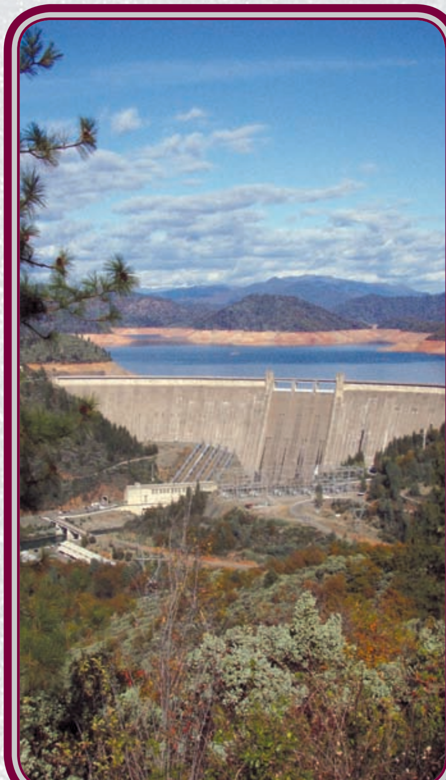
28th Annual Salmonid Restoration Conference
and the
44th Annual American Fisheries Society Cal-Neva Conference

Fisheries Restoration and Science in a Changing Climate

CALIFORNIA-NEVADA CHAPTER

AFS

March 10-13, 2010, Redding Convention Center



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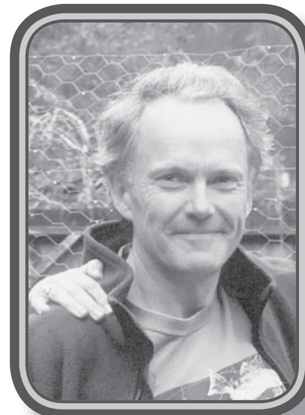
Fisheries Restoration and Science in a Changing Climate



On behalf of the Board of Directors of the Salmonid Restoration Federation I would like to welcome you to 28th Annual Salmonid Restoration Conference, which we are pleased to be combining with the American Fisheries Society's Cal-Neva Conference for the first time. I would like to acknowledge and thank the staff of SRF—Dana Stolzman, Dian Griffith, and Melissa Scott for all the work they have put into organizing the conference.

The theme of this year's conference is Fisheries Restoration and Science in a Changing Climate —an appropriate double entendre considering the challenges facing fisheries recovery from both a political and physical standpoint. 2009 will go down as the year of the Big Freeze, when many fisheries restoration organizations saw their grant funding suspended and State workers saw their paychecks shrink with furlough days while the State grappled with a cash flow crisis. 2009 will also be known as the year of the World Climate Conference and the ongoing heated debate surrounding the issue of global warming caused by human-kind's large carbon footprint.

As you look through the conference agenda you will note that there are two sessions whose titles include climate change and its effect on fisheries—and it is hard to see how climate change does not play a role in every talk in every session. It is obviously one of the hot topic issues of the day—and for good reason. The implications of climate change on sea level rise, melting snow packs, changes in run-off regimes, and instream flows and temperatures translate into huge implications on the viability of cold water fish and the distribution of warm water fish.

Climate change also has indirect effects that have huge potential impacts on fisheries and water availability for instream flows. In a state approaching 40 million people, and with a large irrigated agricultural land base, the demand on water resources will only intensify. We are already hearing talk of raising dams, and building new dams and a peripheral canal. We are looking at an increasing demand on a shrinking resource and the biggest losers may be the fish.

As restorationists and scientists, the challenges before us are immense and it is important that we are informed by sound science. Understanding what climate change will do to instream flows, fisheries habitat, and our water supplies is crucial—not only for understanding the effects on fisheries and wildlife, but also so we can try to help inform legislators and the public so they hear intelligent discussion about why it is important to save the Delta smelt, or why it is important to restore flows in the San Joaquin River, and why the government of California should help pay for the removal of the Klamath dams.

While it would be easy to feel overwhelmed and even discouraged by the challenges facing us, I always find these conferences and the free-flow exchange of ideas to be very informative, invigorating, and even uplifting. I always leave the conference with a renewed sense of hope based on the knowledge that there are some very smart, dedicated, and talented people working on these issues.

The presentations and discussions we will hear today are timely and topical and I am pleased that SRF and AFS are able to join forces to bring together such an outstanding lineup of speakers and relevant issues. I look forward to the presentations, discussions, and sharing of ideas.

Thanks—and Enjoy!

Don Allan

Don Allan
SRF Board Persident

Welcome

Welcome to the 28th Annual Salmonid Restoration and the 44th Annual American Fisheries Society Cal-Neva Conference entitled, "Fisheries Restoration and Science in a Changing Climate," since the conference will address the challenge of recovery and restoration efforts in the face of global climate change, water shortages, and California's evolving political landscape.

In this era of climate change, a state budget crisis that has paralyzed the restoration field, and diminishing salmon returns, it is more important than ever for fisheries scientists and restorationists to gather together to share resources, techniques, strategies, and methodologies to restore habitat and recover wild salmon populations.

SRF is thrilled to have partnered with the American Fisheries Society Cal-Neva chapter to produce this historic joint conference. This has been a truly collaborative effort that has produced an exceptional agenda. This promises to be an outstanding conference that will undoubtedly spawn lively discussions about how to recover salmonids and restore habitat. It is exciting to host this joint conference in Redding to showcase all the multi-stakeholder efforts to restore large river systems on the Trinity, Shasta, and Sacramento Rivers and the inspiring efforts to restore Battle Creek and Clear Creek.

Fisheries specialists, on-the-ground restorationists, students, agency personnel, legislators, and watershed stewards will migrate from all over the Pacific Northwest and beyond to share in this premier fisheries restoration conference that will address pressing issues like groundwater withdrawal, managing instream flows for fisheries, water allocations, fish passage, floodplain and stream channel restoration, and climate change.

The production and coordination of the annual conference was a fluid, dynamic process that engaged Salmonid Restoration Federation's diverse Board of Directors, the American Fisheries Society Cal-Neva Executive Committee, co-sponsors, and colleagues who represent restorationists, fisheries biologists, educators, advocates, tribal members, and agency personnel from the Pacific Northwest all dedicated to habitat restoration and recovery of salmonids.

Creating the conference agenda was a huge team effort. I am grateful for working with Mark Gard, Michelle Workman, Cynthia Le Doux-Bloom, and Wayne Lifton of the AFS Executive Committee. I would like to thank the entire SRF Board especially Mike Berry from the California Department of Fish & Game who helped spearhead the conference in Redding and SRF's Board President Don Allan who has been a constant source of support and guidance. Special appreciation goes to former Board President and sturgeon scholar Josh Israel who helped both AFS and SRF envision how to create a diverse agenda that would address environmental and physical conditions, fish biology and genetics, policy and funding issues, and limiting factors that impact fisheries. All of your input and ongoing participation in this joint venture was invaluable.

I would like to thank all of the participants and fisheads who migrated so far to be here, our illustrious presenters, the amazing volunteer session, field tour, and workshop coordinators for helping to craft an impressive agenda. Thank you to all of our co-sponsors for your time, ideas, donations, and your vital contributions to help make this fisheries restoration conference a reality. Also a big thanks to all of the dedicated work trade folks who rock it every year—you're the future of fisheries restoration.

SRF will also be offering a host of other technical education trainings in 2010 including the 5th Annual Spring-run Salmon Symposium on Butte Creek, the 13th Annual Coho Confab on the Russian River, and hopefully a fish passage field school, and a Humboldt Bay Symposium.

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

Dana Stolzman

Dana Stolzman
Executive Director
Salmonid Restoration Federation

Fisheries Restoration and Science in a Changing Climate

Welcome to the California-Nevada Chapter of the American Fisheries Society's 44th Annual Conference, which this year is a joint conference with the Salmonid Restoration Federation. I was excited for the opportunity to combine efforts of the two organizations, since it provides a number of benefits to both organizations, including (to identify a couple): efficient use of organizational efforts, consolidated educational event for attendees, and greater networking between both organization's participants. Given the state budget crisis, 2010 is an excellent time for a joint conference of the Salmonid Restoration Federation and California-Nevada Chapter of the American Fisheries Society. The Salmonid Restoration Federation is a particularly appropriate partner for a joint conference, given the similar objectives and overlapping membership of the two organizations. Specifically, the objectives of the California-Nevada Chapter of the American Fisheries Society are: a) to promote the conservation, development, and wise use of the fisheries; b) to promote and evaluate the development and advancement of all branches of fisheries science and practice; c) to gather and disseminate to Society members and the general public scientific, technical, and other information about fisheries science and practice through publications, meetings, and other forms of communication; and d) to encourage the teaching of fisheries science and practice in college and universities and the continuing professional development of fisheries workers. Similarly, the objectives of the Salmonid Restoration Federation are: a) to help stream restoration practitioners advance the art and science of restoration; and b) promote restoration, stewardship, and recovery of California native salmon, steelhead, and trout populations through education, collaboration, and advocacy. Personally, I have learned an incredible amount from Dana Stolzman of the Salmonid Restoration Federation about how to have a well-organized conference; I am sure that future Cal Neva conferences will be much better organized thanks to what we have learned from her.

Thanks to the many volunteers from the California-Nevada Chapter of the American Fisheries Society, along with the many volunteers from the Salmonid Restoration Federation, who have given of their time, energy and expertise in pulling this joint conference together: Josh Israel, who put together the initial concept paper for a joint conference; Michelle Workman, who has done at least as much as I have in organizing the conference; Ayesha Gray, who for the third year in a row has provided at no cost the excellent art work for AFS's conference t-shirt; Sarah Giovanetti, who once again has come through with a great conference t-shirt; Brad Cavallo for organizing the job fair; Shelly Hatelberg, who has put in so much work in organizing what will be a great AFS Social at Turtle Bay; Beth Campbell, who agreed to once again head up fundraising for the conference and has done an excellent job; Tom Keegan and the American Institute of Research Fisheries Biologists, who for an amazing eight years have headed up the student presentation and student poster judging; Victoria Poage and Cynthia LeDoux-Bloom for getting all of the items for the AFS raffle; Alice Berg who has organized the spawning run; Zack Jackson, who has gotten a record-breaking commercial exhibitors for the trade show; Jenny Hatch for helping to coordinate the poster session; Shirley Witalis who for the second year has headed up preparing signs and banners for the conference; Keenan True for organizing audio-visuals for the conference; the members of the California-Nevada Chapter Executive Committee, many who are mentioned above; Rachel Madison for coordinating AFS volunteers; all of the other volunteers, particularly Jean Baldridge and Sharon Shiba, who year after year are the key to our conferences being so successful; and last but not least the plenary speakers, trainers, session speakers, and session coordinators who donated their time and shared their knowledge and expertise. Their participation is what makes the annual Cal Neva conference exceptional year after year.

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Mark Gard
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AFS Spawning Run—6:30am start

Cabaret, Banquet, & Dance —6pm start

Poster Session Presenters

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Julie Beagle, *UC Berkeley*

Gina Benigno, *California Department Water Resources*

Cheryl Bondi, *Center for Watershed Science, UC Davis*

John Cain, *American Rivers*

Julie Carlson, *Sonoma Ecology Center*

Florence Consolati, *Pacific States Marine Fisheries Commission*

Daniel Cox, *US Fish & Wildlife Service*

Brian Deason, *El Dorado Irrigation District*

Elliot Doss, *Department of Fish & Game, Bay Delta Region*

Mark Gard, *US Fish & Wildlife Service*

Damon Goodman, *US Fish & Wildlife Service*

John Green, *Gold Ridge RCD*

Greg Guensch, *Balance Hydrologics, Inc*

Mike Guerriero, *Friends of the Eel River*

Brett Harvey, *Center for Watershed Sciences, UC Davis*

Brian Hastings, *Balance Hydrologics, Inc*

Michael Hellmair, *Humboldt State University*

Nicholas Hetrick, *US Fish & Wildlife Service, Arcata*

Drew Irby, *SFR Nomination Table/TUCA*

Michele Johnson, *California Department Water Resources*

Wendy Katagi, *CDM*

Jonathan Koehler, *Napa County Resource Conservation District*

Todd Kraemer, *Pacific Watershed Associates*

Kent Macintosh, *Trout Unlimited*

Graham Matthews, *Graham Matthews and Associates*

L. Breck McAlexander, *California Department of Fish & Game*

John McKeon, *NOAA Fisheries*

Daniel Menten, *US Fish & Wildlife Service*

Shannon Moon, *California Trout*

Chris Mosser, *UC Davis*

Halley Nelson, *UC Davis*

Gerry Ng, *Northern California Council Federation of Fly Fishermen*

Yvette Redler, *NOAA Fisheries*

Michael Saiki, *US Geological Survey*

Jeremy Sarrow, *Napa County Flood Control & Water Conservation District*

Juddson Sechrist, *Bureau of Reclamation*

Matt Smith-Caggiano, *US Fish & Wildlife Service*

Laurie Stafford, *US Fish & Wildlife Service*

Margaret Tauzer, *NOAA Fisheries*

Nicholas Van Ark, *California Department of Water Resources*

Marcin Whitman, *Department of Fish & Game*

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JD Wikert, *US Fish & Wildlife Service*

Sarah Yardell, *Center for Watershed Science, UC Davis*

Cincin Young, *Instream Flow Assessment Program, Center for Aquatic Biology and Aquaculture*

Tara Zuroweste, *Pacific Watershed Associates*

Plus More...

River2D Modeling Short Course Continuing Education Class

Wednesday, March 10

Instructors: ***Terry Waddle, PhD,*** *U.S. Geological Survey,* ***Mark Gard, PhD,*** *and* ***Ed Ballard,*** *U.S. Fish and Wildlife Service*

The River2D workshop is an intensive introduction to the use of the River2D two-dimensional hydrodynamic model to represent segments of streams where quantitative information about aquatic habitats is needed. The workshop consists of lectures and hands-on exercises covering processing of field data, construction of needed input files, quality control and execution of the River2D model, and a brief introduction to habitat modeling based on 2D hydrodynamic model results. Course participants are expected to have basic familiarity with a spreadsheet program and the Windows operating system. Participants will be introduced to the types of data needed for the modeling process, quality control of that data, construction of required input files, running of the River2D model and quality evaluation of its output.

The workshop consists of lectures followed by hands-on exercises. While each exercise builds on the concepts of the last, complete files for each step are included to ensure all participants can keep pace with the intensive time line of the class.

Upon completing the workshop, participants will be able to construct a bathymetric data input file, construct a computational mesh, run the River2D model, evaluate the quality and accuracy of model results, and perform a basic quantification of physical habitat over a habitat study site.

Participants will be expected to provide their own laptop computer. Minimum requirements are: Windows 2000 or XP and 256 Mb of RAM (however, the more RAM the better). River2D works on Vista machines. A fast computer is better for large files. River2D should work with Windows7 as well, but it hasn't been tested to confirm. The River2D software should be downloaded prior to the class from *http://www.river2d.ualberta.ca/download.htm.* This package includes tutorials that new users would be highly advised to work through before the workshop. A full program set will be available at the class on CD ROM and on USB key.

Using Acoustic Tags to Track Fish Continuing Education Class

Wednesday, March 10

Instructors*: Sam Johnston* *and* *Pat Nealson,* *Senior Fisheries Biologists, HTI*

Using Acoustic Tags to Track Fish is an intensive two-day course on the use of acoustic tags for tracking fish. You will learn how acoustic tags are used to estimate fish survival and to monitor fish behavior in 2D and 3D in rivers, lakes and marine environments. The course will include acoustic theory and real world application examples along with hands-on demonstration of acoustic tag deployment, data collection, reduction and analysis, and Q&A with the technology's leading experts. Recent advances in acoustic tag technology, including tag miniaturization, extended detection ranges, real-time access, and remote access will be discussed. An instruction manual will be provided, along with reports and papers from case studies.

Requirements for Completion: Course participants will be required to attend 90% of the lecture and lab. In addition, the participants must complete the course evaluation form and a brief written exam.

Learning Outcomes: Upon completion of this course, fisheries managers will be able to prudently plan acoustic tag research drawing on presented acoustic theory and techniques as well as the pros and cons of acoustic tag studies.

Additional Information: HTI's acoustic tag short courses have been conducted worldwide for over 10 years. Acoustic tag short courses are attended by biologists, engineers, managers, and technicians from fisheries agencies, consulting firms, power producers, and regulatory agencies. A team of two HTI Senior Scientists will lead the course, each with over 27 years experience using and teaching the use of fisheries acoustics.

Workshop Coordinators*: Andy Baker, NCWQCB and* ***Jim Harrington****, DFG*

Strategies for Monitoring the Effectiveness of TMDLs and What Every Fish Lover Needs to Know about Bugs, Bioassessment, and Biocriteria

Jim Harrington, *California Department of Fish and Game, Aquatic Bioassessment Laboratory*

Typically, fisheries biologists and managers do not concern themselves with water quality regulations. However, there is a paradigm shift in the nation regarding water quality regulation that all fish lovers should understand. The foundation for the shift comes from the federal Clean Water Act (CWA) which states that the primary objective of the Act is to protect and preserve chemical, biological and physical integrity of the Nation's waters. Although those words have been around since the writing of the CWA in 1972, not until the late 1980's did the U.S. EPA really push to regulate water quality using biotic and physical indicators instead of just using water chemistry data. Collectively called bioassessment, standardized procedures to measure fish, benthic macroinvertebrate (BMI), benthic algae and physical/ habitat structure are used to determine biotic and physical integrity.

Although fish and algae are also used to determine biotic integrity, BMIs are used in California and throughout the world as the primary biotic indicator since they provide the best signals of stream health. BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. They are also sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution. Together, biological and physical assessments integrate the effects of water quality over time, are sensitive to multiple aspects of water and habitat quality, and provide the public with more familiar expressions of ecological health.

The TMDL process which is a vital part of the CWA, can be thought of as a regulatory tool to rehabilitate damaged streams and rivers. TMDLs are used to fix water bodies that have been designated as impaired and put on the 303d list. Best Management Practices (BMPs) are then implemented to hopefully bring the water body to a healthier state. One of the fundamental uses of bioassessment data is to determine the effectiveness of BMPs or any activity aimed at improving the quality of aquatic systems. In this presentation, I will review some of the monitoring strategies used by other presenters in the workshop and discuss ways to incorporate standardized bioassessment techniques into the TMDL process.

The Tomales Bay Watershed TMDLs

Carmen Fewless, *Environmental Scientist, San Francisco Regional Bay Water Quality Control Board*

Tomales Bay, located in western Marin County about 30 miles northwest of San Francisco, supports commercial cultivation and harvesting of shellfish, and is a popular destination for recreation, such as swimming, fishing and boating. It also supports a diversity of fish-eating birds and aquatic life. The Bay has a surface area of approximately 11 square miles, draining a watershed area of 216 square miles. Tomales Bay receives drainage from Lagunitas Creek, Olema Creek, and Walker Creek watersheds, as well as direct drainage from small tributaries along the west and east shores. Tomales Bay faces water quality challenges from pathogens of fecal origin. The pathogen-impaired beneficial uses of the Bay are shellfish harvesting, water contact recreation, and non-contact water recreation. Walker Creek, draining into the Bay and listed as impaired for mercury originating from the former Gambonini Mine, presents concerns for fish-eating birds.

In September 2005, the San Francisco Bay Water Board adopted the Tomales Bay Pathogen TMDL and Implementation Plan to control pathogen discharges in the Tomales Bay Watershed, and to protect the public from exposure to waterborne diseases. The TMDL identifies source categories that have the potential to discharge pathogens to surface waters: on-site sewage disposal systems, small wastewater treatment facilities and sewage holding ponds, boat discharges, municipal runoff, dairies, equestrian facilities, and grazing lands. In July of 2007, the Water Board adopted the mercury TMDL and Implementation Plan for Walker Creek to address erosion and the potential production of methylmercury if mercury-laden sediments are inadvertently released from bed and banks into the stream.

At the time of the pathogen TMDL adoption, the Water Board had already addressed water quality issues related to most all of the pathogen pollutant source categories. However, grazing operations had not been formally regulated. To address any pollutant releases from grazing lands, the Water Board adopted a Conditional Waiver of Waste Discharge Requirements in July 2008. The Conditional Waiver requires landowners and/or operators of grazing lands draining into Tomales Bay to prepare a Ranch Water Quality Plan that describes a schedule of how and when they will implement multi-objective management measures. The Conditional Waiver not only addresses the existing pathogen and mercury TMDLs, but also addresses the anticipated requirements of future sediment and nutrient TMDLs in the Tomales Bay Watershed.

Assisting Landowners with TMDL Compliance

David J. Lewis, *UC Cooperative Extension County Director and Watershed Management Advisor*

The implementation portion of the Tomales Bay Pathogen TMDL called for the development and approval of a waiver for grazing operations to reduce delivery of nonpoint source pollution including pathogens and sediment, nutrients, and mercury. Through a lengthy process, the Conditional Waiver of Waste Discharge Requirements for Grazing Lands in the Tomales Bay Watershed was approved on July 8, 2008. As a result, approximately 210 working ranches were required to submit Notices of Intent by January 31, 2009 and complete plans including submission of annual certifications on November 15, 2009. A work group of nine supporting organizations (California Cattlemen's Association, Marin Agricultural Land Trust, Marin County Farm Bureau, Marin Organic, Marin Resource Conservation District, Natural Resources Conservation Service, Point Reyes National Seashore, University of California Cooperative Extension, and Western United Dairymen) and ranching community representatives was formed to assist grazing operators in complying with waiver requirements. Each of these partners played a significant role in the success of this program that has lead to a reasonable and feasible approach for grazing operation compliance with TMDLs and Conditional Waivers for pathogens, sediment, nutrients, and mercury. At last count, 160 parcel owners have submitted annual certifications. This presentation will describe the work group's collaborative effort to develop ranch water quality plan templates and assist landowners with completing forms and implementing plans. Additionally, the elements of the waiver program that facilitate increased rancher participation will be discussed including self-certification and on-farm filing of ranch water quality plans.

The Shasta Valley Resource Conservation District and the Shasta River TMDL

David Webb, Shasta Valley Resource Conservation District

As one of the last TMDLs completed by the North Coast Regional Water Quality Control Board, the Shasta TMDL incorporates some of the lessons learned along the way. The Shasta Valley Resources Conservation District was identified in it as the best entity to work one-on-one with the agricultural community on steps needed to reach compliance with the 40-year goals of the TMDL. While the RCD has been engaged in efforts essentially identical to those called for in the TMDL since 1989, there are still surprises, along with the daunting fact that much of what was easily doable has been done, and what remains may not be entirely within our reach. I will touch on recent major projects, hurdles encountered with conflicting state laws, the water quality monitoring now underway, staffing challenges given the magnitude and duration of the TMDL task, meshing coho incidental take permit efforts with TMDL work, and some thoughts on the risks to an organization that was built on assisting voluntary efforts when it dances too close to the regulatory flames.

Implementing the Shasta River TMDL

Andy Baker, North Coast Regional Water Quality Control Board

The Shasta River drains 795,000 square miles in Siskiyou County California and flows into the Klamath River near the Oregon border. Watershed elevations range from 2,000 feet at the mouth to 14,200 feet at the top of Mount Shasta (an active volcano) where glaciers provide a constant source of cold water. Melting snow and glaciers percolate down through lava tubes and emerge as numerous large springs that flow into the Shasta River on the Shasta Valley floor. This cool water source once provided what is considered to be the most productive habitat for spring-run Chinook, fall-run Chinook, coho salmon, and steelhead trout. Fish populations have dwindled drastically due to elevated stream temperatures, low dissolved oxygen levels and migration barriers from several dams. Spring-run Chinook no longer inhabit the river and coho salmon are listed as endangered under the State and Federal Endangered Species Acts. The primary contributors to poor water quality conditions are cattle grazing, water diversions and tail-water return flows. Flood irrigation practices divert water while introducing warm, nutrient rich tail-water into the river.

The Shasta River is listed as impaired on the 303(d) list of the Federal Clean Water Act due to elevated stream temperatures and low dissolved oxygen levels. The Shasta River TMDL was adopted b the USEPA and became State law on January 26, 2007. The TMDL contains an Action Plan with specific actions to improve water quality conditions that include:

- Protect streams to exclude livestock and increase riparian shade.
- Increase dedicated cold water from springs and other sources.
- Remove minor water impoundments that increase water temperatures and decrease dissolved oxygen levels.
- Decrease tail-water return flows that increase water temperatures and introduce harmful nutrients.
- Improve water quality conditions in Lake Shastina
- Decrease the discharge of nutrients, sediment, and other oxygen consuming materials from towns, cities, highways, and other sources.

The Shasta River TMDL relies heavily and builds on existing programs developed by the Shasta Valley Resource Conservation District and the Shasta Valley Coordinated Resource Management Program. The Department of Fish and Game is also in the process of implementing a Coho Salmon Recovery Program and Draft Incidental Take Permit which has many of the same requirements that are contained in the TMDL. Several other agencies/entities', such as the Natural Resource Conservation Service, Siskiyou County, City of Yreka, US Forest Service, US Fish and Wildlife, NOAA Fisheries, the Nature Conservancy, Caltrans, timber companies, irrigation districts, ranchers, and others have watershed restoration programs as well. The North Coast Regional Water Quality Control Board has worked extensively with these agencies/groups for several years in developing and implementing the Shasta TMDL. Some of the past accomplishments and collaborative efforts include:

- Protecting streams and riparian vegetation by installing many miles exclusionary fencing along streams.
- Replanting riparian areas to provide shade to streams.
- Implementing water conservation measures to increase dedicated cold water to the Shasta River
- Implementing tail-water reduction measures to reduce the discharge of nutrients from pastureland.
- Conducting water quality monitoring.
- Removing small dams that are known to increase water temperature and decrease dissolved oxygen levels.

Though much work has been accomplished much more needs to be done to meet temperature and dissolved oxygen standards/objectives to restore cold water fish habitat.

Tailwater Uncovered: How Agricultural Run-off Affects Water Quality in the Shasta Valley

Lisa Unkefer, ***AquaTerra Consulting***

With a Prop 40/50 grant from the State Water Resources Control Board, the Shasta Valley Resource Conservation District finally had the means to get a handle on how tailwater (agricultural run-off) affects the Shasta River. The RCD contracted with AquaTerra Consulting to implement a tailwater monitoring program, identify "tailwater neighborhoods" (mini sub-basins), and create prioritization criteria to discover the areas where tailwater impacts are the greatest.

A key element in discovering where tailwater neighborhoods exist was a LIDAR flight, which obtained a detailed topographic rendering of the irrigated lands of the Shasta Valley. The most important element in determining the impacts of valley-wide tailwater was continuous flow and temperature monitoring of a handful of tail water returns. Using GIS technology with the LIDAR data, neighborhoods valley-wide were outlined, as well as their suspected return points. Creating a rough model using basic run-off and mixing calculations, an idea of where the highest impacts were finally identified. Utilizing the created prioritization criteria, high priority areas can become the focus for outreach to implement tailwater reduction projects.

Garcia River Watershed History, Total Maximum Daily Load (TMDL), and Aquatic Monitoring Program

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

For several million years the watershed area now known as the Garcia River was home to abundant runs of Chinook salmon, coho salmon, pink salmon, and steelhead trout. These four species of Pacific anadromous salmonids endured multiple geologically and climactically challenging eras that included ice-ages, earthquakes, landslides, droughts, and fires.

Shortly after California became the 31st State of the Union in 1850, the condition of the watershed began to change in a dramatic way. Over the past century and a half, land use activities within the watershed included three waves of logging, instream dams, forest conversion for grazing and agriculture, stream diversions, and gravel mining. Together, these activities have caused the watershed to become polluted with excess sediment and elevated stream temperatures, devastating the condition of the instream habitat and resulting in a spiraling decline in the salmonid populations. The history of what occurred in the Garcia River is not unlike many of the watersheds in the North Coast Region with more than half of them being similarly impaired due to excess sediment and elevated temperatures.

Over the past several decades environmental organizations, restorationists, regulators, and landowners have been working together to slow down and turn back these effects from the past. Significant advances have been made to address these past impacts through erosion and sediment control, improved protections associated with land use activities, widespread instream habitat improvement, and streambank restoration.

The Action Plan for the Garcia River Watershed Sediment Total Maximum Daily Load (TMDL) has played an important part of the process. Adopted in 2002, the Garcia TMDL is a regulatory tool that seeks to address controllable human-caused sources of sediment and to improve land management activities across the landscape in order to prevent the creation of new sources of pollution. Currently, private landowners —who together own more than 2/3 of the watershed— are working with staff from the North Coast Regional Water Quality Control Board (NCRWQCB) in an effort to comply with the Garcia TMDL; this in turn is reducing the amount of sediment pollution entering the watershed and its tributaries.

The condition of the watershed and its tributaries are being monitored closely. Beginning in 2007, the NCRWQCB teamed up with The Nature Conservancy in a watershed-wide instream monitoring program in order to determine what the condition of the watershed is currently and whether or not there are any detectable trends towards recovery. Monitoring is based upon the U.S. EPA's Environmental Monitoring and Assessment Program (Western-Pilot Study) as well as the State's Surface Water Ambient Monitoring Program. Data collection includes a suite of physical, biological, and water quality monitoring parameters that are being collected throughout the watershed.

Over the past several decades, numerous successes have been attributed to the restorative work being done by the stakeholders involved in the Garcia River. Together, these ongoing efforts appear to be having a positive effect on the condition of the watershed. The key success will ultimately be determined by the ongoing viability and hopeful rebound of the Pacific salmonid communities.

Sediment TMDLs and Restoration Planning in the Mattole Watershed

Joel Monschke, Mattole Restoration Council

Levels of anthropogenic erosion in the Mattole Watershed average more than 5000 tons/mile^2/year according to the EPA's Mattole River TMDL for Sediment and Temperature. Working in this setting, the Mattole Restoration Council (MRC) has been developing innovative approaches for addressing and understanding the extensive sediment impairment which is adversely affecting salmonids throughout the watershed.

To generate a viable decrease in these large sediment pollution volumes, the MRC is preventing erosion at a large scale through landslide stabilization. The first step is identifying erosion sources where treatments offer a high potential for long-term success. Working in the stream channels to stabilize the toe of landslides is the implementation practice that generates the highest sediment saving. It also provides an opportunity to enhance instream salmonid habitat through large wood placement and reduce long-term water temperatures through riparian planting. The designs for these types of projects utilize riprap rock, willow and wood. The plans are always created on-site. General streambank stabilization and hydrological principals are used, but the specifics have been customized during years of trial and error working in the unstable geology of the Mattole and surrounding areas. (Pre- and post project photos will be shown here).

To help us prioritize future projects and further understand the geomorphic processes at work in the Mattole, the MRC is launching a new sediment modeling project that aims to quantify sediment-related channel conditions throughout the watershed. This model will make projections through time and could be especially useful in predicting estuary recovery. The model will utilize the sediment TMDLs as baseline data for erosion rates and then route this sediment through the channel network. The first step in this process (which is already underway) will be to refine and update the sediment TMDLs at a sub-watershed scale. Then extensive channel measurements, sediment transport modeling, and calibration of the model will produce a tool that will help validate past sediment reduction work, guide project design, and predict future scenarios. The sediment model will be integrated with MRC's GIS software to create visual depictions of model outputs.

The MRC believes that targeted large-scale sediment reduction projects will aid the recovery of the Mattole fisheries and offer the only avenue to approaching the sediment TMDL targets set forth by the EPA. However, given the cost and failure potential of such projects we believe that it is critical to continue to expand our understanding of watershed processes.

Redding Urban Streams: They are Worth the Effort to Rehabilitate

Wednesday, March 10

Field Tour Coordinators*: Mike Berry and Andrew Jensen,*
California Department of Fish & Game

Beginning with the gold rush, Redding area streams have been impacted by human activity. The Redding urban streams tour includes stops at several streams where efforts from agencies and non-profit restorationists have enhanced salmonid habitat through erosion control, culvert baffling, grade control structures, barrier modification, gravel supplementation, riparian planting, and invasive species control.

The Evolution of Restoration Techniques on the Trinity River

Wednesday, March 10

Field Tour Coordinator*: Damon H. Goodman,* *U.S. Fish & Wildlife Service*

In its pristine state, the Trinity River was a large alluvial system that supported a diverse assemblage of fish and wildlife species including large runs of anadromous salmonids. Anthropogenic disturbance caused by extensive historical gold mining, the construction of Trinity and Lewiston Dams in 1964 and the diversion water into the Sacramento River has drastically altered the dynamics of this ecosystem. In 2000, the Secretary of Interior and the Hoopa Valley Tribe signed the Trinity River Mainstem Fishery Restoration Record of Decision which initiated a process-based restoration effort that has been developed and is currently being implemented on the Trinity River. The goals of the restoration effort include returning the Trinity River to a functioning aquatic ecosystem and restoring naturally produced anadromous salmonid populations to pre-dam levels. Restoration actions include flow management, mechanical bank and floodplain rehabilitation, coarse sediment augmentation, watershed restoration and large wood management. These actions are implemented under an adaptive management and science-based framework with specific focus on the evaluation of restoration techniques, and monitoring habitat changes and biological response from restoration. Through the implementation of the Trinity River restoration effort, insights have been gained about restoration implementation and the effectiveness of initial restoration techniques. This has led to an evolution of restoration implementation. In this tour, participants will visit several of the bank rehabilitation sites with a particular emphasis on the evolution of restoration techniques and lessons learned on the Trinity River.

Rebuilding Habitat for Central Valley Salmonids: Clear Creek Restoration Project Tour

Wednesday, March 10

Field Tour Coordinators: ***Matt Brown, Sarah Giovannetti,*** *and* ***Jim Earley,***
U.S. Fish and Wildlife Service

Salmonid restoration in Clear Creek, a tributary of the Sacramento River near Redding, has included increased stream flows, dam removal, large-scale floodplain and stream channel reconstruction, gravel augmentation, erosion control, and fuels reduction. Restoration projects on Clear Creek have improved habitat for steelhead, spring, fall, and late-fall Chinook salmon in the northern Central Valley. Recent increases in the adult populations of steelhead and the three runs of Chinook salmon in Clear Creek suggest that restoration has been successful so far. Additional work remains to acquire channel maintenance flows, develop a long-term flow prescription, secure a long-term supply of spawning gravel, create additional spawning habitat and manage water temperatures in the face of global warming. Our collaborative restoration process has involved diverse federal, state, and local agencies, local landowners, and representatives of power and water companies.

