Navigating the Complexity of Fisheries Science:

CHARTING A COURSE FOR THE FUTURE

California-Nevada Chapter

51st Annual
Cal-Neva AFS Meeting
Eureka, CA
April 5-7, 2017

Table of Contents

Schedule in Brief

Time	Event	Location
Tuesday April 4, 2017		
6:30 pm – 9:00 pm	Introduction to Night Snorkeling	Off site
Wednesday April 5, 2017		
8:00 am – 5:00 pm	Registration	Red Lion Lobby
8:00 am – 5:00 pm	Trade Show/Vendor Set Up	Pacific Room
8:00 am – 5:00 pm	Poster Set Up	Pacific Room
8:00 am – 5:00 pm	Continuing Education – eDNA	Humboldt Room
8:00 am – 5:00 pm	Continuing Education – Fish Passage	Evergreen Room
8:00 am – 5:00 pm	Continuing Education – PIT-tagging	Oak Room
8:00 am – 5:00 pm	Field Trip – Salt River Project	Off site
8:00 am – 12:00 pm	Field Trip – Humboldt Bay and Oyster Farms	Off site
8:00 am – 12:00 pm	Field Trip – Humboldt State University Facilities	Off site
8:00 am – 12:00 pm	Field Trip – Redwood National and State Parks	Off site
5:30 pm – 7:30 pm	Field Trip – Humboldt Bay Cruise	Off site
5:30 pm – 7:30 pm	Poster Social and Tradeshow	Pacific Room
7:30 pm – 10:30 pm	Student Social	Bayside Grange
Thursday April 6, 2017		
8:00 am – 5:00 pm	Registration	Red Lion Lobby
8:00 am – 5:00 pm	Trade Show/Vendor Set Up	Pacific Room
8:15 am – 12:00 pm	Plenary Session	Sequoia Center
12:00 pm – 1:10 pm	Lunch: On Your Own	
12:00 pm – 1:00 pm	Cal-Neva Chapter Business Lunch	Sequoia Center
1:10 pm – 5:10 pm	Symposia and Contributed Papers	Red Lion
1:10 pm – 5:10 pm	Symposia and Contributed Papers	Sequoia Center
3:10 pm – 3:30 pm	Break	
6:00 pm – 10:00 pm	Grand Social/Banquet	Sequoia Center
Friday April 7, 2017		
8:00 am – 12:00 pm	Registration	Red Lion Lobby
8:00 am – 5:00 pm	Trade Show/Vendor Take Down	Pacific Room
9:30 am – 11:30 am	Fisheries Panel	Sequoia Center
8:15 am – 5:10 pm	Symposia and Contributed Paper	Red Lion
9:55 am – 10:15 am	Break	
12:00 pm – 1:10 pm	Student Mentor Lunch	Sequoia Center
12:00 pm – 1:10 pm	Lunch: On Your Own	
3:10 pm – 3:30 pm	Break	Red Lion

President's Message

Welcome to Eureka – The Gateway to Humboldt Bay
51th Annual Meeting of Cal-Neva Chapter of the American Fisheries Society

On behalf of the California-Nevada Chapter, welcome to Eureka! With over 500 members, this marks the 51st Annual Meeting for the third-largest chapter of the Society and Eureka is a beautiful and appropriate place to host this event. The California-Nevada region is perhaps one of the most diverse environments in North America. While our mostly desert and Mediterranean climate suggests an arid land, plate tectonics, numerous mountain ranges, and seasonal storms blown in from the Pacific Ocean set up a hydro-flux unlike anywhere else on Earth. The ebb and flow of nutrients via migratory fish, ungulates, and waterfowl create a productive landscape rivaling the Serengeti. This climate, fertility, and hydro cycle have been mirrored in the influx of diverse peoples, generating one of the highest population growth rates in the world's developed nations. Ignited by precious metals, this combination has generated one of the wealthiest economies and put us at the lead of environmental research and legislation. Yet, it has also set the stage for a potentially devastating outcome as our growing population continues to stress aquatic ecosystems and the resources that rely upon them.

As a major component of the world's economy, our diverse landscape, peoples, and economic backbone (agriculture and technology) create a unique opportunity to study aquatic ecosystem management and how natural resource allocation impacts ecosystem services. It is extremely important that we understand these dynamics to ensure that the resources we rely upon are sustained for future generations. This year's theme *Navigating the Complexity of Fisheries Science: Charting a Course for the Future*, helps set the stage for this important undertaking.

Our members, including you, represent a diverse group of public agencies, education facilities, and private and non-profit groups tasked with the challenge to advance fisheries science and management. AFS is an outstanding venue to disseminate the important work we do through professional presentations, journal publications, and dialogue to inform decision makers.

I echo the sentiments of past officers, that Cal-Neva has a long history of supporting career development of fisheries scientists. Many students and young professionals have benefited from AFS mentors, including attendees of this meeting. I ask that you take time during this gathering to find ways to continue this grand tradition, whether it is providing mentorship to the many new student members or serving as an AFS officer or committee member.

I am proud to be part of Cal-Neva's 51st Annual Meeting. The Planning Committee, officers, and all the volunteers have done an outstanding job, working collaboratively to create another incredible conference. Take this opportunity to network with old and new friends and collaborators. Reach out to our new cohort of young scientists at the Student Symposium. In closing, I encourage us all to participate actively in the interesting discussions over the next three days. I wish everyone a successful and rewarding conference.

Joseph Merz, Ph.D.
President, California-Nevada Chapter of AFS

Conference Theme

Navigating the Complexity of Fisheries Science:

CHARTING A COURSE FOR THE FUTURE

Fisheries science is a complicated discipline, where we must consider fish, habitat, and the human dimension, to fully understand the dynamics of a system. In recent years, fisheries professionals have been faced with major challenges, including: extensive drought, climate change, invasive species, changes in the workforce, and a political climate of reduced budgets and uncertain support for environmental issues. To steer a successful course, we need innovative thinking and cross-disciplinary partnerships, based on lessons learned and new understanding. We also need to cultivate the next generation of fisheries leaders. This meeting will provide an opportunity to strengthen our communication, further the science, and learn from one another, in an effort to find the best path forward for the fishes, our profession, and the science.

Planning Committee

Planning Committee Chair
Laurie Earley

Fundraising and Donations
Maddelyn Harden

Arrangements and Accommodations
Felipe La Luz
Mark Henderson

Audio/Visual
Tom Gast
Felipe La Luz

Student Presentation/Poster Judging
Tom Keegan

Budget and Finance
Laurie Earley
Jim Hobbs
Felipe La Luz

Poster Session
Kirsten Sellheim

Raffle
Russell Barabe
Norm Ponferrada

Student Social
Justin Alvarez

Merchandise
Christina Parker

Time and Place/Catering
Felipe La Luz

Registration
Norm Ponferrada
Bobbie Miller

Continuing Education/Workshops
Norm Ponferrada

Volunteer Coordination
Claire Ingel
Chase Macherzak

Student Symposium Coordinator
Grace Ghist
Katie Osborn

Trade Show
Maddelyn Harden
Jim Hobbs
Felipe La Luz

Field Trip Coordination
Darren Ward

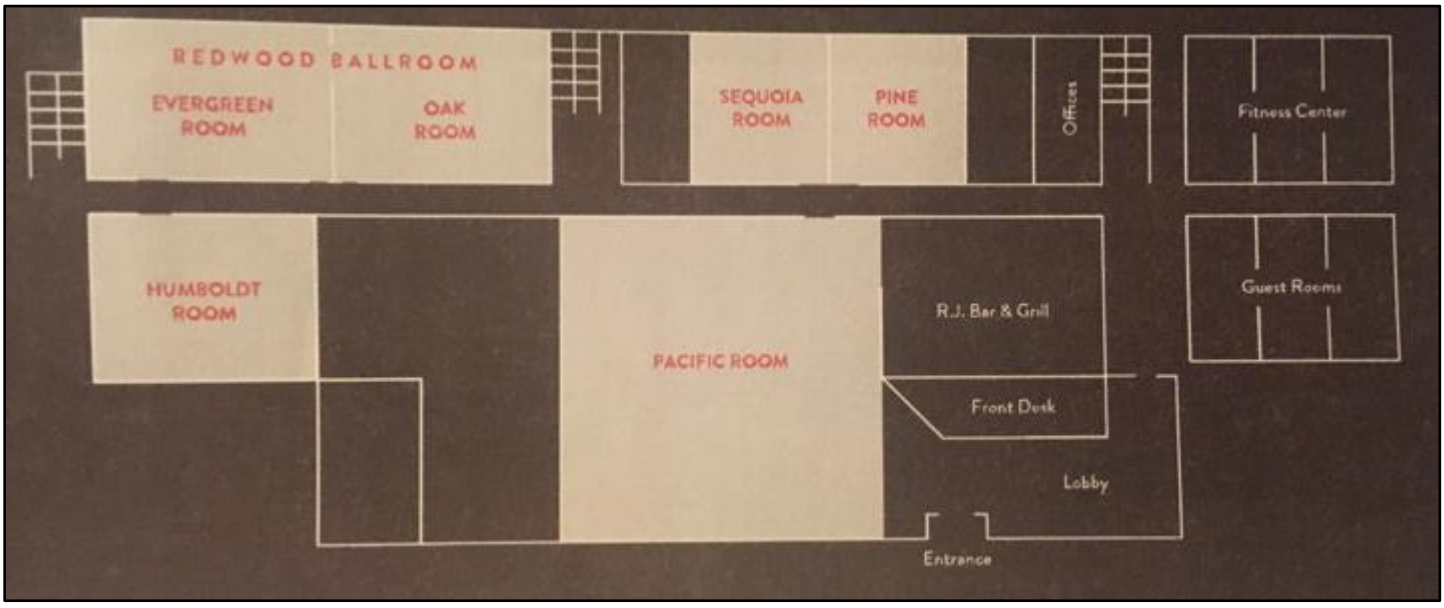
Student-Mentor Lunch
Ramona Swenson
Jahnava Duryea

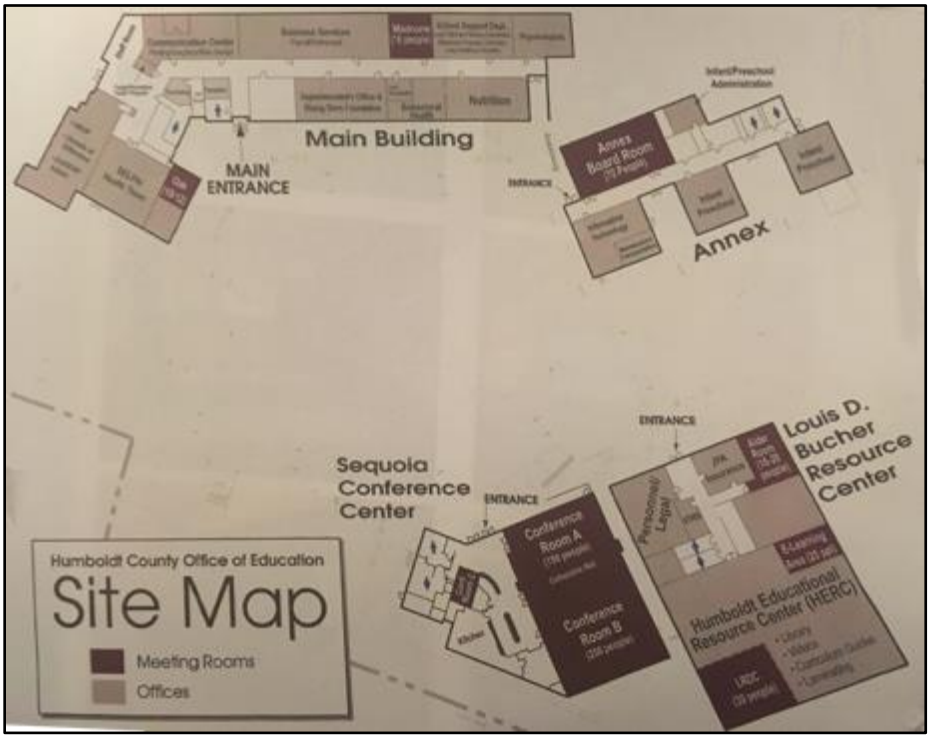
Spawning Run
Dylan Stompe

Signage
Chelsea Pulliam

Program
Laurie Earley
Joe Merz
Steve Brumbaugh
Kirsten Sellheim

Site Map





Red Lion Conference Area (Above)
1929 4th Street
Eureka, CA 95501

Sequoia Conference Center (Left)
901 Myrtle Avenue
Eureka, CA 95501

General Information

Registration

Registration will be open on Wednesday, April 5th and Thursday April 6th from 8:00 am to 5:00 pm. The last day for registration will be Friday April 7th from 8:00 am to 12:00 noon.

Poster Session

There are 35 contributed posters on display throughout the meeting in the Humboldt Bay Room. Poster set up opens on Wednesday April 5th. Make sure to take a moment to attend the Poster Session Social scheduled from 5:30 pm to 7:30 pm on April 5th. Presenters will be available at this time to answer questions. Posters must be dismantled by 12:00 pm on Friday April 7th.

Student Social

The student social will be held from 7:30 to 9:30pm on the evening of April 5th at the Bayside Grange. Please bring an ID if you plan on consuming alcohol. ID's will be checked as you enter the venue. Food will be provided by Carmela's Mexican Restaurant and beer will also be provided. As a special treat Pacific Seafood has offered us an oyster sampling. These are the same oysters that will be visited during the oyster farming field trip.

To help people travel safely, vans will be shuttling people from the Red Lion Inn to the Grange and back. Vans will leave the main entrance of the Inn at 7:10 and will return people to the Red Lion near the end of the social. If you plan on enjoying the beverages provided at the social please take advantage of the shuttle.

If you are transporting yourself to the event the address is 2297 Jacoby Creek Rd, Bayside, CA 95524.

Plenary Session

The Plenary Session begins April 6th at 8:15 am at the Sequoia Center immediately following the opening remarks from Laurie Earley (President-Elect, California-Nevada Chapter), Joe Merz (President, California-Nevada Chapter) and Jim Bowker (Past-President of the Western Division of the American Fisheries Society).

Oral Presentations

There are 10 organized symposia with 130 session papers. Presentations begin on Thursday, April 6th at 1:10 pm. Session papers will be presented at the Red Lion Hotel and the Sequoia Center. There are up to four concurrent sessions.

Raffle

Raffle items will be on display in the Humboldt Bay Room leading up to the Banquet on Thursday April 6th. The raffle includes many wonderful items including artwork, books, gift certificates, fishing gear, and fishing trips.

Snack Breaks and Beverages

A variety of snacks, coffee, soft drinks, and fruit will be available during the morning and afternoon breaks in the Humboldt Bay Room and the Sequoia Center.

Trade Show

Tradeshow set up starts at 8:00 am on Wednesday. Take a few moments to visit with the vendors at the Tradeshow. They will be available from Tuesday from 9:00 am to 8:30 pm, Wednesday from 9:00 am to 6:00 pm, and on Thursday from 9:00 am to

Trade Show (continued)
12:00 pm in the Pacific Room. The Tradeshow/Poster Social is held on Tuesday March 22h from 6:00 pm to 8:30 pm. This is a great opportunity for AFS members to learn about the most advanced equipment available.

Socials and Events
Trade Show and Poster Social – 5:30 pm until 7:30 pm in the Pacific Room, Wednesday April 5th

Student Social – Students and select professionals – do not miss the Student Social scheduled for Wednesday April 5th from 7:30 pm – 10:30 pm. The venue will be the Bayside Grange.

Student Mentoring Lunch – The student mentor lunch will be held Friday, April 7th, during the lunch break. This will be a great opportunity to expand your professional network.

Banquet – The Banquet will be held on Thursday April 6th at the Sequoia Center from 6:00 pm to 10:00 pm. Buffet-style meals with all of the accouterments, soft drinks, and kegs of beer will be provided. Everyone is welcome at the social, raffle, and auction. There will also be a live band and dancing after the banquet so stick around and get your groove on.

Cal-Neva Chapter Business Lunch
The luncheon meeting will be held from 12:00 pm – 1:00 pm on Thursday, April 6th at the Sequoia Center.

Best Student Paper/Poster Awards Ceremony
The best student paper/poster awards ceremony will be held during the banquet on Thursday April 6th. This is a great opportunity to congratulate the winners and their hard work!

(Photo Credit Sarah Gallagher)

Student Awards

AFS Student Oral Presentation and Poster Competition

The Student Oral Presentation and Poster judging competition at the 51st Annual Meeting of the AFS California-Nevada Chapter is being organized and presided over by the Northern California District of the American Institute of Fishery Research Biologists (15th straight year). Oral presentations will be judged during the Student Symposium, to be held the afternoon of Thursday April 6th. Posters will be judged during the Trade Show and Poster Session, Wednesday evening, April 5th. Student presentations and posters will be in the running for cash prize awards; including $150 each for Best Student Oral Presentation and Best Student Poster, $125 each for Best Student Presentation and Poster – Runner up, and $75 each for third place. The award winners of the Oral Presentation and Poster judging competition will be announced during the Banquet, Thursday evening, April 6th.

Prospective judges for both competitions please contact Tom Keegan (TomK@helixepi.com) prior to the meeting. Judging forms will be available at the Registration Desk as well as at the Student Symposium and the Poster Session.

Cramer Fish Sciences Poster Award

Cramer Fish Sciences is honored to present a $200 award for the Student Poster that best commemorates the qualities and memory of Katrina Martens (09/14/1989 – 12/12/2014).

The CFS Poster Award will be judged and presented separately from the AFS Best Student Poster Award. Special consideration will be given to those who exhibit novel research ideas, innovation, and creative methodology.

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Plenary Speakers

Jesse Trushenski, Ph.D.

Fish Pathologist Supervisor, Idaho Department of Fish and Wildlife, Eagle Fish Health Laboratory

1st Vice-President of the American Fisheries Society

"A Smooth Sea Never Made A Skilled Sailor"

Dr. Jesse Trushenski is with the Idaho Department of Fish and Game, based just outside of Boise. She supervises the Eagle Fish Health Laboratory, which provides comprehensive fish health services to IDFG and its partners. Prior to joining IDFG in late 2015, Jesse was an Associate Professor with the Center for Fisheries, Aquaculture, and Aquatic Sciences at Southern Illinois University, where she led one of the leading fish nutrition groups in the country. She remains active in fish nutrition and physiology research, and is proud to provide leadership and mentoring to others in aquaculture and fisheries resource conservation and management. Jesse is currently the 1st Vice President of the American Fisheries Society and will begin her Presidency in 2018.

Cynthia Catton, Ph.D.

Environmental Scientist, California Department of Fish and Wildlife, Bodega Marine Laboratory

"Eyes in the Horizon: Examining the Scale of Fisheries Management in a Changing Climate and the Need for Multi-Institutional Collaborations"

Dr. Cynthia Catton has studied kelp forest ecosystems, including important invertebrate fishery species, for over 15 years in California. She received a BS in Zoology with a Marine Emphasis from the University of Washington, and a PhD in Marine Biology from Scripps Institution of Oceanography. Dr. Catton has worked on the CDFW Marine Invertebrate Management team since 2012, and is currently spearheading work to restore bull kelp forests in northern California to support fisheries, such as abalone and sea urchins. Dr. Catton is based at the University of California Davis' Bodega Marine Laboratory in Bodega Bay, CA and works to form strong multi-institutional collaborative research programs supporting population restoration and fisheries management.

Sean Gallagher

Senior Environmental Scientist, California Department Fish and Wildlife, Fort Bragg, CA

"Wading Through Fisheries Management in California: How AFS and Science Ease the Swift and Deep Spots"

Sean Gallagher is a senior environmental scientist with California state Department of Fish and Wildlife. He earned a BS in ecology with a minor in chemistry and an MS in biological sciences from California State University, Chico. While in Chico, Sean studied under theoretical population ecologist Douglas Alexander. He worked with Doug to investigate vernal pool invertebrate population dynamics, community structure, and their interaction with the vernal pool landscape. After finishing at university Sean, like most early in this field, lived out of his car and took a series of temporary jobs to get experience. One of them gave him the federal classification of fishery biologist. This opened the door for his first permanent job with the USFWS in Sacramento where he worked on IFIM studies of CA's Central Valley rivers for four years. Recognizing that Sacramento was not his favorite city, he moved on and worked with USFWS in Arcata evaluating large river restoration on the Trinity River. In 1999 he was hired by CDFW and has been working on endangered coastal salmon management since. He been involved in developing and implementing California's Coastal Salmonid Monitoring Population Plan since 2004. He has authored over 20 publications and numerous technical reports on populations and ecosystems in Northern California. His current interests include developing science based recovery prescriptions from long term monitoring information. He has been surfing since he was 10, the last year or so he

taught his puppy to surf. His checkered past includes playing bass guitar in punk bands for over ten years.

Scott McBain

Fluvial Geomorphologist, Owner, McBain Associates

"Developing Gaming Tools to Evaluate Tradeoffs and Inform Decision-Makers in Complex Ecosystem and Water Management on Regulated Rivers"

Scott McBain is a fluvial geomorphologist and owner of McBain Associates, a consulting firm in Arcata CA that specializes in regulated river rehabilitation. He received his BS in Environmental Resources Engineering from Humboldt State University and MS in Civil Engineering at UC Berkeley, and is a fluvial geomorphologist with 25 years' experience working on rivers in the western US. His specialty is developing flow and sediment management regimes downstream of dams that improve the physical processes and form necessary to rehabilitate and improve river ecosystems. Scott has participated in numerous large-scale river rehabilitation efforts, including the Trinity River in northern California, and the Tuolumne and San Joaquin rivers in the Central Valley of California, the central Platte River in Nebraska. He enjoys integrating geomorphology, ecology, and riparian considerations into river management programs, as well as rod and reel sampling of nearshore and pelagic fish off the coast of northern California.

Wendy (Poppy) Ferris-George

Cultural Resources Specialist and Board Member Klamath River Renewal Corporation

"Positive Collaboration and Strong Friendships Lead to One of the Largest Restoration Projects in the World"

Mrs. Ferris-George is a certified Para-Archaeologist and studied Anthropology at Sonoma State University. She is a cultural resources specialist who specializes in the art of basket making. She has served on the California Indian Basket Weavers Association for seven years as a board member and as the vice-chair. She has studied in museums throughout the country and was able to learn how to make Jump Dance Baskets, Bark Skirts, and Porcupine Quill Head Wraps. She has served as a cultural arts teacher and has taught native people how to make items that had not been made in over 100 years. Mrs. Ferris-George is a former vice-chair and council member of the Hoopa Valley Tribe. She has also worked for years on the campaign to remove the Klamath River dams. Mrs. Ferris-George was instrumental in the collaboration efforts that brought tribes and farmers together to work on finding a solution to restore the Klamath River. In 2003, she joined with local tribes and fellow council members to travel to the Upper Basin so that they could spend time getting to know the farming community in Oregon. She has spent her life fishing on the Klamath and Trinity Rivers and is heavily involved with those that depend on the Klamath River for cultural, subsistence, and economic purposes. She was appointed to the Klamath River Renewal Corporation by the Karuk Tribe of California. She serves on the Technical, Executive Sub-Committee, and the Audit Committee. She is currently working as a consultant on tribal and environmental issues.

Field Trips

Wednesday, April 5th

Cal Neva AFS attendees will have the option to take advantage of a variety of continuing education workshops, tours, and field trips on the first day of the meeting, April 5th. When you register, sign up for one of these great extra-curricular activities!

Estuarine habitat restoration

This trip includes a tour of two local tidal habitat restoration projects. The first stop is the Salt River project on the Eel River, which is a large-scale effort two restore a channel that was heavily impacted by siltation and agriculture, with objectives combining restored fish habitat and flood control. The second stop is at Wood Creek, a small coastal stream in Eureka with restoration aimed at providing rearing habitat for Coho Salmon. (full day, including lunch). $20

Humboldt Bay and oyster farms

Tour-goers will get a boat tour of Humboldt Bay and an overview of its history and biology, then visit oyster farms in North Bay with personnel from Pacific Seafood. The tour will also include some oyster tasting (half day, afternoon). $10

Humboldt State University aquatic facilities

Humboldt State University has a proud history of fisheries research and education with a hands-on, field oriented focus. Many of these activities rely on the campus's aquatic facilities, including the on-campus fish hatchery, Samoa aquaponics facility, and Trinidad marine lab. This tour will visit these facilities for a behind-the-scenes look at the operation and ongoing projects (half day). $10

Old-growth Redwoods

Forests and fish habitat are linked in the old-growth riparian redwoods in Redwood National and State Parks. This walking tour will include old growth forest and productive salmon-rearing habitats in Prairie Creek in the Redwood Creek watershed (half day). $10

Continuing Education

Wednesday, April 5th

Environmental DNA Techniques for Biological Assessment

INSTRUCTORS: **Scott Blankenship and Gregg Schumer**
Cramer Fish Sciences-Genidaqs, West Sacramento, CA

Description
Despite considerable investment of time and resources, information outcomes from monitoring programs can be substandard or unnecessarily limited in utility. Rapid technical advancements in population genetics and molecular biology are providing many novel, relatively low cost techniques and technologies that are applicable and powerful tools for biologists. These technical advancements can be applied to refine information about the presence/absence of cryptic organisms, geographic and seasonal distributions, and community structure. This course will provide attendees with a working knowledge of molecular diagnostics terminology and procedures. Examples showing both aquatic and terrestrial applications will be used to bring procedures to life.

Objectives
- Empower attendees with knowledge to apply technical advancements in monitoring.
- Introduce basic terminology and processes.
- Introduce monitoring techniques based on molecular biology and genetics.

Your ideas and feedback
We encourage group discussion throughout the course. Questions and comments are welcome within the workshop framework. Additionally, we welcome constructive evaluations, suggestions, and comments regarding the course.

Suggestions for success
This workshop is intended for non-geneticists to gain a basic understanding of new monitoring techniques and how they may be applied. This will not be a “difficult” course, and there will be no grades. Yet, individuals that actively listen, strive to apply course concepts to areas of personal interest, and participate in group activities and discussion will get the most out of this course.

Fish Passage and Screening

INSTRUCTORS: Dr Joseph Merz and Dr. Rocko Brown

Dr. Rocko Brown
Dr. Rocko Brown is an expert design geomorphologist who uniquely balances applied and scientific aspects of geomorphology and engineering. He focuses on process-based assessment and restoration of fisheries resources through channel manipulation integrating geomorphic, hydraulic and ecological frameworks. He has extensive experience in hydraulic and sediment transport modeling and design for fish passage improvements, channel design, large wood and instream habitat structures, and bank stabilization. Rocko has led the design of seasonal floodplain, spawning habitat, and fish passage projects in a diverse array of physical and regulatory settings. He has made contributions to spawning habitat rehabilitation efforts, including assessment, modeling, design and construction of projects on several of California's most-important rivers. Dr. Brown has published heavily on evaluating the interactions of topography and flow hydrology for geomorphic processes needed for salmonids to complete their life cycle and how to design functional riverscapes that honor these linkages. He holds a Bachelor of Science in Environmental Engineering from Temple University and Master's and Doctorate Degrees in Hydrologic Sciences from the University of California, Davis and has taught restoration classes since 2009.

Dr. Joseph E. Merz
Dr. Merz is a registered scientist with the American Fisheries Society. He has over 25 years of experience working with aquatic resources and has been the principal scientist on several habitat restoration programs, including fish passage, in the California Central Valley. He has taught environmental science, salmonid ecology, and restoration courses for the past fifteen years.
Joe is known for his work with human and fisheries habitat interactions, and for his ability to communicate with scientific and stakeholder audiences alike. He has earned degrees in Environmental and Systematic Biology (Bachelors), Cal Poly at San Luis Obispo (1991); Biological Conservation (Masters), California State University, Sacramento (1994); and Conservation Ecology (Ph.D.), University of California, Davis (2004). Dr. Merz has worked for California public, private and non-profit entities on resource monitoring and fisheries habitat enhancement. He is noted as an environmental studies and natural resources lecturer, and for his successes working with stakeholders. He has coauthored a variety of peer-reviewed publications focusing on river rehabilitation, fish movement, invasive species, woody debris/redd associations, and evaluation of spawning habitat enhancement, among others. In line with his professional interests, he is a member of the Ecological Society of America, the American Fisheries Society and the Southwestern Association of Naturalists. Dr. Merz has been honored with a variety of awards and has received research and restoration grants from multiple stakeholders for restoration related projects in California, Oregon and Washington for salmonid habitat restoration; salmonid management and reintroduction; monitoring of fish migration and movement; fish passage improvement; and assessment of invasive species interactions with native salmonid populations.

DESCRIPTION

Anadromous fishes, such as salmon, trout, lamprey and sturgeon, are not only key features of ecosystem function, but are vital aspects of our heritage, culture, economy, and health. As they utilize both freshwater and marine environments, these fish are concurrently subjected to the multiple stressors of an ever increasing human population, facing habitat degradation and fragmentation. Many non-anadromous fish also make significant migrations, including catostomids and cyprinids, and are faced with similar impacts. Of the many stressors facing migratory fishes, one of the most profound and understated is human-caused barriers to their natural migration. In California alone there are over 29,000 barriers to anadramous fish migration, blocking access to at least 75% of their historic range. This workshop will introduce participants to the field of fish passage, a subsidiary of the

broader stream restoration community, drawing on a diverse array of traditional disciplines such as civil engineering, hydrology, geomorphology, biology, and ecology. The workshop will provide participants a working framework to approach fish passage projects, with a practical and working emphasis on lowhead (less than 10 meters) barriers at road crossings. We will cover several aspects of fish passage in this course, ranging from barrier assessment to design to construction.

Salmon River (Photo Credit Bobbie Miller)

PIT Tagging

INSTRUCTOR: Warren Leach

Oregon RFID, Portland, OR

DISCRIPTION

Oregon RFID presents PIT tag classes and antenna workshops for customers and new users. It is a full day event with an introduction to PIT tag technology and how to setup a monitoring site with an emphasis on antenna construction. The presentations are suitable for beginners as well as experienced users.

These subjects are discussed:

- RFID for Fish and Wildlife Tracking
  - PIT tags
  - FDX and HDX technologies
  - Antenna types
  - Data collection
  - Review of notable systems

- Building a PIT Tag Monitoring Station
  - Reader types, capabilities
  - Selecting a location
  - Field power sources
  - Antenna construction
  - Resonance tuning
  - Troubleshooting and maintenance
  - Dealing with noise
  - Performance optimization

Plenary Schedule

Thursday, April 6th

8:15 am -	8:30 am	Welcome Address	Laurie Earley, President-Elect, Cal-Neva AFS
			Joe Merz, President, Cal-Neva AFS
8:30 am -	8:45 am	Why AFS?	Jim Bowker, Western Division AFS Past-President
8:45 am -	8:50 am	Session Overview	Laurie Earley
8:50 am -	9:20 am		Jesse Trushenski, Idaho Department of Fish and Wildlife
9:20 am -	9:50 am		Cynthia Catton, California Department of Fish and Wildlife
9:50 am -	10:10 am	*Break*	
10:10 am -	10:40 am		Sean Gallagher, California Department of Fish and Wildlife
10:40 am -	11:10 am		Scott McBain, McBain Associates
11:10 am -	11:40 am		Wendy (Poppy) Ferris-George, Klamath River Renewal Corporation
11:40 am -	12:00 pm	Panel Discussion	

Pacific Ocean, Mendocino County, California (Photo Courtesy of Sarah Gallagher)

Symposia and Technical Session Details

Symposium # 1. Student Symposium
Organizers: Grace Ghrist, Humboldt State University, and
Thomas Keegan, HELIX Environmental

This symposium gives graduate and undergraduate students in fisheries-related higher education programs an opportunity to describe their research to fellow students and non-student meeting attendees. The symposium comprises oral presentations covering a wide range of topics that are of general interest to fisheries professionals. Students are not only able to engage a broader audience, but also gain valuable experience preparing and delivering their scientific presentation.

Students with oral presentations in the Student Symposium are competing for the "Best Student Paper Award". Students presenting posters are competing for the "Best Student Poster Award". 1st, 2nd, and 3rd place will be awarded for both oral presentations and posters. Student posters will be judged during the Poster/Trade Show Social on Tuesday evening. Volunteer judges will attend and score all oral presentations and posters, and winners of the awards will be announced at the Grand Social/Banquet on Wednesday evening.

We encourage all former students (that would be you!) to support these awards by attending the Student Symposium and Poster/Trade Show Social. Please consider assisting us with the judging. Judging forms will be available at the Student Symposium and the Poster/Trade Show Social, and at the registration desk.

