32nd Annual Salmonid Restoration Conference

March 19-22, 2014, Santa Barbara, CA

Recovery Strategies for Coastal Salmonids

2014 Conference Co-sponsors

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Welcome

to the 32nd Annual Salmonid Restoration Conference in Santa Barbara

The theme of this year's conference is "Recovery Strategies for Coastal Salmonids" and the conference agenda highlights innovative strategies and implementation techniques to restore and recover salmonids. This conference agenda also explores large-scale issues affecting fisheries recovery including climate change and drought as well as the social aspects of how we steward water, plan for resiliency, and leverage limited resources.

In this era of global climate change we are witnessing the effects of extended drought on a landscape level. The conference field tours and workshops focus on community planning and solutions to increase fish passage and improve water management practices.

Conference field tours will visit Ventura River Parkway and the legendary Matilija Dam, urban creek and fish passage projects in Santa Barbara, projects on the Gaviota Coast and Santa Ynez River, and representative anadromous fish habitat restoration projects in the Santa Clara River watershed. Workshops will examine innovative and successful restoration practices including reopening blocked fish passage, innovative stormwater and water conservation programs, steelhead and beaver interactions, and new resources for coastal monitoring.

This year's conference agenda includes a Southern steelhead track that focuses on Southern steelhead life histories, habitat restoration techniques from estuaries to tributaries, and key recovery strategies. Other sessions include: Monitoring Restoration Effectiveness through Fish Habitat Relationships, Landscape Ecology of Salmonids, Living With and Without Dams, California's Salmonid Restoration Economy, Urban Creek Restoration, and Historical Ecology of Salmonids.

The Plenary session focuses on elements of recovery and the landscape of restoration: water and climate extremes, recovery strategies, small and large-scale restoration actions, and what it all means for salmonid recovery.

This annual conference serves as a venue to share newly adopted protocols, learn about pioneering restoration techniques, and engage in constructive discourse about fisheries recovery strategies.

Organizing this conference has been a great barometer for how much the salmonid restoration field has evolved in the last eight years since we last hosted the conference in Santa Barbara. The partnerships and coalitions involved in building the agenda this year have been incredibly cooperative, insightful, and enthusiastic.

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

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

Thanks to all the conference participants who migrate tirelessly to participate in the largest salmon restoration conference in California and for joining us in our efforts to enhance the art and science of restoration, and ultimately recover wild salmonid populations.

Dana Stolzman

Agenda Coordinator
Executive Director
Salmonid Restoration Federation

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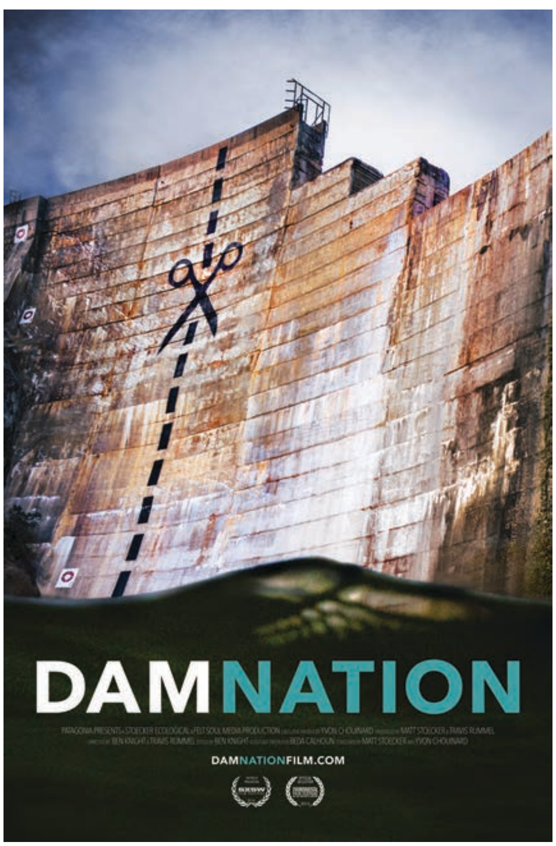
Wednesday, March 19

Pub Crawl and Wine Stroll in the Funk Zone



Thursday, March 20

SRF Annual Membership Meeting
5:30-6:30 pm, Ocean View Room

SRF Membership Dinner
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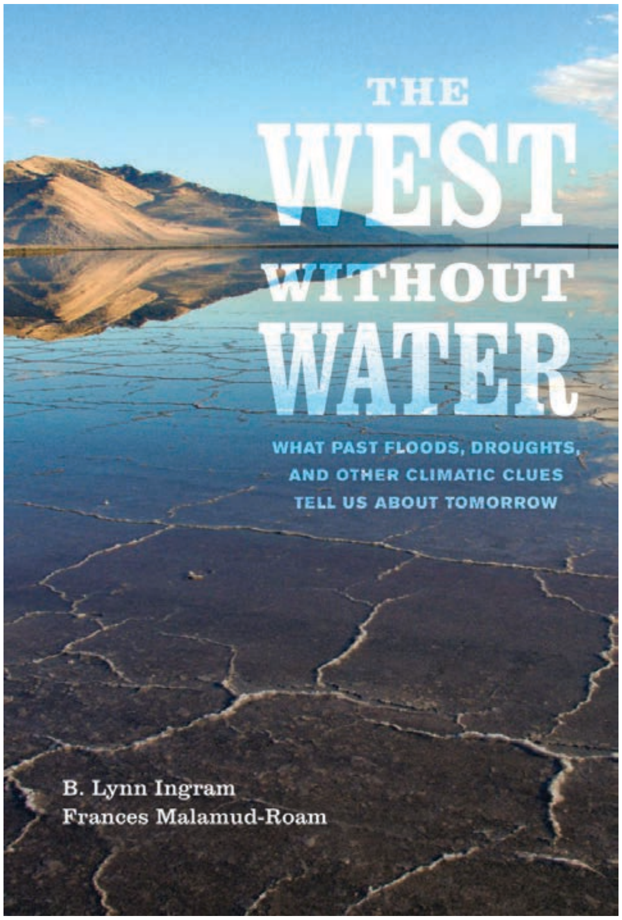
Film Screening

Steelhead Against All Odds
DamNation



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co-author of *The West Without Water*

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Banquet Band

Casey Neill and the Norway Rats

Southern Santa Barbara Coastal Streams Tour: Fish Passage on Agricultural and Urban Streams

Wednesday, March 19

Tour Coordinators*: **George Johnson,** City of Santa Barbara, and **Mauricio Gomez,** South Coast Habitat Restoration*

The Southern Santa Barbara Coastal Streams field tour will stop at several streams where agencies and non-profit organizations have improved habitat for the Southern steelhead trout. We will visit modified debris basins, low water crossing removal/bridge installation, and modified concrete trapezoidal channels. The field tour will provide participants an opportunity to learn about the difficulties in implementing projects on private agricultural and public lands.

Southern California Steelhead Monitoring and Research

Wednesday, March 19

Workshop Coordinator*: Dana McCanne, California Department of Fish and Wildlife*

The Southern California Steelhead Monitoring and Research Workshop is designed to give attendees an overview of the California Coastal Salmonid Monitoring Program (CMP), a statewide implementation program for the Southern California Steelhead Distinct Population Segment. The workshop will start with current monitoring projects that predate CMP implementation on the South Coast. Next, we will feature current CMP efforts, including the utilization of DIDSON technology, as well as future CMP plans. Research needs for the CMP will be presented, as well as the genetics of Southern California steelhead. There will be a presentation on GIS tools that the CMP utilizes to model fish distribution, develop sampling frames, and provide project support. Finally, the database that all CMP projects use will be introduced, with emphasis on how to get data into and out of the database and how to utilize open-source tools.

Passive Monitoring Techniques for Steelhead Migration in the Santa Clara River

Steve Howard (Presenter) *and* ***Mike Booth,*** *United Water Conservation District*

Monitoring steelhead migration in southern California is challenging due to a variety of factors including regulatory limitation on active capture of migrating fish, extreme variability in river hydrology, high sediment loads and low water clarity, and vandalism. Southern California steelhead were listed as endangered by the federal government in 1997, thus reducing the use of active trapping methods within the Southern DPS from the Santa Maria River to the Mexico border. In the Santa Clara River (Ventura County), United Water Conservation District's steelhead monitoring program actively trapped adult steelhead following the completion of the Freeman Diversion fish ladder in 1991, until the species was federally listed in 1997. The elimination of active trapping created a need for more sophisticated passive monitoring techniques. In the early 2000s the District developed a passive monitoring system that included a surveillance camera, infrared scanners, a digital video recorder, and a false weir that forced adult steelhead to jump out of the turbid water to be detected and identified. This system was upgraded in 2010 and again in 2012 by adding high resolution, infrared low-light 0.05 lux color cameras and a computer-controlled surveillance monitoring system that includes motion detection and alarms that can be tracked in real-time and accessed remotely. To assess whether fish were impeded or delayed by the fish ladder, a Dual Frequency Identification Sonar (DIDSON) camera was deployed to monitor steelhead migration timing and behavior as adults arrive at or below the entrance gates. Two DIDSON mounts were designed and fabricated in 2010 and the DIDSON was tested in various locations within the fish ladder as well as in the river below the fish ladder. Operational constraints were identified in 2010 and initial migration data were collected during the 2011 steelhead migration season. A new fish passage facility at the Freeman Diversion is in the early design phase and will have passive monitoring designed into the structure. Early concepts for migration monitoring include incorporating fixed sonar into low turbulent areas of the facility to enumerate anadromous fish including steelhead and Pacific lamprey passing the facility. These complementary technologies, lessons learned, and initial monitoring results will be presented.

Five Years and Counting of Lifecycle Monitoring of *Oncorhynchus mykiss* in Topanga Creek, CA

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

Topanga Creek is a small coastal watershed draining 47 km^2 into the Santa Monica Bay in Los Angeles County. Located entirely within Topanga State Park, the creek is characterized by a narrow mainstem channel, numerous faults, and a well-established riparian corridor. The gradient varies from one to six percent, low in the lower reach and higher in the upper reach. Despite flashy hydrologic conditions common to steep gradient creeks, Topanga Creek provides suitable spawning, summer and winter rearing, and persistent refugia habitat for endangered Southern California steelhead (*Oncorhynchus mykiss*). A one to one and a half kilometer section of the lower reach is typically intermittently dewatered for a portion of the dry season.

Lifecycle monitoring of *O. mykiss* in Topanga Creek was initiated in 2008. At that time, we established a fall mark-recapture effort using passive integrated transponder (PIT) tags and scale and tissue sampling, followed by installation of an instream antenna and migrant weir traps during rain events. Beginning in 2010, we added gastric lavage sampling, as well as more formalized redd surveys and a spring mark-recapture event. With the support and collaboration of the California Department of Fish and Wildlife, we conducted trial deployments of a Dual Frequency Identification Sonar (DIDSON) camera in April 2012 and January 2013. We are beginning to implement a full migration monitoring program that will include simultaneous deployment of all these tools. This presentation will describe the practical logistical field challenges associated with each of these methods, the strengths and limitations of each method, as well as data analysis and management.

Snorkel Surveys as a Method of Monitoring *Oncorhynchus mykiss* in Small Southern California Coastal Streams

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

The Resource Conservation District of the Santa Monica Mountains has been monitoring Southern California steelhead (*Oncorhynchus mykiss*) in three watersheds in the Santa Monica Mountains (Topanga, Malibu, and Arroyo Sequit) for over a decade. The first official sighting of a single *O. mykiss* in Topanga Creek occurred in 1998, and since 2001, the population in Topanga Creek has been the most consistently monitored. Monitoring in Malibu and Arroyo Sequit Creeks started in 2005. This talk will focus on our snorkel survey methodology and associated temperature monitoring.

Snorkel surveys are an effective, relatively low-cost, and low-impact method of tracking the population dynamics of Southern *O. mykiss*. They are particularly useful in deep pools where electrofishing is not feasible. Surveys are conducted by a team of two to four trained biologists and/or volunteers moving in an upstream direction from the lagoon to the upstream limit of anadromy. The number and sizes of *O. mykiss* observed are recorded as is location and habitat data. The presence and abundance of other aquatic species, including native Arroyo chub (*Gila orcutti*), and invasive red swamp crayfish (*Procambarus clarkii*), largemouth bass (*Micropterus salmoides*), carp, and other invasive species are recorded as well. The strengths and limitations of this method will be discussed.

During the dry season (April to October), instream water temperature loggers are deployed in several pools representing typical habitat characteristics and variability. This allows us to continuously monitor the water temperature during a potentially stressful period in pools known to be consistently inhabited by *O. mykiss*. A discussion of the summer temperature monitoring issues will be provided.

Ventura River Basin Steelhead Monitoring, Evaluations, and Research

Scott D. Lewis (Presenter) and **Michael W. Gibson,** Casitas Municipal Water District

The Casitas Municipal Water District began a steelhead monitoring, evaluation, and research program in 2006 with the completion of the Robles Fish Passage Facility. The program includes activities stipulated in a biological opinion necessary for the operation of the Robles Fish Passage Facility. Additionally, baseline monitoring was initiated to provide data on basin-wide environmental and biological trends. Finally, a few key research objectives were developed to understand steelhead/rainbow trout life histories in the Ventura River Basin. The natural hydrologic variation has limited various aspects of the program, but interesting trends and observations have been detected. In addition to a general discussion the Casitas Fisheries Program, several aspects of the program will be presented in greater detail.

The Robles Fish Passage Facility was completed in 2006. This facility was constructed to allow passage for steelhead migrants into historic habitats in the upper Ventura River and North Fork Matilija Creek, which were blocked in 1958 by the Robles water diversion dam. The steelhead monitoring and evaluations outlined in the Biological Opinion were intended to determine the effectiveness of the facility design and operational criteria. These activities include: (1) passage monitoring using a Vaki Riverwatcher and supplemented with snorkel surveys, (2) smolt migration behavior using primarily radio telemetry methods, (3) critical riffle evaluations to validate operational criteria, and (4) sandbar monitoring to determine operational protocol.

Since the Ventura River was lacking any significant ongoing steelhead monitoring, additional basic data collection efforts were started to support other aspects of the Casitas Fisheries Program. Initial stream habitat surveys were conducted to provide a foundation of fundamental habitat characteristics that could be used with future work and analyses. Environmental basin ambient water quality monitoring was initiated to further support other efforts. This included basin-wide steelhead/rainbow trout snorkel surveys to determine steelhead's presence or absence, and general seasonal and annual trends. Closely related, spawning surveys are conducted annually. To understand basin *Oncorhynchus mykiss* connectivity patterns, surface down- and up-welling locations have been monitored in the Ventura River and selected tributaries.

In addition to monitoring and evaluation, research to address key basin-specific life history and population characteristics has been initiated. The three primary objectives of this research are to (1) determine the level of population genetic structure that exists in the steelhead/rainbow trout sub-populations across the basin and identify possible causes and implications, (2) determine smoltification patterns of steelhead/rainbow trout and how those patterns may influence the relation between the two life history forms, and (3) determine juvenile downstream migration patterns for steelhead/rainbow trout and determine how those patterns may be influenced by environmental conditions.

History of Steelhead Monitoring on the Lower Santa Ynez River from 1994 to the Present

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

Through a series of inter-agency agreements, a Biological Opinion, and monitoring plans from 1994 to 2001, a consensus-based long-term Fish Management Program was developed that provides for the monitoring, maintenance, protection, and habitat restoration for the endangered Southern steelhead (*Oncorhynchus mykiss*) downstream of Bradbury Dam on the Lower Santa Ynez River (LSYR). This program began in 1994 as a pilot study looking at the general distribution of steelhead and available habitat within the LSYR watershed. After steelhead were listed as endangered in 1997 and the 2000 Cachuma Project Biological Opinion was issued by the National Marine Fisheries Service to the United States Bureau of Reclamation, the Cachuma Project Water Agencies began a systematic, full-scale monitoring program looking at every aspect of the fishery below Bradbury Dam as it pertained to steelhead protection and recovery. This included monitoring of all accessible mainstem and tributary reaches, fish passage impediments and improvement projects, habitat restoration, and adaptive management activities. Some of the ongoing monitoring activities include migrant trapping, spawning surveys, habitat mapping, native and non-native species monitoring, water quality monitoring, and oak tree mitigation from reservoir surcharging. Specific actions to improve the fishery include fish passage impediment removal, augmented flows for fish passage during the migration season, stream bank stabilization and erosion controls, releases for LSYR mainstem rearing, and pool habitat modifications to improve water quality. The components and general results of the LSYR Fish Management Program will be presented with a specific focus on the transient and over-summering steelhead population observed, habitat water quality within the LSYR basin, population tracking of other species of interest, and performance evaluation of completed tributary enhancement projects. The long-standing dataset of the LSYR Fisheries Program continues to be instrumental in the collective understanding and recovery efforts for Southern steelhead within the Santa Ynez River and other watersheds within the Southern California Distinct Population Segment and Biogeographic Population Region.

Building a Southern California Steelhead Monitoring Program

Mary Larson (Presenter), Chris Lima, *and* ***Dana McCanne,***
California Department of Fish and Wildlife

Southern California steelhead is the southernmost Distinct Population Segment (DPS) of *Oncorhynchus mykiss* and inhabits anadromous streams from the Santa Maria River in northern Santa Barbara County to the Mexican border. This DPS is listed as endangered under the Federal Endangered Species Act (FESA). Data used to support this listing state that only 500 anadromous individuals remain in the DPS. This estimate of 500 fish was a best guess by a department biologist in the absence of any field-collected data. Recent monitoring efforts in the Santa Monica Mountains, and the Santa Clara, Ventura, and Santa Ynez Rivers will not provide the information required to either estimate the number of adult steelhead or assess the appropriate FESA status of the DPS.

A steelhead monitoring program is being developed for the Southern California DPS as part of the statewide California Coastal Salmonid Monitoring Program (CMP). This project will utilize existing efforts in the Santa Monica Mountains, and the Santa Clara, Ventura, and Santa Ynez Rivers, modifying them to provide the data required by the CMP and expand into Southern California steelhead populations currently not monitored. The CMP is developing field protocols that all groups associated with the CMP must follow, as data will be pooled and analyzed across projects. Additionally, the CMP will create sampling frames and draw a random sample of stream reaches which will guide all project sampling. In addition to population estimation, this project must also address numerous research questions described in the Southern California Steelhead Recovery Plan (National Marine Fisheries Service, 2011). Research will address steelhead life history strategies, abundance, productivity (freshwater and marine), distribution, diversity, habitat requirements, and habitat condition.

Currently, CMP level monitoring is occurring in the Lower Santa Ynez Basin, southern Santa Barbara County streams from Jalama to Rincon Creeks, and in the Santa Monica Mountains. In the near future, CDFW will be working to develop monitoring in the Sisquoc Basin and build on existing efforts to have CMP level monitoring in the Santa Clara Basin. Once the majority of steelhead distribution is under a monitoring plan from the Santa Maria Basin to Topanga Creek populations, CDFW will begin developing monitoring plans for Los Angeles River to the Mexican border.

Methods Used in Southern California Steelhead Monitoring and Research

Dana McCanne (Presenter), Mary Larson,* and *Chris Lima,
California Department of Fish and Wildlife

The statewide California Coastal Salmonid Monitoring Program (CMP) has begun a program to monitor the Southern California steelhead (*Oncorhynchus mykiss)* Distinct Population Segment (DPS), a fish population listed as endangered under the Federal Endangered Species Act. This will be a very long-term project that must measure the status and population trend for Southern California steelhead, plus the effectiveness of restoration projects. The methods used in the research and monitoring plan are being developed to adhere to California Coastal Salmonid Population Monitoring: Strategy, Design, and Methods (Fish Bulletin No. 180, Adams et al. 2011) and the Southern California Steelhead Recovery Plan (National Marine Fisheries Service 2012).

Fish Bulletin No. 180 calls for adult abundance estimation, distribution surveys, diversity monitoring, and life cycle monitoring stations (LCS). Diversity monitoring needs to address anadromy/resident ratio, sex ratio, fecundity (including egg size), age and size structure, habitat utilization patterns (freshwater and marine), emigration age and timing, maturity patterns (includes winters at sea), adult spawning timing, and physiological tolerances. LCSs will estimate adult escapement and smolt outmigration, and will be the location for the majority of research studies.

The Recovery Plan lists population-level recovery criteria for delisting, and research needs to refine the recovery criteria. The four population-level recovery criteria are mean annual run size (extinction risk <5% over 10 years), ocean conditions (run size criterion met during poor ocean conditions), spawner density, and anadromous fraction (resident trout are not included in the other criteria). Research activities need to identify ecological factors that promote anadromy, investigate the reliability of migration corridors (and the relationship to anadromous fraction), identify steelhead-promoting nursery habitats, evaluate seasonal lagoons, investigate the potential role of mainstem habitats and intermittent creeks, investigate spawner density as an indicator of viability, clarify population structure, investigate partial migration and life history crossovers, measure the rates of dispersal between watersheds, and provide information to revise the research and monitoring plan.

The Southern California steelhead research and monitoring program is developing two LCSs and a sampling frame for the southern Santa Barbara streams (from Jalama to Rincon Creeks). The first LCS started by the program in the Ventura Basin included redd surveys and Dual Frequency Identification Sonar (DIDSON) operations beginning in 2012. The Ventura basin has also been monitored by Casitas Municipal Water District and NMFS for a number of years. On the ground development for an LCS in the Carpinteria Basin began in December 2013. The tools currently used for monitoring are redd, habitat, and fish distribution surveys. DIDSON units are deployed in the Ventura River, Carpinteria Creek, Santa Ynez River, and Salsipuedes Creek. Trapping and tagging studies have been delayed due to the low rainfall for the 2011-2012 and 2012-2013 water years resulting in high mortalities. Once conditions improve and the data from the existing surveys are analyzed, work on the research projects will begin.

DIDSON in Southern California Streams: Challenges and Potential Solutions

Sam Bankston (Presenter), Heidi Block, *and* ***Patrick Riparetti,*** *Pacific States Marine Fisheries Commission; and* ***Mary Larson, Chris Lima,*** *and* ***Dana McCanne****, California Department of Fish and Wildlife*

The California Department of Fish and Wildlife South Coast Region Steelhead Monitoring Program in cooperation with Pacific States Marine Fisheries Commission (PSMFC) has begun a program to monitor endangered Southern California steelhead trout using dual frequency identification sonar (DIDSON) units. DIDSON units can be incredibly useful in monitoring fish passage of special status species.

As with all sampling methodologies, there are pros and cons to DIDSON usage. To maximize the utility of a DIDSON operation, it is best to recognize the limitations presented by the equipment and sampling site.

This presentation will explore several challenges to consider when planning and implementing a DIDSON monitoring project, which have been highlighted over the course of our operations in southern California. These include deployment in shallow or flashy systems and challenges related to species identification. We will also present solutions developed by the South Coast Region Steelhead Monitoring Program to maximize success of the DIDSON sampling program and highlight future research plans. Southern California Steelhead Monitoring and Research

The Coastal Monitoring Plan Aquatic Survey Program

Douglas Burch (Co-Presenter), Tom Christy (Co-Presenter), *and* ***Seth Ricker,***
California Department of Fish and Wildlife

This program was developed by the California Department of Fish and Wildlife (CDFW) Northern Region to address the database management requirements of the Coastal Monitoring Plan (CMP), Fish Bulletin No. 180, which describes the overall strategy for meeting the monitoring needs of California coastal salmonids, during an interim period and until a state-sponsored enterprise-level monitoring data management system can be developed and implemented. By taking advantage of an already existing data management model, the Field Data Collection Database Template, developed by ad hoc partners within the CDFW for rapid implementation of databases that place an emphasis on the needs of field data collection projects, i.e., manages the raw data well yet is easily scalable to an enterprise system, a workable approach was ready within a short timeline. In conjunction with this database effort, a number of spatial data management concerns had to be addressed in order to also develop a GIS layer, "Cal Streams," that maps survey data to linear stream events as well as provides for all of the requirements of the statistical method, i.e., Generalized Random Tessellation Stratified (GRTS) sampling, used by the CMP. The end products of these efforts have built on earlier efforts within the CDFW, and have shown themselves to be a success by way of a database system that biologists and project leads can manage themselves to a large degree yet adheres to a well-conceived database standard. In addition, the "Cal Streams" stream-based routed GIS layer is now available for use by other efforts beyond the scope of the CMP. And, processes have been developed that provide CDFW Environmental Scientists a tool for quickly deriving any and all of the desired metrics needed for CMP reporting.