Join us as we visit restoration projects and vistas throughout the anadromous portion of the creek. Tour stops will include floodplain and stream rehabilitation sites, spawning gravel supplementation areas, Whiskeytown Reservoir overlook, and the newly constructed greenway project overlook. Members of the Clear Creek Restoration Team will talk about our challenges and successes, and our plans for the future.

Effective Presentation Skills Continuing Education Class

Thursday, March 11

Instructor*: JD Wilkert,* ***Anadromous Fish Restoration Program, U.S. Fish & Wildlife Service***

Students learn the five P's of effectively communicating in front of an audience: Preparing, Planning, PowerPoint, Practicing, and Presenting. Do's and Don'ts for each category are demonstrated and discussed. Students practice presentations and receive friendly feedback from other students and the instructor. Students learn how to avoid common problems when giving presentations, and how to be an effective session moderator.

Restoring Channel and Floodplain Processes to Increase Salmonid Populations Workshop

Thursday, March 11

Workshop Coordinator*: Eric M. Ginney, MS, Philip Williams and Associates, Ltd.*

Rivers and their floodplains are among the most productive and diverse ecosystems on Earth. In California, they are also one of the most-altered ecosystems. In many past restoration efforts and programs, there has been a strong emphasis on restoration of spawning gravel through augmentation and mechanical enhancement. However, in review of river restoration to benefit salmonid populations, there is increasing recognition of the importance of rivers being connected to their floodplains in supporting key ecosystem functions that can increase the number of successfully out-migrating smolts—and also produce larger and healthier juvenile fish which can ultimately lead to higher escapement. Perhaps not so unconnected is that in-channel restoration (i.e., gravel augmentation, riffle construction, LWD placement) commonly targets creation of the form we associate with proper habitat, and the function is assumed to come with it—despite any quantifiable metrics for defining or monitoring the intended function. In this workshop, we explore the functions of, and linkages between, the channel and its floodplain. We also examine how channel and floodplain restoration projects can benefit from a synergistic, comprehensive approach that includes quantifiable metrics to guide design, monitor success, and enable learning—all important aspects of the adaptive management approach that is commonly sought for restoration.

This workshop focuses on providing:

- An overview of the science of rivers and their floodplains, the life history needs of the salmonids that utilize these interactive systems, and the specific physical processes that create and maintain the habitat that these fish require to maintain healthy populations.
- An overview of the impacts to California's rivers flows and sediment supplies, how these impacts influence both salmonids and their habitat, and why in our restoration planning and design we must address the specific physical processes that are impacted.
- A summary of the linkages between channels and floodplains, and overview of quantifiable metrics for characterizing in-channel and floodplain function and quality
- An introduction to tools for assessment, planning and design of channel and floodplain restoration.
- Examination of case studies on the Feather and Trinity Rivers to engage participants with important, real-world restoration challenges in a hands-on environment and reinforce the use of applicable tools for assessing, planning and designing restoration measures.
- Participants are encouraged to come to the workshop with specific rivers or river sites already in mind to help them learn and consider the use of the tools and metrics that will be introduced.

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 these organisms 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 introduction to the workshop, we will discuss important components of stream conditions that affect salmonid habitat, including spawning, incubation, emergence, feeding, predator avoidance and migration.

The Role of Floodplains in the River Ecosystem: The Floodplain Activation Flow (FAF) as a Restoration Metric and Design Tool

Elizabeth Andrews, PE, *Principal, Philip Williams & Associates, Ltd.*

River-floodplain connectivity is a vital driver for a host of ecological functions. These functions occur at time scales brief enough to wash a cottonwood seed onto dampened silt at the margins of a flooded river and long enough to radically reshape the topography and habitat in a valley bottom. In the parlance of the Floodplain Conceptual Model developed for the Sacramento-San Joaquin Delta Regional Ecosystem Restoration Implementation Plan (DRERIP), some functions occur as the floodplain landscape template is itself created. Others occur as a result of that landscape template being inundated. A broad review of these ecological functions and their relationship to river-floodplain connectivity will be provided.

That overview will be followed by a focused exploration of the dynamics that occur during low-magnitude, high-frequency events that historically inundated floodplains along the lowland alluvial rivers of California. 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. 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. 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 valuable focus for restoration.

We will describe our specific investigations focused on identifying the stage characteristics of this flow and the application of this information in the development of floodplain restoration designs. Given the particular characteristics of a desired floodplain hydrologic regime, it is possible to use modeling tools to evaluate where and under what conditions such a condition can be created. The relationships between flows, water surface profiles, and inundated floodplain areas can be evaluated using existing conditions data or records to estimate where inundated floodplains currently exist and how large an area they occupy. Scenarios can also be evaluated using hypothetical information for flow rates and/or floodplain topography to assess potential inundation patterns under modified conditions. Modeling tools may be as simple as regression relationships between adjacent stage gauge records or as elaborate as multi-dimensional hydrodynamic simulation models. Spatial analysis at the reach and landscape scale can be greatly enhanced using GIS tools. Monitoring data at implemented projects can be readily collected (e.g., as stage data time series) to evaluate the modified hydrologic regime and determine how well targets such as inundation seasonality, duration, and intra-annual frequency have been met.

We will describe a pilot investigation along the lower Sacramento River on FAF stages or water surface elevations under the current hydrologic regime. We will also describe our application of a FAF assessment as a tool in the development of floodplain restoration designs along the Bear and Feather Rivers, and present some thoughts on the implications of our findings and the application of such approaches elsewhere.

Impacted River Processes and How They Influence Channel and Floodplain Restoration Design

Andrew Collison, PhD, *Principal, Philip Williams & Associates, Ltd.*

Restoring channel and floodplain processes to increase salmonid populations requires us to understand the underlying physical processes that fish have adapted to over millennia, and how those processes have been impacted over the last 200 years or so. From a management standpoint we also need to know the extent to which those vital processes can be restored or replicated, and which parts of the impacted landscape have the greatest potential for restoration. Finally we need tools to incorporate this knowledge into restoration efforts more systematically.

Impacts to California's rivers started with the arrival of Euro-American settlers in the early 19th century (the rancho period) but became most dramatic during the Gold Rush. Hydraulic mining generated vast amounts of sediment that are still affecting river and floodplain processes to this day. With the Gold Rush central valley cities sprung up overnight in one of the most flood-prone regions of the US, leading to massive flood control efforts that dramatically altered the riverscape—levees, debris dams and ultimately the huge Federal and State water projects with their dams on most of the Sierra tributaries. At the same time population growth in the Central Valley and throughout California has led to massive diversions of water out of the rivers and delta. The physical riverscape has been truncated, simplified and channelized, while the volume, timing and quality of water in it have been degraded.

However, as the 'plumbing' perspective of the Central Valley has been influence by a more geomorphic and ecological approach, the same tools that were used to bring about these changes are starting to be applied to restoring the Valley. Restoration science is moving away from simple empirical or qualitative approaches to a more sophisticated and quantitative understanding of the relationships between physical and ecological processes. Examples include quantitative models of the ecological requirements of flooding in cottonwood recruitment and salmonid rearing, models of sediment transport characteristics to sustain spawning gravels, and hydraulic models of flow heterogeneity and riffle-pool formation. There is an expanding tool box available to help restoration scientists, and an increasing sophistication in the approaches being taken that is a positive development for salmonid recovery.

Integrating Specific Geomorphic Processes to the Design of Riffles and Pools with Floodplain Considerations

Rocko Brown, MS, *EIT, Philip Williams & Associates, Ltd.*

Riffles and pools are the common instream geomorphic unit for the aquatic community in gravel-bed rivers with slopes ranging from 0.001-0.02, and are thus very important components in spawning habitat rehabilitation projects involving direct gravel augmentation. The contrasting hydraulic and geomorphic environments provided by riffle and pool units yield a nested hierarchy in the ecological community. Floodplain benefits for channel stability have been suggested for several decades, but a clear mechanistic understanding of how floodplains interact with in channel morphologic features is lacking. It will be shown that floodplains may actually enhance in channel morphologic features for physical habitat by altering the distribution of energy in the flow field in the main channel. While some guidelines on designing riffle, and pools exist, the majority rely on form replication with the design primarily considering only channel stability and almost no design standards consider floodplains. This presentation describes some of the basic attributes of riffles and pools. New scientific advances in understanding riffles and pools are then applied to the design of riffles and pools using a fluvial hydraulic design basis that focuses on geomorphic sustainability. A design process and some analytical and empirical tools are also presented.

Evaluating Effects of the Trinity River Restoration Program's Rehabilitation on SONC Coho

Nina Hemphill (Presenter), *Trinity River Restoration Program,* ***Wade Sinnen,*** *California Department of Fish and Game, and* ***Robert Chase,*** *Trinity River Restoration Program*

Coho salmon in the Klamath Basin are a listed species. These coho are listed as part of the Southern Oregon Northern California (SONC) Evolutionary Significant Unit. Restoration efforts underway in the Trinity River have focused on providing site fidelity, spatial movement and migration in relation to habitat for salmonids. From 2006 thru 2008 we conducted a snorkeling survey of sub year coho juveniles in five sites below Lewiston Dam. In 2006 we conducted a snorkeling survey of the entire 20 miles below Lewiston Dam to determine late summer habitat distribution and use. The highest numbers of over summering coho were located in the ten miles below Lewiston Dam. As is found in other river systems, coho were associated with off channel areas such as side pools, side channels, woody debris, and other low velocity areas. Very few over summering coho were found 12-20 miles below the Dam. These data have been used by the Trinity River Restoration Program (TRRP) in NEPA and CEQA assessments of proposed actions on a federally and state listed species. We used these data sets to provide input to rehabilitation site designs that were and are still currently being implemented from Lewiston Dam down to Bucktail Bridge in 2007 (Lewiston and Dark Gulch sites), 2008 (Sven Oberson, Deadwood, Hoadley, Gold Bar) and 2009 (Saw Mill). The purpose was to provide input to reduce engineering disturbance of the oversummering or overwintering function of specific restored areas. Designers were responsive to the concepts of over summer and over winter habitat functions. We were able to locate exact areas in the river where high counts of coho were found to pinpoint where mitigation measures such as temporary constructed bridges should go during construction.

In addition to the gravel injections and lowering the floodplains, the program built or changed the function of eight side channels from 2006-2009. Since these rehabilitation sites (2006-2009) substantively changed the off channel and edge habitat in the upper river; we resurveyed over summering habitat for coho juveniles in the 20 miles below Lewiston Dam in 2009. Comparing the 2006 to 2009 distributions provided us with early feedback on the effects of our rehabilitation actions on summer habitat for coho juveniles. Additional snorkeling and surveying of floodplains, high flow scour channels, and side channels during high flows in the winter gave us information on the preferred habitat of overwintering coho.

The data we collect on coho habitat use indicates that we are increasing the habitat of wild sub-yearlings and yearling coho. Complementary efforts are underway to provide feedback to the TRRP designers on all salmonid fry habitat. We will have to wait several generations to know if increased habitat will translate into higher natural coho adult returns. Part of the difficulty with these assessments of the progress of the Trinity River Restoration Program is that potential confounding factors such as hatchery coho spawning in natural areas may outweigh the beneficial effects of habitat production.

Workshop Coordinator*: Chris Pincetich,* *Salmon Protection and Watershed Network (SPAWN)*

Understanding the Environmental Toxicology of Pesticide Exposures in Stormwater Runoff to Salmon

Christopher A. Pincetich, Salmon Protection and Watershed Network (SPAWN)

Pesticide pulses in rural and urban watersheds originating from stormwater discharges can have both short and long-term effects on salmonids at all life-stages, and understanding the combined toxic effects of these exposures over the life of a salmon are critical to managing their recovery. Pesticide exposures can last from a few hours to days, co-occur with the presence of migrating adults, and affect sensitive embryogenesis in salmonid bearing systems. Three pesticides currently used in the Sacramento Valley, which has historically supported the majority of California's Chinook salmon (*Oncorhynchus tshawytscha*) spawning grounds, were chosen to model the exposure of salmon during embryo development to storm-water discharges. The results of static-renewal (96 h EPA method) exposures of dinoseb, diazinon, and esfenvalerate to eyed eggs and alevins resulted in acute toxicity, abnormal development, and significant changes in metabolism. This study clearly demonstrated that sub-lethal effects from the 96 hr exposures resulted in delayed mortality, undermining current reliance on EPA testing methods to determine ecological effects of contaminant exposures in salmonid early life-stages. Other studies detailing the effects of environmentally relevant concentrations of pesticides in stormwater show the disabling of the olifactory organ of salmonids, which is critical to migration success, and maternal transfer of contaminants from adult fish to their embryos. The combined effects of co-exposure to pesticides can be additive or synergistic, resulting in the underestimation of the environmental effects of complex pesticide exposures, especially to salmon already under temperature or parasitic stress. The Salmon Protection and Watershed Network (SPAWN) is currently working on educating retailers and consumers about the harmful affects of specific classes of pesticides to salmon, and advocating the application of current scientific knowledge and regulatory policy governing pesticide applications towards providing increased protection for the endangered coho salmon in the Lagunitas Watershed of West Marin, California.

Effectively Navigating Through the Complex Realm of Storm Water Related Permit Regulations for Restoration/Construction Sites in California

Andrew Jensen, MS, *Staff Environmental Scientist, California Department of Fish and Game*

The realm of stormwater regulation in California is ever increasingly complex, with a myriad of agencies and regulations to deal with. Habitat restoration projects often fall into the category of construction projects that require storm water permit approvals, creation of a Storm Water Pollution Prevention Plan (SWPPP), and implementation of an effective combination of erosion and sediment control Best Management Practices (BMPs). In general, restoration projects are regulated by the Regional Water Quality Control Boards (RWQCB), Department of Fish and Game (DFG), the Army Corps of Engineers (ACOE), NOAA Fisheries, and in some cases local municipalities. The key is to know what approvals are typically necessary, how to obtain those approvals early on, and to work diligently on maintaining compliance with the regulations throughout the life of the project.

In 1972, the Federal Water Pollution Control Act (Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from any point source is unlawful unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. On December 8, 1999, Federal regulations promulgated by USEPA (40 CFR Parts 9, 122, 123, and 124) expanded the National Pollution Discharge Elimination System (NPDES) storm water program to include storm water discharges from municipal separate storm sewer systems (MS4s) and construction sites that disturbed land of one-acre or more. Federal regulation 40 CFR § 122.26(b)(15) defines small construction activity as including clearing, grading, and excavating that result in land disturbance of equal to or greater than one acre and less than five acres or is part of a larger common plan of development or sale. Many restoration projects meet these criteria, and may be required to obtain necessary permit approvals.

Federal regulations allow two permitting options for storm water related discharges (Individual Permits and General Permits), and in California the State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWCB) implement and enforce those permits. Some restoration projects meet the criteria, and are required to obtain coverage under the General Permit. In addition, the SWRCB and RWQCB are responsible for issuing Clean Water Act Section 401 Permits for restoration projects that will be working in Waters of the United States and/or state. The Army Corps of Engineers is the permitting agency for the CWA 404 permit, which in most cases will also need to be obtained for stream and wetland restoration projects. NOAA's National Marine Fisheries Service may also be involved if you are proposing activities in a water body that has listed salmonids in it. The Department of Fish and Game reviews projects and issues 1600 agreements when deemed necessary. Typically, each agency supports and encourages restoration activities, and in many cases there are streamlined approaches to permitting of true restoration projects. Planning ahead to obtain all the necessary approvals, and knowing what streamlined approaches may be available, can save both time and money for your project.

Toxicity in Stormwater and Effects on Salmon

David Baldwin (Presenter), Julann Spromberg, Cathy Laetz, *and* ***Kate Macneale,*** *NOAA Fisheries, Northwest Fisheries Science Center,* ***Jen McIntyre,*** *University of Washington, School of Aquatic Fisheries and Sciences, and* ***John Incardona,*** *and* ***Nathaniel Schoz,*** *NOAA Fisheries, Northwest Fisheries Science Center*

Non-point source pollution is recognized as a major threat to aquatic habitats throughout the United States. An important contributor to this source of habitat degradation is stormwater runoff from agricultural, industrial, commercial, and residential landscapes. While stormwater runoff can degrade habitat in a number of ways, an important one is through the numerous contaminants that stormwater is known to contain and transport to aquatic habitats. This includes a number of contaminants that are known to be toxic to salmon, including polycyclic aromatic hydrocarbons, dissolved metals, and current-use pesticides. However, a fundamental challenge in environmental conservation is understanding the impacts of contaminants across a range of biological organization, from the activity of specific enzymes to the behavior of individual fish to the productivity of populations. This talk will highlight several lines of research designed to span a range of biological scales and examine the threat that contaminants in stormwater may pose to salmon in the western United States.

Metabolic effects of dinoseb, diazinon and esfenvalerate in eyed eggs and alevin of Chinook salmon (*Oncorhynchus tshawytscha*) determined by 1H NMR metabolomics. Aquatic Toxicology, Volume 77, Issue 4, 25 May 2006, Pages 359-371.

Field Sampling: An Overview of Equipment, Containers, Preservatives, and Handling Procedures

James Hawley, Basic Labs Inc.

A proper understanding of the types of equipment, containers, and preservatives used for each analysis for which field samples are collected is vital to the generation of scientifically valid and legally defensible analytical data. The quality of data from a sampling event can be seriously undermined or biased if the incorrect containers are used for sampling, or if an incorrect preservation technique is employed.

The session will focus on answering the following questions regarding field sampling: What manual and automatic sampling equipment is available and appropriate for my sampling event? What types of containers should be used for each type of analysis? What preservatives are required? How is sample filtration performed in the field? How should samples be transported from the sampling site to the laboratory? How quickly must the samples be sent to the laboratory for analysis? Does sample temperature matter?

These questions as well as others will be considered and addressed, and much practical information from many years of project experience will be shared. A time for questions and answers will provide for interaction and dialogue regarding specific challenges faced in real-world sampling situations.

A Systematic Approach for the Assessment and Reduction of Stormwater Related Impacts to Aquatic Systems

Todd Kraemer, *Pacific Watershed Associates*

Classical engineering designs for stormwater and urban development have traditionally focused on conveying water off-site as quickly as possible without concern for off-site effects. This strategy can lead to off-site and downstream aquatic degradation that ultimately requires retrofitting stormwater drainage systems to reduce the magnitude of stormwater runoff. It is imperative to anticipate and properly design treatments that address stormwater flows that would otherwise generate polluted runoff and cause stream channel erosion, hillslope instability, and aquatic habitat degradation. Impervious surfaces, the origin of most stormwater discharges, change landforms, water quality, runoff hydrography, and downstream hydrology of receiving streams.

Stormwater and erosion source assessments can provide valuable information that prioritize and mitigate stormwater and sediment delivery problems. Pacific Watershed Associates (PWA) has developed a methodology to assess current stormwater conditions and develop recommendations for stormwater control and erosion remediation. This field- and GIS-based approach involves detailed site characterization and systematic identification and mapping of stormwater discharge and sediment delivery sources.

Watercourses within and immediately downstream of the stormwater investigation area are mapped, stationed, and surveyed to identify stormwater and erosion inputs from adjacent hillslopes and developed areas. Field data collection includes detailed delineation and characterization of drainage areas leading to stormwater discharge points, and quantitative measurement of erosion and sediment delivery sites. Stormwater discharge points (outfalls) are mapped, as well as the drainage areas and secondary drainage structures contributing to the outfalls. The impervious and pervious areas within each stormwater drainage area are mapped and surveyed to derive runoff volumes. Erosion sites, such as landslides, rills and gullies, and streambank erosion, are evaluated for their potential to either continue to erode and deliver sediment to watercourses or to develop into problematic sites in the future. Field measurements of existing and potential erosion sites are collected to document erosion feature dimensions and to derive volume estimates of erosion and sediment delivery. Finally, stormwater discharge points and erosion sites are prioritized for treatment based on a variety of field indicators. For example, drainage areas with a high percentage of impermeable surfaces or erosion features with a high likelihood of potentially episodic or chronic sediment delivery have a high priority for treatment.

Design flows, flow velocities, and runoff volumes are calculated for each stormwater drainage area. Hydrologic calculations provide information for site specific designs that provide for stormwater retention and control to reduce on-site and off-site impacts of development.

Treatments are prescribed and intended to infiltrate or detain on-site runoff for small or moderate-sized rainfall events. Low impact development treatments extend the duration of flow by detaining runoff and removing the top part of the hydrograph. By redesigning existing surfaces to effectively infiltrate stormwater, off-site effects can be minimized and resultantly benefit the downstream aquatic ecosystem. Directing runoff into cisterns, vegetated bioswales, or absorbent drainage trenches can reduce runoff velocities and minimize downstream effects. These low impact treatments constructed in the midst of developed areas can also improve property-wide aesthetics and lower stormwater management costs.

Stormwater Pollution Prevention Plans and BMP Installations

***Clay Guzi,* ENPLAN**

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from any point source is unlawful unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. On December 8, 1999, Federal regulations promulgated by USEPA (40 CFR Parts 9, 122, 123, and 124) expanded the NPDES storm water program to include storm water discharges from municipal separate storm sewer systems (MS4s) and construction sites that were smaller than those previously included in the program. Federal regulation 40 CFR § 122.26(b)(15) defines small construction activity as including clearing, grading, and excavating that result in land disturbance of equal to or greater than one acre and less than five acres or is part of a larger common plan of development or sale. While Federal regulations allow two permitting options for storm water discharges (Individual Permits and General Permits), the California State Water Resources Control Board (SWRCB) has elected to adopt a statewide General Permit that will apply to all storm water discharges associated with construction activity. Coverage under the SWRCB's Construction General Permit Number 99-08-DWQ is currently required for all projects which disturb one or more acres of soil or whose projects disturb less than one acre of but are part of a larger common plan of development that in total disturbs one or more acres. The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP).

The development and implementation of a proper SWPPP is the key component to ensuring compliance with the Construction General Permit. Lack of compliance, particularly at the implementation phase, significantly increases project owners' and developers' potential to receive regulatory enforcement and associated fines. Storm Water fines ranging from $25,000 to $37,500 per day per project are the associated penalties for non-compliance.

Stiff penalties for non-compliance have been deemed necessary to curtail or minimize sediment-laden storm water discharges. Not only do sediment–laden discharges have the potential to ruin salmonid habitats by removing juvenile salmonid's source for cover and food, they also have the potential to prevent the initial emergence of fry by forming layers of fine sediment over stream gravels. Further, heavy metals and other pollutants can bond to the sediments contained in sediment-laden storm water discharges and additionally impair the health of salmonids. ENPLAN's presentation will focus on how to prepare a fundamentally sound SWPPP, as well as how to ensure the Best Management Practices specified in the SWPPP are installed correctly.

Fish Passage and Habitat Restoration Symposium

Symposium Coordinators*: Marjorie Caisley,* ***California Department of Fish and Game and Joey Howard, PE, Northwest Hydraulic Consultants, Inc.***

This symposium highlights the role engineers and geo-scientists play in species recovery and habitat restoration, while also providing engineers and geo-scientists with up to date information on project design and implementation. There will be presentations on recently completed fish passage and restoration projects as well as presentations about the California Department of Fish and Game fish passage design review process.

Hydraulics of the Caspar Creek Fish Ladders: Labyrinth Weir Gates, Removable Weirs, Subterranean Viewing Ports, and More

Michael Love, PE, *Michael Love & Associates and* ***Steve Allen, PE,*** *Winzler and Kelly*

Cal Fire and the US Forest Service Pacific Southwest Research Station (PSW) jointly cooperate in a comprehensive paired watershed study at the Caspar Creek Experimental Watersheds on Jackson Demonstration State Forest, located in coastal Mendocino County, California. As part of the study, concrete dams equipped with precise flow measurement weirs were constructed in 1962 on the North and South Forks of Caspar Creek. The resulting flow record provides an essential component of the scientific research underway within the Caspar Creek watershed.

By 1964, a wooden fish ladder was built downstream of each weir to facilitate upstream passage of adult salmon and steelhead. To avoid backwatering and submerging the measurement weir, which compromises its accuracy, tailwater levels were kept low requiring fish to leap over a two to three foot water surface drop at the weir. This precluded upstream passage of juvenile salmonids. During low-flow periods, leakage through the wooden fish ladder posed a significant risk of stranding and injury of juvenile salmonids.

In 2003, CalFire and PSW agreed to upgrade the fish passage facility and a number of agencies came together to make it happen, including the Five Counties Salmonid Conservation Program, National Marine Fisheries Service, and California Department of Fish & Game. Project objectives included avoiding any reduction in the accuracy of the measurement weirs while providing adult salmonids upstream passage during the migration season and upstream passage of juvenile salmonids during summer low-flows.

Michael Love & Associates and Winzler & Kelly were tasked with developing the design of the fish passage facility. To overcome competing objectives of flow measurement accuracy and fish passage, the final design incorporated several relatively unique features to control hydraulics and support monitoring and adaptive management of the facility.

The final design included a pool-and-weir fishway containing ten concrete weirs and four removable aluminum weirs. Weirs have a sloping crest and six inch drops to create desirable hydraulic conditions for juvenile salmonid passage. During higher flows, a portion of the streamflow is directed over a spillway rather than into the fishway. The spillway consists of two 21-foot long vertically adjustable weir gates positioned to form a single cycle labyrinth weir. The spillway configuration limits variability in the fishway forebay level (tailwater of the measurement weir) with changes in streamflow. This minimizes the leap height over the measurement weir while preventing submergence of the measurement weir at all flows up to and exceeding a ten-year flood event.

During summer low-flows, the weir gates are raised and all streamflow is conveyed within the pool-and-weir fishway. The four removable weir panels are installed within the fish exit channel at the upstream end of the fishway to raise the forebay to within 0.2 feet of the measurement weir crest, which facilitates upstream passage of juvenile salmonids while maintaining the accuracy of the measurement weir. The weir panels have vertically adjustable crests that can be adjusted to maintain desired forebay level as flows recede during summer months.

Construction of the two fishways was completed in early 2009 and effectiveness monitoring and fish passage research are being planned. Photo and video monitoring will be used to evaluate fishway hydraulics across a range of flows. A larger study plan is being developed using PIT tag arrays to monitor movement of tagged juvenile salmonids through the fishway. Two underwater viewing ports were installed in each fishway to allow for visual observation of juvenile salmonids leaping, with the intent of improving our understanding of both their leaping abilities and behavior.

This presentation will focus on the hydraulic design elements of the project and how they may be applied to other fish passage projects with similar design objectives and constraints. Preliminary photo and video monitoring results will be used to illustrate the fishway hydraulics.

Project Specific Information Requirements for DFG Fisheries Engineering Review

***Marjorie Caisley** and **Marcin Whitman**, California Department of Fish and Game*

The presentation will provide guidance on the type of information required for DFG fisheries engineering staff to complete reviews of project designs for fish passage and screening projects at water diversions and road crossings. Checklists based on project type have been developed almost entirely using published DFG (2000 and 2001) and NMFS (1997 and 2001) criteria and new DFG guidance on fish passage design (2009). Using the checklists will streamline the engineering review process as well as ensure the projects provide sustainable fish protection and passage. There are checklists for the following types of structures/diversions: fish screens, fish ladders, stream simulation, boulder weirs, rock chutes, roughened channels, and at grade diversions. The presentation will also include background and case studies that have informed the development of the checklists.

Upslope Habitat Restoration in Upper Redwood Creek (Humboldt County, CA): A Case Study of Results and Practical Lessons Learned During Ten Years of Planning, Watershed Assessment, Treatment Prioritization, and Restoration Implementation

Mitch Farro, *Project Manager, Pacific Coast Fish, Wildlife and Wetland Restoration Association and* ***Randy Lew,*** *Professional Geologist, Pacific Watershed Associates*

Since 1998, Redwood National Park (RNP), Pacific Coast Fish, Wildlife and Wetland Restoration Association (PCFWWRA), Pacific Watershed Associates (PWA), California Department of Fish and Game (CDFG), Bureau of Land Management (BLM), Green Diamond Resource Company (GDRC) and others have collaborated on watershed-wide road erosion assessments and sediment control projects in the upper Redwood Creek basin (above RNP). These collaborative efforts first began with a joint CDFG and RNP funded road erosion assessment in the 30,000 acre Park Protection Zone (PPZ), immediately upstream of RNP. Since that time, through five different CDFG funded projects, over 70% (780 miles) of the upper basin road network has been assessed for future sediment delivery to Redwood Creek. Subsequently, using data analysis and treatment prioritization to target the highest sediment delivery threats, over 25% of potential road related sediment delivery to Redwood Creek (400,000 yd^3) has been eliminated, largely through road decommissioning projects.

This presentation will focus on results from both watershed-based road erosion assessments and restoration implementation projects in the upper basin from 1998 through the present. An emphasis will be placed on the lessons learned and a streamlined collaborative approach to employing large-scale, watershed-wide assessments and subsequent restoration implementation so that others may make use of similar techniques in other watersheds.

Construction and Monitoring of Fish Passage Structures in Sulphur Creek

John McCullah, Executive Director, Sacramento Watersheds Action Group

This presentation will cover some of the fish passage issues and structures built in Sulphur Creek over the last few years. It will also provide a summary of the over $1.2 million dollars of restoration grant funding that has been implemented since 1996. As indentified in the Sulphur Creek Watershed Analysis and Action Plan (1998), fish passage, both upstream spawning and downstream migration (escapement), are the primary salmonid issues within the lower watershed.

Sacramento Watersheds Action Group (SWAG), a 501(3)(c), non-profit community watershed group was formed in 1996 to help acquire grant funding for the Redding community. Swag's first focus was the 3000 ac urban Sulphur Creek watershed draining to the Sacramento River near Turtle Bay. SWAG also facilitated the formation and regular meetings of the Sulphur Creek Coordinated Resource Management Planning Group (CRMP).

Once considered "dead", SWAG volunteers have documented that Sulphur Creek has been used intermittently by salmonids for spawning and rearing for decades. During some "wet" years, hundreds of steelhead trout and Chinook salmon have been observed. Almost one mile of stream, from the mouth upstream to the Union Pacific Railroad culvert has been "used" historically. However, the 1998 watershed analysis, documented that this stream habitat was marginal and there existed several partial barriers to upstream migration and the subsequent downstream juvenile migration.

Two barriers, in particular, required some innovative approaches. As per the design guidance provided by the NCHRP—Report 544, Environmentally-Sensitive Channel and bank Protection Measures, SWAG designed and implemented several Rock Vanes and one large Newbury Rock Riffle. Cross Vanes, two opposing rock vanes, provide a relatively "fish friendly" grade control structure but even better in terms of fish passage is the Newbury Rock Riffle. SWAG has been offering education on these alternatives to "check dams" or "sheet pile structures".

SWAG also created fish access up to the Union Pacific Railroad Culvert. Fish have not passed thru this culvert since it was built in 1938. However, almost 1.5 miles of suitable habitat exists upstream. SWAG used part of the $400K DWR Urban Stream Renewal Grant to design and build two riffles (step pools) to achieve the five foot rise needed for fish passage. The presentation will discuss how the riffles were built and how they have survived the "big water" experience the last couple of years.

Additionally, SWAG and the City of Redding collaborated to repair a sewer crossing across Sulphur Creek. The original reinforced concrete crossing resulted in a three foot high barrier. SWAG modified the crossing into two cross vane riffles ("Viffles") that pass fish and protect the sewer. The presentation will show how the structures survived the biggest storm in Redding's recorded history, over eight inches in four hours.

A Decade of Fish Passage in the Five Counties Salmonid Conservation Program Area: A Synthesis of Project Design and Effectiveness

Christine Jordan, *Five Counties Salmonid Conservation Program*

For decades, culverts and other crossing structures on established roads have effectively disrupted the spawning and rearing behavior of all four species of anadromous salmonids in California. These culverts have prevented fish passage primarily due to excessive heights between culvert outlets and plunge pools as well as impassably high flow velocities due to slope. The Five Counties Salmonid Conservation Program (5C) has aggressively targeted fish passage as one of its priority program elements since the Programs inception in 1997. From 1998 through 2004, funded by grants from the California Department of Fish and Game and NOAA Fisheries, an inventory of 245 county maintained stream crossings within the program area of Humboldt, Del Norte, Mendocino, Trinity and Siskiyou Counties was completed. Inventories were completed utilizing FishXing and additional habitat quality and quantity data was also gathered. The barriers were prioritized based on biological and physical parameters which provided a first-cut evaluation of high priority barriers to further assess and eventually program for design and construction. The implementation stage of the fish passage element has been well underway since 1999, and 2009 marked the completion of 56 fish passage improvement projects that have restored access to over 137 miles of habitat. The original barrier structures were typically metal or concrete box culverts that were either perched, damaged, or set at too steep a slope (or a combination of these and other factors). Some of the structures had been previously retrofit to improve passage conditions, but in most cases, retrofit attempts did not function to allow passage of juveniles. The 5C program has used a variety of passage improvement techniques over the past decade and although bridge construction has been the most widely used alternative for conveying 100-year flows and passage of all life stages and species, other retrofits and design alternatives have been utilized. Those include but are not limited to: retrofitting culverts with baffles; constructing step-pool and concrete fishways; installing embedded arch culverts and pre-manufactured concrete culverts with baffle structures; and roughened channel construction. Effectiveness in terms of structural durability, passage of target species and life stages, and project cost for these alternatives will be discussed. See the 5C Program website at *www.5counties.org* for more detailed information on the fish passage program element and other 5C Program elements and projects.

Fish Passage Enhancement Project for Southern Steelhead on Cross Creek Ranch, El Jaro Creek, Santa Ynez River

Timothy H. Robinson, *Cachuma Project Water Agencies, and* ***Edward Wallace,*** *Northwest Hydraulic Consultants*

The Cross Creek Ranch low flow crossing with culvert over El Jaro Creek, a tributary to the Core 1 Santa Ynez River Watershed with critical habitat designation for southern steelhead (*Oncorhynchus mykiss*), was evaluated for fish passage using the guidelines presented in Fish Passage Evaluation at Stream Crossings (California Department of Fish and Game, 2003). HEC-RAS, a hydraulic model developed by the U.S. Army Corps of Engineers, was then utilized to estimate depths and velocities through the culvert and over the road crossing, a four to five foot migration barrier. It was determined to be a GRAY fish passage impediment, suggesting modifications for improved fish passage were warranted. Working with California Department of Fish and Game and National Marine Fisheries Service fish passage engineers, the preferred fix was to backwater the crossing with six weirs and install a curb on the downstream edge of the low flow crossing to deepen the flow over the road. Antiquated and damaged bank protection devices were replaced with state of the art vegetated rock slope protection and the area was fully re-vegetated with native shrubs and trees. The project was successfully completed in November, 2009. The design criteria, results, and facility performance after one winter of operation will be presented.