Symposium # 2 Conservation of imperiled non-game freshwater fishes of California
Organizers: Andrew Zinziger, Humboldt State University
Damon Goodman, U. S. Fish and Wildlife Service

California has a highly endemic freshwater fish fauna composed of about 66 native freshwater, estuarine and anadromous fishes. Many of the species in the state, primarily the salmonids, have been divided into units below the species level (e.g., Evolutionary Significant Units), and if these units are considered then the state includes 129 native taxa, 63% that are endemic. The California freshwater fish fauna represents one of the most imperiled fish assemblages in the United States. It is estimated that about 83% of California's freshwater fishes are extinct or at risk of becoming extinct. The primary threats to long-term species persistence of California freshwater fishes are exotic species, hydropower development, and climate change. With the exception of salmon and trout, little is known about the life history, distribution, and taxonomic status of California freshwater fishes. Our objective with this symposia is to fill what we believe is the largest gap in understanding of vertebrate biodiversity in North American: California freshwater fishes. On the whole, fishes are the most neglected vertebrates from the perspective of conservation inventories and California freshwater fishes are perhaps the most neglected in all of North America. This symposium will provide fisheries consultants, faculty, students, and agency biologists an opportunity to present findings regarding one of California's most precious resources – non-game freshwater fishes

Symposium # 3. Watershed impacts from altered flow regimes and agricultural perturbations on the North Coast
Organizer: Kelly Souza, California Department of Fish and Wildlife

Symposium # 4 Blowing Things Up in the Bay – Evaluation of Underwater Sound Effects by Monitoring Two Controlled Implosions in San Francisco Bay
Organizer: Tom Taylor, Environmental Science Associates

Two abandoned concrete support piers, Piers E4 and E5, of the old East Span of the San Francisco-Oakland Bay Bridge were demolished using a controlled implosion technique in the fall of 2016. Multiple hydroacoustic and caged fish studies were coordinated to measure hydroacoustic pressure levels and assess the potential effects on pelagic fishes in the Bay. Hydroacoustic and caged fish studies were employed in 2015 during the demolition of Pier E3 and those study plans were refined for Piers E4 and E5. The two piers were of similar size and conditions in the Bay were relatively consistent for the two implosion events. Both implosions employed a refined blast plan and the use of [pka blast attenuation system to reduce the effect of the blasts on Bay resources. Near- and far-field hydroacoustic monitoring documented the pressure field from the implosions. Caged fish were used to measure impacts of the exposure, injury was documented through live/dead counts and a complete necropsy following exposure in the Bay. This session will present the planning, coordination and permitting challenges required to implement these studies, the study results and interpretation of the data. Results of these demolition events and studies indicate this method is not only successful from a construction standpoint, but is more protective of Bay resources than typical mechanical demolition, can be done much more quickly than mechanical demolition, and is more economical.

Symposium # 5. Microchemistry
Organizer: Malte Willmes, University of California Davis

Symposium #6. Modeling the interactions of aquatic species and their habitats
Organizers: Nicholas Som, Damon Goodman, and Nicholas Heitrick, U.S. Fish and Wildlife Service

Biological and physical models are increasingly utilized to evaluate management decisions or explore ecological interactions. Coupling biological and physical process models often involves specifying a translation of physical characteristics into a measure of habitat suitability or capacity. The last decade has seen tremendous development regarding ecological theory, and statistical, field, and computational methodologies relating to construction of these models. These developments have led to increased frequency in model applications, and interesting questions about what elements of habitat are really essential to model population dynamics. This symposium will bring together presentations of contemporary model applications, and theoretical discussions regarding critical elements of aquatic species population dynamics models.

Symposium #7. Using ecohydrology to establish flow recommendations for California streams
Organizers: Kelly Souza, California Department of Fish and Wildlife
Joseph Merz, Cramer Fish Sciences and University of California Santa Cruz

Symposium #8. Examples of environmental flow applications
Organizer: Kelly Souza, California Department of Fish and Wildlife

The combined sessions about environmental flows starts with an in-depth treatment of the Tiered Environmental Flow Recommendations for California, being developed by a statewide technical workgroup consisting of UC Davis, Southern California Coastal Water Research Project, The Nature Conservancy, UC Berkeley, and the US Geological Survey. The developing framework is for organizing environmental flow analyses across California and providing consistent science-based recommendations for applying appropriate methods to inform setting and managing of environmental flows. The overall goal of this effort is to support regulatory and management agencies in developing and implementing local, regional, and statewide in-stream flow targets to protect aquatic life beneficial uses. The second session focuses on applications and begins with an overview of flow-ecology approaches and the development of eflows needs from around the country. After specific examples from practitioners involved in environmental flow applications in California rivers, the session concludes with a regulatory perspective about efforts to adopt principles and guidelines for the diversion and use of water for cannabis cultivation and to implement a suite of actions to enhance flow statewide in at least five priority stream systems that support critical habitat for anadromous fish.

Symposium # 9. Salmonid monitoring and restoration

Organizer: Farhat Bajjaliya, California Department of Fish and Wildlife

The family Salmonidae is an integral component of California's rich fauna, with populations occurring from Malibu Creek in Los Angeles County to the Smith River near the Oregon border, as well as the Sacramento and San Joaquin rivers. Salmonids have intrinsic value as a natural resource but also support substantial recreational fisheries with significant value to local economies; have various cultural, nutritional, and ecological values; and have been the center of extensive research and habitat restoration. This session highlights noteworthy monitoring and restoration efforts of State and Federal agencies, as well as Non-Governmental Organizations, affecting inland and coastal populations of Chinook and Coho Salmon and Steelhead and Cutthroat Trout.

Symposium # 10. Special Session in Aquaculture

Organizers: Rafael Cuveas Uribe, Humboldt State University
Michael D. Lee, California State University East Bay

U.S. edible fishery product imports totaled almost $19 billion in 2015 and more than 50% of the world's seafood is supplied by aquaculture. According to the National Oceanographic and Atmospheric Administration (NOAA), aquaculture comprises less than 10% of U.S. domestic seafood production and only 1.5% of the entire U.S. seafood supply comes from domestic marine aquaculture. The U.S. imports over 90% of its edible and non-edible fishery products creating a huge balance of payments deficit. There is great potential for significant increases in production in the U.S. The U.S. Department of Agriculture (USDA) 2013 census data indicates that California had only 124 farm operations generating $84 million of product, around 6% of the national aquaculture total by value. For the aquaculture industry to expand, we need to create a regulatory and economic framework in which aquaculture can successfully develop both on land and in freshwater and marine environments and educate the future generation of aquaculturists to take their place in the industry as entrepreneurs and innovators. This special session is a great opportunity to know more about recent advances in aquaculture in the U.S. with special emphasis on California and Nevada. This session will benefit broad audiences with the aim of advancing the science and practice of aquaculture.

Symposium # 11. General Session

Organizer: Laurie Earley, U.S. Fish and Wildlife Service
Mark Gard, U.S. Fish and Wildlife Service
Cesar Blanco, U.S. Fish and Wildlife Service
Larry Brown, U.S. Geological Survey

This session comprises a diverse mix of contributed papers – all excellent!

Panel Session Diverse Perspectives in an Era of Political and Environmental Change

Organizers: Katie Kobayashi, Dave Fryxell, Joe Cutler, Stephanie Webb, Melissa Cronin, and Kat Dale, University of California Santa Cruz

We will host the following five panelists, each of whom will represent a different stakeholder associated with the fisheries of Humboldt County/Northern California. Each panelist will be given an opportunity to introduce themselves, we will hold two different question/answer sessions. The first will be lead by our moderator, Stephanie Webb—a member of our executive committee and PhD student at UCSC, who has a great amount of experience as a consultant to local fisherman. Question topics may range from current obstacles in their field/businesses to predictions for the future in response to changes in our climate, policy, etc. The second question/answer session will take the form of a more open discussion between panelists in response to questions posed by the audience.

Oral Presentation Schedule

THURSDAY AFTEROON ✠ APRIL 6, 2017

Session Name	Conservation of Imperiled Non-Game Freshwater Fishes in California	Watershed Impacts from Altered Flow Regimes and Agricultural Perturbations on the North Coast	Student Symposium	Blowing Things Up in the Bay – Evaluation of Underwater Sound Effects by Monitoring Two Controlled Implosions in San Francisco Bay
Moderator(s)	**Andrew Kinziger and Damon Goodman**	**Kelly Souza**	**Grace Ghrist and Tom Keegan**	**Tom Taylor**
Room Name	**Humboldt Room**	**Evergreen Room**	**Oak Room**	**Sequoia Center – Redwood**
1:10			Biotic and Abiotic Determinants of Fish Behavior and Habitat Use Along A River Continuum **Katie McElroy**	The Story Behind the Story: Contracting an Entirely New Marine Demolition Method in S.F. Bay **Chris Traina**
1:30	Exploring the Fishes and Deep History of the North Fork Pit River, California **Stewart Reid**	What is Water Worth in Growth per Gallon in March, May, or August **Gabriel Rossi**	Developing Fishing Community Sustainability Plans on the California North Coast **Laura Casali**	Changing Course and Modifying Permits: Addressing Hydroacoustic Sound Issues with the Regulatory Agencies **Stefan Galvez-Abadia**
1:50	Climbing Above the Competition: Innovative Approaches and Recommendations for Improving Pacific Lamprey Passage at Fishways **Damon Goodman**	Assessing the Impact of Illegal Pesticides Use on National Forest Headwater Stream Communities **Karen Pope**	Predation as a Driver of Contemporary Evolution of Prey Feeding Traits and Morphology **Rebecca Robinson**	Far-Field Hydroacoustic Monitoring and Piers E3, E4 and E5 **James Reyff**
2:10	Patterns of Pacific Lamprey Adult Life History, Movement, and Abundance in Freshwater Creek, California **Abel Brumo**	Long-Term Monitoring of Frog Breeding in the South Fork Eel Suggests that Trespass Marijuana Cultivation May Accentuate Population Fluctuations **Sarah Kupferberg**	Thermal Refuge for Salmonids at Tributary Confluences in a Warming River Network **Terrance Wang**	Near-Field Hydroacoustic Monitoring around Piers E4 and E5 **Brent Meins**
2:30	From Reviled to Revered: A Historical Perspective of the Russian River's Diverse and Charismatic Fish Fauna **Shawn Chase**	Impacts of Marijuana Cultivation on Aquatic Resources, with an Emphasis on Anadromous Fish **Patricia Bratcher**	Assessing Species-specific Vulnerability of Delta Fishes to Multiple Stressors **Brittany Davis**	Assessing the Effects of Underwater Implosions on Pelagic Fishes in San Francisco Bay using a Refined Caged Fish Study Approach **Tom Taylor**
2:50	Microsatellite Analysis Provides Evidence for Natal-site Fidelity in Klamath Smallscale Suckers *Catostomus rimiculus* **Andrew Kinziger**	What We Know and Don't Know About Marijuana Cultivation and Its Impacts on Northern California Aquatic Ecosystems **Scott Bauer**	Inter-Annual Variability of Timing of Pikeminnow Movements into Upper South Fork Eel River **Philip Georgakakos**	Panel Discussion
3:10	**BREAK**			
Session Name	**Conservation of Imperiled Non-Game Freshwater Fishes in California**	**General Session**	**Student Symposium**	**Microchemistry**
Moderator(s)	**Andrew Kinziger and Damon Goodman**	**Mark Gard**	**Grace Ghrist and Tom Keegan**	**Malte Willmes**
Room Name	**Humboldt Room**	**Evergreen Room**	**Oak Room**	**Sequoia Center – Redwood**
3:30	Genomic clarifies taxonomic boundaries in the California Roach/Hitch Species Complex **Jason Baumstegier**	Juvenile Fish Assemblages on The Lower Yuba River, Part 1: Looking Through the Lens of a Rotary Screw Trap **John Cleveland**	The MPAs and the Mad: Seasonal Fish Communities in 3 Northern CA Riverine Estuaries **Katherine Osborn**	Reconstruction of Habitat Utilization and Growth Histories for Longfin Smelt *Spirinchus thaleichthys* Via Otolith Microchemistry **Levi Lewis**
3:50	Tidewater Goby Salinity Tolerance **Andrew Hillis**	Juvenile Fish Assemblages on The Lower Yuba River, Part 2: Looking Through the Lens of a Snorkel Mask **Loren Stearman**	Green Sturgeon Spawning Run Size and Holding Habitat in the Sacramento River **Liam Zarri**	Are Wild Fall run Chinook Salmon Headed Towards Extinction in the Central Valley, California **Malte Willmes**
4:10	Tidewater Goby of the Santa Clara River: Big Changes for a Small Fish **Ken Jarrett**	Population Responses and Habitat Selection of Native Desert Fishes Following Two Years of Tamarisk Control in the Amargosa River Canyon **Mike Davis**	The Effect of Intraspecific Variation in Predator Defense Traits on Parasite Infection Within and Across Generations **Ben Wasserman**	Using Fin Ray Aging and Microchemistry to Reconstruct Life Histories From White Sturgeon Captures in the San Joaquin River and San Francisco Bay Estuary, California **Kirsten Sellheim**
4:30	Green Sturgeon of the Eel River: Past, Present, and Future **Joshua Strange**	Do We Really Need a Special Mechanism to Explain Longitudinal Patterns in Stream Fish Assemblage Structure? **Loren Stearman**	Small Waterfall Barriers Can Alter the Frequency of Resident Versus Migratory *O. mykiss* in Headwater Streams **Suzanne Kelson**	Otolith Tools in Ecotoxicology Toolbox: Unraveling Sources and Pathways of Se Exposure in Wild Sacramento Splittail with Spinal Deformities **Fred Feyer**
4:50			Evolutionary Restoration Potential Evaluated Through the use of a Trait-linked Genetic Marker **Travis Apgar**	Yolo Bypass: Potential Refuge for Delta Smelt? **Naoaki Ikemiyagu**

Oral Presentation Schedule

FRIDAY MORNING ✠ APRIL 7, 2017

Session Name	Using Ecohydrology to Establish Flow Recommendations for California Streams	Modeling the Interactions of Aquatic Species and Their Habitats	General Session	Diverse Perspectives in an Era of Political and Environmental Change - Panel Session
Moderator(s)	**Joseph Merz and Kelly Souza**	**Nicholas Som, Damon Goodman, and Nicholas Heitrick**	**Cesar Blanco**	**Santa Cruz, Monterey Bay Area AFS Student Sub-unit**
Room Name	**Humboldt Room**	**Evergreen Room**	**Oak Room**	**Sequoia Center**
8:15	Overview of a Three-Tiered Framework for Establishing Environmental Flows for California Streams **Eric Stein**	Coupling Optimal Sampling Designs with Models for the Imperfect Detection to Inform Population Dynamics Models **Nicholas Som**	Food Justice in Eastern Africa: A Commodity Chain Analysis of Farmed Nile Tilapia *Oreochromis niloticus* **Stephanie Webb**	
8:35	Quantifying Reference Hydrologic Conditions for California Streams **Belize Lane**	Essential Elements of Habitat For Modeling Stream Fish Population Dynamics: From Depth and Velocity to Food and Risk **Bret Harvey**	Forecasting and Managing for the Detection Probability of Delta Smelt **Brian Mahardja**	
8:55	Developing Tier 1 Environmental Flow Targets Using a Functional Flow Approach **Sarah Yarnell**	Trinity River Brown Trout: Harmless Sportfish or Restoration Nightmare? **Justin Alvarez**	Delta Smelt Abundances in Cache Slough and Other Non-Index Stations Sampled in the Fall Mid-Water Trawl Survey **James White**	
9:15	Predicting Functional Flows at Ungaged Locations **Ted Grantham**	Evidence-based Environmental Flow Assessment: The Victorian Approach **John Williams**	Incorporating State of Delta Science Into Management Actions for Delta Smelt **Evan W. Carson**	**SEE NEXT PAGE FOR MORE DETAILS**
9:35	Estimating Unimpaired Streamflow for California Streams and an Initial Analysis of State-Wide Streamflow Impairment **Larry Brown**	Moving Beyond PHABSIM: New Directions in Instream Flow Modeling **Steve Railsback**	Working with Veterans to Implement Recovery Plans in CA **Bob Pagliuco**	
9:55	**BREAK**			
Session Name	**Examples of Environmental Flow Applications**	**Modeling the Interactions of Aquatic Species and Their Habitats**	**General Session**	**Diverse Perspectives in an Era of Political and Environmental Change - Panel Session**
Moderator(s)	**Kelly Souza**	**Nicholas Som, Damon Goodman, and Nicholas Heitrick**	**Cesar Blanco**	**Santa Cruz, Monterey Bay Area AFS Student Sub-unit**
Room Name	**Humboldt Room**	**Evergreen Room**	**Oak Room**	**Sequoia Center**
10:15	Development of Environmental Flows and Flow-Ecology Relationships: Examples and Applications Across the U.S. **Julie Zimmerman**	Using Models to Predict the Distribution on Invertebrate Hosts of Salmon Parasites **Julie Alexander**	Evaluating Ecosystem-based Reference Points for a Forage Fish Using Ecopath with Ecosim **Andre Bucheister**	
10:35	Development of Recommended Flow Targets to Support Biological Integrity Based on Regional Flow-Ecology Relationships for Benthic Macro-invertebrates in Southern CA Streams **Eric Stein**	Foothill Yellow-Legged Frog Assessment Model (FYFAM): An Example Application **Don Ashton**	The Role of Fish in the Food Webs of Intermittent Rivers **Pablo Rodrígues-Lozano**	
10:55	Ecologically Meaningful Flows: Hydrograph Classification Beyond the Physical Realm **Joseph Merz**	Mortality of Central Valley Chinook Salmon Smolts Relative to Physical Habitat Features **Mark Henderson**	Maternal Allocation of Carotenids Increases Tolerance to Bacterial Infection in Brown Trout **Laetitia Wilkins**	**SEE NEXT PAGE FOR MORE DETAILS**
11:15	Managing Diversions in Unregulated Streams Using a Modified Percent-of-Flow Approach **Darren Mierau**	Developing Flow-floodplain Area Relationships for Central Valley Streams **Mark Gard**	One Fish, Two Fish, Big Fish, Small Fish: Lessons Learned From a Long-term Video Monitoring Study in a California Central Valley Stream **Ryan Greathouse**	
11:35	State Water Board's Regulatory Efforts to Develop Instream Flows for Cannabis Cultivation and the California Water Action Plan **Daniel Schultz**	What Does Habitat Monitoring Data Mean to Salmonids? Creating Status, Trend, and Recovery Information of Information from Field Data **Sean Gallagher**	Efficacy of Collapsible Minnow Traps in Removing Black Bullhead from a Trout Stream **Russell Barabe**	
11:55-1:20	**LUNCH: On Your Own OR Student-Mentor Lunch**			

Fisheries Panel

"Diverse Perspectives in an Era of Political and Environmental Change"

Presented by the Santa Cruz Monterey Bay Area Student Sub-unit

Sequoia Center
Friday April 7, 2017
9:00 am – 11:30 am

Panelists: We will host the following five panelists from varying positions in the industry: management, research, aquaculture, and recreation and commercial fishing.

We have already compiled a short list of names who we intend to invite to speak—notably, some have worn many hats throughout their careers in fisheries, and can draw from their extensive and diverse experiences to comment on the state and future of our fisheries.

Schedule

9:00 am: Introduction by Santa Cruz Monterey Bay Area Subunit (Dave Fryxell)
9:05 am: Panel Introductions
9:30 am: Moderated Questions
10:15 am: Comments and Break
10:30 am: Audience Questions
11:15 am: Wrap-Up

Further details:

We will begin our session with an introduction by our past-president Dave Fryxell. After each panelist is given an opportunity to introduce themselves, we will hold two different question/answer sessions. The first will be lead by our moderator, Stephanie Webb—a member of our executive committee and PhD student at UCSC, who has a great amount of experience as a consultant to local fisherman. Question topics may range from current obstacles in their field/businesses to predictions for the future in response to changes in our climate, policy, etc. The second question/answer session will take the form of a more open discussion between panelists in response to questions posed by the audience.

Oral Presentation Schedule

FRIDAY AFTERNOON ✠ APRIL 7, 2017

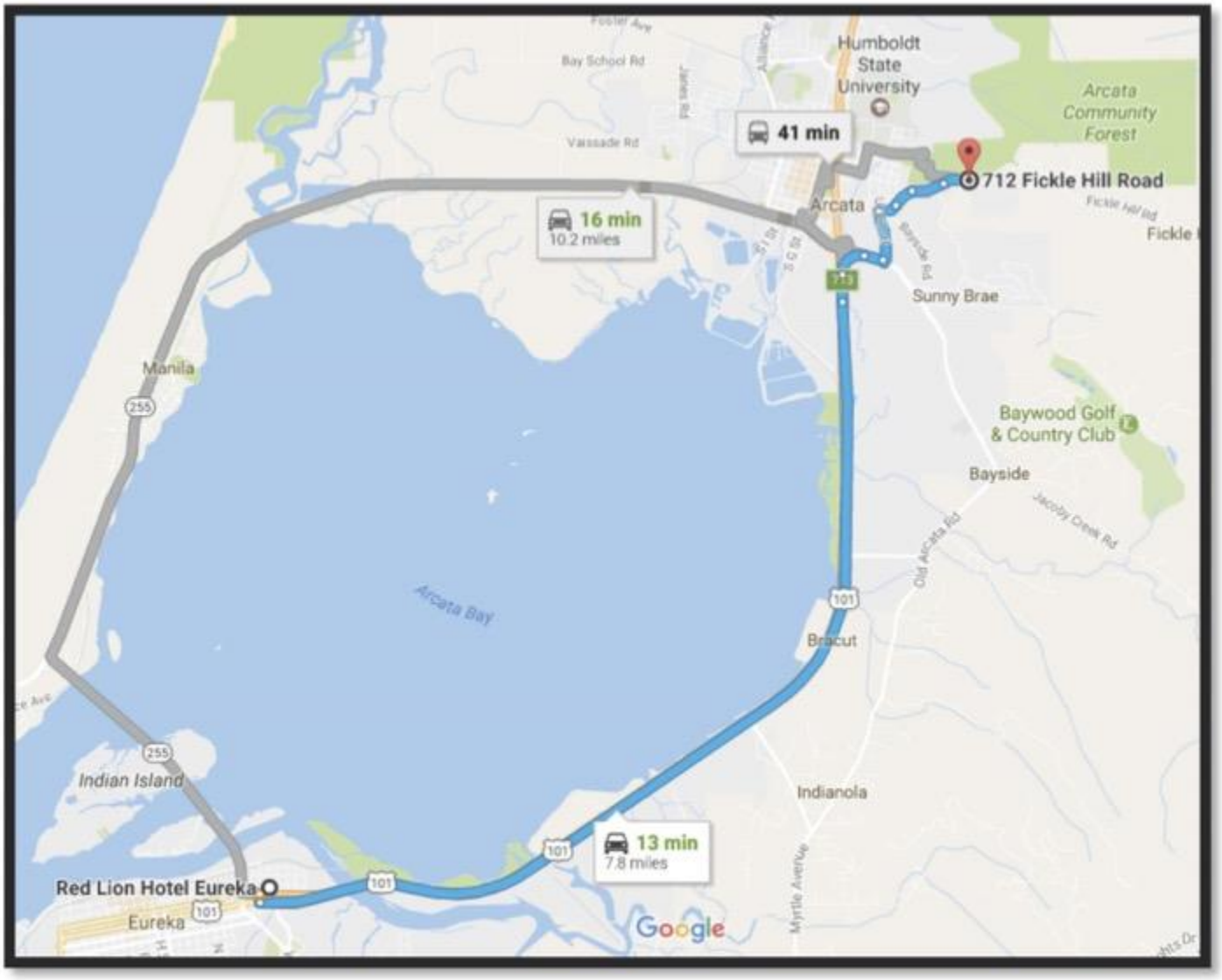
Session Name	Salmonid Monitoring and Restoration	General Session	Special Session on Aquaculture
Moderator(s)	**Farhat Bajjaliya**	**Larry Brown**	**Rafael Cuevas Uribe and Michael Lee**
Room Name	**Humboldt Room**	**Evergreen Room**	**Oak Room**
1:30	Environmental Factors Associated with the Upstream Migration of Fall-run Chinook Salmon and Steelhead on the Stanislaus **Matt Peterson**	Conservation Banking as a Tool for Floodplain Restoration **Daniel Chase**	History and Future Shellfish Farming in Humboldt Bay **Greg Dale**
1:50	Comparison of Night vs. Day Release of Marked Chinook Salmon Juveniles for Determining Smolt Trapping Efficiencies and Population Estimates **Michael Sparkman**	Putting the River Back in the Trinity River **Seth Naman**	Current Status of Aquaculture in California **Randy Lovell**
2:10	Using Didson to Monitor Chinook and Steelhead Escapement in the Smith River, Del Norte County, California, 2014-2015 **Zachary Larson**	The Web of Authorization and Implementation in Trinity River Restoration **Brandt Gutermuth**	Is Aquaculture Sustainable? Mythbusting Fish, Food, and the Future **Jesse Trushenski**
2:30	Response of Steelhead/Rainbow Trout *Oncorhynchus mykiss* Populations to Debris Flows **Jason White**	Restoration in the Napa River Watershed – Are we Seeing More Fish Yet? **Jonathan Koehler**	The Ventura Shellfish Enterprise **Paul G. Olin**
2:50	*Oncorhynchus mykiss* Cover Availability and Use in Southern California Streams **Kathryn Carmody**	Spatial and Temporal Variability in Baseflow Magnitude and Dry Stream Channels in the Mattole River Headwaters: Implications for Salmonids and Restoration **Nathan Queener**	Aquaculture Education. A Review of Options in California and the U.S. **Michael Lee**
3:10	**BREAK**		
Session Name	**Salmonid Monitoring and Restoration**	**General Session**	
Moderator(s)	**Farhat Bajjaliya**	**Larry Brown**	
Room Name	**Humboldt Room**	**Evergreen Room**	
3:30	Restoring Wild Fish Abundance to the Eel River: High-Priority Projects to Increase Salmonid Habitat Capacity **Darren Mierau**	Extreme Drought Drivers Range Contraction of Salmonid Fishes **Stephanie Carlson**	
3:50	20 Years of Stream and Salmonid Work in Sonoma Creek Watershed **Caitlin Cornwall**	Can Summer Wildfire Smoke Reduce Peak River Water Temperatures, Potentially Benefiting Cold-water Fishes? **Aaron David**	
4:10	Lawrence Creek Off-Channel Habitat Restoration and Monitoring **Bob Pagliuco**	Livestock Grazing in the Golden Trout Wilderness: Consequences for Stream Temperatures and Dynamics of Riparian Vegetation **Sebastien Nussle**	
4:30	Water Conservation and Off-channel Storage to Restore Instream Flows in Sonoma County and Associated Biological Monitoring **Sierra Cantor and John Green**	Tracking fine-scale Oncorhynchus mykiss movement in Upper North Fork Matilija Creek (Ventura, CA) **Yi-Jiun Tsai**	
4:50	Restoring Access to Pristine Salmonid Habitat in a Tributary to Sonoma Creek **Lauren Hammock**	Abundance and Distribution of Fishes in the Santa Ana River, California, an Effluent-dominated Urban River **Larry Brown**	
5:10	Long-Term Trend Analysis of the Effects of Restoration on Salmon Rearing Habitat in the Restoration Reach of the Trinity River at Summer Base (12.7 m^3/s) Streamflow, 2005-2015 **Josh Boyce**		

Poster Presentations

Number	Abstract Title	Lead Author
1*	Who's Eating Their Vegetables? Growth Variability May Explain Mismatched Length-At-Date in the Yolo Bypass	Keiko Mertz
2*	From Southern Swamps to Cosmopolitan Model; The Unfinished History of Mosquitofish	David Fryxell
3*	A Comparison of Benthic Macroinvertebrate Assemblages in Perennial and Intermittent Headwater Streams of the Mattole River in Northern California, USA	Mason London
4*	Seasonal Movements and Distribution of Central Valley Striped Bass *Morone saxatilis*	Megan Sabal
5*	Munching Mad Mud: Prey Selection and Benthic Sampling in the Mad River Estuary	Kaitlyn O'Brien
6*	The Effects of Drought on the Marine Survival of Coho Salmon *Oncorhynchus kisutch*	Grace Ghrist
7*	The Effects of Warm Temperature Acclimation on the Generalized Stress Response and Immune Function in 8N and 10N White Sturgeon	Michaiah Leal
8*	Evolutionary Restoration Potential Evaluated Through the Use of a Trait-Linked Genetic Marker	Travis Apgar
9*	En Vogue: Ex-situ calibration of next generation camera technology to assess aquatic food-web structure for juvenile salmonids	Nicholas Macias
10*	Habitat Contraction and Fragmentation in an Intermittent Coast Range Stream in Central California	Jordan Wingenroth
11*	Trends in Mysid Abundance in San Francisco Estuary	Zachary Bess
12*	Tidal Wetland Nursery Function in a Novel Ecosystem	Denise Colombano
13	California Department of Fish and Wildlife Ocean Ranch Unit of the Eel River Wildlife Area - Integrative Ecosystem Restoration Planning	Michelle Gilroy
14	Juvenile Salmonid Responses to Recent Off-Channel Habitat Restoration Projects in the Stream-Estuary Ecotone of Humboldt Bay, CA	Michael Wallace
15	Sticks and Stones: Habitat Response to Concrete Structure Removal and Large Wood Addition – Olds Creek	Michelle Krall
16	Barotrauma Related Mortality of Florida-Strain Largemouth Bass from Winter Tournaments in Diamond Valley Lake, CA	Quinn Granfors
17	Striped Bass in the Carmel River Basin, Monterey County, California	Cory Hamilton
18	Predator Diet and Movement Patterns in the Lower Feather River and Their Effects on Hatchery Smolts	Andrew Hampton
19	An Overview of the San Joaquin River Restoration Program	Hilary Glenn
20	Preliminary Results of a predation survey at Daguerre Point Dam on the lower Yuba River, CA	Sarah Rubenstein
21	Longfin Smelt Distribution, Abundance and Evidence of Spawning in San Francisco Bay Tributaries	Christina Parker
22	Eyes on the Eel: Surveys of Food Webs Assembled Under Different Hydrologic Regimes	Mary Power
23	Making the Carquinez Strait Great Again: Future management of the Peyton Slough Remediation Project	Ali Weber-Stover
24	Juvenile Salmonid Stranding in the Upper Sacramento River	Stacey Alexander
25	Growth Rate and Abundance Comparison of Longfin Smelt *Spirinchus thaleichthys* Between Wet and Dry Years	James Chhor
26	Utilizing Open Source Software to Visualize Spatial Distribution	Arthur Barros
27	Angling-Induced Selection in Brown Trout *Salmo trutta* and Eurasian perch *Perca fluviatilis*	Laura Härkönen
28	Age-Zero Survival of *Onchorynchus tshawytscha* in a Large Regulated River	Jada-Simone White
29	Seasonal Variation in Survival and Speed of Emigration of Age-Zero *Onchorynchus tshawytscha* in a Large Regulated River	Jada-Simone White
30	Juvenile Salmonid Habitat Restoration Effectiveness: Pre-Project Monitoring	Tyler Goodearly
31	Between a Rock and Hard Place; Balancing Competing Life Stage Needs in Habitat Rehabilitation	Jamie Sweeney
32	"Ghost" PIT Tags and Living Fish Have More in Common Then You Might Expect: A Case Study of Watershed Scale Modeling of Tag Fate Over Multiple Winters	Rosealea Bond
33	Improving and Evaluating Warmwater Fisheries in Lake Henshaw	Russell Black
34	Analyzing the Response of Delta Smelt to Increased Outflows from the Yolo Bypass	Brian Healey
35	Juvenile steelhead trout *Oncorhynchus mykiss* in the Lower American River: patterns observed during drought flow conditions (2015) and normal to high flow conditions (2016).	Whitney Thorpe

**Denotes posters that will be part of the student judging*

Spawning Run



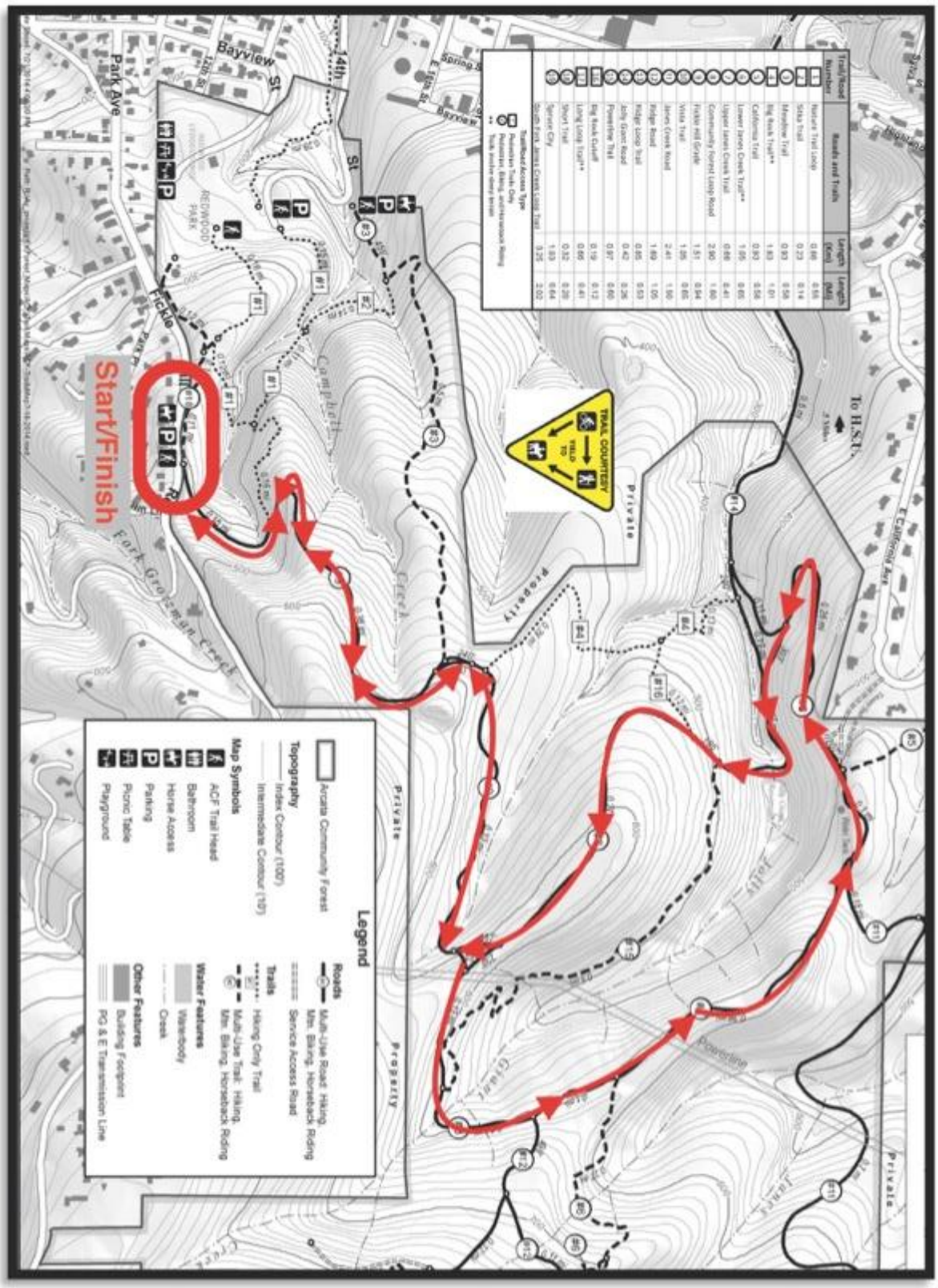
Date and Time: Friday, April 7, 2017 at 7:00am.