Influence of Adaptive Genetic Variation on Life-History in Steelhead/Rainbow Trout

Devon Pearse, PhD, ***Fisheries Ecology Division, NOAA Fisheries, Southwest Fisheries Science Center and University of California, Santa Cruz***

Variation in expression of anadromy in *Oncorhynchus mykiss* is influenced by a combination of environmental, genetic, and developmental effects. However, local adaptation to novel environments, such as above barrier dams, may be accompanied by genetic changes in specific genomic regions that are linked to genes under divergent natural selection. Although such regions may be population-specific, identification of the same genomic regions in multiple studies provides concordant evidence that a particular region contains genes important for adaptive evolution of the selected traits. In *O. mykiss,* a single genomic region on the chromosome Omy5 is strongly associated with life-history variation in resident and anadromous populations in southern California and elsewhere. This association influences genetic variation at the population scale as well as each individual's probability of expressing anadromy. Accurate identification of regions in the genome that are under divergent selection will extend our knowledge of the genetic basis of life-history variation, as well as provide useful information for the management of this species in the context of region-wide population structure.

We Have Much More to Learn about the Basis for Anadromy in Southern Steelhead

David A. Boughton, PhD, NOAA Fisheries, Southwest Fisheries Science Center

In general, the resident form of *Oncorhynchus mykiss* is widespread in southern California watersheds but the anadromous form is not, and a clear priority is better understanding of why this is so. I describe three general areas of research that may aid progress: (1) field studies on the ecological basis for partial migration in *O. mykiss* inhabiting chaparral watersheds, (2) focused studies on the potential role of alluvial rivers in supporting anadromous life-histories, and (3) continued development of efficient quantitative methods for integrating population dynamics and habitat dynamics. I would like to have some discussion of the most productive way to use scarce resources to make progress on these questions, and make some proposals. In addition, it may be worth starting some discussion of how to better learn about impacts of introduced fish species on expression of the anadromous life history in *O. mykiss*.

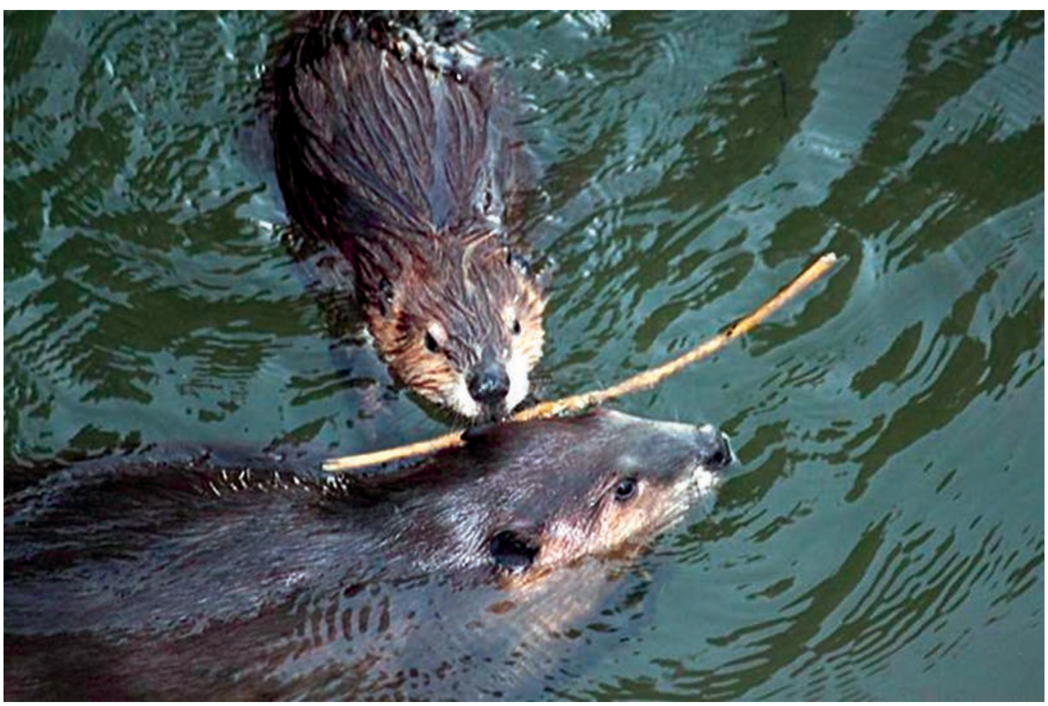
Steelhead and Beaver Interactions Workshop and Field Tour

Wednesday, March 19

Workshop Coordinator*: Tim Robinson, PhD,* *Cachuma Operation and Maintenance Board*

The Southern steelhead (*Oncorhynchus mykiss*) and the North American beaver (*Castor canadensis*) have co-existed in parts of the Southern California Steelhead Distinct Population Segment (DPS) specifically on the Lower Santa Ynez River (LSYR) since before Southern steelhead were listed as endangered in 1997. Under question are whether beaver are native or introduced to this area and whether their existence in rivers supports steelhead recovery in a Mediterranean-like climate.

This workshop will provide a half-day of presentations on the current state of steelhead and beaver within west coast watersheds. The focus of the presentations will be on the interaction and co-habitation of the two species using examples from within and outside of the local DPS. The workshop will bring together beaver experts and fisheries biologists in the spirit of collaboration to shed light on this subject that is not well understood in southern California. The afternoon will be dedicated to going to the Santa Ynez River on a field tour to visit multiple sites where steelhead and beavers are present. Observations of the co-habitation of the two species within the LSYR and its tributaries will be discussed in relation to steelhead migration of upstream adults and downstream smolts, alteration of spawning habitat due to the growing spatial extent of beaver pond formation, water quality within and outside of those ponds influencing steelhead rearing, and creation of favorable habitat for numerous aquatic non-native species within those ponds. Potential management strategies for steelhead and a growing population of beaver and other exotic species will be discussed in context of steelhead preservation, dam releases for steelhead migration and dry-season rearing, habitat restoration, and downstream water rights releases.



Evidence That the North American Beaver was Native to California's Coastal Watersheds

***Richard B. Lanman (Presenter)** and **Christopher W. Lanman,** Institute for Historical Ecology;*
***Kate Lundquist** and **Brock Dolman,** Occidental Arts and Ecology Center's WATER Institute;*
***Heidi Perryman,** Worth A Dam; **J. Eli Asarian,** Riverbend Sciences;*
*and **Michael M. Pollock, PhD,** NOAA Fisheries*

Evidence that North American beaver were native to the watersheds of San Francisco Bay and California's coast (the study area) is important to stream restoration efforts because beaver dams create complex pool habitat that is preferred by juvenile salmonids. This abstract highlights novel findings extending the historical range of beaver to California's coastal streams. Although the historical range of beaver in California was long thought to be limited to the Central Valley, it was recently shown that the mammal is also native to the Sierra Nevada. Here, we present evidence that the historic range of beaver also extends to California's coastal watersheds, based on verifiable (physical) and documented (reliable observational) records.

The physical records include confirmation that a beaver skull was collected in 1906 by John Hornung on Sespe Creek, a tributary of the Santa Clara River in Ventura County. In a 1914 letter penned by the Los Angeles County Museum of Natural History zoologist to Joseph Grinnell, Hornung confirmed that he shot the beaver three miles east of Cold Springs on Sespe Creek. He added: "There are still quite a few beaver in southern California, myself being so lucky as to get hold of one as late as Dec. 24, 1913, three weeks ago." Another beaver skull located in the Smithsonian National Museum of Natural History was collected in 1855 by John G. Cooper in Santa Clara, California. Archaeological evidence of beaver from the sub-atlantic Holocene include several remains of beaver teeth and bones from the Emeryville shellmound as well as a beaver tooth at CA-ALA-555 in the Alameda Creek watershed, both Alameda County sites. Additionally, a 500-1,000 year old beaver molar was found at CA-HUM-277, a coastal location near Randall Creek, south of the Mattole River in Humboldt County.

Documentary records were defined as accounts of beaver by reliable observers such as scientists, trappers, or rangers. Amongst the most noteworthy documentary records included ca. 1900 accounts by ethnolinguist John Peabody Harrington for Santa Barbara County. He reported beaver on Zanja de Cota Creek, a perennial tributary of the Santa Ynez River, and on San Antonio Creek's Los Alamos Valley, also in Santa Barbara County. In addition, Harrington wrote that on the historic Rancho Santa Rosa, "There is Otter Lake, commonly called in Spanish. "Laguna de las Nutrias"… Otter Lake is called in Indian "tš p k isiyo," meaning "Laguna de los Castores." These animals are sometimes called las nutrias but incorrectly for they are really beavers. The otter is an ocean creature. The Indians call otter 'ukpaaš. The Spanish speaking people [refer to Beaver Lake] however, [as] Laguna de las Nutrias. It should be called, however, Laguna de los Castores." The colonial Spanish used the word "nutria" for beaver, perhaps because beaver and otter were extirpated in Spain by the 17th century. David Hoffman reported beaver amongst the fauna of San Diego County in 1864, and a beaver was trapped in 1889 in the north County.

These highlighted findings and additional evidence together extend the historic range of beaver to our entire state.

The Current Distribution of Beavers in California: Implications for Salmonids

Eli Asarian, Riverbend Sciences

This presentation will provide an overview of the current distribution of beavers in California, efforts to update the distribution map, and studies of the effects of beavers on salmonid habitat in the Klamath Basin and California's northern coast.

By the early 20th century, beaver were nearly extirpated from California due to more than a century of intensive trapping and habitat loss. Due to a combination of time, reduced levels of trapping, and a statewide relocation program from 1923-1950, beavers have re-colonized a substantial portion of California. While the complete current distribution is unknown, beaver range is likely still expanding on the California coast and the Sierra Nevada. Recent examples include the re-colonization of beavers into the Russian River basin (Santa Rosa Creek) in 2011 from the adjacent Sonoma Creek watershed, and the upper South Fork Eel River sub-basin in 2012 from the adjacent Outlet Creek watershed.

The Beaver Mapper (*http://www.riverbendsci.com/projects/beavers)* is an online collaborative project to map the distribution of beavers in California, with the goal of providing information to guide the restoration of beaver and salmonid populations. The Beaver Mapper is based on Google Maps and Google Fusion Tables and can be live-edited by many dispersed users across the Internet.

Due in part to the limited current distribution of beavers, studies of the effects of beavers on salmonid habitats in California's northern coast are relatively uncommon. One exception is the Klamath Basin, where recent monitoring and research projects indicate that slow-water habitats in beaver ponds provide high-quality rearing habitat for juvenile coho salmon and steelhead.

The Effect of Beavers on an Urban Stream; Qualitative Observations from Six Years of Citizen Science

Heidi Perryman, PhD, ***Worth A Dam***

In 2007, the City of Martinez was prevented from responding to a problematic dam in Alhambra Creek using trapping. Public pressure forced the city to try instead the installation of a flow device that successfully controlled flooding and allowed the beavers to remain. The subsequent wetlands created drew a succession of at least 15 new species to date, increased the range of rare and shy animals to make them more observable, allowed close observation of beaver behavior with opportunities for broad field education, and encouraged civic participation through ecological awareness. The effects of beaver-assisted creek restoration in an urban setting and the role of citizen science are discussed.

Much has been written about the biodiversity of beaver ponds and their subsequent effect on multiple species. However, these papers often focus on woodland and forest settings or open spaces where beavers could be more easily tolerated and hardscape played little role in creek channels. What would happen if the same principals of water storage, organic matter breakdown, benthic macro invertebrate bloom, and insect diversification happened in an urban creek, burdened with concrete borders and street runoff?

The City of Martinez learned the answer firsthand, with an increasingly diverse bird display, a booming fish population that included three new species, frogs, turtles, otter, and mink. Certainly a human visitor to the creek in 2006 would have seen a very different slice of ecology than what we are served now. With 15 new species identified so far, and more emerging every month, the effect of beavers on our urban creek can be well demonstrated.

The flow device installed, Skip Lisle, has controlled pond height for more than six years now. Because this has allowed the beavers to remain, they use their own naturally territorial behaviors to keep others away. Young disperse to seek their own territory at two, so our population remains at seven. Resolving their flooding challenges was actually easy to do. The hard part of this journey was getting officials to think of the many ecological benefits beyond the addictive, short-term solution of trapping.

Effects of Beaver Dams on Steelhead Populations, A Review of the Science

Michael M. Pollock, PhD, ***Northwest Fisheries Science Center, NOAA Fisheries***

I review available scientific evidence on the use of beaver dams and ponds by steelhead and rainbow trout, drawing extensively on our own research on steelhead-beaver interactions in dryland environments. Relationships between beaver and steelhead are not well known, and there is concern in some dryland rivers (e.g. the Santa Ynez) that beaver dams may create habitat conditions that are unfavorable to the movement and survival of steelhead. Such concerns include water quality issues such as low dissolved oxygen and high temperatures, predation from exotic species that are found in beaver ponds and other lentic environments, and barriers to upstream and downstream migration. Conversely, in dryland river systems, beaver dams can create complex, heterogeneous, and dynamic fluvial environments with a high frequency of pools, and such habitat can be used by steelhead at multiple life stages. Thus under some conditions, beaver ponds may be favorable to the growth and survival of steelhead, whereas in other circumstances, the opposite may be true. The challenge is to identify under which conditions beaver dams are likely to be favorable to steelhead populations, and those conditions which are likely to be unfavorable.

Co-habitation of Steelhead and Beaver Within the Lower Santa Ynez River

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

The Southern steelhead and the North American beaver have co-existed on the Lower Santa Ynez River (LSYR) since before Southern steelhead were listed as endangered in 1997. Under question are whether beaver are native or introduced to the Santa Ynez River and whether their existence in the river supports steelhead recovery. Research on steelhead-beaver interactions is limited in southern California, specifically regarding how beavers affect steelhead during the winter and spring migration with flashy and highly variable runoff regimes typical of a Mediterranean climate, and the summer rearing period with sustained dry and hot conditions. Observations of the co-habitation of the two species within the LSYR and its tributaries will be presented in relation to steelhead migration of upstream adults and downstream smolts, alteration of spawning habitat due to the growing spatial extent of beaver pond formation, water quality within and outside of those ponds influencing steelhead rearing, and creation of favorable habitat for numerous aquatic predator species within those ponds. Potential management strategies for steelhead and a growing population of beaver and other exotic species will be discussed in context of steelhead preservation, dam releases for steelhead migration and dry-season rearing, habitat restoration, and downstream water rights releases.

Policy Opportunities for Working With Beaver in Salmonid Recovery

Kate Lundquist, Occidental Arts and Ecology Center, WATER Institute

Renewed interest in working with beaver to restore watersheds and recover salmonids has raised questions about what California codes and management policy will allow. This presentation will review the history of beaver policy and relocation efforts in California, and explain current known policies. Lessons to be learned from other states' efforts to support working with beaver will be discussed. We will also look at new California Department of Fish and Wildlife and federal efforts to include beaver in restoration and coho salmon recovery plans, highlighting what changes could be made to California policy to remove barriers towards greater utilization of beaver as a salmonid recovery tool.

Santa Clara River Watershed: Anadromous Fish Habitat Restoration Projects Tour

Wednesday, March 19

Tour Coordinator*: Jared Varonin,* *Aspen Environmental Group*

The Santa Clara River is one of the few remaining relatively natural river systems in southern California. With the headwaters occurring east of Santa Clarita, it travels approximately 84 miles to the Pacific Ocean in Ventura. Two anadromous fish species exist in the Santa Clara River, Southern California steelhead and Pacific lamprey. The final steelhead recovery plan for southern California includes many recovery actions that are occurring at the sites we will visit. Also, the United States Fish and Wildlife Service has developed a conservation initiative for Pacific lamprey, and we will discuss some of the conservation actions that are also occurring at some of these sites.

Starting upstream, the tour will begin on Piru Creek downstream of United Water's Santa Felicia Dam, where we will discuss steelhead bypass flows, related effectiveness monitoring, and fish passage. The tour will then proceed downstream to view the Pole Creek debris basin and the location of a new fish ladder installation. Next, the tour will stop at Santa Paula Creek to view a flood control and fish passage on the lower reach of the Creek, and two existing fish passage projects upstream, including one that includes a proposal to decommission a diversion structure to ensure passage of anadromous fish. Continuing downstream, the last stop of the tour will be at United Water's Freemen Diversion on the Santa Clara River where we will discuss steelhead and Pacific lamprey migration monitoring and the development of a new hardened ramp fish passage design. At each stop, staff from involved organizations and municipalities will join us to discuss the challenges of coordinated management including the status of released flows, groundwater pumping and surface water diversions for agricultural uses, status of diversion and ladder improvements, and flood control activities.

Innovative Stormwater and Water Conservation Measures, Strategies, and Programs to Benefit Salmonids Workshop

Thursday, March 20

Workshop Coordinators*: **Rosi Dagit,** Resource Conservation District of the Santa Monica Mountains;* ***Freddy Otte,*** *City of San Luis Obispo; and* ***Regina Hirsh,*** *Sierra Watershed Progressive*

This workshop will explore innovative approaches to stormwater management and water conservation. Presentations will cover topics including how to read a stormwater management plan, harvesting rainwater for stormwater catchment, plumbing for LID measures, and Stormwater LID Capture Project Profile. In the afternoon, case studies will be provided that demonstrate on-the-ground strategies and programs that can help keep water in the streams and rivers for fish, including a dynamic presentation by Brock Dolman focused on "basins of relations," and the "slow it, spread it, sink it" methodology. Presentations will be followed by a brainstorming session on what kinds of programs work, the need for adaptability, and tangible ways to move forward to achieve water sustainability.

Introduction to Stormwater Runoff Calculations

Mark Adams (Presenter) *and* ***Nick Weigel,*** *NorthStar Engineering*

Determining stormwater runoff flow rates is key to designing any collection, treatment, and conveyance system. The industry standard for determining flow rates is the "Rational Formula." In this formula, the Flow Rate "Q" is equal to the Runoff Coefficient "C" times the Rainfall Intensity "I" times the Surface Area "A" that is being drained: $Q = CIA$. This workshop will break the formula down and look at the key influencing factors of Runoff Coefficient, Rainfall Intensity, and Storm Duration. Rainfall Intensity is related to Time and you will learn how it affects your stormwater system. For example, we'll look at two locations, one where detention is positive and one where detention may not be a good idea. We'll also take a look at the relationship between flow rate and velocity. If you can control velocity, you can control erosion. If you can control velocity, you can control treatment. During the discussion, we'll check in on different units of measurement (cfs vs. gpm) as well as take a look at how climate change may be affecting stormwater system design.

Harvesting Rainwater for Stormwater Capture at Cal Poly, San Luis Obispo

Meredith Hardy (Presenter), California Conservation Corps; and Anna Halligan, Trout Unlimited

The purposes of this project are (1) to demonstrate that the use of stored rainwater for certain agricultural uses can be beneficial to both agriculture operations and the environment, (2) to show that riparian well withdrawals during dry months can be reduced and streamflow can be increased, (3) to create a demonstration project for other interested landowners to examine, and (4) to aid in stormwater management at the facility.

The Central Coast of California has a Mediterranean climate with wet winters and dry summers. During times of drought, water can be scarce and the need for water great. Numerous climate change adaptation plans suggest reductions in water quality and flow in California rivers and streams are likely in the future. Our area's surface water provides water for important species and habitats and also supports the majority of our agricultural operations. Exploring creative water management is important for our communities as we prepare adaptation strategies. The practice of capturing precipitation during the winter, when water is plentiful, to then use during the summer when water is scarce, could be an effective way to maintain ecosystem function while still meeting the water demands of the community.

Pennington Creek, adjacent to the Cal Poly Beef Center, has suitable habitat for endangered steelhead. Ensuring adequate flows in the creek could help with steelhead recovery in our watershed. Pennington Creek is also the location of the Beef Center's riparian well used to provide water to the Beef Center and its summer bull rearing population. These bulls rely on Pennington Creek water to maintain their water troughs through the summer and early fall months. The shallow wells that provide cattle water are diverting streamflow that could otherwise provide habitat for juvenile trout.

By constructing the project at this site, the project partners hope to show that rainwater harvesting can be beneficial to certain agricultural uses and to instream flows. The Morro Bay National Estuary Program, working with a partner hydrologist from Center for Ecosystem Management and Restoration (CEMAR), will be monitoring creek flow to determine how effective the project will be.

The Beef Center also makes a good demonstration site due to its central location in Chorro Valley. The Center allows the project to be showcased at California Polytechnic University School of Agriculture events with the agriculture industry, as well as allows students to learn about this conservation practice. It is the project partners' hope that other water users will be interested in rainwater harvesting as a water conservation and management tool. Project partners include the California Conservation Corps, Morro Bay National Estuary Program, California Polytechnic University, CEMAR, Trout Unlimited, the National Marine Fisheries Service, and the California Department of Fish and Wildlife.

CCC Stormwater Capture Project Profile: Lowering Stormwater Hydrograph through Low Impact Development (LID) Treatments

Regina Hirsch (Presenter), *Sierra Watershed Progressive*
and ***Meredith Hardy,*** *California Conservation Corps (CCC)*

In 2012, The Morro Bay National Estuary Program partnered with the (CCC), the Army National Guard, and Sierra Watershed Progressive to implement a demonstration project that addresses stormwater runoff and water conservation on a 20-acre portion of the Camp San Luis Obispo Army National Guard base that the CCC leases for its center operations.

This LID project focused on eliminating flooding issues at and adjacent to CCC Building 1533 near steelhead habitat of Chorro Creek while also increasing high volume of groundwater infiltration by providing site-specific topographical earthwork features. Through the construction of specified infiltration areas, in various sun and soil vectors, habitats were created, soils have been regenerated, buildings were cooled by solar passive placed shade trees, and the esthetic and educational environment for the resident CCC corps members was improved. To ensure success of the planted environment, 61,000 gallons annually of greywater features were utilized targeting specific tree and plant species within the highest solar gain zone. This project included two large inclusion basin (leaf basin type) infiltration off-contour bioswales, three on-contour bioswales, and multiple passive greywater and rainwater basins. Outcomes are based on an estimate of 23 inches of precipitation annually. These known results will also be discussed in the context of applying them to larger scale watershed projects, ease of implementation, and cost-effectiveness.

Folding Salmonid Restoration into a Regulatory Program

Freddy Otte, City of San Luis Obispo, CA

With the adoption of new stormwater requirements effective July 1, 2013 from the State Water Resources Control Board, cities and counties have requirements in their permits that can aid in the restoration of salmonids. Water quality monitoring, pollution hot spot identification, and best management practice upgrades target pollutants before they enter the waterways. Construction and development oversight allows input to reduce the peak and infiltrate stormwater for groundwater replenishment and water filtration. Educating and engaging the public about watershed health can expand the number of watershed stewards locally. Working collaboratively, the restoration community and municipalities can complete watershed assessment studies that offer input as to where habitat improvement projects could offer a win-win situation.

Reconnecting Coastal Streams: An Overview of Cooperative Streamflow Programs and Options in California

Mary Ann King, Trout Unlimited

A variety of cooperative approaches have emerged in California to address low streamflow as a limiting factor to salmonids in coastal streams. By working with landowners to modify their diversion and use of water, these programs aim to reconnect streams and restore streamflow in critical reaches during critical time periods. This presentation provides an overview of such tools (e.g., residential and industrial tank storage, frost protection alternatives, agricultural ponds, irrigation efficiency, rainwater harvesting, etc.) using case studies from various coastal California streams. It will then cover some of the opportunities and challenges to using this approach in other coastal watersheds.