Preparations for Removal of the Feliz Creek Dam, Mendocino County, California

Mark G. Smelser, Engineering Geologist, California Department of Fish and Game

Feliz Creek is a tributary to the Russian River and the confluence of the two watercourses is located just southeast of Hopland in northern California. An 11-foot-high concrete dam exists on Feliz Creek approximately four and half miles upstream from that confluence. This dam is a formidable barrier to upstream fish migration that inhibits steelhead from utilizing about six miles of spawning and rearing habitat. The dam was constructed prior to 1952 at a bedrock channel constriction and is underlain by a shear zone of weak erodible rock. While the dam remains intact, both abutments have been compromised by stream erosion and the left abutment is undermined. The reservoir is completely filled with sediment, the accumulated sediment extends almost one-half mile upstream, and bridges exist within a mile up- and downstream of the dam. The owners maintain a vineyard, just recently constructed their home on a small bluff overlooking the dam's compromised left abutment, and lack the resources to mitigate the fish passage problem. Fortunately, a partnership has evolved between the landowners and various State and local agencies to improve fish passage at this location. Options to address fish passage include either complete dam removal or the construction of a fish passage structure over the dam. The weak bedrock and compromised condition of the dam significantly complicate construction of a durable fish passage structure. Consequently, complete removal of the dam is a worthwhile consideration. Concerns related to post-removal environmental impacts (e.g. headcutting or hillslope erosion) require that the dam removal and channel reconstruction designs be prepared with due diligence by licensed professionals. Such diligence and the acquisition of project funding in this current era of fiscal limitation requires considerable time and coordination between many people from various organizations.

Flat Panel Vertical Fish Screen Facilities, Standardization and Modularization of Designs and Optimization for Operation

Mark Wharry, PE, LEED A.P., Winzler & Kelly

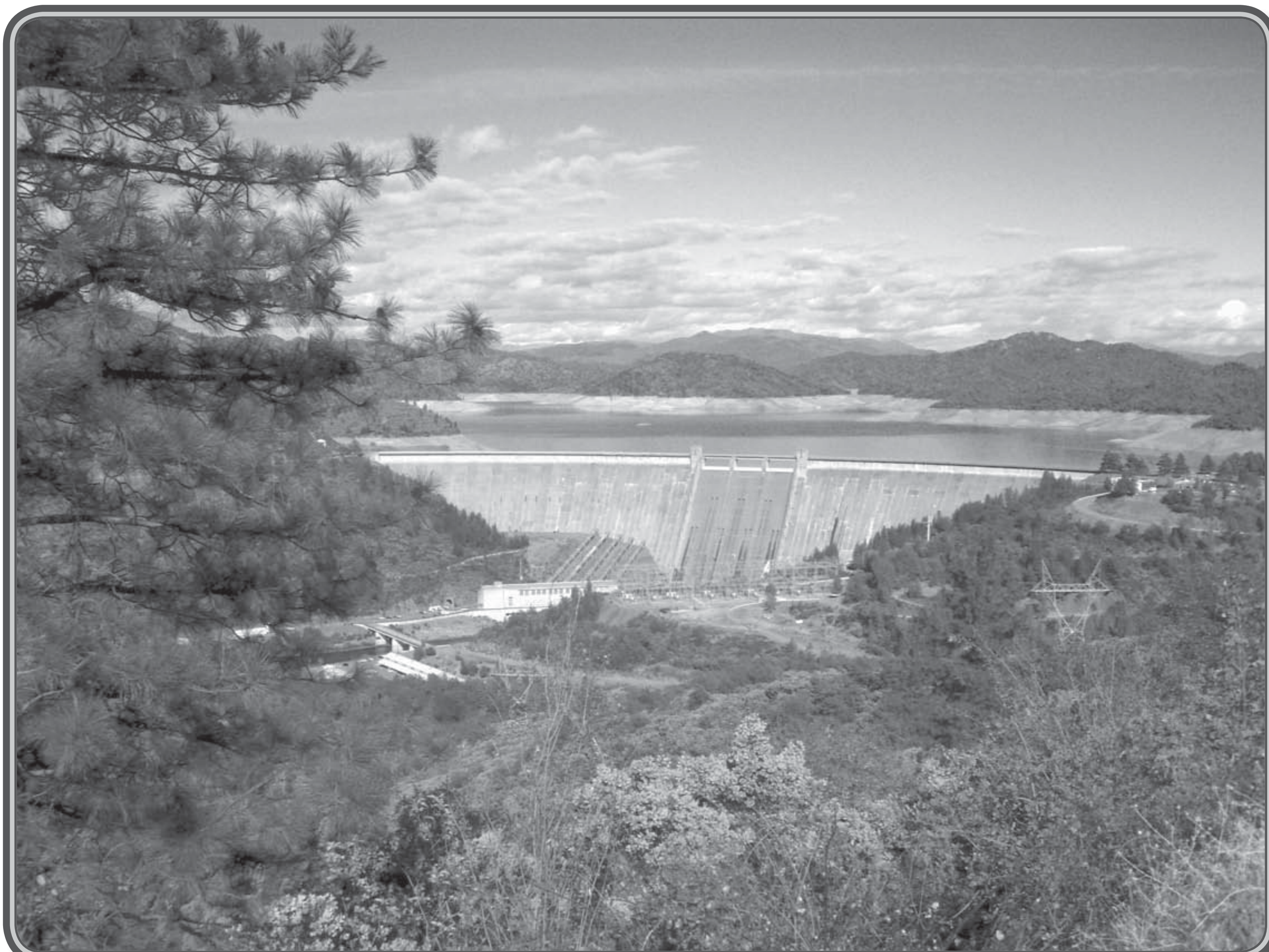
Protection of remaining pristine salmonid habitat while water rights are exercised result in the need to screen diversion flows. Diversion flows vary over a wide range as do their location and geomorphic settings. Because of this diversity in applications, various screen types are used for different reasons. This presentation will focus on the use of flat panel vertical fish screens for larger flow diversions within the Rogue River Basin in southwestern Oregon, where five new fish screens have been constructed over the last ten years. These existing irrigation district diversions were either inadequately screened or were lacking fish screen protection entirely. Winzler & Kelly led the design effort on these new screen facilities and incorporated a standardized design specifically developed for this type of irrigation canal application. Vertical flat panel screen assemblies were configured for each irrigation diversion and were constructed in conjunction with new passage facilities. This presentation will provide a brief overview of the various sites and newly constructed facilities screening over 350 cfs operated by Rogue River Valley, Eagle Point, Medford, and Talent Irrigation Districts. A discussion of how the facilities are standardized to meet regulatory requirements, how the design has been developed to expedite the construction and respond to irrigation district requirements, and how the design has been improved over the years will be presented. Additionally, the presentation will conclude with an overview of how the design is on the drawing board for an upcoming Stimulus Project at the US Fish & Wildlife Malheur National Wildlife Refuge to provide new screening for five currently unscreened canal diversions totaling over 500 cfs.

Sacramento River, Dam to Dam Field Tour: Salmonid Enhancement Projects Between Shasta and Red Bluff Diversion Dams

Thursday, March 11

Field Tour Coordinator*: Mike Berry, California Department of Fish and Game*

The Sacramento River is unique as the only known river in the world which supports four runs of Chinook salmon, steelhead and sturgeon. The tour will begin at the scenic Three Shasta's overlook where we will meet Bureau of Reclamation and US. Fish and Wildlife Service personnel to discuss Shasta Dam, issues related to salmonids, and the nearby Winter-run Chinook salmon conservation hatchery. We will continue downstream with stops to observe gravel enhancement, salmon stranding sites, and floodplain restoration opportunities. The day concludes at Red Bluff Diversion Dam, with a discussion of the history and impacts of the dam, solutions being implemented, and biological monitoring to assure all the efforts upstream are providing positive results.



Restoring the Shasta River Field Tour

Thursday, March 11

Field Tour Coordinators*: Andy Baker,* *North Coast Water Quality Control Board, and* ***Adriane Garayalde* *and* ***David Webb,*** *Shasta Valley Resource Conservation District*

Discover why the Shasta River was historically one of the most productive salmon rearing streams in California. Explore the watershed from its headwaters on the flanks of Mt Shasta (an active volcano) to the confluence with the Klamath River. Learn about geology, coho recovery, TMDL implementation, monitoring, research and how the many stakeholders including ranchers, local entities and government agencies are working together to restore this precious resource. We will visit Big Springs Ranch, an active cattle ranch which was recently acquired by The Nature Conservancy. The ranch has large spring complexes that originate from melted snow and glaciers atop Mt Shasta and flow though lava tubes that emerge on the ranch. These spring complexes provide amazing salmonid habitat and are being studied by leading fisheries experts for the first time. The ranch is also undergoing an extensive stream restoration program that combines ranching, tailwater management, riparian protection and planting. We will also visit one of several small dam removal projects that are occurring in the watershed. The field trip will conclude in the Shasta River Canyon (known as Salmon Heaven) with a stop on the Klamath River. Tour guides include watershed and fisheries experts from the Shasta Valley RCD, The Nature Conservancy, CDFG, and UC Davis.

Battle Creek Restoration Field Tour

Thursday, March 11

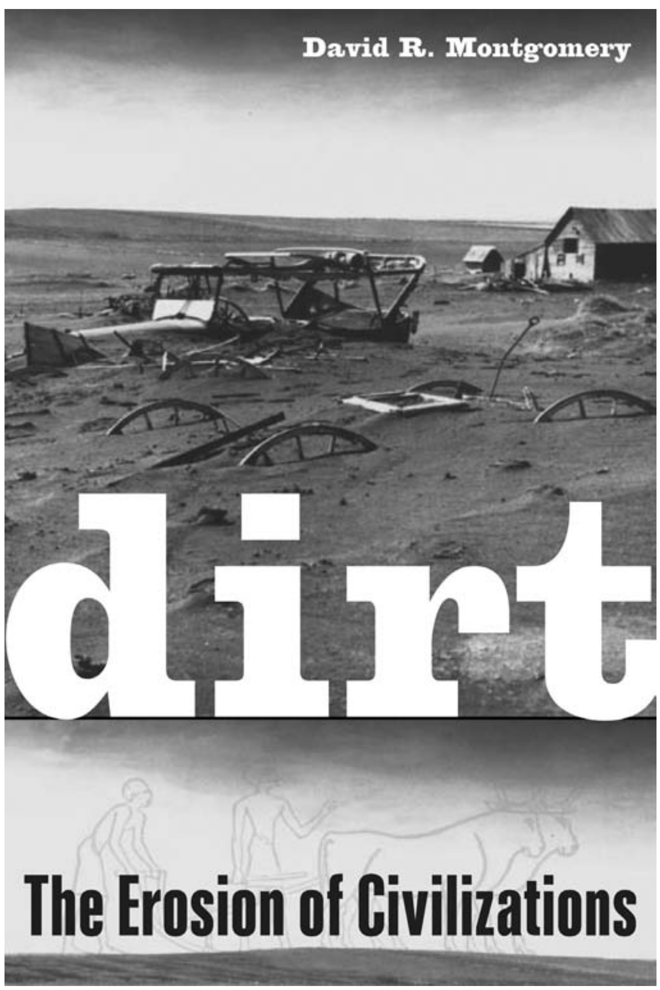
Field Tour Coordinator*: Tricia Parker,* *U.S. Fish and Wildlife Service*

Restoration of anadromous fish habitat in the Battle Creek watershed is underway. This truly collaborative effort includes many participants and will seek to preserve the environmental and economic resources of the Battle Creek watershed through responsible stewardship, liaison, cooperation, and education (per the Battle Creek Conservancy's mission statement). On this tour we will see the significant efforts that have occurred in the Battle Creek watershed in the decade following the 1999 Memorandum of Understanding. In addition to learning about the USBR led hydropower restoration effort, we plan to take an in-depth look at the significant efforts that have occurred on the mainstem of Battle Creek to integrate operations at the FWS Coleman National Fish Hatchery (e.g. new fish ladder and improved water intake system) with watershed restoration efforts. We will also see the juvenile and adult fish monitoring efforts, PG&E's efforts to assist salmon in a hydropower tailrace and collaborative efforts to improve fish passage at an irrigation diversion. We will learn about riparian restoration efforts, fine sediment monitoring, fire/fuels reduction, and many other collaborative efforts to minimize disturbance/enhance production of the naturally produced salmon and steelhead. Key participants from agencies, PG&E, the local watershed group and volunteer Friends Group will participate to share their perspectives. A reference sheet for presentations/posters that link to this tour will be available. By the end of the day, you should feel that you: 1) have specific knowledge of actions completed or underway; 2) have an understanding of upcoming restoration actions; 3) are aware the goals associated with the overall watershed restoration effort; and 4) understand the significant amount of cooperation that has been, and will continue to be, required to achieve these goals.

Dirt: The Erosion of Civilization

David R. Montgomery, *Professor of Earth and Space Sciences at the University of Washington, is author of* King of Fish: The Thousand-Year Run of Salmon *and* Dirt: the Erosion of Civilization.

Dirt, soil, call it what you want—it's everywhere we go. It is the root of our existence, supporting our feet, our farms, our cities. This fascinating yet disquieting book finds, however, that we are running out of dirt, and it's no laughing matter. An engaging natural and cultural history of soil that sweeps from ancient civilizations to modern times, *Dirt: The Erosion of Civilizations* explores the compelling idea that we are—and have long been—using up Earth's soil. Once bare of protective vegetation and exposed to wind and rain, cultivated soils erode bit by bit, slowly enough to be ignored in a single lifetime but fast enough over centuries to limit the lifespan of civilizations. A rich mix of history, archaeology and geology, Dirt traces the role of soil use and abuse in the history of Mesopotamia, Ancient Greece, the Roman Empire, China, European colonialism, Central America, and the American push westward. We see how soil has shaped us and we have shaped soil—as society after society has risen, prospered, and plowed through a natural endowment of fertile dirt. David R. Montgomery sees in the recent rise of organic and no-till farming the hope for a new agricultural revolution that might help us avoid the fate of previous civilizations.



Climate Change and Native Fishes in the San Francisco Estuary and Watershed

Larry R. Brown, U.S. Geological Survey

Possible effects on fishes of changes in water temperatures generated by four 100-year scenarios of climate change for the San Francisco estuary and watershed were evaluated. Input data used to model water temperatures were from two regional climate models at two levels of greenhouse gas emissions. The models produced scenarios with significantly increasing trends for water temperature in the rivers and the Sacramento-San Joaquin Delta (Delta), but only in some months—generally summer and early fall. In the Sacramento River, we assessed the number of years the mean monthly water temperature (MMWT) exceeded 15.5°C in the spawning area of endangered winter-run Chinook salmon. A MMWT>15.5°C would likely result in high mortality of incubating eggs and pre-emergent fry. During the first 66 years of the coolest and warmest 100-year scenarios, MMWT>15.5°C occurred during less than 50% of the years, mainly in August, September, and October. During the final 33 years of the scenarios, MMWT>15.5°C occurred during less than 50% of the years for the coolest scenario, mainly from June through October. For the warmest scenario, MMWT>15.5°C occurred from July through October and during greater than 50% of the years in August, September, and October. In the Delta, habitat area available for the threatened delta smelt decreased substantially under the moderate and warmest scenarios. In the latter 33 years of the scenarios, habitat area defined on the basis of salinity never exceeded current drought levels. In addition, lethal water temperatures (>25 °C) occurred in the northern region of the Delta where most of the remaining habitat occurred. Projections like these provide managers with a useful tool for anticipating long-term challenges to managing fish populations, and possibly adapting water management to ameliorate those challenges in the San Francisco Estuary and watershed.

Planning a Course to Recovery: The NMFS Recovery Plan for Central Valley Salmonids

Maria Rea, *Protected Resources Division, NOAA Fisheries*

NOAA's Fisheries Service has prepared a draft recovery plan designed to restore and stabilize salmon and steelhead species in California's Central Valley that are listed under the Endangered Species Act (ESA). This draft plan addresses recovery efforts for endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon and threatened Central Valley steelhead. The ESA requires the development of a recovery plan for the successful rebuilding of species identified as being at risk of extinction. Although it is a non-regulatory document, the plan will be a roadmap for guiding the recovery of listed species.

This draft plan provides the framework necessary to recover salmon and steelhead listed under the Endangered Species Act in the Central Valley. Ms Rea will discuss the process for developing the plan, the technical and biological considerations of developing a recovery strategy, and the outreach process to solicit input to development of the plan. She will also explain the steps necessary to recover Sacramento River winter-run Chinook, Central Valley spring-run Chinook and Central Valley steelhead, so that they may ultimately be removed from the Endangered Species List.

Local knowledge and input from the public on threats to or the unique needs of these fish is extremely valuable to ensure the plan is comprehensive and promotes stakeholder involvement. The U.S. Fish and Wildlife Service and the California Department of Fish and Game are primary partners with NOAA in the development and future success of the plan. With the public's input, it will also provide significant improvement for other non-listed salmonid species like the commercially valuable fall-run Chinook.

Pacific Salmon Beyond the Crossroads: How Resilient Are Salmon Ecosystems?

Daniel L. Bottom (Presenter), *NOAA Fisheries, Northwest Fisheries Science Center,* ***Kim K. Jones,*** *Oregon Department of Fish and Wildlife,* ***Charles A. Simenstad,*** *University of Washington, School of Aquatic and Fishery Sciences, and* ***Courtland L. Smith,*** *Department of Anthropology, Oregon State University*

In 1991, the first status assessment of salmon populations along the West Coast of the United States revealed a widespread pattern of biological decline and marked a stunning failure of a half century of scientific salmon management. In the last two decades, several dozen Pacific salmon stocks have been added to the U.S. list of Threatened or Endangered species, and the traditional fishery management goal—maximizing salmon production for harvest—has given way to new concerns about the persistence of self-sustaining populations and the resilience of salmon ecosystems to disturbance. Yet the implications of a resilience-based approach to salmon management have not been fully explored. Salmon ecosystem resilience is a function of both biological and cultural (i.e., economic and social) complexity. A key to salmon resilience is the diversity of habitat opportunities and life histories that reflect the "response diversity" of populations in fluctuating environments. In many cases, management actions that expand habitat opportunities for salmon to fully express potential life history variations also may expand social and economic opportunities that benefit the response diversity of local communities. By re-establishing resilient salmon populations, management promotes ecosystem services that people need and value, including clean water, ample stream flows, nutrient cycling, functional wetlands and floodplains, intact riparian systems, and stable and productive fish populations. However, incorporating social and ecological resilience as an explicit management goal requires a fundamental shift for conservation programs and management institutions and the development of appropriate resilience-based performance measures. For example, conservation programs must account for the continuity of salmon life cycles and the diversity of salmon life histories. Performance must be judged based on the full range of salmon ecosystem services and give precedence to long-term population viability over short-term fish production.

Session Coordinator***: Sabra Purdy,*** *UC Davis*

State of California Salmonids

Sabra Purdy, *UC Davis*

California currently possesses 31 distinct types of native salmonid fishes ranging from anadromous salmon and steelhead to inland trout. A 2008 UC Davis report analyzing the status and trends of California's salmonid species found that 65% are at high risk of extinction in the next 100 years if current trends persist. Due to the incredible diversity of species, differing habitat requirements, and broad range of threats among the 31 remaining salmonid taxa, there is no single solution for salmonid conservation. This session will begin with an overview of the UC Davis report findings followed by species- and watershed-specific presentations from salmonid researchers working on a variety of salmonids throughout the state. Presentations will highlight current species status, conservation needs and opportunities, restoration activities, and new developments. In addition, this session is an opportunity to discuss current conservation measures being undertaken by state and local governments, agencies, and other organizations. Presenters may also discuss strategies to stimulate more effective and efficient conservation and opportunities for collaboration and partnerships.

Shasta River Policy and Science: In Time to Save Coho Salmon?

***Curtis Knight**, Deputy Conservation Director, California Trout*

The Shasta River has been recognized as one of the most important spawning tributaries for salmon in the Klamath Basin. The Shasta River is fed by springs originating from 14,162' Mt. Shasta where glaciers provide a constant source of cold, clean water. Melting snow and glaciers percolate down through lava tubes and emerge as numerous large springs. This cool and nutrient-rich water once provided productive habitat for spring- and fall-run Chinook salmon, coho salmon and steelhead. Counts of fall-run returning to the Shasta (even after dams and habitat degradation) went as high as 82,000 in 1931. By the early 1990's fall-run had dropped to a little over 500 fish with an average of less than 5,000 over the last 30 years. Spring-run Chinook no longer inhabit the river and coho salmon may soon follow with adult returns dipping below 50 in recent years. Reasons for the decline in fish populations are poor water quality and fish migration barriers caused by dams. Poor water quality conditions include elevated stream temperatures and low dissolved oxygen.

To address declining fish populations and degraded water quality conditions, a number of policy and on-the-ground restoration activities have been proposed and implemented. The Nature Conservancy has purchased two keystone properties, UC Davis is conducting monitoring and research programs, the Resource Conservation District has implemented fish passage projects and the Department of Fish and Game is proposing a Watershed Wide Incidental Take Permit and Streambed Alteration program. Despite all these efforts coho numbers continue to decline. But, increased knowledge of limiting factors and progressive policy enforcement and reform hold the potential to reverse the decline of coho salmon in the Shasta River.

Southern Resident Orcas and the Collapse of California's Fall-Run Chinook Salmon: Who Affected Who?

Bill Bennett, *Associate Research Ecologist, Center for Watershed Sciences, Bodega Marine Laboratory, University of California, Davis*

The sharp decline of fall-run Chinook salmon, closure of its fishery, as well as added restrictions on water exports from the San Francisco Estuary and Delta have added significant controversy to the overall water problems in California. The recent NMFS Biological Opinion implicated the Central Valley and State Water Projects in contributing to this decline, as well as further imperiling the Southern Resident Orca (SRKW) population by reducing its primary food supply. Various sources of information suggest an alternative explanation: that the sudden loss of fall-run adults was due to predation by the SRKWs. Various sources of information indicate that the SRKW population (about 85-87 individuals) migrated from Puget sound in about 2003, due to the relatively high abundance of its preferred prey Chinook salmon. Bio-energetic studies suggest that each individual Orca can consume a large number (50-100) adult salmon daily. While this suggests significant predation pressure on the fall-run, an anomalously warm ocean climate during summer 2005 may have significantly increased the efficiency of Orca foraging. Thus, the results suggest that the interactive effect of ocean climate and Orca predation may have played a significant role in the sudden disappearance of adult fall-run from the spawning grounds during fall 2005, prompting the closure of the fishery. This hypothesis has major implications for the role of Endangered Species Act as well as on the spatiotemporal scales at which restoration efforts need to operate for restoring salmon populations in the western United States and Canada.

Challenges in Restoring the Rarest Trout in North America: the Paiute Cutthroat Trout

William Somer, ***California Department of Fish and Game***

Paiute cutthroat trout (*Oncorhynchus clarkii seleniris*) (PCT), a federally designated threatened species, are native to 19 km of Silver King Creek, in the northern Sierra Nevada mountain range of California. PCT evolved in isolation from other fish species. Introductions of rainbow trout (*O. mykiss*) and Lahontan cutthroat trout (*O. c. henshawi*) hybridized and displaced pure PCT in their native range, leaving only transplanted isolated headwater tributary populations. The fish was originally listed as endangered in 1967 but reclassified as threatened in 1973 to facilitate management. Chemical treatments in 1964 and 1976 failed to eliminate hybrid trout largely due to single year treatments. The more recent treatments conducted during the late 1980's and early 1990's appear to have been successful in eliminating introgressed trout from headwater tributary populations. The U.S. Fish and Wildlife Service Revised Recovery Plan for the Paiute Cutthroat Trout identified the elimination of nonnative trout from historic habitat in Silver King Creek as a Priority 1 recovery action. Fish and Wildlife Service, Forest Service and California Department of Fish and Game began a project to implement this recovery action beginning in 2001. Since then, environmental groups have sued over environmental compliance issues and state and local agencies have refused to provide needed permits. The use of rotenone has become controversial with groups concerned with treatment impacts to non-target organisms. The recovery effort continues with further environmental analysis of the proposed project. PCT may be the most recoverable trout that is federally listed.

California Spring-run Chinook Salmon: Where are They At? Where are They Going?

Lisa C. Thompson, University of California, Davis, CA

My goal with this presentation is to offer an overview of California spring-run Chinook salmon status and management, to provide you with the available information sources, and to give you a summary of the information they contain, either to spare you from reading a potentially 800+ page document, or perhaps to alert you that you should! I will describe the main spring-run Chinook stocks, past and present: Klamath, Central Valley, and California Coast. I will compare and contrast the genetics of spring-run versus fall-run Chinook in the Upper Klamath-Trinity Rivers (UKTR ESU), and in the Sacramento River watershed (Central Valley ESU). The historical and current distribution of spring-run Chinook in the Klamath and Sacramento River watersheds will be examined, as well as population trends in the two regions. I will describe the role of the technical recovery teams, and the purpose of the documents produced by each team. I will then discuss the work of the recovery planning teams and their recently developed recovery plans. I will explore the potential ramifications of the 2008 National Marine Fisheries Service biological opinion (deliberative draft opinion) on the operation of the Klamath Project by U.S. Bureau of Reclamation, and the 2009 NMFS biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. Finally, I will consider the potential for dam removal and provision of passage around currently impassable dams to improve the prospects for spring-run Chinook recovery.

Sustaining California's Salmon Fishing Communities

Zeke Grader, *Executive Director, Pacific Coast Federation of Fishermen's Associations*

Water measures passed last year by the California Legislature, including a $11.1 billion bond act for the November 2010 ballot, and water transfer legislation now before Congress are intended to address the state's "water crisis" where some communities have gone on rationing and San Joaquin Valley farmers are claiming they are faced with a man-made dust bowl. This presentation will look at the impacts on those forgotten in the debate—California's fishing communities. Two consecutive years of no fishing, and a possible loss of a third in 2010 threatens to collapse the infrastructure of the state's salmon fishery, driving many businesses into bankruptcy. The economic vitality of the fishing community (commercial, recreational and tribal fisheries) has been a strong part of the rationale for maintaining not just residual, but abundant populations of salmon. This is the "food and jobs" argument for California salmon. This presentation will examine the impacts on the salmon communities and what can be done to protect and sustain them for the future.

Session Coordinator*: Jim Harrington,* *Aquatic Bioassessment Laboratory, CA Department of Fish and Game*

The Importance of Using Standardized Bioassessment Techniques to Monitor Stream Restoration and Recovery

Jim Harrington, *Aquatic Bioassessment Laboratory, CA Department of Fish and Game*

Since 1993, the California Department of Fish and Game (DFG) has been working with the State Water Resources Control Board (in recent years their Surface Water Ambient Monitoring Program (SWAMP) and the U.S. Environmental Protection Agency to develop techniques and tools to assess the biotic integrity of wadeable streams throughout the State. Collectively called bioassessment, measures of fish, benthic macroinvertebrate (BMI), benthic algae, physical/ habitat structure and ambient chemistry are used to determine biotic integrity. However, BMIs are used in California and throughout the world as the primary biotic indicator since they provide the best signals of stream health. BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. They are also sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution. Together, biological and physical assessments integrate the effects of water quality over time, are sensitive to multiple aspects of water and habitat quality, and provide the public with more familiar expressions of ecological health.

The bioassessment techniques and reporting framework used in California are based on those developed by the U.S. Environmental Protection Agency (EPA) for use in their National Streams and Rivers Assessment (NRSA) program (*www.epa.gov/riverssurvey/*). By following the EPA lead on bioassessment, California can take advantage of all the research and development products that EPA provides. Furthermore, since bioassessment activities in California are funded primarily by SWAMP, those entities conducting bioassessments in the State can take advantage of state-wide assessment data, quality control activities, databases and other support products available through SWAMP (*www.waterboards.ca.gov/water_issues/programs/swamp*).

One of the fundamental uses of bioassessment data is to determine the effectiveness of Best Management Practices (BMPs) or any activity aimed at improving the quality of aquatic systems. Aquatic habitat restoration has been a techniques use throughout California to improve the quality of streams often damaged by past or present land-use practices. In this presentation, I will discuss how incorporating standardized bioassessment techniques into aquatic habitat restoration projects can be a cost effective measure of the biotic response to restoration activities.

Riparian Fencing is Effective in Restoring the Shasta River

Kim Mattson (Presenter) and Michael Murray, *Ecosystems Northwest,*
and ***David Webb,*** *Shasta Valley Resource Conservation District*

In the Shasta River basin in Northern California, fencing the riparian zone to control cattle grazing has been the single largest category of restoration. We performed a series of surveys of riparian and stream condition of sites that had been fenced or otherwise protected from cattle exclusions for up to 25 years and compared the results to unfenced controls. Most fencing appeared to be highly effective in excluding cattle despite that occasional cattle entries occurred inside the fence. Fencing was associated with increased vegetation growth in the riparian zones and shift in species from non-native grass to native willows and herbaceous vegetation. The increase in trees appeared to be due mainly to colonization and growth of naturally establishing sandbar willows whereas tree planting activities had moderately high rates of failure (30 to 90 % mortality). Principle Component Analysis indicated that it takes ten years of fencing protection to begin to approach riparian conditions similar to an ungrazed condition. Fencing also was associated with other positive in-stream channel changes such as decreased bank erosion, increased cover for fish, increased shade, increased channel complexity, and channel narrowing. Most of these changes were thought to be caused by the riparian vegetation change promoted by fencing. No statistically significant changes in water temperature or water chemistry were detected with fenced sites versus unfenced sites. Macroinvertebrate diversity was higher in fenced sites compared to unfenced controls. Warm water species of fish (native suckers, native dace, and non-native mosquito fish) were observed to be more abundant in fenced areas and appeared to be associated with the greater physical complexity in these sites. However, the effects of fencing on salmonids did not appear to be significant, possibly because the area of the river fenced between Yreka Creek and highway A-12 is not an area highly used by salmonids for spawning or rearing. Steelhead juveniles were observed at low densities and typically in areas that offered turbulence and bubble curtains. Chinook juveniles were locally abundant during the spring and were typically associated in areas of deeper water. No coho juveniles were observed in any sites surveyed. This study demonstrates that fencing has beneficial effects in enhancing the riparian habitat and this has direct effects on the stream habitat.

Monitoring Stream Health and Recovery in the Garcia River Watershed

Jennifer Carah, ***Field Scientist, The Nature Conservancy***

In 2004, The Conservation Fund, in partnership with The Nature Conservancy (TNC), the California Coastal Conservancy and the Wildlife Conservation Board, purchased the 24,000-acre Garcia River Forest (GRF) Property in Mendocino County, protecting approximately 1/3 of the Garcia River watershed. Specific management goals for the GRF Property include: protecting the Property from conversion to vineyards/rural subdivision; restoring forest health and productivity; maintaining and enhancing salmonid habitat; reducing impacts of roads on aquatic ecosystems; generating reasonable revenue by responsible forest management; and establishing a monitoring framework for restoration activities within an adaptive management context. Monitoring key components of aquatic and terrestrial systems at the GRF provides an opportunity to track progress towards meeting management and restoration goals, as well as to inform future strategies. This presentation will review the development and particulars of the aquatic monitoring framework for the GRF, as well as preliminary baseline results.

The Garcia River watershed supports populations of coho salmon (*Oncorhynchus kisutch*), as well as steelhead trout (*O. mykiss*), and has been identified as a high priority watershed for protection and restoration in both state and federal coho recovery planning. As in many California North Coast watersheds, historical forestry practices have had significant negative impact on salmonid habitat. An impairment listing under the Clean Water Act (section 303(d)) for excessive sedimentation and water temperatures, and subsequent Total Maximum Daily Load (TMDL) planning have catalyzed efforts to improve conditions.

On the GRF Property restoration activities including instream restoration and erosion control are under way, as are modest and carefully circumscribed timber harvests. We have developed a monitoring framework to measure indicators of health of key aquatic and terrestrial conservation targets and track progress towards meeting restoration goals. On the aquatic front, TNC partnered with the US Environmental Protection Agency (US EPA) and the North Coast Regional Water Quality Control Board (NCRWQCB) to implement a sampling design that provides a statistically robust assessment of stream conditions using the US EPA's Environmental Monitoring and Assessment Program (EMAP) protocols. To date, 76 permanent EMAP sites have been established across four ownerships in the watershed, from its headwaters to the estuary. These protocols focus on measuring key indicators of stream health including: channel morphology, dimensions and gradient; habitat complexity and cover; anthropogenic alterations; large woody debris frequency/volume; substrate size and type; particle embeddedness; bank characteristics; riparian cover; benthic macroinvertebrate abundance/diversity; and fish abundance/diversity.

TNC, NCRWQCB and partners are using this watershed-wide data to inform restoration activities, as well as document baseline conditions. As surveys are repeated over time, we will use the data to measure trends in stream health and track progress towards meeting restoration and TMDL goals. Results will inform future restoration strategies.

A Multi-scale Evaluation of Restoration Effectiveness of Chinook Salmon and Coho Salmon Rearing Habitat on a Large Regulated River System, Trinity River, CA

D.H. Goodman (Presenter), *U.S. Fish and Wildlife Service,* ***A. Martin,*** *Yurok Tribal Fisheries Program, and* ***J. Alvarez,*** *Hoopa Tribal Fisheries Department*

Many stream rehabilitation efforts are conducted on the Pacific Coast of North America but few of these include a quantitative evaluation of their effectiveness at obtaining restoration goals, particularly in large river systems. We developed a methodology to evaluate the effectiveness of habitat restoration on large scale rivers. The methodology has been evaluated and applied on the Trinity River system in northern California. The completion of the Trinity Division of the Central Valley Project in 1962 drastically altered the aquatic ecosystem and contributed to the drastic decline of anadromous fish populations. A large-scale restoration program was initiated in December 2000, to improve the aquatic habitats of anadromous salmonids, as well as other aquatic species, through a multifaceted rehabilitation effort, including flow management, mechanical channel rehabilitation, and, coarse sediment augmentation. One of the primary goals of the rehabilitation effort is to increase salmonid rearing habitat, the primary limiting factor for their populations. To evaluate the effectiveness of the rehabilitation efforts, we have developed a spatially explicit habitat evaluation methodology targeting Chinook salmon and coho salmon rearing habitat. The rearing habitat evaluation was applied on the Trinity River to evaluate changes in habitat availability at multiple scales of interest to the Trinity River Restoration Program and provide feedback to the adaptive management framework. We applied a pre-construction and post construction study design to evaluate bank rehabilitation sites at a feature and site scale. In addition we implemented a Generalized Random Tessellation Stratified (GRTS) probabilistic sample to develop habitat availability estimates of the 64 km project reach. Results of these evaluations will be presented herein.