Location: Arcata Community Forest, 712 Fickle Hill Road

Distance: 2.74 Miles

Transportation: Group transportation is available leaving Red Lion Inn at 6:30am. Participants can also drive separately.

Prizes: The top male and female finishers will receive a $100 gift card to Sportsman's Warehouse.


Start/Finish
Legend
Arcata Community Forest
Topography
Index Contour (100')
Intermediate Contour (10')
Map Symbols
ACF Trail Head
Bathroom
Horse Access
Parking
Picnic Table
Playground
Roads
Multi-Use Road: Hiking Mtn. Biking, Horseback Riding
Service Access Road
Trails
Hiking Only Trail
Multi-Use Trail: Hiking Mtn. Biking, Horseback Riding
Water Features
Waterbody
Creek
Other Features
Building Footprint
PG & E Transmission Line
TRAIL COURTESY
YIELD TO
To H.S.U.
Bayview St
14th St
Park Ave
Fickle Hill Rd
Campbell Creek
Private Property

City of Eureka

The area surrounding Eureka is an outdoor adventurer's paradise, highlighted by ancient redwood forests, a wild coastline, and some terrific fishing. The coastal city also boasts some excellent coffee houses, art galleries, restaurants, breweries, and bookstores.

Eureka was founded in 1850 as a coastal town that provided a more convenient route for gold miners to access the Trinity region than the overland route from Sacramento. In addition to the gold miners, the coastal redwoods attracted the logging industry and salmon fisheries quickly developed in response to large runs in the local rivers (Eel, Klamath, Trinity, Mad, and Smith).

Regional Highlights

Sequoia Park Zoo – The oldest zoo in California is home to 100 animals on 5 acres, including a petting zoo. Open 10 am – 5 pm Tues-Sun. 3414 W Street, Eureka, CA 95503. (707) 441-4263.

Humboldt Botanical Gardens – A world-class living museum on 44.5 acres featuring a wide variety of native and exotic plats overlooking Humboldt Bay and the Pacific ocean. Open 10 am – 4 pm Weds – Sun. 7707 Tompkins Hill Road, Eureka, CA 95503. (707) 442-5139.

Fort Humboldt State Historic Park – A remote military post established in 1853 to assist in conflict resolution between Native Americans, gold-seekers, and other settlers. Open 8 am – 5 pm daily. 3431 Fort Ave, Eureka, CA 95503. (707) 445-6547.

Old Town Eureka – A meticulously preserved and restored district of unique shops, restaurants, galleries and museums. The core of the district is bounded by First, Third, C, and M streets.

Discovery Museum – A non-profit children's museum that offers interactive exhibits and thematic programs. Open Tues-Sat 10 am – 4 pm, Sun 12 – 4 pm. 612 G St Suite 102, Eureka, CA 95501, (707) 443-9694.

Outdoor Activities

Arcata Marsh and Wildlife Sanctuary – A 307 acres sanctuary that includes freshwater marshes, salt marsh, tidal sloughs, grassy uplands, mudflats, brackish marsh, walking and biking paths, and an interpretive center. Tues – Sun 9 am – 5 pm. 569 S G St, Arcata, CA 95521. (707) 826-2359.

Humboldt Bay National Wildlife Refuge – A nearly 4000 acres wildlife refuge established to conserve precious habitat for the great diversity of birds, mammals, fish, amphibians, invertebrates, and plants that occur in the Humboldt Bay area. Multiple locations. (707) 733-5406

Redwood National Park – Home to some of the tallest trees on Earth as well as vast prairies, oak woodlands, wild riverways, and nearly 40 miles of rugged coastline. Located approximately 40 miles north of Eureka just off U.S. 101 in Orick, CA. (707) 465-7765.

Avenue of the Giants – This world-famous 31-mile scenic drive has an outstanding display of giant redwoods and many trails through the forest. Located 35 miles south of Eureka on CA-254.

Arcata Community Forest – California's first municipally owned forest is a 790-acre tract of second-growth redwoods is used for education, recreation, wildlife habitat, carbon sequestration, and sustainable timber harvesting. There are approximated 19 miles of trails through the forest. 600 South G St, Arcata, CA 95521. (707) 822-7091.

Beaches

- Samoa Dunes Recreational Area – Samoa, CA
- Table Bluff County Park – Loleta, CA
- Clam Beach – Mckinleyville/Trinidad, CA
- Trinidad Head State Beach – Trinidad, CA
- Agate Beach, Patrick's Point State Park – Trinidad, CA

Rivers

- Trinity River
- Mad River
- Eel River
- Van Duzen River

Eat, Drink, and be Merry

Bakeries & Coffee

- Jitter Bean Coffee
- Los Bagels
- Ramone's Bakeries

Casual Dining

- 6th & E Eatery
- A Taste of Bim
- Annie's Cambodian
- Brick & Fire Bistro
- Café Nooner
- Hole in the Wall
- Humboldt Bay Provisions
- Humboldt Smokehouse
- La Patria Mariscos & Grill Restaurant
- Oberon Grill
- Paul's live from New York Pizza
- Siam Orchid Thai Cuisine
- Tandoor Bites Indian Cuisine

Fine Dining

- Eureka Sea Grill
- Humboldt Bay Bistro
- Restaurant 301

Breweries

- Eel River Brewery
- Humboldt Regeneration
- Lost Coast Brewery
- Mad River Brewery
- Redwood Curtain Brewery
- Six Rivers Brewery

Bars

- AA Bar & Grill
- Five Eleven
- Gallagher's Irish Pub and Restaurant

- The Diver Bar and Grill
- The Local Beer Bar
- The Shanty
- The Siren's Song Tavern
- The Speakeasy

Transportation

- Airlines: United Express
- Bus Services: Eureka/Humboldt Transit Authority, 443-0826; Amtrak ThruWay Bus, (800) 872-7245; Greyhound Bus Lines, (800) 231-2222
- Car Rentals: Enterprise Rent-A-Car, 443-3366; Hertz, 269-0290; National Car Rental, 839-3229
- Taxi Services: City Cab, 442-4551; Door to Door Airporter, (888) 338-5497 or 839-4186

More Information

http://www.eurekachamber.com/visitors-guide
http://www.redwoods.info/index.asp

Oral Presentation Abstracts

Abstracts are listed in order by session

#1. Student Symposium

Moderators: Grace Ghrist, Humboldt State University and Tom Keegan, HELIX Environmental Planning

Biotic and Abiotic Determinants of Fish Behavior and Habitat Use along a River Continuum

Katie McElroy, University of California Santa Cruz
Joseph Merz, University of California Santa Cruz and Cramer Fish Sciences
Michael Beakes, Cramer Fish Sciences

Association with physical structure or conspecifics can impact the survival and growth of individuals. The necessity and strength of these associations can change with environmental conditions and ontogeny, acting in concert or in opposition to influence an individual's behavior and ultimate success. To test the hypotheses that affinity for physical structure and aggregating behavior changes along a dynamic river gradient and with development of a migratory fish, we conducted a field experiment on the San Joaquin River, California with juvenile Chinook Salmon *Oncorhynchus tshawytscha*. We created orthogonal combinations of turbidity, fish size, and structural cover by manipulating the presence of artificial structure within net pens at three locations along the river continuum. We recorded the affinity of juvenile Chinook Salmon to physical structure and propensity to aggregate with conspecifics with video cameras. We then used generalized linear models and model selection to evaluate the effects of turbidity, size (fork length), density, and structure level on proximity of individuals to structure and conspecifics. We found the number of aggregating observations increases with increasing density and fork length. When structure was present, aggregating behavior was low across turbidities. In contrast, when structure was absent, aggregating behavior increased in low turbidities. Ultimately, we found both ontogeny and a changing environmental gradient influenced the number of aggregating observations. These results indicate how environmental conditions (turbidity and availability of physical structure), size, and density interact to determine fish behavior and increase our understanding of the complicated interactions surrounding habitat use.

Developing Fishing Community Sustainability Plans on the California North Coast

Laura Casali, Laurie Richmond, and Rob Dumouchel, Humboldt State University

Fishing communities throughout the nation and in California in particular are facing a number of challenges. The number of commercial fishermen has substantially declined over the past two decades and the availability of important infrastructure and support industries has followed. Due to restrictions, fishermen worry that they are becoming over reliant on one or two fisheries, which can expose them to vulnerabilities in low yield years. Communities are also experiencing a phenomena called "graying of the fleet" where the average age of commercial fishermen is rising and fewer young fishermen are entering the industry. In addition, the nation is facing a seafood trade deficit, where the majority of US seafood consumption is imported and much of the US produced seafood is exported; this pattern has made it difficult for communities to purchase locally-caught seafood. These factors are concerning for the Northern California ports community-based fisheries long-term viability. This presentation will summarize an innovative planning process that is underway for the fishing communities of Eureka and Shelter Cove to help them strategically plan for a more resilient future. The project will integrate methods from social science, economics, and community planning. An analysis of secondary data will provide a snap shot of baseline socioeconomic conditions of the community. Then community members will be engaged in a bottom-up planning process that includes one-on-one interviews with waterfront stakeholders, public workshops, and an advisory committee of local representatives. Throughout the process, community members will develop prioritized actions to improve the sustainability of their ports. Planning will take a triple-bottom line approach to incorporate economic, social, and

environmental considerations. Similar initiatives in the ports of Morro Bay and Monterey show that engagement in this type of process can lead to measurable successes.

Predation as a Driver of Contemporary Evolution of Prey Feeding Traits and Morphology

Rebecca Robinson, Michael Kinnison, and Eric P. Palkovacs, University of California Santa Cruz

Predators cause evolutionary responses in prey populations and can also cause trophic cascades. Classic density-mediated trophic cascades occur when predators reduce, through consumption, prey density which in turn decreases the capacity of those prey to reduce the densities of their resources. Our central hypothesis is that the evolution of prey feeding traits in response to predation will have ecological consequences, specifically, that it will amplify the strength of a trophic cascade. Using mosquitofish *Gambusia affinis*, a widespread freshwater fish, we ask whether predation by Larrgemouth Bass *Micropterus salmoides* results in contemporary evolution of mosquitofish morphology and behavior and what the ecological consequences of this evolution is. We tested this hypothesis by measuring the abundance of mosquitofish in 25 ponds with predators (bass) and no predators and collected fish to evaluate morphological variation between predator regimes. We collected wild fish from a subset of these ponds and assessed their boldness. We reared F1 fish from 12 populations where each population was split into two groups and reared in predator or no predator environments. We conducted feeding trials with the F1 fish from each population to assess feeding rates in the presence or absence of predators.

Mosquitofish abundance was significantly higher in ponds without predators; this matches what is predicted by classic trophic cascades. Boldness was not significantly different between predator and no predator populations, but mosquitofish boldness tended to increase with increasing mosquitofish population density. Males had a significantly shorter time to exit suggesting they have higher boldness overall. We found that feeding rates of F1 mosquitofish from both predator and no predator populations are reduced in the immediate presence of predators. Mosquitofish have evolved in response to predation pressures to have varying feeding rates which may further impact their prey source, zooplankton, with the potential to strengthening classic trophic cascades.

Thermal Refuge for Salmonids at Tributary Confluences in a Warming River Network

Terrance Wang, S.J. Kelson, G. Greer, S.E. Thompson, and S.M. Carlson, University of California Berkeley

River networks in California are expected to warm with climate change and modification of land use in catchments. As rivers warm, cold-water-dependent native fish species may alleviate thermal stress by moving into cold-water refugia. We explored the use of tributary confluences as thermal refugia by a native salmonid, *Oncorhyncus mykiss*, in the South Fork Eel River, CA. Tributary confluences provide thermal refugia because shaded, ground-water fed tributary channels tend to be cooler than sun-exposed river mainstems. Ingress of the cold tributary waters into the main-stem therefore provides a localized thermal refuge. We monitored spatial temperature fields at the confluence of the South Fork Eel River and two of its tributaries Cedar Creek and Elder Creek using in-situ grids of temperature sensors. Snorkel surveys were conducted five times a day for five days at each site during summer 2017.

The two tributary confluences had different temperature characteristics, with Cedar Creek being on average 7˚C cooler than the local mainstem, and Elder Creek on average 3˚C cooler. These differences appeared to change the way that fish used the confluence. At Cedar Creek, the salmonid count within the confluence increased as mainstem temperature increased, suggesting that the fish were using the confluence as a refuge. Fish did not preferentially use the coldest locations (14.5˚C) within the confluence, but were most common in locations with temperature between 20-22°C. At Elder Creek, by contrast there was little relationship between temperature and salmonid counts at the confluence.

The results demonstrate spatial variation in the relative importance of confluences as refugia for salmonids. We suggest that tributaries that feed into main-stems at points of warm temperatures may be key thermal refugia sites for native salmonids, and thus of conservation concern.

Assessing Species-Specific Vulnerability of Delta Fishes to Multiple Stressors

Brittany Davis, Dennis Cocherell Anne Todgham, and Nann Fangue, University of California Davis
Ted Sommer, California Department of Water Resources
Randall Baxter, California Department of Fish and Wildlife

Drought conditions coupled with climate change are projected to have cascading effects on the California Delta system, including increases in water temperature and sea level rise leading to saltwater intrusion and increased salinity regimes. Studies have shown thermal and osmotic stressors may negatively impact Delta fishes; however, we know little about how these stressors interact to affect fish performance. For example, how exposure to an initial stressor impacts the ability to cope with a subsequent stressor is unknown. We assessed the capacity of juvenile endangered Delta Smelt (DS) *Hypomesus transpacificus*, invasive Mississippi Silverside (MS) *Menidia beryllina*, and recreationally important Largemouth Bass (LMB) *Micropterus salmoides* to cope with two co-occurring stressors (temperature AND salinity) after an initial single-stressor exposure (temperature or salinity). Critical thermal maxima (CTMax), a measure of upper temperature tolerance, was determined after 0, 2, 4, and 7 days following single and co-occurring stressor exposures. Baseline CTMax's under control conditions (16ºC, 2.5ppt) differed among species with MS having the highest CTMax (34.1ºC), DS having the lowest (28.3ºC), and LMB intermediate (32.7ºC). Salinity as a single stressor (12ppt for DS and MS, 8ppt for LMB) had little effect on CTMax, whereas a temperature increase (20ºC) significantly increased CTMax to 35.0ºC (MS), 29.7ºC (DS), and 35.4ºC (LMB). Each species with an initial thermal stressor had similar CTMax values in the subsequent co-occurring stressor exposure; however, an initial salinity exposure rapidly increased upper tolerance by 1-2ºC. Taken together, these data suggest that salinity does not influence plasticity in CTMax whereas there is a positive relationship between thermal history and CTMax in all species. However, with increasing frequency and duration of warm, Delta water temperatures (i.e. summer means of 20-25ºC), it is notable that native DS have CTMax values that are closest to habitat temperatures (~4-8ºC) compared to non-native MS and LMB (~10-15ºC).

Inter-Annual variability of Timing of Pikeminnow Movements into Upper South Fork Eel River
Philip Georgakakos and Mary Power, University of California Berkeley

Humans are reshuffling the global distribution of organisms through introductions, climate induced range shifts, and local removal. These processes lead to novel assemblages of species, often diminishing societal benefits such as recreation, harvest, and other ecosystem services. Sacramento Pikeminnow *Ptychocheilus grandis* were introduced to the Eel River in 1979, and became widespread in the basin in under a decade. These large cyprinids consume many of the native fishes including culturally and economically important salmonids. We use a combination of snorkel surveys and temperature monitoring to understand if and when these large introduced predators move in the headwaters of the South Fork Eel River. We documented that Pikeminnow expand their range seasonally. As water temperatures warm in the summer, Pikeminnow invade previously unoccupied upstream areas, bringing them in to contact with native prey including steelhead trout [anadromous Rainbow Trout *Oncorhynchus mykiss*]. The timing of this range expansion varies interannually, and is probably influenced by antecedent flow conditions and river temperature. In drier warmer years, upstream movement of Pikeminnow occurs earlier. Early movement could negatively impact Pikeminnow's native prey, by reducing the time predator free refugia are available. These findings imply that Pikeminnow's impacts on native prey could increase with the predicted warming and longer periods of drought in the future.

The MPAs and the Mad: Seasonal Fish Communities in Three Northern California Riverine Estuaries
Katherine Osborn, Eric LeBlanc, Timothy Mulligan, and Frank Shaughnessy, Humboldt State University

The Northern California Coast contains many small estuaries, many of which are largely unstudied. We sampled the summer and winter fish communities of two Northern California estuaries designated as Marine Protected Areas (MPAs), the Big and Ten Mile river estuaries. Sampling occurred summer 2014 through summer 2016. The Mad River Estuary, which lies 175 miles to the north in Humboldt County, was identified as a potential reference site. To determine comparability, we sampled this system monthly, June 2015 – June 2016. Fish were sampled via beach seine or fyke net. The additional sampling in the Mad River Estuary has revealed a greater nuance in how fishes move through these systems. Across all three riverine estuaries, fish abundance and diversity varied more by season than by estuary. Ordination analysis supported

the choice of the Mad River Estuary as a reference site for the two MPAs sampled. This presentation is complimented by a poster, presented here, on the benthic invertebrate community and feeding habits of two benthic fishes: Pacific Staghorn Sculpin *Leptocottus armatus* and English Sole *Parophrys vetulus* found in the Mad River Estuary.

Green Sturgeon Spawning Run Size and Holding Habitat in the Sacramento River

Liam Zarri, University of California Santa Cruz
Ethan Mora and Steve Lindley, National Marine Fisheries Service, Southwest Fisheries Science Center
Russ Bellmer, California Department of Fish and Wildlife

I will present the results of a multiagency effort to study the population size, age structure, and riverine habitat use of the ESA-listed southern Distinct Population Segment of Green Sturgeon *Acipenser medirostris*, an anadromous iteroparous fish that spawns in the upper Sacramento River during late spring and early summer. We used a DIDSON sonar to calculate the average spawning run size between 2010 and 2016 while collecting data on bathymetry, substrate, hydrodynamics, and water temperature. I will present the results of joint DIDSON surveys and acoustic tag monitoring used to estimate population size and structure of green sturgeon. The spatial and environmental data allow us to further understand how hydrodynamics, substrate composition, and proximity to other holding sites affect the use of over-summering habitat.

The Effect of Intraspecific Variation in Predator Defense Traits on Parasite Infection Within and Across Generations

Ben Wasserman and Eric P. Palkovacs, University of California Santa Cruz

Predators and parasites put different selective pressures on a population. We use Threespine Stickleback *Gasterosteus aculeatus*, to ask whether variation in traits that defend individuals against predators affects their response to parasites, and whether such effects are transmitted across generations via the differential effects of host phenotypes on the density of parasites in the environment.

We examined differences among stickleback plate morphs which vary in the amount of body armor. In phase one, we introduced ten Stickleback of the same morph into each mesocosm. Each morph treatment was replicated four times and there were four fishless controls. After six weeks, we removed all fish and determined survival and infection rate of stickleback, and density of pre-infective parasites in the plankton. In phase two, we introduced four Stickleback of each morph into all mesocosms. After two weeks, we determined survival and infection rate of stickleback, and density of pre-infective parasites in the plankton.

During phase one, heavily defended stickleback survived best and left more Ergasilus in the plankton. Less-defended stickleback had lower survival and Ergasilus densities at the end of phase one. Ergasilus densities in fishless treatments were lowest. During phase two, survival was similar between plate morphs, but higher in enclosures that did not have fish during phase one, presumably due to lower parasite densities in the environment. Parasite load on individuals at the end of phase two was shaped by a significant interaction between that individual's plate morph and the morph of the fish inhabiting its mesocosm in phase one.

We found parasite exposure level was influenced by the phenotypic composition of the stickleback population, which influences the relative infection rates across host phenotypes in the next generation. Our results suggest phenotypic variation in predator defense may also affect host-parasite dynamics.

Small Waterfall Barriers Can Alter the Frequency of Resident Versus Migratory O. mykiss in Headwater Streams

Susan Kelson and Stephanie Carlson, University of California Santa Cruz
Michael Miller, University of California Davis

Partial migration is a form of life history diversity within populations in which some individuals migrate and others do not, and is common across fish taxa. One California species that often expresses partial migration is *Oncorhynchus mykiss*. Longitudinal (upstream-downstream) zonation of the life history diversity has been noted throughout their range, with resident forms tending to dominate in upper headwaters. However, within streams where both forms exist and likely

interbreed, little is known about the distribution of each form through space and time. Here, we sampled fish within two tributaries of the South Fork Eel River, CA that contain several waterfalls that may discourage the upstream movement of adult steelhead under some flow conditions. We predicted that the frequency of migratory genotypes will be lower above the waterfalls, particularly following dry winters. To test these ideas, we collected tissue samples from *O. mykiss* from the mouth to the upper extent of fish in each stream, and then used single nucleotide polymorphisms (SNPs) on Omy5, a region of the genome that is closely linked to life history strategy (Pearse et al. 2014), to assign individuals as resident versus migratory genotypes. We are using the resulting genetic data to characterize the spatial distribution of migratory versus resident genotypes longitudinally at the scale of hydrologic units (pools). Specifically, we are exploring the physical parameters of waterfalls that influence the 'resistance' that a given waterfall presents to upstream-migrating adults, borrowing from methods in landscape genetics, where landscape features are used to predict connectivity across the landscape. Understanding which physical aspects of small barriers select against migratory fish will be useful for predicting which barriers are likely to influence the spatial distribution of resident versus migratory *O. mykiss* in streams where they co-occur.

Evolutionary Restoration Potential Evaluated through the Use of a Trait-Linked Genetic Marker
Travis Apgar and Eric P. Palkovacs, University of California Santa Cruz
Devon E. Pearse, National Marine Fisheries Service, Southwest Fisheries Science Center

Human-driven evolution can impact the ecological role and conservation value of impacted populations. Most evolutionary restoration approaches focus on manipulating gene flow, but an alternative approach is to manipulate the selection regime to restore historic or desired trait values. Here we examined the potential utility of this approach to restore anadromous migratory behavior in coastal California steelhead trout [anadromous Rainbow Trout *Oncorhynchus mykiss*] populations. We evaluated the effects of natural and anthropogenic environmental variables on the observed frequency of alleles at a genomic marker tightly associated with migratory behavior across 39 steelhead populations from across California, USA. We then modeled the potential for evolutionary restoration at sites that have been impacted by anthropogenic barriers. We found that complete barriers such as dams are associated with major reductions in the frequency of anadromy-associated alleles. The removal of dams is therefore expected to restore anadromy significantly. Interestingly, accumulations of large numbers of partial barriers (passable under at least some flow conditions) were also associated with significant reductions in migratory allele frequencies. Restoration involving the removal of partial barriers could be evaluated alongside dam removal and fishway construction as a cost-effective tool to restore anadromous fish migrations. Results encourage broader consideration of in-situ evolution during the development of habitat restoration projects.

#2. Conservation of Imperiled Non-Game Freshwater Fishes in California

Moderator: Andrew Kinziger, Humboldt State University and Damon Goodman, U.S. Fish and Wildlife Service

Exploring the Fishes and Deep History of the North Fork Pit River, California
Stewart B. Reid, Western Fishes
Neneekah Forest, Hewisedawi
Marissa Fierro, Pit River Tribe

The North Fork Pit River is the historical outlet of Goose Lake and, as such, forms the northernmost headwaters of the Sacramento River Drainage. Goose Lake itself has not overflowed since the late 1800's. This project, initiated in 2016, is a collaboration between the Pit River Tribe and Western Fishes with the goal of establishing the historical, current and potential fish fauna of the North Fork Pit River to aid with management and promote greater awareness of the role the river has played in tribal life. The project combines current fish surveys with examination of historical records from earlier surveys, museum records, and travelers' diaries. The second primary goal of the project is to survey and document traditional ecological knowledge (TEK) of fishes and ecological conditions, both in the local tribal community and inferred from ethnographic accounts, language and traditional stories. Native fishes include Pit-Klamath Brook Lamprey

Entosphenus lethophagus; Sacramento Pikeminnow *Ptychocheilus grandis*; Hardhead *Mylopharodon conocephalus*; Northern Roach *Lavinia mitrulus*; Pit-Goose Tui Chub *Siphateles thalassinus*; Speckled Dace *Rhinichthys osculus*; Western Sucker *Catostomus occidentalis lacuanserinus*; Pit Sculpin *Cottus pitensis*; and Redband Trout *Oncorhynchus mykiss ssp*.

Climbing Above the Competition: Innovative Approaches and Recommendations for Improving Pacific Lamprey Passage at Fishways

Damon Goodman, U.S. Fish and Wildlife Service
Stewart B. Reid, Western Fishes

We evaluated the behavior and capabilities of upstream migrating adult Pacific Lamprey using a series of experimental trials in relation to existing and novel fishway design features using Passive Integrated Transponder (PIT) telemetry. Five feature types were evaluated, including an existing pool and weir fish ladder, three in-situ modifications of the existing fishway and two feature types designed to provide lamprey specific routes. The probability of passage success through trials (10 m distance and 1 m elevation gain over 1 night) was related to feature type. The existing pool and weir configuration provided the lowest predicted passage efficiency at 0.44 (95% CI 0.29 – 0.59), while tube and culvert configurations had perfect efficiencies. For individuals that successfully ascended trials, passage time was related to feature type. Lampreys ascending the pool and weir structure had the longest predicted passage time at 5.2 hours (95% CI 3.96 – 6.46) while individuals in the tube were the fastest with a 20 fold reduction in migration time at 0.26 hours (95% CI 0.21 – 0.30). We found no support for an effect of lamprey length on passage success or migration time, regardless of feature type. We also incorporated over 200 hrs of nighttime observations into a better understanding of how lampreys pass barriers and where they encounter particular challenges. Our results and observations of lamprey migration behavior confirm that fishways can pose a substantial obstacle to Pacific Lamprey migration. We provide a set of recommendations for behavioral considerations and design features, both beneficial and those that should be avoided at fishways. This study identifies a variety of solutions applicable to a range of obstacles that, if implemented, would significantly improve the opportunity for Pacific Lamprey to pass existing and future man-made structures.

Patterns of Pacific Lamprey Adult Life History, Movement, and Abundance in Freshwater Creek, California

Abel Brumo, Stillwater Sciences
Colin Anderson, Humboldt State University

Very little information on abundance and life history patterns of adult Pacific Lamprey is available for small coastal California streams. In recent years, California Department of Fish and Wildlife has collected data incidental to intensive salmonid monitoring that advances our understanding of Pacific Lamprey adult migration, spawning times, and relative abundance in Freshwater Creek, a tributary to Humboldt Bay in Northern California. From 2007–2016, a weir and trap located near the upper extent of tidal influence were used to capture adult lampreys in the winter and spring—both individuals migrating upstream into freshwater and those moving downstream. Since 2012, captured adults have been PIT-tagged and directional movement has been detected using six paired PIT tag antennas located throughout mainstem Freshwater Creek and at tributary junctures. Data on lamprey redds have also been collected during salmonid spawning surveys since 2011. We synthesized data from these efforts, describing annual adult abundance and movement patterns from time-of-entry into freshwater through the post-spawn period. Results from weir captures indicate considerable annual variation in abundance, multiple spawning cohorts moving from late winter through early summer, and peak movement of both sexually immature and mature fish from March–May. Annual redd counts were highly correlated with weir captures and indicate peak spawning occurred in April and May. PIT tag detections documented a diversity of behaviors within and between years, including extensive movements both upstream and downstream in tidally influenced reaches, downstream movements of post-spawn fish into the estuary, movement into an adjacent Humboldt Bay tributary, and apparent attraction to a tide gate and other infrastructure. This synthesis demonstrates both the utility of collecting incidental data and the value of multiple years of monitoring for expanding knowledge of an understudied species and describing its life history variation.

From Reviled to Revered: A Historical Perspective of the Russian River's Diverse and Charismatic Fish Fauna
Shawn Chase and David Cook, Sonoma County Water Agency

The diversity of fishes in the Russian River has presumably increased over a geologic timescale through natural invasions and anthropogenic introductions, from approximately 8 to 37 species. The original colonizers of the primordial Russian River where likely anadromous or saltwater tolerant species that entered the river through its marine connection with the Pacific Ocean. Subsequently, several freshwater dispersant species took advantage of geologically temporal connections to the Sacramento River, which is the adjacent inland watershed. While connection to the Sacramento River resulted in a diverse native fish community, the intentional and incidental introduction of alien species has resulted in uncertainty in the true origin of some species in the Russian River. Much of the history of the Russian River fish fauna is based on scant records from the late-1800s and early 1900s, an intensive watershed-wide attempt to eradicate non-salmonid "rough fish" in the 1950s, and extensive abundance and distribution studies conducted since the 1990s. Here we attempt to summarize the available information, clarify the origins of inter-basin species, and assess species past and current abundance and distribution in the Russian River.

Microsatellite Analysis Provides Evidence for Natal-Site Fidelity in Klamath Smallscale Suckers (Catostomus rimiculus)
Andrew Kinziger and Steven R. Fong, Humboldt State University
Jason L. White, Rodney J. Nakamoto, and Bret C. Harvey, U.S. Forest Service, Pacific Southwest Research Station

Natal-site fidelity, where migratory individuals return to the location of their birth for spawning, has been shown to produce genetic differentiation among reproductive groups in several species of fishes, including salmonids, esocids, and percids. We hypothesized that catostomids exhibit genetic differentiation among reproductive groups as several members of the family have been shown to migrate to the same spawning areas across multiple reproductive seasons. We examined the genetic structure of Klamath Smallscale Suckers by examining variation in 15 microsatellite loci across 746 larvae from the Smith River, California. Our analysis resolved two genetically distinct groups of larvae collected from the two main tributary areas sampled (North Fork and South Fork of the Smith River). This pattern of genetic differentiation would only be expected if most individuals spawn at the site of their own birth and subsequently return to that site. Downstream collections exhibited increases in genetic diversity (expected heterozygosity and allelic richness), decreases in pairwise relatedness, and were resolved as admixtures of the upstream groups in Bayesian cluster analysis. These patterns are consistent with larval drift from upstream to downstream locations. Mingling of the distinct spawning groups in downstream areas suggests that lack of dispersal is not a likely explanation for the differentiation among spawning groups. The genetic patterns we resolved support the hypothesis of natal-site fidelity in Klamath Smallscale Suckers.

Genomics Clarifies Taxonomic Boundaries in the California Roach/Hitch Species Complex
Jason Baumsteiger, Peter B. Moyle, Sean M. O'Rourke, and Michael R. Miller, University of California Davis
Andres Aguilar, California State University Los Angeles

Modern genomics is a new and exciting way to define species of fish. We demonstrate this in the CA Roach/Hitch species complex, a group of fishes in California with a puzzling taxonomy. Using 22,000 loci and three independent analyses, we demonstrate that the use of two genera (Lavinia – Hitch; Hesperoleucus – CA Roach) is supported. Five species are then proposed, with one newly redefined species (Northern Roach - *H. mitrulus*) potentially belonging in the Lavinia genus. The remaining species were previously identified Hitch *L. exilicauda* and CA Roach *H. symmetricus* along with two newly redefined species: Gualala Roach *H. parvipinnis* and Coastal Roach (H. sp). CA Roach *H. s. symmetricus* is restricted to the Great Central Valley and shows a pattern for a new subspecies (Red Hills Roach) and distinct population structure at every location sampled (including a Distinct Population Segment [DPS] in the Kaweah River). Coastal Roach contains two proposed subspecies coinciding with Northern locations (Russian, Eel, Navarro) and Southern locations (Tomales Bay, Monterey). DPS's were potentially found within each subspecies. Finally, we show evidence that Eel River Roach are introduced from the Russian River. Overall our results clearly demonstrate the power of population genomics for taxonomic assessments.

