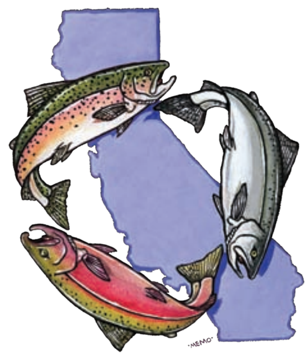
Salmonid Restoration Federation's

26th Salmonid Restoration Conference

Salmonid Restoration and Recovery in the California Heartland

March 5-8, 2008

Lodi, CA



Co-Sponsors:

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26th Annual Salmonid Restoration Conference Preface

Welcome to the 26th Annual Salmonid Restoration Conference entitled, "Salmonid Restoration and Recovery in the California Heartland." As the Salmonid restoration field evolves and adapts to address California's changing landscape, demographics, development, and population growth it is more important than ever to gather together and envision a future with abundant wild salmon runs. A generation ago, restoration pioneers created this salmonid restoration conference to serve the needs of the fisheries and restoration community. Each year hundreds of fishheads migrate to participate in this premier salmon restoration conference where leaders, on-the-ground and in-the-creek restorationists, and watershed stewards spawn innovative ideas about how to save salmon, steelhead, and trout.

The production and coordination of the annual conference is a fluid, dynamic process that engages Salmonid Restoration Federation's diverse Board of Directors, staff and co-sponsors 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.

The planning for this conference is a year-round event for our organization. It begins soon after the conference when SRF analyzes the evaluation forms that participants at the conference fill out. SRF relies on our members to inform us about what types of technical trainings, field tours, and educational workshops that they would like to see offered at the conference and our other events. Next, SRF does outreach to the restoration community in the bioregion where we are interested in holding the conference. Last summer, the SRF Board gathered on the banks of Butte Creek, the Mattole Valley, and the hills of Santa Cruz, California to brainstorm about potential sessions, workshops, and field tours.

Creating the conference agenda and events is a collaborative effort that involves hundreds of people and the support of our co-sponsors. I would like to thank all of the presenters, session, field tour and workshop coordinators for submitting abstracts in time for SRF to be able to offer the Proceedings at the conference. The quality and diversity of the speakers on the agenda has everything to do with the hard work, expertise, and dedication of the incredible session, workshop, and field tour coordinators. Thank you for being leaders in your field and for your tremendous volunteer contribution to make this such a high-caliber conference. Thank you to all of our co-sponsors for your time, ideas, donations, and your invaluable contribution to help make this the best salmonid restoration conference.

SRF is excited to be hosting the conference for the first time in the San Joaquin Valley especially in light of the magnitude of the San Joaquin Restoration settlement and the ambitious attempt to rewater, restore, and repopulate the San Joaquin with native fish.

In addition to the conference, SRF will be hosting the third annual Spring-run Chinook symposium in the Yuba watershed, the Coho Confab on the pristine Smith River, and a series of field schools throughout California. Thank you for your participation in Salmonid Restoration Federation's conference and for being an integral part of this emerging restoration field.

In the spirit of Celebrating Salmonid Recovery,

Dana Stolzman

Dana Stolzman

Agenda Coordinator
Executive Director
Salmonid Restoration Federation

The Next Generation of Salmonid Restoration

By Don Allan, SRF Board President

Salmonid Restoration Federation recently celebrated a generation of hosting the annual Salmonid Restoration conference in California. This premier salmon restoration conference provides a critical forum for salmon restorationists to gather and share new knowledge and lessons learned in the field of salmon and watershed restoration.

In the early days, salmon restoration work was done largely by volunteers. However, the volunteers soon realized their efforts required financial and public support to access funding needed to accomplish the mission of habitat restoration and salmonid recovery. California legislators and citizens have continually supported bills and bond measures to restore salmon habitat.

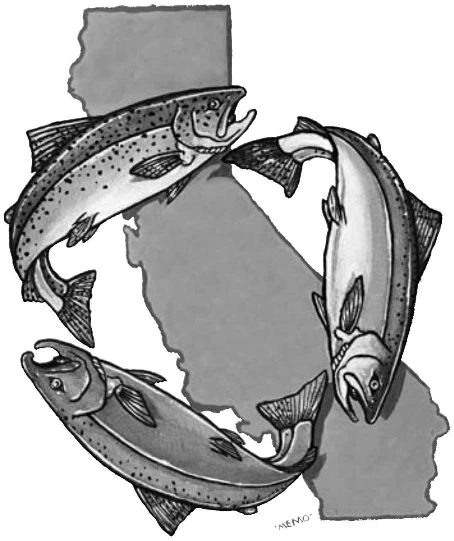
As a restoration community, it is important that we honor the public mandate by utilizing public funds to implement effective restoration techniques. This entails peer review, inter-disciplinary training, and sharing the lessons we've learned. This collaborative sharing is an integral part of SRF's annual conferences. The conference brings the restoration community together and helps catalyze the scientific field of salmon habitat restoration, fosters a growing awareness among the general population of the importance of and plight of salmon, and generates public support for funding programs dedicated to restoring salmon populations.

Education and outreach efforts brought salmon to the classroom and exposed a whole new generation to adopt a stewardship ethic that conserves, protects, and restores salmon habitat. SRF has expanded its role from its primary task of organizing the annual conference, to hosting watershed symposiums, field schools to train practitioners in techniques that range from bio-engineering to storm proofing roads, and participating in legislative days to educate legislators and their staff in Sacramento about watershed restoration.

Many of the restoration pioneers are looking at the twilight of their careers and some have ridden in to the sunset. Yet there is a whole new generation of restorationists who have stepped forward and who are making their own important contributions to watershed restoration. As SRF moves into our second generation, we want to recognize and celebrate the accomplishments of the past, while learning from our mistakes, and preparing ourselves for the challenges of the future. One of SRF's strategic goals is to represent restorationists on a state-wide basis. Hosting SRF's first conference in the San Joaquin Valley allows us to recognize the importance of the San Joaquin River to salmonid resources and the significance of the San Joaquin River Restoration Settlement Act in supporting the recovery of salmonid resources in the southern half of California's largest watershed. We hope the 26th Annual Salmonid Restoration Conference provides a forum to facilitate dialogue between land managers, government personnel, academics, and restorationists with a unified goal of restoring salmonid habitat throughout California.

Jodi Frediani

Salmonid Restoration Federation Board of Directors 2007-2008



Design & layout by Trees Foundation

Wednesday, March 5

Friday, March 7

Plenary Session: Central Valley Salmon and Steelhead: Restoration in the California Heartland

Friday Afternoon Concurrent Session 1

Recovery Planning Models

Friday Afternoon Concurrent Session 2

Friday Afternoon Concurrent Session 3

Friday Evening Poster Session

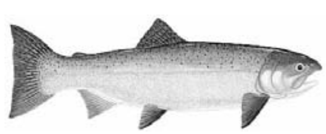
Saturday Morning Concurrent Session 1

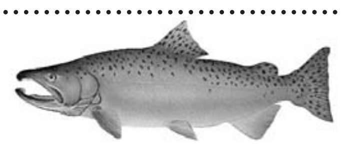
Hydrology, Native Salmon, and Geomorphology: Insights to Rehabilitating the San Joaquin River

Saturday Afternoon Concurrent Session 1

Saturday Afternoon Concurrent Session 2

Saturday Afternoon Concurrent Session 3





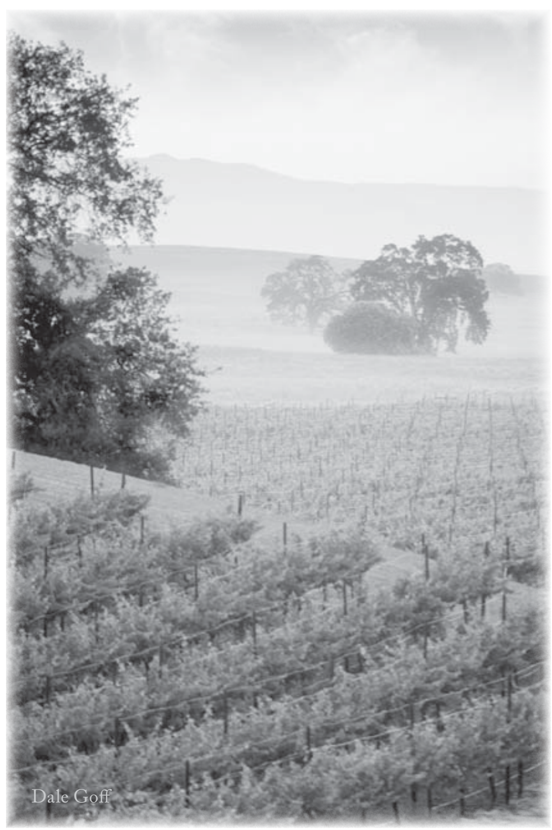
Fins and Zins Workshop and Tour

Wednesday, March 5

Workshop Coordinator*: Kent Reeves,* *Yolo County Department of Parks and Natural Resources*

Resource management professionals recognize the role of sustainable agriculture in the conservation of fish and wildlife. Therefore, understanding the sustainable management of livestock, winegrape, and walnut production can contribute to an overall benefit for fish and wildlife influenced by these three forms of agriculture.

Within the agriculture industry, California winegrape growers are considered leaders in the sustainable farming arena. However, how does one implement sustainable farming in one's own vineyard? The classroom portion of the workshop will address the challenges of sustainable winegrowing, which are: 1) Defining sustainability; 2) Implementing sustainable winegrowing practices in the vineyard; 3) Measuring progress at the individual vineyard level; and 4) Certifying growers who meet specific standards under the LODI Rules! Certification Program. Examples of sustainable winegrape growing adjacent to riparian areas will be discussed.



The Lower Mokelumne River Watershed, California: Vertebrate Species Richness and Biodiversity Conservation in a Vineyard Dominated Working Landscape

Kent Reeves, *Yolo County Parks and Resources Department* [1]

The lower Mokelumne River Watershed is a 28,000 hectare working landscape with greater than 70% of the land in agriculture production. Over 40% of the watershed is in vineyards, which account for 80% of the agriculture commodities produced in the region. The lower Mokelumne River potentially has 12 amphibian and 27 reptile species that may occur in the riparian habitat of the river. A herptefauna inventory identified 3,858 individuals of 16 species (three amphibians and 13 reptiles) during a four-year survey period. Over 200 species of birds have been identified along the riparian corridor in the past 20 years. A total of 112 bird species were detected on point counts over three years of surveys. A total of 16 species of raptors were identified during roadside surveys throughout the watershed from 1998 through 2002. Small/medium sized mammal populations were inventoried along the lower Mokelumne River from 2002 to 2004 using small mammal traps, track plates, coverboard arrays and drift fence arrays with pit traps. Potentially 43 small mammal species occur along the river. The inventory identified 1,136 individuals of 14 species during the survey period. This paper will discuss the collaboration and cooperation among stakeholders to develop a watershed stewardship plan; inventory methods to assess biodiversity; and conservation measures such as habitat restoration, conservation easements and the first programmatic Safe Harbor Agreement to protect, restore, and enhance biodiversity in California.

1 Co-Authors: James Jones, Michelle Workman, and James Smith, East Bay Municipal Utility District; Brook Edwards, Restoration Resources; and Andrea Pfeffer, PRBO, Conservation Science

Farmscaping: Design Considerations, Techniques, Issues

Sam Earnshaw, **Community Alliance with Family Farmers**

Hedgerows, grassed waterways, filter strips, and riparian restoration projects are increasingly being planted on farms and can have multiple functions: they can serve as habitat for beneficial insects, pollinators and other wildlife; provide erosion protection and weed control; stabilize waterways; serve as windbreaks; reduce non-point source water pollution and groundwater pollution; increase surface water infiltration; buffer from pesticide drift, noise, odors, and dust; act as living fences and boundary lines; increase biodiversity; and provide an aesthetic resource. Many plants attract native bees and other pollinators, and some hedgerow and windbreak plants, such as citrus or other fruit trees and herbal plants, can have economic returns. As with any planting, problems and issues can be dealt with through management practices. Most growers use plants that they individually like, and most report that they are pleased with the benefits that farmscaping brings to their farms.

Making the Case for Conservation-Based Agriculture

***Jo Ann Baumgartner**, Wild Farm Alliance*

With agriculture's dominant footprint on the landscape, it has a unique ability to support wild nature. As more farmers become familiar with regulations in place to protect our water, soil, native species and ecosystems, changes are happening on the ground. Both organic and conventional agriculture are profiting from and providing for biodiversity conservation. Protecting water quality is starting to become a standard concern of all California farmers. Moreover, conserving biodiversity is beginning to be an important issue on the 2.3 million acres of organic farms across the country. These positive changes are due to California water quality regulations and National Organic Program rules.

Restoration practices that address these concerns include re-contouring and establishing native grasses in ditches, planting natives in non-cropped areas of the farm, allowing native vegetation to prosper in marginal areas and augmenting it when possible, restoring natural areas on the farm invaded by non-native species, installing sediment basins replete with native plants, and planting structurally diverse habitat along springs, ponds, creeks, and rivers. Tall trees and mid-sized shrubs provide habitat for native pollinators and natural enemy insects, rodent-eating predators, and riparian dependent wildlife, while stabilizing soils. The shorter grasses help to slow water and filter out sediments and some nutrients. The riparian soils themselves break down many types of toxins. Farms can provide beneficial habitat within their borders, feed our local communities healthy food, and ultimately support connections to wildlands beyond—through the conservation and restoration of riparian buffers and corridors for clean water and the safe passage of animals to clear and free-flowing watersheds.

Lodi-Woodbridge Winegrape Commission

Clifford P. Ohmart, PhD, *Research/Integrated Pest Management Director, Lodi-Woodbridge Winegrape Commission*

There are three major challenges in sustainable farming: 1) Defining it; 2) Implementing specific practices; 3) Measuring its effects. The Lodi winegrape growers developed a sustainable farming program over the last 15 years to meet these challenges and their success has influenced the California wine industry as well as other agriculture commodities.

The Lodi-Woodbridge Winegrape Commission (LWWC) is a grower commission formed in 1991 by a vote of the winegrape growers in California Crush District #11. It is funded by an assessment on the annual value of growers' winegrape crops. There are currently about 750 LWWC member growers farming over 90,000 acres of winegrapes, which comprises about 20% of the winegrape production in California. Lodi winegrape growers set three goals when the LWWC was formed:

1. Differentiate Lodi in the marketplace as a producer of premium winegrapes and wine.
2. Fund research on local viticulture issues assisting Lodi growers to produce higher quality winegrapes.
3. Create and implement an area-wide sustainable winegrowing program.

The sustainable winegrowing program has evolved through a series of stages with each stage forming a component of the program. The first component is grower outreach and was initiated soon after LWWC was established. It consists of several types of meetings, research seminars, and field days, as well as a bi-monthly newsletter and website; *www.lodiwine.com.*

The second component was initiated in 1996 with LWWC being award a Biologically Integrated Farming Systems (BIFS) grant from the University of California Sustainable Agriculture Research and Education program. BIFS is a whole farm approach to management where a grower implements sustainable practices to manage their soil, water, and ecosystem in and around the vineyard, as well as pests. The BIFS grant is a demonstration project where growers implement sustainable farming practices in specific vineyards designated as BIFS vineyards. All the activities done in the vineyards, such as pest monitoring, pesticide applications, fertilizer applications, canopy management activities, floor management activities and yields, are recorded in a state of the art database and the results are summarized each year and shared with the participating growers. Furthermore these vineyards serve as sites for field days for all Lodi growers to come and observe the results of implementing specific sustainable practices. There are 45 growers and 70 vineyards in the BIFS program.

The third component was initiated in 2000 with the publication of the Lodi Winegrower's Workbook: A self-assessment of integrated farming practices. Growers use the workbook to: 1) Identify the good things they are doing in their vineyards; 2) Identify areas of concern in their practices either from an environmental or crop quality perspective; 3) Create an action plan to address these concerns; and 4) Develop a time table for carrying out this action plan. The Lodi Winegrower's Workbook has served as a model for a workbook that was developed for the entire California wine community, as well as for wine communities in other states such as Washington and New York.

The fourth component was initiated in 2005 and is a coming together of LWWC's goals #1 and #3. It is The Lodi Rules for Sustainable Winegrowing program, which is California's first third party-certified sustainable winegrowing program. Growers and wineries can use the program to add value to their winegrapes and wine.

Workshop Coordinators*: Louanne McMartin and Kim Webb, US Fish and Wildlife Service*

Habitat for Salmon: Preventing, Detecting, Monitoring and Managing Non-native Invasive Species

The goals of the workshop are to bring people together who are involved with the conservation and management of salmonids and water resources and NIS issues for the purpose of exchanging practical information on control, prevention, and eradication of NIS.

Summary:

- Presentations on NIS management tools.
- Resource materials to improve effectiveness in the field.
- Networking opportunities with practitioners, researchers and government officials.
    - º NIS plants such as *Arundo, Spartina* (cordgrass) *Tamarix* (salft cedar) and *R. armeniacus* (Himalayan blackberry) cause a loss of salmonid habitat by increasing sedimentation, crowding out other streambank vegetation and not providing shade cover for streams. NIS animals such as mudsnails impact the food chain of native salmonids and alter the physical characteristics of the streams. Presentations that address NIS control and restoration activities to improve habitat for salmonids will provide the latest known science on the control, removal and monitoring of these and other NIS.
- Training of HACCP planning for natural resource management.
    - º In natural resource work, equipment, personnel and organisms are often moved from one location to another. During transport, hitchhiking non-native invasive species (NIS) can inadvertently be translocated, setting the stage for a potentially new invasion. Hazard Analysis and Critical Control Point planning (HACCP) for natural resources managers is a planning tool that involves considering potential risks associated with operational logistics and specific pathways that could introduce NIS and other undesirables during routine activities.


courtesy Stockton Fish & Wildlife Service

Environmental Compliance Process for Conservation Projects

Ajay Singh, *Kearns and West*

Whether a project will construct a strip mall or riparian habitat the project is required to undergo an environmental compliance process. From landowners to watershed groups to local governments working on projects near rivers and streams, everyone may need to apply for permits. These permits can be daunting for many who have not gone through the process. Six to seven local, state, and federal regulatory agencies require consultation and permitting applications to complete non-native plant species (NNPS) projects. Additionally there are CEQA and NEPA documents that may need to be developed and put through the process. This presentation will give you an overview of what permits to apply for when implementing NNPS projects.

Hazard Analysis Critical Control Point (HACCP) as a Planning Tool that Identifies and Evaluates Potential Risks for Spreading Invasive Species

Jonathan L. Thompson, *Non-native Invasive Species Program, US Fish and Wildlife Service*

In salmon habitat restoration activities, invasive species and other foreign materials can be spread to new locations when equipment and gear contaminated with these "hitchhikers" are moved from one project site to another and by removal of barriers, invasive species access to habitat can be increased. HACCP is a planning tool for natural resource managers to identify specific pathways that pose a risk of spreading invasive species during work activities. In addition, HACCP identifies methods and procedures to reduce these risks. Participants will learn about the five simple steps of HACCP and how they can develop a HACCP plan for their organization and obtain assistance during their planning process.

Troubled Waters: Biological Invasion of Our Water Systems

***Kim Webb**, Project Leader, US Fish and Wildlife Service*

Throughout North America the spread of non-native species threatens the ecological integrity of forests, grasslands, and waterways and causes significant economic stress in our communities. Identification of aquatic nuisance species is key in addressing the threat to aquatic ecosystems and water delivery systems. This presentation will describe some high profile aquatic nuisance species in North America providing biological characteristics, life history, environmental requirements and the potential ecological impacts they pose.

Guidance on Minimizing Spread of Aquatic Invasive Species when Implementing Fish Passage Projects

Dave Hu, Habitat Restoration Coordinator, US Fish and Wildlife Service

After more than two centuries of building dams and other barriers on rivers and streams, the negative effects of barriers on fish and other aquatic species has emerged as one of the highest priority actions and needs for the restoration of diminished anadromous and inland fisheries in California. In addition, Aquatic Invasive Species (AIS) have set new pressing needs to address and effectively manage the spread and introduction of AIS into new areas. As such, projects designed to restore passage for fish and other aquatic species should be implemented where such reconnection would not result in a net negative ecological effect, such as providing increased habitat for the spread of aquatic invasive species.

Incorporating measures to prevent the risk and spread of NIS/ANS in fish passage projects will require careful planning and proper guidance to fish passage project practitioners. Hazard Analysis and Critical Control Point (HACCP) planning can serve as the primary tool for fish passage projects to minimize this risk of spreading AIS during project implementation. HACCP plans are intended to reduce the risk of AIS spread, but may not eliminate that risk. However, HACCP plans will provide the best strategy to minimize the risk of net ecological effect relative to anticipated risks of AIS.

