is time consuming and expensive However, the ability to adaptively manage and improve a recovery program, identify optimal strategies to increase escapement, and have a scientific basis to document program success are essential in order to maintain the public's support, justify continued funding, and enhance the likelihood of self-sustaining wild runs of coho salmon in the future.

Comparing Coastal Processes and Lagoon Functioning Along the Central Coast, California

David Revell, PhD, ESA PWA

Coastal lagoons or bar-built estuaries function on a variety of time scales and provide critical habitat for salmonid species during the range of their life histories. The lagoon functioning depends on the beach morphology and driving physical coastal processes. These coastal processes affect storage volumes, salinity exchange, and inlet opening and closure all important to salmonid survival and restoration. This presentation will compare the coastal processes and functioning at four Central Coast lagoons—Santa Ynez River, Scott Creek, Waddell Creek, and Pescadero Marsh. Each of these lagoons was studied separately in an effort to understand existing functioning, historic changes and identify restoration options to enhance future habitats. Utilizing results from field data collection, wave modeling and topographic changes, comparisons between the lagoons will be made, highlighting the importance of coastal processes at each stage in the salmonid life history. Results identify the role of coastal processes responsible for lagoon opening and closing as well as those that play secondary roles in affecting lagoon habitat quality. Surprisingly, each lagoon was shown to function differently with some general patterns observed that have implications for lagoon management. Recommendations for changes to management and monitoring of these sensitive systems will be discussed as well in an effort to improve salmonid restoration.

Salt Trap Estuaries

John Largier, *Bodega Marine Laboratory, University of California Davis*

Along the coast of California many estuaries exhibit trapping of salt in deeper sections, resulting in long-residence and marked water quality characteristics. Similar to a salt-wedge estuary, stratification is strong. But, in contrast to salt-wedge estuaries, California estuaries have shoals near the mouth that trap a portion of this high-salinity layer in the estuary—establishing a "salt trap". The water in a salt trap may be retained for just 12 hours between high tides, or for a fortnight between spring tides, or for longer periods when the mouth of the estuary shoals or closes. Strong stratification prevents vertical mixing due to winds, muted tides or weaker river flow. Renewal of the bottom layer is primarily through intrusion of new ocean waters, which may occur infrequently—in which case deeper waters become hypoxic or even anoxic, and mid-depth waters become super-heated. Similar "salt-trap estuaries" occur along other high-energy coasts like California (e.g., South Africa, Chile, Australia). With reference to the Russian River, Scott Creek, Salmon Creek, and other Californian (and South African) estuaries, the physical structure, water quality, and habitat implications of this class of estuaries is described. In particular, marked patterns and extreme water quality characteristics develop when the mouth closes during summer or fall. Multiple vertical zones are identified, demarcated by light, temperature, salinity and dissolved oxygen distributions. The appearance and persistence of different vertical zones in different estuaries is discussed, recognizing the seasonal evolution of water-column habitat in Californian estuaries of varying size. Further, the connection between environmental change, management actions, physical condition and estuary habitat condition will be discussed with a view to recognizing similarities between west-coast salmon-supporting estuaries.

Modeling Restoration Scenarios in a California Bar-built Estuary

Dane K. Behrens (Presenter), *University of California, Davis;* ***John L. Largier,*** *Bodega Marine Laboratory, University of California, Davis;* ***Fabián A. Bombardelli,*** *University of California, Davis*

Bar-built estuaries in California often experience inlet closure during low flow events. This natural process results when waves fill the inlet channel with sediment, temporarily transforming the tidal estuary into a sharply salt-stratified lagoon. Changes in watershed and beach management since the mid-nineteenth century have altered the frequency and seasonality of these events in California. This has consequences for endangered salmonid species which are known to use these closed estuaries as a rearing grounds. Restoration efforts often cannot simply return the system to its natural state because either (1) there is little information about this state or (2) it would pose flooding or other risks to existing development within the estuary. To account for these constraints, we compare several hypothetical management scenarios at the Russian River estuary, in northern California, using a numerical model and an extensive set of boat-based field measurements from the 2009 and 2010 dry seasons. At this site, closures are typically sporadic, short-lived events, although there is some evidence suggesting seasonal events existed in the past, lasting several months at a time. We simulate a three-month dry season period in which the inlet is consistently closed or, alternatively, having a perched one-way overflow channel allowing flow over the beach. We focus on the change in available habitat space based on barrier seepage, stratification and inflows over the three-month period. Finally these results are compared with observations of long-term closure events at the Russian, Gualala and Navarro rivers.

Impacts of Urbanizing Watersheds, Climate Change and Altered Coastal Processes on the Breaching and Closure Patterns of a California Lagoon

***Andrew Rich (Presenter)** and **Ed Keller,** University of California, Santa Barbara*

The breaching and closure of coastal lagoons reflects the interaction of dynamic coastal and watershed processes. In the coming century, these systems will experience increased sea-level, urbanization of the watershed and periphery, and changing stream run-off patterns. To understand how lagoons may respond to these pressures, a hydrologic and geomorphic model of the breaching and closure process has been developed. The model is based upon basic geomorphic and hydrologic principles. Breaching of the estuary is caused when the balance of streamflow, groundwater exchange, evaporation, and wave overtopping causes estuary water levels to exceed the beach berm height. When the estuary inlet is open, closure occurs when the deposition of sand by swash transport exceeds fluvial incision of water flowing through the inlet. The model is calibrated and validated using an 18-year water level record of the Carmel Lagoon. The model is then ran to explore the potential effects of climate change conditions, watershed urbanization, and altered coastal conditions on the breaching and closure patterns of similar lagoons.