Tidewater Goby Salinity Tolerance
Andrew Hillis and Andrew Kinziger, Humboldt State University

We investigated the salinity tolerance of the Tidewater Goby *Eucyclogobius newberryi*, a federally endangered species. Tidewater Goby habitats are naturally subject to rapid increases and decreases in salinity due to lagoon breaching and flash floods. Upper salinity tolerance in tidewater goby (>25mm) was evaluated by acclimating batches of fish (N=10) to salinities of 0 ppt and 30 ppt and then subjecting each batch of fish to a stepwise increase in salinity of 15ppt per hour until a sublethal endpoint was reached. Lower salinity tolerance was evaluated by acclimating batches of fish (N=10) to salinities of 30 ppt and 50 ppt and then subjecting each batch of fish to a stepwise decrease in salinity of 15ppt/hour until a sublethal endpoint was reached or they had tolerated a salinity of 0ppt for one hour. The endpoint was defined as loss of equilibrium or failure to respond to prodding with a probe. Tidewater goby reached our pre-defined endpoint at above 80ppt, revealing that individual tidewater goby can survive rapid increases in salinity. Tidewater goby subjected to salinity decreases were able to withstand decreases as much as 50ppt without reaching our pre-defined endpoint, indicating that tidewater goby are able to tolerate rapid decreases in salinity. Following the completion of the experiment tidewater goby were returned to pretrial acclimation condition and monitored for 3 weeks.

Tidewater Goby of the Santa Clara River; Big Changes for a Small Fish
Ken Jarrett and Ethan Bill, Stillwater Sciences

For several years between 1994 and 2012 researchers regularly observed large abundances of Tidewater Goby *Eucyclogobius newberryi* throughout the Santa Clara River Estuary. However, by 2013 their population and distribution appeared to be in dramatic decline. In 2015 we initiated an intensive effort to evaluate the Tidewater Goby population using seine nets and eDNA to determine presence and distribution. We also collected extensive fish survey, water quality, and habitat data and analyzed long term estuary breach data. We found that under current conditions a population of Tidewater Goby remains in the estuary, albeit in much lower abundance and restricted distribution compared with results from even three years ago. Their current status appears to be strongly related to a prolonged drought, breach dynamics, and the presence of a substantial biomass of invasive species.

Green Sturgeon of the Eel River: Past, Present, and Future
Joshua Strange, Sweet River Sciences
Eddie Koch and Tim Nelson, Wiyot Tribe Natural Resources Department

Green Sturgeon are a culturally and ecologically important non-game anadromous fish native to California's waterways. The only documented contemporary spawning aggregations of Green Sturgeon occur in the Rogue and Klamath rivers (northern Distinct Population Segment [DPS]), plus the Sacramento River (Southern DPS). However, Green Sturgeon in the Eel River comprised one of the most prominent data gaps as officially the Eel River spawning run was considered extirpated and yet sporadic sightings were reported annually. Herein we report historic information on Green Sturgeon in the Eel River as well as the latest findings of an ongoing project documenting the current status of Green Sturgeon in the Eel River and relevant consideration for the future of these iconic anadromous fish in one of California's largest river systems. Here we present findings to date for: 1) an assessment of habitat availability and limitations; 2) results from an adult sturgeon presence and enumeration survey on the mainstem Eel River using a mobile DIDSON sonar camera; 3) tagging of adults in the Eel River with ultra-sonic telemetry transmitters; 4) monitoring movements of tagged adults, tagged in the Eel River or elsewhere, through a sonic receiver detection network at strategic sites in the marine, estuarine, and riverine migration corridor; and, 5) identifying population(s) of origin using genetic analysis of tissue samples. This project is the first systematic study of Green Sturgeon in the Eel River and is an important contribution towards their management and conservation.

#3. Watershed Impacts from Altered Flow Regimes and Agricultural Perturbations on the North Coast

Moderator: Kelly Souza, California Department of Fish and Wildlife

What is Water Worth in Growth per Gallon in March, May, or August?

Gabriel Rossi, Mary Power, Shelley Pneh, and Terrance Wang, University of California Berkeley

Water value fluctuates seasonally and from year-to-year for human users; its worth may also change seasonally for salmonids. Young salmonids foraging in a Mediterranean stream face strongly seasonal flows. As winter gives way to spring, the hydraulic environment begins to recede but the stream's engines of productivity, epilithic diatoms, are just coming to life. Drift-foraging salmonids depend both on production of insects and on the hydraulic conditions which deliver prey and provide foraging positions. In smaller tributaries, a limited window of opportunity may occur when suitable hydraulics intersect with a productive food web. Investigating the duration and timing of these windows of opportunity, and the environmental and human causes which affect them, can provide valuable information to guide management of salmon-bearing tributaries. Using stereo-video methods (Neuswanger 2016), we analyzed the response of juvenile steelhead [anadromous Rainbow Trout *Onchorynchus mykiss*] foraging to seasonal changes in hydraulics, and to invertebrate drift in a South Fork Eel River tributary. Changes in occupied space and indices of movement were compared with reductions in streamflow, velocity, and flux of drifting invertebrates. As out-migrating smolts leave their natal tributaries and enter the mainstem Eel River, their success may also depend on the antecedent winter and spring conditions. Antecedent winter hydrology and summer low flows strongly influence the fate and succession of the Eel River's summer food web – will it grow salmon, armored caddisflies or cyanobacteria? I will also discuss a broader study, undertaken by UC Berkeley researchers at the Eel River Critical Zone Observatory, which investigates food web structure in tributary and mainstem reaches throughout the Eel River. This study is laying the groundwork for a basin-wide perspective on how within and between year variation in hydrologic regimes affect food webs and the salmon that depend on them.

Assessing the Impact of Illegal Pesticides Use on National Forest Headwater Stream Communities

Karen Pope and Adam Cummings, U.S. Forest Service Pacific Southwest Research Station
Mourad Gabriel and Greta Wengret, Integral Ecology Research Center

The illegal cannabis industry in California is expanding dramatically with "trespass grows" on U.S. Forest Service lands. Unregulated grow operations on both public and private land are having dramatic, acute effects on the local ecology. In addition to drawing down headwater streams at the peak of the dry season, cannabis cultivators use numerous pesticides to prevent crop loss to herbivory and to kill nuisance animals. Dangerous pesticides such as anticoagulant rodenticides have been found to kill terrestrial mammals including fisher *Pekania pennanti* and black bear *Ursus americanus*. Traces of Diazinon, one of the pesticides found on illegal grow sites, have been found in stream water directly downstream of recently eradicated grow sites on U.S. Forest Service lands. Here we present on an ongoing study into the effects of toxicants on headwater stream communities. In the fall of 2016 we established access to six cultivation sites on the Shasta-Trinity National Forest, delineated survey reaches up- and downstream of the site run-off footprint, and deployed water quality monitoring devices in each reach. To characterize reach habitat conditions and benthic macroinvertebrates, we implemented the Surface Water Ambient Monitoring Program (SWAMP) bioassessment protocol. For amphibians, we collected Environmental DNA samples and conducted amphibian belt surveys. Toxicant characterization of five sites found that four used ≥2 restricted use pesticides such as carbamate, and three used anticoagulant rodenticides. On average, 1000 lbs of dry fertilizer were used per site. During fall benthic macroinvertebrate surveys, we saw no clear differences between up and downstream reaches, but these surveys were conducted prior to the first rains. Amphibians encountered during initial surveys include coastal giant salamander *Dicamptodon tenebrosus*, foothill yellow-legged frog *Rana boylii*, coastal tailed frog *Ascaphus truei*, and southern torrent salamander *Rhyacotriton variegatus*. Spring resurveys will be conducted in April and May 2017.

Long-Term Monitoring of Frog Breeding in the South Fork Eel Suggests the Trespass Marijuana Cultivation May Accentuate Population Fluctuations

Sarah Kupferberg, University of California Berkeley

In California, marijuana cultivation poses a risk to stream breeding amphibians, including the foothill yellow-legged frog (*Rana boylii*). Although all life stages (embryos, tadpoles, and frogs) are susceptible to the negative effects of surface water extraction for irrigation and pesticide contamination, detecting population level impacts is a challenge. Background inter-annual variability in population size can be high and there are lags in both time and space between detrimental conditions and response metrics such as eggmass counts. Female frogs take 3 years to reach reproductive maturity and migrate long distances between residences in tributaries and breeding sites in mainstems. Nonetheless, time series analysis of the reproductive output of *R. boylii* on a 5 km reach of the South Fork Eel River suggests that a large trespass grow in the upper watershed of Elder Creek may have exacerbated a population decline. In 2012, 30 gardens were discovered with a cumulative total of approximately 75,000 marijuana plants, and cultivation may have begun as early as 2009. Frog breeding censuses began in 1992, and until 2010 there were no significant population trends. During those years the sub-populations associated with various tributaries fluctuated in synchrony. The density (clutches/km) of the Elder Creek sub-population was always within one standard deviation of the mean of five control reaches (each 500 m long, separated from each other by at least 500 m). From 2011-2015, the number of clutches per stream kilometer declined steadily in all reaches, but the Elder Creek sub-population declined at a significantly faster rate and then began to recover after the grow sites were cleared and restored. While most of the population fluctuations can be attributed to documented events, such as late-spring spates scouring eggmasses in some years and drought related mortality in others, the unusual and disproportionate changes near Elder Creek suggest a link to marijuana cultivation.

Impacts of Marijuana Cultivation on Aquatic Resources, with an Emphasis on Anadromous Fish
Patricia Bratcher, California Department of Fish and Wildlife

This study is intended to increase understanding of the effects that marijuana cultivation has on the nearby aquatic environment, with an emphasis on anadromous fish and more specifically, spring- run Chinook Salmon *Oncorhynchus tshawytscha* and Central Valley Steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*], both listed species. The study site is located in Deer Creek watershed, Tehama County. Goals include (1) determining if there is an effect on anadromous fish from marijuana cultivation practices; (2) developing sampling protocols for use in assessing future impacts; and (3) determining the extent of impact from marijuana cultivation versus other land uses or natural perturbations. Study design and preliminary results will be shared, as well as the challenges such a study can face if others plan to study illegal grow sites.

What We Know and Don't Know About Marijuana Cultivation and Its Impacts on Northern California Aquatic Ecosystems
Scott Bauer, California Department of Fish and Wildlife
Karen Pope, U.S. Forest Service Pacific Southwest Research Station
Gabriel Rossi and Sarah Kupferberg, University of California Berkeley

The marijuana cultivation industry has been expanding across California for nearly a decade. The pace of growth is particularly acute in the Emerald Triangle, a part of northern California that incorporates Humboldt, Del Norte, and Mendocino counties. The California Department of Fish and Wildlife has been at the forefront of trying to document and quantify environmental impacts associated with this burgeoning industry, and is now one of a number of state agencies tasked with regulating a once outlaw activity. Water quality and availability are negatively affected by marijuana cultivation, as are the fish and wildlife species that depend on intact habitats. However, there are many environmental consequences of this activity that need focused research. This presentation will explore both the knowns and unknowns and offer suggestions on how we can increase our knowledge of the negative effects of this industry. Increased research efforts will help us better regulate and protect California's fish and wildlife.

#4. Blowing Things Up in the Bay – Evaluation of Underwater Sound Effects by Monitoring Two Controlled Implosions in San Francisco Bay

Moderator: Tom Taylor, Environmental Science Associates

The Story Behind the Story: A New Demolition Method for Removing Unneeded Infrastructure in Tidal Environments Was Made Possible by an Innovation in Contracting
Chris Traina, California Department of Transportation

During the fall of 2015 and 2016, three piers of the old East Span of the San Francisco Oakland Bay Bridge (SFOBB) were demolished using a unique controlled implosion technique. Major issues for the regulatory agencies associated with using this technique included potential barotrauma injury to listed and commercial fish species in the Bay and harassment and harm to listed marine mammals along with effects to water quality. The Department was successful in obtaining regulatory permits for this change in demolition methods and in evaluating the success of this construction method because of a unique pilot contracting tool called the Construction Manager/General Contractor (CMGC) program. On April 22, 2014, the Department advertised a Request for Qualifications (RFQ) for the removal of all marine foundations of the existing SFOBB through the pilot CMGC program. This innovative Project Delivery and contracting method allowed the Project Development Team (PDT) to seek the most qualified contractor based on criteria developed prior to the selection process. The selected contractor became a part of the PDT and helped design the project during the preconstruction services phase of the contract. Once the design was completed the contractor and the Department developed estimates and risk registers and negotiated a Guaranteed Maximum Price (GMP) for the construction of the designed project.

The CMGC process was ideal for this project as the PDT was able to utilize the experience of the contractor on previous marine foundation removal projects and was able to select a contractor with significant experience in controlled blasting of marine structures. This was essential in gaining the confidence of the regulatory permitting agencies approving the permits for this project, and in structuring field studies to validate the successful results of the demolition events. This process also allowed the PDT to develop and sequence phases of the project to ensure they were correctly sequenced with other SFOBB dismantling projects and helped the Department to reduce risk and delays that have been typical for many complex construction projects.

Changing Course and Modifying Permits: Addressing Hydroacoustic Sound Issues with the Regulatory Agencies
Stefan Galvez, California Department of Transportation

A large effort was required to permit the explosive demolition of Piers E4 and E5, even after the successful implosion of Pier E3 as a demonstration project. Effects on marine mammals, fish, water quality and Bay infrastructure had to be addressed and resolved within a compressed time schedule for the implosions of Piers E4 and E5 of the original east span of the San Francisco-Oakland Bay Bridge. This required modifying the initial authorization and permit conditions that were all based on mechanical demolition from several state and federal resource and regulatory agencies having jurisdiction in the San Francisco Bay. The Department of Transportation conducted extensive coordination efforts to address regulatory concerns with 7 agencies charged with protecting natural resources and water quality of the San Francisco Bay. Some of these permits required public hearings and notifications. The Department also conducted public outreach efforts with environmental stakeholders in the region and incorporated several measures to monitor issues of concern raised by these organizations. The Department completed required environmental requirements under the NEPA and obtained regulatory permits before successfully imploding the two piers in October, 2016.

Far-Field Hydroacoustic Monitoring around Piers E3, E4 and E5
James Reyff, Paul R. Donavan, and Carrie J. Janello, Illingworth & Rodkin, Inc.

Extensive underwater sound measurements were conducted during implosions of Pier E5 and E4 of the Old East Span of the San Francisco-Oakland Bay Bridge during October 2016. These measurements are in addition to the measurements conducted for the demolition of Pier E3 in 2015. Adverse behavioral effects to fish were predicted to extend into the acoustic far-field, defined as 1,500 - 4,100 feet from the implosions for these studies. This presentation

describes the results of these measurements and compares them to the more refined methods of predicting these impacts. Underwater sound effects, in terms of potential injuries and adverse behavioral reactions, are addressed. Of special interest is the root-mean-square acoustic metric used to describe behavioral effects to fish. Because this metric is both time and energy dependent, large variations in the effect area can occur based on the interpretation of either parameter.

Near-Field Hydroacoustic Monitoring around Piers E4 and E5

Brent Meins and Cathy Aimone-Martin, Aimone-Martin Associates
Albert vanNiekerk, Contract Drilling and Blasting

Hydroacoustic monitoring of blasting overpressures resulting from the implosion of the old San Francisco Oakland Bay Bridge Pier E4 and E5 foundations, was performed in the near field (out to 800 ft from the pier) and in the far field (1,500-4,100 ft from the pier). A Blast Attenuation System (BAS) was installed and operated around each of the marine foundations during the implosion events to reduce the underwater overpressures. As part of the near field monitoring effort, underwater pressure sensors were installed inside and outside the BAS to evaluate the efficiency of the BAS in attenuating these pressure pulses. Sensors were installed in three different compass directions, and independent high speed transient data acquisition systems were used to collect overpressure data from these three sensor arrays during the implosion events. Pressure data from far field hydrophones was also incorporated in the analyses of BAS efficiency. It was determined that the efficiency of the BAS in reducing these underwater blasting overpressures was between 69.2% and 72.2%. It is therefore evident that the BAS was well designed, constructed, installed and operated with the desired effect, which was to significantly reduce the underwater overpressures resulting from the implosion of the bridge pier outside of the BAS.

A vertical array of five pressure sensors was also deployed 196 ft from the Pier E4 blast and included one fish cage of the same make as those deployed during the caged fish study. Six pressure peaks were analyzed to develop a pressure profile in the vertical water column as well as the relative pressure inside the fish cage compared to outside.

Assessing the Effects of Underwater Implosions on Pelagic Fishes in San Francisco Bay using a Refined Caged Fish Study Approach.

Tom Taylor, Sarah Cannon, and Mark Bowen, PhD., Environmental Science Associates

Attenuated implosions were used to demolish abandoned piers E5 and E4 of the Old East Span of the San Francisco Bay Bridge during October of 2016. Successful caged fish studies were conducted for each pier implosion that occurred two weeks apart. We used replicate cages at each of four distances (120, 200, 500 and 800 feet) from each pier, plus control cages, each with 25 juvenile late-fall run Chinook Salmon *Oncorhynchus* tshawytscha. Protocols for fish and cage handling were modified based on findings from the 2015 Pier E3 Caged Fish Study. We also refined techniques to transition hatchery fish to Bay salinity. Cages were deployed parallel to the south near-field hydroacoustic array for each pier demolition event. Following each demolition event, cages were retrieved from the Bay and brought back to the dock where a randomized assessment of the fish in each cage was used to account for the effect of cage order and differences in holding times on the test fish. All test fish were also necropsied to verify any barotrauma (blast-related) injury. The assessments and the necropsies confirmed a general lack of blast-caused injury and no injury pattern related to proximity to the blast events.

#5. Microchemistry

Moderators: Malte Willmes, University of California Davis

Reconstruction of Habitat Utilization and Growth Histories for Longfin Smelt (Spirinchus thaleichthys) via Otolith Microchemistry

Levi Lewis, James Chhor, Malte Willmes, and James Hobbs, University of California Davis

Habitat utilization and movement patterns of fishes remain critical data gaps necessary for effective conservation and management. Otolith geochemistry is a valuable tool for examining habitat use of fishes throughout multiple stages of development. We used in-situ laser ablation MC-ICP-MS to measure strontium isotope ratios (87Sr/86Sr) across fish otoliths and retrospectively construct habitat utilization patterns of

individual Longfin Smelt *Spirinchus thaleichthys* in the Sacramento-San Joaquin River Delta and San Francisco Estuary.

These geochemical analyses have identified several life-history strategies, with some individuals hatching and rearing for long periods in fresh water, a majority hatching and rearing in fresh to low salinity water and moving rapidly to higher salinities, and some hatching and rearing in saltier brackish-water zones. We also observed Sr values in primordia indicative of oceanic maternal influence as is common for anadromous salmonids. Larvae reared in low salinity (ca. 2-ppt.) waters appear to disproportionately contribute to adult populations, suggesting that the low salinity zone is a critical nursery area for this species. Larval experiments at the UC Davis Fish Culture and Conservation Lab are being used to calibrate our retrospective geochemical and growth estimation techniques and observations. These studies will provide a greatly enhanced understanding of habitat utilization and life-history diversity for this threatened estuarine fish.

Are Wild Fall-Run Chinook Salmon Headed Towards Extinction in the Central Valley, California?

Malte Willmes, Zachary Bess, Justin J. Glessner, Levi Lewis, and Jim Hobbs, University of California Davis
Anna M. Sturrock, University of California Berkeley
Ryon Kurth and Jason Kindopp, Department of Water Resources
Rachel Johnson, National Marine Fisheries Service

The Sacramento-San Joaquin River system in California's Central Valley represents a vital link in California's water supply, and contains the southernmost spawning runs of Chinook Salmon *Oncorhynchus tshawytscha*. Fall-run Chinook from the Sacramento River system form the backbone of California's salmon ocean fishery and are heavily subsidized with the production of hatchery fish. However, the spawning of hatchery origin Chinook with wild fish has been found to compromise the genetic integrity of the wild origin populations through processes such as outbreeding, genetic homogenization and reduction of life history diversity. Identifying temporal trends in the contribution of hatchery and wild origin fish to the overall in-river escapement is thus of vital importance for assessing the extinction risk and resiliency of fall-run Chinook Salmon in the Central Valley.

We used otolith strontium isotope (87Sr/86Sr) ratios of fish collected during carcass surveys from 2002 to 2010 on the Feather River to reconstruct their life history patterns and natal origin. Our results show that a large proportion (~50-90%) of in-river spawners are of hatchery origin, with the proportion of hatchery fish dramatically increasing in 2009 and 2010 after the salmon stock collapse (2007-2008). Constant fractional marking data show hatchery fish continuing to dominate on the natural spawning grounds over the following two years (90% in 2011 and 2012), indicating that hatchery fish have effectively replaced wild fish in this river. This introgression of hatchery with wild origin fish likely further promotes the erosion of life history diversity and weakens the Chinook Salmon population portfolio, causing synchrony among populations and loss of resilience in the Feather River and the Central Valley overall.

Using Fin Ray Aging and Microchemistry to Reconstruct Life Histories From White Sturgeon Captured in the San Joaquin River and San Francisco Estuary, California

Kirsten Sellheim, Jamie Sweeney, Joseph Merz, Cramer Fish Sciences
Malte Willmes and James Hobbs, University of California Davis
Zachary Jackson, U.S. Fish and Wildlife Service

The primary goal of the U.S. Fish and Wildlife Service Anadromous Fish Restoration Program is to at least double natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis. Currently, recovery efforts for sturgeon are hampered by a paucity of basic life history information. Previous research has focused primarily on monitoring efforts and tagging studies which have gathered information for only a small portion of the sturgeon life cycle. Analyzing fin ray strontium isotope ratios (87Sr/86Sr) via laser ablation MC-ICP-MS may provide a non-lethal method to resolve fine-scale movement patterns in sturgeons (Acipenseridae). We first conducted a pilot laboratory experiment to validate the approach, in which juvenile White Sturgeon *Acipenser transmontanus* were exposed to two water sources with distinct strontium isotope ratios. This experiment confirmed that, within 2-4 weeks of exposure to a water source, fin ray strontium value accurately reflects that of the water source to which the

sturgeon was exposed. After validating the method, we examined pectoral fin ray sections from wild adult White Sturgeon collected from the San Joaquin River and the San Francisco Estuary by state and federal monitoring programs and recreational anglers. Preliminary results indicate strontium isotope ratio profiles from the wild fin rays were highly variable, both across individuals and through time within individual fish. Many fish spent the majority of their life in estuarine environments, while some showed evidence of extensive marine or freshwater residence. Freshwater strontium isotope values were not commonly observed, even within the first fin ray annulus, indicating a relatively short freshwater rearing period; however, additional research is necessary to determine at what life stage larval sturgeon fin rays begin to calcify. Migratory history information can help resource managers refine flow management and habitat restoration strategies to optimize potential impact to sturgeon.

Otolith Tools in the Ecotoxicology Toolbox: Unraveling Sources and Pathways of Se Exposure in Wild Sacramento Splittail with Spinal Deformities
Fred Feyer, U.S. Geological Survey
Rachel C. Johnson, National Marine Fisheries Service

Selenium (Se) is an essential nutrient required for oxidative and enzymatic processes, but at elevated levels it can disrupt protein synthesis resulting in deformities in developing offspring of fish and birds. Incidences of individuals with deformities consistent with Se toxicity (e.g., S-shaped spines) have been observed in Sacramento Splittail *Pogonichthys macrolepidotus*, a cyprinid endemic to the San Francisco Estuary and its watershed. Juvenile splittail can be exposed to elevated Se through direct ingestion of prey or through maternally-derived yolk. Here, we use scanning X-ray fluorescence microscopy (SXFM) at Cornell's High Energy Synchrotron Source to detect Se and quantify the chronology of Se in otoliths of wild-caught juvenile splittail that display spinal deformities. We evaluate the spatio-temporal distribution of Se in the otoliths and compare the core (maternal) and edge (environmental) to test the pathway of Se exposure. Results of this study demonstrate the utility of otolith tools in ecotoxicology to differentiate among multiple human-mediated sources of elevated Se in the ecosystem that can influence native fishes.

Yolo Bypass: Potential Refuge for Delta Smelt?
Naoaki Ikemiyagi and Brian Mahadja, California Department of Water Resources
Brian Healey and James Hobbs, University of California Davis

The Yolo Bypass, the primary flood basin of the Sacramento River, has been shown to provide valuable habitat for various native fish species such as the Sacramento Splittail *Pogonichthys macrolepidotus* and Chinook Salmon *Oncorhynchus tshawytscha*. However, recent data from the Yolo Bypass Fish Monitoring Program (YBFMP) indicates that the Yolo Bypass may also be an important habitat for the imperiled Delta Smelt (Hypomesus transpacificus) during non-flood periods via the perennially wetted Toe Drain. We examined Delta Smelt catch data from the YBFMP to identify changes in the distribution and abundance of Delta Smelt within the Yolo Bypass. We found that although Delta Smelt have been captured on an annual basis by the YBFMP since its inception in 1998, the annual Delta Smelt catch for our rotary screw trap has increased nearly ten-fold from pre-Pelagic Organism Decline years (POD) to post-POD years. Unexpectedly, we also observed relatively high annual catches of Delta Smelt during the recent drought years (2012-2015). Moreover, we found that juvenile Delta Smelt caught in the Yolo Bypass appear to be larger earlier in the year than those collected by other monitoring programs within the Interagency Ecological Program. Otolith growth increment data suggest that the larger size of juvenile Delta Smelt in the Yolo Bypass was due to higher growth rates in the region relative to the rest of the San Francisco Estuary. Our results suggest that the Yolo Bypass may provide high quality habitat even during drought conditions and could play a crucial role in the future persistence of this imperiled species.

#6. Modeling the Interactions of Aquatic Species and Their Habitat

Moderators: Nicholas Som, Damon Goodman, and Nicholas J. Hetrick, U.S. Fish and Wildlife Service

Coupling Optimal Sampling Designs with Models for the Imperfect Detection to Inform Population Dynamics Models
Nicholas Som and Derek Rupert, U.S. Fish and Wildlife Service

Russell W. Perry and Edward Jones, U.S. Geological Survey
Kyle De Juilio, Yurok Tribal Fisheries
Paul Petros, Hoopa Valley Tribal Fisheries

Evaluations of the characteristics of habitats utilized by various species and life-stages of fish are often used to improve ecological understanding, inform population dynamics models, and evaluate restoration activities. In lotic ecosystems, the relationship between fish use and habitat is often cast in a suitability framework resulting in the familiar habitat suitability indices. These indices fall between 0 (lowest quality) and 1 (highest quality), and methods to create them range from professional judgment to sophisticated statistical models. Frequently, the data that feed these models are based on point-counts. It is well known that observer efficiencies are less than perfect, and therefore, these methods generally don't lead to estimated relationships between metrics that relate to the local abundance of individuals, but instead a relative measure. Ignoring the imperfect detection can be especially problematic when detection probabilities vary based on the physical characteristics of the sampling units. N-mixture models jointly estimate local abundance and detection. We describe our sampling and modeling approach to evaluate the habitat characteristics of juvenile Chinook Salmon of the Trinity River (CA), and how the results can provide ecological inference and seamlessly integrate into population dynamics models.

Essential Elements of Habitat for Modeling Stream Fish Population Dynamics: From Depth and Velocity to Food and Risk

Bret Harvey, U.S. Forest Service Pacific Southwest Research Station
Steven F. Railsback, Lang Railsback & Associates and Humboldt State University

Contemporary approaches to modeling stream fish populations include spatially explicit, individual-based models, in which population-level outcomes emerge from the success of simulated individuals over their lifetimes and multiple generations. In some process-based versions of these models, fitness-seeking virtual individuals select habitat on daily or shorter time steps, considering their physiological condition, the environment, and their competitors. In these models, as in nature, essential elements of habitat are those that strongly affect fitness. This leads modelers away from focusing on physical habitat characteristics per se toward the question: What do animals need in order to survive and reproduce? The process of formulating such individual-based models commonly raises fundamental questions we should already be able to answer but often can't: Do we need to include benthic food or just drift in models that simulate feeding by stream salmonids? How does risk for fish vary with habitat variables such as water depth and distance to cover? Such questions have framed field studies that have improved efforts to develop models capable of informing real-world management decisions and forecasting outcomes under novel conditions.

Trinity River Brown Trout: Harmless Sportfish or Restoration Nightmare?

Justin Alvarez, Hoopa Valley Tribe
Darren Ward, Humboldt State University

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

Current goals of the Trinity River Restoration Program include recovery of tribally important native fishes including Chinook and Coho salmon and steelhead trout [anadromous Rainbow Trout *Oncorhynchus mykiss*]. Brown Trout *Salmo trutta*, a piscivorous species, have been observed eating the native fishes and there is a concern that the non-native population may be hampering recovery efforts.

Until recently Brown Trout in the Trinity River were only investigated incidentally during surveys targeting Chinook and Coho salmon and steelhead trout. These studies have suggested that the Brown Trout population is growing and with this observation there has been increased motivation to conduct a study to quantify their numbers and gather baseline information. The Hoopa Tribe in collaboration with Humboldt State

University and with the cooperation of the California Department of Fish and Wildlife and National Marine Fisheries service is evaluating the status of Trinity River Brown Trout and their impact on the native fishes using a bioenergetics simulation.

Evidence-based Environmental Flow Assessment: The Victorian Approach
John Williams, Mattole Restoration Council

Twenty-one years ago, Castleberry et al. (1996) asserted that "… currently no scientifically defensible method exists for defining the instream flows needed to protect particular species of fish or aquatic ecosystems" (Fisheries 21(8):20-21). We went on to recommend adaptive management, with three elements: protective interim standards, an adequate monitoring program, and a procedure for revising the standards in light of new information. Here, I assert that the situation has not changed, briefly offer some reasons why, and describe an exemplary application of adaptive management in the Australian state of Victoria. In the Victorian approach, flow modeling and exert opinion was used to develop initial flow targets and a hypothesis-based monitoring program, later followed by assessments combining structured expert elicitation, structured literature reviews, and hierarchical Bayesian modeling utilizing the monitoring data.

Moving Beyond PHABSIM: New Directions in Instream Flow Modeling
Steven Railsback, Lang Railsback & Associated and Humboldt State University

The Physical Habitat Simulation component of the Instream Flow Incremental Methodology has been the backbone of instream flow modeling for many decades, but PHABSIM increasingly seems outdated and less useful than other approaches, and instream flow science seems increasingly isolated from advances in ecological modeling in general. The most fundamental concerns arise from the limited usefulness of habitat selection models such as PHABSIM: they do not address time and changes over time, while river science now sees flow variability over time as critical; and they do not make population predictions that are either testable or directly applicable to management questions. Within the field of habitat selection modeling, PHABSIM has not kept up with many advances, down to the fundamental understanding that models need carefully chosen, biologically appropriate spatial scales, and that different species may need to be modeled at different scales. Even if we continue to use habitat selection models, there are substantially better techniques readily available and widely used in wildlife management. Individual-based models are another newer approach that was designed specifically to overcome the weaknesses of PHABSIM; other speakers in this symposium will discuss individual-based models for instream flow management of trout communities, salmon spawning and rearing, and frog breeding. Most importantly, we need to think about instream flows through the eyes of ecologists and the eyes of the species we are protecting: how do different flows provide not "suitability" but food and good growth conditions, protection from predators and other risks, and conditions for reproduction?

Using Models to Predict the Distribution of Invertebrate Hosts of Salmon Parasites
Julie Alexander and J.L. Bartholomew, Oregon State University
Nicholas Som, Damon Goodman, and Nicholas Hetrick, U.S. Fish and Wildlife Service

Infectious diseases caused by parasites having multiple host lifecycles are often poorly understood. However, models can be useful tools for improving our understanding of complex systems. Salmonid population declines in the Klamath River, CA have been attributed to *Ceratonova shasta*, a myxozoan parasite that alternately infects *Manayunkia speciosa* (freshwater polychaete) and salmonids (obligate hosts). The ability to use flow manipulation to mitigate the effects of disease on salmon by reducing polychaete abundance is limited by a need to understand the potential efficacy of such actions. The aims of this study were to predict the distribution of polychaete hosts in three sections of the Klamath River 'infectious zone,' a section of river characterized by elevated densities of *C. shasta*. Two-dimensional hydraulic models (2DHM) were developed for each of three river sections using topographic survey data, water surface elevation profiles, stage-discharge relationships, and spatial maps of substrate. The 2DHMs were used to describe hydraulic variation (predict depth, velocity, and shear stress) and stratify polychaete sampling locations across gradients of depth and velocity within substrate classes. Benthic samples collected in July 2012 were used to

build predictive models of polychaete distribution. Our results show that polychaete distribution is associated with substrate, as well as depths and velocities predicted from the 2DHMs during the previous water year's peak discharge. We evaluated model performance against independent datasets collected in other water years, including a high magnitude flood. Our results suggest that manipulating the hydrograph may influence distribution of polychaete hosts. This in turn may influence *C. shasta* prevalence in polychaetes and risk of infection in salmonids. Our study provides a tool that allows us to predict how polychaete distribution may respond to flow modification at the study sites and evaluate the potential efficacy of proposed flow management scenarios to affect polychaete hosts.