Successful Techniques for Removing and Controlling Invasive Species.

***Daniel S. Efseaff** and **Christiana Conser**, River Partners*

Invasive plant species can compete with and displace native species that provide bank stability, shading for riverine habitat, instream large woody debris, and riverine nutrient input. River Partners has explored a variety of methods in the course of restoring over 4,000 acres in the Sacramento and San Joaquin Valley. We will present some successful strategies developed during these efforts to control annual and perennial invasive species and also during a demonstration project on Stony Creek to control giant reed or arundo (*Arundo donax*) and salt cedar or tamarisk (*Tamarisk parviflora, T. ramisissima*.) This session will provide a site and species specific approach for invasive plant removal, provide an overview of selected mechanical, biological, and chemical control techniques for large areas, and discuss the role of native plant establishment to prevent the spread of invasive species on three and nine-year old projects.

Habitat Restoration and Monitoring Projects on the Stanislaus River

Tour Coordinators: ***JD Wikert and Carl Mesick,*** *Anadromous Fisheries Restoration Program, US Fish and Wildlife Service;* ***Tim Heyne, Jason Guinard,*** *and* ***Fred Jurick,*** *California Department of Fish and Game; and* ***Jesse Anderson,*** *Cramer Fish Sciences*

The Stanislaus River is one of the three tributaries of the San Joaquin River which still support Chinook salmon populations. The river habitat has been severely degraded by large dams and gravel mining for both gold and aggregate. Restoration to date has focused on restoring spawning gravel which has resulted in increased fry production, but adult production numbers have declined, suggesting that restoration efforts are not addressing the correct limiting factor. Ongoing and future restoration projects are focused on improving the quality and quantity of juvenile rearing habitat.

The tour will visit restoration and monitoring sites on the Stanislaus River including the Lover's Leap site that created 25 riffles and used large boulders and woody debris to create side-channel habitat and a lower floodplain bench. Participants will see the Knight's Ferry site to view ongoing gravel restoration and the potential floodplain restoration project and discuss the basin temperature monitoring/modeling project, escapement surveys, habitat modeling, and the weir.

Fisheries Monitoring and Management Programs on the Mokelumne River

Thursday, March 6

Field Tour Coordinator*: Michelle Workman, East Bay Municipal Utility District*

The lower Mokelumne River supports populations of naturally reproducing fall-run Chinook salmon and Central Valley steelhead. The mitigation fish hatchery on site rears both species to mitigate for loss of spawning habitat associated with the construction of Camanche Dam. We will visit the hatchery facility and see how hatchery production plays a role in regulated river management. Wild population management is accomplished through a variety of projects aimed at increasing both spawning and rearing habitat for salmonids. We will visit a gravel restoration site aimed at increasing spawning habitat, and floodplain inundation potential and two engineered side channels designed to provide juvenile rearing habitat. Monitoring of wild fish populations' response to these on ground efforts is critical to evaluate the success and failure of projects. We will visit a juvenile migration monitoring station and discuss various aspects of fisheries monitoring on the river.


Michelle Workman

Thursday, March 6

Session Coordinators: ***Michael Love**, Micheal Love & Associates* and ***Steve Allen**, Winzler & Kelly*

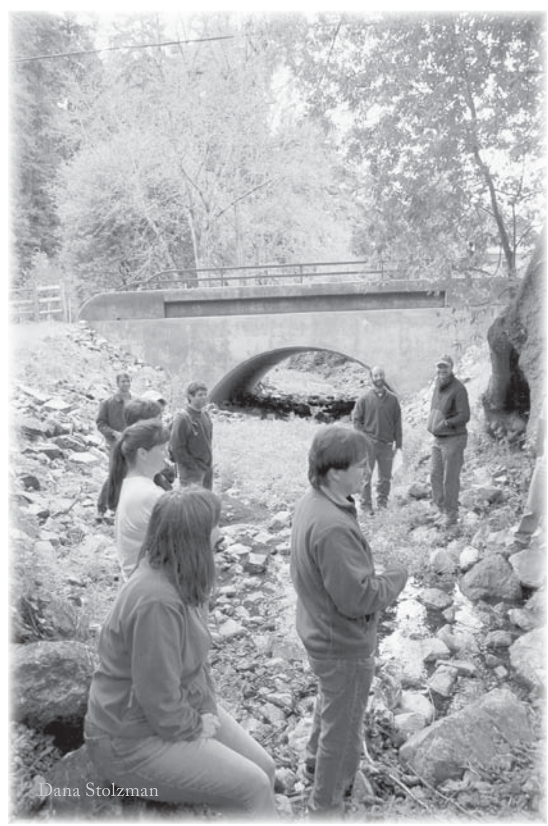
Fish Passage and Protection at Water Diversions and in Flood Control Projects followed by a FishXing Software Tutorial

Providing upstream fish passage and downstream fish protection on flow-regulated rivers and streams and in flood control channels is technically challenging. For upstream passage various types of fishways are often used, and screening of water diversions is a common means of protecting juvenile salmonids from injury, stranding, and predation as they migrate downstream. In flood control channels the challenge is to create suitable water velocities, water depths, and resting areas for the migrating fish while minimizing reduction of channel capacity. Solutions to these types of problems are categorized by California Department of Fish and Game as hydraulic fish passage designs, which must consider the hydraulic environment, sediment and debris loading, the swimming abilities and behavioral characteristics of the target fish, and the potential for increasing predation or poaching opportunities. Additionally, site and cost constraints frequently make it infeasible to satisfy all existing design criteria over the entire design flow range. Often the objective becomes one of maximizing the range of flows passage or protection can be provided. With all of these considerations, there is a substantial amount of uncertainty concerning the anticipated performance of a particular fish passage or protection project once constructed. Given that these types of projects are generally costly to implement, it is critical we examine and learn from previous projects to maximize the potential for success.

In this session speakers will present fish passage and protection projects on rivers and larger streams, with a focus on innovative design approaches, challenges of implementation, and lessons learned. Presentations will also emphasize the various elements that were, or should have been, considered in the project design phases.

In the mid-afternoon portion of the workshop attendees will be provided hands-on instruction into using the newest version of the FishXing software. This software is a tool to assist in the assessment and design for fish passage at stream crossing structures. FishXing allows for application of a hydraulic design approach, design of a roughened channel inside a culvert, or evaluation of a stream simulation type crossing. It can also be used to check the flow capacity of a new or existing culvert and evaluate the mobility of streambed material within a culvert.

Bring to the workshop a PC laptop, or share with other attendees. Before arriving, please load onto the computer the newest version of FishXing 3, available at FishXing.org. It will also be available on CD at the workshop.


Dana Stolzman

A Pugh Decision Matrix to Assist Fish Passage and Multi-Objective Planning —BART Weir, Alameda County

Kozmo Bates, P.E. *(presenter) and* **Emmanuel da Costa,** *Alameda County Flood Control and Water Conservation District*

Fish passage alternatives are compared at the BART Weir in Alameda County using a weighted decision matrix, or Pugh Method. The BART Weir is a complex restoration site with challenges that include a wide range of interests and objectives such as flood control, water supply, protection of infrastructure, and fish passage of ESA-listed steelhead.

The Pugh method is a common decision-support tool allowing decision-makers to make and compare alternatives in complex decisions. Objectives of the comparison were to assist the owner and stakeholders in their planning decisions including providing descriptions and assessments so the owner could be better informed for their planning decisions.

Four plausible options for fish passage improvements were compared: a composite vertical slot/pool-and-weir fishway, a reduced vertical slot fishway, a roughened channel fishway, and a pool and chute fishway. The concepts were markedly different in form and function and involved significantly different design approaches, which made the comparison difficult with this tool.

There are four steps to building a Pugh Method decision matrix. Desirable project characteristics were chosen and weighted based on their relative importance. Eighteen characteristics were split into six general categories: fish passage, operation and maintenance, water supply, design and construction, flood control, and other considerations. Each option was evaluated by how well it would achieve each characteristic. Each option was then scored for each characteristic as the product of the weight and the evaluation and the scores were summed.

Though the matrix provides a final relative score by which alternatives can be compared, the highest score may not represent the best option. Interested parties were encouraged to weigh characteristics independently depending on their roles with respect to the project so each entity might therefore have a different final ranking.

The intent was for the matrix to be a tool to explain the strengths, weakness, and differences among the alternatives rather than to just provide a discrete answer. Characteristics that have a large effect on the ranking of can be further investigated to discover how design alterations can affect the final ranking.

Addressing Fish Passage at Agricultural Diversions on the Scott and Shasta Rivers

***Marjorie Caisley, P.E.**, California Department of Fish and Game*

The California Department of Fish and Game (DFG) is undertaking over 30 fish passage projects at agricultural diversions in the Scott River and Shasta River watersheds through its Klamath River Restoration Grant Program. DFG has decided a more conservative approach to fish passage projects is needed in these watersheds because excessive scour and headcutting at several previously funded boulder weirs in the Scott watershed have recreated barriers to fish passage and there are no past or ongoing studies related to sediment transport or fluvial processes in these rivers. Previously funded fish passage projects replaced push-up gravel dams or flashboard dams with a single vortex shaped boulder weir with 0.4-0.8 feet of drop over it. The new methodology for fish passage projects involves using:

1. Weirs in series, with most downstream weir buried under creek bed
2. Weirs with graded rock aprons at 5% to 10% slopes
3. W-shaped weirs in wider channels with alternating bars

A sampling of the ongoing projects will be presented including the design considerations and conceptual plans, photos of projects during construction and qualitative results from the first migration and high flow seasons.

The Practicality of Migratory Barriers for Fish Species Management

George Heise, P.E., Sr. Hydraulic Engineer, California Department of Fish & Game

If so many roads and small diversion dams are barriers to fish migration, then why for species conservation management is it so difficult to design a barrier to prevent the unwanted migration of fish? This question will be explored along with the application of fish passage principles and criteria as they relate to fish barrier design. An overview of the design and construction of the Templeton barrier in the Golden Trout Wilderness will be presented.

Hydraulic Modeling and Evaluation of Fish Passage at Rock Vortex Weirs

Denis Ruttenberg, M.S., P.E., University of Idaho and Prunuske Chatham, Inc. [1]

In the Upper Columbia River basin, many streams are diverted for irrigation. Some diversion dams are considered to block passage of endangered salmonids to spawning and rearing habitat. In addition, water diversions affect natural cycles of discharge, substrate composition, sediment transport, and channel morphology. On Beaver Creek, a tributary to the Methow River, in north central Washington, the US Bureau of Reclamation replaced irrigation diversion dams with a series of rock vortex weirs, with the goal of passing salmonids and maintaining irrigation diversion. To evaluate the effectiveness of the project for fish passage at rock vortex weirs, a monitoring program was implemented. At the sub-watershed scale, temperature, discharge, and fish movement were monitored. At the site scale, discharge, temperature, channel topography, and substrate were monitored. A linear decoupled approach was applied to develop a four-mode hydraulic model that described flow over the rock vortex weirs as orifice flow, gap flow, weir flow, and rough boundary flow. Using this four-mode model and field observations, rating curves for hydraulic variables important to fish passage were developed and applied to continuous flow records at the study sites, resulting in a chronological record of critical hydraulic parameters. These data were combined with records of fish passage collected by the US Geological Survey's Columbia River Research Laboratory, allowing a comparison of field hydraulic conditions to observed fish migration. Hydraulic drops during fish migration periods were estimated from 0.11 to 0.27 m, compared to the fish passage guideline of 0.24 m, maximum. The ratio of pool depth to hydraulic drop ranged from 1.6 to 6.1, compared to guideline value of 1.5, minimum. Energy dissipation factors in the weir pools varied from 66 to 450 W/m3, versus a guideline of 250 W/m3, maximum. Cross section averaged velocity at the weir crest varied from 0.14 to 0.65 m/s, compared to a guideline of 0.37 m/s, maximum. Using these data, effectiveness of rock vortex weirs on fish passage was quantified by applying a grading scale from A to F to the percent of time over the migration season that hydraulic parameters met existing fish passage guidelines for culverts, as set by the National Marine Fisheries Service and the Washington Department of Fish and Wildlife. The rock vortex weirs demonstrated favorable performance in the first two years following their installation. Methods for application of the four-mode model and hydraulic parameter rating curves are suggested for design of rock vortex weirs, with a focus on upstream fish passage.

1 Co-Authors: Dr. Ing. Klaus Jorde, Stephen Clayton Ph.D, Patrick Connolly Ph.D, and Peter Goodwin Ph.D, University of Idaho

Fish Passage and Screening Design Interplay, Hydraulic Design Challenges of Diversions

Steven Allen, P.E., Winzler & Kelly

Flow diversions are common in California's rivers and streams. Diversions exist for many reasons, including water supply and irrigation needs. Some diversion structures have been in place for many decades and have resulted in barriers to the upstream migration of salmonids. Many of these instream structures function as low head dams, either as permanent structures or as temporarily installed flashboards for seasonal uses. Modifying or removing these diversion structures to improve fish passage while satisfying the water demand can prove challenging.

Maintaining the diversion is often a requirement due to established water rights. The diversion structures were originally put in place to make diverting water feasible. While they may not have been considering migrating salmonids, the hydraulic benefits of a diversion structure were clear. Diversion structures also tend to negatively impact natural processes such as sediment transport and channel morphology beyond the footprint of the structure. The necessity to maintain existing channel grades at the diversion point is often related to the low gradient of gravity diversion canals.

The operational goals and design guidelines for the hydraulic function of diversions can be at odds. Some water rights allow for the diversion of all flows over a minimal required base flow. Screening all flows can be near impossible, especially when dealing with large volumes of sediment and debris. Meeting the low velocity thresholds for diversion screens essentially translates into larger surface areas of screens for larger diversion flows. Many screens have limiting hydraulic head constraints that will not meet screening criteria when exceeded.

Providing upstream passage past diversion structures adds to the design complexity, especially if the structure's height can be modified with flashboards or other means. Varying head requirements make providing passage more difficult, often requiring more human manipulation of facilities, which can lead to reduced passage opportunities for salmonids. Site and cost constraints frequently make it infeasible to satisfy all existing design criteria over the entire design flow range. Under these conditions, the objective often becomes one of maximizing the range of flows that passage or protection can be provided. Project funding and permitting constraints can preclude the removal and reconstruction of an entire diversion facility. So designers are often faced with the challenges of maintaining as much of the original infrastructure as possible to minimize project costs. This presentation will use project examples to describe the hydraulic design interplay with fish passage and diversion projects.

Using New Approaches in Design of Resting Pools for Adult Steelhead within a Concrete Flood Control Channel: Corte Madera Creek, Marin County, California

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

Corte Madera Creek in Marin County flows through the towns of Fairfax, San Anselmo, Ross, Kentfield and Larkspur before entering San Francisco Bay. The creek historically supported runs of coho salmon and continues to maintain a run of ESA listed steelhead trout. The lower 3.9 miles of Corte Madera Creek is contained within a flood control channel designed and built by the US Army Corps of Engineers. Most of the flood control channel is tidally influenced and provides no impediments to migrating adult steelhead. However, the upper 2,400 feet of channel is above mean lower low tide, consists of concrete vertical walls and V-shaped floor, and designed for supercritical flow. Prior to construction of this channel reach in 1972, the potential of creating a steelhead depth and exhaustion barrier was recognized. As a result, 28 rectangular pools spaced 64 feet apart were included in the channel. Each pool is four feet long and 13 feet wide. The pool bottom is flat and placed about an inch below the lowest point in the channel. The outside edges of the pools are 15 inches deep due to the V-shaped bottom. Examination of the flow patterns within the pools combined with observations of steelhead swimming within the channel suggests the existing pools are undersized and provide little to no resting habitat during typical migration flows.

The Friends of Corte Madera contracted Michael Love & Associates and Jeff Anderson & Associates to assess steelhead passage conditions within the present channel configuration and then develop conceptual designs for improving the resting pools and locating pools in such a way as to enable fish to get up the channel over a wide range of stream flows. The project team used several innovative approaches to address the problem, including (1) using volunteers to record field observations of flow conditions and fish movement, (2) development of a 2-D hydrodynamic model to analyze existing hydraulic conditions and evaluate the hydraulic performance for different resting pool alternatives, (3) development and application of a population based fish routing and energetics model to evaluate fish passage conditions and determine preferred pool spacing, and (4) use of a 1-D HEC-RAS model to evaluate potential impacts of the preferred pool design and spacing on water levels during the design discharge of 5,400 cfs.

Issues addressed in the project include attempting to provide upstream passage for an acceptable proportion of the overall steelhead population at migration flows, minimizing pool sedimentation, minimizing impacts to flooding, and ensuring the proposed alternatives were constructible. This presentation will go through the alternatives development process with a focus on how combining 2-Dimensional hydrodynamic modeling and population based fish passage modeling can provide valuable insight during the design process.

The full report is available at the
Friends of Corte Madera website:
http://www.friendsofcortemaderacreek.org/.

Restoring Seasonal Floodplains of the Central Valley by Meeting Multiple Ecological Objectives

Thursday, March 6

Workshop and Field Tour Coordinator*: Joshua Viers,*
Information Center for the Environment, University of California, Davis

Floodplains are among the most productive and diverse ecosystems on Earth and are now being recognized globally for the ecosystem services they provide. However, they are also one of the more impacted ecosystems globally and are at risk of further degradation by a fusillade of anthropogenic stressors and consumptive demands. Natural floodplain ecosystems are a product of, and adapted to, highly variable hydrologic regimes—typified by droughts, catastrophic floods, and frequent periods of inundation—expressed across seasonal, yearly, and decadal dimensions. This hydrologic variability acts to reset various biotic populations within aquatic, riparian, and wetland ecosystems through disturbance, acting as an essential ecological process in maintaining complex ecosystem pathways. Multipath ecological relationships, expressed as trophic food webs or transition states, promote high biodiversity and biological integrity. In floodplain ecosystems, these ecological relationships are underpinned by the fundamental relationship between floodplains and river systems, forming a critical linkage that creates and maintains a mosaic of habitats for groundwater recharge, primary productivity and biogeochemistry, the reproductive cycle of fishes, nesting and foraging of birds, and regeneration of riparian vegetation.

In the workshop, we will use the experimental restoration of the Cosumnes River floodplain to examine watershed dynamics and modeling (L Rodriguez), primary production in seasonal flooding regimes (E Grosholz), salmonid reproduction on floodplains (C Jeffres), and riparian vegetation dynamics (J Viers.) For the field tour, we'll examine sites of experimental levee breaches, seasonal floodplains, and restored riparian forests located at the Cosumnes River Preserve. Botanists and birders will accompany this tour for a multidisciplinary excursion.

courtesy Robertson-Bryan, Inc.

Hydrologic, Geomorphic, and Ecological Tools for Setback Floodplain Design: Lessons learned on the Bear River and Feather River Levee Setback Projects

Eric Ginney (presenter,) Elizabeth Andrews, P.E., Chris Bowles, Ph.D, Chris Campbell, Andrew Collison, PhD, and John Stofleth, Philip Williams and Associates, Ltd.

Floodplains that are regularly inundated for extended periods during certain times of the year are important for their high production of organic matter and invertebrates as well as for the provision of seasonal spawning and/or rearing habitat for native fishes. A recent CALFED-sponsored study identified criteria for the flow associated with such floodplains, the "floodplain activation flow" or FAF. The study hypothesized that there is very little remaining FAF floodplain in California's Central Valley because of a combination of flow regulation, channel incision and levee construction. As a result of development on floodplains, there may be few areas where FAF floodplains can readily be restored without either dramatic changes in reservoir management, levee setbacks, or substantial alteration of floodplain topography. Those areas where FAF floodplains can be restored should be high priorities for the restoration community since they offer floodplain function benefits across a broad range of flood magnitudes and support essential ecosystem functions and anadromous fish habitat.

Two such sites exist: one at the confluence of the Feather and Bear Rivers between Sacramento and Yuba City, where an initial levee setback was implemented along the Bear River in 2006 as part of a multi-objective flood control and habitat restoration project; the other is along a six-mile reach of the Feather River upstream of the Feather/Bear confluence where a larger levee setback project is currently under construction. Both levee setback projects represent opportunities for combining better flood management with significant ecological restoration.

This presentation shows some of the analytical tools PWA is using to maximize the restoration potential of levee setback projects. These include: the identification of a "Floodplain Activation Flow"—the flood elevation associated with greater potential for salmonid rearing on the floodplain; the use of two-dimensional hydrodynamic and sediment transport modeling to optimize geomorphic function and habitat restoration and assess the potential for unintended consequences for erosional and depositional effects of the setback projects on floodplain management; and an assessment of historic meander migration rates to plan levee setbacks and better understand habitat dynamics.