A Feasibility Study of Passive Managed Aquifer Recharge (MAR) of MF/RO Concentrate at the Lower Carmel River Lagoon for Steelhead Habitat

Mark Strudley (Presenter), *and* ***Barry Hecht,*** *Balance Hydrologics;* ***Dane Hardin,*** *Applied Marine Sciences;* ***Andrew Fisher*** *and* ***Tess Russo,*** *University of California, Santa Cruz;* ***Marc Los Huertos*** *and* ***Natalie Jacuzzi,*** *California State University, Monterey Bay*

For over 20 years, the Carmel River has periodically not flowed to the ocean during the summer months due to overdrafting and, in fact, did not flow to the ocean at all from 1987—1991. In 1995, the State Water Resources Control Board passed Order 95-10 that requires California American Water Company to develop a replacement supply for any diversions from the Carmel River in excess of its legal entitlement of 3,376 AF per year, but that has yet to occur and the river remains seriously overdrawn. Moreover, the two dams on the Carmel River, the Los Padres and the San Clemente dams, have largely silted in and currently provide a fraction of their original design storage. Various options also have been proposed for managing the flow in the river to protect steelhead habitat, including a new Los Padres dam, but none of them have been implemented. In its 1996 Steelhead Restoration and Management Plan for California, the Department of Fish and Game recommended that the Carmel River be declared "fully appropriated" year-round by the State Water Board.

Utility of a Newly Developed Rapid Assessment Tool for Describing the Condition and Ecological Services of Central Coast Lagoons

Ross Clark (Presenter), Kevin O'Connor, and Sierra Ryan, Moss Landing Marine Labs

California's bar built estuaries (river mouth lagoons) are unique habitats that provide a wide range of ecological services that benefit rare and endangered species. Physical processes such as beach bar formation and seasonal flooding and ocean overtopping create variability in surface water elevations and salinity gradients that are unique to these systems. The presence and absence of these events will determine the level of services and condition and loss often correlates with human management and watershed impacts. Management strategies often focus on specific species or environmental objectives (i.e. water quality) sometimes at the detriment of other species and services. The Central Coast Wetlands Group at Moss Landing Marine Labs aims to improve our regional understanding of the current ecological services this community of individual systems provides. Our study investigated the capability of a newly created rapid assessment method to describe the current condition of these river-mouth lagoons. Condition assessment data were compared with other environmental variables including water quality, hydrologic management, watershed processes, and habitat loss and alterations relative to 1850s. These comparisons were used to test the capability of rapid assessment data at describing the full range of ecological services that, when present, benefit rare and endangered species including steelhead trout and tidewater gobies. The combine results of the condition assessment, watershed analysis and historical interpretation are combined to create a conceptual model of each lagoon necessary for resource managers to devise better strategies to enhance lagoon ecosystems for multiple objectives and evaluate the effectiveness of these implemented actions.

Removing the Klamath River Dams—Results of Studies from a Landmark Restoration Program to Restore Anadromous Fisheries

***Ben Swann (Presenter)**, CDM; and **Ethan Bell**, Stillwater Sciences*

In the Upper Klamath River Basin, PacifiCorp owns and operates four hydroelectric dams on the mainstem of the Klamath River in the region of Northern California and Southern Oregon. The dams (J.C. Boyle, Copco No. 1, Copco No. 2 and Iron Gate) have directly impacted anadromous salmon fisheries by blocking fish passage and altering physical conditions on the mainstem of the Klamath River.

Klamath River anadromous fish runs (steelhead, Chinook salmon, coho salmon, green sturgeon) contribute substantially to commercial, recreational and American Indian tribal fisheries. Many of these species are now federally listed as threatened or endangered species, due to long-term population declines.

PacifiCorp attempted to relicense the dams and hydroelectric operations with the U.S. Federal Energy Regulatory Commission (FERC) in 2006, following their 50-year license expiration. During the relicensing process, a variety of stakeholders expressed a strong interest to decommission and remove the four hydroelectric dams to address declining Klamath River fisheries.

The removal of the Klamath River dams would represent the largest dam removal project ever undertaken, but includes substantial financial and ecological risk and technical uncertainty. Partly due to these risks and uncertainties, PacifiCorp, the states of California and Oregon, and the federal government signed the Klamath Hydroelectric Settlement Agreement (KHSA) in February 2010, which established a roadmap for removal of the four Klamath River dams by the year 2020. The KHSA designates that technical and environmental studies be conducted (these studies are the primary subject of this abstract) so that the U.S. Secretary of the Interior can make a judgment on whether dam removal will enhance salmonid fisheries restoration and is in the best interest of the public, Indian tribes, and local community.

A team of resource scientists and engineers from federal and state agencies and consulting organizations undertook a multitude of studies to assess the uncertainties and data gaps on the effects and consequences of dam removal, as well as to inform the Secretary of the Interior on a dam removal decision.

The results of the dam removal studies will be used by the Secretary of the Interior to render a dam removal decision by March 31, 2012. The results of all technical, social and economic studies will be contained in two comprehensive studies:

- Klamath Facilities Removal Environmental Impact Statement/ Environmental Impact Report
- Klamath Dam Removal Overview Report for the Secretary of the Interior—An Assessment of Science and Technical Information

The SRF Conference will occur one week following the Secretary's decision on dam removal. This presentation will present the technical, regulatory, and policy challenges of Klamath River dam removal from the perspective of the Department of the Interior's contractors CDM and Stillwater Sciences.