Foothill Yellow-Legged Frog Assessment Model (FYFAM): An Example Application

Don Ashton and Scott McBain, McBain Associates
Steven F. Railsback, Lang Railsback & Associates and Humboldt State University

The Foothill Yellow-legged Frog (*Rana boylii*, FYF) relies on river edgewaters for reproduction, timing its oviposition with hydrograph cycles to minimize scour and desiccation risks to eggs while maximizing development time for offspring. Individual frogs initiate breeding using a suite of environmental cues. Dams can decouple the hydrology, hydraulics, and thermal regimes from other natural environmental cues, hampering oviposition choices of breeding FYF and thus diminishing reproductive success. Managing water resources for biotic benefits downstream requires insight on how organisms will respond to alternative flow release schedules. Climate and flow modeling simulations are often used to predict river conditions under a given flow release schedule and set of meteorological conditions. The Foothill Yellow-legged Frog Assessment Model (FYFAM, developed using support from US Forest Service) uses water temperature, depth, and velocity outputs from hydrologic, hydraulic, and water temperature models to assess potential differences in reproductive success under various hydrograph scenarios. FYFAM uses cell-specific environmental inputs and probabilities to simulate decisions by virtual frogs and tadpoles, and predicts developmental rate of eggs and tadpoles on a daily time step. Currently, FYFAM simulations end at metamorphosis. Number of froglets produced per breeder and median date of metamorphosis are the metrics used for comparing hydrograph scenarios. As an example, we applied FYFAM to a time series of hydrograph scenarios, based on actual meteorological conditions in California's Upper Tuolumne River. Model results suggest springtime water temperature and timing of high flows interact to influence reproductive success for this river-breeding frog.

Mortality of Central Valley Chinook Salmon Smolts Relative to Physical Habitat Features

Mark Henderson, U.S. Geological Survey
Ilysa Iglesias, Cyril Michel, and Andrew Pike, University of California Santa Cruz
David Huff, Eric Danner, and Sean Hayes, National Oceanic and Atmospheric Administration

Spatial variability of Chinook Salmon *Oncorhynchus tshawytscha* smolt survival in California's Central Valley has been ascribed to basin wide fluctuations of flow, temperature, water management and predation. We utilized five-years of acoustic telemetry data for late-fall run Chinook Salmon in the Sacramento River to evaluate the effect of temporally stable physical habitat features (e.g., diversion density), individual specific spatio-temporal factors (e.g., flow), and individual fish attributes (e.g., condition) on overall survival during their outmigration to sea. To estimate habitat conditions experienced by individual fish in each reach we used a 1-dimensional physical model that estimates temperature and flow ever 15-minutes at a 1 km spatial resolution. We used these data as individual time-varying covariates in a Cormack-Jolly-Seber mark-recapture model to estimate survival rates. Results indicate that the best predictors of smolt survival were flow, diversion density, off-channel habitat, individual swim speed, fish condition, sinuosity, and whether or not a fish was released at the same time as large hatchery releases. With the exception of sinuosity, the relationship between each covariate and survival was positive. These results indicate that smolt survival increased in the lower, more modified, regions of the river. We hypothesize that this is due to decreased predation rates in the deeper, more channelized, sections of the river.

Developing Flow-Floodplain Area Relationships for Central Valley Streams

Mark Gard, U.S. Fish and Wildlife Service

A variety of methods were used to develop flow-floodplain area relationships for 26 Central Valley streams, as an input to the Central Valley Project Improvement Act fall-run Chinook Salmon structured decision model. For the Yuba, Tuolumne and Stanislaus Rivers, flow-floodplain area relationships were developed using the results of two-dimensional hydraulic models. For the Sacramento River, flow-floodplain areas were from the NMFS winter-run Chinook Salmon life-cycle model. In addition, I used simplified HEC-RAS models that were extracted from the CDWR Central Valley Flood Evaluation and Delineation (CVFED) Program HEC-RAS models to develop flow-floodplain area relationships. For the remaining streams, flow-floodplain area relationships were developed from LANSET imagery.

What Does Habitat Monitoring Data Mean to Salmonids? Creating Status, Trend, and Recovery Information From Field Data
Sean Gallagher, California Department of Fish and Wildlife

Recovery management requires information on key habitat metrics generated from design based monitoring where data are collected in the field, converted into metrics and these metrics used to generate information. The information generated as high level indicators of salmonid habitat condition can be viewed as the raw material of knowledge necessary for informed management. Commonly used salmon habitat assessment procedures provide a great deal of specifics about what habitat variables to measure and how to measure them, yet are less informative on what the results mean for fish. Current habitat sampling methods accomplished this by comparing habitat variables from stream surveys to generalized ratings or legally defined threshold values which are based on professional judgment and use qualifiers such as desirable and undesirable as criteria. It is difficult to estimate status or monitor the trends in categorical qualifiers. Therefore there is a need for quantitatively derived indicators of salmonid habitat. I will discuss various approaches to developing information and high level indicators of salmon habitat with examples from our current work in Coastal Mendocino County, California.

#7. Using Ecohydrology to Establish Flow Recommendations for California Streams

Moderators: Joseph Merz, Cramer Fish Sciences and University of California Santa Cruz and Kelly Souza, California Department of Fish and Wildlife

Overview of a Three-Tiered Framework for Establishing Environmental Flows for California Streams
Eric Stein, Southern California Coastal Water Research Project
Sarah Yarnell and Sam Sandoval, University of California Davis
Julie Zimmerman and Jeanette Howard, The Nature Conservancy
Ted Grantham, University of California Berkeley
Larry Brown, U.S. Geological Survey

Establishing environmental flow targets to protect biological communities is a priority for numerous programs in California. Although methods vary, each effort aims to achieve similar goals of stipulating flow conditions necessary to protect ecological integrity in light of competing water uses, such as agricultural production (including cannabis), hydropower and dam operation, timber harvest, urban water reuse, consumptive uses (including groundwater extraction), or runoff management. Methods vary based on the ecological endpoint of management concern (e.g. fish, macroinvertebrates, habitat), stream type, and preferences of the implementing agency, and include a variety of established methods, such as Physical Habitat Simulation (PHABSIM), Instream Flow Incremental Methodology (IFIM), functional flows, Ecological Limits of Hydrologic Alteration (ELOHA), and minimum percent of flow. A statewide technical workgroup consisting of UC Davis, Southern California Coastal Water Research Project, The Nature Conservancy, UC Berkeley, and the U.S. Geological Survey has convened to develop a framework for organizing environmental flow analyses across California and provide consistent science-based recommendations for applying appropriate methods to inform setting and managing of environmental flows. A central goal of this framework is to improve the ability to coordinate statewide and local efforts, provide guidance on methodology, share data and tools, and produce consistently interpretable environmental flow

recommendations. This talk will provide an overview and introduction to the three-tiered approach that the workgroup has developed for establishing environmental flows in California. Subsequent talks in this session will provide details and examples of the tools and sample applications of the framework.

Quantifying Reference Hydrologic Conditions for California Streams

Belize Lane and Sam Sandoval, University of California Davis
Eric Stein, Southern California Coastal Water Research Project

Defining environmental flow targets for California rivers is complicated by extreme hydrologic variability and an intensive water and land management legacy. Improved understanding of the diversity of natural streamflow patterns and their spatial arrangement across the state is needed to support the future development of effective environmental flow targets at appropriate scales for management applications with minimal resource and data requirements. This talk outlines the development of a spatially explicit reach-scale stream classification for the State of California culminating from two distinct classification studies based on unimpaired streamflow time-series and geospatial information related to climate, topography, geology, and soils. The resulting classification system identifies nine natural flow classes representing distinct flow sources, hydrologic characteristics, and catchment controls over rainfall-runoff response in California. Dimensionless reference hydrographs were generated to characterize the distinct seasonal patterns and daily within-class variability of each natural flow class. This final integrated stream classification and associated dimensionless hydrographs provide a broad-scale hydrologic framework upon which flow-ecology relationships can be established for the State.

Developing Tier 1 Environmental Flow Targets Using a Functional Flow Approach

Sarah Yarnell, Sam Sandoval, Belize Lane, Rob Lusardi and Jay Lund, University of California Davis
Eric Stein, Southern California Coastal Water Research Project
Julie Zimmerman and Jeanette Howard, The Nature Conservancy
Ted Grantham, University of California Berkeley
Larry Brown, U.S. Geological Survey

Establishing environmental flow targets is a priority for numerous programs in California. Building on previous environmental flow discussions and a growing recognition that hydrogeomorphic processes are inherent in the ecological functionality and biodiversity of rivers, we propose a functional-flows approach to rapidly develop statewide environmental flow recommendations. The approach focuses on retaining specific process-based components of the hydrograph, or functional flows, rather than attempting to mimic the full natural flow regime. Key functional components include wet-season initiation flows, peak magnitude flows, seasonal transition recession flows, dry-season low flows, and interannual variability. The method defines a set of quantitative flow metrics based on the reference or unimpaired hydrologic conditions for each of the California stream classes defined by Lane et al. and Pyne et al. Using "dimensionless reference hydrographs", which are scalable representations of the statistical variability in unimpaired flows within a stream class, we calculate the range of values for specific flow metrics that represent components of the hydrograph associated with critical ecological or hydrogeomorphic functions. The values for each functional flow metric can then be appropriately scaled to a stream of interest and serve as initial Tier 1 flow management targets. Tier 1 flow targets can be further refined by additional site-specific analyses under Tier 2 approaches as defined in the California Environmental Flows Framework. We suggest this approach allows for the rapid development of flow regimes that encompass ecosystem processes alongside varied human needs and can be applied in an adaptive management framework allowing for changing conditions and needs.

Predicting Functional Flows at Ungaged Locations

Ted Grantham, University of California Berkeley
Daren Carlisle, Ken Eng, and David Wolock, U.S. Geological Survey
Eric Stein, Southern California Coastal Water Research Project
Jeanette Howard, The Nature Conservancy

The dependence of riverine biota on streamflow variability, including the timing, magnitude, duration and frequency of flows, is now well-recognized among river scientists and managers. A multitude of hydrologic metrics have been developed to describe the attributes of natural flow regimes, quantify flow alteration, and

provide the hydrologic foundation for the development of environmental flow standards. Many applications require the use of models to predict expected values of hydrologic metrics, for example, when estimating flows at ungaged sites or at sites that have been altered by human land- and water-use activities. We demonstrate how hydrologic models can be used to predict functional flow metrics at streams in California, by relating observed flow patterns at U.S. Geological Survey reference gages with physical basin characteristics, including topography, soils, geology, and climate. We evaluate model uncertainty in predicting different functional components of the flow regime and consider how these models can be used to support environmental flow management.

Estimating Unimpaired Streamflow for California Streams and an Initial Analysis of State-Wide Streamflow Impairment

Larry Brown, Daren Carlisle, and Jason May, U.S. Geological Survey
Julie Zimmerman, Jeanette Howard, and Kirk Klausmeyer, The Nature Conservancy
Ted Grantham, University of California Berkeley

Understanding the natural temporal dynamics of streamflow is critical in assessments of streamflow alteration. Because natural patterns of streamflow are a fundamental property of the health of streams, there is a critical need to quantify the degree to which human activities have modified natural streamflow. We developed empirical models that predict natural monthly flows, annual maximum daily flow, and annual minimum daily flow in streams and rivers from 1950 onward across all stream segments in California, USA. For model development, we screened 1800 U.S. Geological Survey gage sites statewide to select sites that had a minimum of 5 years of streamflow data and minimal land use and hydrologic infrastructure. Our final data set consisted of 250 least-impacted sites to construct our reference hydrology models. Statistical models were developed using monthly streamflow, natural watershed features such as soil and terrain characteristics, and antecedent monthly precipitation data. We then applied the models to monthly precipitation data (1950-2015) and natural watershed features for the 139,912 stream segments defined by the National Hydrography Dataset within the boundaries of California. We compared estimated values of our flow metrics with values calculated from observed flow at 540 gages that had at least 5 years of flow records in the period 1996 to 2015. The comparisons suggest that flow alteration is pervasive in California streams. Only 9% of the 540 gages showed no evidence of alteration of monthly flows. Slightly less than 25% of the gages showed no evidence of change in annual maximum and minimum daily flow. Overall, the data suggests loss of high and low flows and loss of natural seasonal variability. Results from analyses of these data could be linked with conservation assessments of freshwater biodiversity to prioritize watersheds with unimpaired flow regimes for protection or watersheds with impaired flow regimes for restoration.

#8. Examples of Environmental Flow Applications

Moderator: Kelly Souza, California Department of Fish and Wildlife

Development of Environmental Flows and Flow-Ecology Relationships: Examples and Applications Across the U.S.

Julie Zimmerman and Jeanette Howard, The Nature Conservancy
Eric Stein, Southern California Coastal Water Research Project
Sarah Yarnell, Sam Sandoval, Belize Lane, Rob Lusardi and Jay Lund, University of California Davis
Ted Grantham, University of California Berkeley
Larry Brown, U.S. Geological Survey

Defining environmental flows to support river-dependent biota is a key strategy for scientists and managers in California and across the nation. The science of environmental flows began with hydrologic index methods and rules of thumb and evolved into hydraulic rating methods and site-specific studies that focused on flow-habitat relationships for individual species and life stages. Over time, scientists have increasingly focused on regional and multi-species approaches to defining environmental flows, with the understanding that faster progress toward developing flow criteria is needed to protect declining native freshwater biota. Current regional approaches include the Ecological Limits of Hydrologic Alteration (ELOHA) framework, based on a spatially comprehensive

hydrologic foundation and generalized flow-ecology relationships that can be applied across a region to establish environmental flow standards, and the functional flows approach, focused on identifying and retaining specific components of the flow regime that support key ecological functions. This presentation will provide an overview of flow-ecology approaches and the development of environmental flows and flow-ecology relationships from around the country and places them within the context of a tiered approach to determining environmental flow needs. Ultimately, the appropriate approach depends on the decision context, including the spatial scale of the application, management needs and complexity, information available, time available to make the decision, and specific objectives for the species or ecosystems of interest. The first steps to any environmental flows assessment are to define the decision context and determine specific management objectives.

Development of Recommended Flow Targets to Support Biological Integrity Based on Regional Flow-Ecology Relationships for Benthic Macroinvertebrates in Southern California Streams

Eric Stein, Rachel Mazor and Ashmita Sengupta, Southern California Coastal Water Research Project
Brian Bledsoe, University of Georgia Athens
Jason May, U.S. Geological Survey

Changes to instream flow are known to be one of the major factors that affect the health of biological communities. Regulatory, monitoring, and management programs are increasingly using biological community composition, particularly benthic invertebrates, as one measure of instream conditions, stormwater project performance, or regulatory compliance with National Pollutant Discharge Elimination System (NPDES) or other requirements and regulations. Understanding the relationship between changes in flow and changes in benthic invertebrate communities is, therefore, critical to informing decisions about ecosystem vulnerability, causes of stream and watershed degradation, and priorities for future watershed management. We applied to the Ecological Limits of Hydrologic Alteration (ELOHA) framework to develop regional flow-ecology relationships and targets based on responses in the benthic macroinvertebrate community. Our objectives were: 1) Develop a recommended set of flow targets for southern California streams that would maximize the likelihood of maintaining healthy biological communities as indicated by the California Stream Condition Index (CSCI) for benthic invertebrates. 2) Produce a set of tools that can be readily applied to future sites to estimate hydrologic alteration relative to biologically-defined targets. Development of the regional flow-ecology relationships relied on an ensemble of hydrologic models to estimate flow alteration at ungauged sites, and took advantage of a regional bioassessment data that allowed us to assess flow-ecology relationships at broad spatial scales. Our general approach involved developing a hydrologic classification for the entire State of California, calibrating and validating watershed models for the stream classes present in southern California, using the models to assess hydrologic change at 572 bioassessment sites, relating hydrologic change to biological responses, setting targets based on likelihood of biological response associated with changes in key flow metrics, applying the flow-ecology tools to assess regional hydrologic condition, and prioritizing sites for various management actions based on their response relative to the established flow targets.

Ecologically Meaningful Flows: Hydrograph Classification Beyond the Physical Realm

Joe Merz, Cramer Fish Sciences and University of Santa Cruz
Rocko Brown, Environmental Science Associates

The science of flow estimation has allowed us to make significant contributions to understanding river dynamics, flood control, channel maintenance and riverine ecology. However, flow estimate methodology can have resounding effects on management decision outcomes particularly when discussing differences between estimating physical and biological responses that are ephemeral in nature. A primary issue in defining meaningful flows is that hydrologists and ecologists discuss hydrology in fundamentally different ways. Hydrologists tend to use monthly or annual averages and flood frequency distributions to characterize stream conditions. Ecologists often focus on timing and duration of annual flood pulses and low flow extremes, rates of water levels rise and fall and in turn, habitat connectivity during periods that are meaningful for the streamscape's flora and fauna. These disturbances produce a dynamic equilibrium of erosion and sedimentation processes, resulting in high habitat

diversity. Hypothetically, flood disturbances are essential to river and floodplain health because they initiate succession and foster biodiversity by enabling weak competitors to coexist (flood pulse and intermediate disturbance hypotheses). Identifying hydrograph measurements useful to both practitioners of river form and ecological function are therefore important undertakings that greatly benefit restoration efforts. In this presentation, we will compare several key measurements of river flow documented in the scientific literature using flow information from California Mediterranean climate streams. We then discuss several ecologically-based flow estimates that are more meaningful to target organisms within a given watershed (Ecologically Meaningful Flow). Specifically, we will contrast hydrologic analyses for large river engineering, geomorphic, and ecological applications and define the minimum fidelity needed in a hydrologic time series to capture ecological dynamics. We will provide examples focusing on Pacific salmonids to define quantitative indices used to represent flow variability and illustrate the use of these tools on two large California rivers that have varying hydrologic regimes and anthropogenic controls.

Managing Diversions in Unregulated Streams Using a Modified Percent-of-Flow Approach

Darren Mierau, California Trout
William Trush, Humboldt State University and River Institure
Gabriel Rossi, University of California Berkeley
Jennifer Carah and Jeanette Howard, The Nature Conservancy
Matthew Clifford, Trout Unlimited

In Mediterranean-type river systems, naturally low seasonal stream flows are often overexploited, which has implications for managing flows for environmental as well as human needs. Traditional approaches to instream flow management are not well suited to unregulated systems with strong seasonal patterns of water availability and many water diverters, and are challenging to implement in such systems. They often do not protect the full range of variability in the annual hydrograph, require extensive site-specific data, expensive modeling, or both. In contrast, holistic flow management strategies, such as Percent of Flow (POF) strategies are designed to protect multiple ecological processes and preserve inter-annual flow variability. However, POF approaches typically require real-time streamflow gaging, and often lack a robust metric relating a diversion rate to ecological processes in the stream.

To address these challenges, we present a modified percent-of-flow (MPOF) diversion strategy where diversions are allocated from a streamflow baseline which is derived from a regional relationship between a conservative streamflow-exceedance and date. The streamflow baseline remains the same from year to year, and is independent of water-year type. This strategy protects inter-annual flow variability and provides a predictable daily allowable volume of diversion at any diversion point – supporting efficient water management planning. The allowable diversion rate in the MPOF strategy is based not on a fixed percentage of the ambient streamflow but rather on a maximum allowable percentage change in riffle crest thalweg depth, an ecologically-meaningful, common hydraulic measurement. This presentation will demonstrate that the MPOF approach is a holistic approach well suited to manage diversions in unregulated streams typical of California's Mediterranean-type coastal watersheds.

State Water Board's Regulatory Efforts to Develop Instream Flows for Cannabis Cultivation and the California Water Action Plan

Daniel Schultz, California State Water Resources Control Board

Legislation requires the State Water Resources Control Board (State Water Board), in consultation with the California Department of Fish and Wildlife (CDFW) and California Department of Food and Agriculture, to ensure that individual and cumulative effects of water diversion and discharge associated with cannabis cultivation do not affect instream flows needed for fish spawning, migration, and rearing, as well as flows needed to maintain natural flow variability. The State Water Board, in consultation with CDFW, is charged to adopt principles and guidelines (requirements) for the diversion and use of water for cannabis cultivation. The principles and guidelines may apply to groundwater extractions and shall include measures to protect springs, wetlands, and aquatic habitats from negative impacts of cannabis cultivation. The State Water Board is developing a policy for water quality control to establish interim principles and guidelines for cannabis

cultivation. The draft policy is anticipated to be released for public comment in May 2017 and the final policy is anticipated to be brought to the State Water Board for adoption in the fall of 2017.

The 2014 California Water Action Plan (WAP) directed the State Water Board and CDFW to implement a suite of actions to enhance flow statewide in at least five stream systems that support critical habitat for anadromous fish. Through a coordinated effort, the State Water Board and CDFW identified five priority stream systems as a starting point for the WAP effort. The five stream systems identified are: Mark West Creek (tributary to Russian River), Mill Creek (tributary to Sacramento River), Shasta River, South Fork Eel River, and Ventura River.

#9. Salmonid Restoration and Monitoring

Moderator: Farhat Bajjaliya, California Department of Fish and Wildlife

Environmental Factors Associated with the Upstream Migration of Fall-Run Chinook Salmon and Steelhead on the Stanislaus

Matt Peterson, Andrea Fuller, and Doug Demc, FISHBIO

We operated a resistance board weir combined with a Vaki Riverwatcher infrared camera system during the Chinook Salmon *Oncorhynchus tshawytscha* fall-run migration period from 2003 to 2016 on the Stanislaus River. The approach provided accurate daily counts of fall-run Chinook Salmon and steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*] on their spawning migration. Information theoretic and multimodel inferential approaches, as well as generalized additive models, were used to assess the relative importance of water temperature, flow, moon illumination, dissolved oxygen, weather, and several management actions to explain the migratory patterns of Chinook Salmon and steelhead observed at the weir. Precipitation events and the installation of a rock barrier in the lower reaches of the San Joaquin River had positive and consistent influences on counts of Chinook Salmon. Although managed pulse flows have been used since the early 1990s, they only rarely appeared in the top generalized linear models. Additionally, the response was not sustained, lasting only a few days and representing a small portion of the total run. Strong non-linear responses between migratory activity and discharge levels were observed for both species, indicating no additional increases in daily proportions of Chinook or the probability of observing an adult steelhead when pulse flows exceeded about 20 m3/s. Adult steelhead were more likely to be observed only when downstream dissolved oxygen levels and temperatures reached suitable levels. Adjusting the magnitude, duration, and seasonal timing of managed pulse flows should be considered especially during periods of drought, as it may balance the migratory requirements of anadromous salmonids and societal needs. Further, conservation of water during the fall could be used for fisheries needs in the form of increased carryover storage to maintain cooler water temperatures in the upstream reservoir and/or released as larger or longer duration pulse flows during the spring outmigration period.

Comparison of Night vs. Day release of Marked Chinook Salmon Juveniles for Determining Smolt Trapping Efficiencies and Population Estimates

Michael Sparkman, California Department of Fish and Wildlife
Robert Van Kirk, Henry's Fork Foundation

Quantifying the number of anadromous salmonid smolts migrating to the ocean can offer critical insights into population dynamics and stock performance in freshwater. Downstream migrant traps and mark-release-recapture experiments are typically used to determine smolt population abundances. Most smolts migrate downstream during nocturnal hours, however, few studies have addressed whether or not there are differences in recapture rates when marked fish are released during the day or night. We performed mark-release-recapture experiments using 0+ Chinook Salmon (ocean-type) on 13 sample dates between April 20, 2016 and June 29, 2016. On each sample date, two groups of marked fish were released upstream of the smolt trap, one during the day and another at night. This design allowed for control of extraneous factors that may vary across dates, making the statistical analysis a paired comparison. Difference in efficiency between day and night release was tested with mixed-effects logistic regression, and sample date was treated as a random effect to control for variability across dates. We used likelihood ratio test (Chi-square approximation) to assess the significance of release. We

found that although day release and night release efficiencies were highly correlated (r = 0.86), mean capture efficiency varied substantially across sampling dates. Daytime release efficiencies were negatively biased, from -2.70 to -63.6%. The effect of release time was significant (P < 0.001), and estimated capture efficiencies were 32.6% for daytime release and 50.5% for nighttime release. The smolt population abundance estimate using daytime releases was positively biased by 48% compared to the population abundance using nighttime releases. The error term (95% CI or CV) for the abundance estimate using daytime releases was 54% greater than if using nighttime releases. We found that daytime releases overestimated the population abundance, and with greater error terms compared to nighttime releases.

Using Didson to Monitor Chinook and Steelhead Escapement in the Smith River, Del Norte County, California, 2014-2015

Zack Larson, Zack Larson & Associates

Dual Frequency Identification Sonar (DIDSON) was used to count adult anadromous fish migrating through the lower Smith River, Del Norte County, California during the 2014-2015 spawning season. Two long-range DIDSON units operated continuously at river mile 6 for 180 days from 23 Sep 2014 to 31 Mar 2015. Daily DIDSON fish counts were compared to hatchery weir counts at Rowdy Creek, a Smith River tributary located 2 miles downstream from the DIDSON station. A systematic hourly sampling rate of 20 minutes per hour was applied to the entire data set. DIDSON telephoto lenses and software were used to generate length frequency information throughout the season. Two approaches were taken to apportion DIDSON counts for estimating Chinook Salmon *Oncorhynchus tshawytscha* and steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*] escapement; historical angler survey catch data and a cutoff date based on Rowdy Creek weir data. Using DIDSON to monitor Chinook and steelhead escapement to the Smith River should continue in order track trends fish abundance, improve management of recreational fisheries and maintain the fisheries into the future.

Response of Steelhead/Rainbow Trout *Oncorhynchus mykiss* Populations to Debris Flows

Jason White and Bret Harvey, U.S. Forest Service Pacific Southwest Research Station

To better understand the effects of debris flows on salmonid populations, we studied juvenile steelhead/rainbow trout *Oncorhynchus mykiss* populations in six streams in the Klamath Mountains of northern California: three affected by debris flows on January 1, 1997 and three that experienced elevated streamflows but no debris flows. We surveyed habitat and fish in study reaches on all six streams in September for three years following the disturbance. Pool depths, substrate size and substrate embededdness varied among streams but with no clear patterns to distinguish debris-flow from no-debris-flow streams. However, the debris-flow streams had significantly less canopy cover and significantly more woody debris. Debris-flow streams did not differ from no-debris-flow streams in biomass and numeric densities of both young-of-year and age 1 and older (age 1+) O. mykiss. In debris-flow streams in the first year following the debris flows (1997), we observed low numbers of age 1+ O. mykiss and variable year-class strength of young-of-year fish. In 1997, the young-of-year cohort in one debris-flow stream exhibited exceptional growth. In all three debris-flow streams, age 1+ biomass increased each year through 1999 when total *O. mykiss* biomass in the debris-flow streams exceeded that in the no-debris-flow streams. Surprisingly, we collected larval coastal giant salamander *Dicamptodon tenebrosus* in all streams in all years. We suspect the recovery of juvenile *O. mykiss* following the debris flows may have been hastened by increased productivity stimulated by clearing of dense, alder-dominated riparian corridors while salamanders likely recolonized from nearby unaffected tributaries.

***Oncorhynchus mykiss* Cover Availability and Use in Southern California Streams**

Kathryn Carmody and Yi-Jiun Jean Tsai, Pacific States Marine Fisheries Commission
Benjamin Lakish, California Department of Fish and Wildlife

Oncorhynchus mykiss is the only salmonid to reside in southern California and is endangered as a result of habitat loss and degradation. As part of an ongoing monitoring program, stream systems throughout the Santa Barbara and Ventura counties have been surveyed to document habitat characteristics and

relative abundance of *O. mykiss*. However, few studies have addressed fine-scale habitat use by *O. mykiss* in this region, including the use of habitat features that may provide shelter or protection from predators. In this study, we assessed the availability and use of cover by *O. mykiss* in six southern California streams using snorkel surveys. Specifically, we examined the percentage of different cover types comprising the total available cover within habitat units, as well as the number of *O. mykiss* observed in these cover types. We found that boulders comprised the greatest percentage of cover available, and that *O. mykiss* were most often observed using boulders within the stream systems sampled. These results suggest that boulders may play an important role in providing cover and contributing to the habitat complexity favored by *O. mykiss*. However, additional sampling is needed to support these results. Such studies are important to documenting and understanding fine-scale habitat use by the southern California *O. mykiss* populations.

Restoring Wild Fish Abundance to the Eel River: High-Priority Projects to Increase Salmonid Habitat Capacity

Darren Mierau, California Trout

The Eel River once sustained large populations of Chinook Salmon *Oncorhynchus tshawytscha* and Coho Salmon *Oncorhynchus kisutch*, winter and summer steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*], and coastal Cutthroat Trout *Oncorhynchus clarkii*. Pacific Lamprey *Entosphenus tridentatus* and Green Sturgeon *Acipenser medirostris* are also recognized as important native species. Yoshiyama and Moyle (2010) conducted an historical review of Eel River anadromous salmonids in which they estimated combined annual salmon and steelhead runs historically exceeded one million adult fish in good years (~800,000 Chinook salmon, ~100,000 coho salmon, ~150,000 steelhead). Contemporary salmonid abundance is 'guestimated' to be in the range of 20,000 to 50,000 adult fish.

CalTrout's campaign to bring back wild fish abundance to the Eel River is founded upon a comprehensive 'Headwaters to Sea' strategy that embraces restoration or enhancement of tidal marsh and wetland habitat across the Eel River Delta, opening access to natal spawning and rearing habitat through the removal of fish migration barriers (e.g., tidegates, culverts), restoring and protecting public trust stream flows through a broad regional water management strategy, and addressing impacts resulting from Pacific Gas and Electric's Eel River Dams (Potter Valley Project).

Removal of passage barriers is a well-established restoration strategy to increase habitat capacity. This presentation will focus on CalTrout's ongoing barrier removal projects, including: (1) a partnership with The Wildlands Conservancy to modify the historic Cutoff Slough tidegates and install new tidegates into a 100 acre 'Inner Marsh', (2) removal of passage barriers caused by Northwest Pacific Railroad (NWPCo) crossings at Bridge Creek (Humboldt County) and Woodman Creek (Mendocino County), (3) assessing fish passage feasibility at relict structures left by the historic Cedar Creek Fish Hatchery, and (4) assessing current salmon and steelhead habitat capacity in the 288 mi^2.

20 Years of Stream and Salmonid Work in Sonoma Creek Watershed

Caitlin Cornwall, Mark Newhouser, and Richard Dale, Sonoma Ecology Center

We will describe major findings, lessons learned, and new directions from 20 years of collaborative stream and salmonid work in Sonoma Creek watershed, led by Sonoma Ecology Center. This is an anchor watershed for steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*] recovery in the Bay Area, and is also home to Chinook Salmon, California freshwater shrimp, and beaver. We have serious groundwater decline. Streamflows are too fast in the winter and too low in summer and fall, accompanied by pervasive channel incision. Parcel density is very high. The human footprint is growing slowly yet continuing a long history of increasing drainage network density. Still, people here value Sonoma Valley as a beautiful, presumably healthy, rural place. We have worked with others to conduct a wide variety of monitoring, research, planning, restoration, and education activities over the last decades, usually taking steelhead as the primary indicator of watershed health. Several focused years of work culminating in a steelhead limiting factors analysis pointed to rapid runoff, increased drainage network density, and incision as major problems, independent of any particular land use. Recently, we have added water quantity concerns (groundwater, streamflow) to our portfolio, hoping to use SGMA to enhance flows. We seek funding to join the Coastal Monitoring Program, looking first to conduct spawner surveys and relate

those results to streamflow studies. In other efforts to plan stormwater capture and/or groundwater recharge projects that would benefit stream biota, we and others are hampered by limited resources for watershed assessment, and by the difficulties of working in a highly parcelized, largely privately owned watershed. Looking ahead, we see alliances with non-environmental sectors of our community as crucial to achieving environmental successes. We are building ever broader partnerships and communicating more about the pride and the payoffs that a healthy environment brings to people who live and work here.

Lawrence Creek Off-Channel Habitat Restoration and Monitoring

Bob Pagliuco and Leah Mahan, National Oceanic and Atmospheric Administration Restoration Center
Matt Goldsworthy, Margaret Tauzer, Doug Chow, National Marine Fisheries Services, West Coast Region
Liz Perkins, Ocean Associates
Keith Lackey, Humboldt Redwood Company

Juvenile Coho Salmon seek slow velocity areas as rivers rise during storm events, and studies have shown a significant increase in the growth and survival of juvenile Coho Salmon who occupy off channel habitats for refuge or rearing opportunities. These habitats have become limited in availability due to a number of factors, including channelization and loss of wetlands. In 2014, the Humboldt Redwood Company (HRC) identified an abandoned secondary channel that had the potential to become off channel habitat in Lawrence Creek and asked the National Marine Fisheries Service (NMFS) to partner on the project. NMFS conducted the physical surveys, created the design, and a small competitive internal grant from NOAA provided part of the funding for construction of the project. HRC procured all of the permits, donated several days of heavy equipment and operator's time, and provided several large logs with substantial root wads to build the off channel structures.