The authors also intend to discuss how levee setbacks such as these examples are likely representative of the most-significant opportunities in future. As they are one of the few ways of achieving both increased flood protection and habitat restoration, such projects provide multiple benefits to society and therefore illustrative of one of the most-promising solutions to the present levee integrity/flood management crisis in California.

Floodplain Restoration on the Lower Cosumnes River

Larry Rodriguez *(presenter) and* ***Satya Gala Ph.D,*** *Robertson-Bryan, Inc.*

Recent floodplain management planning on the lower Cosumnes River has focused on integrating the river's natural flow regime with restoration of its historic floodplain. The Cosumnes River, which is largely unimpaired, provides a unique opportunity to re-establish connection between the river and its historical floodplain to improve fisheries and riparian habitat conditions.

The evaluation and planning of potential floodplain restoration actions has been completed as a component of the Cosumnes and Mokelumne River Floodplain Integrated Resources Management Plan and the Cosumnes River Preserve Management Plan. Floodplain modeling performed using FLO-2D, a two dimensional software package, evaluated alternative floodplain configurations and levee removal over five miles of river channel and 10 square miles of floodplain. Evaluation of alternative configurations was guided by the goals and objectives set forth by the Cosumnes River Preserve and focused on restoration of riparian oak woodlands, which historically dominated the area. This historic environment supported both terrestrial and aquatic species, and has recently been shown to provide the same benefits in nearby restoration sites.

Hydrologic analyses and floodplain modeling indicate that the project can be successful in meeting annual inundation frequencies and flood durations that supports riparian regeneration, flood and drainage patterns that minimizes fish stranding, and not net-impact criteria for adjacent landowners. The design of the restoration project is incorporating sustainable land features and scientific evaluation protocols for monitoring riverine and riparian processes and surface water/groundwater interaction in the floodplain.

Ephemeral Floodplain Habitats Provide Best Growth Condition for Juvenile Chinook Salmon in the Lower Cosumnes River

Carson A. Jeffres *(presenter,)* ***Jeff J. Opperman,*** *and* ***Peter B. Moyle,*** *University of California, Davis*

The authors reared juvenile Chinook salmon for two consecutive flood seasons within various habitats of the Cosumnes River and its floodplain to compare fish growth in river and floodplain habitats. Fish were placed in enclosures during times when wild salmon would naturally be rearing in floodplain habitats. The authors found significant differences in growth rates between salmon reared in floodplain and river enclosures. Salmon reared in seasonally inundated habitats with annual terrestrial vegetation experienced higher growth rates than those reared in a perennial pond on the floodplain. Growth of fish in the non-tidal river upstream of the floodplain varied with flow and turbidity in the river. When flows and turbidity were high, there was little growth and high mortality, but when the flows were low and clear, the fish grew rapidly. Fish displayed very poor growth in tidally influenced river habitat below the floodplain, a habitat type to which juveniles are commonly displaced during high flow events due to a lack of channel complexity in the main-stem river. Overall, ephemeral floodplain habitats supported higher growth rates for juvenile Chinook salmon than more permanent habitats in either the floodplain or river. Variable responses in both growth and mortality, however, indicate the importance of providing habitat complexity for juvenile salmon in floodplain reaches of streams, so fish can find optimal places for rearing under different flow conditions.

The Response of Aquatic Food Webs to Floodplain Restoration

E. D. Grosholz, Department of Environmental Science and Policy, University of California, Davis

Restoring critical ecosystem functions on river floodplains requires understanding how the timing of the flood cycle dictates food web processes. Although we know generally that floodplains are tightly controlled by the flooding cycle, we know little about how predator-prey dynamics are influenced by the frequency, magnitude, and duration of flooding in highly seasonal floodplains typical of California. We report on the seasonal dynamics of the Cosumnes River floodplain in central California over a three-year period. We compared changes in abundances, size distributions, and fatty acid signatures of aquatic producers and invertebrate consumers through the flood season (January–June) with seasonal changes in the abundance of larval and juvenile fishes. Using diet analysis of fishes and manipulative feeding experiments with fishes in field enclosures, we link specific changes in invertebrate populations directly to feeding preferences of seasonally abundant fish. We also examine patterns of primary and secondary production as a function of floodplain residence time. Early in the flood season prior to March, we found little influence of fish predation, consistent with the near absence of larval and juvenile fishes during this period. Coinciding with the midseason increase in the abundance of larval and juvenile fishes in April, we found significant declines in zooplankton abundance as well as declines in the size of zooplankton consistent with fish feeding preferences. Our results were consistent with results from feeding enclosure experiments. As the flood season ceased, zooplankton abundances rapidly increased, as juvenile fish switched to insect prey. Within the floodplain, sites with higher residence time had increased biomass of zooplankton richer in ALA and EPA fatty acids. However, residence time was correlated with DOC (and bacterial production) which resulted in reduced DHA levels and food quality for fishes. Overall, we found that zooplankton biomass on the floodplain reached a maximum 2–3 weeks after disconnection with the river. We suggest that floodplain restoration in this region should consider management strategies that would ensure repeated flooding every 2–3 weeks during periods that would best match the peaks in abundance of native fishes.

Removal of Eight Earthen Dams, and Restoration of Geomorphic Processes on Dominici Creek, Tributary to the Tuolumne River, Stanislaus County, California

Scott English *and* ***Steve Koskella****, Northwest Biological Consulting*

In 2005, the un-permitted construction of eight large earthen dams on Dominici Creek, created over 8,000 lineal feet of impounded water, up to 20 feet deep in steep sided canyons lands, and changed the channel geomorphology along a two mile reach of the creek. In 2006 the subsequent failure of three of the largest dams (which averaged 40 ft. high X 110 ft long X 45 ft. thick) resulted in the sudden release of water causing catastrophic impacts which resulted in geomorphic changes to the Dominici creek channel and severe impacts to the Tuolumne River into which the creek flows. The major changes included:

1. Aggradation of the stream channel due to sediment deposition, including impacts to downstream salmonid habitat in the Tuolumne River.
2. Widening of the channel due to large slope and bank failures.
3. Modification of the flow regime.
4. Destruction of riparian and wetland vegetation.

A "Clean-up and Abatement Order" was issued by the California Regional Water Quality Control Board requiring that the conditions of the creek that existed before the construction of the dams be restored.

The following restoration elements were completed in order to comply with the "Clean-up and Abatement Order":

- An approved "Work Plan" was developed in order to guide the restoration work.
- Five large earthen dams and three partial breached dams were removed which included approximately 30,000 cubic yards of compacted earth and other dam materials.
- Approximately 25,000 cubic yards of earthen material over a two mile reach was reshaped according to the channel geomorphology into steep and complex sinuous channels and banks that existed prior to the construction of eight dams.
- 13 major slope failures were reshaped and stabilized to fit the existing channel morphology
- Two miles of Dominici Creek channel was planted with a variety of native riparian trees, shrubs, and emergent wetland vegetation.
- A variety of clean-water by-pass systems and other BMP's were utilized to maintain water quality permit standards throughout the project.
- All the restoration work was inspected and approved by a variety of state and federal regulatory agencies.

Tuolumne Restoration and Implementation Tour

Thursday, March 6

Field Tour Coordinator*: Scott McBain,* *McBain and Trush*

Over the past 10 years, considerable work has been done to rehabilitate physical habitat in the Tuolumne River downstream of the lowermost dams. Restoration efforts have included coarse sediment augmentation, spawning gravel augmentation, floodway expansion, channel reconstruction, gravel mining pit filling, riparian plantings, and fine sediment reduction efforts. Millions of dollars has been spent on these habitat restoration efforts, yet fall-run Chinook salmon escapement continues to decline, resulting in "soul searching" and acknowledgement by many that our restoration strategy may need to be revisited.

This field tour will start out with an overview of the fishery flows and overall restoration strategies of the Tuolumne River and will visit several restoration sites where specifics of restoration approach, design, monitoring, and assessment can be discussed as a group. Tour sites will include the SRP 9 gravel pit filling project, the 7/11 floodway restoration project, the LaGrange coarse sediment augmentation project, and the Gasburg Creek fine sediment reduction project.

Rita

by Alison Blehert-Koehn

Rita is a true story based on the filmmaker's childhood. Brought up in a worldwide whirlwind of adventure by her outdoor photographer/travel-guide parents, Alison Blehert-Koehn's early life was filled with the stuff of dreams. It was not until the family set out on an expedition to Mt. Everest, however, that seven-year-old Alison was able to experience her own dream. (USA, 2007, 6 minutes)

courtesy The Fresno Bee

Tales of the San Joaquin

by Christopher Beaver

The San Joaquin River has been called the hardest working river in America and also the most abused. Follow filmmaker Christopher Beaver down the 350 miles from the source near Yosemite National Park, to the point where its waters flow into San Francisco Bay. Once the birthplace of hundreds of thousands of salmon, the river is now completely dry year round. The recent San Joaquin River settlement agreement marked the end of 18 years of litigation and the beginning of an ambitious effort to restore 150 miles of the second largest river in California. *www.cbfilms.ne*t (USA, 2005, 27 minutes)

Oil and Water Project

by Seth Warren

Two kayakers embark on an endless summer-style 35,000 km road trip from Alaska to Argentina in a retro-outfitted Japanese fire truck without a single drop of petroleum. They converted their regular diesel engine to run on everything from pig lard to palm pulp and they traveled for nine months in pursuit of the best whitewater in the Americas. The pair coordinated with schools, local governments, farmers, agricultural research centers, and media to conduct demonstrations advocating for the use of alternative energy all along the way. Best Environmental Film, Taos Mountain Film, Everest Award Recipient for Advocacy. *www.oilandwaterproject.org*. (USA, 2007, 34 minutes)

The Edge of Eden: Living with Grizzlies

by Jeff & Sue Turner

Jury Award—Wild & Scenic Film Festival. Grizzly bears are considered by many to be the most dangerous animal in the world. But there is one man, Canadian Charlie Russell, who thinks differently. He believes that grizzlies are misunderstood animals and that our fear of them is not only unnecessary but driving them to extinction. His beliefs have taken him to Russia, where he has raised orphaned grizzly bear cubs for the past ten years in the wilderness of the Southern Kamchatka Peninsula. Multiple awards. *www.cloudline.org* (Canada, 2006, 89min)

Salmon in 2100: Some Recovery Strategies that Just Might Work

Robert T. Lackey, *National Health and Environmental Effects Research Laboratory, US Environmental Protection Agency*

The primary goal of the Salmon 2100 Project is to identify practical options that have a high probability of maintaining biologically significant, sustainable populations of wild salmon in California, Oregon, Washington, Idaho, and British Columbia. The Project does not support or advocate any particular policy or class of policies, but provides decision makers and the interested public with a diverse set of independently developed, practical policy prescriptions with reasonable prospects of restoring significant wild salmon runs. The Project enlisted 33 scientists, policy analysts, and policy advocates, all well versed and experienced in salmon science and policy. Most policy prescriptions can be sorted into one of four general categories: (1) technological intervention often accompanied by a recalibration of the notion or definition of what is a "wild" salmon; (2) triage approaches that would concentrate recovery efforts on areas where successful recovery is most likely; (3) revamped salmon recovery bureaucracies and institutions including jettisoning "symbolic politics" pervasive in salmon policy; and (4) changed individual and societal behaviors. The policy prescriptions developed as part of the Salmon 2100 Project are likely to produce ecologically viable results, though most are much more socially disruptive than current recovery strategies.

Springing Back Chinook Salmon and Other Native Fishes to the San Joaquin River

Peter B. Moyle, *Center for Watershed Sciences and Department of Wildlife, Fish, and Conservation Biology, University of California, Davis*

Historically, the lower San Joaquin River supported at least 14 species of native fish, of which only seven have been noted in recent surveys, all with limited abundance and distribution. Spring-run Chinook salmon are the iconic missing species for restoring the San Joaquin River and their restoration will be a major step in protecting the Central Valley spring-run Chinook salmon ESU and in bringing the southernmost population of Chinook back to life. A restoration strategy has been worked out by a technical advisory committee, which demonstrates that we can bring Chinook salmon runs, provided flows and funding for infrastructure fixes are provided. The presence of the required (by court order) 'natural' flow regime for spring-run Chinook salmon will provide habitat for a wide array of native and non-native fishes. In particular, there should be a long reach of stream dominated by a fairly complete assemblage of native fishes, as has happened in Putah Creek in Solano and Yolo Counties. The assemblage could contain as many as 10 species of native fish. Most will be recruited from existing local populations but some, such as hardhead and tule perch, will have to be reintroduced. There may also be an opportunity to establish a population of Sacramento perch, now extirpated from its native range. Maintaining native anadromous and resident fishes will require active management of the river and riparian areas, beyond just the flow regime.

Living in Interesting Times: New Challenges for Salmon in the Delta

***Christina Swanson**, Senior Scientist, The Bay Institute*

The Sacramento-San Joaquin Delta is the crossroads linking California's largest watershed, the west coast's largest estuary, and one of the world's largest and most complex water management systems. It is also the common migration corridor for California's largest salmon runs. For the past several years, gathering scientific evidence has indicated serious problems in the Delta: the ecosystem and its key fisheries are collapsing, water quality continues to decline, and water export operations and local land use activities are threatened by island levees increasingly vulnerable to catastrophic failure. Prompted by multiple legal challenges and unprecedented agreement among scientists, resource managers, water users and policy makers that current management of the Delta is unsustainable, a number of multi-disciplinary efforts to plot a new future for the Delta have begun. Most of the alternative visions for the future Delta that are being proposed are based on using different strategies for conveying water destined for export through (or around) the Delta—and all of them have implications for salmon. In this presentation I will discuss the potential opportunities and pitfalls these future Delta "visions" pose for the Sacramento-San Joaquin watershed's salmon and describe some of the scientific tools that are being developed to evaluate both the broad proposals and specific restoration and protection actions.

Watershed Bills and Watershed Moments

***Jared Huffman**, California State Assembly Member*

Elected in November 2006, Jared Huffman represents the 6th District, which includes all of Marin County and the Southern Sonoma County. Assembly member Huffman has been a watershed champion sponsoring several legislative bills including *AB 1338, 1489,* and *1457* that would increase funding for local coastal programs, allow greater access for underserved rural and environmental justice communities to the Integrated Regional Watershed Management Planning process, and address parks and recreation respectively.

As a senior attorney for the Natural Resources Defense Council (NRDC) and as president of the Marin Municipal Water District Board of Directors, Assemblyman Huffman worked to protect Marin County's creeks, fisheries and drinking water for 11 years.

Assembly member Huffman believes that the fisheries restoration field needs to be represented in the legislature in order to advocate for habitat restoration funding, conservation, and protection for imperiled salmonids. An empowered citizenry enables legislators to make positive strides.

A Basic Strategy for Steelhead Recovery in South-Central and Southern California

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

In 1997 the National Marine Fisheries Services (NOAA Fisheries) listed two distinct sub-populations of steelhead (*Onchorhynchus mykiss*) within the southern half of coastal California: a threatened sub-population along the south-central coast and an endangered sub-population along the south coast; the range of the southern sub-population was extended to the US-Mexico border in 2002.

The shape of Recovery Plans for these sub-populations turns on a series of questions regarding the number, size and distribution of anadromous runs; and the role which various life- history types (fluvial anadromous, freshwater resident, lagoon anadromous) play in the persistence of the populations necessary to achieve recovery of the listed species.

NOAA Fisheries Science Center and a Technical Recovery Team has characterized the historic populations of steelhead from the Pajaro River to the Tijuana River, and developed viability criteria for the recovery of these two distinct sub-populations of *O. mykiss* within the southern half of coastal California. For purposes of recovery planning, NOAA Fisheries TRT has divided the northern distinct population segment up into four biogeographic regions, and the southern distinct population segment into five biogeographic regions, based on a suite of hydrologic, geologic, and climatic conditions.

Prescriptive viability criteria address mean annual run size of individual populations, ocean cycles affecting marine survival and growth, spawner density, the anadromous fraction of an *O. mykiss* population complex, the number of populations per biogeographic region, protection of drought refugia, geographic separation of populations within biogeographic regions, and preservation of life-history diversity. A number of the prescriptive population criteria (e.g., run-size, anadromous fraction) are uncertain, and are subject to refinement based upon further research and monitoring.

Recovery of the endangered Southern California Coast Steelhead DPS will require recovery of a sufficient number of viable populations (or sets of interacting trans-basinal populations) within each of the biogeographic regions to conserve the natural diversity (genetic, phenotypic, and behavioral), spatial distribution, and resiliency of populations in the face of natural stochastic processes, and thus the long-term viability of the distinct population segments as a whole. Achieving this goal will require a number of closely coordinated activities, including further research into the diverse life-history cycles and adaptations of southern steelhead to a semi-arid and highly dynamic environment (including the ecological relationship between resident and migratory populations); monitoring of existing populations; and the completion and implementation of a recovery plan.

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

Planning for Recovery of Central California Coast Salmonids

***Charlotte Ambrose**, Recovery Coordinator, North Central California Coast Recovery Domain, National Marine Fisheries Service*

NMFS' Santa Rosa field office is developing draft recovery plans for federally threatened or endangered Central California Coast (CCC) coho salmon, Northern California (NC) steelhead, CCC steelhead, and California Coastal (CC) Chinook salmon. NMFS is requesting information, data and pertinent publications from the public to inform planning and the development of recovery criteria that are site specific, objective, and measurable. Data and information we are seeking includes (1) species status, (2) distribution, (3) habitat conditions, (4) trends, (5) future threats, and/or (6) other information relevant to identification/reduction of factors limiting recovery of salmonids. The specific types of freshwater/estuarine information includes, but is not limited to: summer and winter habitat typing, stream temperature, flow conditions (all life stages), barriers to passage (all life stages), estuarine conditions, instream impairment by substrate and/or fines, water quality, food supply, riparian structure and composition, ecological processes across watersheds, and abundance/distribution/density information for spawners, juveniles and smolts. NMFS is additionally requesting information on anticipated future stresses to habitats, conservation actions in place or expected and the influence of anticipated natural events on habitat conditions.

NMFS is using The Nature Conservancy's (TNC's) conservation action planning (CAP workbook) process as the foundation to the recovery plans for these species. You can learn more about the TNC approach at their website: *http://conserveonline.org/workspaces/cbdgateway/cap*. TNC's CAP workbook provides a consistent, transparent, and measurable approach for assessing current watershed habitat conditions, assessing future threats (both habitat stresses and sources of the stress) and developing strategies (e.g., recovery actions) that link to poor conditions and the highest threats. To inform the CAP process we are compiling the best available information for all watersheds for the species in the Domain beginning with the CCC coho salmon watersheds. For more information on the list of current priority watersheds and the format of how the freshwater habitat information will be input into the TNC CAP workbook template please visit the NMFS recovery planning website at *http://swr.nmfs.noaa.gov/recovery/NCCC.htm*.

Public review and comments on the draft recovery plans should be anticipated in late 2008 when we plan to hold workshops and publish Federal Register Notices.

While all formats of data will be accepted, we prefer electronic format on CDs mailed to the address below. If data are in a zipped drive or requiring minimum space an email is acceptable and should be sent to the following address: *_CentralCoastCoho.RecoveryPlan@noaa.gov* (please note the underscore at the beginning and period between Coho. Recovery or the email will not work.) Metadata, where available, would be greatly appreciated, as it would streamline incorporation of data directly into the recovery plan. We will accept data in all forms (e.g., GIS format, excel spreadsheets, PDF or word documents.)

National Marine Fisheries Service c/o NCCC Domain Recovery Planning 777 Sonoma Avenue, Rm. 325 Santa Rosa, California 95404.

Participation in Hydro Relicensing as a Tool for Furthering NOAA Fisheries Mission

Steve Edmondson, *NOAA Fisheries, Habitat Conservation Division*

In many California watersheds, such as the Sacramento and San Joaquin, (Central Valley) dams block as much as 95% of historic salmonid spawning habitat. As a result, Chinook salmon and steelhead are extirpated from approximately 5,700 miles of their historic habitat in the Central Valley. In most cases the habitat remaining is of much lower quality than the habitat lost and is subject to further degradation by direct and indirect impacts of hydroelectric operations. Non-federal, FERC-licensed dams account for approximately 40% of all surface water storage in Central Valley.

There are 122 FERC licensed hydroelectric projects in California. Of this total, there are 42 project licenses that are either currently undergoing relicensing or will expire between 2000 and 2010. In general, relicensing is initiated five to eight years prior to license expiration. Accordingly, workload is expected to increase rapidly in the next few years.