Adaptive Management in the Delta: Testing the 2-Gates Fish Protection Demonstration Project

Ramona Swenson (Presenter), Tom Taylor, Rob Thompson, Mike Aceituno, and Pat Coulston, ENTRIX

There are many challenges in developing and testing new restoration and management tools in the Delta, including knowledge of fish species' habitat requirements and behavioral responses, regulatory constraints, water supply needs, limited existing data and the ability to monitor low and declining fish populations. Assessment of the 2-Gates Project provides a unique opportunity to test alternate management strategies, gain insights into Delta processes and point the way towards follow-up investigations. The 2-Gates Project is a five-year demonstration project to test a new hydrodynamic and water quality management tool for reducing entrainment of delta smelt by the SWP and CVP export facilities without causing negative impacts on other species. The purpose is to test if two removable operable barriers placed in Old River and Connection Slough and managed in conjunction with current restrictions on reverse (negative) flows in Old and Middle rivers (OMR flows) can assist in reducing delta smelt entrainment. If effective, the Project could provide another tool for increasing water delivery flexibility within existing operational parameters. The Project will evaluate whether entrainment reduction may be accomplished by controlling the distribution and continuity of turbidity and salinity conditions that are habitat components of pre-spawning adult delta smelt. Preliminary results from the newly developed adult delta smelt behavioral model suggest that gate operations in concert with current operations under OCAP RPAs could modify the distribution and density of adults to reduce entrainment risk of adults and their progeny. The project will also test whether operating the gates can enhance transport processes for larval and juvenile delta smelt, via dispersive mixing in the central Delta. Significant challenges exist, however, when conducting adaptive management studies, especially with scarce species in highly variable systems. The Project will address these uncertainties through hypothesis testing, experimental design (BACI approach), hydrodynamic modeling, statistical tools (e.g. bootstrap analyses for estimating variation), focused studies and field monitoring of key physical parameters and biota.

South Delta Temporary Barriers Fish Monitoring Study

***Kevin Clark (Presenter)* and *Javier Miranda,* California Department of Water Resources**

The National Marine Fisheries Service (NMFS) 2008 Temporary Barriers Project Biological Opinion (BO) required the California Department of Water Resources (DWR) to establish a fisheries monitoring program to: 1) examine the movements and survival of Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), and green sturgeon (*Acipenser medirostris*) through the channels in the South Delta; and 2) examine predation effects associated with the temporary barriers project. In response to the BO, DWR began a three-year monitoring program including the 2009 pilot study. The pilot study was conducted to test new biotelemetry equipment, test various assumptions inherent in the monitoring design for quantifying survival of juvenile salmonids in the South Delta, and provide preliminary information on the behavior of salmonids and predatory fish in the South Delta. As part of the pilot study, juvenile steelhead and salmon were surgically implanted with acoustic tags and released in Old River. Predatory fish, striped bass (*Morone saxatilis*) and largemouth bass (*Miropterus salmoides*), were captured and were externally fitted with acoustic tags and released at the same location as capture. A network of fixed-point biotelemetry receivers were deployed to cover the South Delta including receivers in Old River, Middle River, Grant Line Canal, Clifton Court Forebay, and the Central Valley Project (CVP) and State Water Project (SWP) fish facilities. In addition to the broader scale receiver network, a two-dimensional biotelemetry system was deployed at one of the temporary barriers. Two-dimensional fish traces were recorded for acoustic tagged fishes near the barrier. Additionally, a Dual-frequency Identification SONAR (DIDSON) camera was used to document fish behavior and fish presence near the temporary barriers. Preliminary data analysis indicates that the methodology and equipments used are appropriate and satisfactory. Lessons learned and results from the 2009 pilot study will be incorporated in the 2010 and 2011 full-scale studies.

FERC Relicensing and Opportunities for Restoration

Friday Afternoon Concurrent Session 3

Session Coordinator*: Dougald Scott, Northern California Council Federation of Fly Fishers*

The Federal Energy Regulatory Commission's hydropower licensing process has substantially evolved since the heyday of dam building half a century ago. Applicants now must adhere to procedural steps required by the National Environmental Policy Act including compliance with the Clean Water and Endangered Species Acts. Hydropower projects with expiring licenses are required to adhere to the same standards for relicensing as new projects.

FERC now requires applicants to follow an Integrated Licensing Process (ILP) that spells out the steps for licensure. Increased public involvement is one of the goals of the ILP, and to this end the ILP lays out a framework for public input from the earliest stages of the process. The process encourages communication, collaboration and planning among all stakeholders in reaching a settlement. Once FERC determines a settlement meets their guidelines, they may grant the license with the provisions of the settlement incorporated as license articles.

In California, there are 38 hydropower licenses on 31 rivers up for renewal in the next twenty years. The relicensing process on the rivers provides numerous opportunities for salmonid restoration including: increased base flows; improved migration flows; improved water temperatures; removal of passage barriers; and improved riparian habitat.

Speakers in this session have participated in the relicensing process from a number of different perspectives and on a number of different rivers.

The Use and Development of Scientific Information in the Implementation of the Klamath Hydroelectric Settlement Agreement

Mike Belchik, *Senior Fisheries Biologist, Yurok Tribe*

Recently, the Klamath Hydroelectric Settlement Agreement (KHSA) was made public which would result in the removal of the lower four Klamath River Dams in the year 2020. A key element of achieving this milestone was the development of needed information to inform the FERC process as well as the Settlement process. The KHSA calls for the development of additional information so that by 2012 the Secretary of Interior can determine whether facilities removal: 1) will advance restoration of the salmonid fisheries of the Klamath Basin; and 2) is in the public interest, which includes but is not limited to consideration of potential impacts on affected local communities and Tribes. The review and use of existing information, and the development of new scientific information, will be a key determinant of the future of the dams on the Klamath River. This presentation explores the development and review of the existing body of science, as well as the development of new information regarding the largest dam removal and restoration project in the history of the United States.

The Yuba River Watershed in the Next Fifty Years: Citizens Approach Salmon Restoration Through Relicensing

Jason Rainey, South Yuba River Citizens League

The Yuba River watershed contains three large FERC projects in the process of relicensing. Despite each project affecting the availability of anadromous fish habitat, neither FERC nor the licensees take responsibility for the reintroduction of anadromous fish above Englebright Dam, or the restoration of upstream habitats to directly accommodate salmon and steelhead. This presentation will discuss several tools and initiatives for integrative and long-lasting solutions to restoring salmon and steelhead populations in the Yuba River watershed.

A Licensee's Perspective on the Process and Restoration Opportunities

Mary Richardson, *Manager, Power Generation, Hydro Relicensing, Pacific Gas & Electric*

Pacific Gas & Electric Company (PG&E) is keenly interested in participating in restoration programs associated with its Hydro Electric Project operations that have a high potential for success and are cost-effective, and is presently participating in such programs. The focus of PG&E's presentation at the upcoming Joint SFR and AFS Conference will be a hydroelectric project owner's (licensee's) perspective on the Federal Energy Regulatory Commission's Integrated Licensing Process (ILP) and opportunities for restoration. PG&E is responsible for 26 FERC Hydro Licenses and 68 Hydro Powerhouses; 3,900 MW.

PG&E's presentation will provide an overview of the ILP process. The ILP's new structure (up-front scoping, early participation by FERC staff and short timeframes) helps minimize and resolve study disputes. There are two primary points in the proceeding to try to reach agreement: 1) during development of Study Plans; and 2) during development of resource measures; ILP includes specific helpful provisions only with regard to the former.

PG&E will discuss how relicensing studies, in collaboration with stakeholders, are developed and completed on a science-based approach; examples of restoration projects resulting from the ILP process; and examples of other opportunities for restoration, that PG&E has participated in, outside of relicensing.

PG&E will present examples of habitat enhancements related to recently issued licenses throughout the presentation. Additionally, we'll talk about the Habitat Expansion Agreement for spring-run Chinook salmon and steelhead, and the opportunities related to habitat enhancement outside of relicensing, such as the upcoming habitat restoration at Battle Creek (FERC License 1121).

Restoring Central Valley Salmon and Steelhead through FERC Relicensing

***Chris Shutes,** FERC Projects Director, California Sportfishing Protection Alliance*
*and **Cindy Charles,** President, Golden West Women Fly Fishers*

There are four Federal Energy Regulatory Commission (FERC) relicensing processes underway or soon to begin that will offer major opportunities to restore salmon and steelhead in California's Central Valley. Since hydropower licenses are only renewed every 30 to 50 years, relicensing is a critical time-sensitive window where long-term changes can be made to benefit these struggling fish populations.

The projects being relicensed in these four processes are the Yuba-Bear/Drum-Spaulding projects (combined process on the South Yuba and Middle Yuba rivers, and West Placer Creeks), Yuba River Development (main Yuba and two forks), Don Pedro Project (Tuolumne River), and the Merced River Hydroelectric Project and Merced Falls Project (Merced River).

A common thread has been present in the two processes underway (Yuba-Bear/Drum-Spaulding and Merced River/Merced Falls). Each licensee (project operator) and its consultants have sought to use features of FERC's Integrated Licensing Process to avoid studying and addressing project effects on salmon and steelhead. Each licensee has also sought to avoid collecting evidence to evaluate opportunities to change project operations or facilities to benefit salmon and steelhead.

FERC has taken the position that the presence of a combination of factors affecting fisheries downstream of the projects places downstream areas outside the scope of FERC-required studies. The presence of agricultural diversion dams (even if owned by the licensee) downstream of the hydro projects has also led FERC to disallow discussion of fish passage to get salmon and steelhead upstream of dams. Lack of study leads to lack of evidence about project effects. Lack of evidence makes it almost impossible to require mitigations, which under the Federal Power Act must be supported by substantial evidence. By shutting out studies, the licensees effectively shut out most potential restoration.

In response, conservation groups and resource agencies have created strong and organized working groups of NGO and agency personnel in several relicensings, and have thus improved our advocacy and our impact. Even if we lose a battle, we incrementally build a record for a different future outcome. Both conservation groups and resource agencies have also advocated with FERC to change its policies on how it deals with multiple effects and overlapping authorities.

Conditions downstream of Central Valley rim dams are not supporting salmon and steelhead. Those of us working in FERC relicensing must make the process work to improve those conditions. We must also expand the boundaries of the process to get fish past the dams that block passage to the historic habitat. Upstream habitat must be repopulated in order to re-establish robust salmonid populations.

Dam Removal and Salmonid Reintroduction Opportunities Through FERC

Steve Rothert, *California Regional Office Director, American Rivers*

Over the past few years, salmon restoration efforts in the Pacific Northwest and California have seen several important dam removal and fish passage victories induced by the Federal Energy Regulatory Commission hydropower relicensing process. Some have heralded these developments as the dawn of an era of big removal and passage projects—but is it? This presentation will examine recent, ongoing and upcoming FERC relicensings from the West Coast and elsewhere to discern current trends and prospects for continued success in leveraging FERC proceedings to restore salmonid populations.

Opportunities and Challenges of Working in FERC Regulated Rivers in the Central Valley: Implications for Chinook Salmon and Steelhead Restoration

Michelle Workman, *Anadromous Fish Restoration Program, U.S. Fish & Wildlife Service*

Many of California's Central Valley anadromous streams are subject to flow regulation due to hydropower projects. These streams also support declining populations of anadromous salmonids including fall-run Chinook salmon, a commercially and economically important species, and steelhead, a federally listed species. These hydropower projects are regulated by the Federal Energy Regulatory Commission (FERC). The Federal Power Act (FPA) provides for cooperation between FERC and other Federal agencies, including resource agencies, in licensing and relicensing power projects. It also requires each license to include conditions to protect, mitigate and enhance fish and wildlife affected by the project, based on recommendations from the US Fish and Wildlife Service, the National Marine Fisheries Service, and State fish and wildlife agencies pursuant to their respective regulatory authorities under sections 4(e) and 18 of the FPA, the Endangered Species Act (ESA), and the Clean Water Act (CWA). FERC is empowered to resolve any instances in which such recommendations are viewed as inconsistent while according "due weight to the recommendations, expertise, and statutory responsibilities" of the resource agencies. The FERC process provides an opportunity for resource agencies, non-governmental organizations (NGO), and stakeholders to provide input in the development of fishery studies in license agreements along with review and input on study results. License provisions and/or settlement agreements that provide both the data necessary to inform future relicensing decisions, and the protections required to sustain populations under the current licenses, are needed for the long term sustainability of populations and habitats impacted by these projects The challenges and opportunities this process provides will be discussed highlighting current issues on the Tuolumne, Merced, and Mokelumne rivers.

The New Hatchery Management Dynamic

Friday Afternoon Concurrent Session 4

Session Coordinators*: Josh Israel,* ***UC Davis, Jose Setka, East Bay Municipal Utility District, and Shirley Witalis, National Marine Fisheries Service*

Management is not simple in today's fish hatcheries. The reliance on and inherent risks of salmonid aquaculture has broadened our vision of hatcheries beyond what enters the fish ladder. Increasing evidence on the relationship between hatchery management practices and salmonid viability in the natural environment challenges fish culturists, biologists, and resource managers to apply scientific and ecological principles to propagation programs. Problem solving, experimentation, and adaptive management are critical to program success. To succeed in this new and dynamic environment a hatchery manager relies on appropriate monitoring in the natural environment to evaluate effectiveness of program strategies and provide feedback for adaptive management. Biologists focused on research concerning interactions between hatchery and natural fish provide essential information on the demographic, behavioral, and ecological effects of propagated fish that leads to experimentation and problem solving in the hatchery. Hatchery programs have played and continue to evolve a role in salmonid reintroduction and recovery strategies. The 2001 California Department of Fish and Game-NOAA's National Marine Fisheries Service (CDFG-NMFS) Hatchery Review Committee and the recently released CDFG Environmental Impact Report, Environmental Impact Statement (EIR,EIS) on the state hatchery system provide recommendations for minimizing hatchery risks to natural fish. Other efforts, including an interagency panel investigating the implications of mass marking and mark-selective fisheries for California's salmon stocks and an impending Hatchery Scientific Review Panel, will play an important role in balancing hatchery production with fishery management and the recovery of fish listed under the Endangered Species Act. This session presents examples of hatchery managers and biologists conducting monitoring and research to improve hatchery programs, and highlights successful research collaborations that demonstrate the benefits of ecosystem-based approaches to hatchery operations and management.

Exploring the Impacts of and Ways to Improve Salmon Hatcheries as a Recovery Tool in Small Coastal Watersheds

Sean A. Hayes (Presenter), Morgan H. Bond, Gregory Charrier, Danielle M. Frechette, J. Carlos Garza, Elizabeth Gilbert-Horvath, R. Bruce MacFarlane, Jonathan W. Moore, Carla Moss, Ann-Marie K. Osterback, Devon E. Pearse, Scott A. Shaffer, David Streig, and Erick Sturm, National Marine Fisheries Service

The role of hatchery programs in salmonid reintroduction and recovery strategies for natural populations is as varied as the opinions of these programs themselves. This is further complicated by the various reasons hatcheries were created in the first place, both as a fishery enhancement tool and to compensate for habitat loss associated with hydropower, forestry, agriculture and urban development (which result in dam passage issues, flooding, water diversions, seasonal flow alterations, siltation, temperature changes, estuary disturbance, loss of riparian corridors, meanders and natural structure.) There may even be a looming need for "climate change hatcheries." With all of these challenges to salmon populations and society's relative apathy and inability to curb current natural resource consumption rates, it is likely hatcheries will be a tool for salmon restoration and preservation until extinction.

Scott Creek is a small coastal watershed in central California, inhabited by wild (natural) and hatchery populations of steelhead (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) that are confronted by habitat loss and natural issues associated with living at the southern edge of their range. As such, both species are listed under the U.S. Endangered Species Act. The National Marine Fisheries Service and affiliated universities have been working in collaboration for the past eight years with the Monterey Bay Salmon and Trout Project which operates a small conservation hatchery in the watershed. Unlike large production hatcheries, the focus of the MBSTP hatchery is to prevent the extirpation of coho and steelhead with novel production practices and low rearing densities. In previously published work we examined local artificial propagation practices for impacts on wild stocks by monitoring comparative development, predation, and competition between hatchery and wild juveniles. In addition, we compared hatchery and wild adult salmonid spawning behavior and morphology. We concluded that many of the problems commonly associated with artificial propagation can be avoided when wild broodstock are used, fish are released as smolts and river migration distances are short. Recently we have been investigating the influence of juvenile rearing density, fork length, group size and location at release on downstream migration behavior, susceptibility to avian predation, and ultimately marine survival. For returning adult steelhead we have begun to compare the mate choice decisions and relative reproductive success for fish of hatchery and natural origin. For coho salmon, we have implemented a captive broodstock program and genetic breeding matrix as a means of preventing complete stock extirpation south of the Golden Gate Bridge. The current status of these studies will be discussed, along with potential new management tools that may be implied from this work, pertaining to large and small river systems alike.

Supporting Coho Salmon Recovery in California: The Russian River Coho Salmon Captive Broodstock Program

Manfred Kittel (Presenter), *California Department of Fish and Game,* ***Mariska Obedzinski,*** *UC Cooperative Extension, and* ***Ben White,*** *Pacific States Marine Fisheries Commission*

Recovery of endangered coho salmon in the Central California Coast Evolutionarily Significant Unit (CCC ESU) is unlikely without a robust coho population in the Russian River basin. The Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) was initiated in 2001 as a multi-agency effort to reestablish coho salmon populations in this watershed. The program initially used wild coho fingerlings collected from various Russian River tributaries as broodstock but continuing declines of wild populations and local extirpations have forced the program to use artificially spawned coho as broodstock. To minimize inbreeding, hatchery coho are mated according to a genetic breeding matrix. Since 2004, the RRCSCBP has completed six spawning cycles and released nearly 300,000 juveniles throughout the watershed. Coho are released at age 0+ in the spring and fall, as well as at the smolt stage. The monitoring and evaluation component of the RRCSCBP uses downstream and upstream migrant trapping, snorkeling, spawner and redd surveys, and PIT tag detection systems to estimate and compare seasonal survival, smolt abundance, and instream growth among streams and release seasons. Because of the low number of founding individuals, the RRCSCBP has recently begun systematic outbreeding of its hatchery stock with coho from a different, geographically close basin.

Methods Used to Determine the Appropriate Level of Production for Coho Salmon at Trinity River Hatchery, California

Greer Maier (Presenter), *National Marine Fisheries Service, and* ***Wade Sinnen,*** *California Department of Fish and Game*

In recent years there have been large adult returns of hatchery fish to the Trinity River. The average hatchery coho salmon adult and jack return from 1997 to 2008 was 16,469, roughly three times the Trinity River Hatchery coho salmon mitigation goal. The average percentage of hatchery coho salmon in the total return during the same period was 89%. The substantial numbers of adult hatchery fish, the majority of which were not harvested by tribes and could not legally be harvested by recreational or commercial anglers, prompted concern from several stakeholders on the effects of hatchery stocks on naturally produced stocks. The Trinity River Hatchery Technical Action Group was formed to make technical recommendations to a policy group. We used information from historical run sizes, spawner-recruit relationships, smolt-to-adult returns, and "All H Analyzer" modeling to examine current production relative to mitigation goals and objectives. Spawner-recruit relationships indicated that in years of large hatchery returns, carrying capacity of the river may have been exceeded, possibly triggering density dependent mechanisms leading to reduced productivity. Using the smolt-to-adult returns rates from 1997 to 2008, we calculated hypothetical adult returns based on three different theoretical juvenile release levels. We also modeled likely outcomes of changes such as decreased juvenile production and increased natural origin broodstock. Based on the information, we formulated a variety of recommendations to the policy group such as a reduction in juvenile coho salmon production and trapping of surplus hatchery adults.

Accomplishing the Mission of Mitigation in an Ever-changing Regulatory Climate: The Case of the Mokelumne River Fish Hatchery

Jose D. Setka (Presenter), *Supervising Biologist, and* ***Steve Boyd,*** *Fisheries Biologist, EBMUD Fisheries and Wildlife Division, and* ***Bob Anderson*** *and* ***William Smith,*** *Hatchery Managers, CDFG Mokelumne River Fish Hatchery*

The regulatory climate surrounding hatchery management is in a state of flux not unlike the dynamism occurring with the Earth's climate. A number of factors seem to be driving the process including enforcement of the ESA and research indicating certain historical hatchery practices have played a role in reducing the fitness of salmonid populations within the Central Valley. While ongoing research is focusing on identifying the specific mechanisms impacting fitness, the message from the regulatory agencies is clear: certain standard hatchery practices must be advanced to help reverse negative impacts to the genetic integrity of Central Valley salmonids. CDFG and EBMUD have implemented a number of actions at the MRFH to meet this new challenge. Included are implementing a Hatchery Genetics Management Plan, and participating in a real-time CWT reading pilot project to recover Mokelumne River origin fish that stray to Nimbus Hatchery. The ultimate goal is to achieve genetically healthy and self sustaining Mokelumne River Chinook salmon and steelhead populations that support the genetic stability of all Central Valley salmonid populations and mitigates to the extent possible for habitat loss with the construction of Camanche Dam in 1964.

Lahontan Cutthroat Trout Conservation: Broodstock Development, Research, and Adaptive Management Lead to Refined Recovery Strategies for Reintroduction Programs into Historic Lake Habitats

Lisa G. Heki, *Project Leader, Lahontan National Fish Hatchery Complex, U.S. Fish and Wildlife Service*

Lahontan cutthroat trout (LCT), a cutthroat trout subspecies endemic to the Lahontan hydrographic basin of northern Nevada, eastern California and southeastern Oregon, has been listed as threatened since the early 1970's. The historic distribution of this subspecies included large interconnected stream systems and stream and lake systems. Fragmentation of these interconnected habitats has lead to extensive population extirpation. One of the primary recovery goals for this subspecies is to reestablish naturally reproducing lacustrine populations, the majority of which are currently maintained by hatchery production. The Lahontan NFH Complex has developed a Lahontan cutthroat trout broodstock of the single remaining wild population of the original lake form and have being using them in reintroduction and recovery programs in historic lake habitats of Walker and Pyramid Lakes and the Lake Tahoe basin. Through extensive research, monitoring, and adaptive management programs we have begun to refine conservation strategies for successful reintroduction of Lahontan cutthroat trout while concurrently addressing the threats posed by existing non-native trout populations.

Effect of Inland Fishing Closure on Feather River Fish Hatchery Spring-Run Chinook Salmon Program

Ryon Kurth (Presenter) *and* ***Jason Kindopp,*** *California Department of Water Resources*

The listing of Central Valley spring-run (California) Chinook salmon (CVSR) includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River, as well as the Feather River Fish Hatchery (FRFH) spring-run Chinook program. While included in the CVSR Evolutionary Significant Unit (ESU) FRFH spring-run are not afforded the same consideration and protection as other populations within the ESU. Due in large part to genetic impacts resulting from straying and hybridization with fall-run fish, the FRFH is stated to be a primary threat to the overall recovery of the ESU.

Five years ago, the California Department of Water Resources and California Department of Fish and Game initiated a spring-run program with the ultimate goal of reducing the genetic threat of FRFH spring-run salmon to the ESU and promoting conservation of the extant spring-run population in the Feather River. The recent crash in Chinook salmon escapement threatened the future of this program. However, the closure of the inland salmon fishery likely led to significant increases in survival of spring-run adults holding in the Feather River and subsequently returning to spawn at the FRFH. We presents results indicating that harvest of spring-run in the Feather River can be detrimental to the success of the program, particularly in low-escapement years. Our data also suggests that current Feather River angling regulations for spring-run should be changed to provide additional protection from harvest.

Session Coordinator*: Jim Reynolds,* *University of Alaska Fairbanks*

In the southwestern U.S., groundwater sources of water are being actively pursued for development by urban centers as supplies of surface water become less capable of meeting domestic demand. It is widely recognized that groundwater pumping could have adverse effects on the recharge of surface waters and the biota they support. However, the acquisition of scientific data to clarify the cause-effect relationship is a complex and difficult proposition. This session is aimed at helping fisheries biologists gain a better understanding of the complexities of this issue. Speakers in this session will summarize some of the hydrological and ecological principles underlying the effects of groundwater pumping. Other speakers will present case histories where scientific evidence for cause-effect relationships has been demonstrated.

Effects of Past and Anticipated Groundwater Pumping on Great Basin Spring-fed Ecosystems

Don Sada, *Division of Hydrologic Sciences, Desert Research Institute*

The Great Basin is the driest region in the US. Regional aquatic ecosystems have expanded and contracted through ancient pluvial and contemporary arid climates, which has facilitated isolation and diversification of approximately 200 endemic aquatic species or subspecies. Approximately 80 percent of these taxa are crenobiontic and only occupy isolated, spring-fed systems. Few aquatic systems remain in 'natural' condition because water is scarce and there is a premium use of water for agriculture, industry, and municipalities. Streams and rivers provide most water for cities and agriculture, and pumped groundwater supports most rural economies. After World War II groundwater pumping began drying springs and by the early 1970s it had caused extinction of four species or subspecies of spring-dwelling Great Basin fish. Many more species were threatened by pumping and a number of rare macroinvertebrate populations were extirpated. Threats from pumping moderated for the next several decades due to a variety of conservation programs and relative stability in groundwater development. Threats from groundwater pumping have accelerated over the past ten years because surface flow is inadequate to meet municipal water demands, and municipalities now focus on developing distant groundwater resources in rural areas. Substantial funding has been available to develop hydrologic groundwater models but there is weak understanding of the relevance of these models to spring ecology and of the biotic response of spring ecosystems to incrementally decreasing discharge. Integrating ecology and hydrology is necessary to prevent extinctions and extirpations anticipated from additional groundwater development.

Impacts of Groundwater Development on Springs, Streams, and Wetlands

Tim Durbin, ***West Yost Associates***

Groundwater-dependent features within the Great Basin are critical elements of the natural environment, but they are extremely sensitive to anthropogenic impacts. Those features include springs, streams, lakes, and phreatophytic vegetation. Under natural conditions, the cumulative evaporation and evapotranspiration from such features within a groundwater system tend to represent the discharge from the groundwater system of all the natural recharge to the system. A balance exists between natural recharge and discharge. However, groundwater development disrupts that equilibrium, such that long term impact is to decrease the cumulative evaporation and evapotranspiration by an amount equal to the consumptive use associated with the development. That decrease in the pre-development natural discharge is manifested in reduced or dried springs, streams, lakes, and phreatophytic vegetation. While the partitioning of the impact among individual groundwater-dependent features depends on the particular hydrologic setting, the long-term reduction of the cumulative natural discharge by the anthropogenic consumptive use is independent of the hydrologic setting. The setting affects only when and where the impacts will occur. It does not impact the cumulative magnitude of the impacts.

Role of Geology and Chemistry in Defining Reaches of Snake Creek Likely to be Susceptible to Nearby Groundwater Pumping in Southern Snake Valley, Nevada

***Christine E. Hatch (Presenter), David E. Prudic, Scott W. Tyler, and Tracie Jackson,** University of Nevada, Reno*

Geology is an important factor when evaluating the connection of streams with underlying aquifers. Groundwater pumping can affect flow in a stream only if the groundwater table is near or above the streambed and the streambed has sufficient permeability to allow for a connection between the stream and underlying groundwater. Most streams that flow out of mountains and onto valley floors in the Great Basin of Nevada have a cobble and gravel streambed that has sufficient permeability to allow water exchange with groundwater. Typically, mountain streams that flow onto alluvial fans lose flow at a rate dictated only by the streambed permeability because depth to groundwater is far below the streambed. The increased depth to groundwater beneath alluvial fans can be caused by the relatively greater permeability of sand and gravel deposits compared with most rock formations in the mountains. Exceptions do occur in some areas of the Great Basin, particularly where limestone is prevalent in the mountains. Limestone in the mountains can have permeability greater than sand and gravel and streams can gain downstream from the transition from limestone to sand and gravel. Thus, lithology is crucial to understanding where and when streams could be affected by groundwater pumping.

Water chemistry also can play an important role in the connection of streams with groundwater. Chemical reactions within the streambed can result in precipitation of silica or carbonate cement that reduces the permeability of the streambed from groundwater and through time, which greatly decreases the quantity of water exchange between the stream and groundwater. In Snake Creek, the effect of groundwater pumping would be limited most dramatically by the permeability of the cemented layer in or beneath the streambed.

Snake Creek, which drains the eastern slope of the southern Snake Range in Great Basin National Park near Baker, Nevada, is an area where surface water—groundwater exchange occurs in response to many factors, including complex substrate geology. The creek loses flow rapidly in areas underlain by permeable limestone, gains flow where it crosses a fault that emplaced cemented sand and gravel against the limestone, and maintains its flow farther into the valley than similar streams because the streambed has been cemented. Losing and gaining sections and connection with groundwater along Snake Creek were evaluated by measuring: 1) flow along the creek; 2) temperature changes in the creek across contact between limestone and sand and gravel; 3) water-level gradients between creek and shallow piezometers driven into the streambed; and 4) water levels in nearby wells. The role of water chemistry is assessed through collection and analysis of water samples in the creek and groundwater. Nearby groundwater pumping in southern Snake Valley is likely to affect flow in Snake Creek only if the cone of depression expands outward to the area where groundwater is at or very near the streambed.

Protecting Water Levels at Devils Hole

Jennifer Back, Water Rights Branch, National Park Service

Devils Hole and the endangered Devils Hole pupfish were at the center of the 1970's landmark water rights decision where the United States Supreme Court affirmed a lower district court's decision and delivered the opinion that the United States had acquired water rights "sufficient to maintain the level of the pool to preserve its scientific value…". Since the curtailment of pumping in Ash Meadows as a result of the Supreme Court decision, water levels have slowly risen at Devils Hole; however they have never fully recovered. Water levels are currently less than a foot above the court mandated minimum water level. Water levels in the pool are known to fluctuate in response to a number of factors including climate, barometric pressure, earth tides and groundwater withdrawals. However, theories to explain the lack of recovery have focused on increased groundwater withdrawals and the concentration of pumping in the vicinity of the historic Amargosa Farms area of the Amargosa Desert. Recent rulings by the Nevada State Engineer have stated that the Amargosa Desert hydrographic basin is over-appropriated and that the committed groundwater resources currently exceed the basin's perennial yield. However, proponents of groundwater development argue that the majority of existing wells pump groundwater from the fine-grained deposits of the valley-fill aquifer and are not in hydrologic connection to Devils Hole due to a geologic fault that acts as a barrier to flow. In order to address this issue, the NPS is working in conjunction with the USFWS, USGS, BLM and other agencies to refine the existing Death Valley regional groundwater flow model and to better characterize the effects of groundwater pumping in the Amargosa Desert on water levels at Devils Hole. It is anticipated that the Nevada State Engineer will use the model to evaluate future decisions regarding groundwater development and the movement of points of diversion throughout the flow system.

Predicting the Effects of Declining Water Level on the Devils Hole Pupfish

D. Bailey Gaines (Presenter), Michael R. Bower, *and* ***Kevin Wilson,*** *Death Valley National Park, Pahrump, Nevada,* ***Mark Hausner*** *and* ***Scott W. Tyler,*** *University of Nevada, Reno, and* ***Stanley Hillyard,*** *University of Nevada, Las Vegas*

A multi-faceted research and monitoring effort being guided by the National Park Service, U.S. Fish and Wildlife Service, and Nevada Department of Wildlife and implemented in collaboration with diverse academic partners to advance capacity for scientifically credible stewardship of the Devils Hole pupfish will be described. Within this overall stewardship strategy, specific efforts to address long-standing theories of Devils Hole pupfish population responses to varying water level will be detailed. A thermodynamic modeling effort being implemented by the University of Nevada, Reno and aimed at predicting the effects of declining water levels and increasing air temperatures on water temperatures experienced by the Devils Hole pupfish will be described. A sister project being implemented by the University of Nevada, Las Vegas that aims to establish the thermal tolerances of multiple life stages of the Devils Hole pupfish will be described. Finally, a conceptual model based on preliminary findings from these two efforts that includes hypothesized effects of declining water level on the survival or fitness of various life stages of the Devils Hole pupfish will be presented for consideration.

Interaction of Natural Hydrogeologic Conditions and Ground Water Pumping on Stranding and Survival of Juvenile Salmonids in a Coast Range Stream of Northern California

Rocco Fiori (Presenter), *California State Parks and Fiori GeoSciences,* ***Patrick Vaughan,*** *California State Parks,* ***Monica Hiner****, Northcoast Marine Mammal Center, and* ***Sarah Beesley,*** *Yurok Tribal Fisheries Program*

The influence of ground water pumping on water availability and the movement and survival of juvenile salmonids was investigated in a small Coast Range stream in northern California. Juvenile fish became stranded when surface flow diminished and isolated pools and dry reaches formed along a 1.4 mile segment of the West Branch Mill Creek, a tributary to the Smith River. Fish population estimates suggested that 2,000 to 3,000 juvenile fish were stranded annually within this reach and field observations indicate a majority of these fish succumb to predation and desiccation. Observations and snorkel surveys suggest juvenile fish preferred to congregate in deep pools and did not move up or down stream in large numbers to avoid stranding. Several critical riffles were identified within the study reach where shallow stream depth or velocities that exceeded 1 ft/s could limit juvenile fish passage. Surface and groundwater levels were controlled by rainfall inputs, highly permeable alluvial deposits, valley width, and evapotranspiration. However, slight short-term fluctuations in pool stage due to ground water pumping were detected after riffle crests had dried and fish egress was not possible. While stranding avoidance of juvenile salmonids in small streams is poorly understood our findings suggest that evaluations of ground water pumping on juvenile fish stranding need to consider the effects of natural and anthropogenic migration barriers over various temporal and spatial scales.

Session Coordinator*: Cynthia LeDoux-Bloom, Department of Water Resources*

Otolith Derived Insights about the Ecology and Conservation of the Tidewater Goby, *Eucyclogobius newberryi,* in a Northern California Lagoon

Michael Hellmair (Presenter) and Andrew P. Kinziger, Humboldt State University

The tidewater goby, endemic to California and listed as endangered under the ESA in 1994 due to, among other reasons, dramatic declines in suitable habitat, has—to date—been assumed to be an annual species, spawning predominantly in late spring and, to a lesser extent, in early fall. The study of these fish in one of their last population strongholds, namely Big Lagoon, California, as well as a nearby artificial habitat in Humboldt Bay from where they have since been practically extirpated, reveals the vulnerability of these fish to anthropogenic environmental variation, especially during time of population turnover.