In September of 2015, over 2,000 cubic yards of sediment was excavated and removed to create an off-channel pond that is approximately ¼ acre in size and 150 feet long by 45 feet wide. The pond was built to provide a diversity of habitat types and conditions to maximize potential food resources and other ecosystem benefits. The pond was designed with the outlet sill positioned near the 35% exceedance flow elevation, which provides connectivity and flow from Lawrence Creek for approximately 120-days of the year.

The NOAA Restoration Center has been monitoring water quality parameters (DO and Temperature) and salmonid presence and growth through the use of minnow traps and PIT tags on a monthly basis since the project was completed. This presentation will provide details on the planning, design, implementation and monitoring results of the first constructed off channel feature in the Van Duzen River Watershed.

Water Conservation and Off-Channel Storage to Restore Instream Flows in Sonoma County and Associated Biological Monitoring

Sierra Cantor and John Green, Gold Ridge Resource Conversation District

Lack of sufficient streamflow can be a critical issue during the late summer and fall in Coho Salmon *Oncorhynchus kisutch* and steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*]habitat streams in Sonoma County. The relatively high population density and extensive agriculture of the North Bay create elevated water demand during the dry season, when streamflow is already low. This temporal mismatch tends to mask the fact that the problem is not one of water shortage, but a failure in water management. The Gold Ridge RCD and our partners are working to improve summer flows in these streams while increasing water supply security using a range of methods. We are working with the Russian River Coho Partnership on science-based approaches to identifying restorable flow-impaired stream reaches, quantifying critical instream flow thresholds for coho in these reaches, and using that information to identify, plan and implement a variety of water management projects. These projects include implementation of water conservation measures to reduce water demand; installation of irrigation efficiency measures; development of alternative water sources, including rainwater catchment; provision of water storage so that water can be diverted during times of high flow for use during the dry season; and adjustments to the timing and rate of diversion. We believe the science shows that with careful management, it is possible to provide for both human water needs while not impairing habitat for threatened and endangered salmonids.

Another vital tool for restoration planning is biological monitoring to assess spatial and temporal salmonid use throughout the watershed. Habitat assessments, wet-dry mapping, snorkeling and spawner surveys have been used to determine the occurrence of viable habitat and the presence/ absence of Coho Salmon at various life stages and their relative abundance and distribution.

Restoring Access to Pristine Salmonid Habitat in a Tributary to Sonoma Creek

Lauren Hammock and Lucas Walton, Prunuske Chatham, Inc
Tony Nelson, Sonoma Land Trust

Stuart Creek, a tributary to Sonoma Creek in eastern Sonoma County, was known by old-timers to be a good place to catch steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*]. Agency fisheries biologists consider its upper reaches to have some of the best steelhead habitat in the Sonoma Creek watershed. Nearly all of the anadromous portions of Stuart Creek are preserved in public trusts and conservation easements. In 2014, Sonoma Land Trust modified three man-made barriers and re-established fish passage to over 2 miles of high-quality spawning and rearing habitat. The three barriers included a concrete box culvert, a 6-foot headcut at a concrete bridge foundation, and a historic flashboard dam with a 3-foot high perched spillway. This presentation will describe each of the barriers, the site specific constraints, the designs, and post-construction results. A focus will be how the designs addressed balancing geomorphic stability and dynamic processes, minimizing infrastructure risk, maintaining existing instream habitat features, and accommodating public access.

Long-Term Trend Analysis of the Effects of Restoration on Salmon Rearing Habitat in the Restoration Reach of the Trinity River at Summer Base (12.7 m3s-1) Streamflow, 2005-2015

Josh Boyce, Damon Goodman, Nicholas A. Som, U.S. Fish and Wildlife Service
Justin Alvarez, Hoopa Valley Tribal Fisheries
Aaron Martin, Yurok Tribal Fisheries Department

The Trinity River Restoration Program (TRRP) seeks to increase juvenile salmonid rearing habitat, among other restoration objectives, by implementing mechanical channel rehabilitation. Short-term monitoring of select rehabilitation sites has documented increases in rearing habitat as a result of channel construction activity; however, a companion study failed to detect improvements between 2009 and 2013 at a 64-km restoration reach scale. Here, we assessed the effect of construction at summer base (12.7 m3s-1) streamflow, from 2005-2015, at 13 rehabilitation sites surveyed before and after construction. We also developed a sub-sampling protocol to assess trends in the amount of rearing habitat at a total of 23 rehabilitation sites. Rearing habitat increased at 12 of 13 sites after construction. Our sub-sample analysis indicated 10 of 19 sites had less total habitat at the most recent survey than they did at the first survey after construction; 1 of those 10, Hocker Flat, had slightly more optimal habitat. The year of construction does not appear to affect the amount of habitat after construction (n=11 sites) or at the most recent survey (n=19 sites). However, six of seven sites had more habitat at the most recent survey than they did at pre-construction. We examined spatiotemporal changes in natural and constructed side channels and alcoves over the same time period to assess the impact these features had on the trends observed at rehabilitation sites. Kaplan-Meier analysis found evidence that natural features have higher survival than constructed features (Log Rank Test; side channels, p=0.003; alcoves, p=0.062). TRRP rehabilitation site construction increases rearing habitat but less than 50% of the sites have sustained or increased low flow rearing habitat over time. Constructed side channels and alcoves are important sources of rearing habitat but their efficacy can be ephemeral if not associated with geomorphological and fluvial processes that help maintain them.

#10. Aquaculture Special Session

Moderators: Rafael Cuevas Uribe, Humboldt State University and Michael D. Lee, California State University East Bay and Moss Landing Marine Laboratories

History and Future of Shellfish Farming in Humboldt Bay

Greg Dale, Shellfish Farmer

The presentation will cover the 100-year history of commercial shellfish culture in Humboldt Bay, including

the good, the bad, and the ugly. In the early 1900's, culture of native oysters and development of the industry identified several production and water quality issues that required attention, investment and innovation. This led to improvements in local water quality as well as changes in the types of shellfish grown allowing for the growth of production. The production provided economic interest in protecting and improving water quality over the years, but unrestricted growth, as with other industries at that time, led to conflicts with other resources. Regulatory oversight and science-based management of resources led to a significant reduction of resource impacts and informed industry on how best to improve ecologically as well as economically. This, coupled with a growing market for high quality shellfish and technological changes in culture methods, has renewed investment and interest in expanding shellfish culture in both Humboldt Bay and the world.

Current Status of Aquaculture in California
Randy Lovell, California Department of Fish & Wildlife

Commercial aquaculture in California is relatively modest in size, and can best be understood in terms of its diversity. Like the varied environments of the state itself, many different species, raised for many diverse purposes, are cultured using a similarly-varied range of techniques. None of the species can be considered commodity products as each of them fit into fairly small-volume, high-value, niche markets. They are specialty crops in a state, and country, that is otherwise supplied by imported, commodity-scale seafood (over 90%) in a world where over half the seafood supply now comes from aquaculture. Produced for markets demanding food but also valuing recreation, aesthetics, the environment, and many other considerations, the promotion and regulation of the industry is necessarily challenging and fragmented. However, the potential for increased commercial aquaculture production (and the consequent public and private benefit) is immense. With an annual economic impact valued at some $170 million, the aquaculture sector, like other food industries, is responding to the challenge of meeting a growing demand for commercially available food products while ensuring aquaculture practices adhere to environmental policies designed to protect marine and inland ecosystems.

Is Aquaculture Sustainable? Mythbusting Fish, Food, and the Future
Jesse Trushenski, Idaho Department of Fish and Game

Aquaculture is a modern imperative, for food security, economic development, and conservation and recovery of aquatic resources, but popular media includes considerable mis- and disinformation about the science and practice of aquaculture. The public—including, many fisheries professionals—are unfamiliar with aquaculture and uncertain as to its economic and environmental sustainability. This presentation articulates the challenge of seafood security and the mandate for aquaculture as one of the most important sources of protein now and in the future, and addresses several of the most common sustainability concerns and misconceptions about aquaculture, including use of wild fish as feed inputs, water usage, and the health and safety of farmed seafood.

The Ventura Shellfish Enterprise
Paul G. Olin, California Sea Grant; Laurie Monarres, Dudek & Associates; and Everard Ashworth, Ashworth Leininger Group

The Ventura Harbor in southern California is a very active, diverse port where the fishery for market squid *Doryteuthis opalescens* is the largest commercial fishery. The Port Commissioners, seeking to increase and diversify commercial landings, began exploring the feasibility of long-line mussel farms in the area. One impediment to this is the high cost of permitting, making it out of reach for most entrepreneurs. To overcome this hurdle, the commissioners and a diverse group of interested parties created the Ventura Shellfish Enterprise (VSE) to pre-permit mussel farming leases off the coast of Ventura and then sublease them to individuals interested in mussel farming, who thereby avoid the complex and expensive permitting process. The VSE is a multi-party initiative to permit twenty 100-acre plots for growing the Mediterranean Mussel *Mytilus galloprovincialis* via submerged long lines in State waters within the Santa Barbara Channel near Ventura Harbor. VSE partners include Ventura Port District, Coastal Marine Biolabs, The Cultured Abalone Farm, and the Ashworth Leininger Group, in coordination with aquaculture scientists and experts, the California and National Oceanic and Atmospheric Administration (NOAA) Aquaculture Coordinators, and

California Sea Grant. Supported by a grant to the Ventura Port District from NOAA through the National Sea Grant College Program, the Ventura Port District will obtain all the permits and entitlements needed to cultivate mussels on leases that will be farmed by commercial fisherman with mussels landed at existing off-loading facilities in the Ventura Harbor. As part of the grant, Coastal Marine Biolabs, a nonprofit, research-based, science education organization with facilities in the Ventura Harbor, will lead a comprehensive public outreach campaign and a series of workshops to inform commercial fishermen, consumers, Ventura residents, and the public at large of the project's features, benefits and impacts.

Aquaculture Education. A Review of Options in California and the U.S.

Michael Lee, California State University East Bay and Moss Landing Marine Laboratories

Aquaculture in California currently lacks an adequate framework for professional education and California students must therefore go out of state for their formal qualifications. A survey of higher education institutions shows there are no undergraduate and graduate degrees in aquaculture in the Golden State; there is only a single Hatchery Technician certificate at Feather River Community College and a Minor in Aquaculture at the University of California, Davis. Moreover, a review of current published catalogs across the 50 U.S. states and summarized in this presentation shows that there appears to be only 13 undergraduate degrees in this discipline or in a related discipline such as marine science that involves a formal, declared emphasis in aquaculture. Similarly, there appears to be only 13 masters programs nationwide with MS degrees directly in or with an emphasis in aquaculture. Only 16 professional certificates in aquaculture were identified as being offered by U.S. higher education institutions; two at the graduate level, two at the undergraduate level, and 12 at the community college associates level. To support the California aquaculture industry's efforts to grow the sector, Moss Landing Marine Labs is therefore leading a collaborative initiative to establish a new and expanded curriculum within the California State University system through the development of a graduate certificate and, potentially, a Master of Science in aquaculture.

#11. General Session

Mark Gard and Cesar Blanco, U.S. Fish and Wildlife Service,
Larry Brown, U.S. Geological Survey

Thursday Afternoon

Juvenile Fish Assemblages on the Lower Yuba River, Part 1: Looking Through the Lens of the Rotary Screw Trap

John Cleveland, Loren Stearman, and Duane Massa, Pacific States Marine Fisheries Commission

For the past 20 years, rotary screw traps have been utilized in estimating juvenile salmonid abundance and timing of migration throughout the Western United States. However, rotary screw traps do not selectively catch salmonids and non-target species or bycatch are often caught quite regularly. Despite being ubiquitously available data, few researchers ever examine the temporal shifts in species abundance and community structure of bycatch in rotary screw traps. Rotary screw traps do exhibit some trapping bias; however, bycatch data still allow for the study of assemblage dynamics both in short and long-term analyses. The Lower Yuba River is a major tributary to the Sacramento River basin and has 24 river miles of anadromous available habitat. For a ten year span (1999 to 2009), rotary screw traps were operated at a sampling station approximately six miles upstream from the confluence with the Feather River. Crews utilized between one and three rotary screw traps of both 5ft and 8ft diameters. Traps operated year-round as much as river conditions permitted. The majority of fish sampled throughout this period were juvenile Chinook Salmon *Oncorhynchus tshawytscha* and steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*] but also included large numbers of Sacramento Pikeminnow *Ptychocheilus grandis*, Sacramento Sucker *Catostomus occidentalis*, and Pacific Lamprey *Entosphenus tridentatus*, as well as numerous other species which occurred less regularly or less abundantly. Interestingly, sturgeons (genus Acipenser) were entirely absent. General metrics of assemblage diversity show increasing patterns in summer and fall samples, while winter and early spring samples were comprised of simple fish assemblages. Comprehensive assemblage-level analyses found this gradient to be closely related to the proportion of salmonids vs the proportion of both native and nonnative cool and warmwater taxa. We examine IBI-

style metrics from this dataset and explore the management advantages to analyzing the entire dataset from rotary screw traps.

Juvenile Fish Assemblages on the Lower Yuba River, Part 2: Looking Through the Lens of a Snorkel Mask
Loren Stearman, John Cleveland, Ryan Greathouse, and Duane Massa, Pacific States Marine Fisheries Commission

Fish assemblage structure and composition provide fisheries managers with windows into more complete and complex dynamic metrics than single species analyses tend to provide. Most assemblage-level analyses focus on adult fishes, yet important information about the system of the whole can often be gleaned from the phenology and dynamics of the juvenile fishes. While juvenile fish assemblage data is most frequently collected on the west coast in the form of rotary screw trap bycatch, snorkel surveys offer a potentially more robust method of juvenile fish assemblage sampling. Since 2012 the Lower Yuba River Management Team has conducted periodic snorkel surveys of juvenile fishes in the lower Yuba River, California. Species diversity peaked during warm months. Ordination analyses indicated that species accounting for the increase differ between years, with warmer years hosting fish assemblages with a diverse component of introduced species (e.g., bluegill *Lepomis macrochirus*), as well as some less common native taxa (e.g., hardhead *Mylopharodon conocephalus*, speckled dace *Rhinichthys atratulus*). While nonnative taxa were present in most warm-month samples, they invariably comprise <10% of individuals observed at a sample locality. Ordination analyses also indicated that juvenile fish assemblages in cooler months were very stable through time and consisted primarily of juvenile Chinook salmon *Oncorhynchus tschawytscha*; however, early assemblages also included considerable components of unidentified post-larval cypriniform fishes. Longitudinal patterns in both diversity and relative proportion of nonsalmonids were also recovered from analyses. Phenology of juvenile fishes in the river closely matches expected phenology from adult migratory data collected from automated video-monitoring systems on fish ladders on Daguerre Point Dam, at roughly the halfway point of the lower Yuba River. We compare these results to those of long-term sampling with rotary screw traps on the lower Yuba River.

Population Responses and Habitat Selection of Native Desert Fishes Following Two Years of Tamarisk Control in the Amargosa River Canyon
Mike Davis, Stillwater Sciences
Leif Halvorson, Rain Shadow Research
Chris Otahal, Bureau of Land Management

Nonnative tamarisk invasions in arid river systems of the southwestern United States pose a threat to the persistence of native desert fishes through modification of habitat, food webs and aquatic community composition. In this study we examined the effects of tamarisk removal on riverine habitat, community structure and relative abundance of populations of native Amargosa Pupfish *Cyprinodon nevadensis amargosae* and Amargosa Speckled Dace *Rhinichthys osculus* spp. in the Amargosa River Canyon of southeastern California. Results indicated a shift in bank vegetation to dominance by native emergent species, reduced river channelization and increased water temperature following tamarisk control. Accompanying these changes, we documented a 52% increase in pupfish CPUE and an 84% decrease in nonnative crayfish CPUE. We failed to capture any nonnative western mosquitofish, a species that occurred in significant numbers prior to tamarisk control, and observed little change in relative abundance of native speckled dace. We also attempted to identify linkages between outcomes of tamarisk control and population responses by evaluating habitat selection of target species. Comparison of habitat selection models provided evidence that riparian vegetation percent cover is an important element in pupfish habitat selection and is inversely correlated with site selection. This result suggests reduced riparian shading accompanying tamarisk control may have contributed to observed changes in aquatic community structure, however, the mechanisms at work are potentially numerous. We outline these potential mechanisms linking vegetation percent cover and native species abundance and argue that other environmental and population factors (ie. annual hydrograph variability, demographic stochasticity) should be considered in evaluating the efficacy of tamarisk control efforts. We conclude by highlighting the continued need to implement before-after-control-impact (BACI) study

designs to more definitively detect population responses to restoration manipulations in aquatic systems.

Do We Really Need a Special Mechanism to Explain Longitudinal Patterns in Stream Fish Assemblage Structure?
Loren Stearman

Longitudinal patterns in stream fish assemblage structure remain one of the great puzzles of ecology. Nearly every other taxonomic group displays clear patterns of longitudinal ecological zonation, mirroring zonation in physical processes and attributes. Stream fish assemblages instead add species in a downstream direction. There has been no lack of proposed hypotheses for this phenomenon, yet all either have been refuted, work only on a limited scale, or with a limited range of taxa. Most of these explanations also rest on the assumption that rivers are linear gradients. Rivers are instead dendritic in structure. I re-examine the idea of zonation in stream fishes, and highlight the hypothesis that while mobile organisms on a linear gradient would be expected to show ecological zonation, mobile organisms in a dendritic system would naturally produce the phenomenon of species addition due to increased diversity of proximal stream order junctions in higher-order streams. I developed a simple simulation to examine this hypothesis on both simplified linear gradients and on dendritic gradients based on real rivers with Strahler Stream Order (SSO) as a surrogate for environmental gradients associated with stream size. Dendritic networks displayed clear patterns of increasing proximal SSO diversity with increasing stream order. Simulations on linear gradients produced zonation as expected. Simulations on networks based on actual river systems consistently produced clear patterns of species addition. These models also produced many of the same minor patterns widely observed in the wild, such as increased similarity of fish assemblages in low-order streams proximal to higher-order assemblages as compared to assemblages in distal low-order streams, and continued persistence but waning relative abundance of headwater taxa in downstream reaches. I discuss shortcomings of the simple model and then explore future steps in field research to test this hypothesis on actual fish assemblages.

Food Justice in Eastern Africa: A Commodity Chain Analysis of Farmed Nile Tilapia *Oreochromis niloticus*
Stephanie Webb, University of California Santa Cruz

Global and local economies, policies, consumer preferences and an ever-changing environmental conditions influence sustainable food systems and food justice. Integrated approaches are needed to reconcile fish-human phenomena. My research adheres to contemporary debates in food systems research, but instead of having a primary focus on policy, it fills much-needed socio-economic knowledge gaps that can be used for improving seafood markets and thus, globally food security.

Egypt is the number one producer of aquaculture in Africa, and the eight largest producer globally. Egypt is the largest global producer of mullet and the second largest producer of farmed Nile Tilapia. Egyptian aquaculture has been steadily growing over the last two decades and provides 100,000 full-time equivalents jobs. Approximately 65 percent of the fish eaten by Egyptians is aquaculture-derived, and is one of the cheapest farmed animal protein sources in the country. Nonetheless, vast economic challenges and food insecurity continue within the nation. Egypt has been experiencing a rise in poverty and food insecurity for past three years. It is estimated that 17 percent of Egyptians experienced food insecurity in 2011 compared to 14 percent in 2009 (Egyptian Central Agency for Public Mobilization and Statistics). Egypt's unemployment rate has reached 13.2 percent and that number almost doubles in women totaling at 24.2 percent. Paradoxically, women primarily hold retailer roles in the supply chain.

Hosted by Worldfish, an international nonprofit research organization that harnesses the potential of fisheries and aquaculture to reduce hunger and poverty, and the Research and Innovation Fellowship in Agriculture (RIFA), my research draws from political ecology, commodity chain studies and sensory science to research food justice in Egypt, Africa. I examine the nexus of production and consumption in the farmed Nile tilapia commodity chain to identify opportunities/barriers for improving fair labor conditions and reducing national food insecurity.

Forecasting and Managing for the Detection Probability of Delta Smelt

Brian Mahardja, Brian Schreier, Ted Sommer, California Department of Water Resources
Matthew Young, U.S. Geological Survey

Imperfect detection occurs in all ecological monitoring programs, where a non-observation may be a result of either a true absence or a failure of detection. This problem of imperfect detection is often exacerbated when monitoring for a rare and imperiled species. We examined a long-term larval and early juvenile fish monitoring program in the upper San Francisco Estuary evaluate its overall reliability in detecting various fish species, including the imperiled Delta Smelt *Hypomesus transpacificus* for which the program was designed after. Using occupancy modeling, cumulative detection probability of larval and juvenile Delta Smelt over the study period (1995-2015) was found to be generally high (≥ 0.95) based on the current sampling effort of three larval net tows per site. However, detection probability can vary considerably from year to year depending on the species' larval production level. During the recent drought years, low abundance levels of Delta Smelt resulted in low detection probabilities of their larvae and juveniles by this monitoring program. These results demonstrate the need to consider adaptively managing detection probability by increasing sampling effort in years when young-of-year delta smelt abundance is expected to be low. We highlight an example of how a couple of relatively simple regression models can be used to forecast abundance and therefore detection probability of Delta Smelt.

Delta Smelt Abundances in Cache Slough and Other Non-Index Stations Sampled in the Fall Midwater Trawl Survey

James White and Randall D. Baxter, California Department of Fish and Wildlife

The Fall Midwater Trawl (FMWT) was initiated in 1967 to determine the relative abundance and distribution of age-0 Striped Bass *Morone saxatilis* in the estuary, but the data is used routinely for information on upper-estuary pelagic species including but not limited to Delta Smelt *Hypomesus transpacificus* and Longfin Smelt *Spirinchus thaleichthys*. FMWT catch from a subset of stations (100 'index stations', which have been used since the inception of the FMWT) is used to calculate relative abundance indices for 5 species. Starting in 1990, FMWT sampling was expanded to include parts of the Napa and Mokelumne Rivers, and then continued with additional stations in the Sacramento Deep Water Ship Channel (SDWC) and Cache Slough as recently as 2010. These 'non-index' stations were added to increase Delta Smelt sampling distribution in the upper San Francisco estuary. Here we discuss the distribution and abundance of five important pelagic fish species (which have undergone dramatic recent declines in abundance) across the 22 non-index stations from the last 16 years of surveys. Across all years, the non-index catch of Delta Smelt was 6% of the total catch; however this pattern varied greatly, with the 2004 non-index catch representing 62% of the total. Furthermore, for Delta Smelt at non-index stations, the average catch per unit of effort (CPUE) was: in the top 57th percentile of all stations, nearly equal to average index stations CPUE for October and November surveys when pooled by month, 34% of total CPUE by year, and exceeded CPUE for index stations for 6 survey years. With many pelagic fish species in decline and becoming rarer, these twenty-two non-index stations provide valuable abundance and distribution data on important listed species which would otherwise go unnoticed.

Incorporating State of Delta Science into Management Actions for Delta Smelt

Evan W. Carson, Erin Gleason, Li-Ming He, and Matthew L. Nobriga U.S. Fish and Wildlife Service

In 2008 the US Fish and Wildlife Service issued its Biological Opinion on Central Valley Project and State Water Project Water Operations (BiOp). The BiOp used then-state-of-science of Delta Smelt to develop a regulatory framework for management actions and conservation measures to recover the species. These emphasized protecting adults and young-of-the-year from entrainment into Project pumps, increasing outflows to improve conditions for growth and rearing, and restoring tidal marsh habitat. Subsequent advances in research have improved understanding of Delta Smelt life-history and the ecological processes of the Bay-Delta. Continued decline in abundance of Delta Smelt has prompted development of management actions that are adaptable to advances in state-of-the-science and to changes in environmental conditions. For example, in 2016 the State of California developed a resiliency strategy based on contemporary state-of-the-

science to identify needs for rapidly improving the status of Delta Smelt. Similarly, efforts are underway to address opportunities and risks from Cal WaterFix, which proposes new water diversions in the North Delta for conveyance of water to Project pumps in the South Delta. Within this context we discuss regulatory requirements for incorporating life history and state of Delta science into management actions for Delta Smelt.

Working with Veterans to Implement Recovery Plans in CA

Bob Pagliuco, Leah Mahan, and Stacie Smith, National Oceanic and Atmospheric Administration Restoration Center

NOAA has been working with staff from the California Conservation Corps (CCC), the Forest Service and California's Department of Fish and Wildlife (DFW) to provide post 9/11 veterans with jobs and increase veterans work skills, while accomplishing fisheries monitoring activities and restoration projects identified in NOAA's salmonid recovery plans. Since its inception in 2012, the NOAA/CCC Veterans Corps program has been successful at providing jobs for veterans, increasing their work skills in the fisheries monitoring and habitat restoration fields and providing valuable restoration and monitoring services for NOAA trust resources. The NOAA/CCC Veterans Corps program employs post 911 military veterans to conduct ESA listed salmon and steelhead (Salmonidae) population monitoring and habitat restoration to assist with species recovery. Monitoring activities include spawner surveys and juvenile dive surveys to determine salmon and steelhead abundance and distribution in high priority salmon and steelhead populations, characterizing habitat to determine appropriate restoration treatments and implementing on-the ground restoration of riparian, off-channel and instream habitat.

In addition to assisting NOAA with implementing fisheries management and recovery goals, the NOAA/CCC Veterans Corps increases veterans job skills, and thus future work opportunities, through training and on the ground experience with experts in the fisheries field. The program focuses on providing a career path for successful participants. In addition to developing work skills and increasing job opportunities, veterans in the program are also eligible to receive college tuition and a $5,000 AmeriCorps education award. The following is a link to a video developed by NOAA highlighting the Veterans Corps program and the opportunities it provides to NOAA, the partners and the veterans https://www.youtube.com/watch?v=zM4TENrPs08.

Evaluating Ecosystem-Based Reference Points for a Forage Fish Using Ecopath with Ecosim

Andre Bucheister, Humboldt State University
Edward D. Houde and Thomas J Miller, University of Maryland

Efforts to develop ecosystem-based fisheries management (EBFM) have often focused on forage fishes because they support large fisheries and are major prey for other fishes, marine mammals, and seabirds. Management of Atlantic Menhaden *Brevoortia tyrannus* provides a relevant case study that demonstrates the challenges and tradeoffs inherent in managing for the multiple ecosystem services provided by forage fish. To support and inform ongoing fisheries management efforts, we built an Ecopath with Ecosim model of the Northwest Atlantic Continental Shelf from 1982-2013. Model simulations were used to evaluate the future effects that different menhaden fishing mortality rates would have on various ecosystem indicators, including population biomasses, fisheries yields, and ecosystem structure. We quantified the tradeoffs associated with current single-species F reference point proxies as well as ecosystem-based reference points that have been proposed for forage fishes. Results suggested that Striped Bass *Morone saxatilis* were the most sensitive to increases in menhaden fishing, but other higher trophic level groups (birds, highly migratory species, sharks, and marine mammals) were also negatively affected. Among the range of reference points examined, there were substantial differences in the biomasses (40-75% of unfished biomass) and fishery yields (54-100% of maximum sustainable yield) for menhaden and its dominant fish predators. Also, up to 13% of modeled groups were negatively affected (biomass decline of >25%) at the least conservative reference point, indicative of substantial shifts in ecosystem structure. The ecosystem simulations demonstrated the varied responses, potential winners and losers, and complexities resulting from alternative forage fish management strategies, and we use the simulations to

make recommendations for advancing EBFM for forage fishes such as menhaden.

The Role of Fish in the Food Webs of Intermittent Rivers

Pablo Rodríguez-Lozano, University of California Berkeley and Universitat de Barcelona
Jordan M. Wingenworth and Stephanie M. Carlson, University of Califonia Berkeley
Narcis Prat, Universitat de Barcelona

Intermittent rivers are those that cease surface flow at some point in space and time along their course. Intermittent rivers are present in all climate areas, and are especially common in Mediterranean regions, including much of California and Spain. However, most river research has been focused on permanent rivers, and thus, the current paradigms in river science and management have emerged and developed in permanent rivers. Consequently, the importance of top-down effects of fishes in intermittent rivers remains unclear. Here, we introduce preliminary results of our in progress literature review about fish ecology in intermittent rivers, highlighting results regarding the role of fish in the food webs of these systems. Moreover, we present the results of a field experiment to try to complement the previous knowledge on this research topic. In the experiment, we assessed whether the presence/absence of an endangered fish *Barbus meridionalis* (A. Risso, 1827) in an intermittent, Mediterranean stream in Spain affects leaf litter processing. We conducted a leaf bag experiment comparing a control reach with a population of B. meridionalis with an adjacent upstream and fishless reach. In the fishless reach, leaf fungal biomass and microbially mediated breakdown rate were lower compared to the control reach. This was probably caused by the lack of the bottom-up stimulation through nutrient recycling by fish. Shredders and scrapers were found at higher abundance and biomass in the fishless compared to the control reach. Consequently, macroinvertebrate mediated leaf breakdown was faster in the fishless than in the control reach, not only compensating for the lower microbially mediated leaf breakdown in the fishless reach, but accelerating the overall leaf breakdown rate. Together, our experimental study and literature synthesis contribute to a greater understanding of the role of fish in intermittent rivers and the potential ramifying effects that their extinction can cause.

Maternal Allocation of Carotenoids Increases Tolerance to Bacterial Infection in Brown Trout

Laetita Wilkins, University of California Berkeley and Universitat de Barcelona
Lucas Marques da Cunha, Véronique Vocat-Mottier, Matay Hobil, David Nusbaumer, and Claus Wedekind, University of Lausanne
Laure Menin and Daniel Ortiz, Institute of Chemical Sciences and Engineering ISIC

Life-history theory predicts that iteroparous fish allocate their resources differently each breeding season depending on their residual reproductive value. In salmonids, females often vary the size and number of their eggs and the compounds they allocate to their clutch, including various carotenoids whose functions are not sufficiently understood yet. We sampled 37 female and 35 male brown trout from a natural stream network, collected their gametes for in vitro fertilizations, experimentally produced 185 families in 7 full-factorial breeding blocks, raised the developing embryos singly (n = 2,960), and either sham treated or infected them with *Pseudomonas fluorescens*, an opportunistic fish pathogen that had been documented to infect trout embryos in earlier studies. We used female redness (as measure of carotenoids stored in the skin) and allocation of carotenoids to clutches to infer maternal strategies. Astaxanthin contents largely determined egg color. Neither egg weight nor female size was correlated to this carotenoid, however astaxanthin content was positively linked to larval growth and to tolerance against *P. fluorescens*. There was a negative correlation between female skin redness and the carotenoid content of their eggs. Although higher astaxanthin contents in the eggs were associated with an improvement of early fitness-related traits, some females appeared not to maximally support their current offspring as revealed by the negative correlation between female red skin coloration and egg carotenoid content. This correlation was not explained by female size and supports the prediction of a maternal trade-off between current and future reproduction.

One Fish, Two Fish, Big Fish, Small Fish: Lessons Learned From a Long-Term Video Monitoring Study in a California Central Valley Stream

Ryan Greathouse, Duane Massa, and Loren Stearman, Pacific States Marine Fisheries Comission

Two Vaki Riverwatcher (RW) fish counters have monitored fish migration in the Lower Yuba River, Browns Valley CA, since 2003, successfully operating 4,665 of 5,114 (91%) days over that time period. The RWs are located at an impassible barrier formed by a low head dam. Migrating fish navigate through fish ladders positioned on either side of the dam, and are then channeled through weir bars in the top bay of the ladders where the RWs are positioned. Infrared scanners trigger a camera, and generate unique passage data including date, time, fish depth (mm), speed, and position in frame. The technology also produces silhouette images of each passage event. In the 14 year timeframe of the monitoring program numerous other studies have been conducted on the Lower Yuba River, the region has experienced both flood and drought, and advancements in fish monitoring technology have arisen. We examine lessons learned, and compare migration data generated by the RWs to concurrently operating surveys, as well as temperature and flow data. For example, what relationships emerge when comparing RW data with redd survey data? What can we learn from analyzing acoustic tagging/tracking data in conjunction with RW data? What are the advantages and disadvantages compared with a carcass survey? Assessing fish abundance, distribution, and migration is at the core of fisheries monitoring activities, and there are numerous ways of achieving the desired goal of counting fish. Our experience has demonstrated that automated fish counting systems can be an effective, efficient, and accurate means for managers to gather pertinent fisheries data for migratory species. Different river systems will no doubt present their own unique challenges for such remote monitoring technologies; however, lessons learned on the Yuba River may help guide researchers in designing their own programs.

Efficacy of Collapsible Minnow Traps in Removing Black Bullhead from a Trout Stream

Russell Barabe, California Department of Fish and Wildlife

Aquatic invasive species represent a serious threat to freshwater ecosystems worldwide, are considered a threat to biodiversity, and have the potential to result in substantial economic impacts. Detrimental effects of introduced species were cited in 68% of North American fish extinctions, second only to physical habitat alteration. Many invasive species, such as the Black Bullhead *Ameiurus melas*, exhibit life history characteristics which facilitate colonization of areas outside their normal range. For example, Black Bullhead have high fecundity (2,500-3,000 eggs), parental care of offspring, opportunistic omnivorous feeding habits, the ability to withstand temperatures as high as 35°C, and dissolved oxygen levels as low as 1-2 mg/liter. In summer 2016, 8 traps were set in three consecutive pools of the West Fork San Luis Rey River (WFSLRR), a river known to have one of the few remaining native populations of coastal Rainbow Trout *Oncorhynchus mykiss* in southern California. The traps captured 35 Black Bullhead, indicating a potential problem. Four subsequent removal efforts occurred where a total of 228 24”x 12” collapsible minnow traps were baited with tuna flavored cat treats, set, and soaked overnight. The traps captured 1,315 Black Bullhead. The total population was estimated at 1,381 (CI 1,376-1,385) using the DeLury method and 1,361, using the maximum likelihood estimator (CI 1,343-1,379). Based on this information, baited, collapsible minnow traps are effective in removing Black Bullhead from a high gradient, second order trout stream.