With the term for FERC hydropower licenses generally running from 30 to 50 years, hydropower dams in California present unique challenges to anadromous fish. According to a 1994 study by the Department of Energy, upstream passage/protection facilities are present at 6.7% (out of a total of 450 plants) of FERC licensed hydroelectric projects and downstream passage/protection/mitigation facilities are present at 9.3% (42 plants.) Many of the existing passage facilities perform poorly. Additionally, many hydropower facilities significantly decrease streamflow, impair water quality and destroy important fish habitat, causing serious harm to anadromous fish.

Sections 18 and 10(j) of the Federal Power Act (FPA) assign to NOAA Fisheries broad, and in the case of section 18, mandatory authorities for protecting fish. Consequently, the FPA provides a powerful vehicle for achieving fishery management and species recovery goals by reintroducing viable fish runs to historic habitat; enhancing existing runs through habitat improvements within a river basin; and the timely and safe passage of fish around hydropower projects. Because of the unprecedented number of relicensings in California, FERC's shift to the collaborative process, and growing interest in decommissioning, NOAA Fisheries faces a unique opportunity to apply our FPA conditioning authorities more comprehensively. By affording fish access to viable habitats denied for decades a realizable potential exists to restore fish to their historic range where dams have reduced or extirpated salmonid stocks. Further, by improving flows and other key habitat components NOAA Fisheries can increase utilization of the remaining important key coldwater habitat necessary for the stabilization and recovery of many stocks of wild salmonids.

Assimilating and Rating Aquatic Habitat and Upland Data to Support Recovery Planning of ESA Listed Salmon and Steelhead

Patrick Higgins, *Klamath River Information Systems* [1]

The National Marine Fisheries Service (NMFS) is developing a Recovery Plan for a number of Pacific salmon species along the entire West Coast. The NMFS Arcata, California office began using the Conservation Action Planning (CAP) workbook model, developed by The Nature Conservancy, to support development a recovery plan for the Southern Oregon/Northern California coastal (SONCC) coho salmon Evolutionarily Significant Unit (ESU.) NMFS contracted with Kier Associates scientists in 2006 to gather extensive regional field data concerning aquatic habitat and upland conditions into a custom Microsoft Access database to inform the CAP workbook and to provide a quantitative assessment of salmonid freshwater habitat quality and the risk of upland contributions of pollution. By using reliable data from all available sources, and by drawing reference values primarily from the scientific literature, NMFS can provide a collaborative tool for a number of agencies having parallel missions.

The Kier Associates science team had already completed a number of Klamath Resource Information System (KRIS) database projects covering more than a dozen watersheds within the California portion of the SONCC (see *www.krisweb.com*.) Additional regional data were added, but only large datasets that applied to significant portions of the SONCC and that were collected using standard scientific methods. The Northern California SONCC CAP is a suite of 45 CAP Excel workbooks, one for each historical coho population identified by NMFS scientists.

The customized Microsoft Access database stores region-wide data for all aquatic habitat data (indicators) and for upland conditions that might degrade salmon habitat (sources-of-stress.) Custom Python computer programs are used for the data preparation and to populate the CAP workbooks. The data are tagged with spatial coordinates, including stream name, reach codes (LLID), and sub-basin identification so that workbooks for finer- or coarser-grained spatial units can be produced as needed. To ensure transparency, all data in the Access database have been tagged with their source of origin and associated with available metadata. To help review the aggregated data, an Excel workbook is provided that contains box plot charts for each type of data (temperature, turbidity etc.), so that outliers can be identified and patterns in the data can be easily determined.

The reference values used for scoring aquatic habitat quality and the risk of pollution from upland disturbance are based on a comprehensive literature review. Kier Associates prepared a document explaining these reference values. The document was reviewed thoroughly by NMFS staff and other agencies participating in salmon recovery in northern California and southern Oregon.

The SONCC CAP application was funded in part by the California Department of Fish and Game, which is an active partner in coho salmon recovery. Kier Associates began a second project, in August 2007, to support NMFS recovery planning for steelhead in the South Central and South Coastal California steelhead ESUs.

1 Co-Authors: Eli Asarian and Dr. Jan Derksen, KRIS, Kier Associates,

Informing Recovery Planning: Habitat Modeling for Coho Salmon, Chinook Salmon, and Steelhead in California and Southern Oregon

Ethan A. Mora, University of California, Santa Cruz [1]

As an initial step towards Endangered Species Act (ESA) recovery efforts, NOAA Fisheries utilized GIS-based habitat models to describe the potential historical distribution of eight threatened or endangered salmonid Evolutionarily Significant Units (ESUs) throughout California and southern Oregon.

In northern coastal California and southern Oregon, NOAA modeled the distribution of three species, coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*O. tshawytscha*) and steelhead (*O mykiss*.) For these species, a model was implemented that was developed by the Coastal Landscape Analysis and Modeling Study (CLAMS) that predicts the intrinsic potential for stream units to exhibit suitable habitat based on gradient, valley constraint, and mean average flow using suitability curves that describe the response of each species to these variables. In addition, a temperature mask was developed to examine possible impacts of temperature on historical fish distribution in these areas. For *O. mykiss*-bearing watersheds in the Central Valley and central through southern California, the research team modified various aspects of the model to account for differences between the Oregon coast (for which the CLAMS model was developed) and these areas.

In support of regional salmonid restoration efforts, NOAA Fisheries would like to make these GIS datasets available to the public. This presentation will offer examples of these data, describe habitat quantification methods, and provide examples of how these data have informed recovery efforts.

1 Co-Authors: Eric Bjorkstedt, Steve T. Lindley, Brian Spence, David Boughton, and Tommy Williams, NOAA Fisheries

Federal ESA Recovery Planning in the Central Valley Domain

Diane Windham, *Supervisory Resource Management Specialist and Central Valley Domain Recovery Coordinator, National Marine Fisheries Service*

The National Marine Fisheries Service (NMFS) is the Federal agency with regulatory jurisdiction over ESA-listed anadromous salmonids. Thus, NMFS is responsible for developing recovery plans for these species. In California's Central Valley, recovery planning efforts address winter-run and spring-run Chinook salmon and Central Valley steelhead. Key components of the recovery plan include: (1) criteria for population/species viability; (2) assessment of population-based and habitat-based threats; (3) recovery criteria and site-specific management actions that will reduce or eliminate identified threats; and (4) an assessment of costs of implementation. The draft recovery plan for California's Central Valley salmonids is due to be completed in early 2008 with a final plan anticipated in summer 2008. In addition to the development of numerous technical documents that form the foundation of the plan, multiple public workshops have been held in the Central Valley to facilitate public involvement in the process. The resultant draft recovery plan will present a blend of the scientific and policy/management recommendations to achieve recovery of these listed fish.

Dam Removal and Modifications for Salmonid Recovery

Friday Afternoon Concurrent Session 2

Session Coordinator*: Matt Stoecker,* *Stoecker Ecological*

The construction of migration barriers within our watersheds has decimated salmon and steelhead populations throughout California and beyond. Dams, with their associated reservoirs and downstream water releases, represent some of the most limiting factors to salmonids within most watersheds by blocking historic spawning and rearing habitat, degrading downstream habitat conditions, providing safe havens for exotic species, and dramatically altering a watersheds hydrology. Restoring self-sustainable populations of salmonids in watersheds with dams is a challenge. As many dams fill with sediment, become safety hazards with age, and come up for relicensing, unique opportunities to remove or modify these structures to enable salmonid recovery have gained increasing support. This session will showcase dam removal success stories, discuss the evolving science of dam removal, present unique opportunities on the horizon, and show how dam removal or modification can enable recovery of salmon and steelhead populations.

The Very Hungry River: Spectacular Geomorphic Response of the Sandy River to Removal of Marmot Dam

Gordon E. Grant *(presenter,) USDA Forest Service, Pacific Northwest Research Station* [1]

This is an initial report on the impressively rapid fluvial response to the first dam removal involving significant release of sediment. Marmot Dam, a 15 meter concrete diversion dam located on the Sandy River, east of Portland, Oregon, was removed in the summer of 2007. Removal of the concrete structure required construction of a temporary cofferdam composed of sediment upstream of the main structure. This report focuses on the sequence of geomorphic events accompanying breaching of this cofferdam in October 2007, and accompanying erosion and transport of much of the one million cubic meters of sediment stored behind it. The breach occurred during a modest rainstorm and rising hydrograph and was initiated by removal of groundwater pumps that had kept phreatic surfaces within the dam low, and excavation of a small notch at the crest of the cofferdam. Notch position was chosen based on physical models that indicated where an initial breach would lead to maximum erosion of stored sediments.

Time-lapse photographs and videos taken during the breach sequence permit reconstruction of geomorphic events leading up to and following the breach and subsequent erosion of the cofferdam. Prior to notch excavation, rising groundwater levels within the dam led to extensive piping and small mass movements across the dam face. Incision of the dam face by water flowing through the notch was initially quite slow but accelerated markedly as the notch widened and deepened. Small (< 1m in height) knickpoints formed in the channel flowing down the steep dam face; these migrated upstream over time and began to coalesce into larger knickpoints of 1-3 m. The knickpoint located at the notch itself at the crest of the dam did not migrate upstream until erosion of the dam was well advanced and extremely intense, at which point the knickpoint migrated rapidly (~ 10 m/min) upstream. Initially the knickpoint migrated as two distinct arcuate lobes, one moving directly upstream, the other at an oblique angle towards the opposite bank, but the upstream-oriented lobe incised more rapidly, reducing flow over the other knick, which stalled and became an emergent terrace. Upstream migration and incision of the knickpoint, and accompanying channel widening was extremely rapid and efficiently eroded a large fraction of the stored sediment. Within 12 hours following the breach, there was little trace of the cofferdam and only a few remnant mid-channel and marginal bars. The channel through the former reservoir and downstream was transformed from a coarse, stable, cobble-bed channel to a very actively braiding sand-bed channel. Aggradation immediately downstream of the dam was on the order of 2-3 m. Bedload and suspended load measurements were taken at a cableway located 200 m below the dam throughout the breach sequence and record the passage of both a sand and gravel wave. The author will also report on initial analysis of the continuing measurements of both sediment transport and channel morphology being made throughout the winter of 2007-2008.

1 Co-Authors: Jim O'Connor, US Geological Survey, Oregon Water Science Center; Jon J. Major, US Geological Survey, Cascade Volcano Observatory; Rose Wallick, Barbara Burkholder, and Sarah Lewis, Department of Geosciences, Oregon State University

The Promising Role of Dam Reoperation and Dam Removal in the Restoration of Salmonids in the San Francisco Bay-Delta and Central Valley Watersheds

Ann Hayden, Senior Water Resource Analyst, Environmental Defense

Recent events have confirmed what water policy insiders and many elected officials in California have long realized: the ecological health of the Sacramento-San Joaquin Bay Delta and Central Valley watersheds is in serious decline and the entire system faces grave future threats associated with possible levee failure and sea level rise. Populations of both the Bay-Delta's resident fish and the salmon and steelhead that pass through the Delta en route to and from spawning grounds in Central Valley streams have significantly declined. Efforts are currently underway to evaluate improvements in the state's water management system to both improve reliability and resilience of water supply and avoid further ecological deterioration of the largest and one of the most valuable deltas on the Pacific Coast of the Americas. Reservoir reoperation has long been considered an effective tool, when properly applied, to help recover salmonids by rebalancing existing and new water supplies and improve the efficiency of existing uses. Today, as factors such as population growth, with its commensurate demand for more water, better understanding of the environmental impacts of water development, and changing laws and values, have gained attention, incentives have been created to evaluate how existing facilities can be best be reoperated for both better water management and ecosystem recovery.

Spurred by lawsuits and legislation, actual and threatened, over the past fifteen years, many state, federal and local agencies have taken action to restore self-sustaining populations of salmonids in watersheds via reservoir reoperation or dam removal. There have been varying levels of success. Much of the environmental water promised by the CALFED Bay-Delta program, especially the Environmental Water Account and the Central Valley Project Improvement Act's 800,000 acre-feet of dedicated yield, has not been provided to help fisheries as intended. On the other hand, after an Environmental Impact Statement, a lawsuit and subsequent administrative follow-up, the Trinity River is getting the water intended for it. The limited funding for the ecosystem restoration component of the Trinity plan, however, is slowing completion of the river's restoration plan. The CVPIA and CALFED have led to dam removal projects on Clear Creek and Butte Creek, and there are plans, albeit not much action at present, to remove dams on Battle Creek.

We must learn from these recent experiences, as we evaluate and pursue alternative strategies both to improve California's water supply system and to reoperate reservoirs, while perhaps removing a few, for the benefit of salmonids in the San Francisco Bay-Delta and Central Valley Watersheds. If we fail to learn from mistakes made in the past, we will be doomed to repeat them.

Matilija Dam: Implications of Dam Removal on Floodplain and Watershed Management

Paul Jenkin, *Surfrider Foundation and Matilija Coalition*

The Matilija Dam Ecosystem Restoration project includes dam removal and watershed management intended to restore fish passage to the upper watershed and natural sediment transport to nourish coastal beaches. Project design constraints include water supply and floodplain management, as well as environmental considerations.

Planning for the removal of Matilija Dam is based upon the fundamental objective of restoring the natural sediment transport regime. This has significant implications in the semi-arid climate of southern California, where consideration is required for the management of sediment without disruptions to water supply. The Ecosystem Restoration project includes extensive re-engineering of water diversion facilities, as well as modification of levees and bridges. With continued funding, deconstruction of Matilija Dam will begin in 2009 and will be one of the highest dams ever removed.

Removing Searsville Dam—Restoring San Francisquito Creek

Matt Stoecker, *Director, Beyond Searsville Dam and Stoecker Ecological*

Located within the Jasper Ridge Biological Preserve and owned by Stanford University, Searsville Dam was built between 1889-1891 and is the largest dam in the San Francisquito Creek watershed. The concrete dam measures approximately 64 feet in height and 240 feet in length. Fish passage facilities were never built and all releases flow down the face of the dam. Approximately 1.5 million cubic yards of sediment have accumulated behind the dam, reducing the original 350 million gallon capacity by almost 90%. Currently, the dam is obsolete as a water diversion source and provides no electricity or flood control benefits.

Searsville Dam causes several negative impacts to one of the last wild runs of threatened steelhead trout in San Francisco Bay, including but not limited to: blocking access to miles of former spawning and rearing habitat, the interruption of suitable spawning gravels downstream, and harboring exotic predatory species that compete with and prey upon native wildlife while spreading to downstream habitats. These and other impacts harm steelhead and other aquatic species by causing significant elimination and degradation of habitat that impairs essential life stages, including breeding, rearing, and migration. Dam removal would allow for the recovery of steelhead to over ten miles of historic habitat upstream in the streams flowing through Woodside and Portola Valley, restore the now submerged Confluence Canyon and meeting place of five creeks, reestablish historic wetland ponds currently buried under the dam and reservoir, eliminate exotic fish and frog species that occur in Searsville Reservoir, and eliminate the safety liability and costs of maintaining this over-a-century old structure adjacent to the San Andreas Fault and its mostly sediment filled reservoir.

Across the country and world, dams that have outlived their usefulness are being removed to restore ecosystem health, reduce safety risks, comply with environmental regulations, save money, and revitalize communities. Stanford University has a unique opportunity to be a leader in the emerging field of dam removal study while promoting native ecosystem restoration at their Jasper Ridge Biological Preserve. In addition, San Francisco Bay wetland restoration projects have a need for "clean and local" sediment that could be provided with Searsville Dam removal offering a unique dual restoration opportunity.

The group Beyond Searsville Dam was recently formed due to the expressed need for an independent group promoting the investigation of removing the Searsville Dam. BSD is advocating for restoration of steelhead and a free flowing San Francisquito Creek through removal of Searsville Dam in a safe manner that is consistent with protecting creekside communities and watershed resources.

Removing Klamath River Dams: One Small Step for a Utility, One Giant Leap for a River

Steve Rothert, *Director of American Rivers' California Office*

For that past seven years, stakeholders in the Klamath River basin have been struggling with the utility PacifiCorp through the Federal Energy Regulatory Commission hydropower relicensing process over the fate of the company's four Klamath River dams. Conservation groups, tribes and resource agencies have argued the dams' costs outweigh their benefits and removing them would be the single most important restoration action for the recovery of the Klamath and the communities that depend on it. PacifiCorp has argued they are committed to keeping them because they provide low cost, low carbon power for its 1.6 million customers.

The dams block access for salmon and other anadromous fish species to over 300 miles of historic habitat; they impair downstream water quality; and they promote vigorous summer blooms of toxic algae in project reservoirs, among other adverse impacts. Moreover, studies indicate it will cost PacifiCorp customers more to install fish ladders, screens and other environmental and safety measures required for a new FERC license than it would to tear the dams out and replace their generation with renewable energy sources.

Klamath River basin stakeholders are on the cusp of reaching a historic settlement agreement that will resolve many of the disputes that have plagued the basin for decades. Notwithstanding PacifiCorp's public statements to the contrary, many believe the company will come to agree that it should join this effort and voluntarily retire its uneconomic and harmful Klamath hydro project. Taking this seemingly obvious step would propel the Klamath River far along the path toward recovery.

Dam Removals Large and Small, How Best to Learn from Them All?

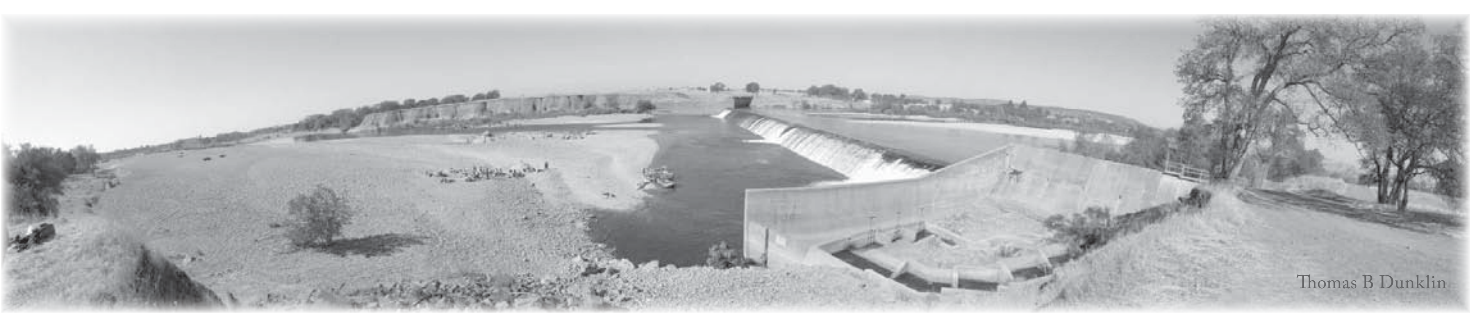
Marcin Whitman, *California Department of Fish and Game*

Large dam removals continue to be considered and small dam removals continue to be performed in California, largely driven by aging infrastructure and endangered salmonid habitat needs. Although large and small dam removals often have different technical issues and considerations, there is still a surprising amount of overlap in core issues, and especially process, for successful removal. Authors will explore the common ground between large and small removals and discuss how tools such as the Clearinghouse for Dam Removal Information at UC Berkeley—*http://www.lib.berkeley.edu/WRCA/damremoval/*—can help these efforts inform each other.

Central Valley Chinook, Steelhead and Trout

Session Cordinator*: Cindy Charles,* *Conservation Chairperson, Golden West Women Flyfishers*

The rivers of California's vast Central Valley were once the place to find numerous and spectacular Chinook salmon runs in four different upstream migration seasons: fall, late fall, winter, and spring. The mighty steelhead trout traveled even further upstream into the remote creeks of the Sacramento and San Joaquin River drainages. Now, the salmon runs are a shadow of what they were and the Central Valley steelhead are listed as a threatened species. However, there is a strong movement to protect and restore what we have left. This session will highlight some successful Chinook salmon restoration projects as well as the most recent research of steelhead/rainbow trout ancestry. Current fishery restoration practices will also be discussed including a new computer tool for water management decisions as pertains to fish. This session will provide attendees with a multi-faceted picture of salmonid recovery efforts in the Central Valley. The results of these projects will certainly contribute to the landmark restoration of the great San Joaquin River.