A size stratified sample of 25 fish have been sacrificed on a monthly basis, starting in April of 2009, for determination and enumeration of daily otolith increments. Daily growth increment deposition was validated by calcein marking and recapturing several fish after a predetermined time period, then locating the fluorescent increment on the otolith and counting the increments thereafter, which corresponded to the number of days elapsed between marking and recapture. To date our analyses support daily increment deposition for the tidewater goby. Pelagic larval duration, as indicated by settlement checks identified in otoliths, is approximately 20 days, consistent with values reported in the scientific literature. Tidewater gobies, unlike many other small and short lived fishes, do not exhibit the typical linear growth, but instead show a rapidly declining rate of growth at a relatively young age, presumably in order to devote more energy to upcoming reproductive efforts. The vast majority of reproduction occurred in late spring, but spawning has continued throughout the summer and into fall, resulting in a variety of size- and age classes being present most of the year, reducing potentially devastating impacts of environmental fluctuations on the population as a whole. However, as a result of the peak in spawning activity in spring, it appears that goby populations experience an almost complete population turnover, indicated by a drastic decrease in abundance of adult individuals, followed soon thereafter by the appearance of the post-settlement juveniles. The maximum attained age is much less than one year for all gobies aged to date.

Food Habits of Native Fishes in Lagunitas and Olema Creeks, Marin County

Barbara A. Martin (Presenter) *and* ***Michael K. Saiki,*** *U.S. Geological Survey, Biological Resources Discipline, Western Fisheries Research Center, and* **Darren Fong,** *National Park Service, Golden Gate National Recreation Area*

This study was conducted to examine the food habits of seven native fishes in two adjoining creeks that flow into Tomales Bay. The information was needed to better understand the food habits of cohabiting native species, and to determine if the California freshwater shrimp (*Syncaris pacifica*; a federally listed endangered species) was included among their food items. We determined the gut contents of 273 prickly sculpin (*Cottus asper*), 329 riffle sculpin (*Cottus gulosus*), 1,093 threespine stickleback (*Gasterosteus aculeatu*), 228 California roach (*Hesperoleucus symmetricus*), 25 coho salmon (*Oncorhynchus kisutch*), 106 steelhead trout (*Oncorhynchus mykiss*), and three chinook salmon (*Oncorhynchus tshawytscha*) captured with minnow traps and seines in Lagunitas and Olema creeks on a quarterly basis from May 2003 to August 2004. All salmonids were represented by juvenile life stages (fry and fingerlings), whereas other species included both juveniles and adults. Prickly sculpin and riffle sculpin ate aquatic insects and fish, salmonids and threespine stickleback ate mostly aquatic insects, whereas California roach ate a combination of aquatic insects, plant material, and detritus. Although diets of salmonids and sticklebacks were similar over creeks, habitats, seasons, and fish body size, diets of sculpins and roach were not similar over the same variables. In general, sculpins ate more fish in Lagunitas Creek than in Olema Creek, more fish in glides and pools than in riffles, more fish in November than in February, May, or August, and more fish as they increased in size. We also found California freshwater shrimp in guts of two prickly sculpin and three riffle sculpin, but not in guts of other fish species. Although consumed by sculpins, the shrimp comprised a minor portion (< 1%) of their diets. Roach ate more aquatic insects in Lagunitas Creek than in Olema Creek, more aquatic insects in riffles than in pools or glides, more aquatic insects in February and August than in May and November, and more aquatic insects at small body sizes than at large body sizes.

Long-term Isolation and Genetic Divergence Between Populations of the Threatened Rough Sculpin (*Cottus asperrimus*) Separated by Hat Creek Fault

Andrew Kinziger (Presenter) *and* ***Michael Hellmair,*** *Humboldt State University,*
and ***Damon Goodman,*** *U.S. Fish and Wildlife Service*

The rough sculpin (*Cottus asperrimus*) is a state threatened species confined to about 80 km of stream in the Pit River system (California). Within this region, rough sculpin are restricted to cold spring-fed pools over sand and silt bottoms. An active fault traversing the mainstem Pit River has created a series of steep rapids, cascades and waterfalls (some up to 12 m) potentially forming a long-term isolating barrier to rough sculpin migration. To determine if the fault zone has restricted gene flow between rough sculpin populations we compared variation in mitochondrial DNA ATPase 8 and 6 genes and two nuclear microsatellite loci from populations occurring on opposite sides of the fault zone. Analysis of microsatellite data indicated significant levels of genetic differentiation, FST = 0.30, between populations isolated by the fault. Similarly, analysis of mitochondrial DNA strongly supported reciprocal monophyly of populations from opposite sides of the fault zone. Populations from opposite sides of the fault zone differ by 0.83% sequence divergence, providing an estimated of date of divergence between these populations of approximately 0.8 to 1.6 million years ago. The initiation of faulting in the region has been dated to approximately one million years ago, consistent with the mtDNA molecular clock estimate. Patterns of genetic differentiation are paralleled by divergence in pectoral-fin rays and spawning time. Concordant divergence in multiple character types supports recognition of rough sculpin populations on opposite sides of the fault zone as distinct management units.

Effects of a Restored Freshwater Tidal Wetland Complex on Habitat for Imperiled Native Fish

Gina Benigno (Presenter), Ted Sommer, and Nick Van Ark,
California Department of Water Resources

The recent collapse of pelagic fish populations in the Sacramento-San Joaquin delta has led to increased interest in habitat restoration. Successful tidal wetland restoration has occurred naturally in the northern delta at Liberty Island, where a levee breach inundated the island in 1998 and a highly productive tidal freshwater wetland has developed. Liberty Island and its surrounding sloughs, known as the Cache Slough Complex, are now considered key habitat for endangered native fish species. The Cache Slough Complex is a priority area for future habitat restoration efforts to protect and enhance native delta fishes. This study examines the hydrodynamic "footprint" of Liberty Island in the Cache Slough complex. Continuous monitoring of flow, temperature, turbidity, and salinity is coupled with quarterly sampling of biological resources over spring and neap tidal cycles. We report seasonal diel patterns in chlorophyll-a, zooplankton, and mysid abundance from Liberty Island and surrounding sloughs. Understanding the patterns of hydrodynamics and productivity is important to describe the habitat of pelagic fishes including delta smelt, and will help to identify and plan future restoration projects in the region.

Geomorphic Monitoring of Lower Clear Creek: Ten Years of Observations

S.A. Pittman (Presenter) *and* ***G.W. Matthews,*** *Graham Matthews and Associates*

Impacts to Clear Creek below Whiskeytown Dam vary by reach, with distance from dam and with proximity to tributaries or locations of instream gravel mining/historic dredger mining. Since dam closure in 1965, riparian encroachment, sediment starvation, riffle coarsening and channel incision have combined to reduce the instream and floodplain habitat quality in Clear Creek. Numerous restoration design, gravel augmentation and flow/sediment transport modeling projects have incorporated geomorphic monitoring components. Types of monitoring studies included: repeat channel geometry surveys (cross section, thalweg profile, topography, bathymetry); particle size analyses; thresholds of bed mobility; repeat ground-level photography; and aerial photo/LIDAR-based analyses.

Riparian berm confinement continues to promote undesirable channel form and high sediment transport capacities in upstream reaches. Available spawning area has increased in these upper reaches (within the influence of the Whiskeytown Dam gravel injections) by several hundred percent. Headcuts and channel incision persist in downstream alluvial reaches despite restoration efforts. Thresholds of bed mobility appear to be reduced on riffles influenced by injected gravel. However, within floodway restoration areas, vegetation colonization of depositional features is reducing the threshold of bed mobility bar surfaces. Saeltzer Dam-liberated sediments appeared to overwhelm certain sub-reaches while moving through others. Much of the reservoir deposit appeared to move through as suspended sediment in the first hydrologically significant water year (2003) following removal, while coarser sediment has locally aggraded downstream reaches and in one case caused channel adjustment reducing available spawning habitat.

In tributary-influenced reaches, the leading edge of gravel injections was difficult to discern. In sediment-starved reaches, quantitative and qualitative surveys of stream channel segments below gravel injections reveal the leading edge translating as a lobe, partially filling lateral voids, and to a lesser degree pools, as the threshold of alluviation is met. Translation rates (longitudinal distance of channel "re-charge" per year) of 250 to 450 feet/year were measured, corresponding to injection rates of 750 to 1,800 tons/year. At these rates, it will take over 60 years to achieve complete sediment routing in Clear Creek.

Session Coordinator*: Cynthia LeDoux-Bloom, Department of Water Resources*

Evaluation of *Ceratomyxa shasta* and *Parvicapsula minibicornis* in Returning Adult Chinook Salmon (*Oncorhynchus tshawytscha*) Throughout the Klamath River Basin

Ryan Slezak (Presenter), *Graduate Student, Humboldt State University and U.S. Fish & Wildlife Service,* ***Gary Hendrickson,*** *Department of Fisheries Biology, Humboldt State University, and* ***J. Scott Foott,*** *U.S. Fish & Wildlife Service, CA-NV Fish Health Center*

I examined incidence and severity of *Ceratomyxa shasta* and *Parvicapsula minibicornis* in adult Chinook salmon (*Oncorhynchus tshawytscha*) returning to spawn in the Klamath River Basin. From August 2007 through December 2007, 506 adult salmon were sampled at various locations throughout the basin. Trophozoite and myxospore life stages of the myxozoan parasites *C. shasta* and *P. minibicornis* were identified and quantified using wet mount, histology, and polymerase chain reaction. Chi-square tests were used to correlate any temporal or geographical patterns with incidence and severity. Incidence and severity for both pathogens peaked on October 25 in samples collected from Iron Gate Hatchery. No clear trends were seen in samples collected from Trinity River Hatchery. Chinook salmon carcasses collected from Bogus Creek, Shasta River, and the mainstem Klamath River were found to have significantly more *C. shasta* myxospores than Chinook salmon artificially spawned at Iron Gate and Trinity River Hatcheries. Further research should focus exclusively on naturally-spawned salmon carcasses to gain a better understanding of the timing and frequency of the myxospore load in the Klamath River Basin.

Reproductive Attributes of Sympatric Chinook Salmon (*Oncorhynchus tshawytscha*) Runs

James W. Hearsey (Presenter), *Student, Humboldt State University,*
and ***Andrew Kinziger, Ph. D.,*** *Associate Professor and Curator of Fishes,*
Department of Fisheries Biology, Humboldt State University

The Klamath River system produces two runs of Chinook salmon (*O. tshawytscha*), identified as either "spring" or "fall" by their return timings. The spring-run enters freshwater from May to July, prior to spawning from September to October. The fall-run enters from August to mid-October, before spawning from late October to early December. Our hypothesis was that extra fat content would be needed by the spring fish to fuel their longer period of off-feed metabolism and gametic development. It was also hypothesized that spring fish's gonads would be less developed (i.e. smaller testes and smaller diameter eggs). We collected Chinook salmon on a weekly basis (N = 250) upon freshwater entry between April and October in the Klamath River and recorded total mass, fork length, egg diameter, gonad and liver mass, and dried:fresh liver weight ratios (which is proportional to fat content), and morphometrics of secondary sexual characteristics. We detected a clinal increase in mean egg diameter, from 3.8 mm for the earliest spring-run samples collected in May, to 6.4 mm for the last of the fall-run collected in October. Concordantly, fat content decreased through time with early spring-run fish having higher fat content (mean dried:fresh liver weight ratios 0.31) than the late fall-run fish (0.26). These data are consistent with our hypothesis that fish that return earlier have smaller eggs and higher fat content, with fish returning during the middle of the season intermediate for these attributes. This study showed that upon freshwater entry the two runs are phenotypically distinct and allocate their resources according to their unique life histories and reproductive strategies.

Limitations of Genetic Stock Identification of Chinook Salmon, *Oncorhynchus tshawytscha*, in the Klamath-Trinity Basin, and Implied Consequences for Wild Stock Recovery

Michael Hellmair (Presenter), *and* ***Andrew P. Kinziger*** *and* ***Dave G. Hankin*** *Humboldt State University*

Genetic stock identification using microsatellites is a commonly applied method to estimate stock composition in mixed-stock fisheries. The most important factor determining the ability to correctly assign fish to their respective stocks of origin is significant genetic differentiation between the potential source populations. While studies have been conducted on large riverine systems, such as the Columbia and Yukon Rivers, the Klamath-Trinity Basin presents an opportunity to evaluate the accuracy of GSI on a relatively small geographic scale. Further complicating GSI in the Klamath River is the extensive history of hatchery reared out-of-basin transplants, increasing geneflow between populations and therefore reducing the level of genetic differentiation between stocks. A 17-locus baseline was constructed composed of 12 salmon stocks, including all drainages that support appreciable numbers of returns, wild and hatchery populations, and spring- and fall-run populations. Major findings include the resolution of substantial genetic structuring of Klamath-Trinity Chinook salmon despite the large amount of out-of-transplantation that has occurred in the basin, the presence of four genetically differentiated and geographically isolated groups of Chinook salmon in the Klamath-Trinity basin as well as assignment accuracy of nearly 90% to region of origin (based on simulated mixtures as well as repeat baseline samples), and 72% (simulated mixtures) and 88% (repeat baseline samples) to population of origin.

Despite the degree of assignment accuracy obtainable by employing microsatellite data, the same data also suggests substantial gene flow from hatchery to wild stocks, the effect of which is related to both, the relative population size of the "donating" as well as the "receiving" stocks. Hatchery influence can be genetically detected in sub-basins not subject to direct hatchery input, and wild stocks—including those of special concern—have been inundated with hatchery genes.

Preliminary Analysis of Green Sturgeon, *Acipenser medirostris*, Bioenergetics in Relation to Fish-screen Interactions

Halley Nelson (Presenter), Jon Reardon, Dennis Cocherell, and Joseph J. Cech, Jr.,
Wildlife, Fish, & Conservation Biology, University of California, Davis

Fish in regulated-river systems may be exposed to numerous anthropogenically-altered environments (e.g., with insertion of water-diversion structures) during their various life stages. To ensure healthy populations of resident and migratory fishes in these altered systems, it is crucial to secure a rather complete understanding regarding the potential related impacts. For example, the effects of fish screens and their challenging hydraulic conditions, in the riverine habitats of the threatened, North American green sturgeon are poorly understood. Young fish use acquired energy for growth, movement, and other needs associated with survival in their habitats. Swimming is metabolically costly, and their swimming performance limits (e.g., critical swimming velocities), the energetic costs of swimming (i.e., "active" metabolism) at relevant velocities, and calculated aerobic scopes (i.e., "active" minus "resting" metabolism) provide excellent indices of a fish's ecological performance. Using spawn from UC Davis brood fish, we conducted a preliminary study of juvenile green sturgeon swimming performance and related metabolic costs to address their potential interactions with water-diversion fish screens. Using a Brett-type, recirculating-flow respirometer, we measured critical swimming velocities (Ucrit) and metabolic rates of swimming fish. With available metabolic data on resting, juvenile green sturgeon, we calculated aerobic scopes. Bioenergetic studies, such as these, should provide fisheries and habitat managers with useful, quantitative tools to properly assess potential impacts of altered environments on resident and migratory fishes.

Incision History Influences Restoration Priority Areas for Steelhead on Carneros Creek, Napa Valley, California

Julie Beagle (Presenter), *Candidate MLA-EP and* ***Professor Matt Kondolf,*** *Department of Landscape Architecture and Environmental Planning, University of California, Berkeley*

Carneros Creek, a tributary of the Napa River, California (drainage area 17 km^2), is incised from two to six m below its valley bottom. The stream provides habitat for steelhead trout (*Oncorhynchus mykiss*), so incision-related degradation of habitat has been a concern for ecological management agencies. Previous studies have offered conflicting interpretations of the stream's geomorphic history, one report concluding that the incision was primarily post-1940, another that the incision dates from the 19th century, when intensive livestock grazing began. We conducted the first comprehensive field mapping and topographic surveying of the channel and coring of riparian trees along the entire length of Carneros Creek. Our results provide evidence for both episodes of incision. Upstream of a bedrock outcrop (not described in prior studies) the channel is incised about two to three m, flanked by a single terrace. Downstream of this outcrop, the channel is incised about six m in total, flanked by two distinct terraces. Dendrochronologic evidence supports the interpretation that a 19th-century episode of incision (probably induced by grazing) affected the entire nontidal length of the stream, while a post-1940 episode of incision (presumably triggered by extensive land-use conversion to vineyard) affected the lower reach, which received runoff from the vineyards. The reach upstream of the bedrock outcrop did not incise, because the catchment above this point was not subjected to extensive vineyard conversion, and because the bedrock prevented regressive erosion from propagating upstream from the rejuvenated downstream reach.

These findings indicate the need for different management strategies dependent on land evolution patterns and current geomorphic processes. The middle and lower reaches of the creek, which were most likely prone to flooding and were at one point connected to a floodplain have been incised and thus disconnected from their floodplain or fan base, to the most severe extent. Using the mapped data, and a multi-criteria decision-making GIS based suitability analysis, we ranked priority areas for maintaining quality fish habitat for rearing steelhead. The analysis used different criteria depending on geomorphologic process, land evolution history and observations. Results showed that priority areas for fish habitat corresponded to different geomorphic and biologic factors given the position in the land evolution pattern. For example, above the sill-bedrock, perched pools dominated as prime fish habitat, and below the sill-scour pools below spider trees, LWD were most important for over-summering fishes.

Caples Lake: A Case Study of Fish Rescue and Restocking at a High-Elevation Sierra Nevada Reservoir

Brian Deason (Presenter), *Hydroelectric Compliance Analyst, El Dorado Irrigation District and* ***Jay Rowan,*** *Associate Fisheries Biologist, California Department of Fish and Game*

In June 2008, divers discovered severely corroded outlet gates at the Caples Lake main dam. Dam safety experts determined that a near complete reservoir drawdown would be necessary to meet minimum safety requirements during the repairs. The extent of the drawdown raised concerns that there may be significant impacts to the State renowned trophy trout fishery in Caples Lake and the local recreation industry. In response, the El Dorado Irrigation District (EID) and the California Department of Fish and Game (DFG) joined forces to implement an extensive fish rescue and restocking program.

Several actions were taken to address the impending impacts to the reservoir fishery. First, EID coordinated with DFG to conduct fish rescues during the drawdown. Second, EID and DFG jointly developed a reservoir fisheries restocking plan.

DFG conducted the two fish rescues during the course of the reservoir drawdown. The first rescue, funded by EID, took place over a four-day period in late August. DFG staff, with the help of volunteers from the Sacramento-Sierra Chapter of Trout Unlimited and California Sportfishing Protection Alliance, used various types of nets and electrofishing boats to capture fish. DFG estimates approximately 6,300 fish were rescued and transported to nearby lakes. Rainbow, brown, and lake trout were moved to Silver Lake, while brook trout were moved to Red Lake. The second rescue lasted one day in mid-September, after a temporary coffer dam system was removed, which was in place during the emergency repairs to manage remaining reservoir storage and protect the contractors working inside the outlet works of the dam. This effort, also a collaboration of EID, DFG, and volunteers, resulted in the removal of an estimated 20,000 fish and fingerlings to Silver and Red lakes. This was the first fish rescue of such magnitude in a high-elevation Sierra reservoir.

During the drawdown and fish rescues, EID continued to work with DFG to devise a comprehensive fish restocking plan for the lake, which was based on the DFG's highly successful Lake Davis restocking plan. The goals of the plan were to immediately reestablish a trophy lake trout fishery and to provide continued opportunities for trophy rainbow and brown trout fishing over a ten-year period, until the existing trophy fishing assemblage was anticipated to recover. The plan, which was divided into two phases, commenced when ice melted and suitable conditions occurred in May of 2009 and continued through September. During that time, 9,000 pounds of trophy rainbow trout—approximately 1,500 fish—were released into the lake. Approximately 25,000 pounds of catchable rainbow and 6,600 pounds of catchable brown trout were also released. Additionally, 175,000 fingerling and sub-catchable rainbows, along with 80,000 fingerling lake trout were planted during the phase one. The plan calls for additional stocking over nine years, beginning in 2010. EID is working closely with a local utility district in the region administering an existing successful stocking program to implement the remaining years of the plan.

These efforts provide a model for agency collaboration to address a major natural resource challenge during an emergency situation.

Save Our Salmon (SOS):
Salmon Creek Habitat Rehabilitation Program—Phase I

John Green, ***Gold Ridge Resource Conservation District***

Although their range once stretched inland along more than 250 miles of California's central coast, coho salmon (*Oncorhynchus kisutch*) are on the brink of extinction, with only a few central coast watersheds now supporting more than remnant populations. The decline of the central coast coho has resulted in their listing as endangered under both the California and Federal Endangered Species Acts.

In an effort to aid the recovery of coho populations by improving spawning and rearing habitat conditions, the Gold Ridge Resource Conservation District (GRRCD) and our partners—Prunuske Chatham, Inc. and Dragon Fly Stream Enhancement—have focused restoration efforts on the Salmon Creek watershed, near Bodega, CA. Salmon Creek supports a fledgling coho salmon population, and is protected as part of the Sonoma Coast State Marine Conservation Area.

With funding provided by NOAA Fisheries through the American Recovery and Reinvestment Act of 2009, GRRCD is implementing the Save Our Salmon program—a suite of projects with the goal of attaining self-sustaining coho populations in the Salmon Creek watershed. Restoration efforts are focused on four key habitat factors: enhancement of riparian vegetation, installation of large instream wood structures, stream flow augmentation, and reduction of fine sediment.

SOS will provide both short and long-term economic benefits to the community of Bodega. In addition to providing employment for local restoration and construction professionals, the program will support the local agricultural economy by providing drought relief for some agricultural operations. It will also demonstrate sound practices for water conservation and management, helping local ranchers, growers, and dairy operators stay in business. And in the long run, restoration of the coho will help to revive the local fishery, which has been decimated by the collapse of salmon populations.

Using Radio Telemetry to Inform Rescue Strategies for Central Valley Spring-run Chinook Salmon

***Chris Mosser (Presenter),** and **Lisa Thompson,** UC Davis, and **Josh Strange,** Yurok Tribe*

The timing of Pacific salmon spawning migrations with respect to the local climate is particularly important for races that over-summer in freshwater for several months before spawning in the fall, such as in Central Valley spring-run Chinook salmon, *Onchorhynchus tshawytscha*, listed as threatened under the Endangered Species Act. Summer survival and in-stream migration success of mature adult salmon are directly related to freshwater flow and temperature regimes. Climate change scenarios for the Central Valley, a region with stream flow dominated by snowmelt, predict earlier onset and longer duration of high summer air temperatures, combined with reduced snowpack and earlier snow melt, resulting in lower flowing, warmer water during the summer.

Over the last three summers the Central Valley, including Butte Creek, near Chico, has experienced extreme drought conditions. During the last two summers, some Butte Creek spring-run Chinook salmon became stranded downstream of their summer holding habitat by mid June. This led to agency rescue operations, in which late arriving salmon that had failed to move upstream past barriers were trapped and trucked upstream. Approximately 350 salmon were rescued in June 2008, of which only five fish were confirmed to have lived long enough to spawn. In May 2009 regulatory agencies signed a memorandum regarding fish rescues, acknowledging the lack of information concerning the fate of rescued fish. The current study is a step toward better understanding the outcomes of fish rescues.

On June 30, 2009, twenty-six adult Chinook salmon were rescued by agency staff and were given esophageal radio tags. We tracked the salmon weekly until the end of the spawning season in the fall, from as far upstream as the salmon could migrate given natural barriers, to five km downstream of the rescue site. By early August, about a month and a half before the start of the spawning season, we had recovered 23 tags. Ten tags were recovered downstream of the release site, within one km. Twelve tags were recovered upstream within 3.5 km of the release site, and one tag was found six km upstream. One additional tag was rumored to have been found by a member of the public, but this was unconfirmed. Eight tags were recovered within salmon remains and the fish were considered to have died. An additional seven tags were recovered on the bank, some distance from the water's edge, or within close proximity of salmon remains, and these fish were also assumed dead. The remaining eight recovered tags were found in the water, without any salmon remains in the immediate area, so the fate of these fish is uncertain. However, previous research on tag retention suggests that most fish would have retained their tags and that these fish also died. This pilot study suggests a distinct decrease in survival of fish on the tail end of the migratory distribution.

Truncated Juvenile Emigration Season: Implications to Life History Diversity and Conservation of Central Valley Fall-Run Chinook Salmon

Yvette J. Redler and Rosalie B. del Rosario, National Marine Fisheries Service

The four runs of Chinook salmon in California's Central Valley have co-existed successfully for thousands of years by using different migration windows. Within a run, variation in juvenile migratory behavior or response can result in increased life history diversity, which is a key component for contributing to abundance of populations and to their resilience in the face of environmental variation or change. Of the Chinook salmon in the Central Valley, fall-run is the most abundant run, has the longest juvenile emigration season, and the largest geographic distribution, inhabiting tributaries of both the Sacramento and San Joaquin Rivers. The fall-run population is heavily supplemented by hatchery stocks to support commercial fishing. However, there is much controversy as to whether the hatchery fish are supplementing the wild stock or instead straying and interbreeding with the wild fish resulting in maladaptive traits.

All juvenile Central Valley Chinook salmon runs must migrate through the Delta to continue their juvenile development in the ocean. We identified patterns of juvenile migration entering and exiting the Delta utilizing monitoring data from the lower Sacramento River at Knights Landing and Sacramento, and in the western Delta at Chipps Island. We analyzed data from 1995-2008 to examine Chinook salmon emigration patterns under management conditions implemented by the 1995 Water Right Decision 1641 regulating flow standards for the Bay-Delta Estuary.

We detected reduced temporal diversity of juveniles leaving the Delta at Chipps Island for all runs of Chinook salmon, but most significantly for fall-run populations. Based on relative abundance and fork length data, emigration of fry-sized (<70mm) wild fall-run occurs during January through March. This is followed by larger smolt-sized (>70 mm) fall-run, predominantly of hatchery origin, starting in April. From 1995 through 2000, fall-run emigrated from the Delta over a seven month period, January through July. However, starting in 2001, we detected a truncated emigration for fall run from seven to four months, by an absence of fry-sized fall-run, presumably of wild origin, at Chipps Island during the months of January and February. The emigration window was further shortened starting in 2007, when fry-sized fall-run were no longer captured in March. Two notable events occurred that likely have compromised fall-run populations in recent years: 1) cohort replacement rates have fallen and remained below 1.0 since 2004; and 2) the 2008 adult return of fall-run juveniles that emigrated in 2005 was a near record low, and resulted in the unprecedented closure of the commercial salmon fishery off the coast of California. This closure remained in effect in 2009.

Understanding population trends and knowing what factors may be responsible for species decline are essential for conservation and recovery.

Restoring 1,200 feet of Stream Channel by Removing Several Sediment Sources from a Tributary to Scotts Creek, Napa County, California

Tara Zuroweste, Bill Birmingham, and Danny Hagans, Pacific Watershed Associates

Pacific Watershed Associates (PWA) partnered with the Napa County Resource Conservation District (NCRCD) and Natural Resources Conservation Service (NRCS) to restore approximately 1,200 ft of ephemeral stream channel on the Saintsbury Vineyards property in the Carneros Creek watershed, Napa County, California. The project site is located along a tributary to Scotts Creek, approximately 0.5 mile upstream from the confluence with mainstem Carneros Creek. The area was originally disturbed in the 1940s with the creation of a road network and construction of three stream crossings. The project site was further altered in the mid-1990s with the construction of three earthen dams along the stream channel to create stock ponds.

Based on data from PWA's 2002-2003 assessment of road related erosion on selected parcels in the Carneros and Sulfur Creek watersheds and pre-implementation layout and design, PWA estimated that this site represented the largest single anthropogenic source of sediment in the Carneros Creek watershed. Field data showed that two of the three stream crossings had partially or completely failed, and all three dams had failed, resulting in significant erosion and the delivery of fine sediment to the stream. As the channel was becoming reestablished, erosion continued for both the placed fill material and stored sediment from the ponds.

With funding secured by the NCRCD, erosion control and erosion prevention implementation began in the summer of 2009. The main project components consisted of removing remaining fill material from three failed earthen dams; decommissioning a culverted road crossing and upgrading two additional culvert crossings; reestablishing the stream channel thalwag and floodplain; recontouring the channel side slopes; constructing cattle exclusion fencing; and revegetating the project area. Non-native vegetation was mechanically removed and fill material was excavated from all crossings and earthen dams. Excavation of stored sediment within the channel allowed PWA staff to estimate the course of the original stream bed. A fairly constant grade along the restored segment of stream channel was established as channel sinuosity and narrow meander locations were determined. Once the location of the channel was finalized, floodplains were reconstructed, the valley sideslopes were recontoured to match the existing hillslopes, and the two new culverted road crossings were installed. PWA staff documented the implementation process from various vantage points using time-lapse photography. To accommodate continued cattle grazing practices in the area, cattle exclusion fencing was constructed and the disturbed areas were revegetated with native grasses, shrubs, and trees as per the NRCS "Saintsbury Scotts Creek Revegetation Plan."

PWA estimates that implementing this project prevented the delivery of more than 2,200 cubic yards of fine sediment to the Carneros Creek system. Post excavation cross sections and a long profile were surveyed to document future channel changes, and help to evaluate the long-term success of the project.

Quicksilver Lampreys: Mercury Contamination in Lampreys of the Klamath Basin

***J. Bettaso** and **D.H. Goodman**, United States Fish and Wildlife Service*

Mercury has been linked to a host of lethal and non-lethal impacts to biological organisms. Impacts from mercury include immunosuppression, teratogenic effects and endocrine disruption. Mercury, referred to as Quicksilver by goldminers, was widely used in Northern California during the gold rush. High levels of mercury in the Trinity River led to health advisories for the consumption of fish in Trinity Lake. We investigate presence of mercury in long lived filter feeders in the Klamath Basin, lamprey ammocoetes (*Entosphenus spp.*). In 2007, we sampled freshwater mussels (*Margaritifera falcata*) and lamprey ammocoetes from three paired locations in the Trinity River. We identified 12 to 25 times the concentration of total mercury concentration in lamprey ammocoetes at the paired collections. In 2008, we investigated the three factors including the relationship between lamprey size and total mercury concentration, lamprey ammocoete and sediment sample total mercury concentration, and distribution of total mercury in lamprey ammocoetes among 31 locations in the Klamath Basin. A significant relationship was not identified between total mercury concentration and ammocoete size. Mercury contamination in ammocoetes was not correlated to sediment sample contamination at paired collection sites. We identified 24 of 31 or 77% of sites to be above 0.30 ppm total mercury concentration. These results indicate that mercury contamination could be a population level concern for lampreys in the Klamath Basin and warrant further investigation.

Scenarios for Restoring Ecologically Functional Floodplains and Providing Ecosystem Services in the Central Valley, California

Mary Matella, PhD candidate, *Department of Environmental Science, Policy and Management, University of California, Berkeley and* **John Cain,** *Director of Conservation for California Flood Management, American Rivers*

California's Central Valley was once a large dynamic river-floodplain system that flooded seasonally, creating heterogeneous habitat supporting biodiversity. Native fishes adapted to this predictable flooding regime, using floodplains for spawning and rearing. Over the last century, dams and levees have severed the hydraulic connection between the river channels and their floodplains by containing flood waters between levees or in reservoirs. Not only has this loss of periodically inundated floodplains significantly reduced habitats required to sustain native fishes, migratory birds and other wildlife, but it has diminished natural processes that cycle nutrients, cleanse water, and recharge aquifers, and, paradoxically, has increased economic damages associated with large floods.

The State of California has embarked on the development of a new flood plan for the Central Valley that could either perpetuate the loss of inundated floodplain habitat or substantially restore it. Ideally, new flood management projects could be designed with the dual goals of lowering flood stage during extreme flood events, but also increasing the wetted surface area during regular high–flow events. For example, setting back levees and expanding flood bypasses could increase flood conveyance capacity, reduce flood stage and velocity for sensitive areas, and restore critical floodplain habitat for migrating salmon and cyprinids. Our study is based on the premise that an understanding of the basic processes that shape habitat, and the scales at which they operate, will aid the development of flood management strategies that both reduce flood risk and restore ecological function, but flood management and ecologically functional floodplains occur at very different temporal and spatial scales.

The overall goal of our research is to develop a geo-spatial method for determining where levee setbacks and bypasses could be located to optimize both flood risk reduction and ecological benefits. As a first step toward this overall goal, we have characterized the hydrologic and geo-spatial attributes that are necessary to create both floodway expansion projects that reduce flood hazard and floodplain restoration projects that benefit declining native fish species. We will use a coarse scale spatial analysis that is based on a synthesis of high-resolution spatial and hydrologic data to identify where these attributes co-occur and thereby identify locations for promising multi-purpose floodplain restoration projects across the entire valley. Individual project sites identified through this analysis could be aggregated in various combinations along with reservoir operations to quantify timing, frequency, duration, and area of inundated floodplain habitat under various scenarios. The end product of our approach is a template for developing multiple scenarios of restored floodplain based on adjustments of flood stage and topographic alterations (e.g., levee setbacks). Ultimately, defining and quantifying the area inundated by the regular, frequent flood pulse that supports floodplain ecological processes will help managers plan and evaluate floodplain restoration projects.