Conservation Hydrology Pondering & Implementation

Brock Dolman, *Occidental Arts and Ecology Center's*
Watershed Advocacy, Training, Education, & Research Institute

The speaker will discuss rainwater harvesting as a strategy of water conservation and instream flow enhancement from roofs to the broader landscape. He will expand on ideas of Conservation Hydrology, which emphasizes the need in many areas for human development designs to move from drainage to retainage. Instead of land use practices that by design capture and convey excess volumes of stormwater discharging this often degraded water offsite, he will discuss ideas on how landowners can "slow it, spread it, and sink it" with the stormwater on their site. Moving away from run-off to run-on type land uses can result in multiple watershed benefits such as mitigated flooding, improved water quality, increased groundwater recharge, benefits to stream structure and function, enhanced instream and upland wildlife habitat, short-term and long term economic benefits, and improved localized aesthetics.

A Practitioner's Guide to Instream Transactions in California: Instream Flow Enhancement Approaches and Lessons Learned from Members of the Small Watershed Instream Flow Transfer Working Group

***Chris Alford**, American Rivers and **Amy Hoss**, the Nature Conservancy*

With many of California's rivers and streams already over-burdened by water diversions, voluntary changes to existing water rights have the potential to be one of the most significant tools in protecting California waters, particularly in locations where small water diversions may have a significant impact on instream flows and the salmonids that depend on them. California does not permit new water rights to be designated for instream uses without diversion. However, existing water rights can be transferred in part or whole to instream flow use through California Water Code Section 1707. The potential importance of Section 1707 transfers in maintaining the sustainability of our water supplies has been affirmed in the California Water Plan and California Drought Contingency Plan, as well as in federal and state plans for salmon recovery. Although Section 1707 is widely viewed as an important tool for the protection and enhancement of stream resources, to date it has been used relatively sparingly.

One reason for the limited use of Section 1707 transfer provisions is ongoing uncertainty associated with the petition approval and implementation process. Those who have pursued instream flow transfers under Section 1707 continue to encounter a range of practical uncertainties regarding issues such as timeframes for petition processing, risk to water rights, procedures for addressing potential impacts to other existing water rights, baseline information collection requirements, practicality for use in emergency or temporary situations, and other petition approval and implementation procedures. These uncertainties can act as barriers to implementation of Section 1707 and other relevant water code transfer provisions that could otherwise benefit instream flow conditions.

The Small Watershed Instream Flow Transfer (SWIFT) Working Group, a group comprised of practitioners that work on instream flow enhancement efforts in California, has collectively worked on the development of "A Practitioner's Guide to Instream Transactions in California" with assistance and input from State Water Resources Control Board and California Department of Fish and Wildlife staff. The purpose of this guidance document is to help petitioners through the process of submitting and completing instream flow dedications in California. The primary audiences for this guide are water rights holders interested in dedicating water to instream uses as well as organizations or entities that may assist those petitioners through the process.

This presentation will provide an overview of the issues covered in the guidance document such as how to navigate, troubleshoot, and work through the instream flow petition and transfer process, using Section 1707 of the Water Code. Additionally, we will present several different project-specific approaches for enhancing instream flows, such as water conservation, changes in water diversion methods or timing, and coordinated water management amongst water rights holders along a stream course. Lessons learned and suggestions for determining when the application of a 1707 transfer is appropriate for each type of project will also be discussed.

Ocean Friendly Gardens Are Salmon-Friendly Gardens! How Surfrider Foundation's Ocean Friendly Garden Project Benefits Salmonids

Steven Williams, *Resource Conservation District of the Santa Monica Mountains*

The largest source of water pollution cannot be traced to any one point—it's all of us. Pollutants "run off" our buildings, driveways and parking lots, landscapes, and streets, degrading the natural beauty, and our enjoyment, of waterways and the ocean. For example: fertilizers increase algae populations and red tides, high bacteria counts close beaches, and car exhaust, oil, brake pad dust, pesticides, herbicides and fungicides can poison fish. Runoff can occur when it is raining and during dry periods.

Ocean Friendly Gardens (OFG) lessen these runoff pollution impacts through CPR (Conservation, Permeability, and Retention). Conservation refers to the conservation of water, energy, and habitats through native and climate adapted plants, using the most efficient irrigation system to supplement rainwater. Permeability requires the use of mulch and the creation of biologically active soil, and the reduction of impervious hardscapes. Retention includes the use of devices like rain barrels and swales or dry stream beds that soak up rainwater in the soil for the dry season or store it for irrigation, preventing it from running off of the property.

All of these practices have at least two potential positive effects on salmonids. First, the climate appropriate and native plantings require less water, thus reducing water consumption. As much of our water is imported from the Bay-Delta, less water will be taken from that habitat, which is beneficial to salmonids. Second, OFGs incorporate various runoff infiltration techniques. Sinking the runoff lessens polluted runoff flow to creeks, rivers, and oceans. In some areas, it may also reduce sedimentation to these bodies of water.

Ocean Friendly Gardens create a buffer between stormwater pollutants and streams, while requiring less water from sensitive fish habitat in the California Bay-Delta.

Santa Ynez River and Gaviota Coast Fish Passage Tour

Thursday, March 20

Tour Leaders*: **Tim Robinson, PhD,*** *Cachuma Operations Maintenance Board;*
and ***Mike Garello,*** *HDR Fisheries Design Center*

This all-day tour of the tributaries of the Santa Ynez River and creeks of the Gaviota Coast will visit multiple fish passage projects with a wide variety of implemented designs. Discussion at each site will focus on the design and permit process, landowner relationships, construction, and fish passage performance. Completed projects that we will visit include bridge installations, several types of fish ladders, step-pools with rock weirs, bank slope protection, and creek watering systems at Hilton Creek, Quiota Creek, Salsipuedes Creek, El Jaro Creek, and Arroyo Hondo Creek. Weather and time permitting, lunch will be at the coastal lagoon of the Santa Ynez River.

Blocked Habitat: Taking a Watershed-Scale View to Fish Passage

Thursday, March 20

Workshop Coordinator*: Michael Love, Michael Love & Associates*

There are numerous conditions that impede fish migration and prevent full utilization of spawning and rearing habitat within a watershed. Impediments can be the stereotypical dam or culvert, or can be inadequate instream flows that lead to insufficient depth and lack of a biological-drive for fish to immigrate or emigrate. To begin recovery of anadromous salmonid populations within a watershed often requires addressing multiple impediments in a coordinated effort. This workshop will focus the various types of barriers to consider, and strategies for addressing them on a watershed-wide basis. Topics to be discussed include natural low-flow barriers and triggers to generating immigration behavior, design flows and resulting fish immigration delay within different regions of California, effects of migration delay on spawning success, continuity of passage corridors, the passage assessment database and efforts to prioritize barrier removals, and case studies of projects aimed at restoring fish access as part of a watershed-wide effort.

Steelhead Passage Versus Migration Streamflows

William J. Trush, PhD, ***Humboldt State University River Institute and Department of Environmental Science and Management, Humboldt State University***

We implement fish passage projects with the intent of expanding successful anadromous adult salmonid migration into as much of a watershed's stream network as possible for as many years as possible. Successful migration is a non-negotiable cornerstone for restoring a steelhead population's capacity for self-renewal (Aldo Leopold's definition for 'biotic' health); too few incubating eggs producing emergent fry results in a lack of self-renewal. Prescribing a true minimum passage streamflow that marginally provides "adequate water for physical movement through the most critical riffles" (Thompson's definition for a 'minimum') does not assure migratory success. Thompson and his colleagues at the Oregon Game Commission in the early-1970s intended to achieve more than the minimum while valuing the Thompson Method's simplicity. If faithfully implemented, the Thompson Method targets more than a minimum passage streamflow without explicitly addressing migratory success. This was accomplished primarily by requiring two passage route widths (expressed as a percentage of a riffle's total active channel width using minimum passage depths as route bookends) based on field experience. The Thompson Method has been criticized for not producing minimal instream flow recommendations many instream flow practitioners expected. Consequently, the Thompson Method has a long history of being modified—through decreasing minimum depths, route width, and cross section length to less than the active channel width—to estimate a lesser minimum streamflow. California Department of Fish and Wildlife (CDFW) Instream Flow Program 001, "Standard Operating Procedure for Critical Riffle Analysis for Fish Passage in California" (February 2013) attempts to standardize Thompson Method protocols. However, even with standardization of these protocols, the question as to what quantity of streamflow is necessary for migratory success remains unaddressed. In this workshop, qualitative and quantitative differences between passage streamflows and successful migration streamflows will be presented for steelhead populations in southern California rivers.

Spawner Risk Assessment Model to Evaluate Instream Flows for Spawning Success

Gabriel Rossi, McBain and Associates

Anadromous salmonid spawning success requires more than adult fish successfully arriving at a spawning destination. Spawning success requires a specific combination of streamflow magnitude, duration, and timing to enable a female to reach the spawning destination, successfully construct her redd, and have sufficient streamflows for incubating the eggs through fry emergence, while not scouring the redd. In regulated rivers, passage over critical riffles is often the primary instream flow consideration to achieve spawning success; however, flow management based on this approach may not provide the characteristics of flow (especially duration) that will encourage spawning and egg incubation at desired spawning locations.

The Spawner Risk Assessment (SRA) model predicts anadromous salmonid spawning success from a risk perspective. Risk is defined as any delay in migration, spawning, or desiccation or scour of redds during egg incubation, which alone or cumulatively could prevent spawning success. The SRA model uses a spreadsheet tool to identify "low risk days" for anadromous salmonid spawning. A low risk day for a salmon or steelhead entering a river is one in which it will encounter sufficient streamflows to (a) reach its spawning destination, (b) successfully spawn, and (c) produce a redd that remains submerged and avoids scour for the entire egg incubation period. Sensitivity analyses are performed on each model parameter to determine which has the greatest effect on predicted spawning success. Managers of regulated rivers can use the SRA model to evaluate different proposed flow scenarios and use the number of low risk days as a metric to compare the flow scenarios and identify a flow regime that promotes successful salmonid spawning.

This presentation will first describe the computational framework of the SRA model, and then work through an application of the model from an SRA assessment in Alameda Creek. We will evaluate two flow scenarios, identifying low risk spawner days for each scenario, and discuss the strengths and weaknesses of various model parameters. Attendees should leave this presentation understanding the basic parameters and process to perform a Spawner Risk Assessment.

Fish Passage Design Flows: Resulting Passage Windows and High-Flow Delay in Coastal California

Margaret Lang, PhD, P.E, Humboldt State University;
and Michael Love, P.E., Michael Love & Associates

A study was initiated to evaluate whether California's current methods of defining the high fish passage design flow for adult anadromous steelhead are appropriate for all of California's coastal climatic regions. The current fish passage design flow criteria for California, which differs from criteria used in the Pacific Northwest, are defined by the National Marine Fisheries Service (NMFS 2001) and the California Department of Fish and Wildlife (CFDG 2002). The criteria is based on using the one percent annual exceedance flow obtained from mean daily flow data or alternatively, 50 percent of the two-year peak flow. Selection of one percent annual exceedance flow was based primarily on hydrologic data and field observations of fish migration timing in north-coastal California streams (Lang, Love & Trush 2004).

Climatic differences between the northern and southern regions of California has generated interest as to the impacts of high flow migration delay imposed on coastal central and Southern California steelhead by current high passage design flow criteria. In general, the mean annual precipitation decreases moving from north to south, as does the frequency of rainfall and runoff events that adult steelhead may utilize to migrate inland. Annual and inter-annual variability in rainfall patterns also increases from north to south, which may further influence the window of opportunity adult steelhead have within a given year to migrate to their spawning grounds.

This study investigated regional differences in the frequency and duration of provided passage windows and potential delay imposed by current passage design flow criteria for adult steelhead. The coastal regions investigated are Pacific Northwest (Oregon Coast), northern California (Oregon Border to Monterey Bay), and southern California (south of Monterey Bay to Orange County). Evaluated passage design flow criteria included those currently used in California, Oregon, and Washington. Additional passage design flow criteria were also evaluated.

This study has identified regional hydrologic differences that have potential implications on the frequency and duration of steelhead migration opportunities as it pertains to the selection of the high fish passage design flow. These differences will be highlighted as part of this presentation and a discussion of their implications on fish passage windows and migrational delay will be included.

Tools for Stream Habitat Connectivity Restoration: the Passage Assessment Database and Other Datasets Available on the CalFish Website

Anne Elston, ***Pacific States Marine Fisheries Commission***

The Passage Assessment Database (PAD) is an ongoing map-based inventory of known and potential barriers to fish in California. The PAD compiles currently available fish passage information from several sources, including federal, state, and local government agencies and from non-governmental sources throughout California. The PAD is an important tool for planning and tracking the outcomes of anadromous fish passage improvement projects. The PAD enables analysis of barriers relative to each other and in the context of a watershed. The PAD can be used to locate and prioritize barriers for modification or removal. The PAD identifies downstream and upstream barriers by PAD ID, the number of upstream barriers, and the number of stream miles above each barrier to the end of anadromy or to the end of a stream network. These attributes were developed for the Fish Passage Forum's APASS (Anadromous Fish Passage Optimization Tool) model to assist in prioritizing barriers for removal. Together, the PAD and the APASS model are a powerful planning tool for restoring habitat connectivity.

For the PAD to be useful as a restoration tool, the data within the PAD needs to accurately depict the on-the-ground reality of fish passage constraints, and requires that the PAD be updated regularly and available to fish passage practitioners. The PAD is publicly available via the CalFish website (*www.calfish.org*).

CalFish, a California Cooperative Anadromous Fish and Habitat Data Program, is a multi-agency website presenting anadromous fish, stream habitat, and migration barrier data in California which includes standards and tools used for the collection, management, and analysis of these data.

This presentation will include an overview of the PAD and available datasets on CalFish and how to access the data and submit revisions. The presentation will also include a description of new datasets available on CalFish, including California Department of Fish and Wildlife (CDFW) priority barriers for removal, and CDFW coho Evolutionary Significant Unit, and a demonstration of the new tool available for easy review and submittal of revisions to the PAD.

The Anadromous Fish Passage Optimization Tool: Using Optimization to Strategically Manage Fish Barrier Remediation in California

Donald Ratcliff (Presenter), *U.S. Fish and Wildlife Service;* ***Jesse R. O'Hanley,*** *Kent Business School;* ***Paul Kemp,*** *University of Southampton;* ***Robin Carlson, Brett Holycross,*** *and* ***Anne Elston,*** *Pacific States Marine Fisheries Commission; and* ***Martina Koller,*** *Delta Stewardship Council*

The California Fish Passage Forum (Forum) is developing a methodology for prioritizing fish barrier remediation to improve the collective efficiency of fish passage programs and aid practitioners in implementing projects throughout the anadromous waters of California. This methodology is intended to overcome the critical deficiencies of scoring and ranking procedures through the use of sophisticated optimization modeling and solution techniques. Optimization-based methods provide a systematic, objective, repeatable, and strategic means of maximizing benefits to aquatic species and habitats even with highly limited resources to complete passage projects. The optimization methodology being developed by the Forum uses data similar to that used in existing prioritization methods such as barrier location, estimated project cost, and aquatic habitat gained. The addition of gained habitat quality modifiers, species-specific passage needs, spatial structure of barriers, and cumulative passability within a specific migratory pathway increase the ability to identify cost-efficient passage improvements that maximize desired benefits. The optimization methodology has been built into an interactive model called APASS (Anadromous Fish Passage Optimization Tool) that is supported by a graphical user interface. Optimal solutions can be easily and quickly obtained using APASS for large numbers of barriers and different funding levels. Additional functionalities have been built into APASS for performing batch runs across a range of budget values and for performing basic what-if analyses such as varying the weights placed on different target species, changing the spatial focus (i.e., selecting subsets of watersheds) and forcing specific barriers into or out of the final optimal solution. Beyond its use as a strategic planning tool for targeting high impact barriers, APASS can also be used for screening among project proposals that have been submitted to an organization for funding consideration. APASS has been intentionally designed as a generic planning tool that can be applied to any spatial scale or geographic area. In the near future, the Forum will release APASS to the greater fish passage and aquatic restoration communities in California and beyond. Additionally, through the unique partnership between the Forum and our collaborators, the general methodologies used in these efforts will be shared with interested parties at no cost for academic and non-commercial use.

Potential for Fish Passage Barrier Remediation as Compensatory Mitigation

Jason Q. White (Presenter), Eric Ginney, and Carlos Diaz, ESA PWA

Anthropogenic barriers block passage to spawning and rearing habitat critical to anadromous fish species in completing their lifecycle. California coastal watersheds alone contain over 3,000 known barriers, and another 9,000 potential barriers. Fish passage barrier remediation is frequently listed as a top priority in many recovery plans for endangered anadromous species; however, the biggest challenge to fish passage barrier remediation is funding. Currently, there are too many potential projects and too little available funding. A large number of known and potential barriers continue to go unaddressed.

We propose that fish passage barrier remediation be funded through compensatory mitigation. Compensatory mitigation, used to offset unavoidable impacts to the environment, has funded the restoration, creation, enhancement, and/or preservation of vast quantities of critical habitat across the U.S. Under our concept, permit applicants with projects having unavoidable impacts to habitat critical to listed anadromous fish, namely salmonids, would be able to offset these impacts through funding the implementation of a fish passage barrier remediation project that provides connectivity with upstream critical habitat.

The benefits of using fish passage barrier remediation as a means of compensatory mitigation include (1) increased funding of high-priority actions and projects supporting the recovery of listed species, (2) the habitat created is of a known quantity and quality and is instantaneously available for use by the listed species—there is no time lag for vegetation to mature or for restored channel conditions to evolve, and (3) the newly-available critical habitat is "created" at a relatively-low cost and long-term maintenance and monitoring efforts are likely to be non-existent or are simple and predictable.

Several challenges will need to be addressed for this to become a viable funding option, the biggest challenge being development of a functional mitigation crediting system. Mitigation credits represent a measurable unit of the ecological resources or services that are restored, created, enhanced, or preserved at a site. Typically, credits are equal to the ecological resources or services lost at the site of unavoidable impacts. For compensatory mitigation to work, the entity responsible for causing unavoidable impacts must either develop sufficient habitat (measured as credits) to offset the impacts, or obtain such habitat in the form of credits made available by another entity.

This presentation will examine the opportunity to credit fish passage remediation projects and the challenges in doing so. Other forms of mitigation, such as stream mitigation, have successfully worked through similar opportunities and challenges. The potential anadromous fish species' benefits from barrier removal make compensatory mitigation an intriguing option worthy of further examination.

Hydraulic and Geomorphic Monitoring of a Constructed Roughened Channel to Evaluate Temporal Variation in Fish Passage Ability

Brian Wardman (Presenter), *Northwest Hydraulic Consultants;* ***Joey Howard,*** *Cascade Stream Solutions;* ***David White,*** *National Marine Fisheries Service; and* ***Joe Issel,*** *San Mateo Resource Conservation District*

Roughened rock ramps are engineered channel reaches intended to provide fish passage while maintaining hydraulic grade control. These channels utilize large boulders and engineered rock streambed gradations to create an immobile streambed with hydraulic diversity emulating conditions found in steep natural channels. This hydraulic diversity includes spatial variation in depth, velocity, and turbulence within any given channel cross-section. One of the primary assumptions of the roughened rock ramp design is that this hydraulic diversity will provide pathways of suitable conditions for fish passage. Hydraulic conditions within the roughened channel often vary with time. These temporal variations occur due to changes in flow rate and sediment transport through the site, as well as geomorphic conditions upstream and downstream of the site. Bed forms and deposits of transitory sediment passing through the site affect channel roughness and local hydraulics. Changes in geomorphic conditions upstream or downstream of the site, such as lateral migration of a low flow channel, can alter the roughened rock ramps' connectivity to nearby stream reaches. Hydraulic design of roughened channels are often limited to expected post-construction conditions, as it is difficult and potentially impractical to identify the full variability of conditions.

This study seeks to better understand the variability in hydraulic fish passage performance by monitoring a recently constructed roughened rock ramp. The monitoring site is located on the San Francisquito Creek in San Mateo County. The ramp was constructed in the summer of 2013 to replace Bonde Weir, a concrete grade control structure identified as a partial barrier to steelhead migration. The constructed ramp is 100 feet long, about 40 foot wide, and built at a one percent grade. A post-construction survey was performed to identify baseline topographic conditions. A long-term monitoring plan to observe temporal changes in channel configuration and hydraulics has been developed. As part of this plan, topographic surveys will be performed during months when fish migration is expected to occur to evaluate variability in channel elevations upstream, downstream, and in the constructed channel. Point velocity measurements will also be collected with an Acoustic Doppler Velocimeter and/or an Acoustic Doppler Current Profiler at identified points across channel cross-sections to evaluate both spatial and temporal hydraulic variability. Photographic surveys will be used to qualitatively evaluate variation in channel conditions. This presentation will present the monitoring plan and will compare observations from the 2013-2014 winter season with passage criteria and design model results.

Construction and Monitoring of the Caltrans Santa Paula Creek Rock Weir Fishway

Stan Glowacki, GPA Consulting

Santa Paula Creek is a tributary to the Santa Clara River located in Ventura County, and is within the range of endangered Southern California steelhead. In 2005, an estimated 100-year storm occurred in the watershed that substantially altered a section of Santa Paula Creek beneath a Caltrans bridge structure on State Route 150, resulting in a ten-foot high fish passage barrier that blocked all upstream passage for steelhead. Working with National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW), Caltrans designed and constructed a 400-foot long fishway consisting of a series of 15 rock weirs to help restore upstream passage for steelhead and provide access to approximately eight miles of spawning and rearing habitat in the upper reaches of Santa Paula Creek and Sisar Creek.

Work on the project began in 2011, and shortly after construction began, numerous challenges were encountered and subsequently overcome over the two-year construction period. GPA Consulting monitored the construction of the fishway, and assisted Caltrans through all phases of project construction. Because this project was one of the first of its kind to be implemented by Caltrans in southern California, a monitoring plan was developed for the fishway with monitoring beginning in the winter of 2013. As with all fisheries restoration and barrier removal projects, monitoring of the fishway is essential for evaluating project success.

Monitoring efforts are currently ongoing to assess under what flow conditions the facility meets steelhead passage criteria required by NMFS and CDFW. Additionally, the current monitoring program is evaluating the long-term structural stability of the rock weirs, the geomorphic response of the stream channel to the rock weir system, the effects to riparian vegetation recruitment, and the effects to instream fish habitat within the project reach in Santa Paula Creek. Preliminary results of the monitoring efforts will be discussed.

From this monitoring work, a better understanding of steelhead passage flows, instream fish habitat dynamics, and stream channel geomorphic response to multiple rock weir fishway designs is being obtained, and will serve to improve the design and implementation of future steelhead barrier removal projects in southern California.

City of Goleta San Jose Creek Flood Control and Fish Passage Project

Steve Wagner, *City of Goleta and* ***Brian Trautwein,*** *Environmental Defense Center*

The City of Goleta's San Jose Creek Flood Control and Fish Passage Project is a multi-objective project to reduce flooding in Goleta's Old Town during high flow events and provide fish passage for steelhead trout. The project includes the removal of approximately one mile of concrete trapezoidal channel and the construction of a larger vertical walled channel with an articulated concrete revetment bottom formed to provide a fish passage channel. Slotted weirs were placed in the low flow channel to provide velocity cover and resting areas for migrating steelhead.

The San Jose Creek watershed has been cited as one of the most important areas for steelhead recovery in various studies, including: the Conception Coast Project's Steelhead Assessment and Recovery Opportunities Report, the San Jose Creek Watershed Plan, and the 2011 Federal Recovery Plan for the Federally Endangered Southern California Steelhead. Removal of the concrete trapezoidal channel eliminates the primary barrier to fish passage on San Jose Creek, opening up over two miles of habitat, and is a critical step in restoring access to the upper San Jose Creek watershed.