Thomas B Dunklin

Yuba River Salmon: Status and Challenges

Gary Reedy, *South Yuba River Citizen's League*

The Yuba River has unique status among salmon rivers of California, and provides special opportunities for recovering threatened populations of spring-run Chinook, steelhead and green sturgeon. In surprising contrast to the history of watershed devastation by placer mining, the Yuba River is the last large river in the Central Valley with persistent wild stocks of salmon and steelhead. One of only four extant and independent populations in the Central Valley, spring-run salmon of the Yuba River are at high risk of extinction due to a lack of habitat and influence of hatchery strays. Cooperative management via the Yuba Accord provides exceptional monitoring data and evaluation opportunities. This presentation will explain four key challenges to restoring anadromous fish populations in the Yuba River, including full fish passage at Daguerre Point Dam, habitat restoration in the Gold Fields, and gains of cold water through FERC relicensing. For more information, go to *www.saveyubasalmon.org*.

Butte Creek Salmon and Steelhead Restoration—Can Salmonid Restoration and Hydroelectric Operations Coexist?

Allen Harthorn, Executive Director, Friends of Butte Creek

Butte Creek, located just outside of Chico in the Sacramento Valley, has the largest run of spring-run Chinook salmon in California. Since 1995, the average run has been nearly 10,000 fish per year. It wasn't always so. In 1987 only 14 fish returned. Two actions, increased flows released from the Pacific Gas and Electric hydro project in critical holding and spawning areas in 1992, as well as improved flows and fish passage at the more than 20 agricultural dams in the valley in the late 1990s, have helped the fish to rebound.

Despite record runs returning to Butte Creek, the population has been seriously reduced by the summer deaths of hundreds and sometimes thousands of spring-run salmon that are listed as threatened by both State and Federal agencies. PG&E operates the DeSabla-Centerville hydroelectric project on Butte Creek, which includes an inter-basin transfer of water. During the summer of 2002, as PG&E completed the drafting of the shallow Round Valley Reservoir on the West Branch of the Feather River, temperatures in the import water coming into Butte Creek hit lethal levels. This triggered a disease outbreak that caught all the agencies by surprise. Recognizing the problem, the agencies, most notably NOAA Fisheries, encouraged PG&E to consider alternatives to keep the fish alive in 2003. Unfortunately, DFG nixed any efforts in 2003 and simply did a better job counting the mortalities. Once again, lack of management led to over 11,000 salmon mortalities before spawning in 2003, leaving only 6,000 of a 17,000 fish run to spawn.

Others feel quite differently about the situation. The Friends of Butte Creek, California Sportfishing Protection Alliance, Sacramento River Preservation Trust, Pacific Coast Federation of Fisherman's Associations, Friends of the River, Northern California Council Federation of Flyfishers, and Earthjustice have annually filed 60-day notices of intent to sue for failure to protect these spring-run salmon from the harmful effects of PG&E operations. Over the last several years, summer weather conditions have been much better and some PG&E operational changes have helped moderate water temperatures reducing mortalities to several hundred a year.

The DeSabla-Centerville hydroelectric project on Butte Creek is currently undergoing relicensing with the Federal Energy Regulatory Commission, and efforts are underway to ensure that these fish have the best chance possible to survive. Butte Creek spring-run salmon have shown up in the Feather River, Battle Creek and Clear Creek indicating that they may be the source population to help with recovery in other watersheds. The fish's value to all of us is something we are barely able to recognize. For more complete population data visit the website of Friends of Butte Creek and stay tuned for our online Salmoncam; *www.buttecreek.org*

Ancestry and Origins of *Oncorhynchus mykiss*, Steelhead/Rainbow Trout in the Central Valley Inferred from Population Genetic Analysis

John Carlos Garza *(presenter) and* ***Devon Pearse,*** *Southwest Fisheries Science Center*

The Sacramento/San Joaquin river basins of the Central Valley are inhabited by fish of the species *Oncorhynchus mykiss*, which are commonly known as steelhead when they are anadromous and rainbow trout when they are not. *O. mykiss* are ubiquitous in the basin and are found above and below dams, and other barriers to anadromy. However, the genetic relationships of fish found above and below these barriers, and throughout the basin, are generally unknown. Further complicating matters is that hatcheries have been operating in the basin for more than 100 years and have raised and released fish from a wide variety of broodstock sources, including trout from distant river basins and those collected in the Central Valley as both anadromous steelhead and resident rainbow trout.

The authors use population genetic data and analyses to investigate the relationships between populations of *O. mykiss* in the Central Valley. Fish populations were sampled by the California Department of Fish and Game from 10 tributary rivers, as well as from hatcheries. Fish were sampled both above and below dams in four tributaries. The authors genotyped nearly 1500 fish using 18 highly variable microsatellite genes. The authors use both population—and individual-based analyses to investigate the relationships of these populations with one another and to estimate movement between them. The authors also examine patterns of genetic diversity and determine the extent to which hatchery trout are present in stream populations above and below dams.

Conservation and Restoration of Central Valley Native Trout: Issues, Actions, and Research Needs

Lisa C. Thompson *(presenter,) Wildlife, Fish, and Conservation Biology Department, University of California Davis, and* ***Larry C. Forero*** [1]

Rainbow trout are the main native trout species in California's Central Valley. Bulltrout were once present in the McCloud River, but have been extirpated there. Many rainbow trout populations in the basin are grouped as resident rainbow, and two groups of sub-species, the upper Kern redband, and upper Sacramento redband occupy tributaries at the northern and southern ends of the Central Valley. While rainbow trout are widespread in the Central Valley their future is by no means secure. Challenges come from the growing human population and its impacts, including dams, diversions, stream channelization, levees, water pollution, introductions of non-native fish species and hatchery-bred trout, and land conversion from forest to agriculture, rural-residential, and urban uses. Climate change also threatens native trout, mainly through impacts on annual hydrographs and water temperatures. As summer air temperatures in the Central Valley increase, stream temperatures will also increase, with lower reaches of streams becoming less habitable, and trout populations may be compressed into headwater refuges. Dams and diversions complicate this potential response of trout to climate change, by hindering upstream movement. I will present results from several studies to illustrate many of these impacts. Projects include a multi-year study of rainbow trout distribution and habitat use in Cow Creek, a tributary of the Sacramento River near Redding, impacts of dams and flow regulation on rainbow trout in the upper American River watershed, and impacts of climate change on salmonids in Butte Creek. I will also discuss potential management practices that may ease these impacts and assist in compensating for the effects of climate change. Adaptive management experiments can be used to integrate research questions into ongoing monitoring programs, and to test the response of habitats and trout to different management policies, such as altered flow regimes below dams, and improved tailwater management practices.

1 University of California Cooperative Extension, Shasta County

The Sacramento River Ecological Flows Tool (SacEFT): A Tool for Evaluating Water Management Operations Effects on Sacramento River Fish Populations

***Ryan Luster**, The Nature Conservancy* [1]

In the summer of 1999, TNC initiated a study to investigate whether regulation of the Sacramento River's flow regime by dams, diversions, levees, and other infrastructure was resulting in limitations to natural cottonwood tree recruitment. This study provided TNC with a better understanding of when and how cottonwoods regenerate along the river, including how much river flow would be required to "mimic" the flow patterns needed to regenerate streamside forests.

TNC also began to study the Sacramento River's flow regime as it relates to large-scale water management and planning efforts that have the potential to affect riparian ecosystems. These efforts include the proposed North of Delta Off Stream Reservoir, raising Shasta Dam, and new diversions and water transfers. Water use planning for the river system currently attempts to balance the social and economic needs of agricultural production, flood protection, municipal and industrial water supply and power generation. A full understanding of the operational impacts of these projects is currently limited by a lack of ecosystem information that could help inform a multiple benefit project design—ideally, one that meets human water demands while providing ecological benefits. To better inform these management decision processes, TNC has developed a water management and riparian system decision analysis tool.

The Sacramento River Ecological Flows Tool (SacEFT) is a computer tool developed as one component of TNC's Sacramento River Ecological Flows Study. The purpose of the SacEFT is to improve water use decisions on the Sacramento River, incorporating physical models of the river (historical and simulation scenarios of discharge, temperature and gravel augmentation) with biophysical habitat models of six "focal" species: Chinook salmon, steelhead, green sturgeon, bank swallows, western pond turtles, and Fremont cottonwood.

This presentation will present the functionality of the SacEFT software and results from directed Sacramento River flow regime analyses as it pertains to salmon, steelhead, and green sturgeon populations.

1 Co-Authors: Mike Roberts, The Nature Conservancy, and Clint Alexander, ESSA Technologies Ltd

Factors Influencing Chinook Salmon Production in the Lower Tuolumne River

Carl Mesick, *US Fish and Wildlife Service,*
and ***Dean Marston*** *and* ***Tim Heyne***, *California Department of Fish & Game*

The production of fall-run Chinook salmon in Tuolumne River has declined from an average of 18,946 fish during the Central Valley Project Improvement Act, Anadromous Fish Restoration Program's (AFRP) baseline period from 1967 to 1991 to an average of 8,941 fish between 1992 and 2006, a 53% decline. In contrast, the goal of the AFRP is to increase production to about 38,000 fish. In addition, the escapement has dropped to 500 fish or less from 2005 through 2007. The low number of spawners does not reach the level believed to be necessary (e.g. >1,000 spawners) to protect the genetic integrity of the Tuolumne River fall-run Chinook salmon run nor does it produce enough fry to maximize smolt production. In fall 2004 and 2005, substantially more adult salmon returned to the Stanislaus and Merced rivers than to the Tuolumne River, and so it is likely that the decline in the Tuolumne River salmon population is at least partly due to degraded conditions within the Tuolumne River.

Since 1992, several types of restoration actions have been undertaken in the Tuolumne River to increase adult escapement abundance. The actions include elevated instream flows, filling or isolating in-river gravel pits with populations of predatory black bass, and adding gravel to improve spawning habitat quantity and quality. Other actions in the Delta to protect migrating juvenile salmon include timed pulse flows from all three San Joaquin tributaries, installation of the Head of the Old River Barrier, and reductions in Delta export levels usually between mid-April and mid-May. Ocean harvest rates have also been reduced in recent years. However, in spite of these actions, salmon production has declined in the Tuolumne River. From a management perspective, better understanding of how these actions influence fall-run Chinook salmon abundance in the Tuolumne River is necessary to focus precious limited restoration resources (e.g. time and money.)

Recently, state and federal fish agency scientists developed a conceptual model of the stressors that affect fall-run Chinook salmon production in the Tuolumne River. This model evaluated the trends in juvenile and adult salmon abundance in response to various flow releases and restoration actions and prioritized them in order of population level response. Of the restoration actions assessed (e.g. instream flow, ocean harvest, spawning habitat, and entrainment), improving the magnitude and duration that high flows inundate highly vegetated floodplain habitat during the rearing and smolt outmigration period (i.e., February through June) is the action that appears most likely to increase adult fall-run Chinook salmon production in the Tuolumne River. Presumably, floodplain inundation provides food resources, refuge from predators, improved water quality, and suitable water temperatures for rearing and outmigrating juveniles. Restoration actions should primarily focus on improving instream flows as well as restoration of riparian vegetation and connectivity between the river and floodplain (e.g. add gravel to raise hydraulic controls and remove levees and dredger tailings) to make substantive progress toward the doubling goal for the Tuolumne River.

Results of a Two-Year Fish Entrainment Study at Morrow Island Distribution System in Suisun Marsh

Cassandra Enos and Jessica Sutherland, Department of Water Resources, and Matthew Nobriga, CALFED Science Program

Suisun Marsh is a significant fish nursery. Long-term monitoring has shown declines in many Suisun Marsh native fishes. Water diversions may be one factor contributing to declining fisheries. There are 366 known water diversions in Suisun Marsh; only 2% are screened to exclude fish. Few data are available regarding fish entrainment dynamics in Suisun Marsh. The purpose of this study was to provide fisheries data on the Morrow Island Distribution System (MIDS) diversion to inform managing agencies on screening needs and water diversion operations that minimize fish entrainment. We sampled fishes in diverted water and adjacent channels weekly to monthly during September 2004 to May 2005, and October 2005 to June 2006. Fishes collected from diverted water reflected species behavior and seasonal abundance patterns much more than variation in water diversion operation. Two species that associate with structure, threespine stickleback and prickly sculpin, comprised most of the entrained fish. Entrainment of open-water fishes was very low (<1% of total catch) and entrainment of special-status open-water fishes was exceptionally low (2 Chinook salmon and 1 delta smelt.) Multiple age-classes of splittail were common in Goodyear Slough, but we only observed occasional, seasonal catch of age-0 splittail in diverted water. Although the MIDS intake is capable of diverting water through three 1.2 m culverts, it is rarely operated to full capacity, typically diverting less than 20% of capacity. Its large conveyance capacity is primarily utilized for drainage, not diversion. The largest diversions occur in late fall-early winter, when fish densities are at annual lows. Therefore, current MIDS operations provide some protection against entrainment.

A Century of Riparian Change in the Lower Mokelumne River

Brook R. Edwards, *Restoration Resources,* ***Steven J. Steinberg,*** *and* ***Kent A. Reeves***

Riparian ecosystems are spatially and temporally dynamic systems shaped by fluvial and upland geomorphic processes. Restoration of these ecosystems requires an understanding of how the river's channel, floodplain and vegetation have changed due to natural processes and human alteration. This project conducted a time series spatial analysis (1910- 2001) of the lower Mokelumne River (LMR) using riparian-stream metrics to characterize the structural attributes of the riparian system. Historical aerial photographs and maps of the study area were rectified and important structural attributes of the river were quantified. Results of the study indicate that over 70% of the LMR floodplains have been cleared of riparian forest and shrub communities. Fragmentation of the riparian buffer ranged from a low of 3% to over 80%. Mean width of woody vegetation reached a low for most reaches in 1963, while lateral composition metrics indicate a high percentage of riparian forests were converted to agriculture. All secondary channels were removed from the floodplain and over 80% of seasonal lakes were converted to agriculture. Channel width of reaches 1 and 2 declined, while reaches 3 and 4 increased. In addition, the natural pulse of instream flow from spring snowmelt in the upper reaches has been reduced by over 80% for the month of May, and bankfull discharge has experienced similar reductions. Currently, riparian vegetation adjacent to the river has regenerated in many areas and indicates a promising trend for restoration of the riparian buffer. Based on measurements from 1927, restoration efforts should strive to reduce buffer fragmentation to 5% or below, with a mean width of at least 30 m. The first 20-30 m of the buffer should be composed of at least 75% riparian forest and 20% riparian shrub. Restoration efforts can be monitored by applying the same set of metrics to future vegetation maps of the riparian corridor and correlations between vegetation structure and indicator species (fish, birds, mammals) can be investigated.

Modified Inventory and Assessment Form for Large Woody Debris in Four Central California Streams

***Michelle A. Leicester** and **Jerry J. Smith**, Department of Biological Sciences, San Jose State University*

To inventory large woody debris (LWD) in four central California streams, we modified the California Department of Fish and Game's inventory form by: 1) identifying upslope and channel wood to species; 2) separating upslope habitats into three zones: perched (within or at the edge of the bankfull channel), riparian (differentiated stream-dependent vegetation, with width determined), and upslope; 3) separating the channel into lowflow and bankfull zones for tallies of inchannel wood; 4) indicating the effect of LWD on habitat features (logjams, pools and backwaters); 5) indicating location(s) and probable source of channel wood; and 6) using symbols to indicate logs within jams, "old" conifer pieces, leaning trees, multi-trunked trees, downed trees with rootwads, and downed live trees. Procedures were also altered by tallying wood in large jams even if they were not located in the 200 foot sample areas. The modified form required little additional time during stream LWD surveys, but provided substantially more detail about sources, types and values of LWD.

Inchannel wood in the lower reaches of all 4 streams was mostly small diameter, short-duration alder, while upstream reaches were dominated by larger, "old", persistent redwood. Gazos and Waddell creeks had about twice as much inchannel wood as Scott Creek, primarily because much of the surveyed length of Scott Creek was bordered by flood plains dominated by alders. However, even Scott Creek had 10 times as much wood as Soquel Creek, a more developed watershed were wood removal occurs. Otherwise the patterns in the 4 streams were quite similar. Much of the wood was within the bankfull rather than the lowflow channel, and a majority of the wood was "extra" wood that was not creating backwater or pool habitats. This was particularly true of smaller hardwood pieces, unless they were "caught" by large wood as part of large or small log jams. Pools and backwaters were formed primarily by large (>2' diameter) long (>20') conifer logs and rootwads. Much of the inchannel wood was concentrated in a relatively few large logjams. Throughout the streams, even in reaches where most upslope trees were conifer, most potential natural wood recruitment was from small diameter perched alders. Large conifers are apparently recruited episodically in years such as the El Nino winter of 1997-98, when landslides deliver upslope trees to the channel and floods erode stream banks.

Enhancement does not require importing logs to the streams. Much of the "extra" wood already present can be moved within the channel to locations (bends, existing debris jams) where it can enhance habitat values. Since large conifers are rarely recruited, immediate benefits could be provided by cutting and pulling or dropping large (>2' diameter and > 2X bankfull width in length) conifers into the channel for habitat and to serve as "catcher" logs for mobile small wood. Rare, severe events provide abundant new wood; rapid response in those particular years can manipulate the new wood within the channel to improve habitat.

Upstream Fish Passage at a Resistance Board Weir Using Infrared and Digital Technology in the Lower Stanislaus River, California

Jesse T. Anderson, Clark B. Watry, and Ayesha Gray, Cramer Fish Sciences

Cramer Fish Sciences used a resistance board weir equipped with an infrared scanner and digital camera (Vaki RiverWatcher) to collect abundance, run timing, and biological data from salmonids and other incidental species in the Stanislaus River, a tributary to the San Joaquin River, California. The weir was installed on September 8, 2006 and operation ceased on June 25, 2007. During this period, we counted 3,078 Chinook salmon (*Oncorhynchus tshawytscha.*) Peak passage (27% of entire run) occurred on November 13 and 14. Biological data, including species, sex, length, and scale samples were collected from 64 Chinook salmon captured in the weir's live trap. Using the RiverWatcher, we determined sex ratio and adipose fin presence for all Chinook salmon. Females comprised 52% of the escapement population while 2% of the population had adipose fin clips, indicating coded-wire tag (CWT) presence. The average total length of male and female Chinook salmon without fin clips was 821 mm and 745 mm, respectively. In all, 12 *O. mykiss* were also counted during the sampling period; average total length was 455 mm for these fish. Other fish species counted at the weir included 3,388 Sacramento sucker (*Catostomus occidentalis*), 451 Sacramento pikeminnow (*Ptychocheilus grandis*), 390 hardhead (*Mylopharodon conocephalus*), 240 striped bass (*Morone saxatilis*), 171 common carp (*Cyprinus carpio*), 81 unknown *Ictalurus spp.* and *Ameiurus spp.*, 73 Sacramento blackfish (*Orthodon microlepidotus*), 53 American shad (*Alosa sapidissima*), 36 black bass (*Micropterus spp.*), five goldfish (*Carassius auratus*), and 2 chum salmon (*Oncorhynchus keta.*) Instantaneous water temperatures during the monitoring period ranged from 7.8°C to 23.4°C and turbidity ranged from 0.22 to 7.12 NTU. Daily average discharge as recorded at Ripon (RIP—*http://cdec.water.ca.gov*) ranged between 462 and 1,790 ft3/s. Environmental parameters were graphed with passage numbers to display trends.

Limiting Factor Analyses for the Tuolumne and Stanislaus Rivers, San Joaquin Basin, California.

Zachary Jackson and Carl Mesick, US Fish and Wildlife Service, Anadromous Fish Restoration Program and Dean Marston and Tim Heyne, California Department of Fish & Game

Limiting factors are the physical, biological, or chemical conditions and associated ecological processes and interactions that influence the abundance and productivity of adult salmon. Our analysis of limiting factors was based on the relationships between fish production (adults and juveniles), parental stock (spawner) abundance, and key environmental conditions over time. Linear-regression analyses indicate that the mean flow in the San Joaquin River during the winter and spring explained 80% to 96% of the variation in estimates of adult recruitment from 1980-2004 in the Stanislaus, Tuolumne, and Merced rivers. Rotary screw trap estimates of juvenile abundance indicate that flows in February and March strongly affected the abundance of smolt-sized juveniles that outmigrated from the Tuolumne and Stanislaus rivers in April and May. For example, in the Stanislaus River during 1998, 1999, and 2000 when flows were high between February and June, the number of juveniles that survived to smolt size (fork length > 70 mm) as they migrated through the lower river averaged 84 percent. In addition, there were more smolt-sized fish near the terminal end of the river (Caswell) than near the lower end of the spawning grounds (Oakdale) in April and early May, suggesting that juveniles were successfully rearing in the lower river. In contrast, during 2001 to 2003 when flows were pulsed primarily between mid-April and mid-May, juvenile survival averaged 10 percent and there was no evidence of successful rearing in the lower river. The rotary screw trap data also suggest that although the spawning habitat in the Stanislaus and Tuolumne Rivers is highly degraded, many more fry are produced than can be supported by the rearing habitat. For example, after 18 spawning beds were restored in the Stanislaus River in 1999, fry production increased by 32% to a total of about 2,500,000 juveniles, but there was no increase in the number of smolts migrating from the river in comparison to the previous year when spawner abundance and flows were similar.