Marmot Dam: the Remains of the Day

Gordon Grant (Presenter), *USDA Forest Service, Pacific Northwest Research Station;* ***Jon Major,*** *U.S. Geological Survey, Cascade Volcano Observatory;* ***Jim O'Connor,*** *U.S. Geological Survey, Oregon Water Center; and* ***Chuck Podolak,*** *John Hopkins University, Department of Geography and Environmental Engineering*

Dam removal has emerged as an important river restoration strategy in the U.S. Removals offer an excellent setting for validating analytical models of sediment transport and morphologic change, and testing our capacity to predict channel evolution in response to changing water and sediment transport regimes. The breaching of the Marmot coffer dam on the gravel-bed Sandy River in Oregon, USA in October 2007 was at that time the largest instantaneous and uncontrolled release of sediment accompanying a dam removal. Here we report on what we've learned about the geomorphic response to this singular event over the past four years of monitoring and analysis, and extract lessons useful in other dam removals.

Marmot Dam was a concrete diversion dam built in 1913 that stood 14.3 m high by 50 m wide. At the time of removal, the upstream reservoir was completely filled with approximately 750,000 m3 of sand and gravel. The decision to remove the dam was motivated by a combination of increasing maintenance costs and unfavorable economics. To remove the concrete structure, a temporary coffer dam was constructed out of river bed and reservoir sediment approximately 70 m upstream. The main structure was dynamited in July 2007 but the river was allowed to naturally breach the coffer dam and erode the remaining impounded sediment (730,000 m3) during the first fall storms in October, 2007, setting off a dramatic sequence of geomorphic events, both upstream and downstream.

We monitored sediment transport and morphologic change in the days, weeks, months, and years following removal through event-based measurements of suspended sediment and bedload, repeat surveys of channel cross-section and planform change, reservoir incision, and repeat LIDAR surveys. Measurements of sediment transport immediately downstream of the dam following breaching show a rapid initial increase in fine suspended sediment within minutes followed by high rates of suspended-load and bedload transport of sand and, later, gravel. The elevated sediment load was derived from eroded reservoir sediment, which began eroding when a meters-tall knickpoint migrated about 200 meters upstream in the first hour after breaching. Over the following days and months, the knickpoint migrated upstream more slowly; within seven months the knickpoint had migrated two km upstream. Knickpoint migration, vertical incision, and lateral erosion evacuated about 15 percent of the initial reservoir volume (125,000 m3) within 60 hours following breaching, and by the end of high flows in May 2008 about 50 percent of the reservoir sediment volume had been evacuated.

About 25 percent of the total volume of sediment eroded from the reservoir was re-deposited in a sediment wedge extending about 2 km downstream from the former dam site. The balance has been distributed along, and partly fills, pools within the Sandy River gorge, but most is likely broadly dispersed along the channel farther downstream. A two-fraction sediment budget indicates that most of the gravel eroded form the reservoir reach was deposited along the channel immediately below the dam site, whereas sand input to and eroded from the reservoir reach largely passed through the gorge and was broadly dispersed farther downstream, chiefly along an 8-km-long channel reach below the river gorge.

At the end of the day, the Marmot dam removal demonstrates that an energetic river can rapidly erode, transport, and redistribute unconsolidated coarse sediment released during dam breaching. The subsequent river morphology evolves more slowly, and it may take years before a pre-dam longitudinal profile is re-established. Aquatic habitat, as reflected in bar and pool morphology, appears to recover quickly—on a timescale of months—and this bodes well for future removals.

An Update of Dam Removal Activities in the Elwha River—Dam Removal, Sediment Dispersal, and Fish Relocations

Jeffrey J. Duda (Presenter), *U.S. Geological Survey, Western Fisheries Research Center;* ***George R. Pess,*** *NOAA Fisheries, Northwest Fisheries Science Center;* ***Samuel Brenkman,*** *Olympic National Park;* ***Roger Peters,*** *U.S. Fish and Wildlife Service—Washington Field Office;* ***Mara Zimmerman,*** *Washington Department of Fish and Wildlife; and* ***Michael McHenry,*** *Lower Elwha Klallam Tribe*

After years of anticipation, volumes of Environmental Impact Statements, unprecedented mitigation projects, and the multifaceted collection of pre-dam removal data, the deconstruction phase of the Elwha River restoration project officially began on September 17th, 2011. With their simultaneous decommissioning, the removal of the 64 m Glines Canyon Dam and 33 m Elwha Dam represents one of the largest such projects of its kind in North America. The nearly 19 million m3 of sediment residing in the deltas and reservoirs will be eroded by the river in one of the largest releases of sediment into a river and marine waters in recorded history. The controlled release of sediment and the halting of dam notching and reservoir draw down during "fish windows" is largely determining a deconstruction schedule expected to last between two to three years. High suspended sediment concentrations, modeled to exceed 10,000 mg/L during the highest flows and lowest reservoir conditions and exceeding 500 mg/L for 39% of the time in year 4 of the project (15% is the recorded background level entering the upper reservoir), could last for up to three to five years following dam removal depending on weather conditions and river discharge. Anadromous fish, including three federally listed species (Puget Sound Chinook, steelhead, and bull trout), reside in the river downstream of Elwha dam for part of their life cycle. All five species of Pacific salmon and steelhead, which are either locally extirpated (sockeye) or persist in degraded spawning and rearing habitat, are expected to recolonize the watershed to degrees that will vary spatially and temporally due to life history characteristics and levels of human intervention. Because no fish passage structures were provided, naturally migrating salmon and their marine-derived nutrients have not seen the protected waters inside Olympic National Park since the Elwha dam was completed in 1913 at river kilometer 7.9. When passage is restored in 2014, salmon will have access to over 65 river kilometers of mainstem spawning and rearing habitat, at least as much floodplain channel habitat, and numerous tributaries, much of which occurs in wilderness. This presentation will provide an update of dam removal progress, highlight some pre-dam removal studies, and detail recent fish relocation efforts to protect (bull trout) and jump start (coho) salmon recolonization.