The project has been the City's highest priority capital improvement project since 2003, and is supported by numerous public and private partners.

Carpinteria Creek Steelhead Recovery—Upstream Passage Nearly Complete!

Erin Brown, ***South Coast Habitat Restoration***

In 2001, a group of dedicated creek enthusiasts came together joined by the idea of restoring Carpinteria Creek in order to once again see steelhead trout runs in their local stream. Since the founding of the Carpinteria Creek Watershed Coalition nearly 13 years ago, ten barriers to migration have been removed or modified in the watershed, two bank stabilization projects have been implemented, and numerous native revegetation efforts have occurred. These efforts have been carried out by members of the Coalition including the Santa Barbara County Flood Control District, the City of Carpinteria, the Santa Barbara Agricultural Commissioner's Office, and South Coast Habitat Restoration (SCHR). SCHR has spearheaded a number of restoration efforts in the watershed. Most recently, the Pinkham Fish Passage Restoration Project was completed in the fall of 2013. SCHR worked with the landowner and various project partners and funders to remove an undersized bridge and a 100-foot long section of concreted stream channel from the mainstem of Carpinteria Creek. Since 2011, steelhead passage has been open from the ocean up into the headwaters of Gobernador Creek, the Watershed's largest tributary. There is currently one final major barrier remaining on the main stem of Carpinteria Creek and SCHR is working with the landowner and has begun engineering designs for the project with the goal of removing the barrier during the summer of 2014.

SCHR has been working on Southern steelhead trout restoration efforts throughout Santa Barbara and Ventura Counties for a number of years. SCHR identifies projects, works with private property owners, secures project funding and permitting, all to implement voluntarily stream restoration projects.

It Takes a Watershed to Restore a Steelhead—Chronicles of Mission Creek

George Johnson, City of Santa Barbara

Efforts to restore steelhead in California often focus on the removal of fish passage barriers and in some cases exclusively on removal of one "keystone" barrier (Matilija Dam on the Ventura River, Rindge Dam on Malibu Creek-Rindge Dam, Freeman Diversion on the Santa Clara River). Although this is and should remain the primary focus for obvious reasons (no access to spawning areas equals no fish), there are many other factors that are vitally important to restoring steelhead to a creek/river system. If resources and organizational capacity exist, a watershed-wide approach to steelhead restoration has many advantages. Factors such as water quality/temperature, water supply—especially in low rainfall years, quality/quantity of habitat (spawning/perennial flow), human disturbance, urban/agricultural development, land ownership, political will, and presence/absence of fish ultimately decide whether long-term restoration of steelhead will be successful. Methods to improve conditions for steelhead on a watershed scale are often challenging to implement and slow to show results. This presentation will outline the approach for assessing barrier removal projects on Mission Creek as well as the City of Santa Barbara's efforts to address some of the other threats to steelhead throughout the watershed.

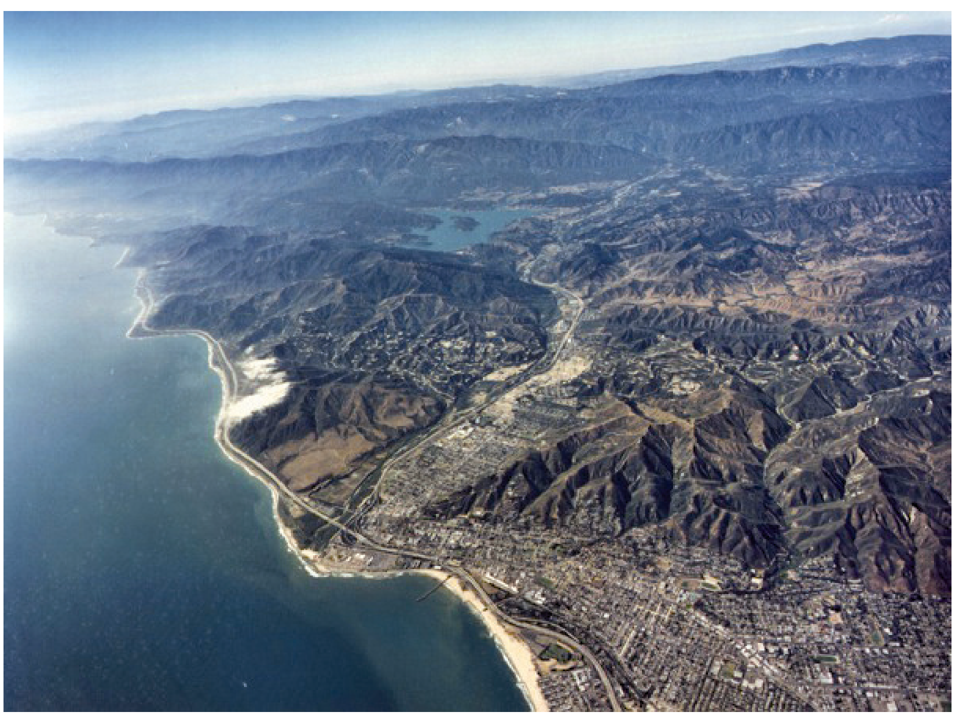
Ventura River Parkway Field Tour

Thursday, March 19

Tour Coordinators*: Paul Jenkin,* *Ventura Campaign Coordinator, Surfrider Foundation,* ***Derek Poultney,*** *Ventura Hillsides Conservancy, and* **Brian B. Stark,** *Ojai Valley Land Conservancy*

The Ventura River Parkway connects parkland and open space over 16 miles of the Ventura River connecting the community with the river upon which it depends for water supply, recreation, and a unique quality of life. This tour highlights ongoing community-based acquisition and restoration. The tour begins at the mouth of the Ventura River where the recently constructed Surfers' Point Managed Shoreline Retreat project provides a precedent-setting example of coastal restoration adjacent to the estuary. Just upstream, a recent acquisition by the Ventura Hillsides Conservancy has served as the catalyst for a major cleanup and restoration effort in the lower river. Further upstream, the Ojai Valley Land Conservancy has acquired over five miles of the main stem of the river along with two tributary watersheds. And 16 miles upstream, the obsolete Matilija Dam remains in place pending removal through a planning process that continues after almost two decades.

The Ventura River Parkway provides a means of reconnecting a community with their watershed. The region is impacted by conflicts over water supply, flood damages, loss of habitat, beach erosion, and degraded surface and coastal water quality. Increased attention on the watershed and emerging planning processes may provide significant opportunities for integrated ecosystem-based management (EBM) solutions. Community-based watershed restoration projects at varying scales provide opportunities for ongoing outreach and education. This presentation outlines ongoing efforts to implement a vision for integrated watershed management by linking a holistic set of demonstration projects including the Surfers' Point Managed Shoreline Retreat, Matilija Dam Ecosystem Restoration, and provides the context for the other projects in this conference session and field trip. Current efforts to enhance the Ventura River Parkway provide a common thread that links these efforts through recreational trails and interpretive experiences.



Recovery Strategies for Coastal Salmonids—The Social Science of Saving Salmon and Steelhead

Charlotte Ambrose, National Marine Fisheries Service, West Coast Region

Nearly all salmon and steelhead species on the West Coast are listed as threatened or endangered under the Federal Endangered Species Act. Once listed, the National Marine Fisheries Service is required to develop a plan for species recovery. Recovery plans link listing and five-year status reviews to delisting goals. They detail information on: (1) biological viability, (2) factors that led to the species decline, (3) status of protective/conservation efforts, (4) priority actions, and (5) criteria to guide delisting determinations. Recovery plans are road maps for recovery and provide a series of recommended recovery strategies to public and private entities. The success of saving listed salmonids depends in large part on raising awareness and capturing the attention of a public who, today, are generally focused on things other than salmon recovery. However, since Paleolithic times, and at a global scale, salmonids have been esteemed by humans in creation stories, feasts, carvings, writings, lore, laws, policies, and science. Despite this, biologists and conservationists from the old world of Europe (including Charles Dickens) to the new world of North America have witnessed salmonid declines and sounded alarm bells, unfortunately, to little avail. Ultimately, their writings chronicled the salmon's demise and extinctions. While the biology, life history and viability of these species are relatively understood, the definitive methods to recover them are not. Even for fisheries scientists, the road to recovery is not well understood and we should recognize that scientific knowledge alone will not save our salmonids. "Biologists and scientists face the challenge to better understanding one species: our own. This one social species will solely and dramatically affect the entire living system of our planet" (Saunders et al. 2005). Conservation efforts, policies, and successful recovery strategies will rely on our ability to embrace the concept that the social sciences play an equal role in our work. Something not included in our academic training nor envisioned as part of our profession. Montgomery (2003) reminds us that "the story of a salmon crisis is nothing new"; thus, we must think and act anew. This presentation offers an overview of current federal recovery planning and recovery strategies for coastal salmonids, and a glimpse into the social dimensions of saving salmon and steelhead at the 40th anniversary of our nation's Federal Endangered Species Act.

Drought and California's Climate of Extremes

***Frances Malamud-Roam, PhD*, co-author of *The West without Water*,**
and Senior Environmental Planner, Caltrans

This year is heading for the books as one of the driest years in our state's history—in fact, possibly drier than any in 400 years. However, research into California's climate history (paleoclimatology), suggests that droughts are a common aspect of our climate. They come in different forms: short but severe, such as the 1976-77 drought or the prolonged but relatively low-level droughts such as we saw in the late 1980s extending into the 1990s. Paleoclimate researchers use different tools to detect these droughts based on the ecological signatures they leave in their wake. The records used to reconstruct climate in California span the last 10,000 years, the interglacial period known as the Holocene. California's climate has cycles of wetter and drier conditions and often these involve extreme events such as mega-droughts (some lasting over a century) and mega-floods.

Southern Steelhead Habitat: It's All about Water and Boulders

E.A. Keller, PhD (Presenter), *University of California, Santa Barbara;*
and ***Garret Bean,*** *Silverado Power*

Rattlesnake Creek, with a drainage area of a few square kilometers, is located on the south flank of the Santa Ynez Mountains near Santa Barbara. The rock type varies from weak shale to strong sandstone. Sandstone units are important in providing Large Boulder Roughness Elements (LBREs) that control channel gradient and the location, abundance, and type of pools. The dominant pool type is step pool (plunge pool). Larger, deeper pools, especially important as fish habitat, are forced pools that are often the best fish habitat. Forced pools are formed and maintained by convergent flow and scour linked to LBREs and bedrock outcrops.

Statistical analysis suggests that bedrock geology, rock strength, and fracture density of the bed and banks do not significantly control pool or channel morphology. The LBREs armor the channel and are first order controls on channel morphology and gradient as well as location, and abundance of pools.

A few water rich fractures in the Coldwater Sandstone are important point sources of spring flow that locally provide base flow at times when much of the channel may be nearly dry. Seeps and springs allow cool-water pools to form as refuge for endangered southern Steelhead trout and other aquatic organisms. Six springs with water flowing from fractures in the Coldwater Sandstone (in 2005) along a 1.5 km reach of channel each discharged about 250-800 square meters of water per day.

There is no generally accepted explanation for how step pools (the plunge pool below the step) form or are maintained. Boulder steps cannot be formed unless the boulders are transported and deposited in a step across the channel. For large boulders of a meter or so in diameter found in small channels, high magnitude flow well beyond bankfull are necessary to form a step. Better understanding of step pools has been hindered because of the difficulty of measuring the hydrology of plunge pools as water falls over a step. We hypothesize that step pools when inundated with sand and fine gravel from a disturbance (such as wildfire) during a flow event, fill at or above bankfull stage, and scour on falling stage below bankfull when unit stream power is a maximum over the step. Thus, as with forced pools, pool maintenance depends on a specific pattern of discharge and process. The process of scour during falling stage reestablishes step pools during moderate flows following disturbance.

The roles of LBREs and large woody debris are similar, in that both affect the development of pools, routing and storage of sediment, and debris control drop in elevation of the channel. A major conclusion is that LBREs control the morphology of the channel in steep boulder bed channels such as Rattlesnake Creek. In the absence of large roughness elements and resistant upstream rock units, the channel and pool morphology would be much different.

Adaptive Monitoring to a Large-Scale Restoration Action

George Pess, PhD, Northwest Fisheries Science Center, NOAA Fisheries

The removal of the Elwha River dams on the Olympic Peninsula of Washington State is a unique opportunity to examine ecosystem recovery on a watershed scale. Over the last century, the two dams blocked the upstream movement of anadromous fish to over 90% of the watershed, and restricted the downstream movement of sediment, wood, and other organic materials to the lower river and estuary. Populations of all five Pacific salmon species and steelhead in the Elwha are critically low, habitat complexity decreased in the middle and lower river, and downstream coastal habitats sediment starved.

Simultaneous deconstruction of the two dams began in September 2011 and is expected to take three years to complete. During and after that time, researchers are examining dam removal effects in three geographic regions: the former reservoirs, across the river floodplain, and in the nearshore environment. Short-term (less than three years after dam removal) monitoring is focused on the downstream transport of approximately 13 million cubic meters of fine sediments accumulated in the reservoir deltas, associated peaks in river and estuary turbidity levels, and re-vegetation of the reservoir themselves. Longer-term effects of dam removal (more than five years) to be evaluated are the delivery of gravels and cobbles to the lower river and nearshore, the re-establishment of a natural wood delivery regime, the re-colonization of the upper watershed by anadromous fish, and the associated effects on aquatic and riparian foodwebs.

The recent removal of the Elwha dam has also given us an opportunity to explore linkages among changes in ecosystem attributes, salmonid populations, and sediment supply. Sampling of each of these elements before and during dam removal, as well as in nearby reference rivers has given us insights into functional relationships among salmonid populations, life history strategies, and resultant ecosystem dynamics. This talk will provide an overview of the Elwha restoration project, and highlight recent changes observed in this first year and a half of dam removal.

A key preliminary result is that restoration monitoring, regardless of the focus, needs to be flexible and adaptable to the ever-changing physical conditions. Comprehensive baseline data, combined with a suite of potential hypotheses related to the action, and consistent observations during the action is critical in documenting the multi-scale spatial and temporal changes that have occurred.

Fish-Habitat Relationships and the Effectiveness of Habitat Restoration

***George Pess, PhD (Presenter), Phil Roni** and **Tim Beechie,** Northwest Fisheries Science Center, NOAA Fisheries*

Decades of fish-habitat research have demonstrated the importance of freshwater and estuarine habitat for various life stages of Pacific salmon. Moreover, research has shown the negative impacts of human actions on habitat quality and localized salmon carrying capacity, growth, and life history diversity. More recently, efforts have been quantifying effectiveness of different restoration techniques. Many studies have reported improvements in physical habitat particularly at a reach scale for various techniques. Fewer studies have quantified biological responses, but several studies have shown localized (reach scale) increases in fish abundance for placement of instream structures and reconnection of both tributary and floodplain habitat. Moreover, few of these studies have explicitly examined changes in salmon or steelhead survival. Less information exists for other techniques and additional research is needed to quantify changes in fish survival and abundance due to restoration at both a reach and watershed scale.

Scaling these reach-scale effects up to the watershed or population-scale requires either watershed or population evaluation or life-cycle modeling. Several intensively monitored watershed studies are currently underway to quantify population level responses to restoration and quantify the effects of multiple restoration techniques throughout a watershed on salmon survival and production. Initial results from these studies are promising; however, results will not be available for most of these studies for five or more years and the results may not be directly transferable to other populations and watersheds. Until these studies are completed, predicting population level responses to habitat change can be estimated with statistical/computer models. These include two general categories: (1) limiting-factors models based on habitat capacity, and (2) life-cycle models that account for survival and abundance at each life stage. While modeling approaches are useful, there is much uncertainty in all models, and quantifying this uncertainty with Monte Carlo simulations and sensitivity analysis can provide useful information to managers. Regardless of our uncertainty in estimating salmonid response to watershed restoration, the most successful restoration efforts will be those that address the root causes of habitat and population declines, so that natural processes sustain habitats over time and continued management intervention is not needed.

Dry Season Southern Steelhead Pool Habitat Monitoring on the Lower Santa Ynez River, Santa Barbara County

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

The endangered Southern steelhead within the Southern California Distinct Population Segment are subject to varying water quality conditions in refuge habitats during the extended dry season typical of a Mediterranean-like climate. The Cachuma Project Biology Staff closely monitor these rearing habitats within the Lower Santa Ynez River (LSYR) and its tributaries to better understand pool habitat dynamics as it relates to the presence, absence and sustainability of steelhead. Results of LSYR mainstem monitoring effort, specifically water quality and snorkel surveys, will be presented for various pool habitats within the LSYR mainstem regarding habitat quality, temperatures, dissolved oxygen concentrations, and abundance of steelhead and invasive aquatic fish species such as centrachids, catfish, and carp. Potential management strategies for native and non-native fish will be presented. The data are being used to evolve management strategies for native and non-native fish species and to develop future research and management objectives.

Monitoring the Response of Steelhead and Physical Habitat in a Dryland Stream that is Being Restored Using Beaver

Michael M. Pollock, PhD, *Northwest Fisheries Science Center, NOAA Fisheries*

Stream habitat is often restored for the purpose of improving fish habitat, particularly for salmonids, but there are few data to suggest what types of restoration are most effective, and whether restoration actually has any measurable effect on salmonid populations. Here we report the results of an expansive long-term restoration and monitoring project on a dryland stream that was designed with the explicit aim of causing a measurable population-level effect on the Endangered Species Act-listed steelhead that utilize the stream. Numerous habitat variables were also measured to better understand the physical changes that occurred concurrent with any observed changes to the abundance, growth, or survival of steelhead. After three years of post-restoration data, the fish response and the physical habitat responses have generally been positive, but elucidating causal mechanisms between the observed physical and biological changes remains as an ongoing challenge.

Monitoring of a Dam Removal Project in a Coastal Mendocino County Watershed

Ross Taylor (Presenter), *Ross Taylor and Associates; and* ***Renee Pasquinelli,*** *California State Parks*

Glenbrook Gulch is a small tributary to the lower Albion River with a drainage area of approximately 1.5 square miles. In 2007, the earthen dam located 1,400 feet up Glenbrook Gulch was assessed for fish passage by Ross Taylor and Associates (RTA) during an inventory of stream crossings throughout the Mendocino District of California State Parks. RTA determined the dam was most likely a complete migration barrier to adult salmon and steelhead due to the six-to-seven foot drop over the spillway. Pre-project electrofishing sampling indicated that no fish were present in the channel upstream of the dam.

State Parks worked collaboratively with RTA and the California Geologic Survey to develop project proposals for submission to state and federal agencies. The proposal to remove the barrier also included: (1) installing 23 instream habitat structures within the lower 1,400 feet of channel, (2) decommissioning approximately 1,400 feet of legacy logging road located along the right-bank of Glenbrook Gulch, and (3) re-contouring another 2,000 feet of logging road and landings to restore natural hydrologic function.

This presentation provides a summary of the pre-project and post-project monitoring activities conducted by RTA between 2010 and 2013. The monitoring program included collecting both physical and biological information to evaluate the channel's response to dam removal and the native fish communities' ability to re-colonize previously inaccessible habitat. The physical monitoring included surveying channel longitudinal profiles and cross sections and conducting pebble counts in transects downstream and upstream of the dam removal location. The biological monitoring included conducting adult spawner surveys during the winter and juvenile distribution surveys during the summer.

The dam was removed in September 2010. Most of the stored sediment above the dam remained onsite to be flushed downstream during the coming winter's elevated flows. The plan was to let the channel adjust during the initial post-project winter of 2010-2011, and then conduct additional in-channel and road decommissioning work during the summer of 2011. The 23 habitat structures included large woody debris structures to improve juvenile salmonid rearing habitat and rock weirs to improve spawning habitat by retaining bedload mobilized after dam removal.

The 2011-2013 post-project channel profile surveys revealed that the channel head-cut was within the expected extent and that the head-cut was eventually controlled by a nick-point in the upstream channel. The pebble count data confirmed that bedload stored behind the dam was transported and deposited in the lower channel.

The detection of two coho salmon redds during the third post-project spawning season was consistent with other studies monitoring the re-colonization of habitat opened-up by barrier removal projects. Research in the Pacific Northwest has documented that re-colonization of previously inaccessible habitat by adult anadromous salmonids typically occurs within one to five years after barrier removal. The initial movements of juvenile steelhead and coastal rainbow trout into the channel reach above the Glenbrook Gulch dam removal location occurred during the first and second post-project winters. This initial re-colonization by juvenile fish was also consistent with other monitoring studies that often documented juveniles moving into previously inaccessible habitat prior to adult spawners.

Juvenile Coho Salmon Growth and Behavior: A Comparison between Natural and Constructed Habitats in the Mid-Klamath Watershed

Shari Witmore (Presenter), *National Marine Fisheries Service;* ***Darren Ward,*** *Humboldt State University,* ***Toz Soto,*** *Karuk Tribe; and* ***Will Harling,*** *Mid Klamath Watershed Council*

Coho salmon in the Klamath River basin often move long distances when their natal streams become inhospitable due to high summer water temperatures and high winter flows. Non-natal rearing sites such as tributaries and off-channel ponds have been identified as important to the survival of juvenile coho salmon. The construction of off-channel ponds has emerged as a popular restoration technique in the mid-Klamath basin with eight ponds constructed in the last several years and at least five more planned for the near future. We compared three of these constructed ponds to seven natural sites that have the potential to provide winter and summer rearing habitat. The natural sites consisted of both small tributaries and ponds that had beaver influence. This study provides information and raises additional questions in regards to the design and benefits of constructed off-channel ponds.

Juvenile coho salmon were Passive Integrated Transponder (PIT) tagged and measured across each of the ten study sites to evaluate their growth, retention within the habitats (a combined metric of survival and site fidelity), and seasonal movement patterns. Results from this study showed that individual site characteristics played a larger role in the growth of juvenile coho than the type of site (tributary, constructed pond, or beaver-influenced). Growth rates varied significantly across each of the ten study sites and residence time was found to be strongly related to the depth of pools within the sites. None of the physical habitat parameters measured were found to be related to growth rates of juvenile coho salmon. We found that the constructed off channel ponds, designed for winter rearing, also supported fish through the summer. Using PIT tag arrays we found fish may move extensively to and from ponds, sometimes on a daily basis, indicating access and connection of the outlet are important to the design of these habitats.

During the winter season, two of the three constructed ponds showed relatively high rates of growth, while the third pond had the lowest of all winter rearing sites. Additionally, we found two of the beaver-influenced sites had the highest rates of growth compared to all other winter sites with one site displaying the highest rates of growth seen anywhere all year. These two beaver-influenced sites were unique in the way they were connected to the mainstem Klamath River during the winter season. The mechanisms responsible for differences in growth rates across sites remain unknown, however in future studies it will be important to investigate different physical parameters of the constructed ponds such as productivity, dissolved oxygen, and connection of the outlet and its interaction with the mainstem.

Effectiveness Monitoring and Adaptive Management for Santa Felicia Dam FERC project on Piru Creek

Mike Booth (Presenter) *and* ***Steve Howard,*** *United Water Conservation District;* ***Mark Allen,*** *Normandeau Associates, Inc.; and* ***David Cerasale,*** *Westland Resources, Inc.*

United Water Conservation District (United) received a jeopardy Biological Opinion (BO) from the National Marine Fisheries Service (NMFS) during the Federal Energy Regulatory Commission (FERC) relicensing of its Santa Felicia Dam Hydropower project on Piru Creek, a tributary to the Santa Clara River. A subset of the reasonable and prudent alternatives (RPAs) listed in the BO provide alternatives to United's original operations that would not be likely to jeopardize the continued existence of Southern California steelhead or destroy or adversely modify its designated critical habitat. The implementation of these RPAs will provide opportunities for adult and juvenile steelhead migration and conditions suitable for steelhead spawning and rearing. In essence, these RPAs require United to (1) develop a water release plan and habitat improvement plan to benefit steelhead spawning, rearing, and migration, (2) identify uncertainties in the water release and habitat improvement plans, (3) develop appropriate, hypothesis-driven monitoring methods to assess the effectiveness of the plans and (4) create an adaptive management protocol that addresses the uncertainties in these plans, incorporates new information, and provides an opportunity to optimize water releases and habitat improvement efforts. The general approach of the Adaptive Management and Effectiveness Monitoring Plan (AMEMP).