The limiting factors analysis provides evidence supporting three hypotheses regarding the production of adult fall-run Chinook salmon in the San Joaquin Basin: 1) the most critical life history stages are the rearing juveniles and outmigrating smolts; 2) the critical life history stages are strongly affected by conditions in the tributaries as well as conditions in the Delta, Estuary, and the ocean; and 3) the most important environmental factor that affects the critical life history stages is streamflow (i.e., floodplain inundation) during late-winter and spring. The regression models of adult recruitment indicate for every cubic-foot-per-second of flow, there have been 2.8, 1.9, and 1.0 adult salmon produced on the Tuolumne, Merced, and Stanislaus rivers, respectively. The relatively low production of salmon on the Stanislaus River is probably at least partly caused by the lack of functional floodplain habitat on the Stanislaus River compared to the Tuolumne and Merced rivers. We suggest that restoring floodplain habitats in the San Joaquin tributaries to become inundated between February and May will substantially increase adult salmon production.

Restoring Rangeland Watersheds and Freshwater Fisheries: Pine Creek Watershed and Eagle Lake Rainbow Trout

***Lisa C. Thompson** and **Gerard Carmona Catot** (presenters), Wildlife, Fish, and Conservation Biology Department, University of California, Davis* [1]

Pine Creek has historically provided critical spawning and rearing habitat for Eagle Lake Rainbow Trout (ELRT, *Oncorhynchus mykiss aquilarum*.) Over the past 100+ years modifications of Pine Creek watershed (e.g., overgrazing, timber harvest, passage barriers, and culverts) decoupled the ELRT from its stream habitat. The 1940 introduction of brook trout (*Salvelinus fontinalis*) led to competition for habitat in the upper watershed. Passage barriers were constructed at the mouth of the Eagle Lake tributaries to prevent ELRT from spawning in degraded habitat. Since 1950 the fishery has been maintained by artificial spawning, after fish are trapped at the mouth of Pine Creek. Offspring are reared in hatcheries and released into Eagle Lake.

Since 1987 the Pine Creek Coordinated Resource Management Planning Group has lead changes in grazing management, reconstruction of culverts, and other conservation projects that have resulted in marked improvement of habitat, but ELRT have only rarely been allowed to attempt their natural spawning migration. The authors report on a study to (1) Track the migration of ELRT spawners in Pine Creek, and (2) Test the ability of ELRT to spawn and rear in a tributary of Pine Creek following temporary removal of brook trout. In spring 2007 stream flows were low and the migration study was precluded. The authors transported 16 ELRT spawners to the upper watershed to see if they would spawn. Several redds were observed, but no young-of-the-year rainbow trout were observed in subsequent surveys. In spring 2008 the authors plan to track the migration of PIT-tagged ELRT spawners using a series of five antennas located along Pine Creek.

From May to October 2007 the authors conducted monthly habitat and snorkel surveys at nine sites in the upper Pine Creek watershed. Brook trout were present at all sites and were the most abundant fish species, with high densities. Other species observed were: Lahontan redside (*Richardsonius egregius*), rainbow trout, speckled dace (*Rhinichthys osculus*), and Tahoe sucker (*Catostomus tahoensis*.) In August 2007 the authors removed brook trout from Bogard Spring Creek with the support of the California Department of Fish and Game, US Forest Service, Susanville Indian Rancheria, and numerous volunteers. The authors conducted triple pass electrofishing along all of Bogard Spring Creek (3 km.) All brook trout were removed from the creek, measured for length and weight, and had scales removed for aging. All other species were measured for length and weight and returned to the stream. A total of approximately 4,887 brook trout were removed, with an approximate biomass of 110 kg. A total of 170 rainbow trout were observed, with lengths from 75 to 171 mm, which appeared to fall into two ages classes: 1+ and 2+. Most rainbow trout were smaller than the "½ pound" trout stocked by CDFG, indicating that stocked fish or transported ELRT spawners reproduced successfully in 2005 and 2006. In 2008 the authors plan to transport ELRT spawners to both Pine Creek and Bogard Spring Creek to test whether the removal of brook trout from Bogard Spring Creek affects the ability of the ELRT to spawn and rear successfully.

1 Co-Authors: David Lile, University of California Cooperative Extension, Lassen County; Teresa Pustejovsky and Peter B. Moyle, Wildlife, Fish, and Conservation Biology Department, University of California, Davis; and Kenneth W. Tate, Plant Sciences Department, University of California, Davis

Hydrology, Native Salmon, and Geomorphology: Insights to Rehabilitating the San Joaquin River

Saturday Morning Concurrent Session 1

Session Coordinators*: Scott McBain*, *McBain and Trush*
and ***Eric Ginney,*** *Philip Williams and Associates, Ltd.*

Prior to Euro-American alterations to its watershed, the San Joaquin River was the Sacramento River's southern "twin sister" in terms of flow and fish populations in the Central Valley. Today, flows in the San Joaquin River often do not reach the Delta and anadromous salmonids were extirpated in the 1940s. Presently, attempts are being made to restore flows to the river and bring back a lost run of salmon. This session provides an overview of hydrology, geomorphology, channel rehabilitation, fish habitat, and fishery restoration considerations that will inform implementation of the San Joaquin River Restoration Program.

Overview of Hydrology and Geomorphology of the San Joaquin River

***Scott McBain**, McBain and Trush*

The historical San Joaquin River functioned similarly to its northern tributaries: a snowmelt dominated annual hydrograph with periodic winter high flow events; a gravel-bedded reach at the exit from the Sierra Nevada foothills, transitioning to a sand-bedded reach as the river approached the axis of the San Joaquin Valley; and large Chinook salmon populations. However, the San Joaquin River has several unique aspects, including: 1) low valley slope (<0.001) in the gravel-bedded reach, 2) periodic hydrologic connection with the Kings River and Tulare Lake basin, 3) artesian springs along the axis of the valley in the sand and silt-bedded reach, 4) large tule swamps and anabranching channels in the lower reach caused by the Merced River delta and low sediment supply, and 5) long, low-gradient channel reach along the axis of the valley. Many of these unique qualities have been severely reduced or eliminated, while others create substantial constraints and challenges to restoration under contemporary flow and land management. This presentation describes the underlying historic geomorphology and hydrology that provides context for some of the restoration issues on the San Joaquin River.

The Hydrogeography and Water Management of the San Joaquin River: Making Restoration Work in a Highly Modified Watershed

Peter Vorster, *The Bay Institute*

The main-stem of the San Joaquin River is arguably the most modified river in the Central Valley. Hydropower production, water supply diversions and conveyance, irrigation drainage, groundwater pumping, gravel mining, and flood control have significantly altered its hydrology, quality, and morphology. Salmonid restoration may be constrained by the legacy of these alterations but opportunistic integration of restoration flows and actions with the existing water management system can mitigate their impacts.

The Sierra watershed is intensively managed for hydropower production, and multiple reservoirs curtail winter peaks and augment dry season flow into Millerton Reservoir, the main-stem's largest reservoir, and which presently is primarily managed for agricultural water supply and flood control. Current releases from Millerton Reservoir of 117 TAF/YR to satisfy downstream water diversions provide a base flow in the first valley-floor reach, on top of which restoration flows will be added. Periodic flood control releases can be shaped as restoration flows while also reducing the water supply impact to existing users. Periodic high inflows also occur from the Kings River into the main-stem at Mendota Pool, a regulating reservoir for imported Delta water that is used to irrigate surrounding farmland and wildlife refuges. The imported water and its return flow will be a large component of the summer base flow in the river reaches below Mendota Pool. The dry reaches of the river are within large groundwater depressions and are significant losing reaches when wetted, with steady-state losses of 80 to 100 cfs; these losses become part of the regional water supply and help ameliorate groundwater overdraft. Further downstream the river gains water from high groundwater levels, which can contribute cooler water to the river.

Integrating Restoration with Flood Management Improvements on the San Joaquin River

Paula J. Landis, *Department of Water Resources*

Significant flood control problems currently exist on the San Joaquin River. The Restoration Program will not implement any action that could contribute to existing flooding problems and will seek to reduce flood impacts whenever possible by integrating flood control system improvements with channel restoration needs.

Existing flood control problems include vegetation encroachment and sedimentation which have reduced flow capacity in some reaches. Levees constructed on unstable, porous foundations can result in numerous sand boils and often levee failure. Even at low flows, seepage damage can occur.

Some proposed settlement actions may improve flood protection on the San Joaquin River system such as channel modifications to ensure conveyance of at least 4,500 cfs and modifications to the Chowchilla Bifurcation Structure and the San Slough Structure to enable effective routing and conveyance.

In this post-Katrina mentality, there is a heightened sense of urgency regarding flood control and the State is working with the Restoration Program to assure that we achieve our common goals.

A Flow Regime to Restore Salmon on the San Joaquin River, California

Matt Kondolf *(presenter,) UC Berkeley and* ***John R. Cain*** [1]

While many factors constrain restoration of wild salmon on the San Joaquin River, flow regime is clearly the most important. By causing reaches of the river to dry up in many months of many years, diversions (from Friant Dam and downstream) made migration impossible, even though suitable spawning and rearing habitat remained in a perennial reach below the dam. The San Joaquin has been irrevocably changed, so the goal was not to restore pre-disturbance conditions, but rather to estimate minimum flows needed to support specific salmon life stages, such as upstream migration of adults, spawning, incubation, rearing, and downstream migration of smolts, as well as dynamic physical processes such as frequent bed mobilization. The authors used existing data and collected new data, including observations of tracer gravel movement that demonstrated the riverbed was mobile at flows much lower than predicted by an uncalibrated computer model. Drawing upon our analyses and those of other experts, we developed restoration hydrographs for a range of year types, from very wet to critically dry. The resulting hydrograph requires water in comparable amounts to flows that currently support salmon on the Merced, Tuolumne, and Stanislaus rivers, all roughly similar in size to the San Joaquin.

1 Natural Heritage Institute

Matching Salmonid Life History Strategies to a Restored San Joaquin River

Michael Fainter (presenter) and Frank Ligon, Stillwater Sciences

Early in the litigation over the San Joaquin River, it was presumed that fall-run Chinook salmon would be the primary target of any restoration activity implemented in the river. This presumption sprang from several agency reports that had concluded that fall-run Chinook salmon would be the only salmonid species/race suitable for restoration to the San Joaquin River because of water temperature conditions in the southern San Joaquin valley, and because fall-run salmon are the only run that occupies other San Joaquin tributaries such as the Merced, Tuolumne, and Stanislaus rivers. However, additional analyses suggested that the life history strategy and traits of spring-run Chinook salmon were better suited to the environmental conditions in the San Joaquin River, and that spring-run Chinook would require less water as compared to other races. This presentation describes some of the analyses that led to the selection of spring-run Chinook salmon as the primary target of restoration defined in the San Joaquin River settlement agreement reached between NRDC and Friant Water Authority. This presentation will also describe the utility of considering life history characteristics of candidate species when selecting a target assemblage for river restoration programs. This presentation will also describe some of the lingering scientific uncertainties underlying the establishment of a new population of a threatened species to a river that has been altered dramatically by decades of intensive resource management and anthropogenic disturbance.

Engaging Watershed Communities in Salmonid Restoration

Session Coordinator: *Jeff Martinez,* *South Yuba River Citizens League*

The positive impact and long-term sustainability of salmonid restoration programs, within California watersheds hinges upon the ability of lead agencies and NGOs to engage local communities, at multiple levels and various timeframes throughout the process. Such engagement involves partnerships, collaborations, focus groups, and other entities with a goal toward broad based educational dissemination of pertinent information supported by both science-based and grass roots advocacy groups. Such engagement must include a community voice and input into the planning process and eventual participation in hands-on restoration programs and activities. This session will give attendees the opportunity to learn about various strategies and models for engaging the community in salmonid restoration while addressing multiple levels at which such engagement can take place in various salmonid restoration initiatives. Session presenters represent programs in multiple stages of implementation and distinctly different California watersheds.


Jeff Martinez

Becoming Stewards of the Land We Live On

***Derek Hitchcock**, Yuba Strategy Manager and **Jeff Martinez**, River Teachers Director, South Yuba River Citizens League*

In the summer of 2007, as part of a watershed assessment process, the South Yuba River Citizens League (SYRCL) engaged local residents to begin to systematically walk the watershed armed with a digital camera and GPS, and the simple directive to survey the landscape to identify the location and effect of the deepest scars, and the areas of highest value. This Citizen Stewardship Program quickly evolved to develop a standardized process for citizen based sub-watershed assessment, facilitate appropriate advocacy actions, ground truth GIS data layers, and build a foundation for a sustainable locally customized form of adult education. Conducting watershed assessment by engaging residents of the watershed to gather some of this information, including historical land use and historical conditions for each sub watershed, can provide substantially more data while providing an experiential learning process that develops modern ecological literacy in resident communities. While capturing on the ground realities that directly inform sound management decisions, a citizen stewardship program can more fundamentally serve to bring about an alignment of values based out of the shared understanding of place.

Redefining the Community

Sharon Weaver, San Joaquin River Parkway and Conservation Trust

The long-term success of large scale habitat restoration projects is dependent upon support and assistance from the local community. But how do you engage the average citizen in restoring a resource that they don't understand? The San Joaquin River Parkway and Conservation Trust has completed research on public attitudes and opinions about rivers and river restoration in order to communicate effectively with targeted populations. Learn how we have provided effective education to different segments of the community, including Latinos and mothers with young children, new Southeast-Asian immigrants, and K-8 children. Educational tools include paid media, small-group presentations, and unique educational games that can be used in a camp or field-trip setting. The two final presenters will provide examples of inspirational art and poetry that can be used to translate head knowledge into heart knowledge.

Development and Implementation of Floodplain Restoration Projects Benefiting Salmonids and Terrestrial Wildlife Species

Stacy L. Small, Ph.D., *Restoration Ecologist, River Partners—San Joaquin Valley Project*

The riparian zone is the transition area between aquatic and terrestrial environments that provides critical habitat for fish and wildlife in all phases of the life cycle. River Partners designs and implements riparian restoration projects specifically targeted for fish and wildlife species. Designs are based on local site characteristics and are intended to maximize benefits for both terrestrial and aquatic communities. We have planted 6,000 acres of native riparian vegetation in the Central Valley to date, providing habitat benefits for riparian songbirds, mammals, and salmonids that include food, shade, breeding sites, and shelter from predators. By restoring large river floodplains with native vegetation and reconnecting river channels with floodplains, we are increasing flood storage capacity, improving in-stream conditions, and creating potential salmon rearing habitat throughout California's Central Valley. River Partners engages communities by working with local Resource Conservation Districts and businesses, participating in education activities with local schools, and coordinating outreach activities such as canoe tours of project sites.

California Conservation Corps—California's Future Restoration Workers

Allan Renger*, Fisheries Biologist, Department of Fish and Game;* ***Leah Mahan****, Marine Habitat Resource Specialist, National Marine Fisheries Service;* ***John Griffith****, California Conservation Corps-Fortuna Center; and* ***Gary Burica****, California Conservation Corps-Ukiah Center*

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, Corps members, 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 Corps members develop a strong work ethic and marketable job skills while learning responsibility, self-discipline, teamwork, self-care, and good work habits. Corps members 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.

Typical CCC restoration projects include 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. Restoration work is focused on streams and watersheds that have the greatest ability to increase threatened and endangered salmonid populations over the long term. The CCC will restore, enhance, and conserve watershed, stream, and estuary habitats and ecosystems vital to salmonid population recovery. This will also benefit other species of fish, plants, and wildlife.

At this presentation you will hear project partners talk about the benefits to their organizations of working with the CCC. 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 the 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?

Come learn about this little known State department and hear first hand how linking up with the CCC in your area can help California's young adults, environment, and future.

Implementation of the Lower Mokelumne River Watershed Stewardship Plan: Lessons in Collaboration

John Brodie, *San Joaquin County Resource Conservation District and* ***Richard Leong,*** *Watershed Planning Analyst, East Bay Municipal Utility District*

One of the primary concerns about the lower Mokelumne River is that, as a highly controlled system, the river has lost much of its historic and natural function. The lower Mokelumne River is also considered impaired for copper and zinc and is on the 303(d) list for those two substances. More than 90% of land within the watershed is privately owned and agriculture is the predominant land use, though development pressure is converting many of these agricultural acres into home sites. Parts of the watershed also have non-native invasive species crowding out native riparian vegetation.

The guiding principle of the 2002 Lower Mokelumne River Watershed Stewardship Plan (LMRWSP) is that all of the constituents of the Lower Mokelumne River Watershed are interrelated. No single element or action stands alone. Good stewardship is about pointing a finger at ourselves and not at each other. The community must consider each chapter of the Lower Mokelumne River Watershed Stewardship Plan as a component of a broader picture—an overall approach to the good stewardship of the Lower Mokelumne River Watershed—an approach which depends on many different actions by many different individuals working towards a common goal. The Plan encourages all to take individual responsibility for maintaining and improving the resources of the Lower Mokelumne River Watershed and to get involved!

Implementation of the Plan is guided by the Lower Mokelumne River Stewardship Steering Committee—a community-based group consisting of all interested parties in the community and beyond. Stakeholders are not determined by the Committee, they are self-identified. Implementation of the plan has included activities such as:

- An agricultural water quality best management practices field day held in conjunction with government agencies and nongovernmental organizations to meet their needs while promoting best management practices to reduce non-point source pollution that enters the river.
- Continued to work with the Student and Landowner Education Watershed Stewardship (SLEWS) program of the Center of Land-Based Learning by working with SLEWS staff to select restoration sites, the types of plants to be planted at the sites, and the students that would be involved with the program. The SLEWS program provides high school students with hands-on watershed stewardship experiences.
- Continued to work with the San Joaquin Watershed Education Partnership (SJWEP) to promote using the Mokelumne Watershed as a focal point for place-based learning activities.
- Collaboration with the Lower Mokelumne River Partnership (California Dept. of Fish and Game, East Bay Municipal Utility District, US Fish and Wildlife Service) to support the protection and enhancement of the anadromous fishery in the lower Mokelumne River consistent with the Partnership's Water Quality and Resource Management Program.
- Coordination of ongoing riparian restoration projects with a variety of private landowners along the lower Mokelumne River
- Establishment of a programmatic Safe Harbor Agreement (Valley Elderberry Longhorn Beetle)

The central focus of all the implementation elements of the Plan is to encourage community "ownership" of the watershed and to build strong collaborative partnerships between landowners, non-profits, government agencies, local businesses, etc. to establish and maintain a strong watershed stewardship network on the lower Mokelumne River.

Basins of Relations

Brock Dolman, *WATER Institute Director, Occidental Arts and Ecology Center*

Our Californian watersheds have been dramatically degraded due to extensive landscape modifications by agriculture, logging, ranching, rural and urban development. The dramatic population declines of "totem" salmon throughout California and the Pacific Northwest are but one charismatic indicator of the need for a new relationship with our watersheds. Heightened public awareness of these myriad issues has resulted in a demand for locally based creative solutions.

Since 2000 OAEC's WATER Institute, through its Basins of Relations Training Program, has promoted and supported the creation of 25 community-based groups organized within watershed boundaries in Central and Northern California. The Program is designed to increase the level of awareness and familiarity that citizens have within their Basin of Relations, and to empower them to initiate local education, monitoring and restoration efforts.

The Basins of Relations four-day training program is designed to address basic watershed concepts, science, and organizing tools for protecting and restoring watersheds. Participants are made up of resident teams from a number of watersheds that come to the training with the intention of organizing efforts within their home watershed. Training topics include: watershed processes, terminology, salmonid ecology, water quality monitoring, stormwater management, uplands erosion control, road restoration, native habitat restoration, community group process and funding opportunities. During the training, teams develop a strategic plan to facilitate the development of a watershed group in their home watershed.