Friday Afternoon

Conservation Banking as a Tool for Floodplain Restoration

Daniel Chase, WRA, Inc.

Conservation banking provides a unique opportunity for public and private partnerships to restore and protect habitat for threatened and endangered species. Private land and capital can be directed towards the restoration of key habitat areas, with the design, ecological benefit, and long term monitoring standards reviewed and approved by public regulatory agencies. Conservation banking provides an option for landowners to receive a financial return on their property in a way that benefits native species and habitat and does not rely on developing or exploiting those resources. Using established science and emerging conservation biology, restoration practitioners work with public regulatory agencies to create habitat that will be protected for perpetuity. For protected species of fish, this can result in the connection and restoration of high quality floodplain habitat along important migratory and rearing corridors. Within Northern California’s Butte

Creek watershed, conservation banking is being used to create and improve floodplain habitat in former agricultural fields. We present a case study on the conceptual design for high quality rearing and migratory areas for protected salmonids and native fish. This location provides an optimal area of restoration for threatened spring-run Chinook Salmon *Oncorhynchus tshawytscha* and steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*], and presents a challenging balance to reach the desired habitat goals without adversely impacting flood control, private property access, and surrounding agriculture. We provide a summary of the conservation banking concept and how this partnership provides a unique tool for the recovery of protected species.

Putting the River Back into the Trinity River
Seth Naman and Wes Smith, National Oceanic and Atmospheric Administration

Since 1963 the Trinity River has been damned and diverted for hydropower and consumptive water use. In addition to the loss of habitat upstream of the dam, decades of static and simplistic flow regimes lead to simplification of fish habitat and further declines of fish and wildlife in the Trinity River. Significant improvement in both the quantity of water and changes in the simplistic flow regime occurred as a result of the implementation of the Trinity River Record of Decision in 2000. However, the current dam releases result in static baseline flows of 8.5 cms for seven months of the year, from October to May when streams in the region experience their largest and most variable flow events. We developed a new method to adjust dam releases daily during the winter months which synchronizes dam releases with tributary freshet events, while at the same time meeting the water allocation volumes outlined in the Record of Decision. We simulated flows in the Trinity River from 1963 to 2015 and used the results to asses various flow, fish, and geomorphic objectives to test the effectiveness of the new method. Our method reduces the frequency of safety of dams releases, increases habitat for rearing fish in the winter months, provides fall and winter cues for outmigrating juvenile salmonids and Pacific Lamprey, meets geomorphic objectives, and has numerous administrative and procedural benefits over the current flow allocation system.

The Web of Authorization and Implementation in Trinity River Restoration
Brandt Gutermuth, Bureau of Reclamation

In 2000 the Trinity River Record of Decision (ROD) prescribed a suite of activities to restore functioning river conditions and anadromous fish populations. These activities included: variable annual flows, gravel augmentation, and mechanical channel rehabilitation. Toward this, Trinity River Restoration Program (TRRP) staff and partners completed programmatic National Environmental Policy Act and California Environmental Quality Act documents to cover planned activities and acquired long-term permits for work. Still, project-specific environmental documents must be completed and all authorizations received before channel rehabilitation actions begin each year.

In order to predict and evaluate conditions that result from TRRP management activities, the Program developed and shared digital terrain models (DTMs) with local agencies. These DTMs allow design condition modeling and were used to update Trinity River flood insurance rate maps (FEMA maps). Now project construction plans must receive explicit landowner and FEMA approval prior to project implementation. What is more, floodplain development guidelines allow only changes that maintain predicted base flood elevations. Unfortunately, construction requires real-time adjustment to match site conditions and ensure self-maintenance while plans are based on expected conditions. For example, a design may call for a 4,500 cfs (125 cms) floodplain while field conditions support construction of an alcove. Full disclosure and strict adherence to permitted plans may result in sub-optimal project creation.

TRRP projects must support long-term fish and wildlife needs while also fulfilling landowner obligations, permit requirements, and environmental mitigation commitments. In the end, overall implementation funding is reduced proportionately. To achieve long-term success, management must remain adaptable and support projects that have been refined based on public perception, expected outcomes, and measurement of prior cumulative impacts. Lessons learned through implementation and subsequent monitoring will allow future problem avoidance while increased river-floodplain interaction will work to enhance frequently inundated floodplain habitat and river function.

Restoration in the Napa River Watershed – Are We Seeing More Fish Yet?

Jonathan Koehler, Napa County Resource Conservation District

Large-scale habitat restoration efforts are underway in the Napa River to improve conditions for fish, wildlife, and stream-side landowners. Over 15 miles of river have been assessed and are undergoing significant geomorphic transformations including channel widening, installation of instream habitat structures, and levee setbacks. A primary goal of these efforts is to improve spawning, rearing, and migration conditions for anadromous salmonids, specifically steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*] and Chinook Salmon *Oncorhynchus tshawytscha*. Habitat restoration is also intended to maintain the diverse native fish assemblage by creating favorable habitat complexity, where little currently exists. In 2009, the same year earth-moving work began for restoration, the Napa County Resource Conservation District (RCD) began operating a rotary screw trap (RST) several kilometers downstream. The RST has been operated at this same location during the spring salmonid outmigration period (March-June) every year since.

Now with eight years of fish monitoring data, do we see signals that the restoration is working? The results thus far appear to be inconclusive. From 2009 through 2013, steelhead smolt catch rates exhibited a positive trend; however, a sharp decline occurred in 2013 and continued through 2016. Chinook smolt catch rates during this same period were highly variable, including years of relatively high abundance (2010, n=1520; 2011, n=7,377) contrasted with years when no smolts were captured (2014, 2015). These trends may be attributed, at least in part, to reduced flows associated with drought. In spite of these varied water year types (wet vs. dry), steelhead smolts were consistently large in all sampling years with a median fork length of 189mm. Native fishes comprised the vast majority (>90%) of the catch in all years, and included captures of locally rare species such as River Lamprey *Lampetra ayresi*, Hardhead *Mylopharodon conocephalus*, and Tule Perch *Hysterocarpus traski*.

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

Nathan Queener, Mattole Salmon Group
Andrew Stubblefield, Humboldt State University

Pronounced seasonality in rainfall and streamflow are natural components of a Mediterranean climate, and better understanding the processes that regulate the storage and release of water from catchments in the dry-season will help inform decisions intended to improve salmonid habitat.

Using repeated measurements of streamflow and surveys of the extent of dry channel in small fish-bearing streams in the southernmost 85 km2 of the Mattole River watershed, we found that tributary unit-area streamflow within this physiographically homogenous area varied by over two orders of magnitude. Losing reaches exhibiting downstream declines in both discharge and unit-area yield were common, even in streams with no water diversions. Basins with greater baseflow had steeper slopes, narrower valleys, more dissected topography, and more precipitation. The magnitude of difference in water yield among basins was much greater than the difference in precipitation, suggesting that flow differences were the result of the combination of differences in basin water inputs, storage capacity, and routing.

The distribution of dry channels showed no clear tendency towards reaches “drying down” or “drying up”, although flow going subsurface near the stream mouth early in the summer while upstream reaches subsequently maintained surface flows for months was common, eliminating the potential for downstream migration early in the dry season.

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

Extreme Drought Drives Range Contraction of Salmonid Fishes

Stephanie M. Carlson, S.J. Kelson, C. Woelfle-Erskine, S.E. Thompson, and M.E. Power, University of California Berkeley
C. Renger, California Department of Fish and Wildlife

Droughts are a complex meteorological phenomenon, with impacts that are not purely influenced by an overall lack of rain, but also by the spatial and temporal patterns of the rain that does fall. California's recent multi-year drought, potentially the most severe encountered in the past 500 years in terms of total rainfall, was also unusual in the timing of its large rainfall events. Using long-term flow records, we demonstrate that during the 2013-14 water year, the timing of large flows was shifted very late in the winter. This created a mismatch between the occurrence of elevated flows, required to allow adult salmonids access to small tributary breeding habitats, and the phenology of breeding salmonid fishes. We then explore the consequences of delayed high flows on the distribution of salmonid fishes using data from multiple monitoring efforts in central and northern California, including adult breeding surveys and juvenile fish surveys (with the assumption that the presence of juveniles indicates successful spawning). We report that the hydro-phenological mismatch eliminated access to breeding and rearing habitat for three species of salmonid fishes (*Oncorhynchus kisutch*, *O. mykiss*, *O. tshawtyscha*) based on absence of adults or juveniles from "perennial" salmonid habitats. Our results emphasize that magnitude and timing of winter storms can dramatically influence the distributions of migratory salmon and trout in California near their southern range limits, shifting their overall distributions down-river. Such step-wise range contractions represent a previously unrecognized threat to the persistence of salmonids at the southern end of their range, although their long lifespan and migratory life history provides resilience against such extreme events because some individuals will be in the ocean and return to freshwater 1-3 years later, perhaps when conditions are more suitable.

Can Summer Wildfire Smoke Reduce Peak River Water Temperatures, Potentially Benefitting Cold-Water Fishes?

Aaron David, U.S. Fish and Wildlife Service
Frank K. Lake, U.S. Forest Service
Eli Asarian, Riverbend Sciences

We evaluated whether wildfire smoke can reduce summer river water temperatures in the Salmon River watershed in Northern California. While wildfire is a terrestrial phenomenon, fires can substantially influence river ecosystems and fish populations. Previous studies of the thermal effects of wildfires on rivers have focused on either the effect of the heat of combustion on water temperatures during a fire or the effect of decreased shading and increased solar radiation associated with the loss of riparian vegetation on post-fire water temperatures. However, we are not aware of any studies of the effects of wildfire smoke on water temperatures of nearby river systems. Specifically, we examined whether wildfire smoke can cool river water temperatures by attenuating solar radiation and air temperature, and what the magnitude of the effect was, if any, of smoke on water temperatures relative to other variables widely known to influence water temperatures. To address these questions we assembled data on wildfires, smoke, weather, river discharge, and water temperatures from a 19 year period (1997-2015) in the Salmon River watershed. Wildfire smoke is difficult to quantify due to high spatial and temporal variability, but we successfully used a newly available daily high-resolution dataset of aerosol optical thickness derived from MODIS satellite imagery to represent smoke density. Preliminary analyses indicate that during large wildfires, smoke can reduce river water temperatures, particularly when inversions trap smoke in river canyons. This smoke-induced river cooling may benefit salmonids and other cold-water adapted species.

Livestock Grazing in the Golden Trout Wilderness: Consequences for Stream Temperatures and Dynamics of Riparian Vegetation

Sebastien Nussle and Stephanie M. Carlson, University of California Berkeley
Kathleen R. Matthews, U.S. Forest Service (retired)

In 1978, the Golden Trout Wilderness area was established within the Inyo National Forest and Sequoia National Forest to protect the California Golden Trout *Oncorhynchus aguabonita* and its habitat, which is currently restricted to the upper watersheds of the Kern River and South Fork Kern River, in the Sierra Nevada mountain range. Because of the effects of livestock grazing on riparian vegetation in the Golden Trout habitat (occurring since the 1800s), meadow restoration

activities were initiated in several meadows in 1991, including variable cattle exclusion measures. This variability in management - from total exclusion to partial exclusion to cattle inclusion - allows for an estimation of the impact of livestock and management measures in these sensitive habitats. Using data from a network of loggers monitoring water temperature, we estimated the impact of grazing on current and future water temperatures accounting for climate warming. Additionally, we estimated the influence of different management strategies on riparian vegetation by measuring the height of riparian vegetation within areas that have been grazed versus closed to grazing ('rested') since 1991. We found that water temperatures were cooler in rested meadows compared to the actively grazed one, and that predicted temperatures under different global warming scenarios were likely to be higher in presence of livestock, emphasizing an interaction between land use and global change. We also found that riparian vegetation was higher and denser in rested zones, resulting in shadier rivers and lower maximal stream temperatures. Finally, we found that cattle exclusion – both partial and full exclusion - is an effective measure for protecting riparian vegetation, but that recovery from grazing could take several decades, as the areas that have been closed to grazing for 25 years have not yet fully recovered.

Tracking Fine-Scale *Oncorhynchus mykiss* Movement in Upper North Fork Matilija Creek (Ventura County, CA)
Yi-Juan Tsai, Pacific States Marine Fisheries Commission

In southern California, *Oncorhynchus mykiss* is the only native salmonid species present, and its anadromous form (steelhead) is endangered. In a pilot study that contributes to a larger monitoring project, we examined fine-scale *O. mykiss* movement in Upper North Fork Creek (Ventura County, CA), a fourth-order tributary located within a watershed of high priority for steelhead recovery. We used a portable reader and pole antenna to scan for passive integrated transponder (PIT) tags that were implanted into wild trout. During scanning surveys, we detected a high percentage of implanted tags and found that only a small number of these tags had moved from the habitat unit in which tagged trout were released. These results suggest that *O. mykiss* may not move often between habitat units. However, given the limitations of this pilot study, further research is required to support these preliminary results. More importantly, though, these results suggest that PIT tag scanning may be a useful tool for monitoring *O. mykiss* in southern California, where the small, low-flow stream systems are conducive to PIT tag scanning, and where relatively little is understood regarding O. mykiss habitat use and movement.

Abundance and Distribution of Fishes in the Santa Ana River, California, an Effluent-Dominated Urban River
Larry Brown, Jason T. May, and Marissa Wulff, U.S. Geological Survey
Heather Dyer, Can Bernardino Valley Municipal Water District
Kerwin Russell, Riverside-Corona Resource Conservation District
Kai Palenscar, U.S. Fish and Wildlife Service

Understanding the distribution and abundance of sensitive species is critical to inform sound management. In support of a Habitat Conservation Plan for the Santa Ana River watershed, we examined the distribution and abundance of fishes in an effluent-dominated 8-km section of the Santa Ana River near Riverside, CA, emphasizing the native species Santa Ana Sucker *Catostomus santaanae* and Arroyo Chub *Gila orcuttii*. This section of river is part of the designated critical habitat for the Santa Ana Sucker, which is federally listed as a threatened species. In September 2016, we sampled 20 stream reaches using snorkeling, seining, and electrofishing. The reaches were 50 m long and enclosed with block nets. The native fishes, Santa Ana Sucker and Arroyo Chub, were most dense (fish/km) downstream of the main wastewater outfall within the upper 3 km of the study area. This area was characterized by high flows and coarse substrate with densities of up to 3900 suckers/km and 5560 chubs/km. Santa Ana Suckers tended to be more abundant in reaches with limited canopy, which may be likely is related to production of benthic algae, their primary food source. Density of Yellow Bullhead *Ameiurus natalis*, an introduced species, was highest upstream of the main wastewater outfall. Maximum density was 2340 bullheads/km. This area was characterized by low flows and heavy canopy. These data will be useful in developing a conservation strategy for the Habitat Conservation Plan, designing habitat restoration projects, and understanding the ecological outcomes of water management actions.

Salmon River (Photo Credit Bobbie Miller)

Poster Presentation Abstracts

Who's Eating Their Vegetables? Growth Variability May Explain Mismatched Length-At-Date in the Yolo Bypass

Keiko Mertz, Pascale Goertler, Jeremy Agundes, and Naoaki Ikemiyagi, California Department of Water Resources
Mariah Meek, Michigan State University
James Hobbs, University of California Davis

Salmon are reproductively isolated due to natal homing abilities, which results in genetically distinct populations within a watershed. California's Central Valley (CCV) Chinook Salmon *Onchorynchus tshawytscha* are composed of four distinct populations, named for the return to river timing of adults. Under the Endangered Species Act (ESA), the winter run and spring run populations are listed as endangered and threatened, respectively. Differences in the ESA listing status among runs has made identifying juvenile life stages to run type difficult, and as a result the California Department of Fish and Wildlife developed a length-at-date (LAD) criteria based on a temporal isolation, and a uniform growth rate for all runs. Several studies, however, have shown that the LAD approach is inaccurate, and genetic analyses have demonstrated significant overlap in runs based on LAD (Harvey et al. 2014, Pyper et al. 2010). In this study, we hypothesize that this inaccuracy in LAD run assignments originates from its assumption of a uniform growth rate. Growth is a common metric for fitness consequences to individuals and has been shown to vary between different types of nursery habitat for juvenile fish. The Yolo Bypass, a floodplain-tidal slough complex in the north Delta, is part of the suite of habitats used by out-migrating juvenile salmon that could be generating growth variability. In this study, we will use otolith microstructural analysis to quantify growth variability in juvenile CCV Chinook Salmon captured in the Yolo Bypass with mismatched LAD and genetic run assignment. Our aim is to use otolith microstructure to show that the mismatch between LAD and genetic assignments for juvenile salmon is caused by inherent growth variability and overlap in growth trajectories between runs.

From Southern Swamps to Cosmopolitan Model; The Unfinished History of Mosquitofish

David Fryxell, University of California Santa Cruz

The most widespread and abundant inland fish in the world is probably the Mosquitofish *Gambusia affinis*. It was introduced worldwide from the southeast USA in the early 20th century in an effort to control mosquitoes and mosquito-borne disease. A few zealous protagonists discovered the mosquito-feeding tendencies of mosquitofish, and then advocated their spread as a relatively ecologically-safe and long-term mosquito solution compared with draining and oiling watersheds. Early on, some understood the limits of Mosquitofish efficacy for biocontrol, but the lack of acknowledgement of potential ecological costs led to their continued spread. The discovery of DDT shifted focus away from biological control around World War II, but Mosquitofish already flourished in their global distribution. The innate voracity and aggressiveness of Mosquitofish contribute to their now well-documented impacts on native prey and native competitors. Today they are on the IUCN's list of the world's 100 worst invasive species, but are still used extensively by some governments for biocontrol outside of their native range. The recent emergence of Zika and other infectious diseases has reinvigorated the debate between conservation biologists, who advocate ceasing their use and eradicating nonnative populations, and human health officials, who see their use in biocontrol an important component of integrated pest management. To date, methods for eradication of Mosquitofish have largely proven ineffective. Promising novel genetic eradication techniques are currently under development. In the meantime, Mosquitofish ranges are likely to continue to expand. Because of their widespread distribution and recent introduction to a diversity of environments, Mosquitofish are emerging as a model system in the fields of ecology and evolution.

A Comparison of Benthic Macroinvertebrate Assemblages in Perennial and Intermittent Headwater Streams of the Mattole River in Northern California, USA

Mason London, Michael A. Camann, Alison O'Dowd, Humboldt State University

Intermittent streams are common throughout the world and comprise 60% of total river lengths in the conterminous United Sates. Despite their prevalence, intermittent streams are understudied, particularly first-order headwater streams, which are vital for maintaining the function, health and biotic diversity of river networks. In June 2016, ten headwater streams (five intermittent and five perennial) were sampled in the Mattole River watershed in northwestern coastal California, USA, to compare benthic macroinvertebrate (BMI) assemblage between intermittent and perennial streams. BMI samples were collected using a D-net at eight randomly located riffles along a 150-m reach on each of the 10 streams. Chemical (e.g., pH, dissolved oxygen, temperature, flow) and physical (e.g. bed substrate composition, bankfull width, slope) were measured at each stream reach. BMI samples were identified using Standard Taxonomic Effort (STE). Results indicate only subtle differences between intermittent and perennial streams. Other factors such as pH, temperature and amount of bedrock appeared to be more influential on taxa composition then the degree of intermittency. Further studies with a temporal factor are needed to validate these findings.

Seasonal Movements and Distribution of Central Valley Striped Bass *Morone saxatilis*

Megan Sabal and Curil Michel, University of California Santa Cruz
Joseph Smith, University of Washington
Andrew Hampton, California Department of Water Resources
Sean Hayes, National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center

Acoustic telemetry was used to examine Striped Bass *Morone saxatilis* movements in the Sacramento-San Joaquin River system in California. We detected seasonal movement patterns in residence by regions (bay, delta, and river), mean rate of movement (m/s), and percent of Striped Bass moving between regions. In the spring, Striped Bass spent more time in the river, traveled with the fastest rate of movement, and had the most adjacent movements between the river and the delta—a potential signal of a spawning migration. In summer, residence time in the bay increased and adjacent movements between the bay and delta were common. In the fall, we witnessed a wide distribution of Striped Bass, and in the winter, Striped Bass appeared to overwinter in the delta with increased residence and reduced movements between regions. Striped Bass also were observed to have more movements to new receivers at night, and larger Striped Bass traveled longer distances. Non-hierarchical cluster analyses revealed groups of striped bass that varied in their residence of different regions. We used and compared two separate residence metrics (days vs. hours per receiver) throughout the paper. Residence days has the potential to overestimate time spent in a region if there are sparse detections, while residence hours per receiver may underestimate residence time if Striped Bass spend long periods of time at receivers. This project greatly expands our knowledge of Striped Bass movements in California which is pertinent to help assess population dynamics and interactions with the environmental and other species.

Munching Mad Mud: Prey Selection and Benthic Sampling in the Mad River Estuary

Kaitlyn O'Brien, Katherine Osborn, Eric LeBlanc, Timothy Mulligan and Frank Shaughnessy, Humboldt State University

The estuaries of northern California experience especially large seasonal fluctuations in temperature, salinity and flow. Surprisingly, the fishes and benthic communities of these systems remain largely unstudied. We examined how seasonal fluctuations affected the relationship between the benthic invertebrate community and the diet of two benthic fishes: Pacific Staghorn Sculpin *Leptocottus armatus* and English Sole *Parophrys vetulus*. Fish were collected monthly via beach seines in the Mad River Estuary from June 2015 through June 2016. Benthic invertebrates were sampled by coring at low and mid-tide elevations. Gut contents and benthic invertebrates were identified to the lowest possible taxon. Diversity of benthic invertebrates varied seasonally, although polychaetes, amphipods, and isopods were common throughout the year. English Sole diet did not correlate well with the benthic invertebrates observed, due to limitations in the methods used to sampling the benthic. However, some seasonal variation was evident in English Sole diet. Pacific Staghorn Sculpin diet showed minimal seasonal variation and was dominated by amphipods, year-round, regardless of the overall benthic invertebrate

community. This poster is complimented by a presentation, given here, on the fish community of the Mad River Estuary.

The Effects of Drought on the Marine Survival of Coho Salmon *Oncorhynchus kisutch*
Grace Ghrist, Humboldt State University

2011 to 2015 were the driest years on record for California. I wanted to determine the effects of low water flow on the population dynamics and demographic rates for Coho Salmon *Onchorynchus kisutch* during this time period. Freshwater creek near Eureka California hosts a life cycle monitoring station for salmonids. Data is collected on every stage of the salmonid freshwater life cycle to determine population trends as well as the estimation of important demographic rates like overwinter and ocean survival. A time series analysis of smolt to adult return (marine survival) was conducted for the drought years and compared to years of average rainfall. Additional time series analyses were performed for smolt length at emigration and jack to hooknose ratios during this time. It is important to understand how Coho Salmon population dynamics respond to drought especially when considering the imminent effects of climate change.

The Effects of Warm Temperature Acclimation on the Generalized Stress Response and Immune Function in 8N and 10N White Sturgeon
Michaiah Leal, Brigitte E. Clark, Joel VanEenennaam, and Anne T. Todgham, University of California Davis

Evidence suggests fish with additional copies of their genome have an elevated stress response, underperform in suboptimal conditions, and are more susceptible to disease. The objective of this study was to determine the role ploidy plays in the stress and immune responses to chronically elevated water temperatures in White Sturgeon *Acipenser transmontanus*. White Sturgeon of two ploidies (8N and 10N) were acclimated to ambient (18°C) and warm (22°C) water. Whole blood, plasma and gill samples were taken before (baseline) and after a 6 week acclimation period (experimental). Bioindices of stress (plasma cortisol, glucose and lactate, total erythrocyte count, hematocrit, hemoglobin, mean erythrocyte volume, mean erythrocyte hemoglobin, and mean erythrocyte hemoglobin concentration), immunity (respiratory burst, plasma lysozyme, and total leukocyte count), and metabolic status (lactate dehydrogenase and citrate synthase) were measured. Before and after acclimation, 10N white sturgeon had lower plasma cortisol, hematocrit, hemoglobin, total erythrocyte and leukocyte counts, yet higher mean erythrocyte volume and hemoglobin. After acclimation, enzyme activity differed between ploidies; 10N fish exhibited lower citrate synthase but higher lactate dehydrogenase activity. A higher acclimation temperature resulted in an increase in hematocrit, hemoglobin, total erythrocyte count, plasma lysozyme, and lactate dehydrogenase activity, regardless of ploidy. Temperature and ploidy had no effect on plasma lactate or respiratory burst activity. Hematological indices and enzyme activities suggest 8N fish and 10N fish are similar in oxygen carrying capacity but may exploit different metabolic pathways under warming conditions. Baseline and experimental immune and stress parameter results indicate 8N and 10N white sturgeon are similar in immune capabilities and are capable of acclimating to warmer water temperatures. However, 8N and 10N differ in stress response to long term exposure to higher water temperature. Further research is needed to elucidate the differences in inducible stress and immune responses and metabolic strategies of White Sturgeon of different ploidies.

Evolutionary Restoration Potential Evaluated Through the use of a Trait-Linked Genetic Marker
Travis Apgar and Eric P. Palkovacs, University of California Santa Cruz
Devon E. Pearse, National Oceanic and Atmospheric Administration Southwest Fisheries Science Center

Human-driven evolution can impact the ecological role and conservation value of impacted populations. Most evolutionary restoration approaches focus on manipulating gene flow, but an alternative approach is to manipulate the selection regime to restore historic or desired trait values. Here we examined the potential utility of this approach to restore anadromous migratory behavior in coastal California steelhead [anadromous Rainbow Trout *Onchorynchus mykiss*] populations. We evaluated the effects of natural and anthropogenic environmental variables on the observed frequency of alleles at a genomic marker tightly associated with migratory behavior across 39 steelhead populations from across California, USA. We then

modeled the potential for evolutionary restoration at sites that have been impacted by anthropogenic barriers. We found that complete barriers such as dams are associated with major reductions in the frequency of anadromy-associated alleles. The removal of dams is therefore expected to restore anadromy significantly. Interestingly, accumulations of large numbers of partial barriers (passable under at least some flow conditions) were also associated with significant reductions in migratory allele frequencies. Restoration involving the removal of partial barriers could be evaluated alongside dam removal and fishway construction as a cost-effective tool to restore anadromous fish migrations. Results encourage broader consideration of in situ evolution during the development of habitat restoration projects.

En Vogue: Ex-Situ Calibration of Next Generation Camera Technology to Assess Aquatic Food-Web Structure for Juvenile Salmonids

Nicholas Macias, Liam Zarri, and Eric P. Palkovacs, University of California Santa Cruz
Eric Danner, National Oceanic and Atmospheric Administration Southwest Fisheries Science Center

Conventional methods of measuring insect drift can become difficult with increasing water velocity due to the accumulation of organic material within nets of a certain mesh size. The processing of multiple net samples can prove to be time consuming and expensive. Together these constraints significantly limit the capacity to sample food-web structure at the necessary temporal and spatial scales within critical habitat for certain size classes of juvenile salmonid. The Scripps Plankton Camera (SPC) employs a 0.137X magnification lens, onboard Odroid – XU4 and LINUX operating system which can evaluate particles down to 1mm in length and measure the major axis of the particles within the frame of view of the camera. We utilized an experimental flow-through chamber attached to a variable speed water pump then manipulated frame rate, exposure time, and processing area range to increase resolution of sample particles. We also instituted a PYTHON Image Learning Package to differentiate between insect, detritus, and turbulent bubbles with 85% efficiency. Preliminary results indicate that the development and fine tuning of high resolution photographic technology could prove to be a valuable alternative when sampling insect dispersal in various capacities of lotic environments.

Habitat Contraction and Fragmentation in an Intermittent Coast Range Stream in Central California

Jordan Wingenroth and Stephanie M. Carlson, University of California Berkeley
M.T. Bogan, University of Arizona
R.M. Leidy, U.S. Environmental Protection Agency

Intermittent streams exhibit regular cycles of contraction and interruptions in surface flow during dry periods, followed by expansion and re-connection during wet periods. Intermittent streams are especially common in Mediterranean-climate regions, including much of California. We explored patterns of stream habitat contraction and fragmentation in Coyote Creek, Santa Clara County, across the dry season (June-October) during 2015 and 2016, at the height of California's most recent multi-year drought. During the dry season, remnant pools in Coyote Creek support a very diverse assemblage of native aquatic species, including the Western Pond Turtle *Actinemys marmorata* and the California Floater Mussel *Anodonta californiensis*. We characterized the hydrological patterns of each year's preceding wet season by measuring differences in comparison to the long-term record at a nearby USGS streamflow gauge. Next, we mapped the extent of wetted habitat in a 5.4 km reach of Coyote Creek once each month across the dry season. At the same time, we collected in situ information on several habitat characteristics from remnant pools (e.g., maximum depth, stream temperature). Preliminary results revealed similar patterns of fragmentation and contraction across the dry seasons of 2015 and 2016, along with more reach-specific changes in water quality parameters and pool geometry. We plan to continue this study during non-drought years, including following the extraordinarily wet winter of 2016-17. Our goal is to tease apart the effects of intra-annual and interannual variation in precipitation on patterns of habitat contraction and fragmentation. Ultimately, we aim to understand how changes in habitat quantity and quality during the dry season influence the dynamics of the resident aquatic vertebrates.

Trends in Mysid Abundance in San Francisco Estuary

Zachary Bess, Jim Hobbs, Micah Bisson, Christina Parker, Arthur Barros, Alyssa Alfonso, Abigail Alfonso, University of California Davis

This poster will present data on mysid shrimp catch and species associations with water quality. Samples were collected principally in 10-minute tows with a 0.505-mm-mesh mysid net and simultaneous water quality measurements were performed with a YSI 6600 sonde or a YSI Pro2030 handheld sonde. Mysid sampling occurred in San Pablo Bay and its northern tributaries as well as the Alviso Salt Pond Complex on a monthly basis. Untargeted mysids were also caught in a 0.505-mm-mesh smelt larval survey net deployed during winter months. Tow catches primarily consist of three species: *Alienacanthomysis macropsis, Acanthomysis bowmani*, and *Neomysis kadiakensis/japonica* (cryptic species). Analysis of variance (ANOVA) or a Kruskal-Wallis test will be used to look for a difference in means of these parameters with respect to each species. A 3D graph will be presented to group the three species. The geographic distribution of the three species throughout the sampling region will also be presented. The poster will also present a t-test or Mann-Whitney U Test to present a difference in mysid abundance between the San Pablo Bay and South San Francisco Bay systems.

Tidal Wetland Nursery Function in a Novel Ecosystem
Denise Colombano, Amber Manfree, Teejay O'Rear, John Durand, and Peter Moyle, University of California Davis

Coastal fish nurseries provide essential habitat for juveniles of species that make ontogenetic shifts to adult populations. Currently, the leading hypotheses are that nurseries increase contribution of biomass to adult populations via increases in density, growth or survival, and that connectivity along a habitat continuum facilitates juvenile recruitment. However, we have a limited understanding of nursery functions of highly modified, or novel, coastal wetlands. We asked, 'Do native and alien species partition juvenile rearing habitats in space and time?' and 'What factors contribute to juvenile habitat use in reference and modified marshes?' Using a long-term otter trawl dataset, we examined spatial and temporal patterns of juvenile fish abundance and biomass to identify and classify nurseries in a large brackish wetland that is extensively diked and managed for waterfowl (Suisun Marsh, San Francisco Estuary, California). Further, we evaluated the relative effects of structural complexity, connectivity and food resources on juvenile fish abundance using Generalized Linear Mixed Models. We found that the most abundant species had consistently higher than average annual abundance and biomass in two core habitat patches: a reference marsh (a National Estuarine Research Reserve site) and a modified marsh surrounded by diked ponds and grazed pasture. Additionally, our model results indicated that elevation, vegetation and connectivity to freshwater creeks were important predictors of juvenile abundance, and that species-specific responses varied with freshwater flow. These findings provide evidence for the prevailing nursery paradigm, and show that reference and modified marshes can function as high-value nurseries for native and alien species.

California Department of Fish and Wildlife Ocean Ranch Unit of the Eel River Wildlife Area – Integrative Ecosystem Restoration Planning
Michelle Gilroy, Linda Miller, and Michael van Hattem, California Department of Fish and Wildlife

The California Department of Fish and Wildlife (CDFW) Ocean Ranch Unit (ORU) of the Eel River Wildlife Area (ERWA) is located in the Eel River estuary and represents one of few remaining estuarine and coastal dune ecosystems on the North Coast. CDFW began interdisciplinary program coordination and planning meetings and site specific field data gathering in 2006. The goal of this project is to restore and expand natural estuarine and dune ecosystem functions, including the recovery and enhancement of native species and habitats, including estuarine fish, invertebrates, wildlife, and plants. The primary project objectives are to restore the natural tidal prism and improve connectivity of tidal and freshwater habitats within approximately 475 acres of the ORU brackish marsh complex; control invasive non-native dense-flowered Cordgrass *Spartina densiflora*, and eradicate where feasible European Beachgrass *Ammophila arenaria to* restore natural dune

vegetation communities and restore ecosystem function.