Geomorphic Response to a Blow-and-Go Dam Removal on the Central California Coast

***Michael Love**, Michael Love and Associates; and **Matt Stoecker**, Stoecker Ecological Consultants*

Horse Creek is a tributary to the Sisquoc River within the Santa Maria River Watershed of northern Santa Barbara County. A small dam on Horse Creek was demolished with explosives in the fall of 2006 by California Department of Fish and Game (DFG), Stoecker Ecological, Los Padres National Forest, the California Conservation Corps, and other project stakeholders. The demolition was aimed at providing steelhead trout, a Federally listed endangered species, access to approximately 20 miles of upstream spawning and rearing habitat.

In preparation for the dam removal, Stoecker Ecological and Michael Love & Associates (MLA) conducted a geomorphic assessment of the proposed dam removal project. As part of the geomorphic study, the channel profile and cross sections were surveyed and the geomorphic characteristics of Horse Creek above and below the dam were documented. The information was used to make predictions of geomorphic response following dam removal, such as the length of channel that would degrade, and the rate and volume of sediment that would be released.

Shortly after the dam removal, much of the Horse Creek watershed experienced an intense fire. Following several dry years after the dam removal, the lower Sisquoc River and its tributaries experienced several high flows, including an approximate 5-year peak flow event. This event dramatically released the stored sediments upstream of the removed dam and caused extensive channel changes along with restoring upstream steelhead access.

MLA and Stoecker Ecological, along with DFG, returned to Horse Creek in 2011 to document channel response to the dam removal for the purpose of evaluating:

- Accuracy of methods used to estimate the volume and rate of sediment mobilized and the resulting shape and alignment of the channel upstream of the dam
- The nature of sediment release and channel response in the hydrologic and fire regimes characteristic of central and southern coastal California.

From this work a better understanding of channel response to dam removal has been obtained and will serve to improve analysis and decision-making for future projects.

Monitoring Fish and Habitat Responses to Barrier Removal Projects

Leah Mahan, NOAA Restoration Center

Restoration practitioners and natural resource agencies strive to predict the benefits of individual fish passage barrier removal projects, and the potential for these projects to improve fish populations by restoring access to blocked habitat. The NOAA Restoration Center is working through its Open Rivers Initiative to develop a nationwide monitoring program to evaluate fish and habitat response to barrier removal projects, and is coordinating with other practitioners and agencies to learn from their monitoring efforts. In Coastal California, several barrier removals are being monitored to determine patterns of fish recolonization, and habitat changes. Pre- and post- project adult spawner and juvenile electrofishing surveys are being conducted to quantify changes in anadromous fish numbers, use and distribution. In addition, habitat surveys before and after project implementation are underway to assess the changes in habitat value to salmonids above and below barrier removal sites. The surveys are helping to improve restoration practitioners' understanding of salmonid response to barrier removal in Coastal California. Lessons learned from these efforts will provide valuable information to guide future project prioritization and inform expectations of temporal and spatial fish and habitat response following barrier removal.

Freeing the Rogue River: Four Dams Down

Scott Wright, P.E., *Water Resources Engineer, River Design Group Inc.*

In a span of just three years, three mainstem dams were removed from the Rogue River and one tributary dam was partially removed. This historical achievement in Southern Oregon opened up over 157 miles of mainstem river habitat to unhindered fish passage and freed the way to hundreds of more miles of tributary habitat. This effort was undertaken in response to the Endangered Species Act (ESA) with the goal of recovering Southern Oregon/Northern California coho salmon and their designated critical habitat while removing relic dams.

Savage Rapids Dam was the catalyst that started the dam removal frenzy on the Rogue River. It was determined from evaluation of fish passage performance in the 1980s that the 36-foot high concrete dam was killing and obstructing fish passage for salmon and steelhead. These evaluations started in motion a series of lawsuits and advocates that supported dam removal which ultimately created momentum for multiple dam removals in the Rogue River Basin.

Gold Hill Dam was the first removal that started in 2008 at river mile 121. This full-spanning dam consisted of a 900-foot long concrete structure ranging in height from 4 ft—14 ft. The dam was no longer used to generate power and served no purpose. At the same time, the Army Corps of Engineers' Elk Creek Dam was partially removed. This partially constructed roller compacted concrete dam was 83 feet high and had a base that spanned more than 300 feet across the valley and completely blocked fish passage in this important tributary to the Rogue River for more than 20 years.

In 2009, the Savage Rapids Dam was removed with a portion of the structure retained for stability of the banks at river mile 107. In addition to dam removal, a new irrigation water pumping plant was installed to maintain irrigation diversion. Finally, Gold Ray Dam (river mile 126) was removed in 2010 marking the removal of three mainstem dams and one tributary dam in the Rogue River basin. Gold Ray Dam was a defunct hydropower facility that had not generated power since 1970 and created a significant hindrance to fish passage due to an inadequate fish ladder. The concrete buttress dam was 38 ft high and spanned 360 ft causing over one mile of slack water conditions in the Rogue River. Removal of the three mainstem Rogue River dams created 157 miles of natural fish passage and improved habitat conditions.