AMEMP uses reference streams or literature values as comparison points for response variables in evaluating the effectiveness of water releases for steelhead migration, spawning, and rearing. The data gathered through monitoring will be fed into an adaptive management framework designed to allow modification of monitoring and management protocols throughout the course of the project.

This talk will focus on the uncertainties of the water release plan and corresponding monitoring components of the AMEMP, including (1) adult and juvenile steelhead migration (life cycle monitoring station), (2) steelhead spawning and incubation, (3) steelhead fry and juvenile rearing, (4) steelhead stranding (due to changes in water releases), (5) alternative dam operations (temporary reduction in water releases for maintenance or inspection), and (6) migration flow trigger, initiation, frequency, and duration. The AMEMP is still in development in collaboration with NMFS and field components have not been implemented, but results from completed historical analyses will be presented.

A Lifecycle Perspective of Climate Impacts on West Coast Salmon, and Why it Matters for Habitat Restoration

Nate Mantua, Southwest Fisheries Science Center, NOAA Fisheries

Climate influences every part of salmon habitat, and is among the key physical factors that limits the range and contributes to variations in salmon productivity. Recent climate trends and extremes have factored into the fate of many west coast salmon populations that also experienced extensive loss and degradation of freshwater and estuarine habitat, overfishing, and detrimental hatchery practices. The Pacific Decadal Oscillation, a pattern of North Pacific climate variability, contributed to a north-south seesaw in salmon production between Alaska and west coast stocks over much of the past century that saw especially good climatic conditions for west coast salmon from the mid-1940s to mid-1970s, and has favored improved ocean conditions for west coast stocks for most years since 1998. Climate extremes linked with El Niño and La Niña events have also caused year-long changes in west coast salmon habitat, with warm periods generally bringing poorer ocean conditions and cool periods improved ocean conditions. Climate extremes related to the drought in 2001-2002 and consecutive years of poor ocean conditions in 2005 and 2006 also contributed to regional crises for some west coast stocks that led to extensive fishery restrictions and closures. Because the climate will continue to cause trends and variations in salmon habitat, short-term goals for salmon restoration actions should include expectations for variable population responses that depend in part on a climate that sometimes favors and sometimes inhibits high salmon productivity. The success of habitat restoration actions aimed at long-term recovery should benefit from the consideration of climate-related habitat scenarios for the next few decades and beyond when human-caused changes in climate are expected to become a dominant force in salmon habitat, especially near the edges of the historical range for each species.

Parallel Evolution of the Summer Steelhead Ecotype in Multiple Populations of *Oncorhynchus mykiss* in Oregon and Northern California

Martha Arciniega-Hernández (Presenter), Anthony J. Clemento, John Carlos Garza, PhD, *and* ***Devon Pearse, PhD,*** *Fisheries Ecology Division, Southwest Fisheries Science Center, NOAA Fisheries and Institute of Marine Sciences, University of California, Santa Cruz;* ***Michael R. Miller,*** *University of California at Davis;* ***Matt Peterson,*** *Humboldt State University*

Movement among populations and watersheds influences the genetic relationships among fish populations and facilitates the spread of adaptive genetic variation. Life-history variation in steelhead, including variation in anadromous run timing, is an important aspect of their biology and adaptation to local habitats. Here, we present a genetic analysis of naturally spawning Pacific Northwest steelhead to evaluate genetic relationships and ancestry of sympatric summer and winter reproductive ecotypes in northern California and southern Oregon. Adult and juvenile fish from both summer and winter reproductive ecotypes were evaluated using 12 microsatellite loci and 90 single nucleotide polymorphisms (SNPs). Phylogenetic trees and molecular analysis of genetic variance revealed that sympatric reproductive ecotypes within a river were generally each other's closest relatives. Isolation by distance (IBD) confirmed that genetic relatedness was strongly associated with genetic distance, with limited migration or gene flow among river basins. This pattern suggests that the summer ecotype has repeatedly evolved through parallel evolution. Further investigation of the underlying molecular mechanisms for the divergence of winter and summer steelhead life-history traits will inform management and conservation efforts.

Quantifying the Role of Woody Debris in Providing Bioenergetically Favorable Habitat for Juvenile Salmon

Lee R. Harrison (Presenter), *Southwest Fisheries Science Center, NMFS;* ***Andrew W. Hafs,*** *Bemidji State University;* ***Ryan M. Utz,*** *National Ecological Observatory Network; and* ***Thomas Dunne,*** *Bren School of Environmental Science and Management, University of California, Santa Barbara*

The habitat complexity of a riverine ecosystem substantially influences aquatic communities, especially the bioenergetics of drift feeding fish. We coupled hydrodynamic and bioenergetic models to assess the influence of habitat complexity, generated via large woody debris (LWD) additions, on juvenile Chinook salmon growth potential in a stream that lacked large wood. Model simulations indicated that LWD diversified the flow field, creating pronounced velocity gradients, which enhanced fish feeding and resting activities at the micro-habitat (sub-meter) scale. Fluid drag created by individual wood structures was increased under higher wood loading rates, leading to a five to 19% reduction in the reach-averaged velocity. We found that wood loading was asymptotically related to the reach-scale growth potential, suggesting that the river became saturated with LWD and additional loading would produce minimal benefit. In our study reach, LWD additions could potentially quadruple the potential growth area available before that limit was reached. Wood depletion in the world's rivers has been extensively documented, leading to widespread attempts by river managers to reverse this trend by adding wood to simplified aquatic habitats, though systematic prediction of the effects of wood on fish growth has not been previously accomplished. We offer a quantitative, theory-based approach for assessing the role of wood on habitat potential as it affects fish growth at the microhabitat and reach-scales.

Are Low Summer Flows Limiting Survival of Salmonids at the Stream and Watershed Scales in the Russian River Watershed?

Amelia Johnson (Presenter), Andrew Bartshire, Nicolas Bauer, Sarah Nossaman, Mariska Obedzinski, *and* ***Paul Olin,*** *California Sea Grant, UC Cooperative Extension*

The Russian River (RR) watershed is a complex system with streams crossing multiple landscape types including urban, rural, and agricultural development, while simultaneously supporting populations of endangered coho salmon and threatened Chinook salmon and steelhead. Human water usage in combination with naturally low flows during the summer and fall seasons are likely stressors for juvenile coho salmon in the watershed because of their need for cold, oxygenated pools to survive the dry summer season. In order to determine if available fall habitat spatially aligns with summer juvenile salmonid distribution, fish counts, and minimum flow, data collected during the dry season are analyzed relative to available fall habitat in RR tributaries. Salmonid counts are estimated using summer snorkel surveys in pool and flatwater habitat units, and at stream scales within anadromous salmonid habitat to document summer dispersal of juvenile steelhead and coho salmon.

In September 2012 and 2013, when flows were predicted to be at their minimum for the year, additional surveys were conducted to document flow levels in stream habitats where summer snorkel surveys had been conducted. Low flow surveys consist of upstream wading to collect GPS point data on flow type boundaries between dry, intermittent, or continuous flowing stream reaches, along with data on water temperatures and tributary inflows. Low flow reach layers are then digitized and overlaid with summer salmonid counts using ArcGIS mapping software to compare summer salmonid distribution to fall habitat availability.

Preliminary 2013 data from 12 RR streams suggests that fall habitat availability is limiting both coho salmon and steelhead young of year (YOY): a quarter of coho salmon YOY and almost half of steelhead YOY observed in the summer were located in reaches identified as dry during low flow surveys. The continued collection of summer and fall salmonid counts as well as low flow and other flow influencing variables could help prioritize future restoration and water conservation efforts at the reach and stream scales.

Combining Stable Isotope Analysis with Telemetry to Identify Trade-Offs Between Thermal and Trophic Resources for Fish in Thermal Refugia

Kim Brewitt, University of California, Santa Cruz

In river systems with elevated summer water temperatures, Pacific salmonids often behaviorally thermoregulate by seeking out cool water refugia. While fish obtain thermal benefits from refugia, prey availability within refugia could be limited, and fish may be forced to leave refugia to forage. I investigated the potential trade-off between thermal and trophic resource requirements for juvenile steelhead in thermal refugia on the Klamath River in northern California in summer 2012. I used stable isotope analysis and a Bayesian mixing model to assess what proportion of fish diet was derived from mainstem versus tributary prey sources, and whether the fish diet changed seasonally across the summer. In addition, I used temperature-sensitive radio tags to assess individual steelhead habitat use at refugia sites. Preliminary results indicate that fish obtain almost all of their prey from mainstem resources, although there is a slight shift to more tributary-based prey sources later in the summer. However, individual steelhead body temperatures indicate that fish are spending the majority of time holding in the tributary or thermally mixed refugia area. This mismatch between prey sources and thermal habitat use suggests that although refugia are important for thermal respite, they may not satisfy juvenile steelhead resource requirements, and fish still rely on the mainstem river for foraging opportunities. These results demonstrate that maintaining connectivity between refugia and the mainstem river may be important for satisfying trophic requirements of fish using thermal refugia, as well as the importance of habitat heterogeneity for mobile consumers that take advantage of spatial variation to satisfy both thermal and trophic requirements.

Seascape Genetic Analysis of Chinook Salmon in the California Current Reveals Distinct Marine Distributions Among Stocks

John Carlos Garza, PhD (Presenter) *and* ***Crandall, E.D.,*** *Southwest Fisheries Science Center, NOAA Fisheries;* ***M.R. Bellinger, J.Minch,*** *and* ***G. Sylvia,*** *Hatfield Marine Science Center;* ***S. J. Bates,*** *California Salmon Council; and* ***P. W. Lawson,*** *Northwest Fisheries Science Center, NOAA Fisheries*

Information about the marine stock distributions of salmon is important for successful management of fisheries, as well as for illuminating the ecology and evolution of these fish. Here, we present data on the ocean distribution of Chinook salmon on a stock-specific basis. Because of their anadromous life-history and natal-homing, the many Chinook salmon stocks in the California Current are genetically and demographically distinct, but they lack morphological differentiation and are not visually distinguishable. As such, we used genetic stock identification assignment methods to identify them and seascape genetic techniques to understand what influences their distribution. Over the 2010- 2012 fishing seasons, we obtained 26,250 tissue samples from Chinook salmon caught in the California Current south of the Columbia River with exact geo-referenced (i.e. GPS coordinates) catch locations. We generated either single nucleotide polymorphism or microsatellite genotypes for most of them and assigned each fish to its stock of origin using large reference databases of known-origin fish. Maximum-entropy stock distribution models for the 12 most commonly encountered stocks revealed significant differences in the spatial distribution of most Chinook salmon stocks (as measured by Warren's I). Four stocks originating between Cape Mendocino and Cape Blanco have probability maxima to the south of their natal river mouth. Moreover, these stocks, together with most stocks from the Columbia River, show distinct responses to bathymetry, with clear probability maxima for bottom depths between 200-500 meters. Reasons for these distinctive spatial patterns are unclear, but might reflect different feeding strategies and/or preferred prey species. Our results suggest that Chinook stocks may be fished selectively, decreasing pressure on weak stocks by restricting fishing to certain depths or areas.

Fire, Drought, Landslides, and El Niño—Oh My: Steelhead Life-Histories in Southern California's Dynamic Landscape

Jacob Katz, CalTrout

That steelhead are still present in southern California streams is a tribute to the tenacity of a species adapted to a land of extremes. This talk will explore the amazing diversity of life-history strategies that allows *Oncorhynchus mykiss* to persist in extremely variable inland and marine environments. The Ventura River system will be used to as a model to discuss how Southern California steelhead populations persisted and thrived in watersheds prone to drought, flood, wildfire, and landslides as well as extreme variations in ocean conditions. In the Ventura River, fish historically took advantage of a mainstem with high winter flows, cool permanently flowing headwaters, and a large, productive terminal lagoon to create runs, in most years, of 4,000 and 6,000 fish. The juveniles could live one to three years in the headwater streams, integrated with populations of non-migratory trout. If a natural disaster such as wildfire or landslides wiped out the headwater populations, they could be quickly recolonized by progeny of the ocean-going steelhead. If drought and low flows blocked access to headwaters for a few years, preventing reproduction by steelhead, the steelhead population could become re-established by offspring of resident fish or by anadromous colonists from neighboring watersheds. This method of sustaining a dynamic population via integration of migratory and resident life histories distinguishes the life history of southern California populations but has been undermined by alteration of coastal rivers, especially barriers to migration, which inhibit spawning between steelhead and resident phenotypes.

Comparing the Demographics of Two Steelhead Populations and Their Habitat Characteristics

Eileen Baglivio (Presenter), Royden Nakamura, and Jennifer Nelson, Cornell University

Little is known about the demographics of steelhead trout populations in San Luis Obispo County. Specifically, demographic information is lacking regarding length and age when first leaving a watershed for the open ocean. Demographic and habitat data from the steelhead populations of two northern San Luis Obispo County coastal streams, San Simeon and Santa Rosa Creeks, were analyzed in order to gain greater insight into these populations.

Habitat mapping surveys were conducted on each stream to identify suitable habitat for various steelhead life stages. The data generated from the habitat mapping surveys was compared between the two creeks over two different survey years (1993 and 2005). The results of these surveys showed that habitat types have changed on San Simeon Creek between survey years, while Santa Rosa Creek appeared to remain the same.

Biological inventory methods were conducted on the populations of steelhead trout in San Simeon and Santa Rosa Creeks in the spring of 2005. During the 2005 out-migrant trapping season, the data revealed that non-smolting fish were moving downstream in the watershed in addition to smolting fish. Older, larger steelhead trout tend to migrate downstream earlier in the trapping season. There is also evidence that age 1+ and 2+ fish made up the majority of downstream migrants.

Further analysis of juvenile steelhead trout scales sampled from the populations on San Simeon and Santa Rosa Creeks in 2005 gave greater insight into the growth of these fish. In most cases, steelhead trout from Santa Rosa Creek have greater growth increments and higher circuli counts per annuli than those surveyed from San Simeon Creek. The average number of circuli to the first annuli is significantly different between watersheds, as is the relationship between fork length and scale radius. The majority of scale samples analyzed showed significant growth since the last annuli mark suggesting an increase in growth over the winter months. Additionally, short-term perturbations in the environment appear to affect scale growth, creating a biological record of environmental changes such as water flow.

Analyzing steelhead demographics is important to understanding the life history pattern of steelhead in the South Central California Coast Distinct Population Segment (DPS). Surveys that monitor environmental conditions and habitat help to identify potential limiting factors and risks to steelhead populations. The results of this study contribute to the necessity of continued research and efficient management practices of steelhead trout populations in San Luis Obispo County.

Life History Characteristics of Southern Steelhead in the Lower Santa Ynez River Watershed Revealed by Scale Reading

Sarah Horwath (Presenter), *Cardno ENTRIX; and* ***Tim Robinson, PhD, Scott Volan,*** *and* ***Scott Engblom,*** *Cachuma Operation & Maintenance Board*

Scales of Southern steelhead (*Oncorhynchus mykiss)* sampled from the Lower Santa Ynez River (LSYR) watershed were evaluated to determine age and the life histories of fish in three hydrologically diverse streams: (1) the LSYR mainstem, (2) Salsipuedes Creek, a flashy tributary with intermittent lower reaches, and (3) Hilton Creek, a formerly ephemeral tributary which is now perennial due to a creek watering system which pulls water from the neighboring reservoir. The confluence of Salsipuedes Creek with the LSYR is located approximately ten miles upstream of the Pacific Ocean and the Hilton Creek confluence with the LSYR is more than 48 miles upstream of the Pacific Ocean. Temporal patterns in life history stages, ages, and sizes of sampled *O. mykiss* were investigated with comparisons to hydrologic and climatologic variables. Back-calculated sizes of adult steelhead at ocean entry were estimated using regression equations of scale radii and fork lengths from over 900 *O. mykiss* migrants. During migrant trapping, some fish were captured more than once, as confirmed with photographic analysis of the fish and genetic analysis of fin clips from those fish. Back-calculation equations were validated with scale radii and fork lengths data from these recaptured fish. The results from the scale analyses are presented in context of the dynamics of the LSYR *O. mykiss* population.

A Perfect Match for Self-Renewal: Steelhead and the Santa Ynez River Ecosystem

William J. Trush, PhD (Presenter) *and* ***Alison O'Dowd,*** *Humboldt State University River Institute, Department of Environmental Science and Management, Humboldt State University*

The Santa Ynez River ecosystem was the perfect match capable of sustaining a large steelhead population close to the southern limit of the species' geographic range. Aldo Leopold's elegant definition for ecosystem health summarized as "the capacity for self-renewal" can be applied to populations as he applied it to ecosystems. The capacity for self-renewal in arid southern California begins with spatial scale. A watershed must be sufficiently big to reliably sustain a large returning adult steelhead population. Unit runoff (cfs/mi^2) requires sufficient watershed size to cumulatively generate annual hydrographs with the magnitude, duration, frequency, and timing of mainstem streamflows necessary to support significantly diverse steelhead life history tactics. The Santa Ynez River Basin at approximately 900 square miles could do this, whereas smaller river basins could not.

Larger tributaries in the Santa Ynez River Basin have the capacity to offer migrating adult steelhead high quality, low-risk spawning days in most water years, though wetter years generate considerably more low-risk days than drier years. Large and unregulated basins generated the magnitude and duration of baseflows that encouraged adult access up through the mainstem channel in most years January through early April; when a tributary storm unfolded, adult steelhead were there to enter the smaller tributaries and spawn within the short window of opportunity afforded by the spiked storm hydrographs. Annual adult steelhead access up the mainstem Santa Ynez River was the norm, not the exception (i.e., limited to wet years).

The same water that aided adult steelhead migration upstream aided their offspring's growth and migration downstream. Large volumes of winter and early spring water flowing under San Lucas Bridge, the gateway between the upper and lower basin, were stored in the floodplains' annually rechargeable groundwater reservoirs that returned late spring and summer streamflow into the Lower Santa Ynez River mainstem. Before the early 1920s, a dry mainstem channel in the lower basin in mid-August was a rarity. There were two basic juvenile steelhead life history tactics deployed in the Santa Ynez River Basin: 'to stay' and 'to leave.' Both started out the same. Migrating adults passing through an open Santa Ynez Lagoon would strive to blanket as much of the basin area with their offspring (young-of-the-year or YOY) as the hydrograph allowed. But that year's annual hydrograph exerted additional control.

The YOY blanketing strategy would have more losers than winners even in a wet spring. Many more millions of YOYs probably left their natal origin than stayed. As late as the 1940s, Leo Shapovalov documented millions of 0+ juvenile steelhead moving into the Santa Ynez River mainstem as tributaries dried. The Santa Ynez River mainstem below San Lucas Bridge would have been a productive, dependable 40-mile long biological hotspot for rearing 0+ juvenile steelhead throughout spring and into summer. With smolt-to-adult return (SAR) curves (X-axis = Smolt Size (mm) and Y-axis = Probability of Adult Return (%)) sharply increasing above 140 mm, only the bigger, healthy watersheds (particularly with substantial estuaries) could reliably produce abundant larger smolts and thus maintain a capacity for self-renewal.

Spawning Characteristics of Sympatric Steelhead and Resident Rainbow Trout in Southern California

Anthony P. Spina (Presenter) *and* ***Richard Bush,***
National Marine Fisheries Service, West Coast Region

The spawning ecology of *Oncorhynchus mykiss* (both anadromous and resident forms) is a topic of uncertainty in the Southern California Steelhead Distinct Population Segment. The National Marine Fisheries Service conducted census level surveys in the Ventura River watershed from 2010-2012. All ocean-accessible habitat in the Ventura River watershed (totaling 51.6 kilometers) was surveyed bimonthly. Additionally, surveys were conducted on Matilija Creek upstream of impassable Matilija Dam (not ocean-accessible) to evaluate Ventura River resident rainbow trout spawn timing and redd characteristics. Measurements of Matilija Creek resident trout redds provide support for redd classification based on measured redd area. Redd area measurements in the mainstem Ventura River and Ventura River tributaries comprising the anadromous reach were comparable, ranging from 0.2—2.5m^2 (n = 110) and 0.1—2.61m^2 (n = 365), respectively. Resident trout redds upstream of impassable Matilija Dam ranged from 0.1 to 0.9m^2 (n = 29). In the three years studied, *O. mykiss* spawning collectively occurred from mid-December through April. The timing of 50% spawning was similar for redds measuring ≥1.0m^2 (assumed to be constructed by steelhead) as compared to redds ≤1.0m^2 (i.e., resident rainbow trout). Fish selected substrate sizes of one to 14 centimeters, and water depths of ten to 85 centimeters. Spawn timing was distributed throughout the survey season, but annually varied widely in regards to flow magnitude and duration. Season total spawning density (i.e., redds per kilometer) ranged from zero to 23 redds per kilometer. Survey results suggest that spawning is patchily distributed throughout the watershed and that the timing of redd construction is related to periods of elevated streamflow. Based on our findings, we suggest that steelhead and resident trout in the Ventura River do not constitute reproductively isolated populations.

Relative Proportion of Adults with Anadromous and Resident Maternal Origin in an Endangered Southern California Steelhead Population

Richard A. Bush (Presenter) *and* **Anthony Spina,** *National Marine Fisheries Service, West Coast Region; and* **James Hobbs,** *University of California, Davis*

The anadromous and resident forms of *Oncorhynchus mykiss* are both capable of producing resident and anadromous offspring. *O. mykiss* offspring are also capable of exhibiting the opposite life history strategy as their parents, which is referred to as a life history crossover. As an initial step to understand how divergent life-history strategies may contribute to population dynamics, we salvaged 15 adult *O. mykiss* carcasses measuring ≥38cm fork length from the Ventura River Watershed during the peak of the spawning season for this species (January-April) in 2011 and 2012. Sagittal otoliths were extracted, air dried, prepared, and analyzed by the UC Davis Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) Laboratory. Maternal origin was identified by comparing otolith strontium isotope ratios (87Sr/86Sr) in the primordia and freshwater growth regions of the otolith using laser ablation-multicollector ICP/MS via spot analyses. Life history crossovers were identified using otolith line-scan analysis. The findings indicate steelhead maternal origin differed significantly between the two collection years. Adult *O. mykiss* of anadromous maternal origin had a mean (±SD) fork length (42.8 ± 30cm) that was not significantly different from adult *O. mykiss* of resident maternal origin (44.6 ± 28cm). Although ground surveys for carcasses were extensive and the survey effort was equal in mainstem river and tributary habitats, carcasses of the anadromous form were recovered six times more frequently in the mainstem river than in tributaries. While our samples are limited to the fraction of the population that died post-spawning, our findings suggest that the anadromous and resident form may not isolate reproductively in the Ventura River. If these findings represent the life-history strategy of *O. mykiss* watershed-wide, the life history crossover strategy reported here may play a key role in maintaining the anadromous form.

South-Central California Coast Steelhead Recovery Plan: Conifers to Chaparral

Mark H. Capelli, PhD, *National Marine Fisheries Service, NOAA Fisheries*

The National Marine Fisheries Services (NMFS) listed in 1997 two distinct sub-populations (DPS) of steelhead within the southern half of coastal California at the southern extent of their range in North America: 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 U.S. Mexico border in 2002.