"Envisioning Futures" for Habitat Restoration and Salmon Protection in the Delta

***Christina Swanson**, Senior Scientist, The Bay Institute*

The Sacramento-San Joaquin Delta is the common migration corridor for California's largest salmon runs. Decades of research has indicated that ecological conditions in the Delta have declined and that numerous anthropogenic activities, including water diversion and export operations, have direct and indirect adverse effects on salmon moving through this essential ecosystem. Recent legal challenges as well as growing agreement among scientists, resource managers, water users and policy makers that current management of the Delta is unsustainable has spurred a number of multi-disciplinary efforts to plot a new future for the system. For salmon, the key elements of Delta ecosystem restoration and management plans are designed to improve habitat conditions and productivity, facilitate passage, and reduce direct and indirect mortality. The high priority habitat restoration and fish protection activities consistently identified by the various planning efforts include: a) increased amounts and improved function of intertidal habitats used by salmon for forage and refuge and which export nutrients and planktonic organisms to the upper estuary; b) increased frequency of inundation of seasonally flooded habitat and migration corridors like the Yolo Bypass; and c) various strategies to prevent migrant salmon from straying into central Delta where their survival is reduced and they are vulnerable to entrainment by the Delta water export pumps. This last element, because it is also related to proposed alternatives for conveyance of water through and/or around the Delta, is (to put it mildly) somewhat controversial. In this presentation I will briefly describe some of these proposed habitat and salmon protection actions and the scientific tools that will be used to evaluate them.

2007 Merced River Juvenile Salmonid Out-migration Monitoring

John Montgomery, Cramer Fish Sciences

The lower Merced River contains fall- and late-fall Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead/rainbow trout (*O. mykiss*) which are listed as species of concern under the Endangered Species Act (ESA.) From January 23 to June 1, 2007, Cramer Fish Sciences conducted rotary screw trap operations on the lower Merced River near the town of Stevinson, California to enumerate and detail various aspects of juvenile salmonid out-migration for the US Fish and Wildlife Service's Anadromous Fish Restoration Program. Abundance estimates were calculated using a logistic regression model which predicted daily trap efficiency based on flow. Seasonal passage estimates for natural and hatchery Chinook salmon were 28,889 (± 9,122) and 38,276 (± 10,987), respectively. No steelhead/ rainbow trout were captured. For Chinook salmon, we found low catch abundance, a compressed migration time and truncated life history types (compared to other Central Valley rivers) characteristic of a depressed population. Our natural Chinook salmon catch was 98% smolt-sized (age-0) fish, likely representing one life history strategy, no (age-0) fry, and one yearling emigrant. Out-migration timing of natural fish strongly coincided with hatchery releases upstream, and weaker associations were observed with temperature and lunar cycle. Observations this season seem to indicate very poor natural production of Chinook salmon, however subsequent monitoring of population trends over several seasons is necessary before conclusions or management decisions are made. A more thorough understanding of *O. mykiss* populations on the Merced River may explain the lack of out-migration observed during the 2007 season. Monitoring at Hatfield State Park rotary screw trap site will provide data on Merced River salmonid populations to help Andronomous Fisheries Restoration Program and Comprehensive Assessment and Monitoring Program meet their objectives.

Juvenile Chinook Salmon Out-migrant Abundance Estimates in the Lower Stanislaus River

***Clark B. Watry** (presenter,) Cramer Fish Sciences* [1]

Cramer Fish Sciences completed extensive exploratory analyses of ten years (1996-2005) of screw-trap sampling data across both trap sites on the Stanislaus River to assess abundance of juvenile fall Chinook salmon and potential factors influencing their survival and body size. Our objectives were to use trap-efficiency models to estimate abundance of migrating juveniles by life stage, and to quantify relationships between annual survival of migrating juveniles and environmental conditions. The authors found significant ($P < 0.05$) relationship between flows and the annual survival-rate estimates, whereby higher flow was associated with higher survival and this relationship was highly influenced by the fry lifestage of migration. The authors found that turbidity can greatly enhance fry migration success when turbidity levels spike. Temperature did not appear to have a significant impact on survival rates. We found a strong relationship between density and body size, whereby juveniles experienced higher growth rates when abundances were low. We found significant differences in size between the two trap sites suggesting extensive juvenile rearing between these sites and the parr lifestage may have strong tendency to rear during low flow years. Analyses suggest that the parr and smolt lifestages are not strongly related to flow though juvenile rearing may bias these results. We recommend continued use of screw trap sampling at the Oakdale and Caswell sites as well as complimentary coded-wire tag or pit-tag studies to further investigate effects of specific flow ranges and their implications for different lifestages.

Co-Authors: Ryan Cuthbert, Ayesha Gray, Brian Pyper, Cramer Fish Sciences

Flood Corridor Restoration Improves Anadromous Fish Migratory Habitat at the Big Bend Project along the Tuolumne River, California

Patrick Koepele, *Central Valley Program Director, Tuolumne River Trust*

The January 1997 flooding in California set a new benchmark by which floods on Central Valley Rivers are judged locally, prompting flood managers to consider new approaches to reducing flood damages. In 2000, California voters approved Proposition 13, which established the Flood Protection Corridor Program managed by the Department of Water Resources (DWR.) This new program was designed to reduce flood damages while improving habitat. In 2002, at the Big Bend Floodplain and Riparian Restoration Project, the Tuolumne River Trust and its partners, including DWR, the USDA-Natural Resources Conservation Service (NRCS), the East Stanislaus Resource Conservation District, NOAA Fisheries, the California Wildlife Conservation Board, and the FishAmerica Foundation, purchased permanent floodplain easements (held by the NRCS) and restored 240 acres of floodplain and riparian habitat. The project was designed to improve channel-floodplain connectivity, improve migratory and rearing habitat conditions for Chinook salmon and steelhead, enhance native riparian vegetation, while removing invasive vegetation and preserving flood conveyance capacity to reduce the risk of flood damage. Earthwork consisted of notching private farmer-levees to improve channel-floodplain connectivity. Planting of trees and shrubs was undertaken over three seasons and completed in the spring of 2007. Planting of herbaceous vegetation is scheduled to begin in the fall of 2007/winter of 2008. Through this project, we have seen several successes, including the improvement in floodplain inundation frequency. Increased inundation frequency has had the added benefit of allowing for increased utilization of the floodplain by migrating salmonids while also contributing to the revegetation efforts at the site. Low-elevation fields have exhibited significant natural recruitment of cottonwoods, while planted fields have required little to no irrigation during the first two summer seasons. This floodplain project is important because it has created the foundation for a flood corridor along the lower Tuolumne River with significantly enhanced floodplain and riparian habitat.

Evaluating Success of Restoring Ecosystems Using a Bioenergetics Model

Ayesha Gray, Cramer Fish Sciences [1]

In restoring essential habitats for fish, determining nekton response to restoration projects is essential to achieving a better understanding of mechanisms underlying fish performance and success, and in assessing how habitat restoration may contribute to rehabilitating fish populations. A bioenergetics model integrates a suite of site-specific variables to determine potential growth response of a fish. Relative modeled growth response can be compared among habitats (restored, reference) as a metric of success which is closely related to ecosystem function. We explored the use of this technique at the Salmon River estuary, Oregon USA, where dikes were installed in three locations in the early 1960s, and then removed at nine-year intervals creating a space-for-time substitution. These restoration sites coupled with an undiked reference site provided a unique series of ecological conditions to pose questions about habitat redevelopment and potential fisheries benefits. We used a bioenergetics model to compare growth potential of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) with site-specific diet composition and temperature, estuary-specific prey energy density, average fish size and calculated consumption rates from one natural and three emergent marshes at different stages (age) of restoration during 1998-2002. Prey consumed by juvenile Chinook salmon was dominated by various taxa and stages of invertebrates originating from within the marshes, but diverged between natural (large contribution by epibenthic crustaceans) and restoring marshes (predominantly various stages of flies.) Modeled growth potential was positive (from 0.001 – 0.07 g • g-1d-1), and unrelated to stage of marsh development. Growth rates approximating the natural marsh were found in the youngest restoration site demonstrating the benefit of early restoration stages as fish habitat; however, differences in variability of growth potential between restoration and reference sites existed. These results indicate reference sites may be more stable in terms of growth potential than restored sites. We found bioenergetics modeling to be used an effective and sensitive tool for distinguishing relative performance of nekton in restoring and natural estuarine emergent marsh ecosystems, and in the future, we will apply this technique to evaluate salmonid growth performance in a restored side channel and floodplain on the Stanislaus River. Site-specific monitoring efforts may help us better understand benefits available to fish using restored ecosystems, and more closely evaluate effectiveness of restoration efforts.

1 Co-Authors: Charles A. Simenstad, Wetland Ecosystem Team, University of Washington School of Aquatic and Fishery Sciences; Daniel L. Bottom, National Marine Fisheries Service/National Oceanic and Atmospheric Administration; and David A. Beauchamp, Washington Cooperative Fish and Wildlife Research Unit, University of Washington School of Aquatic and Fishery Sciences

Assessing Progress Toward the Fish Production Targets in the Central Valley Project Improvement Act: Are We Making Progress and Where Do We Go from Here?

Douglas Threloff, *US Fish and Wildlife Service, Comprehensive Assessment and Monitoring Program, Sacramento Fish and Wildlife Office*

The Central Valley Project Improvement Act (CVPIA) was authorized in 1992. Section 3406(b)(1) authorizes and directs the Secretary of the Interior to implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967–1991. Pursuant to the CVPIA, the US Fish and Wildlife Service's Anadromous Fish Restoration Program (AFRP) developed fish production targets for several anadromous fish taxa, including four runs of Chinook salmon. This program has also completed a substantial number of restoration projects designed to enhance the production of anadromous fish. Pursuant to section 3406(b) (16) of the CVPIA, the Comprehensive Assessment and Monitoring Program (CAMP) monitors the natural production of anadromous fish taxa to determine if the AFRP fish production targets are being met.

Between 1992 and 2006:

- Watershed-specific AFRP production targets for fall-run Chinook salmon were met six or more times in the American River, Battle Creek, Butte Creek, Clear Creek, and Mokelumne River. In contrast, production targets for fall-run Chinook salmon were met three or fewer times in Deer Creek, Feather River, Merced River, Mill Creek, Sacramento River mainstem, Stanislaus River, Tuolumne River, and Yuba River.
- The watershed-specific AFRP production target for late fall-run Chinook salmon may have been met seven times on Battle Creek. In contrast, the watershed-specific production target for late fall-run Chinook salmon on the Sacramento River mainstem was met once.
- The watershed-specific AFRP production target for winter-run Chinook salmon was never met on the Sacramento River mainstem.
- The watershed-specific AFRP production target for spring-run Chinook salmon was met twelve times on Butte Creek. In contrast, watershed-specific production targets for spring-run Chinook salmon were never met on Deer Creek, Mill Creek, and the Sacramento River mainstem.
- The run-specific AFRP production target for fall-run Chinook salmon was probably never met, run-specific AFRP production targets for winter- and spring-run Chinook salmon were never met, and the run-specific AFRP production target for late fall-run Chinook salmon was met once.
- The total Central Valley-wide AFRP production target for the four runs of Chinook salmon was probably never met.

Substantial increases in the production of Chinook salmon in some watersheds after 1992 suggest that management activities can result in greater numbers of adult salmon. In watersheds where AFRP production targets are rarely met, substantial increases in the commitment of resources will likely be required to produce more salmon.

A wide variety of monitoring activities in the Central Valley are currently being used to collect data that are used to monitor the abundance of adult and juvenile anadromous fish. While these data are extremely useful, standardizing and enhancing the procedures that are used to collect, analyze, and report these data in a timely fashion would provide a greater ability to assess temporal changes in fish abundance.

Saturday Afternoon Concurrent Session 1

Session Coordinator: *Zoltan Matica,* *California Department of Water Resources*

The San Joaquin River is one of the largest in California and one of the most degraded from an environmental standpoint. The completion of Friant Dam in the 1940s extirpated one of the largest Chinook salmon populations in the Central Valley by diverting nearly all of the rivers flow for human needs. But the San Joaquin River Restoration Program is about bringing a river back to life. As a result of a lawsuit settlement, there is now a joint state and federal effort to restore the San Joaquin River and the historic fisheries beginning with the reintroduction of spring-run Chinook by 2012.

The San Joaquin River Restoration Program is one of the largest river restoration efforts in the nation. Over 150 miles of the river will be restored. Accomplishing this task will necessitate the cooperation and coordination of federal, state, and local governments, along with environmental organizations, academia, water users, and landowners.

This session will provide an overview of the restoration efforts, biological issues, and time lines of the settlement by speakers involved in the lawsuit, those from the San Joaquin River Restoration Program, and other involved individuals. It will address the issues and goals in a large scale restoration program, and the challenges ahead with a focus on native fishes, toxicology, genetics, and management needs.

Toxicological Considerations in the Restoration of San Joaquin River Salmonids

Abimael Leon Cardona, *Environmental Scientist,*
San Joaquin District, Department of Water Resources

Salmonid restoration efforts in the San Joaquin River (SJR) will likely be affected by water contamination from diverse sources. Contaminants of concern include aquatic and terrestrial herbicides, urban and agricultural pesticides, trace elements from agricultural activities and other contaminants of natural or anthropogenic origin in the San Joaquin Basin. Poor water quality in the lower reaches of the SJR due to point and non-point sources of pollution will likely affect juvenile salmonids. These contaminant sources can have potential acute, sub-lethal or indirect effects on reintroduced populations of Central Valley salmonids. The Fisheries Management Work Group of the San Joaquin River Restoration Program acknowledges the importance of avoiding adverse effects of contaminants on reintroduced spring-run and fall-run Chinook salmon.

Bringing Back Fish Diversity to the San Joaquin River

Peter B Moyle, *Center for Watershed Sciences, and Department of Wildlife, Fish, and Conservation Biology, University of California, Davis*

The present day San Joaquin River supports only limited populations of a few native fishes below Friant Dam, a mixed fish assemblage from the Delta below Mendota Dam, and an assemblage of small, highly tolerant fishes in reaches filled with polluted agriculture return water above its confluence with the Merced River. Restoration of a 'natural' flow regime will permit the return or expansion of populations of at least 10 native species. Some (e.g., hardhead, hitch) may have to actively moved back into the river while others will come back on their own. The lowermost reaches of river will likely be dominated by a mixed assemblage of alien and native species that can support fisheries. Success of this strategy is predicted by the success of native fish restoration to Putah Creek. It may also be possible to restore Sacramento perch, a species now extirpated from its entire native range, to the renewed river.

Blueprint for River Restoration: A Summary of the San Joaquin River Settlement Agreement

Monty Schmitt, Senior Water Resources Scientist, Natural Resources Defense Council

The recent San Joaquin River settlement agreement marked the end of 18 years of litigation and the beginning of an ambitious effort to restore 150 miles of the second largest river in California. Nearly 60 years after the river was dewatered and the last salmon runs were extirpated from the system, the settlement requires reestablishing naturally reproducing and self-sustaining populations of spring and fall run Chinook salmon. This presentation will discuss some of the analyses that provided the basis for establishing the flow releases and the restoration actions necessary to meet salmon life history requirements as well as other important elements including water management goals, timelines, funding mechanisms, provisions for on-going management, and participation by other parties including the State of California. Many thought the San Joaquin River could never be restored, but this settlement demonstrates the potential to balance the needs of aquatic ecosystems with the water supply.

Agency Approach to the San Joaquin River Restoration Program

***Jason Philips**, San Joaquin River Restoration Program Manager, US Bureau of Reclamation*
*and **Dan Castleberry**, Fisheries Program Manager, US Fish and Wildlife Service*

After the San Joaquin River Settlement Agreement was reached, the responsibility for action shifted from the settling parties to the implementing agencies. The Department of the Interior was established as the primary party for implementing the Settlement, with the State of California as a partner. A five-agency Program Management Team was established to guide implementation of the Settlement Agreement. Significant progress has been made to date, including the formation of a Program Management Plan, scopes of work for environmental compliance and related studies, as well as numerous technical memoranda. The agencies also are initiating preliminary investigations to establish a foundation for successful restoration, including geologic surveys, topographic mapping and installation of monitoring stations along the river.

Fisheries Management Planning Approach

***Jeff McLain**, US Fish and Wildlife Service and **AJ Keith**, Stillwater Sciences*

A Fisheries Management Workgroup was established composed of implementing agencies and consultant representatives. A key task is the development of a Fishery Management Plan containing conceptual and qualitative models, monitoring objectives, and an adaptive management plan. Conceptual models will be used to explain in conceptual and qualitative terms how environmental factors are expected to influence the abundance of salmon in the San Joaquin River between Friant Dam and the Merced River confluence. It is the intention that these conceptual models would be used to identify and prioritize limiting factors and restoration actions in a general sense; whereas quantitative models are needed to develop testable hypotheses that would form the basis of an adaptive management strategy for the restoration program. Quantitative models could also help develop and refine quantitative population goals for salmon, assist with the assessment of restoration alternatives, and guide restoration flow and management actions. The conceptual and quantitative models would provide a critical framework for understanding the observed responses of Chinook salmon in the San Joaquin River and provide a means of assessing the relative effects of in river restoration and management actions versus the effects of downstream, Delta, Bay, and ocean conditions.

Genetic Issues for the Reintroduction of Native Fishes on the San Joaquin River

Joshua A. Israel, Department of Animal Science and Center for Watershed Sciences, University of California, Davis

Recovery of the native aquatic ecosystem along the San Joaquin River can provide numerous opportunities for evaluating the reconstruction of salmonid and other native fish populations and succession and formation of a naturalized fish community. The processes of translocation, natural recolonization, and hatchery reintroduction can each influence the genetic composition of a recovering population, regardless of even the most thoughtful planning. Translocated fish can play a role in reconstructing a population, when there is no prior stock available. Fish populations established through this process and populations reconstructed via natural recolonization both typically have greater chances for viability than hatchery-initiated populations, when habitat availability does not limit population growth. An iterative framework that provides management feedback is necessary, so a shift from manager-assisted hatchery production to river-facilitated natural reproduction can occur quickly and increase the potential for long-term viability of spring-run Chinook resulting from the San Joaquin Restoration Program.

Pre-project information about the baseline population structure, number and frequency of alleles, and adaptive genetic variation is necessary to evaluate long term population viability and genetic concerns observed following any population reconstruction strategy. A baseline genetic study of possible source and recolonizing populations is necessary to compare the genetic diversity, fitness, and effective population size of adult stocks possibly influencing reconstruction of fish populations. Initial vetting of potential source stocks for reintroduction has centered on life history timing, habitat requirements, and migration distance. Pre-action consideration of the genetic diversity of suggested source stocks is essential for evaluating recovery scenarios and being able to assess future results in light of concerns like changes in genetic composition caused by inbreeding or hybridization and reduced effective population size.

The long-term viability of a population can be reduced through alteration of genetic diversity, decreases in fitness, and reduction in effective population size of hatchery and wild stock components. Genetic research will need to be incorporated iteratively for evaluation of the long-term viability and success of fish population recovery in the San Joaquin. One mechanism that can accomplish this is a genetic monitoring program to make certain genetic diversity is maintained throughout all life history stages influenced by stock enhancement. A monitoring program should assess genetic diversity when selecting the out-of-basin source broodstock, releasing juvenile cohorts, and finally spawning returning adults, which are contributors to the reconstructed stock until genetic equilibrium is attained (no signs of genetic alteration.) A Genetic Management Plan should be completed for species of management focus in the San Joaquin Restoration Program. The most informative pre-project study can enable managers to determine whether individual fish present in the San Joaquin are derived from naturalized (or translocated), hatchery, or admixed broodstocks. Restoration of fish stocks in the San Joaquin provides opportunity to genetically evaluate recovery strategies of fishes within a river, describe the success of native and invasive species recolonization, and potentially characterize contemporary adaptation of life history variants of San Joaquin fishes.

Management Implications of Mokelumne River Salmon Origin (Hatchery Versus Wild)

***J.D. Wikert**, Anadromous Fish Restoration Program, US Fish and Wildlife Service*

The Mokelumne River is one of four Central Valley watersheds with large salmonid production hatchery facilities. Concurrently, efforts are underway to restore natural production of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss.*) Evidence continues to accumulate identifying adverse impacts of hatchery origin salmonids to wild or natural origin stocks. A recent study demonstrated a loss of fitness of 40% in steelhead in one hatchery generation, and other authors have identified additional genetic and competition hazards to natural origin salmonids in the presence of those hatchery origin. The Mokelumne River hatchery and natural production data are analyzed and implications for management are discussed.