Estimates of Hatchery Contribution to California's Central Valley Chinook—Results of 2010 Constant Fractional Marking Program Recovery Data

Brett Kormos (Presenter), Melodie Palmer-Zwahlen,
and Alice Low, California Department of Fish and Game

Annually, over 32 million Fall Chinook salmon are produced at five major hatcheries in California's Central Valley (CV). Production from these state and federal hatcheries contributes to major sport and commercial fisheries, in addition to annual escapement. Until 2007, releases of Fall Chinook were not externally marked and coded-wire tagged with any consistency. In 2004, the CALFED Ecosystem Restoration Program funded a study to design a constant fractional marking and coded-wire tagging program for production releases of Fall-run Chinook salmon from CV hatcheries, with the goal of estimating the relative contribution of hatchery production. The study recommended the implementation of a system-wide marking and tagging program for production releases. Planning studies indicated an optimum marking and tagging rate of 25% for CV Fall Chinook.

Beginning with brood year 2006, a minimum of 25% of the production releases of Fall Chinook at Coleman National Fish Hatchery, Feather River Fish Hatchery, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery have been adipose fin clipped and coded-wire tagged each spring. This Constant Fractional Marking (CFM) program is a cooperative effort of the California Department of Fish and Game, the California Department of Water Resources, the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service, the East Bay Municipal Utilities District, and the Pacific States Marine Fisheries Commission. Additionally, 100% of the Fall Chinook produced at the Merced River Hatchery, 100% of the Spring Chinook reared at Feather River Hatchery, and 100% of Late-fall Chinook reared at Coleman National Fish Hatchery have also been marked and coded-wire tagged.

Coded-wire tags are recovered from adult fish in the ocean commercial and recreational fisheries, the inland sport fishery, escapement surveys, and at hatcheries. 2010 is the first year in which the majority of the Fall Chinook recovered in the harvest and escapement were ad-clipped and coded-wire tagged at a minimum 25% rate as a part of the CFM program. Brood years 2006-2008 were represented by the two, three, and four year olds in the 2010 harvest and spawning escapement. Age five Chinook make up a very small fraction of the total escapement and do not significantly affect estimates.

This work evaluates the 2010 CV Fall, Late-fall, and Spring Chinook coded-wire tag recovery data in accordance with program objectives. Estimates of hatchery and natural proportions in escapement to hatcheries and CV streams are reported. In addition, estimates of hatchery contribution to ocean harvest as well as stray and recovery rates as they pertain to release strategy are also reported. Results should be viewed as a snapshot of a single year. In 2007, there was a significant decline in CV Fall escapement and west coast ocean salmon fisheries have been very constrained the last several years. As the CFM program continues, future recovery data will allow for better evaluation of hatchery practices in the CV of California.

Loss of Genetic Diversity and Fitness for Central Valley Fall-Run Chinook: Symptoms, Causes, and Solutions

Brad Cavallo, *President and Senior Scientist, Cramer Fish Sciences*

Fall-run Chinook were once considered the most abundant and stable of the four Chinook salmon races native to California's Central Valley. Their rapid, steep decline in abundance, which began in 2006, seems to have finally abated with a relatively strong return in 2011. However, the underlying ultimate causes of the decline, which pre-date 2006, are poorly understood and remain largely uncorrected by management action.

While the 20th century decline of CV Chinook salmon is primarily attributable to spawning and rearing habitat lost to impoundments constructed on nearly every major Central Valley tributary, the hatcheries created to mitigate for this lost habitat are increasingly recognized as a leading threat to conservation and recovery of natural origin Fall-run CV Chinook salmon. Studies from the Pacific Northwest have shown hatchery salmon are often poorly adapted for survival in the wild; with natural origin fish exhibiting reduced fitness after a single generation of interbreeding with hatchery origin stock. These studies have important implications for recovery of Fall-run Chinook in the CV where 31 million juvenile Fall-run Chinook are produced annually in mitigation hatcheries. The sheer volume of artificial propagation may disrupt natural selection, preventing traits and behaviors uniquely suited for Central Valley habitats from being successfully conveyed to subsequent generations of natural origin fish. Though we have only begun to understand the imperiled status of natural origin CV Fall-run Chinook (their actual status having been obscured for decades by abundant and visually indistinguishable hatchery origin fish), recovery will require biologists and managers to carefully reconsider aspects of Fall-run Chinook hatchery management including production levels, broodstock selection (both in the hatchery and in the river), marking rates, harvest levels, and smolt release practices. Each of these topics will be discussed. Special attention will be paid to mass marking. While not a panacea, nor a substitute for addressing chronic habitat, mortality and genetic management problems in the CV, implementation of mass marking will profoundly improve our ability to successfully protect and restore salmon populations through better management of hatchery practices, CV riverine habitats, water projects, and harvest regulations.

Managed Metapopulations: Do Salmon Hatchery 'Sources' Lead to In-River 'Sinks' in Conservation?