NMFS Technical Recovery Team (TRT) for southern steelhead divided the South-Central DPSs into four Biogeographic Regions (BPG), characterized by a distinguishing suite of physical, climatic, and hydrologic features, reflecting the diversity of stream and watersheds within the BPG. These watersheds fall into two basic types: coastal watersheds draining directly westward into the ocean, and inland watersheds separated from the coast by extensive mountainous areas. The coastal watersheds tend to be small, numerous, and are strongly influenced by a marine climate. The inland watersheds are relatively few, large, and have a continental climate. The vegetative cover in both types of watersheds is dominated by chaparral and oak grassland woodland, with notable stands of conifers in the northern most inland watershed (Pajaro River), and along the Big Sur coast.

Recovery of the South-Central California steelhead DPSs will require the restoration of a minimum number of viable populations within each of the four Biogeographic Regions. The core watersheds identified in this biological strategy are geographically dispersed across the recovery planning area (extending from Monterey Bay to San Luis Obispo Bay) to preserve the existing diversity of life-history forms (ranging from anadromous to resident) and their evolutionary trajectories. Additionally, this biological strategy is intended to minimize the likelihood of extirpation of individual populations within each Biogeographic Region by natural perturbations (ranging from periodic drought and wildfires to longer range climatic changes), and to preserve the potential natural dispersal of fishes between watersheds. To determine the level of redundancy and distance between populations within the Biogeographic Regions, the expected geographic extent of a thousand-year wildfire was estimated based on wildfire data from 1910 through 2003. The analysis indicated that at least one viable population, plus the maximum number of wildfires expected for that BPG, or whichever was less, was needed to ensure the long term resiliency of the suite of populations in each BPG, and the DPS as a whole. The recommended minimum distance between individual viable populations was estimated at 68 kilometers (42 meters).

The South-Central California Coast Steelhead Recovery Plan also identifies a series of recovery actions intended to address the threats currently facing the species, as well as future threats posed by climate changes and related habitat transformations. Additionally, a long-term research and monitoring program is proposed to address a number of key issues (such as the relationship between anadromous and resident forms), and refine the population and DPS-wide viability criteria developed by the TRT. Recovery will require re-integrating the listed steelhead populations back into habitats in a manner that allows the co-occupancy of watersheds populated with approximately 2.8 million people.

The City of Santa Cruz Draft Habitat Conservation Plan and Central Coast Steelhead Recovery—Moving Toward Balance

Chris Berry (Presenter), Linette Almond, *and* ***Bill Kocher,*** *City of Santa Cruz Water Department;* ***Shawn Chartrand,*** *Balance Hydrologics;* ***Jeff Hagar,*** *Hagar Environmental Science;* ***Gary Fiske,*** *Gary Fiske and Associates, Inc.;* ***Sean Skaggs,*** *Ebbin, Moser and Skaggs LLP;* ***Donna Meyers,*** *Conservation Collaborative; and* ***Nicole Beck, PhD****, 2NDNATURE*

The City of Santa Cruz Water Department provides drinking water to more than 90,000 people in the northern Monterey Bay region, relying solely on local surface and groundwater to meet consumptive demand. Water supply sourced from local streams carry pre-1914 water rights and senior appropriative rights, but also the significant responsibility of operating surface diversions on streams that support anadromous salmonids, including Central Coast steelhead. Provided the declining status of salmonids on the central coast, the challenge of operating these facilities has grown significantly. As a result, the City of Santa Cruz entered into a habitat conservation planning effort with several resource agencies in order to protect its existing water supplies, and simultaneously to improve conditions for salmonids and their associated habitat. The process has undoubtedly presented the City and the agencies with numerous process and technical challenges.

Given the relatively complex and differing regulatory authority of the California Department of Fish and Wildlife (DFW) and the National Marine Fisheries Service (NMFS) over coho salmon, steelhead trout, and resident rainbow trout, navigation of the regulatory process has been challenging. DFW does not have jurisdiction under the California Endangered Species Act (CESA) over Central Coast steelhead; however they do have jurisdiction over resident rainbow trout through the Fish and Game Code and obviously have jurisdiction over coho salmon through CESA. On the other hand, NMFS has jurisdiction over both steelhead and coho, but not over resident rainbow trout. Typical permit process hurdles, in addition to the already monumental problem of lack of adequate municipal water supply, add to the complexity of the effort.

In spite of these challenges, the City is currently actively engaged with both federal agencies in negotiating a final conservation strategy and significant progress has recently occurred. Notably, all parties have agreed on modeling methodology that demonstrates the City's effects on Central Coast steelhead. Additionally, the City has begun implementation of interim instream flows to be provided on a short-term basis until Endangered Species Act "take" authorization is ultimately granted. These flows have already provided a substantial improvement to instream habitat conditions, and are also significant from a historical perspective. This work was founded upon the aforementioned complex hydrologic, water supply, and biological models. In summary, an evaluation of the City's current operations' effects on instream habitat suitability in varying hydrologic conditions was conducted. Secondarily, improvements to instream flows, based on specific life cycle requirements, were considered and prioritized in partnership with the agencies. Thirdly, limiting factors to implementation of more optimal instream flows were evaluated to inform the long-term viability of implementation of any particular conservation strategy, both in terms of benefits to the species and impacts on public health and safety.

Ultimately, providing adequate instream flows for Central Coast steelhead and delivery of municipal water supply requires an ongoing commitment on the part of all parties involved, significant technical and financial resources, and recognition by all involved that the only viable path forward is in the balance of meeting competing goals.

Floodplain Rehabilitation as a Hedge against Hydroclimatic Uncertainty: a Case Study of a Steelhead Migration Corridor

David A. Boughton (Presenter), *Southwest Fisheries Science Center, NOAA Fisheries ; and* ***Andrew S. Pike,*** *Southwest Fisheries Science Center, NOAA Fisheries, and Institute of Marine Sciences, University of California, Santa Cruz, CA*

A strategy for recovering endangered species during climate change is to restore ecosystem processes that moderate effects of climate shifts. In mid-latitudes, storm patterns may shift their intensity, duration, and frequency. These shifts threaten flooding in human communities and reduce migration windows (conditions suitable for migration after a storm) for fish. Rehabilitation of historic floodplains can in principle reduce these threats via transient storage of stormwater, but no one has quantified the benefit of floodplain rehabilitation for migrating fish, a widespread biota with conservation and economic value. We used simple models to quantify migration opportunity for a threatened migratory fish, steelhead, in an episodic rain-fed river system, the Pajaro River in central California. We combined flow models, bioenergetic models, and existing climate projections to estimate the sensitivity of migration windows to altered storm patterns under alternate scenarios of floodplain rehabilitation. Generally, migration opportunities were insensitive to warming, weakly sensitive to duration or intensity of storms, and proportionately sensitive to frequency of storms. The rehabilitation strategy expanded migration windows by 16–28% regardless of climate outcomes. Warmer conditions raised the energy cost of migrating, but not enough to matter biologically. Novel findings were that fewer storms appeared to pose a bigger threat to migrating steelhead than warmer or smaller storms and that floodplain rehabilitation lessened the risk from fewer or smaller storms across all plausible hydroclimatic outcomes. It follows that statistical downscaling methods may mischaracterize risk, depending on how they resolve overall precipitation shifts into changes of storm frequency as opposed to storm size. Moreover, anticipating effects of climate shifts that are irreducibly uncertain (here, rainfall) may be more important than anticipating effects of relatively predictable changes such as warming. This highlights a need to credibly identify strategies of ecosystem rehabilitation that are robust to uncertainty.

Instream Flows for Anadromous Fish Passage on the Intermittent and Partly Regulated Santa Maria River, Coastal Southern California, USA

Derek Booth, PhD (Presenter), *Bren School of Environmental Science and Management; and Stillwater Sciences,* ***Yantao Cui, Zooey Diggory,*** *and* ***Dirk Pederson,*** *Stillwater Sciences,* ***Jordan Kear,*** *Kear Groundwater; and* ***Michael Bowen,*** *California Coastal Conservancy*

Setting instream flows to protect aquatic resources is required by California state law, but this task is not straightforward for an intermittent river that is dry six or more months of every year. The Santa Maria River, 200 kilometers northwest of the Los Angeles metropolitan area, lies within the northern range of the federally endangered Southern California steelhead and historically supported the anadromous life history of this species. However, fish must navigate the lowermost 39 kilometers of the commonly dry mainstem river to move between the ocean and freshwater habitats in the upper watershed. Mainstem flows are partly controlled by Twitchell Dam, constructed across one of the Santa Maria River's two main tributaries in 1962. The dam is operated to maximize groundwater recharge through the bed of the mainstem Santa Maria River, thus minimizing discharge to the Pacific Ocean and so reducing already limited steelhead passage opportunities.

Existing criteria and methodologies for determining suitable instream flows for steelhead passage are ill-suited to such Mediterranean-type rivers, because they ignore large inter-annual flow variability, the critical importance of multi-day discharges, and the potential decoupling of perennial headwater flows from passage-adequate mainstem discharges. Previously invoked thresholds of flow depth, width, and velocity judged adequate for both upstream and downstream passage were compiled from scientific literature, but they do not address the range or sequence of daily flows that must serve as the hydrologic attraction cues to initiate migration. For purposes of this study, hydrologic metrics derived from the "natural" (i.e., pre-dam) gauge record of the mainstem Santa Maria River were assumed to be the most reliable indicator of the magnitude, frequency, and duration of hydrologic conditions suitable for migration. Although the long history of groundwater extraction means that the pre-dam hydrograph cannot be considered fully natural, the multiple reports of anadromous steelhead migration during the pre-dam period suggest that this historical record provides an adequate, if not optimal, flow regime for migration.

These criteria provided an objective basis for evaluating past, present, and alternative future dam-management scenarios for enhancing presumptive steelhead passage. Existing dam operations, designed to maximize groundwater recharge and minimize through-going flows to the Pacific Ocean, have only modestly reduced the raw number of days of potential upstream fish passage per year, but they have greatly altered the degree to which upstream tributary flows provide a reliable hydrologic indication of successful downstream migration. Metrics of flow magnitude alone cannot reveal these changes; even ecologically based indicators of flow frequency and duration have limited utility in such a setting and do not reveal the likely magnitude of impacts. A set of operational "rules" for reservoir releases were identified that largely eliminates these impacts by targeting the relatively narrow range of flows when passage would naturally have occurred but are now impaired by dam operations. Their total long-term impact on water releases is no more than three percent of the total storage, although their implementation would require redirection of some water that for the past half-century has exclusively supported irrigated agriculture.

Regional Assessment of Instream Flows Needs for Steelhead in San Luis Obispo County

Ethan Bell (Presenter), Sebastian Araya, *and* ***Derek Booth,*** *Stillwater Sciences; and* ***Nicole Smith,*** *Coastal San Luis Resource Conservation District*

In both the South-Central and the Southern California steelhead recovery plans, the National Marine Fisheries Service (NMFS) identifies surface-water diversions and groundwater extraction as some of the most severe threats to steelhead recovery. However, detailed studies to identify instream flow requirements have been conducted in very few watersheds in either recovery domain. Although recovery of steelhead requires the identification of watershed and stream-specific flow requirements, conducting precise estimates of instream flows across a large region would be time-intensive and likely cost-prohibitive.

In this study we developed an alternative, efficient approach to estimate site-specific flow requirements for steelhead in San Luis Obispo County, in the middle of the south-central/Southern California steelhead recovery area. We conducted a rapid field assessment in numerous fish-bearing watersheds throughout the County to estimate the minimum flows needed to support steelhead rearing during the sensitive spring and summer rearing periods. These results were analyzed to identify relationships between instream flow requirements and physical watershed characteristics (e.g., drainage area and physical landscape terrain of the contributing watershed). We found that drainage area was the best predictor of instream flow requirements, likely because channel geometry is a function of drainage area. The calculated relationship between instream flow requirements and drainage area was extrapolated to the remaining watersheds with potential steelhead rearing habitat in the County to predict flow requirements. Based on this approach, we predicted minimum flow requirements for steelhead in high-potential rearing habitat within all watersheds throughout the County. Stream channels where intrinsic conditions support migration but not rearing were considered separately. Measured spring flow requirements ranged from 0.35 cubic feet per second (cfs) to four cfs, and measured summer flow requirements ranged from 0.20 cfs to one cfs. Minimum spring flow requirements predicted for the County ranged from 0.30 cfs to 56 cfs, and predicted minimum summer flow requirements ranged from 0.2 cfs to 14 cfs. Predicted flow requirements were compared with existing flow conditions, where data was available, to identify whether streams had sufficient or insufficient instream flows during spring and summer rearing periods, and to thus identify candidate watersheds for conservation, enhancement, or restoration. There are obvious limitations to this approach, including an inability to estimate the response of habitat to a range of flows, or the ability to determine flows that maximize useable habitat. However, results of this effort can be used to prioritize watersheds for more precise estimates of instream flows, and to improve the assessment of environmental water demand used by the County in their Master Water Plan.

Developing a Monitoring Program that Will Include Measuring Success of Restoration Actions in Promoting Steelhead Recovery

Dana McCanne, California Department of Fish and Wildlife

The California Department of Fish and Wildlife South Coast Region Steelhead Monitoring Program in cooperation with the statewide California Coastal Salmonid Monitoring Program is developing a research and monitoring project for the federally endangered Southern California steelhead. Southern California steelhead are the southernmost Distinct Population Segment of steelhead in California. These fish are found in anadromous water from the Santa Maria River at the San Luis Obispo-Santa Barbara County line to the Mexican border. One of the tasks that the project must address is the efficacy of restoration projects.

Often tests for restoration efficacy involve taking measurements in the area around restoration projects. However, our restoration projects are for the recovery of anadromous Southern California steelhead. Seeing an increase in the number of juvenile steelhead and resident trout around the restoration project could be a product of moving fish around rather than increasing the population. While seeing an increase in the number and/or size of smolts for an entire basin is a good indication of restoration effects, it meaningless if there is not a corresponding increase in adult steelhead returns. To further complicate any study, there must be an accounting of adult straying into and out of the watershed.

Benefits and Risks of Using Large Woody Material in Urban Streams

Jeff Peters and Kevin MacKay, ICF International

Many stream restoration projects include installation of large woody material (LWM) structures to enhance aquatic habitat for salmonids and other native fish. In many cases, particularly in urban streams, large woody material has historically been removed to maintain conveyance capacity and reduce the potential for debris jams, backwater effects, and flooding of adjacent properties. Recruitment of large woody material in these streams is also limited because in many cases the watersheds are highly urbanized and lack streamside vegetation. As a result, the instream aquatic habitat in many urban streams is fairly uniform consisting primarily of deep glides and pools that favor non-native predatory fish, and lack pool/riffle variability, instream cover, and high flow refugia. In addition, because of the lack of woody material and vegetation, flow velocities are fairly constant across the channel cross section, resulting in deposition of a homogenous mixture of silts, sands, and gravels in the channel bed when high flows recede.

Installation of LWM structures as part of a holistic stream restoration effort can substantially improve aquatic habitat quality for native fish, and depending upon the type and location of the structure, can provide a number of benefits including: (1) promoting localized scour along channel margins to increase/enhance instream cover, (2) narrow the low-flow channel, increase localized velocities, and promote bed material sorting, entrainment of finer bed materials and oxygenation and food availability, (3) provide refugia during moderate to high flows, and (4)establish more frequent pool/riffle complexes, increase riffle lengths, and decrease pool/glide lengths. However, because of the urbanized nature of these streams, LWM structures can also pose a number of risks including: (1) public safety hazards associated with exposed anchoring devices (e.g., rebar pins, wire cables, helical anchors), (2) flooding hazards associated with displacement of the logs, and downstream transport, and accumulation at channel pinch points (i.e., bridges), and (3) damage to bridge pilings and other infrastructure by displaced logs. This presentation will provide an overview of several urban stream restoration projects planned, designed, and implemented in northern California over the past 10 years, and review and discuss many of the challenges faced by these projects regarding the use of LWM to enhance aquatic habitat.

Restoring Endangered Southern California Steelhead to an Urban Stream

George Johnson, *City of Santa Barbara*

Small south coast streams play an important part in restoring the endangered Southern California steelhead. Unfortunately, many of these streams have been negatively impacted by urban development. Barriers to migration are the primary issue impacting steelhead restoration in these small coastal streams. Over the last seven years, the City of Santa Barbara has been working to remove the barriers to migration on the lower section of Mission Creek. This section of Mission Creek is heavily urbanized and has two significant fish passage barriers. The largest barrier on lower Mission Creek is at the Caltrans Channels. The Caltrans Channels consist of two separate trapezoidal channels with concrete floors and banks designed to reduce flooding and allow for construction of Highway 101. The concrete channels create significant barriers to steelhead migration because flow rates and flow depths within the channels are too fast and/or too shallow for fish to swim upstream. The City recently completed construction of an innovative fish passage design that will allow fish to migrate upstream through the concrete channels. The City also removed another barrier to fish migration on lower Mission Creek at the Tallant Road Bridge. This project was completed utilizing more standard methods of restoration through construction of a natural creek bed with native rock to improve fish passage conditions. Using very different restoration techniques, these two projects will allow fish to migrate upstream to spawning habitat in the upper watershed and help recover the endangered Southern California steelhead.

Is Soil Bioengineering within an Urban Stream Setting Mission Impossible?

***Mike Vukman,** Stantec Consultants*

Is working on an urban stream an exclusive mission for James Bond?

I am here to argue that we can ask James Bond to stand aside with all due respect. We, as a community of practitioners, need to continue to build upon the collective body of knowledge handed to us by the Roman and Chinese civilizations that soil bioengineering is within everyone's reach even for very difficult situations.

In an effort to continue to advance the field of soil bioengineering, we need to constantly challenge many of the assumed standards and limitations of these techniques. At the same time, we also need to be humble in a transparent manner, sharing the invaluable lessons gleamed from our collective mistakes.

Using a comprehensive approach that brings back the pattern, profile, and dimension in an effort to restore the form, function, and dynamics of a stream in a balanced manner, soil bioengineering and its myriad of techniques continues to offer us an opportunity to restore numerous ecological functions while preventing continued streambank erosion and a consequential loss of instream habitat. During this presentation, I will share examples of soil bioengineering projects that have been designed and installed in urban stream settings, including successful innovations that have pushed the known limits of established techniques. The cases describe cases that have not performed up to expectations, including the lessons learned.

While working on restoring ecological functions within the context of an urban setting can be extremely challenging, I believe that we can tell James Bond to stand down.

Urban Stream Steelhead Restoration through Daylighting

Drew Goetting, Principal, Restoration Design Group

In 2012, the City of San Pablo restored 600 feet of Wildcat Creek which had been buried under the Davis Park baseball field for 50 years. Restoration Design Group (RDG) designed the project for the city. The daylighting had been identified as a high priority through multiple planning processes including the Wildcat Creek Restoration Action Plan and the Davis Park Master Plan. The project removed one of the two remaining fish passage barriers between San Pablo Bay and the upper watershed located in natural regional parks, Wildcat Canyon and Tilden Parks. The double-barreled culvert was also a public safety nuisance and its removal was strongly advocated by the San Pablo Police Department.

In addition to the geomorphic, hydraulic, and ecological design components associated with stream restoration, it was essential that this project appropriately addressed urban design issues such as public access, park usage, and public safety. Although creek daylighting was the primary driver of this project, it was also required that the existing park uses be maintained and upgraded. This lead to a complete park refiguration including redesigning and re-locating baseball and soccer fields in Davis Park, building a pedestrian bridge, and installing new electrical systems and ball field lighting. A cost-effective approach was required to meet limits on the grant budget, most notably, the strategy used to remove the old culvert. Finding a balance between the restoration objectives and urban design was critical during the process of developing the revegetation design. RDG worked with the California State Water Resources Control Board to identify a suitable plant palette that was robust enough to withstand user impacts in a heavily used urban park. This project will be complemented by future upstream restoration efforts in the City of San Pablo.

Beaver Impact on City Stream Habitat: Martinez, CA

Heidi Perryman, PhD, Worth A Dam

In 2007, beavers dammed Alhambra Creek in Martinez, California, threatening the business district with flooding, which prompted the city to recommend trapping. A dramatic resident response spurred media attention, which forced city officials to find another way to solve the problem. Expert Skip Lisle was flown in from Vermont to install a flow device at the dam site which lowered the dam permanently and prevented flooding. The beavers responded to the water loss with a series of smaller secondary dams, which expanded and enriched the wetlands, drawing new wildlife to the creek, including otter and mink. The group Worth A Dam was formed to advocate for the beavers and educate the public about their role in creek restoration. Community events and a yearly beaver festival have been celebrated since that time, and Worth A Dam has assisted other cities in learning how and why to live with beavers. The effects of beaver-assisted creek restoration in an urban setting and the role of citizen science are discussed.

Martinez is located in northern California and was the home of John Muir for the last 25 years of his life. The stream that flows through downtown had problems with flooding before the beaver adopted it in 2006, building first a dam and then a bank lodge. Because of their prominent locations, it was possible for passersby to see the beavers in the mornings or evenings, and residents got quickly engaged with watching the animals. By the time the City announced that they were going to be trapped, a large number of citizens had seen them firsthand. The arrival of four kits made them even more exciting to watch. People lingered at the creek-side Starbucks, where they could see and hear the beavers 15 feet away.

Very quickly, we realized that our beavers were protected by the "opposite of camouflage" (the more people saw them, the safer they were getting). Residents acted as docents, explaining behavior and making sure the habitat was not intruded upon. National media attention quickly made these the most famous beavers in the nation and pressed city officials to pay for a humane solution.

With the installation of the flow device, the worries about flooding were allayed. Quickly we observed the impact of the beaver dams on other fish and wildlife, and in a very short time there were new and increasing species at the ponds including kingfisher, steelhead, green heron, egret, otter, scaup, mink, and hooded merganser. In 2008, we saw the first effects of coppicing when beaver-chewed trees re-grew into dense, bushy nesting habitat for phoebes and song sparrows. Beavers were changing our urban stream before our eyes, but this was just the beginning.

Systematic Framework for Improving Environmental Flows below Dams in California

Ted Grantham (Co-presenter), *Center for Watershed Sciences, University of California, Davis;* ***Curtis Knight (Co-presenter),*** *CalTrout;* ***Peter Moyle,*** *Center for Watershed Sciences, University of California, Davis;* ***Rene Henery,*** *University of Nevada, Trout Unlimited; and* ***Monty Schmitt,*** *Natural Resources Defense Council*

There are thousands of dams in California, each one contributing to the degradation of aquatic ecosystem function in some way. Most of these dams were built and are operated with little consideration for their effects on fish, although for 100 years the State of California has officially recognized the need to provide adequate flows for fish below dams under Fish and Game Code Section 5937 and the Public Trust Doctrine. Recent successful lawsuits for restoring flows in California rivers indicate that there is an opportunity for broader implementation of environmental flows in California's rivers and streams. However, determining which dams may not be in compliance with State law is a daunting task that agencies have not undertaken to date. Here, we present an evaluation framework to identify dams in California where flow modifications and/or other management actions may be warranted to comply with Section 5937. The approach follows a tiered framework that focuses on the inventory, characterization, and screening of dams based on evidence of flow regime alteration and downstream fish community impairment. Approximately 200 dams (of an initial 1,400) are identified as high-priority candidates for improving environmental flows. Given the rapid declines of native freshwater fish populations and pervasive alteration to rivers, this evaluation approach may be useful for guiding strategic implementation of environmental flows in California and elsewhere.