Distribution of Lamprey Genera in the Battle Creek Watershed

Kellie S. Whitton, Jess Newton,* and *Matt Brown*, *U.S. Fish and Wildlife Service

In California, most species of lamprey are listed as "species of special concern" or are on the watch list because declining numbers, limited ranges, and continuing threats make them more vulnerable to extinction. These classifications should call attention to their status, allowing the issues to be addressed early enough to secure their long-term survival; however, within the Central Valley, threatened and endangered salmonids receive the bulk of funding in an effort to restore historical runs. In the meantime, much of the information about lamprey is collected during salmonid monitoring projects. In 2007 and 2008, we conducted the pre-restoration phase of a community study on Battle Creek to document the current distributions of fish in order to determine how distribution will change in response to large-scale restoration (i.e., dam removal, installation of fish ladders and fish screens, and increased flows). Although the goal of the restoration project is to provide additional spawning and rearing habitat for threatened or endangered salmonids, this study provided the opportunity to document the current distribution of lamprey within the Battle Creek watershed. In November 2007, we established 19 sample sites throughout the Battle Creek drainage; four were on the mainstem, eight were on the south fork, and seven were on the north fork. Each site was sampled four times to capture seasonal variation. Snorkeling and electrofishing were the primary sample methods used at all sites. Lamprey ammocoetes were identified to genus using pigment patterns in the caudal fin and caudal ridge. All other life-stages were identified to genus or species based on dentition patterns. If possible, 20 lamprey were collected from each location during the first survey to allow for meristic counts of myomeres. *Lampetra spp.* and *Entosphenus spp.* were both found in the Battle Creek drainage, but both were not found at all sites. No lamprey were captured at the five most uspstream sites on both the south and north forks. In addition, *Entosphenus spp.* were not found above or immediately below Coleman Diversion Dam on the south fork, and *Lampetra spp.* were not found above or immediately below Wildcat Dam on the north fork. We captured both *Entosphenus spp.* and *Lampetra spp.* in all mainstem sites. Current distributions in the Battle Creek drainage likely differ from historical distributions, but to what extent is unknown. Natural barriers likely limited historical distributions within the drainage, but dams likely further restricted distributions, particularly for anadromous Pacific lamprey. The impact of dams on non-anadromous lamprey may be limited, particularly if they exhibit limited migratory behavior. If funding were available, further studies would provide important information about population trends of anadromous and brook lamprey within the Sacramento drainage as well as important life history information.

Lesson Learned: Acoustic Fish Monitoring in the Delta Using HTI Tracking Array

Michele Johnson, Javier Miranda, Gina Beer, Gabe Singer,* and *Kevin Clark,
California Department of Water Resources

Proper deployment and testing of biotelemetry equipment is crucial to the successful implementation and collection of acoustic information about fish behavior in the Sacramento-San Joaquin Delta. Understanding the behavior and movement patterns of outmigrating juvenile salmonids throughout the Sacramento-San Joaquin Delta (Delta) is imperative to assessing the survival of these fishes within the Delta. Projects, including the VAMP (Vernalis Adaptive Management Plan) study, Temporary Barriers Fish Monitoring Study, and the North/Central Delta Salmon Outmigration Study, are using biotelemetry techniques to track steelhead, salmon and predatory fish within the Delta. Juvenile steelhead and Chinook salmon are tagged with Hydroacoustic Technology Incorporated (HTI) acoustic tags and released at various points throughout the Delta. Predatory fish are caught via gill netting or hook-and-line, tagged, and released. Their movement patterns are recorded using underwater hydrophones with corresponding onshore receivers/dataloggers. The data collected is processed and analyzed, ultimately resulting in a statistical analysis of route-selection behaviors and survival rates. Various logistical constraints exist when placing this equipment to ensure beneficial data collection, including water depth, channel width, ADCP noise, and boat sonar. It is also important to make sure land-based equipment (node, extender box, and cables), are properly secured and camouflaged to reduce risk of damage and theft. By evaluating the different projects and their respective equipment system, operations and placement, we have been able to develop more effective means of setting up equipment and collecting data.

Session Coordinator*: Lisa Thompson, Department of Wildlife, Fish and Conservation Biology, University of California, Davis*

Status of the Inland Fish Fauna of California

Peter B. Moyle (Presenter), Rebecca M. Quiñones, and Jacob Katz, Department of Wildlife Fish and Conservation Biology and Center for Watershed Sciences, University of California, Davis

California has a rich fauna of native inland fishes. There are 131 kinds (taxa) currently recognized; 59% are endemic to the state, with an additional 20% found in only one other adjacent state. We assessed the status of all taxa in 1989, 1995, and 2009. In 1989, 12 fishes (9%) were formally listed and 45 (30%) were regarded as species of special concern. In 1995, the numbers were 15 (12%) and 52 (41%), respectively. In 2009, the numbers were 28 (21%) and 59 (45%), respectively. About one-two species per year are qualifying to be listed and, on average, one fish taxon per year is being formally listed by state or federal governments. The only thing that has not changed is the number of extinct taxa, which has remained steady at nine. Overall, 88 (67%) of the taxa still with us are either formally listed or are likely to be so by the end of 21st century if present trends continue. It is highly likely that many of these species, especially those already listed, will become extinct. The causes of the decline in the native fish fauna are multiple and interactive, but the ever-increasing growth of the human economy of California, combined with the ever-increasing demand for resources, especially water, is at the root of the problem. The increasing number of listed species is going to make every water allocation decision in the state more contentious unless California embarks on a large-scale aquatic ecosystem conservation program.

Mono Basin Restoration: The Reason, The Fish, The Process, and the People

***Mark Drew, PhD (Presenter)**, Eastern Sierra Program Manager, California Trout,*
*and **Lisa Cutting**, Eastern Sierra Policy Director, Mono Lake Committee*

Based on landmark court cases (Audubon, Caltrout 1 and Caltrout II), the Mono Basin has been at the center of a restoration program for over a decade. Although not native to the Mono Basin, fish—specifically trout—have and continue to play a lead role in the mandated recovery of Mono Lake's streams. It was trout that first motivated legal action using Fish and Game Code 5937 as the legal leverage necessary to invoke the Public Trust Doctrine. Ironically, it is still trout that are leading restoration activities in the Mono Basin.

Central to the restoration has been Decision 1631 and Restoration Orders 98-05 and 98-07. The Decision along with the respective Orders established a court mandated process to restore four of the main tributaries to Mono Lake (Rush Creek, Lee Vining Creek, Walker and Parker Creeks) to conditions which existed prior to the Los Angeles Department of Water and Power's water diversions to the city of Los Angeles in 1941. Based largely on the testimony of Eldon Vestal, a CA Fish and Game field biologist during pre-diversion times, the State incorporated Termination Criteria into the Orders as a means to establish target conditions, particularly for the fisheries, that will signify restoration has been achieved.

Led by state appointed Stream Scientists while working with state agencies, California Trout, and the Mono Lake Committee, and following adaptive management protocols, a great deal has been accomplished with respect to improving the fisheries and associated riparian habitats of the Mono Basin. In late 2009, several scientific studies were concluded. These studies include, among others, documenting fish-relocation and spawning events for Rush Creek, an instream flow study for Rush and Lee Vining Creeks which focused on optimizing winter holding and summer foraging habitats, and a water temperature modeling project to determine how varying flows in Rush Creek influence water temperatures. Ultimately, the findings from these studies, combined with existing annual fish, avian and riparian habitat monitoring results, will contribute to the body of knowledge that will be used to make final flow recommendations that will help further restoration efforts and meeting termination criteria. Although restoration trends are positive and much has been accomplished, challenges do remain, primarily having to do with institutional and agency operational planning and execution. It is one thing to know what flows are needed for the system and another to be able to actually deliver the required flows. In projects such as the Mono Basin, restoration is as much about interactions amongst relevant stakeholders as interactions amongst the biotic and abiotic components of the ecosystem itself.

Sources of Production Supporting Trout Production in Four Terminal Lakes with an Emphasis on Resource Utilization in Pyramid Lake

Sudeep Chandra (Presenter) *and* ***John Umek,*** *Department of Natural Resources and Natural Science, University of Nevada Reno*

Terminal lakes in the Western United States support a variety of native or nonnative trout species. The native species are either managed by state, federal, or tribal agencies for recovery and angling (Walker, Eagle, Pyramid Lakes) while nonnative species currently persist without management (Crater Lake). In order to recover, manage, or understand the role of trout within these environments, it is critical to understand the food web structure and energetics of trout in these ecosystems. The objective of this study was to compare and contrast food web structure across four large terminal lakes in order to document the contribution of benthic versus pelagic resources contributing to each lake's fishery. A secondary objective is to understand the bioenergetics of Pyramid Lake's Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), a fish currently managed through hatchery processes by the Pyramid Lake Paiute tribe to determine the relative consumption rates of trout across habitats (pelagic vs. benthic) and in relation to the endangered cui-ui (*Chasmistes cujus*), an endangered endemic sucker. Trout are supported from a mix of benthic production (22-80%) depending on the lake indicating that managers of certain ecosystems should monitor benthic habitats in order to understand the production of trout. Pyramid Lake cutthroat trout rely moderately on benthic resources and was the greatest consumer in the lake (730 kg/ cutthroat per year) compared with other species. Endangered Cui-ui fed on slightly less benthic resources (130 kg/ cui-ui per year) than pelagic resources (152 kg/ cui-ui per year). Based on the consumption calculations of cui-ui, cutthroat, tui-chub, and suckers there is likely significant overlap of consumption between cui-ui and chub for similar resources indicating that stocking regimes and maintenance of fishes may influence individual productivity if there are limited resources of production supplied to fishes.

A Minnow at the Intersection of Taxonomy and Conservation

Jacob Katz, *Graduate Student, Department of Wildlife, Fish, and Conservation Biology, University of California Davis*

This presentation will begin with a review of the taxonomic history of the cyprinid genus *Lavinia* which consists of roach and hitch. The California roach is an endemic minnow first described from the San Joaquin River in 1854. By 1913, six species had been described in California based on morphology and distribution. In the late 1940's, as species concepts changed, all species were merged. Recent genetic research, however, lends credence to the original taxonomy and has led recent workers to resurrect two roach taxa to full species status. Nine taxa of roach are now recognized, several of which have high probability of also being recognized as full species as more intensive phylogenetic research is conducted.

Hitch, the other species in the genus, extensively hybridize with roach in some but not all of the streams where they overlap. Three subspecies of hitch are recognized, one of which, the Clear Lake hitch, is likely to be listed in the near future. How taxa are defined within this cryptic species complex of closely related endemic minnows has important conservation implications here in California, but also sheds light on the role taxonomy plays in determining the level of threat facing native fish assemblages on a global scale.

Potential Interactions Among Native and Non-native Fishes in a Large River in the Western Great Basin, Nevada

Joseph C. Sullivan (Presenter), Sudeep Chandra, Laurel Saito, *and* ***Lisa Atwell,*** *Department of Natural Resources and Environmental Science, University of Nevada, Reno,* ***Alan C. Heyvaert,*** *Division of Hydrologic Science, Desert Research Institute,* ***Kim Tisdale,*** *Nevada Department of Wildlife, and* ***Matt Maples,*** *Nevada Department of Wildlife*

Historically, Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) and mountain whitefish (*Prosopium williamsoni*) were the only native salmonids in the Truckee River, NV, USA. Following the extirpation of cutthroat trout, introduced brown (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) filled the ecological niche formerly occupied by cutthroat trout. The ecological impacts imposed upon native fishes by non-native trout, however, are poorly understood in this system. This study was the first attempt to investigate the competitive and predatory interactions between native and non-native fishes in a large western Great Basin river. We compared the dietary habits of dominant native and non-native fishes and used a bioenergetics model to a) estimate consumption by piscivorous brown trout and b) determine the predation potential on resident and hatchery-raised fishes during two separate years. Chesson's alpha and Schoener's indices calculated from dietary information showed native and non-native salmonids utilized similar prey items, suggesting competition. In a one month period, brown trout consumed 58% and 39% of the resident prey fish biomass during the years 2005 and 2007, respectively. Annually, brown trout consumed 16% and 15% of cutthroat trout biomass stocked into the study reach in 2005 and 2007, respectively, and 8% and 14% of the total rainbow trout biomass stocked in 2005 and 2007, respectively. Our results demonstrate the potential for non-native trout to influence fish communities through competitive and predatory interactions. These interactions should be studied in greater detail, as the ecological impacts are still unknown. Given their persistence, non-native trout in the Truckee River may impact not only resident native fishes, but also management efforts to successfully re-introduce cutthroat trout.

Distribution and Ecology of the Russian River Tule Perch (*Hysterocarpus traski pomo*)

David G. Cook, Sonoma County Water Agency

The Russian River is a coastal stream located north of the San Francisco Bay drainage, California, and has a fish fauna derived from the Sacramento River system. Although the Russian River tule perch (*Hysterocarpus traski pomo*) is unique in that it is the only endemic fish in the watershed, this taxon has received limited study. I determined the distribution and relative abundance of this fish, provided additional life history information, and described habitat use. Historic and recent records indicate that Russian River tule perch are widespread in the watershed. Tule perch were found in 92% of the 156-km-long river mainstem, and the lower valley reaches of nine large tributaries. No tule perch were found in two large reservoirs located on tributaries, although they occurred in free-flowing waters prior to the construction of these reservoirs. A temporary seasonal dam on the Russian River mainstem appeared to have both beneficial and negative effects on tule perch abundance. Our visual encounter snorkel surveys in the upper Russian River found tule perch abundance as high as 2,424 fish/km and comprised from 2.9% to 9.5% of the species composition. In other mainstem reaches, tule perch composition was as high as 26.7%. Our life history findings were similar to other studies where females give birth in May, young double or triple in fork length the first summer, and few adults are greater than one year of age. Although tules (*Scirpus sp.*) provide the species namesake, this marsh plant is nearly absent from the Russian River. I found tule perch use mostly complex wood debris habitats associated with riparian forest, and also utilize boulders and widgeon weed for cover when present.

Session Coordinators*: Wayne Lifton and Mitchell Katzel, ENTRIX*

Bed Mobility and Channel Change Monitoring to Inform Levee Setback Design on Deer Creek, California

Mark Tompkins (Presenter) and Anthony Falzone, CH2M Hill, and Matt Kondolf, University of California, Berkeley

Deer Creek is one of three Sacramento River tributaries with still-healthy runs of spring-run Chinook salmon. The spring-run spawn in bedrock canyon reaches upstream. The lower ten mi of Deer Creek traverse its alluvial fan on the Sacramento Valley floor, and provide passage for the spring-run and rearing habitat (including non-natal) for a variety of native salmonids. Habitat in lower Deer Creek was degraded by a flood control project in 1949. The formerly narrow, sinuous low-flow channel with its complex bed and frequent pool-riffle alternations, was simplified and widened. Levees now confine flood flows, concentrating and deepening flood flows, which increases shear stress on the bed, and which in turn further simplifies channel form by washing out gravel bars and riparian tree seedlings that might provide complexity. The levees have failed (most recently in 1997) and there is interest in re-designing the flood management system on Deer Creek, creating an opportunity to set levees back to allow floods to flow out over part of the floodplain, reducing shear stress in the main channel, and allow the channel to build bars, establish bankside vegetation, and increase its complexity. The conceptual model is that by allowing floods to flow out over the floodplain again, the channel will recreate a more complex form over time. The watershed of Deer Creek is relatively undisturbed, and consequently its flow regime and sediment load are essentially still natural. Geomorphic theory tells us that Deer Creek can recreate its complex channel forms so long as we remove the disturbances, which here are the narrow levees confining the flood flows and the periodic 'maintenance' of the channel (bulldozing bars and removing vegetation to reduce hydraulic roughness within the low-flow channel).

But how can we be sure that Deer Creek will evolve as expected? A multi-year monitoring study of bed mobility and channel change demonstrated that the bed experienced partial mobilization at flows as low as 3,000 cfs, with full mobility, bar deposition, bank erosion and recruitment of large wood, and scour of pools at 10,000 cfs, (about a five-year flood) in 2006. Based on the geomorphic work accomplished by the five-year flood, we predict that over a period of four decades, Deer Creek should be able to largely recreate its former natural, complex bed.

Restoration Design and Construction Implementation to Restore Channel Morphology and Floodplain Connectivity on the Upper Truckee River, Lake Tahoe, California

Brendan R. Belby (Presenter), Michael J. Rudd, Charles Miller, and Chad Krofta, ENTRIX

Lake Tahoe in California and Nevada of the United States is world renowned for its spectacular alpine setting and deep water clarity. Unfortunately, Lake Tahoe's water clarity has declined since measurements began in the 1960s due to increased atmospheric and watershed pollutant inputs of fine-grained minerals and phosphorous and nitrogen nutrients. The Upper Truckee River watershed drains 145 square kilometers and is the largest tributary in the Lake Tahoe Basin. Before the river empties into the lake, it flows through one of the largest meadows in the Sierra Nevada. Construction of an airport on the river's floodplain in the 1960s resulted in channelization of the river and loss of two-thirds of available floodplain. Historically, the meadow stored fine-grained minerals and nutrients deposited by the river's near-annual floods, thus filtering pollutants and contributing to the maintenance of Lake Tahoe's water clarity. The impact of channelization and other watershed-scale disturbances have degraded the river's geomorphic condition. Field studies and modeling show the river currently has twice the in-channel flow capacity it did prior to degradation. As a result, the meadow floodplain is becoming increasingly hydrologically disconnected from the channel and now only receives overbank flows approximately once every five years. The severity of the channel degradation and loss of floodplain connectivity has led to the river's identification as a major contributor of pollutants detrimental to Lake Tahoe's water clarity.

ENTRIX is working with federal, state, and local agencies to implement Upper Truckee River channel and floodplain restoration designs for projects that extend 11 kilometers through delta and meadow environments. The primary goals of the projects are to reduce suspended sediment and nutrient delivery to Lake Tahoe and to improve aquatic and riparian habitat. Construction on the first project to restore a floodplain and re-meander the reach channelized to accommodate the airport began in summer 2008. This presentation begins with a short description of the historic geomorphic adjustments of the river and related declines in aquatic habitat due to human impacts, followed by a longer description of how we developed a restoration design that is: 1) based on applying recent advances in geomorphic science that link sediment transport and hydrologic regimes with a sustainable channel form; and 2) capable of creating new channel and floodplain that is compatible with existing urban constraints that include an airport and utility lines. This case study illustrates the many considerations that were made in the design process to develop a new functioning floodplain that will recreate the meadow's historic processes in a confined environment.

Designing and Monitoring a Large River Bioengineering Project: Flood Fencing in the Braided Reach of the Skykomish River

Paul DeVries (Presenter), *R2 Resource Consultants, and* ***Bob Aldrich,*** *Snohomish County Surface Water Management*

We evaluated hydraulic and sediment transport processes influencing channel changes at the reach scale in a ~16 km long wandering/braided section of the Skykomish River, Washington, to aid in strategically identifying, designing, and constructing habitat restoration projects. The study reach is generally characterized as a depositional environment overall with active channel migration, avulsion, and abandonment. We used a suite of simplified geomorphic analyses to collectively help identify suitable and unsuitable locations for different types of restoration projects intended to enhance, restore, or protect fish habitat while also protecting infrastructure. Several projects were selected for construction, and all are currently in the permitting and design stage. As part of the program, we developed an effectiveness monitoring framework and specific protocol for large river restoration. The first project was completed in August 2009 and will be monitored this winter, and is a focus of this presentation.

Incremental Restoration of an Anabranching River, Upper Quinault River Valley, Washington

Tim Abbe (Presenter), *ENTRIX,* ***Bill Armstrong,*** *Quinault Indian Nation, and* ***Jack Bjork,*** *ENTRIX*

A unique scientifically and community based approach was developed to restore the Upper Quinault River valley on the Olympic Peninsula of Washington State. Clearing of the temperate rainforest mantling the valley early in the twentieth century resulted in degradation to salmon habitat which has gradually become more pronounced with time. A key element of the Quinault River prior to European settlement was big trees and logjams that created a complex system of channels and islands in the valley. Forest clearing transformed a relatively stable system into an ever widening zone of active migration. The residence time of newly constructed floodplain land is only 20-30 years before it is re-processed by the river. The unraveling of the Upper Quinault is also impacting the human community as the river consumes farms, homes and roads. Big trees once formed stable snags that initiated "hard points" deflecting river flow to create and sustain the development of side channels and the foundation for future big trees. In order to restore the Upper Quinault it is imperative to get these hard points back into the river. There is no shortage of unstable driftwood moving down the river, just nothing to stabilize it without restoring the hard points once formed by large snags. Restoration actions were needed to reverse this degradation in a way that was both economic and compatible with the local community. Our restoration plan incorporates engineered logjams to create a matrix of in-stream structures which limit the historic expansion of the main channel migration zone while creating an outer zone of productive side channels favored by sockeye salmon critical to the Quinault Indian Nation. The plan also provides erosion protection to infrastructure and local landowners. The plan was developed to be applied incrementally as funding was available, utilize local materials, provide jobs to the local community, reduce economic damages resulting from flooding and river migration, and most importantly, restore the Blueback sockeye. In the first phase of the plan, thirteen engineered logjams (ELJs) were constructed to protect the upstream segment of the Alder Creek Side Channel along the South Shore Road. Implementation of the first phase has already excited the local community, increased awareness on river restoration and provided a large scale example of going from research and planning to actual implementation. After several major flood events in the winter of 2008-2009 the project is performing as intended. The ELJs have protected the side channel, created new pools, and forming stable planforms for riparian trees to mature. Success of the project has won the respect of the local community who are anxious to implement similar projects elsewhere on the river, a critical factor for any restoration plan to be successful.

Off Channel Habitat for Salmonids in the Russian River: Historic Context and Restoration Opportunities

Mitchell Swanson, President, Swanson Hydrology & Geomorphology

Assessments of the original historical anadromous salmonid habitats in the Russian River watershed, a major river system in northern coastal California, revealed extensive off channel habitats that were likely highly productive for juvenile rearing, especially for coho salmon. Hundreds of acres of off-channel habitats were destroyed beginning in the mid to late 1800s in favor of agricultural land "reclamation" and flood control as well as gravel mining in deep, off-channel gravel pits. An analysis of habitat restoration needs for rearing juvenile coho conducted by NOAA National Marine Fisheries Service indicates a priority for off-channel habitat restoration in the form of seasonally flooded riparian woodlands, seasonal and perennial/emergent marsh wetlands and submerged shoals. Current proposals for off-channel habitat restoration include constructing seasonal connections to old gravel pits and creation of wetland landforms. This effort would reverse recent strategies to isolate deep pits from main river channels due to concerns over predation, temperature effects and geomorphic stability. A review of literature and assessment of case studies from other locations suggest good potential for the Russian River gravel pits but concerns over methyl mercury production, predation and stranding remain as risks to the potential rewards. However, as ocean survival and adult return appears linked to smolt size and there is clear evidence from other locations, including case studies within California rivers, of superior juvenile growth in off-channel habitats versus in-channel habitats, overall benefits may outweigh risks. In addition, there is high potential for restoration of extensive off-channel habitats by excavation of terraces along historically incised river reaches of the Russian River. A multi-agency developed River Enhancement Plan for the Alexander Valley Reach has been developed to merge off-channel habitat creation by gravel mining.

Using PIT Tools to Inform Habitat Restoration and Population Recovery Efforts

Gregg E. Horton (Presenter), *Senior Environmental Specialist (Fisheries), Sonoma County Water Agency, and* ***Mariska Obedzinski,*** *Coho Monitoring Coordinator, U.C. Cooperative Extension, Sonoma County, Sea Grant Extension Program*

Monitoring programs for anadromous stream salmonids have a long history of using estimates of population density (number of fish produced per unit area) to guide management decisions and validate the success of population and habitat enhancement efforts. Abundance estimates based on closed mark-recapture models where short sections of streams (sites) are temporarily closed off and fish are captured during multiple passes through the site with a backpack electrofishing unit have been the mainstay for obtaining these estimates. By repeated sampling at the same sites over multiple years or multiple sites within the same year, estimates of pre-smolt density have been used as an index to population abundance in a stream or stream reach. Observed changes in population density over time and space are then assumed to reflect the effect of the management or recovery action (e.g., habitat enhancement). One problem with this approach is that attributing changes in density to a specific action (treatment) ignores the multitude of factors influencing populations that have nothing to do with the treatment and instead may be driven by non-treatment factors. A method that partially overcomes this problem is Hankin and Reeves' basinwide visual estimation technique (BVET) which stratifies abundance estimates by habitat type. Another way to help overcome this problem is to operate smolt traps and, along with estimates of trapping efficiency (e.g., from program DARR), monitor changes in annual smolt production from a restoration reach. When incorporated into long-term, before-after-control-index (BACI) designs, it may be possible to isolate treatment effects from non-treatment effects. By combining estimates from these two methods for each life stage (parr and smolts), approximations of parr to smolt "survival" are possible. Even with the use of BACI designs, however, attributing changes in production or survival to the treatment can be problematic unless movement in to and out of the restoration reach can be accounted for. PIT tags and stationary, continuously-recording PIT tag antennas are tools that can help account for movement especially when used with mark-recapture models to estimate survival. We use data from ongoing coho and steelhead recovery efforts in the Russian River to show a suite of metrics and monitoring options that can be used to address restoration-related questions.

Session Coordinator*: Brock Dolman,* *Occidental Arts and Ecology Center's Water Institute*

Basins of Relations: Thinking Like a Watershed

Brock Dolman, ***Occidental Arts and Ecology Center***

Occidental Arts and Ecology Center biologist and educator Brock Dolman will offer a series of slide images and interpretation about water, watersheds, human development patterns and restoration ideas that support regenerative ecological integrity and instream flows for salmonids. Water is the 'element of life' on Planet Water and the conservation of native ecosystems swimming, crawling, flying and walking with biodiversity is absolutely dependent upon hydrologically intact watersheds.

Brock will discuss rainwater harvesting as a strategy of water conservation from roofs to the broader landscape. Brock will expand on ideas of "Conservation Hydrology" and Low Impact Development, which emphasizes the need in many areas for human development designs to move from drainage to retain-age. Instead of land use practices that, by design, capture and convey excess volumes of stormwater discharging this often degraded water off site, we will discuss ideas on how landowners can spread, slow and sink stormwater on their site. Moving away from run-off to run-on type land uses can result in multiple watershed benefits, such as enhanced late season baseflows, reduced flooding, improved water quality, increased groundwater recharge for local supply, benefits to stream structure and function, enhanced instream and upland wildlife habitat, short term and long term economic benefits and improved localized aesthetics.

Groundwater Storage for Streamflow Enhancement in the Mattole Headwaters

Tasha McKee, Stewardship Program Director, Sanctuary Forest

The goal of the Mattole Flow Program is to restore healthy dry season flows to the Mattole River headwaters for the benefit of salmon, other aquatic species and the human community. The program began in 2005 with the primary goal of ending dry season pumping through water storage and forbearance. However, an important finding of our research indicated that changes in human use would not be enough to restore healthy flows in extreme drought years. In the drought of 2008, this lesson was brought home as river reaches and tributaries unaffected by human use dried up that had never dried up before. Preliminary research begun in 2004 had shown that groundwater enhancement projects have the potential to restore healthy flows, even in drought years. Past land use practices including extensive logging and road systems have greatly decreased groundwater storage capacity resulting in higher winter runoff rates and lower summer flows. Groundwater storage projects are designed to sink and store some of the winter rain in the ground to augment summer flows. Groundwater storage projects also have the potential to lessen the devastating effects of increased flooding and drought predicted as part of climate change. Sanctuary Forest has completed extensive research, monitoring, and preparation of a groundwater management plan and implementation of groundwater storage projects is planned for 2011.

Water Use in the Shasta and Scott River Basin Under Coho Salmon Incidental Take Permits and Prospects for Pacific Salmon Restoration

Patrick Higgins, *Senior Watershed and Fisheries Scientist, Kier Associates*

Scott and Shasta River basin coho salmon Incidental Take Permit (ITP) Environmental Impact Reports (EIRs) describe baseline conditions as those prevailing in the basins as of April 2005, when farm and ranch groups filed their applications. In fact baseline conditions in both basins included river courses that meandered across the width of their entire valley floor with numerous side channels and beaver ponds. Wetlands and beaver ponds not only served to help buffer water temperatures, they also had significant water storage capacity. Increasing water use, including groundwater extraction, and lack of enforcement of Fish and Game and California Water Codes has allowed both the Shasta and Scott Rivers to be virtually dried up. Fish habitat critical to ESA-listed salmon and steelhead populations is greatly diminished and the reduction in the volume of flow contributes to both thermal and nutrient pollution. The ITPs envision purchasing water from willing sellers but just during the times of coho adult and juvenile migration. This sets a bad precedent with regard to public trust and the likelihood that additional water would have to be purchased in the future for other species.

Content of this paper is information assembled for the Klamath Basin Tribal Water Quality Work Group, a consortium of the environmental departments of five federally recognized Indian tribes (*www.klamathwaterquality.com)*.

Getting Into the Flow: A Legal and Policy Perspective on Protecting Instream Flows in CA's Coastal Watersheds

Brian Johnson, *California Water Project Director and Staff Attorney, and* ***Mary Ann King,*** *Stewardship Coordinator, California Water Project, Trout Unlimited*

Water diversions and diminished streamflow remain among the most critical—yet relatively unaddressed—threats to salmon and steelhead in California's coastal streams. This presentation identifies the need for streamflow protection in California's coastal streams, identifies some of the legal, political, and social challenges to achieving such protection, and describes how regulatory and voluntary programs are developing and evolving in California to overcome those hurdles.

Water Conservation and Streamflow Augmentation in the Salmon Creek Watershed: Water Security for Fish and People

***Lauren Hammack (Presenter)** and **Aimee Crawford,** Prunuske Chatham, Inc., **Brock Dolman,** Occidental Arts and Ecology Center's Water Institute, **Kathleen Kraft** and **Ann Cassidy,** Salmon Creek Water Conservation Program, and **Virginia Porter** and **Lisa Hulette,** Gold Ridge Resource Conservation District*

Salmon Creek, a coastal stream in western Sonoma County, once supported a strong coho population and maintains a relatively robust steelhead population. The watershed has recently been included in California Department of Fish and Game's coho broodstock program, with adult releases of a combination of Russian River and Olema Creek fish. Habitat assessments indicate that low summer streamflows and the resultant poor water quality, in both the upper watershed and the estuary, are impacting juvenile survivorship. The effects of insufficient streamflow on rearing habitat conditions have been especially devastating during the recent drought.

Water supplies for human needs are limited as well in this region. Groundwater is scarce and existing wells are losing production. Surface water sources are of poor quality, limited supply, and require water rights permits for use. Residents of the watershed need reliable, safe, and sustainable water supplies for homes, gardens, livestock and businesses.

To support the needs of both the fish and the human residents of the Salmon Creek watershed, the Salmon Creek Water Conservation Program has been initiated to:

- Assess water supply and demand needs;
- Develop alternative water supply solutions that support human needs and protect instream flows;
- Reduce human-related water demand pressures on Salmon Creek during the critical low-flow period (July-October) through implementation of water conservation measures, water distribution and storage system upgrades, and non-extractive water supplies;
- Promote long-term water security for all inhabitants by developing a community-based water conservation and streamflow augmentation program; and
- Focus efforts to reduce extractive demands on priority salmonid rearing reaches to improve juvenile salmonid survivorship.

The Salmon Creek Water Conservation Program is a collaborative effort of local organizations, state and federal agencies, and residents. Funding to begin this Program has come from State Coastal Conservancy, NOAA, Department of Water Resources, and NRCS. All products from this Program will be transferrable to other rural coastal watersheds and communities.

Research is being conducted to quantify current water supplies and demands within the watershed, including an evaluation of rural residential use, agriculture production, and community systems. Conservation tools are being developed, education and outreach through workshops and newsletters is ongoing, and a Salmon Creek Water Conservation Plan will incorporate all the research, planning, and materials.

The Bodega Pilot Program, focused on the community of Bodega, incorporates the first phase of the Water Conservation Program's implementation projects. The Program team is working with the Bodega Water Company, Bodega Volunteer Fire Department, and local residents to install roofwater harvesting and storage systems, remove instream pumps, and apply strategies for upgrading the Bodega community water system to improve efficiency and reduce dry season demand on instream sources in a salmonid rearing reach.

Can Beaver Dams be Used to Increase Streamflows and Lower Stream Temperatures?

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

We review the accumulating evidence that beaver dams and the ponds they create may contribute to increased stream flows and help to create perennial streams that were previously intermittent. We also present recent findings demonstrating that beaver ponds lower stream temperatures, in contrast with conventional wisdom. We discuss the hydrogeomorphic mechanisms that are likely leading to increased stream flow and lower stream temperatures. We also present results from recent modeling efforts that compare the cumulative effects of beaver dams on stream flow with expected changes in streamflow resulting from climate change.

Marine and Estuarine Fisheries: Research, Conservation, and Management in a Changing Climate

Saturday Morning Concurrent Session 4

Session Coordinator*: Cynthia LeDoux-Bloom,*
Staff Scientist, California Department of Water Resources

California has the largest human population in the United States with 90% living within 15 miles of the coast. Subsequent large-scale development has decreased and altered the aquatic habitat available to marine and estuarine dependent fish species to the extent that some fisheries are closed (e.g. Chinook salmon) while others are in decline (e.g. striped bass). California's burgeoning human population depends on water exported from the Sacramento-San Joaquin watersheds usually pumped from the San Francisco Estuary, the largest estuary on the west coast. Water exports significantly changed the flow regimes and tidal mechanisms within the San Francisco Estuary and near-shore coastal waters. Fluxes in both the marine and estuarine habitat quality have contributed to the listing of several estuarine-dependent fish species (e.g. delta smelt, coho salmon, and green sturgeon) by state and federal agencies.

Anticipated future climate change has driven research, modeling, and forecasting efforts to detect and predict changes in fish populations, distributions, and assemblages resulting in new management strategies and policies. Presentations in this session glimpse into the future by linking current marine and estuarine fisheries research, conservation and management efforts with climate change.

Variation in Response of Pacific Salmon to Environmental Variability

***Louis W. Botsford (Presenter)** and **Lee Worden,** University of California, Davis, **Michael J. Fogarty,** National Marine Fisheries Service, Woods Hole, **Francis Juanes,** University of Massachusetts, Amherst, **Alan Hastings, Matt Holland,** and **Will White,** University of California, Davis, and **Hui-Yu Wang,** University of Massachusetts, Amherst*

Differences over space and time in the way that a higher trophic level species responds to environmental variability are often ascribed to physical and biological differences in their local environment (e.g., upwelling, primary productivity). However, differences in population dynamics caused by, for example, differences in individual growth rates or fishing mortality rates may play a role in these differences in responses to the environment. Responses will also vary with the point in the life history that is varying in response to the environment (e.g., adult survival vs. individual growth rate). Here we show how: 1) differences in spawning age structure; 2) differences in point of action of the environment forcing; and 3) differences in survival rates cause differences in response to environmental variability. We illustrate these differences with examples from Pacific salmon, showing how they might respond to climate change, and illustrating some of the difficulties in detecting response to climate change.