Rachel C. Johnson (Presenter), *University of California, Santa Cruz, Institute of Marine Sciences;* ***Peter K. Weber,*** *Lawrence Livermore National Laboratory, Chemical Sciences Division;* ***John D. Wikert,*** *U.S. Fish and Wildlife Service, Anadromous Fish Restoration Program;* ***Michelle L. Workman,*** *East Bay Municipal Utilities District;* ***R. Bruce McFarlane,*** *National Marine Fisheries Service, Southwest Fisheries Science Center;* ***Marty J. Grove*** *and* ***Axel K. Schmitt,*** *University of California, Los Angeles, Department of Earth and Space Sciences*

Maintaining viable populations of salmon in the wild is a primary goal for many conservation and recovery programs. The frequency and extent of connectivity among natal sources defines the demographic and genetic boundaries of a population. Yet the role that immigration of hatchery-produced adults may play in altering population dynamics and fitness of natural populations remains largely unquantified. Quantifying whether natural populations are self-sustaining, function as sources (population growth rate in the absence of dispersal, (> 1), or as sinks (< 1) can be obscured by an inability to identify immigrants. In this study, we use a new isotopic approach to demonstrate that a natural spawning population of Chinook salmon (Oncorhynchus tshawytscha) considered relatively healthy actually represents a sink population when the contribution of hatchery immigrants is taken into consideration. We retrieved sulfur isotopes (34S/32S, referred to as (34S) in adult Chinook salmon otoliths (ear bones) that were deposited during their early life history as juveniles to determine whether individuals were produced in hatcheries or naturally in rivers. Our results show that only 10.3% (CI = 5.5 to 18.1%) of adults spawning in the river had otolith 34S values less than 8.5‰, which is characteristic of naturally produced salmon. When considering the total return to the watershed (total fish in river and hatchery), we estimate that 90.7 to 99.3% (CI) of returning adults were produced in a hatchery (best estimate = 95.9%). When population growth rate of the in-river spawning population was modeled to account for the contribution of previously unidentified hatchery immigrants, we found that hatchery-produced fish caused the false appearance of positive population growth. These findings highlight the potential dangers in ignoring source-sink dynamics in recovering natural populations, and question the extent to which declines in natural salmon populations are undetected by monitoring programs.

Temporal Trends in Hatchery Releases of Fall Chinook from California's Central Valley

Stephanie M. Carlson, PhD, (Presenter), *and* ***Eric R. Huber,*** *University of California, Berkeley*

Fall Chinook salmon (*Oncorhynchus tshawytscha*) from California's Central Valley collapsed in 2008, resulting in a moratorium on fishing in 2008 and 2009, and only limited openings in 2010. The closure was the first in the fishery's 157 years and was declared a federal emergency disaster. While the proximate cause of the collapse is thought to be poor ocean conditions that resulted in low juvenile survival when fish first arrived at the ocean, the strong influence of hatcheries in this system also warrants inspection. Recent research suggests that roughly 90% of ocean fishery catches in this system are Fall Chinook produced in one of five hatcheries (four state, one federal) suggesting that fishery dynamics are largely determined by the dynamics of hatchery fish. Here we compiled information on the temporal trends in the number of juveniles released from each of the five hatcheries propagating Fall Chinook as well as their sizes, ages and stages (fingerling vs. advanced fingerling) at-release for a period of roughly five decades. A coarse-scale analysis of locations-of-release (inside San Francisco Estuary versus. outside) is also presented. For the four state hatcheries, this involved reviewing over 170 annual reports, many of which were still in draft form (33% of total). For the single federal hatchery, this involved obtaining a preexisting electronic database that included these same data. Nearly two billion fish from this complex were released as of 2008 with peaks in the early 1960's when many fish volitionally migrated from hatcheries. About half of the total releases have been from a single hatchery (Coleman) and the other half from the remaining four hatcheries. The 2000's have been marked by a shift towards releasing a higher proportion of older and larger (i.e., advanced fingerlings) smolts into the San Francisco Estuary, presumably to avoid poor conditions in Central Valley rivers and the Delta. We highlight the importance of thoroughly reviewing hatchery practices to better understand the influence of hatcheries on this stock complex and perhaps lend some insight into its recent collapse.

Trans-Generational Genetic Tagging as a Potential Means to Investigate Hatchery Effects: a Case Study from Lower Columbia River Fall Chinook

Scott M. Blankenship (Presenter), *Cramer Fish Sciences;* ***Daniel j. Rawding,*** *Washington Department of Fish and Wildlife; and* ***Cameron S. Sharpe,*** *Oregon Department of Fish and Wildlife, Corvallis Research Laboratory*

Basic biological data (abundance, recruitment) is often inadequate and/or underutilized for salmon populations. Genetic methods offer an alternative means of collecting population information that is accurate and more content rich than is currently available. We present here a case study on lower Columbia River Fall Chinook, which is a part of an ongoing Washington Department of Fish and Wildlife project using trans-generational genetic tagging to enhance capabilities for more effective population recovery and fishery management actions. While the primary study objective was precision abundance estimation, the methods that underlie the genetics-based abundance estimators provide an approach for obtaining vital information about the population dynamics of hatchery and natural fish in-river. Quantified metrics were recruits (fry and sub-yearling parr migrants) per spawner (hatchery and natural), distribution of matings, distribution of family size, effective number of breeders, and effective population size. These example data and associated study design show that introgression and the effect of straying can be directly observed without substantial changes to existing field monitoring protocols. Implications will be discussed for enhancing the investigation of potential fitness effects of Central Valley fall hatchery Chinook spawning in natural environments.

We Can Have Our Salmon and Eat Them Too: A Conservation Management Assessment of Central Valley Fall-run Chinook

Jacob Katz, PhD candidate, *University of California, Davis Center for Watershed Sciences*

Obscured by massive hatchery production, the decline of California's naturally produced Fall-run Chinook salmon populations have gone largely unnoticed. Artificial production has not only masked the problems, but has also played a major role in the collapse of self-sustaining, natural populations of Central Valley Fall-run Chinook. Although there are two goals for the management of California's salmon—(1) to ensure self-sustaining, naturally produced populations and (2) to ensure adequate abundance to support commercial and sport fisheries—hatcheries have subsidized the second goal, often poorly, while unintentionally sacrificing the first. Put simply, hatcheries both drive decline and prevent recovery of natural populations. The mechanisms for this are many, complex, and interacting and will be explored in this presentation.