Evaluation of a Volitional Release Strategy for Hatchery-produced Fall-run Chinook Salmon in the Lower Mokelumne River, California

Michelle L. Workman *(presenter,) East Bay Municipal Utility District*
and ***Joseph E. Merz,*** *Cramer Fish Sciences*

The authors evaluated the strategy of volitionally releasing hatchery-produced fall-run Chinook salmon in the regulated lower Mokelumne River by comparing volitionally and forced released hatchery-produced Chinook salmon ocean harvest, hatchery escapement, and straying rates; and, comparing development, habitat use, migration patterns and diets of naturally-produced and volitionally-released hatchery-produced Chinook salmon. Coded-wire tag recoveries from one brood year (2003) indicated volitionally-released hatchery-produced fish had higher ocean harvest rates and escapement to the Mokelumne River Fish Hatchery than forced released fish, with no significant difference in straying rates. Fish sampled by rotary screw trap and electrofishing (2003 to 2006) suggested volitionally-released fish grew and developed faster than their naturally-produced conspecifics, had less size variability, were less evenly dispersed, were found in fewer habitats (except during flooding), and emigrated significantly faster in all years. While hatchery-produced juveniles had significantly more food items per stomach, naturally-produced juveniles had fuller stomachs contained larger and more diverse prey items and exhibited significantly more piscivory. Naturally-produced and volitionally-released hatchery fish both migrated at higher rates during the night except during 2004, a year with higher relative hatchery-produced fish abundance. Hatchery-produced fish abundance may trigger a behavioral effect on migration patterns in the naturally-produced population. Further assessment of subsequent release groups needs to be conducted before definitive conclusions regarding the effects of a volitional release strategy compared to a downstream forced release on natural river production can be made. If further evaluation supports a volitional release strategy, relative abundance of naturally-produced and volitionally released hatchery-produced fish and annual variation in the river environment will need careful consideration.

Geomorphic and Ecological Interactions of Large Wood, Pacific Salmonid Redds, and Habitat Units in the Lower Mokelumne River, California.

Anne E. Senter, University of California, Davis [1]

Large wood pieces (LW, >1 m length, >10 cm diameter) are important components of geomorphic and ecological dynamics within river systems. Physical presence of LW within the bankfull channel can influence hydraulic variability, sediment deposition and scour patterns, storage of organic matter, habitat creation, and nutrient sources for aquatic species. In regulated rivers hydrologic connectivity has been lost and ecosystem dynamics disrupted, yet lower reaches continue to serve as habitat and now as headwaters, for a myriad of species including anadromous salmonids returning to spawn. Because watershed connectivity has been severed, riparian zones highly altered, and LW removal remains common, LW levels are thought to be very low in regulated ecosystems. In our conceptual model it was conjectured that a dynamic and healthy ecosystem might have areas of low, optimal, and overabundances of wood, which might correlate respectively to low, optimal, and low redd abundances. On the other hand, in an ecosystem where connectivity is diminished an increase in the amount of LW may potentially convert otherwise unsuitable redd habitat to highly preferred redd habitat. In this research, interactions between LW, Pacific salmon redds, and hydraulic habitat units were explored along a 7.5 km reach on the Mokelumne River directly below Camanche Dam. Riffles and glides were defined as shallow and fast (<3', >2.5 ft/s), and shallow and slow (<3', <2.5 ft/s), respectively. Runs and pools were defined as deep and fast (>3', >2.5 ft/s), and deep and slow (>3', <2.5 ft/s), respectively. Characteristics of 540 LW pieces, 650 redds, and habitat units were mapped during the 2006-07 spawning season. Large stretches of glide and pool zones dominated the study reach, while discrete units of riffles and glides were most prevalent. There were no significant differences in LW density across habitat types. Redd density was significantly higher in riffles than in runs, glides, and pools. Few redds were located in runs and none in pools. There were no areas where an overabundance of LW prohibited redd activity. Initial analysis suggests that redds located in glide zones may benefit from hydraulic variability provided by LW, while in riffles LW presence or absence is less important than depth and velocity of the geomorphic unit. Overall, in-stream geomorphic features appear to play the primary role in redd location, while LW may be an important secondary feature in marginal habitat units. Additional data analysis will report whether correlations exist between redd locations and wood locations in and across habitat units. Further research is needed to determine what quantity of LW might be considered optimal in below-dam ecosystems.

1 Co-author: Gregory B. Pasternack, Department of Land, Air, and Water Resource, University of California, Davis

The Effects of Engineered Side Channel Habitat on Macroinvertebrate and Fish Populations in the Mokelumne River, California.

Walter Heady, PhD, Student, University of California, Santa Cruz

The Mokelumne River is a tributary to the Sacramento-San Joaquin Delta. The riparian areas of the Mokelumne River historically supported a diverse and dynamic ecosystem of oxbow lakes, seasonal wetlands, side channels and extensive, forested floodplains. Since California's gold rush in the mid 19th century, the river has been modified by mining, agriculture, forestry, levee and dam construction, and water diversion. The lower Mokelumne River (LMR) includes approximately 54 km of regulated river between Camanche Dam, a complete barrier to anadromous fish, and the Sacramento–San Joaquin Delta. Since 1927, approximately 190,000 m2 of side channels have been eliminated in the 14.5 km section below Camanche Dam (Edwards et al. 2004), the extent of the remaining salmonid spawning reach in the LMR. Historically, side channels provided high-quality rearing habitat for juvenile Chinook salmon and steelhead.

In 2005, EBMUD, in cooperation with CDFG, and USFWS, acquired funds to engineer 1,915 m2 of side channel habitat in the LMR. EBMUD conducted monitoring of abiotic and biotic factors following completion of the two engineered side channel habitats, constructed to flow at dam releases above 14.5 m3sec-1. Here we analyzed physical features, macroinvertebrate colonization, and fish utilization within the two side channels. Drift and benthic macroinvertebrate samples and fish community data were collected monthly. Life-stage, weight and length were collected on all fish sampled and a sub-sample of diet was taken for steelhead and Chinook salmon. Steelhead and Chinook salmon were also checked for Passive Integrated Transponder (PIT) tags, coded wire tags and hatchery markings. We examined ecological responses such as abundance, species richness, diversity, and community assembly for macroinvertebrates and fish. We also investigated differences in fish utilization and diet preferences between steelhead and Chinook salmon, wild and hatchery fish, and those found in the side channels relative to those found in the adjacent mainstem.

Aquatic macroinvertebrate abundance and taxonomic richness increased over the monitoring period. A pattern of succession was also observable in macroinvertebrate community structure. A suite of fish species utilized the side channel habitats including juvenile Chinook and steelhead. Juvenile salmonids seemed to respond to preferred diet items made available by the newly engineered habitats.

In this manner, there were observable differences between Chinook salmon and steelhead, hatchery and wild, as well as fish found in the mainstem compared to those utilizing the side channels. Restored side channel habitats like these provide beneficial rearing habitat for salmonids in regulated systems. Projects like this one aimed at increasing habitat heterogeneity and lateral habitat expansion increase potential rearing habitat in systems that are linearly limited by complete barriers such as dams. Lateral expansion of rearing habitat, may be a good manner to augment existing spawning habitat restoration efforts, thereby increasing benefit to populations of sensitive species. Restoration efforts such as these also help to increase habitat heterogeneity in degraded systems with a suite of ecological benefits.

Using GIS in Salmonid Spawning Surveys: A Valuable Tool for Designing Projects and Measuring Success

***Jose Setka** (presenter,) **Bert Mulchaey,** and **Thomas Newcomb,** East Bay Municipal Utility District*

Since 1997, EBMUD Biologists have been using GPS units to map redd locations on the lower Mokelumne River. Improvements in GPS technology have expedited data collection, improved the accuracy of positions collected, and allowed for more precision in GIS analysis. The precision of the data allows for its use in developing complex models related to habitat restoration projects and activities. In this presentation we highlight three uses of the data including spawning gravel augmentation, gravel cleansing flows, and spatiotemporal distribution analysis of spawning locations. These examples will show the benefits of collecting precision data including rapid accessibility, integration with GIS software/ analysis tools, and adaptability to modeling tools. Ultimately the information collected is used, along with data from other monitoring projects, to determine the success of river restoration efforts related to salmonid spawning.

A Comparative Study of Hatchery and Wild *Oncorhynchus mykiss* in the Lower Mokelumne River California

Joseph E. Merz, *Cramer Fish Sciences and Michelle. L. Workman* [1]

We compare feeding, habitat use and migration patterns of hatchery-produced and wild *Oncorhynchus mykiss* in the regulated lower Mokelumne River. Fish sampled by rotary screw trap and electrofishing (2006-2007) suggested volitionally-released fish grew and developed faster than their naturally-produced conspecifics, had less size variability, were less evenly dispersed, were found in fewer habitats, and emigrated earlier in the season than their wild counterparts although individuals of both groups remained in-river beyond the scope of this study. Naturally-produced juveniles had fuller stomachs containing larger and more diverse prey items. The effects of origin on piscivory and behavioral interactions on migration patterns will be discussed.

1 East Bay MUD

Restoring Natural Hydrographs: Water Resource Management and Fish

Session Coordinator: ***Gregory B. Pasternack,*** *Department of Land, Air, and Water Resources, University of California, Davis*

There exists a growing scientific understanding of the importance of a river's flow regime for linking hydrological, geomorphic, and ecological dynamics in natural rivers. Based on this understanding, experiments with naturalized flow regimes and with channel rehabilitation on regulated rivers have been underway for over a decade in the western United States. This session seeks a broad cross-section of recent research related to natural flow regimes, flow re-regulation experiments, and channel rehabilitation to answer key questions, such as 1) What are useful metrics for tracking changes in linked hydro-eco-geo dynamics?, 2) Is there hysteresis in the trajectory of change after flow re-regulation that prevents channels from returning to their pre-regulated condition?, 3) When is flow re-regulation more or less effective than channel rehabilitation?, and 4) What has happened in the major flow re-regulation experiments? Discussion of the role of institutional and political constraints on flow re-regulation is also welcome.

Engineered Channel Controls Are More Limiting Than Flow Regime for Rehabilitating Many of California's Regulated Rivers

Gregory B. Pasternack, *Department of Land, Air, and Water Resources, University of California, Davis*

In efforts to rehabilitate regulated rivers for ecological benefits, the flow regime has been one of the primary focal points of management strategies. However, channel engineering can impact channel geometry such that hydraulic and geomorphic responses to flow re-regulation do not yield the sought for benefits. To illustrate and assess the impacts of structural channel controls and flow re-regulation on channel processes and fish habitat quality in multiple life stages, comparative analyses were performed for rivers with very different flows and channel constraints—the Mokelumne, Yuba, and Trinity Rivers. In each case, highly detailed digital elevation models were produced and analyzed for a river reach downstream of the primary fish-migration barrier dam using a suite of hydrologic, hydraulic, geomorphic, and ecological methods. For the Mokelumne, results show that fish and benthic macroinvertebrates have responded positively to re-contouring the channel with 29,873 metric tons of gravel between 1999-2007, even though the flow regime has not been re-regulated. Conversely, results from the Trinity show that flow re-regulation to produce a scaled-down natural hydrograph has limited value in the reach at Lewiston Dam, because anthropogenic boundary controls have severely altered geomorphic processes associated with geomorphic self-sustainability and instream habitat availability. Finally, results from the Yuba River, with its diverse flow regime and an unnaturally plentiful supply of gravel and cobble from historic hydraulic gold mining, show the value of having much more of both flow and gravel. Given the similarity of the Trinity and Mokelumne Rivers to many others, we conclude that the potential utility of natural flow regime reinstatement in regulated gravel-bed rivers is conditional on concomitant channel rehabilitation and gravel augmentation.

System-Wide Analysis of the Potential to Restore Environmental Flows and Augment Water Supplies in the Central Valley Tributaries through Reservoir Reoperation and Fluvial Process Restoration

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In order to meet the growing water needs of all water use sectors, including the environment, water managers in the Central Valley of California must devise new strategies for expanding the benefits derived from a fixed endowment of water. There is a growing sense that this can be accomplished through more productive operation of existing storage and delivery infrastructure, in coordination with highly leveraged additions to the system. There is also a growing consensus that all future water management innovations, and physical water infrastructure developments, must provide for net environmental benefits. This paper describes how the re-operation of reservoirs can restore environmental flows for aquatic species—including salmonids—and recover important environmental benefits without impinging on the water supply purposes for which the reservoirs were constructed.

The Natural Heritage Institute (NHI) recognizes that developing secondary storage through off stream surface water storage could offer certain flexibilities not available through groundwater banking. While it has focused on conjunctive use as the most appropriate secondary storage option, NHI's work demonstrates the feasibility of the re-operation of the terminal reservoirs in the Central Valley to produce water, if the associated reservoir releases can be conveyed to secondary storage for subsequent retrieval and beneficial use. This is in contrast to most of the current discussion regarding both conjunctive use and off stream surface water storage, which tend to focus primarily on capturing peak flows in the system.

This paper describes a multi-year work plan that defines the opportunities and constraints of reservoir re-operation in association with secondary storage though conjunctive use and off stream storage in the Central Valley, both as stand-alone strategies and in combination. In addition, the project incorporates an important objective into the reservoir re-operations calculus, namely the restoration of natural hydrologic and fluvial function of important rivers downstream of the major terminal reservoirs. Evaluating this objective is also highly relevant to the efforts of the Bay-Delta Conservation Plan and the Delta Vision, which are working to restore more natural hydrologic conditions and ecological functions in the San Francisco Bay-Delta.

NHI's starting hypothesis is that reservoirs can be re-operated to release water in a pattern (magnitude, duration, and frequency) which, when added to flows that are otherwise occurring, could produce the desired fluvial process benefits, while still meeting all existing obligations for water supply, environmental restoration, and temperature control. The "surplus" water committed to this purpose will be generated by re-operating reservoirs to allow for greater capture of the peak flow events in existing on-stream reservoirs; that is, water that would otherwise be released for flood control purposes. This can be done by conveying some portion of the water released for fluvial restoration into a secondary storage facility—either a groundwater bank or an off stream storage facility—in advance of the wet season so as to create additional flood retention capacity in the reservoir. The foregone flood control releases held in secondary storage will allow all water supply obligations of the reservoir to continue to be met. Any water released for fluvial process restoration that cannot be conveyed to secondary storage could be allowed to flow through the system to meet Delta inflow/outflow requirements for the entire system. To the extent that an increase in Delta inflow/outflow freed the operators of the other reservoirs in the system from their obligation to release water for this purpose, water supply credits for a portion of the fluvial process restoration releases from a reservoir could be established in the facilities that experience a reduction in their Delta inflow/outflow release obligations.

Changes in River Ecological Functionality Due to Floods and Gravel in Two Regulated Central Valley Rivers

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Anadromous fish populations along the Pacific coast have been declining for decades, partly due to river regulation. This study presents an application of the "functional flows model" that integrates the role of hydrogeomorphic processes and ecological functions in stream physical habitat evaluations. Functional flows are discharges that serve ecological functions. In this study, the key question was how flow functionality for the spawning life stage of fall-run Chinook salmon changes in response to rapid alterations of channel morphology. The assessment of functional flows involved evaluation of shear stress dynamics to determine sediment transport stages favorable for ecological functions that require either channel stability or change. Ecological functions studied were bed occupation—spawning, incubation, and emergence—and bed preparation-periods when the river bed is reworked. Model inputs were discharge, cross section geometry, water surface slope, and median bed-material grain size. Model outputs were the ranges of streamflow that are functional, and the number of days within a water year that present functional flows. The model was applied to evaluate the ecological functionality of riffles undergoing rapid hydrogeomorphic changes in two different rivers supporting fall-run Chinook salmon: the narrow, sediment starved, low-flow Mokelumne River (MR) which has undergone river habitat rehabilitation through gravel augmentation, and the wide Yuba River (YR), with abundance of hydraulic mining sediment in floodplain and diverse flow regime which has undergone rapid morphologic changes due to floods. Each river was analyzed at three cross sections and at three water years. Results indicate that river rehabilitation on the MR has caused a statistically significant increase in the number of days with functional flows and that natural floods on the YR has caused a statistically significant increase in the functional ranges of flows even as the channel incises. A comparison between the rivers shows that the even though the Mokelumne River presents greater geomorphic performance, the YR presents greater ecological performance due to the ample availability of flows. Functional flows analysis provided an objective comparative tool to assess changes in ecological functionality at distinct hydrogeomorphically dynamic sites.

Can Gravel Augmentation Below Dams Mitigate Thermal Effects of Reservoirs?

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Reintroducing gravel to rivers whose sediment supply has been reduced or depleted by dams and reservoirs is emerging as a new approach to river restoration. Although gravel augmentation is primarily used to allow rivers to rebuild bars, riffles, and other habitat features, it may also help mitigate the thermal effects of reservoirs by increasing hyporheic exchange, thereby reducing temperature peaks and variation. The hyporheic zone influences the thermal regime of rivers, buffering temperature by storing and releasing heat over a range of timescales. We examined this relationship between hyporheic exchange and temperature along a 24-km reach of the lower Clackamas River, a large gravel-bed river in northwestern Oregon (median discharge = 75.7 m3/s; minimum mean monthly discharge = 22.7 m3/s in August 2006.) With a simple mixing model, we estimated how much hyporheic exchange cools the river during hot summer months. Hyporheic exchange was primarily identified by temperature anomalies, which are patches of water that demonstrate at least a 1 °C temperature difference from the main channel. Forty hyporheic temperature anomalies were identified through field investigations and TIR (Thermal-Infrared-Radiometry) in summer 2006. The location of anomalies was associated with specific geomorphic features, primarily bar channels and bar heads that act as preferential pathways for hyporheic flow. Detailed field characterization and groundwater modeling on three Clackamas gravel bars indicate residence times of hyporheic water can vary from hours to weeks and months. This was largely determined by hydraulic conductivity, which is affected by how recently the gravel bar formed or was reworked. Upscaling of modeled discharges and hydrologic parameters from these bars to the other anomalies on the Clackamas network shows that hyporheic discharge from anomalies comprises a small fraction (<< 1%) of mainstem discharge, resulting in small river cooling effects (0.012 °C.) However, the presence of cooler patches of water within rivers can act as thermal refugia for fish and other aquatic organisms, making the creation or enhancement of hyporheic exchange an attractive method in restoring the thermal regime of rivers. These data provide a sound technical basis for predicting likely temperature benefits of gravel augmentation and designing optimum augmentation strategies.

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Improving the Understanding of Sediment Pulse Impacts on Downstream Biological Processes

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Dam removal is an effective measure for restoring regulated rivers in many instances, allowing at least a partial return to natural flow conditions and sediment supply to downstream reaches. Certain short-term negative ecological effects following dam removal, however, may hamper the removal of some of the dams that could otherwise be suitable for decommissioning. For example, fine sediment released as a result of dam removal can cover downstream bed deposits, thereby significantly affecting key aquatic biological processes for uncertain duration.

We have conducted theoretical, physical, and numerical studies at multiple spatial and temporal scales that provide insights into some of those potential negative short-term impacts following dam removal, including (1) the infiltration of fine sediment into gravel deposits that may serve as spawning habitat; and (2) the dynamics of downstream movement of the reservoir deposits at both the reach and the biological habitat unit scale.

Flume experiments on fine sediment infiltration into a static bed show that the amount of fine sediment infiltration does not increase as the sand feed rate increases, indicating potential benefits of a quick sediment release. Through a series of regression analyses that combine physical principles with experimental data, we developed a theory and quantitative relations describing the process of fine sediment infiltration.

The theory and relations indicate that the infiltration process is largely governed by the grain size distributions of the ambient bed material and infiltrating fine sediment. Results from the theory and the relations suggest that the interaction of fine sediment with the coarse bed material following dam removal will be limited only to a very shallow depth of the coarse deposit. This further implies that a quick sediment release will be advantageous in terms of limiting impacts from fine sediment infiltration because the fine sediment source will exhaust more rapidly and allow subsequent high flows to remove the remaining fine sediment on the channel surface and at shallow depths within the channel bed.

Experiments releasing large volumes of fine and coarse sediment, similar to a dam removal scenario, into a channel with pool-riffle morphology and armored bed provide many insights into sediment deposition and erosion patterns at a morphologic unit (or habitat unit) scale. For example, we found that pools did not ubiquitously fill in with sediment, but maintained water depths similar to their initial depths in areas of higher shear stress while contracting in areal extent as sediment accumulated in areas of lower shear stress. Comparison of results from previously developed 1-D numerical models (DREAM-1 and -2) with the experimental data indicates that the two models closely reproduced the fine and coarse sediment deposition and erosion process on a reach-average scale. Results from the studies are then correlated to anticipated impacts on biological processes such as salmonid egg incubation and survival-to-emergence.

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SRF Mission Statement

The Salmonid Restoration Federation was formed in 1986, to help stream restoration practitioners advance the art and science of restoration. Salmonid Restoration Federation promotes restoration, stewardship, and recovery of California native salmon, steelhead, and trout populations through education, collaboration, and advocacy.

SRF Goals & Objectives

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

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