Forecasting Returns of Coho and Chinook Salmon in the Northern California Current: A Role for High-frequency, Long-Term Observations

William Peterson (Presenter) *and* ***Edmundo Casillas,*** *NOAA-Fisheries, Northwest Fisheries Science Center, and* ***Cheryl Morgan,*** *Cooperative Institute for Marine Resources Studies, Hatfield Marine Science Center, Oregon State University*

Successful weather forecasting is based on a basic understanding of the underlying physics and physical mechanisms that determine the weather. Similarly, forecasting of ecological phenomena in the ocean requires a basic understanding of the physical and ecological mechanisms that determine the outcomes which one hopes to predict. Successful prediction of fishery yields for example will require at least a modicum of knowledge of where in the ocean the given species lives during all parts of its life cycle, and of processes that determine the key recruitment bottlenecks. Towards this end, we have monitored hydrography, plankton and juvenile salmonid abundance in coastal waters off Washington and Oregon for 12 years, and hydrography, zooplankton and krill in off Newport Oregon for 14 years. It is now well established that most coho and fall Chinook stocks live in shelf waters off the Pacific Northwest thus recruitment depends on processes in these waters. Using our oceanographic data, we have had some success with qualitative forecasts of coho and Chinook salmon (e.g., good, fair, or poor returns). The rates at which these salmonids return to their natal streams are clearly a function of the phase of the Pacific Decadal Oscillation (negative phase results in good returns; positive phase, poor returns), but although the phase of the PDO is a necessary condition, salmon returns are best predicted by local biological factors: date of biological spring transition, biomass anomalies of northern lipid-rich copepods, copepod community structure, and catches of juvenile Chinooks during June surveys and juvenile coho in September surveys. Our ability to forecast salmon in the future will depend in part on our ability to forecast the impact of global climate change on ocean conditions in coastal waters. Models along with long-term ecosystem observations will become a requirement for understanding how variations in physical climate forcing will affect fisheries and marine ecosystem productivity.

Modeling the Effects of Future Freshwater Flow on the Abiotic Habitat of an Imperiled Estuarine Fish

Frederick Feyrer (Presenter), *Applied Science Branch, U.S. Bureau of Reclamation,* ***Matthew Nobriga,*** *Water Branch, California Department of Fish and Game,* ***Ted Sommer,*** *Aquatic Ecology Section, California Department of Water Resources, and* ***Ken Newman,*** *U.S. Fish and Wildlife Service*

Future climate change and water development pose a potentially serious threat to estuarine fish populations around the world. We examined how the abiotic habitat of delta smelt, a state and federally protected species, might be affected by changes in freshwater flow in the San Francisco Estuary due to future climate and water demand. We used 40 years of sampling data to define suitable abiotic habitat of delta smelt as a function of salinity and water transparency, and modeled how the amount (habitat availability of surface area) of habitat varied with freshwater flow. We applied this information to output from models predicting freshwater flow under future water demand and climate change scenarios. The model results suggested large decreases in habitat area in all but dry years from simulated future water demand, an effect which was exacerbated by all but one of the five climate change scenarios we examined.

Ecologic Response to Climate-Change Induced Water Temperature Changes in the Sacramento-San Joaquin Delta

Wayne Wagner (Presenter) *and* ***Mark Stacey,*** *Department of Civil and Environmental Engineering, University of California, Berkeley,* ***Larry Brown,*** *US Geological Survey, and* ***Michael Dettinger,*** *US Geological Survey and Climate Research Division, Scripps Institute of Oceanography, University of California, San Diego*

Changes in water temperatures due to climate change in California's Sacramento-San Joaquin Delta will alter the ecosystem through effects on fish and invertebrate biology. The magnitude of the effect of climate change on water temperatures is, however, unknown. This study presents statistical projections of water temperature in the Delta in response to atmospheric conditions and riverine flows. We modeled daily-averaged, maximum, and minimum water temperatures using historical data from locations around the Delta. The model performs well, with r^2 values greater than 0.9 for model verification periods for all stations within the Delta and San Francisco Bay provided that at least one year of calibration data is available. The model was then used to forecast water temperatures for the next 100 years, forced by data from downscaled global climate models. The ecological implications of the projected water temperatures will depend on species specific critical temperature thresholds or windows for ecological function. To provide a specific example, we focus on the effects these changes would have on the Delta smelt, a federally-listed threatened species indigenous to the Delta. In the coming century, scenarios of climate change lead to increases in water temperature that cause an increase in the number of stress days, making some areas of the Delta unsuitable as smelt habitat. In addition, water temperatures suitable for spring spawning shift earlier in the year, potentially causing early life stages to be out of phase with other ecologically important variables (e.g., abundances of food organisms).

What Do Resource Managers and Researchers Need in Planning for Climate Change?

Russell J. Bellmer (Presenter), *Coordinator, Coho Recovery Plan, California Department of Fish and Game Fisheries Branch, and* ***Joe Duran,*** *California Department of Fish and Game, Ocean Science Project*

Predicted increases in water temperature and changes in historical hydrologic flows in response to climate change will have large implications for aquatic ecosystems, such as altering thermal habitat and range changes of fish species. Warm water fish populations would have access to additional “favorable” thermal habitat under increased water temperatures, thereby shifting limit of the distribution of the species that would in turn negatively impact native cold water fish populations. These native fish populations would have reduced habitat. We reviewed and analyzed existing and historical California Department of Fish and Game (DFG) salmonid monitoring programs relative to metrics that would aid in assessing climate change effects on native California fish populations. This effort consisted of literature research, database searches, and interviews with fisheries biologists. We used these data along with climate change modeling produced by other state agencies to develop a conceptual model of how modified fisheries monitoring programs may be used to generate data that would provide the bases for quantitative models to be used by decision makers in fisheries management programs, fisheries habitat restoration programs, and population recovery strategies.

Climate Variation and River Regulation Effects on Early Salmonid Life History at the Southern Extent of their Range

Joseph E. Merz, PhD, *Cramer Fish Sciences and University of California, Santa Cruz*

The California Central Valley is the southern extent of the Pacific salmon spawning range. The Mediterranean climate suggests summer temperatures can be quite high and winter temperatures relatively mild. High human density and limited water resources have resulted in large dams altering flow and sediment regimes, affecting overall water quality of spawning streams. In California, several salmon races are now listed under the Endangered Species Act. Global and regional climate change poses an additional risk to the survival of these fish. By 2100, mean Central Valley summer temperatures may increase by 2-8°C, precipitation will likely shift to more rain and less snow, with significant declines in total precipitation possible, and hydrographs will likely change, especially in the southern Sierra Nevada mountains. Reduced cloud cover and snow pack suggest further negative consequences for development and survival of salmonid embryos and larva within the extent of their range.

Session Coordinator*: Brian Ellrott,* *Fisheries Biologist, NOAA Fisheries*

Update on the Central Valley Salmon and Steelhead Recovery Plan

Brian Ellrott,* *Fisheries Biologist, NOAA Fisheries

Human development of the Central Valley, California has not been compatible with many native species, including anadromous salmonids. As a result, nearly all populations of winter-run Chinook salmon and spring-run Chinook salmon have already been extirpated from the Central Valley and there are very few wild salmon and steelhead remaining. There is great need and urgency for action to protect and recover these species. Equally important is an overarching, coordinated plan to direct such action. The National Marine Fisheries Service has worked with public stakeholders and agency co-managers to develop a draft plan to recover the endangered Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU), the threatened Central Valley spring-run Chinook salmon ESU, and the threatened Central Valley steelhead Distinct Population Segment (DPS). The recovery plan serves as a roadmap that describes the steps, strategies, and actions that must be taken to return each of these species to a viable status such that they can be removed from Federal protection under the Endangered Species Act. The basic strategy of the recovery plan is to secure all extant populations and expand habitat such that new populations are established. Extant populations cannot be secured without habitat restoration on both large (e.g., tidal wetlands) and small (e.g., diversion dams) scales and improved and coordinated management of water, fisheries, and hatcheries. In addition, full recovery in the Central Valley cannot be reached without expanding the range of habitats accessible to anadromous salmonids. The draft plan was made publicly available on October 7, 2009 commencing a comment period which ended on February 3, 2010. The presentation will include specific information regarding the strategies, actions, and criteria contained in the draft plan as well as information on the process and timeline for issuing a final recovery plan.

Overview of the Biological Opinion on the Long-term Operations of the Central Valley Project and State Water Project

Bruce Oppenheim, *Protected Resources Division, National Marine Fisheries Service*

Collectively, the facilities and operations of the U.S. Bureau of Reclamation's (Reclamation) Central Valley Project (CVP) and the California Department of Water Resources' (DWR) State Water Project (SWP) constitute one of the largest water management systems in the world. After several years of technical assistance, in 2008, Reclamation and DWR requested an Endangered Species Act (ESA) section 7 consultation with NOAA's National Marine Fisheries Service (NMFS) to insure that the proposed operations of the CVP and SWP through the year 2030 would not jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley (CV) spring-run Chinook salmon, CV steelhead, Southern Distinct Population Segment of North American green sturgeon, and Southern Resident killer whales. The formal consultation process was completed on June 4, 2009, with NMFS' issuance of a biological opinion. NMFS determined that the proposed operations would likely jeopardize the continued existence of those species, would result in the destruction or adverse modification of critical habitat, and provided a reasonable and prudent alternative (RPA) for Reclamation and DWR to consider in order to avoid the jeopardy and adverse modification determinations [i.e., comply with section 7(a)(2) of the ESA]. Reclamation and DWR provisionally accepted NMFS' RPA, and the three agencies have been working to implement those operations and actions. This presentation will provide an overview of the approach and analyses NMFS used in making its ESA determinations on Reclamation's and DWR's proposed operations. The presentation will also provide an update on implementation status of the RPA, with particular emphasis on actions in the upper Sacramento River, including actions related to water temperature control and habitat improvements downstream of Keswick Dam, as well as actions related to reintroducing anadromous salmonids to historic habitats upstream of Shasta Dam.

Web-based Spatial Representation and Implementation Tracking of the Central Valley Salmon and Steelhead Recovery Plan

Gretchen Umlauf, Fisheries Biologist, NOAA Fisheries

Recovery is the process by which listed species and their ecosystems are restored and their future secured to the point that protection under ESA is no longer needed. The process for anadromous fisheries recovery for the California Central Valley is described through the National Marine Fisheries Service's (NMFS) October 2009 draft Fisheries Recovery Plan for the Central Valley spring-run Chinook salmon, the Sacramento winter-run Chinook salmon, and the Central Valley steelhead.

The ESA §4(f) requires that recovery plans be prepared, and it envisions them as the central organizing tool for guiding the recovery process for each species and for implementing the ESA as a whole. Recovery plans are guidance documents, not regulatory documents. The plan is intended as a road map for species recovery and is one of the most important tools to ensure sound scientific and logistical decision-making throughout the recovery process.

This session will focus on NMFS's work on the development of their Central Valley Recovery Plan using a spatial interface which enables agencies, stakeholders, and other publics to view much of the recovery plan through a spatial framework. This GIS based tool uses ARCINFO and Google mapping capabilities to bring the recovery plan actions to the user through the internet. Tracking of recommended actions and attribute criteria is also being programmed through the spatial system that the NMFS Sacramento office is developing.

Recovery Actions for the Yuba River: Progress and Possibility

Gary Reedy, *River Science Program Director, South Yuba River Citizens League (SYRCL)*

Spring-run Chinook salmon and steelhead trout populations persist within the lower Yuba River below Englebright dam without a hatchery and despite catastrophic-scale land form changes from historic mining activities. Both environmental and political factors support the assertion that the Yuba River may be the best opportunity in the Central Valley to recover at risk populations to independence. The Draft Recovery Plan describes seven restoration actions within the lower Yuba River, as well as a phased approach to reintroduction to historic habitats above Englebright Dam. This presentation will review progress, priority and feasibility for these restoration actions from the standpoints of salmonid ecology, hydrofacilities, regulatory processes, collaboration and funding.

Residence of Winter-Run Chinook Salmon in the Sacramento-San Joaquin Delta: The Role of Sacramento River Hydrology in Driving Juvenile Abundance and Migration Patterns in the Delta

Rosalie B. del Rosario (Presenter) *and* ***Yvette J. Redler,*** *National Marine Fisheries Service, and* ***Patricia Brandes,*** *U.S. Fish and Wildlife Service*

The Sacramento-San Joaquin Delta provides essential habitat for juvenile Sacramento River winter-run Chinook salmon as they rear and physiologically transform for ocean life. We identified patterns of juvenile abundance and migration entering and exiting the Delta by using monitoring data of winter-run sized fish based on assumed growth and size on date of catch criteria from the lower Sacramento River at Knights Landing and Sacramento and in the western Delta at Chipps Island.

Sacramento River hydrology drives smolt abundance and emigration patterns in the Delta. The catch of winter-run per unit effort is highly dependent on Sacramento River flows. Annual cumulative winter-run smolt abundance entering the Delta at Knights Landing (measured as number of winter-run per hour fished) and exiting at Chipps Island (measured as number of winter run per m^3) are each positively correlated with Sacramento River flows measured at Freeport, and neither significantly correlated with annual spawner abundance (multiple regression, Knights Landing: R^2=0.76, F=12.6, p=0.003; Chipps Island: R^2=0.93, F=53.7, p<0.0001). Migration patterns in the Delta are dependent on autumn and winter Sacramento River flow patterns. The first autumn pulse flow exceeding 15,000 cfs at Wilkins Slough triggers emigration of half the cumulative catch at Knights Landing on average four days following the event. The early emigrants leave the Delta at Chipps Island before spring on average nine days following Sacramento River winter flow events exceeding 20,000 cfs, measured at Freeport.

Sacramento River hydrology also creates diversity in migratory routes and rearing habitats for winter-run, when peak winter discharge allows for inundation of the Yolo Bypass floodplain. Patterns of winter-run emigration from the floodplain are responsive to the floodplain's hydrograph, such that timing and frequency of floodplain drainage contributes to the temporal and size diversity of emigrants leaving at Chipps Island.

Sacramento River hydrology is related to average winter-run residence time in the Delta, which is primarily a function of time of entry into the Delta. In a typical year, at least half of the cumulative catch at Chipps Island leaves the Delta during the month of March. Average residence time in the Delta ranges from 2.5 to three months, and generally spans from November through April. During their residence in the Delta, on average winter-run increase in size by roughly one-third before leaving to continue their growth in the ocean.

Winter-run's endangered status and critical habitat designations affect natural resource uses throughout the Central Valley. Understanding the role of Sacramento River hydrology in winter-run abundance and migration patterns in the Delta is crucial to informing current water management decisions seeking to balance water demands and species conservation.

The Anadromy/Residency Question in *O. mykiss*: Old and New Hypotheses

David R. Swank, *National Marine Fisheries Service, Protected Resources Division*

I will review major hypotheses on the residency/anadromy question in *Oncorhynchus mykiss,* and introduce the results of a state-dependent life-history model that uses an optimization of expected lifetime fitness (Satterthwaite et al., in press). It has been shown that anadromy has a high degree of heritability, but that the ability to smolt is retained in populations even after many generations of isolation from the ocean. Most genetic analyses have found larger differences between watersheds than between anadromous and resident *O. mykiss* within a watershed, and it is now well known from otolith microchemistry that each life-history form can give rise to the other. Some studies have shown that stream temperatures can explain the pattern of residency/anadromy within a watershed, leading to concerns that maintaining cold stream temperatures may drive populations towards residency, but the proximate mechanisms determining residency are still poorly understood. The state-dependent life-history model did a good job of matching recent field observations of two populations in California's Central Valley. Based on hatchery returns, PIT tagging, and acoustic tagging, it was determined that the Lower American River had a mostly anadromous population, while the Lower Mokelumne River had a mixed resident and anadromous population. The model included parameters for juvenile growth, juvenile survival (in the stream and the ocean), and asymptotic size as an adult, and compared the relative expected lifetime fitness of female *O. mykiss* that choose to either smolt or mature. The survival of emigrating smolts had the largest impact on the choice of strategy, but large changes in freshwater survival and growth rates were also important variables, as was asymptotic size.

Session Coordinator*: Jacob Katz,* *UC Davis*

Longfin Smelt and Pelagic Organism Decline in the San Francisco Bay Estuary

Jim Hobbs, PhD, ***Researcher Scientist, Interdisciplinary Center for Inductively Coupled Plasma Mass Spectrometry, University of California Davis***

Dr. Jim Hobbs will present on the recently listed longfin smelt (*Spirinchus thaleichthys*).

The San Francisco Bay population of longfin smelt (*Spirinchus thalichthys*) historically has fluctuated significantly in accordance with freshwater flow to the estuary, however a precipitous drop in abundance occurred in 2001 along with several other pelagic fishes in the estuary termed the "Pelagic Organism Decline". Since then, the population has seen several record low abundance indices, spurring the state to list them as "Threatened" under the State Endangered Species Act in 2008. Myriad variables have been identified as causative factors for the decline of longfin smelt, including entrainment loss to the large freshwater pumping facilities located in the South Delta, reduced prey abundance and toxic exposure to list a few. Here we will present current information pertaining to the recent population decline and outline the conceptual linkages between causative factors and the life-cycle of longfin smelt.

Weakened Portfolio Effects in California's Recently Collapsed Central Valley Fall-run Chinook Salmon

Stephanie Marie Carlson (Presenter), *University of California Berkeley, Department of Environmental Science, Policy, and Management, and* ***William Hallowell Satterthwaite,*** *University of California Santa Cruz, Center for Stock Assessment Research, Department of Applied Mathematics and Statistics and MRAG Americas*

Understanding the importance of diversity in generating stability is a central goal in ecology. Several recent studies have highlighted the importance of intraspecies diversity among populations in fostering the stability of population complexes. This work has revealed that diversity of phenotypes and dynamics among constituent stocks results in a variance-buffering effect, whereby the variance in aggregate of stocks ("the portfolio") is less than the variance in constituent stocks. Here we focus on California's recently collapsed fall-run Chinook salmon and ask whether portfolio-effect-induced-buffering is observed at any level across the complexity hierarchy from individual stocks, to stocks within river basins, to the Central Valley system as a whole. We found that some variance buffering was observed, particularly when comparing the coefficient of variation in adult returns between river basins (Sacramento or San Joaquin) to their constituent stocks. However, a lack of variance buffering was apparent when comparing adult returns to the Central Valley as a whole to the returns to the Sacramento River Basin, and this is a consequence of the significant difference in returns to the two river basins (returns to the Sacramento River Basin far exceed those to the San Joaquin River Basin). The San Joaquin River stocks contribute little to the overall production in this system and, consequently, the addition of these stocks does little to buffer returns to the Central Valley as a whole. We also found that correlations in population dynamics between rivers increased significantly with distance, suggesting evidence of some biocomplexity in this collapsed stock complex. Taken together, these results suggest that the greatest potential for strengthening the portfolio effect in Central Valley fall-run Chinook would likely come through restoration of San Joaquin River stocks, which currently contribute little to the overall buffering in adult returns to the Central Valley.

Sacramento Perch: New Findings on California's Only Endemic Sunfish

Patrick Crain (Presenter) *and* ***Peter Moyle,*** *Center for Watershed Sciences and Department of Wildlife, Fish, and Conservation Biology, University of California, Davis*

The Sacramento perch has been extirpated from its native habitats and is confined to 28 waters outside its original range, mostly within California and Nevada. Most populations exist in reservoirs and ponds from which other centrarchid species are absent. The Sacramento perch is similar to other California native freshwater fish species in habitat requirements and behavior. In waters with summer temperatures below 20˚C, Sacramento perch are highly tolerant of high pH, low DO, and high salinity. Juvenile Sacramento perch exhibit higher tolerance to temperature than adults so are able to take advantage of littoral areas for food and cover. Adults and juveniles feed largely on aquatic invertebrates but larger fish include fish in their diets. They are stronger swimmers than similar centrarchids (eg. *Pomoxis annularis*). Overall adults appear to be adapted for life in large, highly variable rivers (eg. Sacramento-San Joaquin River system) and juveniles for backwater habitats, although they are absent from such habitats today. Sacramento perch spawn in their second or third year, with water temperature and photoperiod being the primary spawning cues. Males guard the nest, but it is unknown if parental investment is equal to other sunfish. Sacramento perch populations appear mainly limited by negative ecological and behavioral interactions with alien species, especially other sunfish. Predation on early life history stages and stress-related disease may be the major sources of mortality. Remaining populations suffer from genetic "founders effects" and a lack of gene flow between populations. Sacramento perch have survived because of they can tolerate waters too alkaline to support other game fishes. Even with this adaptability there is no guarantee that they can survive into the next century. The historic record suggests that isolated introduced populations will eventually become extirpated just as the natural populations did in their native range.

Delta Smelt: How Did We Get There, and Are We Just Flirting with Time?

Bill Bennett, *Associate Research Ecologist, Center for Watershed Sciences, Bodega Marine Laboratory, University of California, Davis*

Delta smelt, *Hypomesus transpacificus*, has recently become one of the most urgent environmental issues in the United States. This small (<80 mm) and primarily annual species is endemic to the northern San Francisco Estuary and Delta where it has been routinely subjected to entrainment mortality, or "harvest", by pumping facilities that remove massive volumes of fresh water from the estuary to supply California's significant agricultural and urban demands. Entrainment mortality is highly controversial because of restrictions on water exports and uncertainty of their impacts on the species. Over the past several decades pumping has been scaled-back during April-May to protect juvenile salmon, and presumably other species, including delta smelt. This "high-low" pattern of pumping during the delta smelt spawning season, however, also imposes "un-natural selection" by disproportionately entraining early versus late-spawned larvae. We evaluate the implications of apparent un-natural selection by: 1) measuring variation in several key life history traits in delta smelt; and 2) examining long-term trends in fish length, fresh water inflow to the estuary, and pumping intensity. Finally, we examine patterns in selective mortality by estimating hatch-dates and size-at-age information from otoliths to compare the period "before" the population collapsed (1999-2002) with recent years (2004-2007) "after" the decline. Parental effects were observed over small size and age ranges; egg number and diameter, larval size, and yolk-sac volume scale with female length, with these larger fish also spawning early in spring. A step-like decline in the mean size of adults is highly associated with lower inflows (dry winters) that enhance entrainment. In the "before" period fish larger-at-age or with higher growth rates generally also had higher survival to the adult stage (in December), whereas in the "after" period patterns of survival were generally opposite, with survivors initially smaller-at-age and growing slower than average. Fish hatching in late April and May during the period of reduced exports grew rapidly, but were generally unable to survive through the summer. Overall, these results suggest "un-natural" size-selection systematically interfered with natural selection and played a significant role in the demise of delta smelt. Disproportionate entrainment of early-spawned larvae removed fish that were more likely to survive adverse summer conditions, and thus was a subtle but significant factor involved in the collapse and poor resilience of the population.

Riverscape Management for Green Sturgeon

Joshua A. Israel (Presenter), *Department of Animal Science, UC Davis,* ***Richard Corwin,*** *Bureau of Reclamation,* ***William Poytress,*** *U.S. Fish and Wildlife Service, Red Bluff, and* ***Michael J. Thomas****, Department of Wildlife, Fisheries, and Conservation Biology, UC Davis*

Green sturgeon (*Acipenser medirostris*) in the Sacramento River were listed as a threatened species under the Endangered Species Act in 2006, while populations on the Klamath and Rogue rivers were identified as a Species of Concern by the National Marine Fisheries Service. Considerable results are available via laboratory studies about the environmental preferences and requirements of the species, however the rarity of these fish and lack of directed field research have made understanding their ecology difficult. Rivers can be characterized by environmental variability (i.e., temperature, flows, nutrients) that fluctuate spatially and temporally along these ribbons of aquatic habitats. It is the variability of these parameters that fish have adapted to support viable, self sustaining populations. Some adaptations green sturgeon have made to these variations include increased tolerance of warmer temperatures, early tolerance to seawater, opportunistic foraging behavior, and iteroparity. By understanding how environmental drivers influence biological processes of green sturgeon at the riverscape scale, ecologists can establish a context for managing the species by maintaining necessary environmental conditions at a scale appropriate for a viable population. Recent monitoring results have described the spatial distribution of different life stages. This presentation will describe laboratory results and observed distributional data, which can be integrated to delineate the environmental biology of green sturgeon. Additionally, environmental variability in riverscape habitats used by green sturgeon for migration, adult spawning, egg incubation, and juvenile rearing will be assessed. In light of these data, implications for riverscape management of green sturgeon will be discussed to advance ecological management of the species and identify critical unknowns requiring additional research.

Status, Ecology, and Management of Coastal California Steelhead (*Oncorhynchus mykiss*)

Gordon Becker, *Center for Ecosystem Management and Restoration*

A review of steelhead (*Oncorhynchus mykiss*) resources in the Eel River basin produced findings consistent with those of previous studies of San Francisco Estuary tributaries and coastal drainages south of the Golden Gate. Notably, the vast majority of coastal watersheds and streams historically occupied by steelhead continue to host reproducing *O. mykiss* populations, although less than one-half of these systems now exhibit regular anadromy. Available abundance information suggests that current spawning runs coast-wide are a small fraction (~five percent?) of mid-20th century estimates. Causes of continuing decline likely relate to over-appropriation of streamflow, degradation of estuarine, riverine, and riparian habitat, and water quality concerns including sedimentation, temperature, and runoff contamination.

Recent research on coastal streams emphasizes several important aspects of steelhead ecology. First, "…temperature limits 'depend' on a variety of factors that relate to food abundance and availability, including streamflow quantity." Next, juveniles reared in high-growth rate habitats such as estuaries have a large survival advantage at sea. Moreover, juveniles may retreat to upstream habitat after estuarine rearing. In a study, these second outmigration individuals were mostly of anadromous ancestry and comprised the bulk of returning steelhead adults. Lastly, steelhead populations may be maintained over time by runs in "good years."

While a highly proactive "triage" program to conserve California's coastal steelhead resources is called for, it remains elusive--underfunded, impolitic, and insufficiently informed. Innovative science and engineering are being applied to instream flow and passage barrier problems throughout the region, but current efforts and policies are not keeping pace with threats. Many coastal areas lack effective watershed management programs, and would benefit by monetizing environmental services provided by streams (including providing steelhead habitat). Overall, conserving California's coastal steelhead will require meaningful progress in: developing and enforcing instream flow provisions, restoring stream corridors, and creating long-term mechanisms to fund stewardship.

Water Diversions and Fish Impediments —Can California's Water System and Delta Fisheries be Fixed with the New State Legislation and Bond Act?

Session Coordinator*: Tom Stokely,* ***Water Policy Coordinator, California Water Impact Network***

A Trail of Broken Promises

Tom Stokely, Water Policy Coordinator, California Water Impact Network

Fall 2009 passage of a package of five water "reform" bills for California, including an $11 Billion Bond Act scheduled for the voters in November 2010, contain many promises to improve California's water supply and the aquatic ecosystems where the water originates. However, California's infamous "water wars" are full of broken promises to all parties. The State Water Resources Control Board admits that it has overallocated water rights in the state by a factor of four to eight times. Water contractors are receiving minimal water deliveries during drought and perhaps only half of their allocations during normal years. Environmental commitments such as the Central Valley Project Improvement Act and CalFed are admitted failures (see *http://cvpiaindependentreview.com/FisheriesReport12_12_08.pdf*). Salmon, steelhead and pelagic fish in the Delta and Central Valley rivers and streams are on the brink of extinction. Commercial salmon fishing has largely been banned off of the California North Coast for the past two years. The recent legislation and proposed water bond do nothing to solve the "real" problems of water in California. They only further the problem of promising more water than exists to all parties. Ending "paper water", retiring drainage problem lands in the Western San Joaquin Valley and reinstating the urban preference in State Water Project contracts would have been a good place to start, but they were not included in the recent legislative package. Solutions to California's water problems can be found at the California Water Impact Network's web page at *www.c-win.org/*.

A Stacked Deck Geared for Destruction of the Bay-Delta Estuary

***Dante John Nomellini, Sr.**, Manager and Co-Counsel for the Central Delta Water Agency*

The cornerstone of the hope for meaningful protection of fish, wildlife and other public resources including honoring the promises and law for the protection of the Delta and other areas of origin in the "New State Legislation and bond" is in the Delta Stewardship Council and its Delta Plan. The Delta Stewardship Council will consist of seven members, four appointed by the Governor, one by the Senate Committee on Rules, one by the Speaker of the Assembly and one is the Chairperson of the Delta Protection Commission. The initial term of two of the four members appointed by the Governor is four years and the initial term for the other two is six years. The Governor has made it very clear that he wants a peripheral canal. This desire was clear before the Delta Vision Blue Ribbon Task Force made recommendations and was recently reaffirmed with some variant as to the possibility of a peripheral tunnel. The Delta Vision process as well as the Bay Delta Conservation Plan process have been and are intended to facilitate construction of a peripheral canal. The BDCP process including its environmental review is unaffected by the legislative references to needed fresh water flows and reduced reliance on the Delta in that approval by the Department of Fish and Game insulates the BDCP process from the Delta Stewardship Council. The Department of Fish and Game has never been willing or able to protect fish against the operations of its sister agency, the Department of Water Resources and surely the appointees of the Governor on the Delta Stewardship Council and State Water Resources Control Board are not likely to run counter to the clearly expressed desires of the Governor who made their appointment.

History has confirmed the broken promises to restore fish and the repeated use of emergency powers by Governors including the present Governor to avoid protections in favor of exports of water from the Delta. The so-called reforms intended to reduce reliance on exports from the Delta are simply tools to break down the water rights in the Delta and other areas of origin to better satisfy the demands of the exporters who hold junior rights. The lack of willingness of the SWRCB to enforce as against the SWP and CVP has not been resolved.

The hoped for shift in water project costs from the public to project beneficiaries is not secured. The requirement that the project beneficiaries are to pay for the cost of construction and mitigation of a peripheral canal ignores the obligations of the projects for fish restoration and salinity control as well as mitigation for all of the other project-related impacts including those relating to construction and operation of dams, other diversion facilities, and the failure to construct a San Joaquin Valley Drain. The bond language specifically provides that public funds may be used for the Bay Delta Conservation Plan which is the very mechanism required for the ESA take permits for operation of the projects.

The plan by export interests is clearly to destroy the Delta under the guise of environmental protection and conservation and use taxpayer funds to do it. Destruction of the Bay-Delta Estuary not accomplished by the BDCP, DFG and SWRCB will surely be the task of the Delta Stewardship Council.

Making Historic Decisions in the Face Of Continued Scientific Uncertainty—What Have We Learned From the Last 20 Years?

Jason Peltier, *Chief Deputy Manager Westlands Water District*

The passage of the 2009 State water legislation was an historic moment. The legislation clearly articulates that this State has co-equal goals of restoring the Delta ecosystem and creating a reliable water supply for the State. The legislation represents a sensible balance between efforts to restore the Delta and efforts to supply the water necessary to sustain the economy of the State.

The passage of this legislation and the water bond creates a clear path for the construction of new water supply infrastructure, including conveyance facilities in the Delta that will benefit both the environment and the people around this State who rely on water imported from the Sacramento River watershed. California has taken an important step toward fixing our broken water system.

The passage of this legislation will not provide immediate relief from the water shortages we are facing. However, the legislation lays the foundation for restoring reliability to California's water supplies over the long term. In the meantime, we must continue working together to take the necessary actions to help us get through the years ahead while these reforms are being implemented.

The defects of the Biological Opinions on Delta smelt and Central Valley salmon demonstrate the folly of pursuing a piecemeal species-by-species approach to the environmental needs of a complex ecosystem such as the Delta. We need to complete the Bay-Delta Conservation Plan (BDCP) as quickly as possible so we can replace this kind of patchwork with a fully integrated comprehensive program for repairing the environmental health of the Delta and making the long-term improvements that are needed to restore the reliability of California's water system.

The 2009 Legislative "Water Deal": Where's the Magic?

Bill Kier, ***Institute for Fisheries Resources***

Judging from the inglorious history of the State Water Resources Control Board's efforts over the past 40 years to craft and adopt water quality and water rights rules to protect the public trust resources of the San Francisco Bay-Delta estuary, there is little reason to believe that the 'water deal' struck by the California Legislature, the Governor, and some—but not all—of California's water stakeholders in early November, 2009 will "fix" the broken Delta.

It will take an extraordinary and totally unprecedented fidelity by the Legislature, and the Legislature's dominant constituencies, to the deal's smiley face whatever-science-dictates promise to round up enough freshwater to make things right in this most valuable estuary of the West Coast of the Americas.

For those whose livelihoods and cultures depend on the Delta's trust resources, including California and Oregon's Central Valley salmon-dependent fisheries, little remains but to put on smiley faces and go forward with the deal's process—and watch for early signs of aversion to science by the dominant dealmakers.

Protecting California's Fisheries, Rivers, and the Bay-Delta While Supporting Practical and Sustainable Solutions for Cities and Farms

Spreck Rosekrans, *Economic Analyst, Environmental Defense Fund*

For almost four decades, the Environmental Defense Fund has been committed to protecting and restoring California's rivers, streams and the Bay-Delta. We believe that long-term protection of these precious natural resources will only be possible if the needs, though not necessarily the wants, of the urban and rural sectors are met as well.

Our famous water wars reached a perhaps unprecedented level of conflict in 2009 after three years of drought. Many fish populations reached historic lows, and fishermen were put out of work. Decreased Delta exports led to particularly low water allocations on the west side of the San Joaquin Valley, where some called for a suspension of the Endangered Species Act. This "fish vs. farms" debate is almost certain to loom as large in 2010, even if (and perhaps especially if) it is a wet year. Of course, controversy has also surrounded the ongoing effort to find a long-term solution in the Bay-Delta where the lower San Joaquin River runs backward for most of the year and where fragile levees threaten the ability to move water through the estuary to Central and southern California.

Amidst these controversies, EDF has supported the following endeavors that we believe will result in improved environmental stewardship and water management. While we readily concede that none are perfect and that all are accompanied by a certain level of concern, we maintain that they all represent progress.

- The Ba y-Delta Conservation Plan
- The State Legislative water policy package passed in November
- Senate Bill 1759, designed to encourage the transfer of water supplies between federal contactors

The BDCP process intends to develop a Habitat Conservation Plan to deliver reliable water supplies from the Delta and may well include a Peripheral Canal around (or possibly under) the Delta as an alternative. The Peripheral Canal is hugely controversial. EDF believes that we are better able to influence a better outcome for the BDCP by being involved in than by being on the outside. We have taken no position on the Peripheral Canal—from our perspective it has not yet been shown to be environmentally acceptable or economically feasible.

The State legislation does much to support a sustainable outcome for the BDCP. It requires a first-ever comprehensive assessment of how much water is needed to protect the Delta's public trust resources. It requires the State's highest standards for endangered species recovery and habitat conservation. The legislation also ensures that a Peripheral Canal must be financed by those who would receive water from it.