Considerable evidence, much of it presented in the other talks in this symposium, suggests that the past 60 years of Central Valley hatchery production to support fisheries has obliterated natural population structure, disrupted natural selection, and resulted in a significant reduction in the reproductive capacity of naturally produced Fall-run Chinook salmon. Asymmetry in recruitment and selection regimes for hatchery versus naturally produced stocks results in replacement of natural populations with maladapted fish of hatchery ancestry. This has contributed to the current situation whereby artificial production is at an all-time high while natural returns are at an all-time low.

In the CV, where so much salmon habitat has been lost, recovery actions tend to focus on restoration. Because habitat diversity is essential to maintaining life-history diversity, conservation strategies that restore and improve physical habitat quality, extent, and connectivity are essential tools in improving the resilience of salmon populations. However, restoration alone will never result in recovery of self-sustaining, naturally produced populations of Central Valley Fall-run Chinook if hatchery practices continue to limit the reproductive and adaptive potential of naturally produced fish. This presentation will conclude with discussion of management alternatives designed to alleviate the demographic and genetic impacts of artificial propagation on natural populations. These reforms, if implemented along with landscape-level habitat restoration, could benefit commercial fisheries and increase the likelihood of recovering naturally produced self-sustaining populations of Central Valley Fall-run Chinook. We can have our salmon and eat them too.

- Mark all hatchery fish with external marks so targeted management is possible.
- End, as much as possible, gene flow between hatchery strays and naturally reproducing spawning groups. This is essential for recovery of naturally reproducing stocks. Segregation of hatchery and naturally reproducing gene pools can be achieved in two ways: (1) physical segregation via active sorting at weirs or dams whereby only non-hatchery fish are passed upstream above barriers, and (2) use of hatchery brood stocks that are divergent from local genomes so that when hybridization between naturally produced individuals and hatchery strays inevitably occurs, the hybrid progeny inherit a genome unfit for local conditions, experience extremely high mortality, and are rapidly culled from the naturally produced gene pool.
- Move artificial production to support commercial fisheries to estuarine locations and establish highly efficient terminal fisheries. This action would reinvigorate commercial fisheries (putting California salmon back on California tables) while limiting genetic dilution of wild gene pools and minimizing ecological competition with natural fish.
- Artificial propagation meant to subsidize commercial and sport fisheries should use genomes as divergent from native salmon genomes as possible. Broodstock for artificial propagation should be selected for life history characters (especially migratory timing) incompatible with California streams.
- Close hatcheries where adverse impacts to natural spawning populations outweigh benefits.

Meeting the Information Needs for Restoration: Fisheries Studies for Water Year 2011/2012 on the San Joaquin River

***John Netto** and **Michelle Workman**, U.S. Fish and Wildlife Service, San Joaquin River Restoration Program*

As a planning tool, the San Joaquin River Restoration Program prepares and releases a Monitoring and Assessment Plan (MAP) annually that describes the studies proposed for the upcoming fiscal year. The Fisheries Management Work Group develops and prioritizes fisheries studies for submission to the MAP based on timely information needs for program planning and implementation. In 2011, researchers submitted several proposals to address a broad range of topics including: habitat assessments, survival studies, predation risks, and fish passage evaluations. This presentation will provide a brief overview of these studies and discuss the relevance of each in the context of meeting restoration goals in the San Joaquin River.

Evaluation of Hills Ferry Barrier Effectiveness at Restricting Chinook Salmon Passage on the San Joaquin River

Don Portz (Presenter), Eric Best, Chuck Hueth, and Norm Ponferrada, U.S. Bureau of Reclamation

The Hills Ferry Barrier on the San Joaquin River (SJR) near Newman, California is constructed in the fall to restrict passage of adult fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*) upstream of the confluence of the Merced River where habitat and water quality may be unsuitable for these fish. The San Joaquin River Restoration Program is restoring flows to the SJR from Friant Dam to the Merced River confluence and will re-establish a self-sustaining population of Chinook salmon and other native fishes. Public Law 111-11 Section 10004 (h)(4) requires that the Secretary of the Interior, in consultation with the California Department of Fish and Game, evaluate the effectiveness of the Hills Ferry Barrier in preventing the unintended upstream migration of anadromous fish in the SJR and any false migratory pathways. Barrier physical characteristics, river hydrology and bathymetry, as well as fish behavior in proximity to the barrier were examined and evaluated in order to develop refined operating guidance and determine effectiveness of the barrier at preventing or reducing fish passage. Dual-frequency identification sonar underwater camera (DIDSONTM), Acoustic Doppler Current Profiler (ADCP), and visual observations were used to identify problems and limitations of the barrier. Sand, silt, and clay river substrate eroded around the barrier's support structures, footings, base, and conduit panels. Scour holes underneath and at the terminal ends of the barrier develop from erosion and enable adult Chinook salmon to evade the barrier and swim upstream of this location. Information gathered from DIDSONTM, ADCP, and visual accounts identified potential improvements to barrier design, operation, and location to improve barrier effectiveness.