The Roles of Geology, Geography, and Climate in Planning Dam Removal

Brian Cluer, PhD, *National Marine Fisheries Service, West Coast Region*

Dam removal has now occurred or is underway from northern Washington to southern California on the United States' West Coast. This dynamic and diverse region spans a variety of geologic and climatic settings and the different dam removal approaches used provide an opportunity to examine some planning considerations that may improve early dam removal planning approaches. Planning and executing dam removal projects requires understanding the physical context within which the dam is located and how it was constructed. For example, dams in highly erodible geologic settings (e.g. southern California coast range) typically trap larger volumes of sediment over shorter time spans than do dams in erosion resistant catchments (e.g. Klamath River dams). The ratio of reservoir fill dramatically alters dam removal options and natural erosion options. Similarly, catchments in climates dominated by distinct cycles of wet versus dry annual precipitation (i.e. El Niño/Southern Oscillation) present less frequent hydrologic opportunities to manage the natural transport of accumulated reservoir deposit with stream flow. Here, mechanical sediment management may be required. Dams in catchments with wildfire processes may trap reservoir deposits that represent only one or two wildfire events separated by a few decades between fires, while densely forested catchments more likely yield a relatively uniform sediment rate tracing hydrologic patterns. The scale of the dam relative to its catchment and sediment delivery rates and processes vary by dam location within its catchment and the dam's scale relative to annual water yield. In addition to the scales of physical dam and catchment attributes, the downstream associated infrastructure such as water diversions and human structures often restrain the options for sediment delivery, and the rate of dam removal. Dam reservoirs trap not only sediment but organic materials too. The release and transport of organic materials, as well as the restoration of continuity of organic loads from the catchment upstream, are planning considerations critical to water supplies downstream. Dam construction techniques also moderate demolition options which in turn regulate sediment release options. A survey of dam removal experiences across this region will be used to discuss the different physical, climatic, geologic, geographic, and structural considerations for dam removal planning.

Removal of San Clemente Dam—Project Summary and Unique Challenges

Jonas Minton, *Planning and Conservation League*
and ***Rob Maclean,*** *California American Water Company*

San Clemente Dam (SCD) is a 106-foot high concrete arch dam located approximately 18.5 miles from the Pacific Ocean on the Carmel River in Monterey County, just downstream of the confluence of the Carmel River and San Clemente Creek. When the dam was constructed in 1921, it had a reservoir capacity of approximately 1,425 acre-feet. Today the reservoir has been filled by more than 2.5 million cubic yards of sediment, leaving a reservoir capacity of approximately 70 acre-feet. California American Water (CAW) owns and operates the dam.

The California Department of Water Resources Division of Safety of Dams issued a safety order for the dam structure in the early 1990s, determining that the SCD could potentially fail in the event of either the maximum credible earthquake or probable maximum flood. Strengthening SCD would resolve the public safety issues, but would not address other issues such as impaired access for steelhead, disruption of sediment transport to the lower river, and ecological discontinuity of aquatic and riparian habitats. Removing the dam would help resolve these issues and provide significant benefits to both steelhead and California red-legged frog.

For these reasons, the California Coastal Conservancy (as the lead for the State), National Marine Fisheries Service, and the Planning and Conservation League Foundation worked with CAW to develop a feasible approach to cooperatively implement an option that would stabilize sediment in a portion of the Carmel River channel, reroute the Carmel River into a portion of San Clemente Creek around the stabilized sediment, and remove the dam. By 2013, permits were obtained and sufficient funding was secured for the project. The first phase, providing road access to the site, has begun.

The Primary Project Goals are:

- Provide a long-term solution to the seismic dam safety issue.
- Improve steelhead habitat and fish passage since South-Central California coast steelhead are listed as threatened under the Endangered Species Act. The numbers of adult fish returning to the area have declined between 50- 75% since the mid-1970s. The removal of SCD will provide improved access to over 25 miles of spawning and rearing habitat for steelhead.
- Minimize mobilization of sediment from the project and diminish the potential for excessive erosion, undermining, sloughing, or slope failure that would lead to mobilization of sediment from the project to downstream reaches.
- Avoid exacerbating downstream flooding between SCD and the ocean. Significant flooding of the Carmel River occurred in 1943, 1958, 1969, and twice in 1995, as well as more regular flooding of downstream portions of the developed floodplain.

Carmel River Reroute & San Clemente Dam Removal Project —Project Summary & Unique Challenges

Seth Gentzler, PE (Presenter), *URS Corporation*
and ***Richard Svindland, PE,*** *California American Water*

San Clemente Dam (SCD) is a 106-foot-high concrete arch dam located approximately 18.5 miles from the Pacific Ocean on the Carmel River in Monterey County just downstream of the confluence of the Carmel River and San Clemente Creek. When the dam was constructed in 1921, it had a reservoir storage capacity of approximately 1,425 acre-feet. Today the reservoir has been filled by more than 2.5 million cubic yards of sediment, leaving a reservoir storage capacity of approximately 70 acre-feet as of 2008. California American Water (CAW) owns and operates the dam.

The California Department of Water Resources (CDWR) Division of Safety of Dams issued a safety order for the dam structure in the early 1990s, determining that the SCD could potentially fail in the event of either the maximum credible earthquake or probable maximum flood. Strengthening the SCD would resolve the public safety issues, but would not address other issues such as impaired access for steelhead trout to 25 miles of upstream spawning habitat, disruption of sediment transport to the lower Carmel River, and the ecological discontinuity of aquatic and riparian habitats. Removing the dam would help to resolve these issues and provide significant benefits to both steelhead trout and California red-legged frog. For these reasons, the California Coastal Conservancy (as the lead for the State of California), National Marine Fisheries Service, and the Planning and Conservation League Foundation worked with CAW to develop a feasible approach to cooperatively implement an option that would stabilize reservoir sediment in a portion of the Carmel River channel, reroute the Carmel River into a portion of San Clemente Creek around the stabilized sediment, and remove the dam. In December 2007, CDWR certified the Final Environmental Impact Report/Statement, and in February 2008, indicated that the dam safety issue could be addressed through implementation of the River Reroute and Dam Removal Project.

URS was hired as the owner's engineer in 2008 to help move the project forward by refining the project design and developing a project procurement strategy for delivery of a design-build project. The design-build procurement strategy was selected for a number of reasons. One of the most compelling was the fact that the proposed reroute and dam removal solution involved construction of a new river channel within alluvial materials and bedrock, currently covered by up to 80 feet of accumulated reservoir sediments. The new river channel alignment would be placed in a creek valley that had not previously seen the full river flow, and would need to provide fish passage for steelhead. Due to the limited information available regarding the 1921 pre-dam surface, the design-build strategy would allow for flexibility to adapt the design while the accumulated sediments were excavated, and would deal more effectively with unknown subsurface conditions such as bedrock outcroppings or material discrepancies.

Due to the design-build nature of the project, some unique challenges had to be overcome to allow for construction to begin included the development of (1) design-build design criteria and performance specifications (including fish passage and channel design) to a level of detail necessary to obtain permits (without detailed design plans), and (2) practical hydraulic and seismic criteria to ensure stabilization of sediments to be permanently disposed of onsite that would meet the dam safety regulator's expectations to ensure long-term safety downstream of the site.

Matilija Dam: Taking another Look

Paul Jenkin, ***Surfrider Foundation***

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 sediment management without disruptions to water supply. The Matilija Dam Ecosystem Restoration project approved by Congress in the Water Resources Development Act of 2007, includes extensive re-engineering of water diversion facilities as well as modification of levees and bridges. In 2009, the project stalled due to the cost of mechanical management of fine sediments stored behind the 200-foothigh dam.

In 2014, a consultant team will re-examine the federal plan and analyze a range of alternatives in an effort to develop a cost-effective plan for the removal of this obsolete structure.

Branciforte Dam Removal Project, Branciforte Creek, Santa Cruz, CA

Chris Hammersmark (Presenter) *and* ***Ben Taber,*** *cbec, inc. eco engineering;* ***Jim Robins;*** *Alnus Ecological; and* ***Kelli Camara,*** *Resource Conservation District of Santa Cruz County*

While dams provide several benefits towards mankind's occupation of the arid west (e.g., water supply, power generation, flood regulation, recreation, etc.), they also impose several impacts, particularly upon physical and biological processes in river systems. Branciforte Dam was constructed on Branciforte Creek, a tributary to the San Lorenzo River, in 1931, for the purpose of water supply and recreation. The approximately eight-foot tall dam altered sediment movement downstream and fish passage to the approximately 3.5 mile watershed located upstream, where high quality habitat exists. Multiple past attempts retrofitted the dam in order to provide and/or improve fish passage; however the dam still posed an impediment to upstream migration across a range of flow conditions. In the late summer and early fall of 2013, Branciforte Dam was removed. The project was led by the Resource Conservation District of Santa Cruz County, with funding for coordination, feasibility assessment and design provided by a grant from the California Department of Water Resources Integrated Regional Water Management program, as well as the California Coastal Conservancy. The preliminary assessment and design were vetted through consultation with project partners including representatives from the National Marine Fisheries Service, California Department of Fish and Wildlife, National Resource Conservation Service, Santa Cruz County, Santa Cruz County Resource Conservation District, Army Corps of Engineers, and the Regional Water Quality Control Board. Following the assessment and development of an engineered design, the dam was removed with construction funding provided by a grant from American Rivers. Details of the feasibility assessment, engineered design, construction, and post-project monitoring will be discussed during the presentation.

Lillingston Creek Debris Dam Removal: Steelhead Restoration off the Beaten Path

Seth Shank and Andrew Raaf, Santa Barbara County Flood Control District

The Lillingston Creek debris dam was constructed in the early 1970s following a wildfire in the foothills above Carpinteria, CA, in Santa Barbara County. During the last 30 years, the dam filled with sediment and created a major fish-passage barrier in Carpinteria Creek, a promising watershed for steelhead recovery. During the same time, the backcountry road leading to the site degraded from minor landslides and rapidly growing riparian vegetation. In 2011, the County Flood Control District embarked on a challenging project to deconstruct the debris dam and return steelhead passage to the site. With partial assistance from California Department of Fish and Wildlife grant funds, the project was completed in fall 2013. The County employed innovative approaches to the project because there is no road access for heavy equipment or export of accumulated sediment. Deconstructing the dam employed a multi-year phased approach with walking-spider excavators, sediment redistribution, and extensive onsite monitoring. The dam removal has been completed, while sediment migration and re-vegetation are ongoing, relying mostly on natural processes to re-establish a slightly meandering channel. The project summary will provide information on funding, access, technical studies, and future assessment of success criteria.

California's Powerful Salmon Restoration Economy—Collaborating to Provide the Influence Necessary to Strategically Focus Restoration Funding and Turn Recovery into Reality

Saturday Afternoon Concurrent Session

Coho Salmon Restoration —the Creation of a Restoration Economy on the North Coast

Lisa Hulette, The Nature Conservancy

In California, we are experiencing the steepest decline in salmon populations in the West with seven of the ten coastal California salmon and steelhead species federally threatened or endangered. Our iconic salmon are imperative to California's economic, recreational, and environmental welfare.

There exists a $1.5 billion commercial and recreational salmon fishing industry, and more than $225 million has been spent on instream habitat restoration in the past decade, resulting in approximately 3,000 California jobs. Restoration work has been shown to provide as many or more jobs per million dollars spent as many other industries, including agriculture, oil and gas development, and gray infrastructure, such as construction and transit repair. With over a quarter of a billion dollars having been spent on primary funding for salmon and steelhead restoration instate over the past decade, a significant number of jobs have been created through the effort to recover salmon and their habitats in California. It is imperative that as a restoration community, we work to ensure that every dollar spent can catalyze salmon recovery throughout their historic range.

The overarching goal of The Nature Conservancy's Salmon Initiative is to restore and protect coho salmon, Chinook salmon, and steelhead trout populations to sustainable and fishable abundance and demonstrate solutions with broader application by 2031 and through 2100.

Salmon, trout, and their relatives are the iconic fishes of California and the Pacific region. They are characteristic of the region's cold productive oceans, rushing streams and rivers, and deep cold lakes, and are important ecologically, culturally, and economically. Despite having been the focus of much restoration and recovery effort of the past 30 years, populations of salmon, steelhead, and trout in California remain just a fraction of their historical numbers. Yet the extent and plight of California's salmon and steelhead populations is relatively unknown to Californians due to a lack of reporting of all but hatchery derived stocks in the Central Valley. The Nature Conservancy is determined to change that.

In California, the future of salmon conservation rests with timber companies, ranchers, and other private landowners. Since the majority of land around wild streams in California is privately owned, The Nature Conservancy, even with government and non-profit allies, will not be able to bring salmon back without strategic partnerships. By developing and demonstrating solutions to salmon recovery that can be readily adopted by industry and agriculture, and actively removing barriers that inhibit farmers and foresters from aiding salmon recovery, the Conservancy's California Salmon Initiative is developing promising avenues for widespread salmon restoration that have broad implications for recovery in California and beyond.

The Nature Conservancy is working on solutions to: (1) target wild salmon populations with the best chance for recovery, (2) demonstrate solutions to remove the critical life cycle bottlenecks for those salmon populations, and (3) catalyze widespread adoption of those solutions by private landowners.

Optimizing the Coho Salmon Potential Supplementation Landscape

Jeanette Howard, PhD (Presenter), *The Nature Conservancy; and* ***Kurt Fesenmyer,*** *Trout Unlimited*

The National Marine Fisheries Service (NMFS) has identified coho salmon populations in the Central California Coast (CCC) and Southern Oregon Northern California (SONCC) Evolutionarily Significant Units where reintroduction, supplementation, or reestablishment are priority recovery actions. The purpose of our study was to develop methods to identify optimal locations for coho salmon reintroduction, supplementation, or reestablishment.

We reviewed the recovery actions listed in the CCC and draft SONCC coho recovery plans and generated a list of populations requiring reintroduction, reestablishment, or supplementation as priority recovery actions. We used information within Trout Unlimited's Conservation Success Index (CSI) for coho salmon to summarize and interpret landscape-scale factors related to the habitat conditions and future threats relative to those populations. The CSI provides 58 watershed-scale variables for all sub-watersheds in California that historically supported runs of coho salmon. This database included 38 variables related to the human footprint, 17 variables related to abiotic or climatic condition, and three variables related to coho distributions.

To provide additional layer of prioritization, we used the conservation reserve design software Zonation to identify the optimal location of reintroduction and supplementation activities based on the location of NMFS priority populations relative to existing coho populations and landscape factors in the CSI.

Our results provide a series of unique optimization solution sets ranking subwatersheds and populations to help identify places with a higher likelihood of success of supplementation or reintroduction activities.

California's Powerful Salmon Restoration Economy—Collaborating to Provide the Influence Necessary to Strategically Focus Restoration Funding and Turn Recovery into Reality

Saturday Afternoon Concurrent Session

California Salmon Strongholds: Institutionalizing a "Protect the Best" Strategy

Curtis Knight (Presenter), *CalTrout;* ***Mark Trenholm,*** *Wild Salmon Center;* ***Jeanette Howard,*** *The Nature Conservancy;* ***Brian Johnson,*** *Trout Unlimited;* *and* ***Kevin Shaffer,*** *California Department of Fish and Wildlife*

A network of California salmon and steelhead strongholds has been identified by the California Salmon Stronghold Partnership, a public /private effort led by the Wild Salmon Center, California Department of Fish and Wildlife, CalTrout, Trout Unlimited, and The Nature Conservancy. Six strongholds were identified in each of six defined ecoregions in California. These strongholds represent 28 salmon and steelhead populations identified as "strong" and cover 70% of the diversity (run-timing/Evolutionarily Significant Unit /ecoregion) of the State's strong populations. The salmon stronghold approach works under a simple premise: securing the long term health of the state's strongest populations and most productive salmon ecosystems is essential to range-wide recovery; if we lose our strongholds, recovery can never be achieved. The California Stronghold Partnership is currently working to institutionalize support for stronghold conservation through the development of new policy and funding initiatives. We are also continuing outreach to local and regional partners to determine common needs and challenges faced by those who are working in strongholds and charged with the protection of California's last, best salmon and steelhead rivers.

A Biologist's Cost-Benefit Analysis for Salmon Habitat Enhancement

Gregory Andrew, Marin Municipal Water District

As biologists, we often have to be aware of the economics of salmonid recovery, but it is rare that we think in terms of the cost-benefit aspects of our work. As part of a grant application to fund a Proposition 84, Integrated Water Resources Management Project, I had to develop a cost-benefit assessment in terms of the numbers of salmon and economic values resulting from a habitat enhancement project in Lagunitas Creek, an important coho and steelhead stream in Marin County. The project was a culvert replacement project to reduce sediment loading into Lagunitas Creek and improve fish passage into a tributary stream. The cost-benefit analysis considered three benefits anticipated from the project: 1) spawning and rearing habitat, 2) barrier removal, and 3) winter refuge. The economic values calculated for the project were boiled down to a $2,000 value per fish for adult salmonids returning to spawn (i.e., fish that would not otherwise survive to adults and return as spawners). The cost-benefit analysis made a number of fairly conservative assumptions but still resulted in the following relatively high values: spawning and rearing benefit = $206,000, barrier removal benefit = $88,000/year, and winter refuge benefit = $10,000/year. Over a ten-year period, the annual benefits amount to a substantial value from the project. This presentation will walk through the steps leading to the cost-benefit analysis, describing the assumptions and calculations made. It will serve as one small example of how those of us working to restore and recover salmonids can place a value on our efforts that may be tangible to society and, perhaps more importantly, serve to increase funding for restoration.

California's Powerful Salmon Restoration Economy—Collaborating to Provide the Influence Necessary to Strategically Focus Restoration Funding and Turn Recovery into Reality

Saturday Afternoon Concurrent Session

Moving Beyond a Salmon Restoration Economy—Time to Imbed Preventative Financial Incentives in Everyday Land Use Decisions and Economies

***Sungnome Madrone**, Mattole Salmon Group*

The Restoration Economy is built on a house of cards that is beginning to crumble. The cards in the house are all of the state, federal, and private grant programs that have developed and evolved to support the growing watershed restoration field. These cards are getting less plentiful as bond moneys run out, and the competition for them increases competition and reduces the collaborative spirit so needed for success.

Like any house built of straw or sticks, it can blow away when severely tested. So where do we get the bricks and mortar to make the house strong? How do we increase the financial investments into watershed protection and restoration, because even when grant funds have been plentiful, they are still a drop in the bucket when compared to the restoration needs?

It is time to tap the private sector like never before and it is time to imbed financial incentives and rewards for good land stewardship. Current tax and permit laws are full of disincentives for sound land stewardship.

Economics 101 teaches us that incentives are a more cost-effective way to get things done than trying through fines and penalties. We have plenty of laws on the books that say you must do so and so to protect the environment, but many of these laws are not enforced. Why?

What if we turn all that on its head and start creating tax and permit laws that are well integrated, and simple to manage, that provide financial incentives for good land stewardship? These new sweeping laws at the state and federal levels could be combined in a set of Stewardship Act bills that would institutionalize good land use practices.

An example of how this might work can be given using the State of California's Williamson and Timber Production Zone Tax Break Programs. If one keeps your land in agricultural or timber production, then you have a lower property tax burden. That is great and helps prevent agricultural land conversion. What if we took this further and said there is a "Gold Standard" Williamson and Timber Production Zone Program that says if one keeps it in agriculture and uses Best Management Practices to maintain that land, they then get to write off all of their expenses against their tax liability for the year. Imagine that an annual audit by Resource Conservation Districts, Natural Resource Conservation Service, and watershed groups could provide a landowner with a Stewardship Certification and further permit streamlining and reduced fees for projects on their land if practicing Best Management Practices.

This way, agricultural land can be managed in a way that helps prevent the need for watershed restoration in the first place. Prevention is sustainable. Restoration is not!

This presentation will explore these ideas and present some practical ways that such a program could be implemented. The sooner we begin this adaptation of our existing tax and permit laws, the sooner the industry can move to a more sustainable future that creates jobs and supports a healthy economy and communities.

The California Trout Directed Southern California Steelhead Coalitions—Integrating Efforts, Funding, Capacity, and Resources to Leverage Efforts for Southern California Steelhead Recovery

Candice Meneghin (Presenter), Kurt Zimmerman and Roxanne Carter, CalTrout

The formal launches of the Santa Clara River Steelhead Coalition and South Coast Steelhead Coalition were made possible by significant grants from the California Department of Fish & Wildlife's (CDFW) Fisheries Restoration Grant Program (Grant no. P1150007 and P115011) and the National Oceanic and Atmospheric Administration—Fisheries Pacific Coastal Salmon Recovery Funding, together with private donations. California Trout's southern California Regional Manager Kurt Zimmerman chairs the Coalitions, which are coordinated by Roxanne Carter (South Coast) and Candice Meneghin (Santa Clara River), respectively. Under CalTrout's energetic leadership, the South Coast Steelhead Coalition members or participants have grown to include Trout Unlimited (our Co-Chair), Golden State Flycasters, San Diego Coastkeeper, Chaparral Lands Conservancy, CDFW, the National Marine Fisheries Service (NMFS), the United States Fish & Wildlife Service (USFWS), and the United States Forest Service (USFS). The Santa Clara River Steelhead Coalition's members include The Nature Conservancy, Friends of the Santa Clara River, Keep the Sespe Wild, Wishtoyo Foundation/Ventura Coastkeeper (Native American Foundation), the University of California at Santa Barbara's Riparian Invasion Research Laboratory, and Stoecker Ecological.

The goal of the Coalitions is to advance the protection and restoration of Core 1 steelhead populations (as determined by NMFS) in the Santa Clara River watershed and watersheds across San Diego and Orange counties. Towards that goal, the Coalitions will engage a broad alliance of members, participants, and other partners already committed to steelhead protection and restoration, while simultaneously generating support for their efforts from the general public, as well as target audiences.

The Coalitions' members, participants, and other partners collaborate and leverage their collective resources and experience to identify, prioritize, and implement recovery projects with broad, or even watershed-wide beneficial impacts, e.g., habitat restoration, fish passage improvement and restoration, innovative water conservation, planning for climate change, etc. Several larger-scale projects demand an integrated approach, as they are difficult, if not impossible, to implement by any one organization.

Our presentation will showcase the Coalitions' prioritization and planning process, key restoration projects that have been identified and/or funded, as well as successful public outreach activities to date, and how we have strategically focused restoration funding and recovery. We will share successes and challenges, and opportunities for the future. We are confident that a Coalition-approach will facilitate the species recovery.

Assessing Limiting Factors from Tributaries to the Estuary for the Steelhead Population in the Big Sur River

Ethan Bell (Presenter), *Stillwater Sciences,*
and ***Steph Wald,*** *Central Coast Salmon Enhancement*

Few aquatic species are adapted to surviving in the challenging habitat conditions of south-central and southern California coastal streams, where high sediment loads, highly variable flow regimes, and high water temperatures are the norm. Steelhead employ highly plastic phenotypic and life-history variability to exploit these habitats which would not sustain populations of other salmonids. The Big Sur River, with its nearly pristine habitat conditions, supports a steelhead population that has long been recognized as one of the most productive in the South-Central California Distinct Population Segment (DPS). As a significant source population for the DPS, continued and increased production from the Big Sur River is important in the recovery of the DPS. However, because the current population is believed to be far less productive than it was historically, we conducted focused research into factors that affect the persistence and potential for recovery of the steelhead population in the Big Sur River watershed.

We assessed the physical habitat within the Big Sur River watershed from the tributaries to the lagoon using available data and focused field surveys, including evaluating rearing habitat, large woody debris frequency, fish passage barriers, water temperature, food availability, sediment, and lagoon sandbar dynamics. We found that several dominant environmental factors characterize the Big Sur River watershed, including relatively high summer flows, frequent disturbance from wildfire, intensive recreation, a perennially open lagoon, and a natural anadromous fish passage barrier within the lower eight miles of the river. Of these physical factors affecting the population, the lower basin upstream migration barrier at Pfieffer Falls is the primary limitation to the Big Sur River population. The barrier prevents access to most of the suitable steelhead habitat in the watershed; the even more pronounced effect is that the barrier restricts the anadromous population to spawning and rearing in a lower river mainstem reach. In this presentation, we discuss why steelhead are not adapted to use lower river mainstem habitat, and the implications of a population lacking spatial distribution and restricted to habitat affected by wildfire. The result is a smaller population that is vulnerable to disturbance. Based on our assessment, we recommend specific restoration actions for the watershed, including protecting instream flows and habitat values, and improving spatial distribution and habitat access in the watershed. We recommend improving passage within tributaries, as well as evaluating access opportunities at Pfieffer Falls. Pfieffer Falls is a natural barrier, and it may not be feasible or appropriate to provide anadromous passage there. However, based on the current status of the DPS, and based on the substantial and varied benefits of improved passage, we present a case for considering modifications to the barrier.