In addition, the State legislation will require increased urban water conservation and the opportunity for improved agricultural conservation as well. It also requires California, for the first time to measure groundwater levels state-wide. Any one of these provisions would be important, together, they're historic.

Importantly, none of these reforms depend on passage of the $11 billion dollar water bond up for a vote next year.

Finally, Environmental Defense Fund continues to support many water transfers as a cost-effective solution for communities and farms to have access to additional supply without building another dam or diverting more water form the environment. Transfers encourage all users to use water efficiently, including those with plentiful rights and cheap supplies who otherwise would not have any such incentive. We have recently supported S 1759 in an effort to encourage water transfers, especially among and between south-of-Delta Central Valley Project agricultural water users. Ultimately we believe California needs improved markets for water and that these markets can be successful within the agricultural sector, within the urban sector and without long-term conversion of farmland that supports urban sprawl.

Half a Loaf: More Work Ahead to Achieve Viable Fisheries and Reliable Water Supply for California

Christina Swanson, ***The Bay Institute***

On November 12, 2009, Governor Schwarzenegger signed the Sacramento-San Joaquin Delta Reform Act of 2009. Building on the work of the independent Delta Vision Blue Ribbon Task Force, the legislation mandates a set of major new water policy reforms, including: mandatory urban water conservation; reduced reliance on water exports from the Delta; identification of freshwater flows needed to maintain fish, wildlife and other public trust resources in good condition in the Delta and throughout its watershed; groundwater monitoring; and establishment of a new Delta Stewardship Council to create and oversee implementation of a Delta Master Plan that integrates land use, water operations, flood management and other concerns, and a new Delta Conservancy to acquire and restore habitat. Contrary to some news reports, the legislation does not authorize or fund new conveyance facilities, such as a peripheral canal, nor make it easier for such facilities to be approved. If anything, the Reform Act raises the threshold for restoring flows and recovering endangered fish populations that any new proposed project must meet. However, important provisions to significantly strengthen the state's efforts to control illegal water diversions and fully fund the Council's oversight activities were dropped from the legislation, and the state's compliance with the legislative mandates to identify Delta flows and agricultural conservation targets will need to be closely monitored. Signing the Sacramento-San Joaquin Delta Reform Act has moved water policy at least partway into the twenty-first century but much more remains to be done to strengthen California's ability to restore the endangered species and habitats of the Bay-Delta system and shift water project costs from the public to project beneficiaries.

Session Coordinator*: Michael Furniss, Pacific Northwest Research Station, Arcata, CA*

Climate Change and Salmonid Recovery

Michael Furniss, Pacific Northwest Research Station, Arcata, CA

Climate change presents major challenges to fisheries and watershed managers both because of the magnitude of potential impacts of climate change on aquatic ecosystem structure, process, and function, and because of the uncertainty associated with those potential ecological impacts. Furthermore, managers lack adequate tools and operational strategies to aid in adaptation to climate change. In the nascent literature on climate change adaptation, much of the focus has been on conceptual issues, potential actions by governments and municipalities, individual resources, and biological diversity. This session will provide some conceptual frameworks and specific strategies and actions that can be employed now to conserve salmonid populations in the new context of rapid climate warming.

Integrating Global Climate Change into Salmon and Trout Conservation: The Klamath River, California

Rebecca M. Quiñones, PhD candidate (Presenter), *and* ***Peter B. Moyle,*** *University of California Davis, Wildlife and Fisheries Conservation Biology*

Anadromous fishes are particularly vulnerable to climate change because they use different habitats at different phases of their life: rivers, estuaries and oceans. For anadromous Pacific salmonids (*Oncorhynchus spp.*) in North America effects of climate change are likely to be noticed most strongly at the southern end of their range, in California. The effects are likely to be especially severe in the Klamath River watershed, California's second largest river, where six salmonid species already have declining populations. In the river, climate change is expected to alter flow patterns, including the seasonality and magnitude of droughts and floods. The estuary will be impacted by more frequent and extreme tides and storms, and will experience altered salinity distribution as sea level rises. Although localized increases in ocean primary productivity may favor growth for some salmonids, benefits to populations will largely depend on movement patterns dictated by currents and new predator-prey interactions. Water temperature in all three habitats is predicted to steadily increase throughout the 21st century, perhaps beyond salmonid tolerances. Salmonid abundance in the Klamath River Basin may decrease by as much as 50% by 2100, with the loss of three salmon species, unless climate change is actively incorporated into conservation efforts. Conservation of Klamath River salmonids will require creative, cooperative management of both the fish and their ecosystems, backed by the legal authority of state and federal endangered species acts, various clean water acts, and the public trust doctrine. Specific conservation actions exist that must be implemented rapidly in order to increase the likelihood of salmonids' persistence in the face of climate change. Management actions recommended for the Klamath River can be used to resolve salmonid declines throughout the state and western North America.

An Integrated Framework for Streamflow Management in Mediterranean-Climate Streams: Examples from Sonoma County, California

***Ted Grantham (Presenter), Adina M. Merenlender,** and **Vincent H. Resh,** Department of Environmental Science, Policy & Management, University of California, Berkeley*

In Mediterranean and other water-stressed climates, water management is a critical component of river restoration and freshwater ecosystem conservation. To secure and maintain water allocations for the environment, integrated water management approaches are needed that consider ecosystem flow requirements, patterns of human water demands, and the temporal and spatial dynamics of water availability. We propose an integrated framework for streamflow management that explicitly considers the temporal and spatial dynamics of water supply and needs of both human and natural systems. This approach makes it possible to assess the effects of alternative management strategies to human water security and ecosystem conditions and facilitates integrated decision making by water management institutions. We illustrate the approach by applying a GIS-based hydrologic model in a Mediterranean-climate watershed in Sonoma County, California, USA. The model is designed to assess the hydrologic impacts of multiple water users distributed throughout a stream network. We analyze the effects of vineyard water management on environmental flows to: i) evaluate streamflow impacts from small storage ponds designed to meet human water demands and reduce summer diversions; ii) prioritize the placement of storage ponds to meet human water needs while optimizing environmental flow benefits; and iii) examine the environmental and social consequences of flow management policies designed to regulate the timing of diversions to protect ecosystem functions. Spatially explicit models that represent anthropogenic stressors (e.g. water diversions) and environmental flow needs are required to address persistent and growing threats to freshwater biodiversity. A coupled human-natural system approach to water management is particularly useful in Mediterranean climates, which are characterized by severe competition for water resources and high spatial and temporal variability in flow regimes. However, lessons learned from our analyses are applicable to other highly seasonal systems and those that are expected to have increased climate variability resulting from climate change.

Quantification of the Effects of Global Climate Change on Endangered Species Habitat: Application to ESA and NEPA

C. Anna Toline (Presenter), Larry Wise, Dan Tormey, and Jean Baldridge, ENTRIX

The issue of climate change is at the forefront of discussion in the scientific community and a critical element in restoration and recovery planning. To this end, the ecological significance of climate change is being recognized by the courts as an essential element considered in the environmental permitting process. ENTRIX is currently utilizing their ecologists, physical scientists, and academic partners in a project directed at addressing this important issue. ENTRIX is working in partnership with the Bureau of Reclamation, South Central California Area Office to evaluate the effects of climate change on the habitat of a group of federally-listed species including: southern steelhead, giant garter snake, San Joaquin kit fox, California red-legged frog, California tiger salamander, and two rare plants. This project encompasses the Central Valley Project (Friant, San Luis, San Felipe, and Delta Divisions) and the Cachuma Project; the sensitive species represent taxa utilizing diverse aspects of the ecosystem in Reclamation's project jurisdictions. The purpose of this evaluation is to provide information necessary to incorporate the potential effects of climate change into the assessment of the effects of future planning efforts, and thus aid in the development of NEPA and ESA environmental documents. Physical climate change data based upon the previous 50 years, along with other information, such as greenhouse gas level data, will be used to predict climate change over the next 20 years. These data are utilized in concert with physical attributes of habitat use by individual species at a landscape scale. This information is combined in a GIS-based model and other predictive approaches are used to re-define species habitat distribution as it tracks changes in atmospheric conditions in the changing climate.

Climate Change and Butte Creek Spring-run Chinook Salmon: Predictions and Management Options from Coupled Watershed and Population Dynamics Models

***Lisa C. Thompson (Presenter), Peter B. Moyle, Christopher Mosser,** and **Melanie Allen Truan**, University of California Davis, and **David Purkey** and **Marisa Escobar,** Stockholm Environment Institute, Davis, CA*

Spring-run Chinook salmon are particularly vulnerable to climate change because adults hold over the summer months in freshwater before spawning in autumn. We are using an integrated water resources management model (WEAP21, developed by David Purkey, SEI, and David Yates, National Center for Atmospheric Research) to simulate potential changes in flow and temperature in Butte Creek, (near Chico, California) in response to climate change. The resulting outputs are being used to drive a fish population model (SALMOD, originally developed by USGS) that simulates response to changing environmental conditions, including threshold effects on survival. Literature reviews, field surveys and an expert panel are being used to develop a conceptual model of the impacts of changes in the salmon marine-derived nutrient subsidy to terrestrial wildlife.

Our basic objective is to determine the flow and temperature thresholds that lead to long-term losses or reductions in spring-run Chinook salmon in Butte Creek. Hypothesis 1. Climate induced changes in flow and temperatures will lead to critical reductions in the available habitat of spring-run Chinook salmon. Hypothesis 2. The loss/reduction of Chinook salmon will reduce the diversity and abundance of animals in the riparian corridor. Our final objective is to evaluate management options to ameliorate these impacts.

Our approach to assessing non-linear and threshold responses to gradual climate change on spring-run Chinook and dependent terrestrial ecosystem services is both analytical and expert-panel based. The primary, linked analytical models are WEAP21—an integrated watershed hydrology, water and irrigation management, and water quality model, and SALMOD—a spatially explicit and size/stage structured population dynamics model. SALMOD predicts the growth, survival, and movement (habitat choice) of salmon in freshwater systems from spawning to the egg, juvenile, and smolt life stages, based on water quantity and quality conditions. Model results and the knowledge base of our study team will provide information for an expert panel that will help us to evaluate potential impacts of climate change, and of management policies to address these impacts.

Expected results include greater insight into the sustainability of spring-run Chinook salmon and their role in defining the terrestrial biodiversity of the riparian corridor. Bringing climate change to bear on the issues will determine environmental thresholds that will also be decision-making thresholds. We will provide stakeholder and management groups with tools and information to help determine: 1) if salmon are in increased danger from climate change; 2) if there are strategies to save the fish and fish-dependent wildlife species from climate change effects; and 3) when and how these strategies can be implemented. The analytical process and expert panel opinion will lead to: 1) possible water management strategies to counter climate change impacts on stream ecosystems and the services they provide; and 2) an improved understanding of the potential tradeoffs between services provided by water diversion versus services provided by water left in the stream.

In this presentation we will introduce the WEAP21 and SALMOD models developed for Butte Creek, and show the results of model runs based on a range of California climate change scenarios.

Effects of Elevated Water Temperature on Early Life Stage Development and Survival of Spring-run Chinook Salmon in the Trinity River, California

Keith Marine, *North State Resources, Inc.*

Key uncertainties regarding the adequacy of temperature management criteria for protecting spring-run Chinook salmon were identified by the Trinity River Flow Evaluation due to a lack of information on stock-specific responses to water temperature regimes. Temperature-specific development and mortality of incubating eggs and pre-emergent larvae between 10 °C and 16.6°C were evaluated in an experimental design using replicates blocked on eggs from 10 one male to one female matings (to control for interfamilial variation) over the two study years. Temperature-specific mortality rate exhibited a threshold response as opposed to a continuous function reported for a number of other salmon species. A statistically significant ($P<0.001$) critical water temperature threshold was identified at 14.5°C above which the mortality of incubating embryos and pre-emergent larvae rapidly increases. Temperature-specific embryo development followed a typical van't Hoff rate function. Fry surviving incubation at temperatures above 14.5°C were significantly ($P<0.001$) smaller at emergence than fry incubated at cooler temperatures. Furthermore, latent mortality of post-emergent fry generally increased for eggs incubated at and above 13.3°C compared with eggs incubated at lower temperatures. This latter result suggests that the temperature conditions during egg incubation and its effects on embryonic development persist after fish begin to exogenously feed.

Session Coordinators*: Doug Threloff* *and* ***Mark Gard,*** *U.S. Fish and Wildlife Service*

Using Trap Catches of Salmonid Smolts Migrating Downstream to Index Population Abundance: Does it Work?

Michael D. Sparkman, *California Department of Fish and Game*

Quantifying the number of salmonid smolts migrating to the ocean can offer critical insights into population dynamics, stock performance in freshwater and potentially, effects of stream and watershed restoration. Downstream migrant traps and mark/recapture techniques are typically used to determine smolt population abundances on a weekly and seasonal basis. Given enough consecutive study years, population data is tested for trends over time to determine whether the smolt populations are increasing, decreasing, or remaining stable. However, a major obstacle can occur when mark/recapture experiments fail, and when the resulting point estimates (of abundance) are considered unreliable. I analyzed techniques that used total catch data instead of population data for trend analysis purposes, using nine consecutive years of smolt data collected in a free flowing coastal stream supporting wild Chinook salmon and steelhead trout. Results showed that catch data closely followed population data on a weekly and seasonal basis for both 0+ Chinook salmon smolts and 2+ steelhead trout smolts. The same conclusions drawn from testing trends in population data occurred when using catch data. For 0+ Chinook salmon, both catch data and population data showed a non-significant trend ($p > 0.05$), and for 2+ steelhead trout, catch data and population data showed a significant, negative trend over years ($p < 0.05$). In those cases where mark/recapture assumptions cannot be met, or when sparse data lead to unreliable point estimates of abundance, trap catch data may prove to be useful to draw inferences about population trends.

An Overview of Long Term Coho Monitoring Programs for the Central California Coast Coho Salmon Evolutionary Significant Unit (CCCESU)

Sarah Carlisle (Presenter) *and* ***Brannon Ketcham,*** *Point Reyes National Seashore Association (PRNSA),* ***Michael Reichmuth,*** *National Park Service, and* ***Angela Rodoni,*** *Conservation Corps North Bay*

In 2005, the National Marine Fisheries Service completed a rulemaking process that downgraded the status of the central California coast coho salmon evolutionary significant unit (CCCESU) to Endangered. The CCCESU includes all naturally spawned populations of coho salmon (*Oncorhynchus kisutch*) from Punta Gorda in northern California south to and including the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system. Although the California coho recovery strategy outlines broad monitoring goals within the CCCESU, it does not provide details on the monitoring strategies to be used within the region. Thus CCCESU coho monitoring programs have been developed independently with various methods used and reported metrics.

Long term monitoring data is collected within the evolutionary significant unit (ESU) by many different groups including federal, state, local, and non-profit organizations. Comparisons made between programs for the purpose of determining population trends and limiting factors can be difficult when dealing with multiple organizations and survey techniques, as they may not be comparable for the purposes of scientific analysis. This presentation will provide an overview of the long term monitoring methods used by the various agencies and organizations within the CCCESU, paying particular attention to data compatibility between watersheds. We will discuss past survey techniques but will focus on providing a synthesis of current methodology being used and reported metrics for each watershed. This presentation is intended to facilitate communication and collaboration between CCCESU coho monitoring groups.

3-D Modeling of Steelhead/Rainbow Trout Passage in Southern Santa Barbara County

Timothy H. Robinson, Cachuma Project Water Agencies

3D-modeling in conjunction with a developed multi-purpose GIS-database were used to study southern steelhead (*Oncorhynchus mykiss*) stream passage through two creeks in southern Santa Barbara County, Quiota and El Jaro creeks, which are tributaries to the Santa Ynez River. The Santa Ynez River basin is a Core 1 watershed and has been determined by the National Marine Fisheries Service (NMFS) to be a high priority stream within the Southern California Steelhead DPS/ESU. Hydraulic and fish passage design and engineering were evaluated in HEC-GeoRAS, HEC-RAS and AutoCAD. All elements of the design were incorporated into a GIS-based simulation tool to evaluate facility performance over a range of stream flows. The two structures were completed in 2008; each will be described specifically for the implemented fish passage criteria as well as their performance after two winters of operation. Swim-through (fly-through) imagery will be shown in context of structural and fish passage performance. Southern steelhead were federally listed endangered species in 1997, hence require careful analyses of any riparian corridor projects within critical habitat reaches. The developed 3D-models have proven to be valuable tools for management and evaluation objectives. Tributaries of the Lower Santa Ynez River below Lake Cachuma are well known for spawning and rearing of steelhead. The successful stream restoration projects presented directly supports NMFS' southern steelhead recovery planning efforts specifically within a high priority watershed for southern steelhead restoration.

Large-scale Parentage Inference for Fishery Management and Ecological Investigation

John Carlos Garza (Presenter) *and* ***Eric Anderson,*** *NOAA Southwest Fisheries Science Center*

Monitoring and evaluation of salmonids generally employ coded wire tags (CWTs) as the primary method of identifying fish. In spite of their utility, CWT recovery rates are very low (<0.5%), and massing marking programs pose enormous challenges to CWT programs; over 80% of ad-clipped fish now sampled in many salmon fisheries do not carry CWTs.

Parentage-based tagging (PBT) is a novel, intergenerational genetic tagging method that has broad potential application to monitoring and evaluation, fishery management, evaluation of hatchery practices and ecological investigation. It is predicated upon the idea that sampling and genotyping the broodstock at a hatchery, or the spawning adults in a natural population, provides genetic tags for ALL of their offspring that are recovered through large-scale parentage analysis. Since the "tagging" process requires genotyping the parents only, PBT is highly efficient, with one pair of genotypes providing tags for all of their 1000s of offspring. Matings need not be recorded, but efficiency is dramatically increased if samples from hatchery broodstock are separated by spawning date. We have determined that single nucleotide polymorphisms (SNPs) are the molecular marker of choice for PBT and we present power analyses that show that 80-100 of our newly-discovered SNPs are sufficient to implement PBT in California salmonid hatcheries for both Chinook salmon and steelhead/ rainbow trout.

We envision a future data collection system for salmonid fishery management that integrates PBT with standard genetic stock identification (GSI), as an integrated PBT/ GSI program provides stock of origin for every fish, and age for many. Applications of PBT extend beyond salmonids to any highly fecund organism.

Mainstem Trinity River Salmon Spawning Distribution: 2002-2009

Charles D. Chamberlain, U.S. Fish and Wildlife Service

The temporal and spatial distribution of salmon spawning in the mainstem Trinity River has been documented regularly since 2002. In that time, multiple channel rehabilitation projects have been constructed, diversion of water out of the Trinity River basin has been reduced, flow regimes that incorporate annual and inter-annual variability have been initiated, and significant quantities of gravel have been reintroduced. Spawning distribution is anticipated to respond to the changes in channel morphology that result from all of these actions. Recent improvements in our methods will facilitate investigating the response of spawning distribution on multiple scales. Distributions from 2002-2009 are presented, and resolution of data collected with new methods beginning in 2009 is demonstrated.

Dip, Drop, or Alarm: Coho Salmon Status and Trends in Mendocino County, California—2000 to 2009 and Beyond

Sean P. Gallagher (Presenter), Shaun Thompson, Scott L. Harris, *and* ***Wendy Holloway****, California Department of Fish and Game, and* ***David W. Wright,*** *Campbell Timberlands Management*

Understanding the status and trends in Viable Salmonid Population (VSP) criteria is important for recovery of coho salmon in coastal California. Adult and smolt abundance and population productivity are two important components of the VSP. The California Department of Fish and Game (CDFG) have been monitoring adult coho salmon escapement and smolt abundance in the South Fork Noyo and Little rivers and Caspar Creek since 2000. In 2002 CDFG and Campbell Timberland Management began monitoring escapement in Pudding Creek. In 2005, with oversight from NOAA Fisheries, we received the first of a series of grants from the Fisheries Restoration Grants Program to conduct pilot studies to monitor salmonid life cycles in these steams. Adult abundance was estimated using mark-recapture methods and redd data. Smolt abundance was estimated with mark recapture methods using fin clips prior to 2006 after which we used a combination of PIT tags and mutilation marking. We examined this ten year dataset for trends in abundance, survival, and productivity. Adult escapement, smolt to adult survival and spawner/recruit ratios (productivity) showed significant negative trends for all cohorts. However, there were no trends in smolt abundance for any cohorts. We speculate on the cause and meaning of these findings relative to the duration of our monitoring, climatic conditions, and recovery and restoration. Our findings indicate that ocean conditions likely drive these trends. To accurately assess trends in these variables we suggest continued monitoring over multiple generations.

Session Coordinators*: Wayne Lifton and Mitchell Katzell,* *ENTRIX*

Mega Wood Loading Projects for Coho Recovery: How Do We Get There? Examples from North Coastal California

Rocco Fiori, California State Parks and Fiori GeoSciences

Experimental wood loading projects that have increased fluvial wood levels to background rates have been conducted in several third to fifth order streams in north coastal California. These projects were designed to restore geomorphic processes in valley ecosystems to improve salmon habitats and riparian resiliency. Construction methods did not rely on traditional wood anchoring techniques (cable, riprap, etc.) but rather using geomorphic and Engineered Log Jam principles. Site selection, use of natural and emplaced pilings (riparian trees and poles), whole tree materials (stems with intact rootwads and limbs), and slash were critical to achieve design outcomes. These projects have preformed exceptionally well through several geomorphically effective floods. Fish population monitoring from a paired watershed study suggest juvenile coho survival improves in association with mega-wood loading projects that affect available habitat at the sub-watershed scale; and that transform plane-bed channels into complex habitats with increased pool frequency and side-channel connectivity. Case histories of construction and geomorphic performance will be presented. These projects illustrate the need for improved incentives and coordination between landowners, agencies, and practitioners to obtain and use whole tree materials, and project scale needed to effectively restore coho populations.

Restoration on Big Springs Creek, Shasta River: Where You Can Have Your Cattle and Your Restoration Too

Carson Jeffres (Presenter), Andrew Nichols, *and* ***Rob Lusardi,*** *Center for Watershed Sciences, University of California, Davis, and* ***Mike Deas*** *and* ***Ann Willis,*** *Watercourse Engineering, Inc.*

Historical unrestricted cattle access to riparian and aquatic areas of Shasta Big Springs Ranch resulted in habitat conditions detrimental to the survival of federally-listed coho salmon and other salmonid species (Chinook salmon and steelhead) in the Shasta River watershed. Such access allowed cattle to: 1) trample streambanks, facilitating a widening and shallowing of the stream channel; 2) browse aquatic and emergent macrophytes, thus removing in-stream and riparian structural habitat and shading elements; and 3) trample remaining salmonid spawning gravels. Resulting channel and riparian conditions did not provide suitable habitat for spawning or rearing salmonids and allowed for rapid heating of water derived from voluminous cold-water spring sources. Poor habitat conditions and elevated water temperatures had been identified as the primary factors limiting salmonid production at Shasta Big Springs Ranch. Despite its degraded condition, Big Springs Creek had very high potential for restoration due to abundant nutrient-rich cold spring water and very high densities of aquatic macrophytes and invertebrates. In March, 2009 The Nature Conservancy purchased Shasta Big Springs Ranch with the goal of restoring salmonids populations in the Shasta River while maintaining a working cattle ranch. Immediately after the purchase of the ranch, restoration activities were initiated, beginning with a cattle exclusion fence in the riparian area. After the cattle were excluded, aquatic macrophytes grew rapidly and the channel narrowed. The narrow channel increased velocities, increased depth, and reduced residence time and water temperatures cooled throughout the summer. After only a single summer of modified resources management, restoration potential is already being realized in the form of cooler water temperatures and improved habitat conditions in Big Springs Creek.

Large Wood in Channels: Re-defining the Problem

***Neil S. Lassettre (Presenter)* and *Matt Kondolf,* Department of Landscape Architecture and Environmental Planning, University of California, Berkeley**

Most research on wood in fluvial environments has taken place in rural, forested ecosystems (Harmon et al. 1986, Bilby and Bisson 1998). But, in urban areas, humans exert the greatest pressure on the natural function of aquatic ecosystems and the interaction of infrastructure and LWD is one that confronts managers. During high flows, water-borne large woody debris can collect upstream of culverts and bridge pilings, undermining and weakening structures (Diehl 1997). Common management responses are to remove LWD or to install debris racks to intercept wood in transport (Federal Highway Administration 1990). A more sustainable approach in urban systems is to accommodate the processes of wood input, storage, and transport. Under this approach infrastructure could be modified to allow the downstream passage of LWD, and the creation and maintenance of aquatic habitat.

We examine past and current LWD management within Soquel Creek (Santa Cruz County, CA), which has a history of wood and infrastructure-related flooding, then describe an alternative approach that relies on modifying infrastructure. We measured the sizes of wood and infrastructure to identify potential restrictions on transport. The costs of modifying infrastructure were compared to the costs of past and current management. Management costs included costs of programmatic wood removal, wood-related flooding, and loss of habitat. We estimated lost habitat using data from Leicester (2005), who surveyed Soquel Creek and several nearby unmanaged creeks.

Along two reaches we counted 617 LWD pieces with median and 90th percentile lengths of 4.6 and 15.1 m. Culvert widths ranged from 1.8 to 3.7 m and were narrower than 59-87% of LWD; bridge openings ranged from 7 to 44 m and were narrower than 1-32% of LWD. Estimated costs of building infrastructure able to pass the median and 90th percentile LWD length were nearly double and quadruple that of replacing with current size. Wood loading (pieces/m) in Soquel Creek (0.007) was an order of magnitude lower than unmanaged streams (0.087). When comparing historical, current, and wood passing approach, our estimates predict that even large increases in spending on infrastructure are offset by reduced flood damage and gains in habitat.

Habitat Enhancement in the Upper Klamath Basin: Historical Channel Reactivation on the Sprague River

Troy Brandt, *Fisheries Biologist, River Design Group, Inc.*

Since 2001, River Design Group, Inc. (RDG) has collaborated with resource agencies and landowners to enhance habitat in the Sprague River watershed. Mainstem Sprague River and tributary stream restoration and fish passage projects have followed guidance outlined in the Master Plan for the Restoration of the Sprague and Sycan Rivers near Beatty, Oregon. Projects have included historical channel reactivation, large wood placement, revegetation activities, and off-channel habitat enhancement. These activities are intended to improve habitat conditions for target fish species including federally endangered Lost River sucker (*Deltistes luxatus*) and the shortnose sucker (*Chasmistes brevirostris*), and federal species of concern Klamath largescale sucker (*Catostomus snyderi*) and Klamath redband trout (*Oncorhynchus mykiss newberrii*).

In 2009, RDG with funding provided by the Natural Resources Conservation Service, U.S. Fish & Wildlife Service, and the U.S. Bureau of Reclamation, completed the last of the three mainstem Sprague River projects recommended in the Master Plan. Channel avulsions believed to be related to historical grazing practices, beaver loss due to trapping, and accelerated sediment delivery caused by upstream river straightening, shortened the project area's channel length by over 60 percent. The design process incorporated a surface model comprised of LIDAR and bathymetry data, and monitoring data collected from two previously completed projects. Existing and proposed condition HEC-RAS models were developed to evaluate river hydraulics and to determine potential flood effects. Implemented actions included reactivating 3,700 ft of historical Sprague River channel, installing over 25 large wood habitat structures, revegetation, and filling the existing channel with excavated soils. An as-built survey was completed following construction in order to monitor future channel response. RDG is discussing opportunities with U.S. Fish & Wildlife Service to monitor adult and juvenile fish use of habitats in the project reach.

Technically Challenging Problems and Solutions Associated with the Decommissioning of Stream Crossings on Fish Bearing Streams in Forested Watersheds

Tom Leroy (Presenter), Danny Hagans, and Bill Weaver, Pacific Watershed Associates

Reestablishing fish passage at road crossings has comprised a significant portion of watershed enhancement efforts in forested watersheds of the Pacific Northwest over the last decade. To date the most visible of these efforts are undertaken on public road systems in the lower portions of watersheds, and primarily entail costly upgrading of stream crossings and the adjacent channel to provide for reliable fish passage. Alternatively, decommissioning of watercourse crossings on fish bearing streams mostly occurs on private roads, and presents a unique opportunity to permanently provide for fish passage at significantly lower costs with the same, and possibly greater environmental benefits. A third situation arises where a private or public road stream crossing will be reconstructed for fish passage, but the removal of decades of accumulated channel stored sediment upstream of the crossing effectively requires channel reconstruction (i.e. essentially a form of decommissioning) along anywhere from tens to hundreds of feet of channel.

We present observations from several case examples of stream crossing and stream channel decommissioning efforts on fish bearing streams in Northern California and identify specific assessment criteria and implementation strategies needed to address technical issues common to stream crossing decommissioning in managed watersheds.

Assessment needs unique to stream crossing decommissioning include long term transportation planning to determine which roads are no longer needed and can be targeted for decommissioning. It also requires a detailed assessment of channel conditions upstream and downstream from the road crossing to assure minimal channel bed and bank adjustments occur along the excavation. This is important as the act of road decommissioning may have effectively isolated the site from future equipment access. Technical issues associated with decommissioning a fish bearing stream crossing may include: excessive stored sediment in the channel above the crossing, lack of woody debris and channel complexity in the post-decommission channel, pre-existing management-related stream baselevel changes (i.e. recently incised channels or headcuts that may impede fish passage), and difficult grade transitions from the excavated channel to the adjacent, undisturbed natural channel. Our observations suggest that identifying and removing all anthropogenic sediment related to the crossing, incorporating large woody debris and/or rock into the excavated channel design, and using roughened channels or similar strategies to provide grade control or profile transitions may need to be evaluated as necessary first steps in successful stream crossing and stream channel decommissioning on fish bearing streams. Other mitigation strategies to address fish passage issues are common but need to be employed on a site by site basis with solutions rooted in detailed assessments of the current disturbed channel, predicted post-construction channel and flow conditions, and knowledge of fish biology and life stage requirements (athleticism).

California Conservation Corps—California's Future Restoration Workers

Anna Halligan, *Morro Bay National Estuary Program*

Who is the California Conservation Corps? Perhaps you have seen these energetic crews of young people working in your community or neighborhood. Where do they come from? How are they chosen for this important opportunity? How does their work relate to the larger fisheries restoration community as a whole? How can you find a way to partner with the Corps to enhance your fisheries projects? This presentation will answer all these questions and more as CCC staff, corpsmembers, and fisheries restoration partners give their perspectives on working with this important State department.

The California Conservation Corps is a workforce development program that hires young adults between the ages of 18 and 25 to spend a year of their lives engaged in conservation and restoration work throughout California. During their one to two year 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 a responsibility to society as a whole. In the process, the CCC improves the ecology of California's lands and rivers.

Each summer for the past two and a half decades young adults have come together for the purpose of restoring California's fisheries habitat as part of the CCC/DFG Salmon Restoration Program (SRP). When NOAA joined this partnership in 2003, SRP expanded and became known as the Coastal California Salmonid Restoration Project Partnership (CCSRPP). The partnership with NOAA enabled the CCC and DFG to build capacity for additional collaborative efforts and expand the CCC's fisheries restoration activities from California's remote North Coast south to Santa Cruz and continuing to Ventura County in Southern California.

The CCC's restoration program is the largest and longest running fish habitat restoration project in the country. The program won the Renew America National Environmental Achievement Award in 1991 and 1992, Chevron/Time Magazine's Mirror Conservation Award in 1995, and an Environmental Achievement Award from the California National Guard.

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

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

Typical CCC fisheries restoration projects include the following: modifying barriers to fish passage, planting trees in the 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 in pool and flat water habitats.

At this presentation you will have a chance to listen to CCC crew supervisors outline the ins and outs of the CCC's crew-based structure and share their experiences teaching these young adults about the technical aspect of fisheries restoration work. Best of all, you will have the opportunity to hear directly from CCC corpsmembers that have benefited from the program. How has the CCC given them direction, changed their lives, and shaped their future as contributing members of the restoration community?

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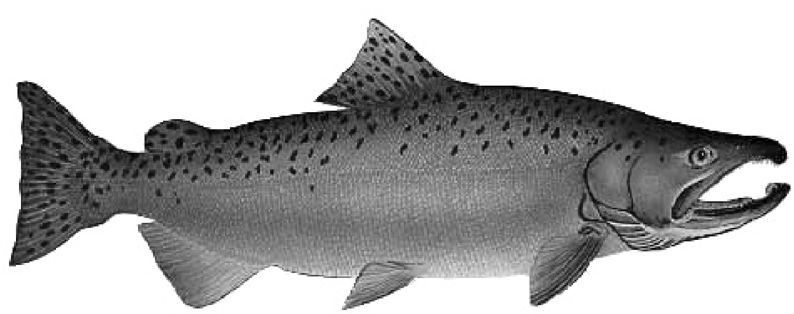


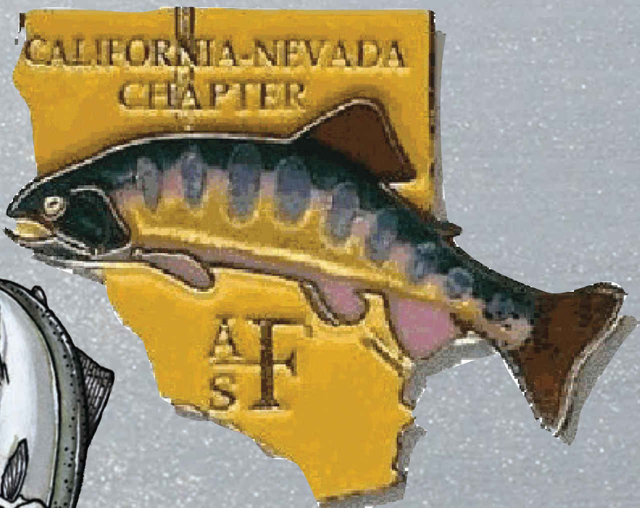
Notes:

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.

AFS Mission Statement

The American Fisheries Society was founded in 1870, to improve the conservation and sustainability of fishery resources and aquatic ecosystems by advancing fisheries and aquatic science and promoting the development of fisheries professionals.



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.

AFS Goals & Objectives

1. To promote the conservation, development, and wise use of the fisheries
2. To promote and evaluate the development and advancement of all branches of fisheries science and practice
3. To gather and disseminate to Society members and the general public scientific, technical, and other information about fisheries science and practice through publications, meetings, and other forms of communication
4. To encourage the teaching of fisheries science and practice in college and universities and the continuing professional development of fisheries workers.

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