Restoration of Reach 2B—Integrating Salmon Restoration with Water Supply, Habitat Restoration, and Fish Passage

Tom Taylor, Cardno ENTRIX

Reach 2B is a low-gradient, meandering 11.3 mile reach of the San Joaquin River located on the west side of the southern San Joaquin Valley in California and is geographically situated between the Chowchilla Bifurcation Structure (CBS) and Mendota Dam. This reach of the river has not received consistent flows since Friant Dam was closed and substantial water diversions began in the mid-1940s. Under existing conditions the Reach 2B channel can accommodate about 1,700 cfs while the Settlement Agreement calls for a design capacity up to 4,500 cfs. Prior to the start of Interim Flows, the upper four miles of Reach 2B was typically dry supporting only marginal riparian vegetation. The remainder of the reach, called Mendota Pool, is backwatered by Mendota Dam. Flow management in Reach 2B needs to consider upstream and downstream Spring-run Chinook salmon passage under both restoration and flood flow scenarios which requires consideration of irrigation water delivery, flood management, and in wet years, seepage, that affects adjacent agricultural lands. Water for agriculture is delivered to Mendota Pool via the Delta-Mendota Canal, but can also be supplied by the river. Floodplain expansion in Reach 2B is being evaluated through the use of a 2-D model. The big challenge down the road for Reach 2B is how the flood control and water delivery functions will be integrated into fishery management needs. Adult Spring-run Chinook salmon move upstream in late winter through spring, while juveniles are moving downstream. How Restoration Flows and Flood Flows are managed will be essential in successfully restoring Spring-run Chinook salmon to the San Joaquin River.

Juvenile Chinook Survival and Migration through the San Joaquin River Restoration Area During Flood Operations, Spring 2011

Michelle Workman (Presenter), *U.S. Fish and Wildlife Service,*
and ***Matt Bigelow,*** *California Department of Fish and Game*

Stationary acoustic telemetry receivers were deployed within the San Joaquin River Restoration Area from Friant Dam to the confluence of the Merced. Acoustic tracking was used to assess survival and movement through captured mine pits, at unscreened diversions, in both bypasses and the river channel at critical decision points for juveniles attempting to emigrate from the system to the Sacramento San Joaquin Delta and to the Ocean. 200 Feather River Hatchery Fall-run Chinook juveniles were acoustically tagged and released in a larger group of coded wire tagged juveniles. Releases were made in two locations in the river to assess alternative pathways available during flood operations. Fish were released in April of 2011 and final receiver downloads were completed in August of 2011. This presentation highlights preliminary data collected and plans for continued study in the coming years.

Application of the Emigrating Salmonid Habitat Estimation (ESHE) Model or San Joaquin River Chinook Salmon Restoration

Paul Bergman (Presenter), Ben Rook, and Joe Merz, Cramer Fish Sciences

In order to restore degraded river systems and develop large-scale, sustainable watershed strategies, it is essential for managers to consider the habitat requirements for salmonids and re-establish the amount and range of habitat features that salmonids prosper under. To maximize the benefits received from restoration efforts, quantitative measures of habitat features preferred by salmonids will be required to increase the likelihood of a restoration program being successful and cost-effective. We have recently developed the Emigrating Salmonid Habitat Estimation Model (ESHE) that models the rearing and emigration of individual daily cohorts of juvenile Chinook salmon and tracks their average growth, emigration, territory size, and ultimately the amount of suitable habitat required to sustain the number of juvenile salmon present within a model reach, on a given day throughout the rearing and emigration period. The ESHE Model also allows user-modified inputs and provides measures of uncertainty about estimates of required suitable habitat. Our goal for developing the ESHE model was to create a tool that estimates habitat requirements for the population as a whole throughout the emigration season, without modeling the range of life-history diversity of juvenile salmonids. Although the present model does not explicitly model life-history variants (e.g., fast-moving, fry-sized juveniles or slow-moving, rearing smolts), we assume that accounting for the habitat requirements of the average migrating juvenile salmon will be adequate to estimate the requirements of the majority of the population. Our next goal is to apply the ESHE model to the San Joaquin River Restoration project to quantify and qualify Chinook salmon rearing habitat essential to support future salmon adult escapement targets. We present the conceptual framework underlying the ESHE Model, examples from the Central Valley, and an initial description of data that will be used to parameterize ESHE model relationships for the San Joaquin River.

Developing an Experimental Population Rule, ESA Section 10(J), for Spring-Run Reintroduction

Rhonda Reed, National Marine Fisheries Service

Spring-run Chinook salmon (*Oncorhynchus tshawytscha*) were extirpated from the San Joaquin River over 60 years ago when Friant Dam operations were brought fully on line and large stretches of the river became dewatered. Remaining Central Valley Spring-run Chinook salmon populations are listed as threatened under the Endangered Species Act (ESA). Fall-run Chinook salmon persist in dwindling numbers in the large tributaries to the system, but are not listed under the ESA. A legal settlement calls for the reintroduction of these salmon runs. The enabling statute requires use of the ESA experimental population designation, section 10(j), and section 4(d) rule to avoid impacts to third parties that could result from such reintroduction. The first use of an experimental population designation for an anadromous fish has been proposed in 2011. Significant challenges exist to address these requirements while successfully establishing the new runs. Various methods are being employed to obtain sensitive information needed for crafting these rules, while protecting proprietary information, and creative approaches are required. These methods may be useful to other efforts to develop safe harbor or experimental population rules for highly migratory and anadromous fish species.

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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 and hands-on trainings to the restoration community.
2. Conduct outreach to constituents, media, and students to inform the public about the plight of endangered salmon and the need to preserve and restore habitat to recover the species.
3. Advocate on behalf of continued restoration dollars, protection of habitat, and recovery of imperiled salmonids.

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