Balancing Habitat Needs for Rearing and Migratory Steelhead with Other Beneficial Water Uses in the Santa Clara River Estuary

Noah Hume, PE, PhD (Presenter) *and* ***Glen Leverich,*** *Stillwater Sciences;* ***Scott Dusterhoff,*** *San Francisco Estuary Institute;* ***Dan Pfeifer,*** *City of Ventura;* ***Catherine McCalvin,*** *United Water Conservation District; and* ***Lydia Holmes,*** *Carollo Engineers*

The Santa Clara River, one of the largest watersheds in southern California that still functions in a relatively natural state, provides critical habitat for steelhead, among other threatened and endangered species. Maintenance of lagoon habitat for rearing juveniles as well as seasonal passage flows in the lower river is particularly important for the recovery of the Southern California Steelhead Distinct Population Segment (DPS). During summer conditions as well as years with low rainfall, flows in the lagoon are dominated by discharges from the City of Ventura Water Reclamation Facility located adjacent to the estuary. Beginning in 2008, the State Water Resource Control Board required a series of special studies to evaluate habitat needs for steelhead in conjunction with other T&E species, including tidewater goby, western snowy plover, and California least tern. We used simplified eco-hydrologic models in conjunction with water treatment and re-use options to determine how best to reduce the frequency of unseasonal breaching of the lagoon while maintaining suitable habitat for steelhead and other focal species.

In a parallel process, the United Water Conservation District, which manages water resources in the Santa Clara River and Oxnard plain, initiated habitat conservation planning for steelhead in 2009 to allow continued operation of the Freeman Diversion Dam, situated approximately ten miles upstream from the mouth of the estuary. Bypass flow scenarios were designed to provide continuous passage upstream of the estuary based on minimum flow triggers occurring during winter and spring seasons. We updated our estuary eco-hydrologic model to evaluate the flow scenarios for several representative water-year types and lagoon morphologies.

The intersection of objectives for these water resource agencies related to the functioning of the Santa Clara River Estuary lagoon and the connection with upstream habitats have important implications for the recovery of Southern California Steelhead DPS. Depending on inter-annual variations in seasonal run-off, control of unseasonal breaches, coupled with passage flows, cooperative management of estuary inflows will ensure suitable rearing and migratory habitat conditions at timescales relevant to steelhead life history timing.

Scott Creek: The Restoration of a Critical Coastal Lagoon for Steelhead and Coho Recovery

David Revell, PhD (Co-Presenter), *ESA PWA;* ***Brandy Rider (Co-presenter),*** *Caltrans; and* ***Jim Robins,*** *Santa Cruz Resource Conservation District*

Scott Creek in northern Santa Cruz County is a critical watershed for both anadromous steelhead and coho and has been identified in the respective recovery plans as a high priority for restoration. The lagoon on Scott Creek has been the focus of much research aimed at understanding the importance of the lagoon at various life history stages of these species. This research has been widely published and incorporated into management decisions in other coastal confluences. In the 1930s, a Highway 1 bridge was constructed along with levees significantly altering the channel extent, lagoon depths, and significantly changing the lagoon function. Some 75 years later, as the bridge nears the end of its useful life, efforts to design a replacement bridge are opening doors to relax various constraints and restore the lagoon. This talk will present work completed for Caltrans in 2012 to examine the past, present, and future conditions associated with the bridge. In the historic analysis, shoreline change, marsh plain elevations, and lagoon depths were documented. Field data collection from a variety of researchers and stakeholders was compiled and analyzed to evaluate the physical processes along with the existing habitats to examine the current lagoon function. Various bridge alternatives were identified by stakeholders and analyses conducted to project the long-term evolution of the system. These analyses provide an initial assessment of the tradeoffs and costs of different bridge lengths and alignments on lagoon function. Recommendations for bridge alignments and lengths were identified as a result of these comparisons. The presentation will conclude with a summary and discussion of next steps in the process including an innovative multi-agency, multi-objective approach to balancing the critical species and transportation needs on this important coastal ecosystem.

Habitat Improvement Plan for Lower Piru Creek; Proposed Gravel Augmentation and Water Release Measures

Linda Purpus, United Water Conservation District

United Water Conservation District owns and operates the Santa Felicia Dam and Lake Piru located in Ventura County. The Santa Felicia Dam and its operations are licensed by the Federal Energy Regulatory Commission (FERC). United developed a habitat improvement plan (HIP) to comply with the FERC license and the associated Biological Opinion, issued by the National Marine Fisheries Service (NMFS), for endangered Southern California steelhead. The HIP is designed to minimize the geomorphic effects of the Santa Felicia Dam and its operations on the quality and quantity of habitat for steelhead in Piru Creek downstream of the dam (lower Piru Creek). Specifically, these effects are related to the quantity and quality of spawning gravel and fine sediment impacts on steelhead spawning and rearing habitat quality.

In order to address the effect of the Santa Felicia dam and its operations on spawning gravel supply, United proposes to implement gravel augmentation at two sites. At each site, spawning-size gravels will be placed in the stream channel to create spawning habitat, and a boulder weir will be constructed at the downstream end of each site to enhance gravel stability during high flow events. In addition to improving spawning habitat, these augmentation projects will provide valuable information to inform future habitat management decisions.

The gravel augmentation projects will be implemented in combination with a water release regime that is expected to mobilize and flush both surficial fine sediments and bedload material to improve spawning and rearing habitat quantity and quality. The HIP includes performance monitoring to evaluate the effectiveness of the gravel augmentation approach and water release regime in enhancing spawning habitat availability and quality as well as adaptive management measures and decision criteria.

Habitat Capacity, Limiting Factors, and Effective Restoration Strategies for Steelhead in the Pescadero Creek Watershed

Joshua Strange, PhD (Presenter), Frank Ligon, Zooey Diggory, and Peter Baker, Stillwater Sciences

Pescadero Creek, located on the coast between Santa Cruz and San Francisco, is indicative of many central and southern California watersheds. Dry summers lead to water supply challenges and instream flow depletion from water withdrawals, and cumulative land use impacts have led to excessive sediment inputs and related habitat impairments. Removal and loss of in-channel wood and other modifications have simplified habitat and disconnected the channel from its former floodplain in lower reaches. A large estuary lagoon, relative to the size of the watershed, and areas of higher quality habitat in upstream canyon reaches provide some buffer for rearing steelhead prior to emigration to the ocean, yet the population is tenuous and a small fraction of its historic abundance. A number of potential habitat degradation factors were implicated as limiting the population, but uncertainty clouded resolution of what factors truly limited the population and what restoration strategies would be most effective. Additional uncertainties related to global warming and sea level rise further complicated the prognosis. To help address these uncertainties and guide restoration and management actions, we conducted a limiting factors analysis of life-stage specific density-dependent habitat carrying capacity and density-independent mortality using a spatially explicit, habitat based life-cycle and population dynamics model (RIPPLE). This approach allowed us to identify and rank the limiting factors and eliminate factors that are unimportant at a population level, and also to test the likely effects of restoration and management actions to address the identified primary limiting factors. Combined with expertise in effective habitat restoration, these results allowed us to develop a restoration strategy that would be the most biologically effective. In addition, herein we examine land use constraints and examine approaches and techniques that have been used to overcome or mitigate such challenges. This strategy is repeatable and applicable to other central and southern California watersheds.

Using Imagery and Mapping to Detect Riparian Landscape Changes in Southern California

Brittany Struck (Presenter) and Richard Morse,
National Marine Fisheries Service, West Coast Region

Historical aerial photography combined with Geographic Information System (GIS) maps of the Santa Ynez River (12-year time series) and the Sisquoc River (22-year time series) in Santa Barbara County were analyzed by fisheries managers for evidence of natural (e.g., flood events) and man-made changes to the riparian corridors within a ten-mile study reach on each river. Discrete polygons were digitized within the riparian corridor to define: (1) streambank and flood-plain vegetation, (2) partially vegetated areas showing evidence of discharge-induced scour and deposition, and (3) dense vegetated areas on the channel bed lacking evidence of scour and deposition. Polylines were used to map active channels and side channels from 1938 to present. The temporal patterns of both flood disturbance and influence of anthropogenic activities (e.g., agriculture, flood control, and gravel mining) that were documented through our analyses contribute to understanding the capacity of a river-corridor system to support a riparian buffer and the historical and present-day extent of the buffer given floodplain conditions. Riparian vegetation patterns and responses can assist managers in relating landscape variables to some physical and biological measures of river conditions such as habitat heterogeneity for anadromous species. We believe such information will also be useful for restoration ecologists to consider when contemplating recovery actions for endangered steelhead.

Santa Ynez River Steelhead: an Angling History

Mark H. Capelli, PhD, National Marine Fisheries Service, NOAA Fisheries

An investigation of the historical distribution and abundance of anadromous steelhead and associated freshwater rainbow trout in the Santa Ynez River watershed of northern Santa Barbara and western Ventura Counties prior to the completion of Bradbury Dam in 1953 records the rise and fall of an extensive steelhead fishery in south-central and southern California.

Steelhead and rainbow trout once occurred throughout the Santa Ynez River watershed, which periodically supported one of the largest steelhead runs in south-central and southern California. Prior to European exploration and settlement of California, limited archaeological evidence suggests the seasonal steelhead runs were only opportunistically exploited by native Chumash peoples, consistent with an observed trend in the increasing use of salmonids by native peoples from southern to northern latitudes on the Pacific Coast. Evidence from the Mission and Rancho Eras (1769-1849) provided little additional information on the status or exploitation of steelhead or rainbow trout by early Europeans in California, perhaps because this Spanish and Mexican socio-economic system relies heavily on cattle and irrigated agriculture for material and food sources. The first explicit historical records of steelhead and rainbow trout in the Santa Ynez River come from the Early American Era (1849-1880), with the first published use of the term "steelhead" in connection with the Santa Ynez River appearing in 1908. The extensive exploitation of Santa Ynez River steelhead by European and Eastern North American immigrants began during the Progressive Era (1880-1920), concurrently with the management and scientific study of California's freshwater anadromous fishes and the development of transportation facilities (railroad and automobile) and increased leisure and a related tourist economy.

The significant decline in habitat conditions within the watershed, and corresponding decline of the steelhead runs, occurred during the Era of Big Water Projects (1926-1953). Historical records indicate that the size of the Santa Ynez River's steelhead runs varied dramatically due to climatic and hydrologic cycles. However, the River still supported an important recreational steelhead (and related freshwater resident trout) fishery until the early 1950s, when the fish populations collapsed following the construction of Bradbury Dam. Few steelhead spawn in the Santa Ynez today (though headwater tributaries continue to support native freshwater rainbow trout, and at least one adfluvial population of a remnant steelhead run in its headwaters. Despite the substantial modifications of the mainstem of the Santa Ynez River (particularly its low reaches below the lower most major dam), a majority of the River and its upstream tributaries remain intact, and largely protected within the Los Padres National Forest. The Santa Ynez River has been identified as one of the core steelhead populations within the National Marine Fisheries Service's Southern California Steelhead Recovery Plan, and is an important focus of recovery efforts for the Southern California steelhead, which since 1997 have been listed as endangered under the United States Endangered Species Act.

Historical investigations of anadromous fisheries can provide insights into the restoration and management of fisheries which have been substantially impacted by anthropogenic changes over historical and pre-historical time-frames, and assist in distinguishing the natural range of environmental variation from more recent and rapid changes due to human activities.

The Status of California Salmon Habitat Based on a GIS Analysis.

***Charleen Gavette,** and **Brian Cluer, PhD,** National Marine Fisheries Service,*
*and **Robin Grossinger,** San Francisco Estuary Institute*

Pre-European development, salmon habitat in California extended from the coastal streams along the Mexico border to the Sierran streams stretching to the Oregon border. A GIS analysis using multiple databases results in a clear picture of the magnitude of habitat losses across the range of anadromy for California. Currently, about 15% of the historic salmonid habitat remains, a six-fold reduction, predominantly in the North Coast Range. The loss of habitat was from multiple development sectors: land drainage blocking access to millions of floodplain wetland acres, dam building blocking access to thousands of stream miles, and numerous roads and crossings blocking or partially blocking access to untallied small stream miles. Particularly sacrificed were the alluvial valleys where floodplain wetland systems were drained, diked, and developed for agriculture. These were probably the key producer habitats, where numerous recent scientific studies document the most successful juvenile salmon rearing occurred in winter and spring. Therefore, the overall habitat loss is greater than the simple areal proportions indicate.

Restoration of salmon habitat has focused on enhancing the remaining streams, predominantly confined channel habitat. However, the productivity of floodplain wetlands in alluvial valleys is generally irreplaceable outside of alluvial valleys. Floodplain habitat restoration is uncommon, novel, and considered experimental by fisheries managers, although there have been some notable recent demonstrations in rice fields in the Central Valley. The perspective of historic salmon habitat in conjunction with large historic populations leads to the conclusion that recovery of large salmon stocks appears unlikely without restoring floodplains, particularly in the immense Central Valley.

Historical Ecology of Salmonids in the Klamath River Basin: Perspectives on the Role of Traditional Ecological Management by Indigenous Tribes and Lessons for Modern Times

Joshua Strange, PhD, Stillwater Sciences

The Pacific Northwest once teemed with hyper-abundant salmon runs that provided a seasonal bounty for wildlife and indigenous peoples alike. While salmon populations historically waxed and waned with cycles of glaciation and warming, they appeared to be in a period of maximum abundance upon arrival of Euro-American colonizers from the East. Pacific salmon in particular are known for forming diverse population structures that are adapted to local conditions. Indigenous tribes were also adapted to local conditions through co-evolution with the landscape and the biota that sustained them. In order to truly understand Pacific salmon of today and find solutions to the various threats they face, it is necessary to examine the historic baseline conditions that shaped their evolution and ecology. Such an examination also requires exploring the impact and role of indigenous tribal populations and their traditional ecological management practices. The Klamath River basin of modern day northern California and southern Oregon provides an excellent case study to explore this topic. The three indigenous tribes in the lower basin (the Karuk, Yurok, and Hoopa tribes) are river peoples with salmon-centric cultures. Traditional ecological knowledge of resource management was and is entwined with their spiritual worldviews, an arrangement that existed in dynamic equilibrium for millennia. In more recent history, the Klamath River basin was one of the last areas in the lower 48 states to be settled by Euro-Americans with the onset of the gold rush in 1849. A succession of oppression and resource exploitation followed that was enabled by the colonizers' worldview. Today, a new dynamic is emerging with contrasting themes of globalization, reemergence of tribal resource management guided by both modern scientific and traditional ecological knowledge, and continued co-evolution by biota and cultures in the Klamath River basin. This talk will offer the author's personal and professional interdisciplinary perspectives from spending 25 years working and living closely with the tribes of the lower Klamath River basin. From water management techniques that could be used to help mitigate global warming in the Klamath River basin, to broadly applicable lessons about the role of worldview in resource management, this presentation will explore the entwined themes of traditional indigenous ecological management and the coevolution of landscape and its biota. From this, a deeper understanding emerges of the historic ecology of salmonids and how to apply traditional ecological knowledge to modern resource management.

Salmon as a Contemporary and Historical Critical Fish for California Indian Tribes

***Fraser Shilling, PhD (Presenter), April Negrette,** and **Lori Biondini,** Department of Environmental Science and Policy, University of California, Davis*

As part of a collaborative project, developed by several California Tribes and UC Davis, more than 400 members of over a dozen tribes were interviewed about their contemporary and historical use of fish. Standardized interview questions and open-ended questions were used during 10-20 minute interviews. Two types of questions were asked: regarding traditional or historical uses of fish and regarding contemporary uses of fish. Several tribes declined to have members interviewed because of concerns about how information about contemporary fish use might affect their rights to fish. The amounts of fish people reported consuming were among the highest recorded in California. Provisional rates for high-end consumers are 100-170 grams per day (95th percentile), roughly one meal per day, which is similar to the historical, traditional rate (about one fish meal per one to two days). Salmon were reported as the primary species consumed in terms of frequency. Most fish use was strongly related to cultural events, family get-togethers, and seasonal availability of fish. In places where native fish had disappeared and/or been replaced by non-native fish, fish use reflected this pattern. In these locations, tribe members reported greater availability of native fish only one or two generations previously. Lower use of native fish was primarily associated with reported degradation of water quality and water loss from streams and rivers. Salmon originating from coastal rivers and tribes were shared throughout California. Inland tribes who don't fish on the coast reported eating salmon originating from relatives and others on the coast. This extensive and culturally critical trade network adds support to the need to restore salmon populations in California streams and rivers.

Historical Ecology of California Lagoons—Implications for Salmonid Restoration on the Changing California Coast

David K. Jacobs, PhD, *Department of Ecology & Evolutionary Biology, University of California, Los Angeles*

It has recently been demonstrated that a period of residence in lagoons contributes to the growth and recruitment potential of steelhead. This, in turn, leads to questions as to the historic fate of California's lagoons and lagoonal habitat, and how such habitat might be restored. In an effort to initiate quantification of these changes, and how they might affect salmonids as well as other endangered taxa and ecological services, an interpretation of estuarine geomorphic processes operative on the historic landscape from the Bay Bridge to the Mexican Border is under development. This effort involves the construction of an initial template of Holocene estuary formation, based on broad geomorphic coastal units, followed by an analysis of the historic 19th century "T-sheet" record. This early mapping provides the first detailed view of the California coast. Our interpretation assesses process operative on the landscape. It is informed by a range of historic data, as well as geomorphic inference, and identifies the physical mechanisms forming, and operating on, the 19th century landscape. The effort here is to identify a set of repeated geomorphic features and processes rather than static "habitat types." These features are often unrecognizable on the modern landscape. Unappreciated aspects of the historic coast include: (1) the frequency of multiple/alternative mouth systems - a byproduct of the frequency of bar/berm/dune closure resulting in mouth displacement, (2) floodtide delta isolation of embayments, (3) the loss of hydrologically variable small drainage/large lagoon systems, and (4)the dramatic early anthropogenic impacts to some systems in the 19th century. Preliminary interpretation suggests that the loss of the ability of lagoonal systems to "perch-up" behind beach berms and dunes may have critically limited steelhead habitat along stretches of the California Coast. Perching of lagoons generates large intermittently flooded landscapes and fostered the presence of scour pools and sloughs along the coast as flows breach to the sea at alternate locations. Loss of these system behaviors likely strongly impacted salmonids.

Assessment of lagoons and their restoration requires an understanding of the closure processes that generate lagoons. Closure impacts the vast majority of estuaries along California coast, resulting in a range of consequences for salinity, tidal connection, and resultant type of habitat. Thus a more detailed understanding of closure processes is essential to lagoon management. In this context, it is critically important to recognize that closure of lagoons is not a binary phenomenon, as it can vary in duration, frequency, as well as degree of closure. We continue to develop a suite of methods for objective assessment, and quantification, of closure state using a scale that extends from sub-tidal to dune dammed. This assessment is here extended to aspects of impoundment status of the lagoon. We apply this approach both to historic T-sheet data and modern imagery, and relate it to assessment of lagoonal habitat for salmonids.

On the Margins: In Search of Historic Evidence of the Southern California Steelhead South of the Ventura River

Tom Tomlinson, PhD, Gould School of Law, University of Southern California

The photograph of Leonard Hogue holding a 25" steelhead taken in January, 1940 records the improbable presence of this fish in the most improbable of places: it was taken in the Los Angeles River, two years after lining the River with concrete had commenced. Hogue's fish image documents the historic resilience of the species in the southern California watershed, yet the picture itself is as rare to the history of the fish as it was to the 1940 fish. Restoring the Southern California steelhead to its historic southern California watershed is an invitation to restore the cultural history of the fish to its future.

Creating and restoring a written and visual record of the presence of the Southern California steelhead will rely on a variety of representative sources, some informal, some official. The writings of southern California naturalist, Frederick Holder (1851-1915), particularly those conveyed in My Life in the Open (1906) evidence his appreciation for and knowledge of the rainbow trout and steelhead trout in his relationship with the fish in the Arroyo Seco, a tributary of the Los Angeles River. The records of Henry O'Melveny (18 59-1941), whose Creel Club outings on the San Gabriel River with many Los Angeles anglers indicate an informed layman's knowledge of the culture of trout and steelhead. So, too, do the reflections of O'Melveny's early law partner, Jackson Graves (1852-1933), record the presence of large trout in a tributary of the Santa Ana River. Both men note that at the end of the nineteenth century, the San Gabriel River was one of the best trout fisheries in California. Local newspapers reported on and pictured steelhead catches, too. Representative photos of steelhead appeared in the Los Angeles Times (1909) and Azusa Times (1919). Like Hogue's snapshot, similar informal images will make the historic fish visible.

Formal, institutional records exist. The California Department of Fish and Wildlife (CDFW) made the steelhead official by declaring seasons, politicking limits and seasons, conducting research, and publishing reports. The work of Carl L. Hubbs (1894-1979) in particular bears the imprimatur of his professional training in ichthyology and research at the Scripps Institute of Oceanography. Miscellaneous reports from CDFW field agents range from descriptions of large fish in Orange County watersheds to reports of steelhead swimming up the Tijuana River. Other institutional holdings testify to the historic and continuing presence of the steelhead. The California Academy of Sciences holds a steelhead-in-a-bottle taken from San Pedro Harbor in 1938 while the Los Angeles Natural History Museum has a 1967 steelhead from Piru Creek; the Scripps collection includes a steelhead taken in northern Baja in 1961.

Discovering and documenting the presence of the Southern California steelhead in the watershed south of the Ventura River will provide a historic gravitas to the hopeful restoration of the rare and endangered fish.

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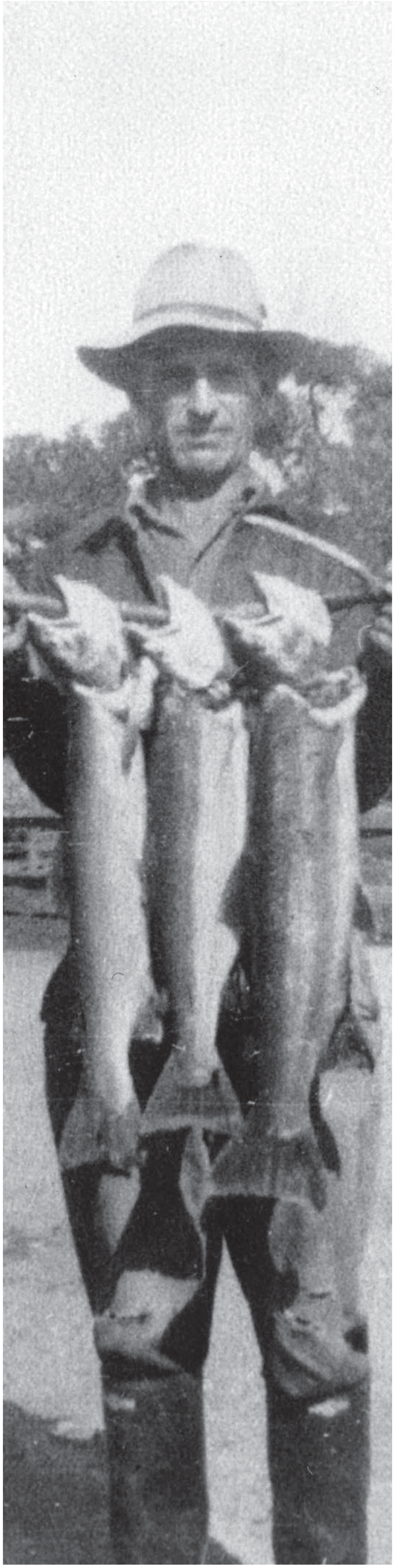

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SRF Mission Statement

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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