Accomplishments to date include and are not limited to: fisheries and water quality sampling; water level monitoring; Watershed Assessment; tidal marsh analysis; topographic and bathymetric surveys; hydraulic modeling, tidewater goby and northern red-legged frog surveys, and vegetation sampling and vegetation community mapping; planning meetings with numerous project partners; and a CDFW Fisheries Restoration Grants Program and State Coastal Conservancy funded Feasibility Study completed by Ducks Unlimited in December 2015.

Juvenile Salmonid Responses to Recent Off-Channel Habitat Restoration Projects in the Stream-Estuary Ecotone in Humboldt Bay, CA

Michael Wallace, California Department of Fish and Wildlife
Eric Ojerholm, Tony Scheiff, and Mark Zuspan, Pacific States Marine Fisheries Commission

There has been a growing appreciation of the importance of the stream-estuary ecotone (SEE) to juvenile Coho Salmon *Oncorhynchus kisutch* which has resulted in numerous habitat restoration projects being planned and completed in this habitat throughout northern and central California. The California Department of Fish & Wildlife (CDFW) is assessing restoration project performance and working with the restoration community to help design and improve future restoration projects. This poster presents results from the two latest restoration projects in Humboldt Bay; two off-channel ponds in Jacoby Creek completed the fall of 2015 and Wood Creek Phase 2 off-channel wetlands completed the fall of 2016. Both projects were designed to provide juvenile salmonid over-winter habitat, which has been identified as a main factor limiting Coho Salmon production in Humboldt Bay tributaries. Large numbers of juvenile salmonids, mostly Coho Salmon, moved into both project sites during the first large streamflow events each year. During both years in Jacoby Creek the upstream pond was populated by hundreds of juvenile Coho Salmon along with small numbers of juvenile steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*], while in the downstream pond we captured only small numbers of juvenile Coho Salmon. Some fish reared in the upstream pond for months. This year in Wood Creek, juvenile Coho moved into the project site by November and some are still rearing there as of this writing in late January. CDFW has found that juvenile Coho Salmon captured in the SEE are larger than their cohorts rearing upstream in stream habitat and that restoring SEE habitat can benefit salmonids from the entire basin. Both of these recent projects are providing important over-winter rearing habitat for juvenile salmonids.

Sticks and Stones: Habitat Response to Concrete Structure Removal and Large Wood Additions – Olds Creek

Michelle Krall and Trevor Lucas, Pacific States Marine Fisheries Commission
Gayle Garman, California Department of Fish and Wildlife

Using a Before-After Control-Impact (BACI) design, the Monitoring and Evaluation of Salmonid Habitat Restoration (MESHR) team is monitoring habitat and fish response to a restoration project on Olds Creek, tributary to the Noyo River in Mendocino County of Northern California. Olds Creek is one of several in-stream projects we are evaluating using a BACI study design to see if habitat restoration projects meet the goal of enhancing fish habitat. In the second year after removal of the concrete base of an old mill pond dam on Olds Creek, we see measurable changes in pool number and depth, large woody debris volume, sediment sorting, and fish cover.

Barotrauma Related Mortality of Florida-Strain Largemouth Bass from Winter Tournaments in Diamond Valley Lake, CA

Quinn Granfors, California Department of Fish and Wildlife

Fish captured and retained during fishing tournaments can experience initial or delayed mortality from barotrauma caused by the rapid elimination of hydrostatic pressure that occurs when a fish is brought from depth to the surface. Florida-strain Largemouth Bass (FLMB), *Micropterus salmoides floridanus* in Diamond Valley Lake, California are vulnerable to barotrauma-related stress when caught, due to their consistent habitation in depths that result in barotrauma (9 to 27 meters; personal observations). Bass tournaments are held on Diamond Valley Lake (DVL) up to 85% of all weekends annually. The small size

of the reservoir, large number of tournaments and the vulnerability of FLMB to barotrauma-related stress can potentially affect the fishery. Eight bass tournaments were sampled for the incidence of barotrauma-related symptoms and 36-hour delayed mortality rates of bass with and without physical signs of barotrauma, caught as part of catch-and-release fishing tournaments during winter. The 36-hour delayed mortality rates of manually deflated FLMB with barotrauma were determined to be significantly lower than those that were not deflated following capture in winter tournaments. FLMB caught in tournaments with physical symptoms of barotrauma were also more likely to die than those asymptomatic. Bass tournament organizations that manually deflate barotrauma afflicted FLMB by knowledgeable and qualified staff would reduce 36-hour mortalities.

Striped Bass in the Carmel River Basin, Monterey County, California

Cory Hamilton, Monterey Peninsula Water Management District

The Carmel River is a small coastal watershed on the Central California coast that meets the ocean at Carmel Bay, which is located below the Monterey Bay. It is home to a federally listed "threatened" run of steelhead [anadromous Rainbow Trout *Oncorhynchus mykiss*] and is one of the three largest steelhead runs in the South Central California Coast Distinct Population Segment. Striped Bass *Morone saxatilis* were never consistently present in the watersheds of the South Central California Coast, south of Monterey Bay, in contrast to their long-standing abundance in the Sacramento/San Joaquin drainages, and their seasonal presence in near-shore Monterey Bay ocean waters. However, since 2009, unusually large numbers of Striped Bass have consistently been observed in the Carmel River Lagoon. In 2015, Striped Bass adults were observed in the river at approximately 2.5 miles upstream of the lagoon. This marked the first documented case of Striped Bass moving up stream in the Carmel River. In 2016, Striped Bass had been observed up river again, in larger abundances and approximately 8 miles upstream. This poster is meant to document the upstream migration of Striped Bass in the Carmel River over the past few years, and to start the dialogue between potential data needs to address the possible impacts to "threatened" steelhead that occupy these small coastal streams.

Predator Diet and Movement Patterns in the Lower Feather River and Their Effects on Hatchery Smolts

Andrew Hampton, Pacific States Marine Fisheries Commission
Ryon Kurth, California Department of Water Resources

Full in-river release of hatchery origin salmonids, as close to the hatchery as possible, was one of several reforms recommended by the California Hatchery Scientific Review Group (CAHSRG 2012), and a goal of draft Hatchery and Genetic Management Plans for the Feather River Fish Hatchery. However, results from acoustic studies on hatchery origin spring run Chinook Salmon *Onchorynchus tshawytscha* and Central Valley steelhead (CVST) [anadromous Rainbow Trout O*nchorynchus mykiss*] smolts in the Feather River (and out to the ocean) reveal their downstream migration success is very poor. Such high mortality is problematic for advancing toward our goal of full in-river release. Various release techniques have been implemented to improve migration success, however very little improvement has been observed and the direct cause of mortality has not been identified. Predation is one likely source of mortality that may explain poor outmigrating smolt survival in the Feather River. In an effort to better understand the role of predation, we conducted a fish predator study, focusing on movements and diet. Predators such as Striped Bass *Morone saxatilis*, Largemouth Bass *Micropterus salmoides*, Smallmouth Bass *Micropterus dolomieu*, White Catfish *Ameiurus catus*, Channel Catfish *Ictalurus punctatus* and Sacramento Pikeminnow *Ptychocheilus grandis* were tagged with Vemco acoustic tags and monitored over the course of two years. Stomachs from these species were also collected and compared to identify prey selection in the Lower Feather River throughout the entire year. We compared seasonal diets and noted presence and absence of certain species found in the stomach contents. Using angling and acoustic tag data we were able to identify 'predator hotspots'. Identifying these hot spots may provide opportunity to adjust release strategies to minimize predator success.

An Overview of the San Joaquin River Restoration Project

Hilary Glenn, National Oceanic and Atmospheric Administration

The San Joaquin River Restoration Program (SJRRP) is a direct result of a 2006 legal Settlement that ended an 18 year legal dispute involving the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority. One of the two principal Settlement goals was, "To restore and maintain fish populations in "good condition" in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish." Several large populations of spring-run Chinook Salmon *Onchorynchus tshawytscha* used to inhabit the San Joaquin River, until the completion of Friant Dam led to their extirpation over 50 years ago. The SJRRP aims to restore habitat and reintroduce Chinook Salmon populations in the Southern San Joaquin River Basin, through the projects outlined in the settlement. The goal is simple enough, but the various actions required to implement the SJRRP, including ensuring the soundness of the regulatory framework involved, are quite complicated. Initial reintroduction activities required not just the creation of a conservation hatchery facility, the reevaluation of flow regimes, and the collection of broodstock from protected populations, but also the designation of an Experimental Population under Section 10(j) of the Endangered Species Act. This poster focuses on the details, accomplishments, and continuing efforts of the reintroduction, restoration, and monitoring of fish in "good condition" in the San Joaquin River Restoration Area and shares some "lessons learned" for salmon reintroductions elsewhere. The poster will also highlight the large extent of this project that is being undertaken to bring a threatened species back to its native habitat and how that reintroduction will potentially help recover the species within the California Central Valley.

Preliminary Results of a Predation Survey at Daguerre Point Dam on the Lower Yuba River, CA

Sarah Rubenstein, Loren Stearman, John Cleveland, Ryan Greathouse, and Duane Massa, Pacific States Marine Fisheries Commission

Juvenile salmonids face many natural stressors in their environment and human alterations to aquatic systems have the potential to compound these challenges. One such threat includes predation from native and introduced species in altered riverine environments. Dams in particular have the potential to concentrate piscivorous fishes at critical migration points for juvenile salmonids. The purpose of this pilot study is to quantify predation from potential piscivorous fishes on Chinook Salmon *Oncorhynchus tshawytscha* and Rainbow Trout *Oncorhynchus mykiss* in proximity to an ogee low-head dam, Daguerre Point Dam, in the Yuba River. Predatory species were sampled monthly from three different sites by hook and line. Each sampled fish was identified to species, tagged, and underwent nonlethal gastric lavage. Stomach contents were later classified to the lowest possible taxonomic level in a laboratory. Preliminary results indicate that Sacramento Pikeminnow *Ptychocheilus grandis* preyed predominately on nonnative Signal Crayfish *Pacifastacus leniusculus,* while Striped Bass *Morone saxatilis* had more diverse dietary habits of both fishes and invertebrates. Chinook Salmon comprised a minority of all dietary items and Rainbow Trout were absent entirely. Body size was not found to correlate particularly strongly with any dietary items. As a pilot survey, the sampling period for these data encompassed only the tail end of the main migratory period for juvenile Chinook Salmon and ongoing sampling during this year should provide more insight into the dietary habits of piscivorous fishes at this dam during the bulk of the migratory period of Chinook Salmon

Longfin Smelt Distribution, Abundance, and Evidence of Spawning in San Francisco Bay Tributaries

Christina Parker and James Hobbs, University of California Davis

Surveys conducted as part of IEP and other monitoring programs have shown evidence suggesting Longfin Smelt *Spirinchus thaleichthys* may utilize tributaries in North Bay and South Bay as spawning and larval rearing habitat predominantly during high outflow years; however, the frequency and magnitude of the contribution of tributary spawning to adult abundance and year class strength is currently unknown. In January 2015, we began sampling tributaries to the San Francisco Bay Estuary, downstream of the legal Delta, to document the distribution and relative abundance of adults, larvae, and juvenile recruits. In four tributaries, (Napa River, Sonoma Creek, Petaluma River, and Coyote Creek) adults were sampled using an otter trawl monthly, while larvae were sampled (to avoid gear bias)

using a replica of CDFW's Smelt Larval Survey sled biweekly from January through the end of February. In 2016, we included the 20-mm net in the North Bay tributaries from March-June to document juvenile distribution and abundance. Larval and juvenile Longfin Smelt were found in the Napa River, Sonoma Creek and the Petaluma River in 2015 and 2016, however; no larval or juveniles were found in South Bay tributaries. Meanwhile adults were more abundant in South Bay tributaries than the North Bay suggesting this area may operate as a sink to the Longfin Smelt population. Larval life stages were found predominantly in lower salinity (1-3ppt) habitats than juveniles (4-6ppt) and adults (>10ppt), and no Longfin Smelt were found in the North Bay or South Bay after May when water temperatures exceeded 18 ºC. These data suggest Longfin Smelt spawned North Bay tributaries during this critical drought period and at least some fish are frequently found outside of the existing monitoring range. To better document the distribution and abundance of larval and juvenile Longfin Smelt, IEP surveys must be expanded into San Pablo Bay.

Eyes on the Eel: Surveys of Food Webs Assembled Under Different Hydrologic Regimes

Mary Power, Stephanie Carlson, Suzanne Kelson, Gabe Rossi, Phil Georgakakos, Keith Bouma-Gregson, Sarah Kupferberg, Shelley Pneh, Noah Israel, Garbo Gan, Terrance Wang, Victoria Uva, Nick LaPaglia, Wes Slaughter, and Ari Nuri, University of California Berkeley

"Eyes on the Eel" is a multi-year survey of low-flow states of river and tributary food webs along Eel mainstems and tributaries. A Berkeley-Angelo Reserve based crew has been documenting physical conditions, cyanobacterial and algal abundances, invertebrates, and vertebrates along 48 transects and 16 pool-riffle units in four tributaries and four mainstem sites down the South Fork and mainstem Eel River. We are testing the hypothesis that summer food webs are shaped by winter hydrology (whether bed-scouring floods have occurred or not), and summer hydrology (whether flows in sunlit mainstem channels are sufficient to prevent death of edible algae and its replacement by potentially toxic cyanobacteria). During the summer low flow season, the algal-based food web of the Eel River may assemble into one of three alternative states. In 'Salmonid' state, rock substrates and early summer blooms of macroalgae *Cladophora glomerata* become covered with highly edible, fat-rich diatoms, which in turn support invertebrates and tadpoles that are prey for juvenile salmonids and other aquatic predators. Salmonid state generally occurs after winters with one or more scouring floods, which reduce defended, slower-growing grazers. Dicosmoecus state occurs if scouring floods have not occurred during the previous winter. Large, predator-resistant armored grazing caddisfly larvae survive in great numbers, and suppress algae from the start of the low flow season, so that less energy flows up the food web to sustain fish and other predators. If summer flows are severely low, Cyanobacteria state emerges. Cyanobacteria (some potentially neurotoxic, e.g. Anabaena) flourish, and overgrow and smother edible algae stressed by warm stagnant conditions. Eyes on the Eel surveys are comparing food web states in years of contrasting hydrologic regimes to study how environmental conditions, including summer and winter diversions, may steer the river food web toward one or another of these three states.

Making the Carquinez Strait Great Again: Future management of the Peyton Slough Remediation Project

Ali Weber-Stover, AECOM

Large areas of tidal marsh restoration in the San Francisco Estuary are ongoing and planned as a means of improving habitats lost or destroyed within the last 150 years. Legacy contaminants from industrial activities can increase challenges for wetland restoration projects. The Peyton Slough Remediation and Restoration Project in Martinez, California was designed to improve subsided marshland and contaminated soils within Peyton Slough that discharges into Carquinez Strait. Eco Services Operations Corp., current owner of the site and a sulfuric acid regenerator, launched a project in 2004 to reduce mobility of legacy metal contaminants from a former copper smelter that occupied the site, and restore tidal wetlands in the area. Construction was completed in 2006 and monitoring has documented use of the restored wetlands by benthic invertebrates, fish, river otter, waterfowl and shorebirds.

Ten years after construction of the remediation project, stakeholders are challenged with creating a multi-objective management plan for Peyton Slough and its adjacent wetlands. We discuss elements of the

remediation project, potential benefits to fisheries, results from ongoing monitoring efforts on the tidal marsh fish community and discuss challenges of multiple habitat objectives within the Slough.

Juvenile Salmonid Stranding in the Upper Sacramento River

Stacey Alexander, California Department of Fish and Wildlife
Dylan Stompe, Pacific States Marine Fisheries Commission

Reductions in flow throughout the Upper Sacramento River can cause juvenile salmonids to become stranded in pools that were once connected to the river but later become isolated. Juvenile stranding surveys were implemented to observe and report on locations that could potentially contain stranded salmonids. The main objectives of juvenile stranding surveys were to locate new stranding sites and to monitor the known sites for stranded juvenile salmonids. Fish rescues were implemented if juvenile fish were observed in disconnected pools in which survival seemed unlikely after significant flow reductions from Keswick Dam. During monitoring, we observed 180 stranding locations between Keswick Dam and Tehama Bridge (73 river miles). A total of 181 Winter-Run Chinook Salmon *Onchorynchus tshawytscha* and 6,748 Fall, Late Fall, and Spring-Run Chinook Salmon juveniles were observed stranded and rescued by crews during the 2015-2016 season. This data provided information to fishery managers to help determine optimal timed flow releases from Keswick Dam to minimize impacts to juvenile Chinook Salmon in the Sacramento River.

Growth Rate and Abundance Comparison of Longfin Smelt *Spirinchus thaleichthys* Between Wet and Dry Years

James Chhor and James Hobbs, University of California Davis

The San Francisco Bay-Delta is host to the southernmost population of Longfin Smelt *Spirinchus thaleichthys*, which is listed as a threatened species in California. Fall Midwater Trawl (FMWT) surveys show abundance of age-0 Longfin Smelt is correlated with freshwater flow; however, the mechanism behind the pattern is unknown. We hypothesized that along with abundance, growth rates would be higher during high freshwater flow years. As in many estuaries, high freshwater outflow is associated with increased primary production and zooplankton prey availability thus potentially fueling increased growth of Longfin Smelt. We tested this hypothesis using otolith aging techniques to back-calculate size at age-1 for adults, otolith increment widths for juveniles, and estimated growth rates from age-length keys. We found that Longfin Smelt were larger at age-1; however, growth for juveniles were decreased during dry years. Furthermore, we found a persistent reduction in mean length during the September surveys of the FMWT over the years suggesting long-term climate patterns and shorter-term hydrology may be interacting to influence growth and survival of Longfin Smelt. Consistent dry years, lack of freshwater flows, and the threat of increased extremes due to climate change will put Longfin Smelt in a more precarious position than they are currently. If freshwater flows are important to Longfin Smelt abundance and growth, management options that provide adequate freshwater flows will provide a necessary component for Longfin Smelt population recovery.

Utilizing Open Source Software to Visualize Spatial Distribution

Arthur Barros, Christina Parker, M. Bisson, L. Lewis, and James Hobbs, University of California Davis

Visualizing the spatial patterns of fish distribution often requires the implementation of GIS and data management systems such as R, Microsoft Access, and ArcGIS. This can be tedious and frustrating for researchers without the time to learn how to use or implement these systems. However, new, open source software is now available that can be implemented with minimal training, and freely shared among the research community, allowing many groups to include data for visualization and interpretation collaboratively. Utilizing the R program language and packages Shiny and Leaflet, we developed a web-based application to display species distribution and catch data for otter trawl surveys we conducted in the North Bay and Lower South Bay in 2016. The app is a simple tool to visualize catch by species and time frame selected by the end-user and is similar to fish distribution maps available CDFW surveys. The app is scalable using standard GPS data for stations, allowing various research and monitoring groups to contribute to data visualizations, covering several connected survey regions. Also

important is that all the software used in creating this app is open source and free, and available for sharing and collaborating via github. This app is an effective way to allow users and researchers access to the spatial distribution of multiple datasets spatially and temporally. We encourage IEP collaborators to test drive our database via our website (hobbslab.com).

Angling-Induced Selection in Brown Trout *Salmo trutta* and Eurasian Perch *Perca fluviatilis*

Laura Härkönen, University of California Berkeley
Pekka Hyvärinen, Natural Resources Institute Finland
Anssi Vainikka, University of Eastern Finland

Fishing represents the most important source of mortality for adult predatory fishes. It has been suggested that consistent individual differences (CIDs) in fish behavior may explain individual differences in vulnerability to fishing. Any selection acting on CIDs in behavior could affect not only the evolution of behavior but also the evolution of any co-varying trait. We present data from series of behavioral and fishing experiments that link the CIDs in behavior with vulnerability to angling in Brown Trout *Salmo trutta* and Eurasian Perch *Perca fluviatilis*. Based on continuous tracking of PIT-tagged individuals in semi-natural enclosures, both brown trout and perch displayed individually consistent behavior across time and contexts. In both species, angling was demonstrated to impose selection especially on explorative behavior that was not clearly linked with any of the studied life-history traits. Our results also showed that locomotor activity of trout or boldness of perch under predation risk were not directly related to vulnerability to angling. Instead, a higher risk of angling mortality was associated with low body condition in trout and with shoal leadership in perch. In conclusion, due to e.g. state-dependent and social effects on behavioral variation, evolutionary effects and ecological consequences of angling may be more difficult to predict than those of size-selective harvesting, and still require further research.

Age-Zero Survival of *Oncorhynchus tshawytscha* in a Large Regulated River

Justin Call and Jada-Simone White, Pacific States Marine Fisheries Commission
Jason Kindopp, California Department of Water Resources

In the lower Feather River, a coded-wire tag study of >750,000 age-0 wild fall-run Central Valley Chinook Salmon *Onchorynchus tshawytscha* was conducted over a five-year study period (2008-2012). Recovery rotary screw traps were located at an upstream location (Herringer) as well as another location ~12 river kilometers downstream (Sunset Pumps), allowing additional comparisons of both survival and speed of emigration (km/d) between locations. Overall, age-0 Central Valley Chinook Salmon experienced higher survival with faster speed of emigration (km/d) across the five-year study period. Survival was higher in the upper reaches, relative to the lower reaches downstream; as a result, the relationship with speed was stronger for Herringer, relative to Sunset. Coarse examination of environmental variables (water temperature, flow, and turbidity) indicated there were no significant differences between locations. Follow-up analyses will delve into location-specific patterns to elucidate the factors driving the observed variation in survival and speed of emigration of age-0 Chinook Salmon in the lower Feather River.

Seasonal Variation in Survival and Speed of Emigration of Age-Zero *Oncorhynchus tshawytscha* in a Large Regulated River

Jada-Simone Whiteand Justin Call, Pacific States Marine Fisheries Commission
Jason Kindopp, California Department of Water Resources

Water flow-levels in the lower Feather River are regulated by the Oroville Dam. Nevertheless, water releases (and corresponding flows) are generally highest in the winter, when water temperatures are also coldest (December/January). The survival of age-0 Central Valley Chinook Salmon *Onchorynchus tshawytscha* varied predictively with speed of emigration (river kilometers per day); however, patterns coincided with changes associated with the seasonal winter-to-spring transition: survival was highest in January, intermediate in February, and lowest in March. Speed of emigration illustrated a similar trend, with considerably faster speeds (km/d) in January, relative to both February and March. Of the tested seasonal environmental drivers (water temperature, flow, and turbidity), only temperature offered a strong predictive relationship with both survival and speed of emigration across the study

period: survival was greatest when water temperature was coldest and flows were highest (beginning in January) and decreased linearly with seasonal warming and reduced flows across the CWT release period (ending in March). Given the regulated status of the Lower Feather River, flow levels are often sustained. This regulation allows examination of relationships while essentially holding water flow levels constant; however statistical power is admittedly reduced due to smaller sub-sample sizes. For example, the impact of turbidity on survival and speed of emigration was weakly negative or non-significant, respectively, across the study period. However, in March there were sustained lower flows and higher temperatures, during which strong positive patterns in survival and speed driven by turbidity emerged, suggesting possible seasonal variation in foraging rates and/or predation pressure. In summary, wild fall-run Chinook Salmon emergence that corresponds with the earlier winter season may experience enhanced survival rates; however, additional research is necessary to elucidate whether physical and/or biological factors are driving the observed patterns in survival and emigration.

Juvenile Salmonid Habitat Restoration Effectiveness: Pre-Project Monitoring

Tyler Goodearly, Kirsten Sellheim, Michael Beakes, Joseph Merz, and Philip Colombano, Cramer Fish Sciences

Mining and dredging have significantly altered California's Central Valley rivers. In response, river restoration projects are implemented to enhance habitat for salmonids and other native fishes. However, few studies have measured the effectiveness of juvenile salmonid habitat restoration projects in terms of rearing success and reduction in non-native fish species. We conducted pre-restoration monitoring at two locations in the Goldfields reach of the Yuba River. One site (Hallwood) will be restored over the next several years. The other site (Kino), located approximately 1 km downstream from the Hallwood site, will serve as an unenhanced control following restoration implementation. Both sites are long, deep backwater areas connected to the main river channel. We will implement a Before-After-Control-Impact study design to test for differences in rearing habitat quality at the Hallwood site following restoration. To this end, we conducted pre-restoration monitoring at both the restoration and control site to account for existing differences between study sites.

To measure salmon outmigration timing and growth , we injected passive integrated transponder (PIT) tags into 2000 juvenile Fall-run Chinook Salmon *Onchorynchus tshawytscha* from the Feather River hatchery. We released 1,000 tagged fish at the upstream end of each site. We installed fyke nets at the downstream end of both sites to capture PIT tagged juveniles salmonids and other downstream migrants. We also collected environmental data, including temperature, dissolved oxygen, and water velocity. The Kino site was warmer, had lower velocity, and had a significantly higher proportion of nonnative fish compared to the Hallwood site. Fewer PIT-tagged juvenile salmon were captured in the fyke at Kino than at Hallwood, and tagged fish spent more time at Hallwood than Kino before outmigrating.

Following restoration, the two sites will be monitored again, using the same methods, to test for differences in salmonid growth and outmigration timing and non-native fish.

Between a Rock and Hard Place: Balancing Competing Life Stage Needs in Habitat Rehabilitation

Jamie Sweeney, Joseph Merz, Michael Beakes, Kirsten Sellheim, Cramer Fish Sciences
Chris Hammersmark, CBEC Eco Engineering

Coarse sediment is often augmented to stream channels to rehabilitate salmonid spawning and incubation habitat. While general sediment size guidelines have been developed, little is known about specific female spawner preferences or embryo survival among different sediment sizes used for these projects. Furthermore, benefits bestowed by a specific condition for one life stage may not equally benefit the next life stage of a given species (e.g. parent-offspring conflict). To address these concerns, we conducted an experiment on a Northern California salmonid stream in which different sized gravel (small, medium, and large) patches were placed into the stream's degraded spawning reach. We documented Chinook Salmon *Oncorhynchus tshawytscha* spawning activity within the three gravel sizes for three seasons, recording depths and velocities for redds observed. Chinook Salmon embryos were deployed into each gravel size and allowed to incubate until estimated emergence time was reached. Although all experimental gravel sizes

were predicted to be within the spawning population's mobilization capabilities, results from a AICc top-ranked generalized linear model (GLM) incorporating water depth, velocity and mean substrate diameter indicated that the probability of salmon building redds increased as substrate size decreased. Conversely, embryo survival increased as gravel size increased. This decreased survival correlated with higher presence of embryo predators associated smaller gravel. Modeling spawner gravel size selection and embryo survival suggests an intermediate grain size would provide the greatest benefits to ultimate reproductive success. Our results demonstrate that environmental response to restoration actions is neither uniform nor unidirectional and resource managers must consider the potentially competing requirements of multiple life stages to optimize project success.

"Ghost" PIT Tags and Living Fish Have More In Common Then You Might Expect: A Case Study of Watershed Scale Modeling of Tag Fate Over Multiple Winters

Rosealea Bond and Colin Nicol, University of California Santa Cruz and National Oceanic and Atmospheric Administration Southwest Fisheries Science Center
Joseph Kiernan and Brian Spence, National Oceanic and Atmospheric Administration Southwest Fisheries Science Center

Interpretation of Passive Integrated Transponder (PIT) tag detection data from fixed and mobile antennas can be confounded by loose "ghost" tags that have been shed after tagging or liberated when a fish dies. Ghost tag detections can produce biased estimates of movement, survival, or population size if detections are assumed to represent living fish. We have conducted studies to estimate the abundance and document the movement of ghost tags from captive broodstock PIT-tagged Coho Salmon *Oncorhynchus kisutch* smolts in Scott Creek, Santa Cruz County, CA. Ghost tags were identified and georeferenced over four 10 km surveys completed in October 2014, January 2015, November 2015, and May 2016. The combined total of unique ghost tags over the four surveys was 952 and 1203 for BY11-12 and BY12-13 broodstock Coho Salmon tags respectively. Tags were found throughout the mainstem channel, with highest densities within 2100 m of the mouth. The study spanned two winters, in which ghost tags were mobilized by multiple flow events, moving on average 310 m (ranging from 0 to 2000 m). Our results suggest winter flows changed the detectable assemblage of tags by burying them beyond the range of our mobile antennas and potentially transporting them out of the system. We are employing a multi-state modeling approach to estimate the rates at which tags transitioned between the upper, middle, and lower watershed, and between detectable (surface) and undetectable (buried) states.

Improving and Evaluating Warmwater Fisheries in Lake Henshaw

Russell Black, California Department of Fish and Wildlife

Lake Henshaw is a shallow reservoir in Eastern San Diego County created in 1923 with the completion of Henshaw Dam at the confluence of the San Luis Rey River and Matagual Creek. The lake encompasses a relatively flat alluvial floodplain and any sediment transported through the tributaries remains trapped within the reservoir. As a result, much of the submerged fish habitat that existed after the construction in 1923 has been silted over. The importance of structural cover as a component of fish habitat has been well documented. Installing natural brush piles that are complex and durable, such as oak and citrus, are most likely to provide long term habitat to increase juvenile survival. In 2013 The California Department of Fish and Wildlife implemented a plan to monitor and improve reservoir fisheries for the benefit of anglers. The department conducted general fish surveys prior to the introduction of fish habitat in the form of hard wood brush piles, catfish spawning tubes and bluegill attractors. Post project general fish surveys have shown increased condition factors for all species along with increased numbers of Largemouth Bass *Micropterus salmoides*, Bluegill *Lepomis macrochirus* and Channel Catfish *Ictalurus punctatus*.

Analyzing the Response of Delta Smelt to Increased Outflows from the Yolo Bypass

Brian Healy, James Hobbs, and Mackenzie Gilliam, University of California Davis
Naoaki Ikemiyagi, Brian Schreier, Brian Mahardja, California Department of Water Resources

The California Department of Fish and Wildlife (CDFW) conducts the yearly Fall Midwater Trawl Survey (FMWT) to determine the abundance and distribution of fish species within the estuary. Data from this survey have

been used to track the decline of the endangered Delta Smelt *Hypomesus transpacificus*. In December 2016 surveys, a significant number of Delta Smelt were captured across several sites. These findings mark an upward trend in Delta Smelt abundance and come after new management policies were implemented by the North Delta Food Web Action project. This project aimed to increase outflows in the Yolo Bypass to stimulate a plankton bloom that could be utilized by Delta Smelt in downstream locations. We hypothesized that Delta Smelt caught in December 2016 surveys would exhibit higher growth rates than those caught in FMWT surveys from 2011-2014. We extracted otoliths from 31 Delta Smelt caught in December 2016 and used laser ablation technology to determine life history strategies and fall residencies using strontium isotope ratios (87Sr /86Sr). We measured rates of otolith accretion for the month of August to compile growth profiles. Zooplankton data from the Yolo Bypass were analyzed to determine if there was a correlation between flow regime change and habitat productivity. Results showed that Delta Smelt from December 2016 had increased rates of otolith accretion for the month of August compared to 2012-2014 surveys. Strontium isotope analysis showed that all 2016 Delta Smelt were migratory fish that tended to have lower 87Sr / 86Sr ratios for fall months than previous years. Increased flows in July 2016 correlated with higher trends in zooplankton abundance within the Yolo Bypass. This study indicates that the management policies implemented by the North Delta Food Web Action project were effective in increasing zooplankton abundance for utilization by Delta Smelt.

Juvenile Steelhead Trout *Oncorhynchus mykiss* in the Lower American River: Patterns Observed During Drought Flow Conditions (2015) and Normal to High Flow Conditions (2016)

Whitney Thorpe, Luis Santana, Shawn Simkins, and Charles Cardenas, California State University Sacramento
Rob Titus, California Department of Fish and Wildlife

The distribution of steelhead trout [anadromous Rainbow Trout O*nchorynchus mykiss*], native to the Lower American River (LAR) in Sacramento, California, is restricted to the lowermost 23 miles of river. The available spawning and rearing habitat in this stretch of the LAR has been altered by practices including gold mining, building dams, and water management. These and other anthropogenic factors impacting the condition and physical characteristics of the river are being addressed through gravel augmentation and habitat restoration projects that have been, and continue to be, implemented in the LAR to improve the quality of salmonid spawning and rearing habitat. The heterogeneity in both the availability and quality of juvenile steelhead rearing habitat combined with recent severe drought conditions during critical rearing months provided us the unique opportunity to investigate patterns in the population of juvenile steelhead in the LAR. In 2015 and 2016, from April to October, we conducted regular seining surveys at multiple sites along the river (between river miles 5 and 26) to capture juveniles, calculate CPUE, determine relative abundance and relative density, and collect biological data. Our results show that spatial patterns in juvenile steelhead population metrics differed markedly between sites and between the two study years, which we predicted based on the extreme drought conditions encountered during the 2015 field season, and normal to high flows encountered during the 2016 field season.

2017 Meeting Program

Your 2017 Planning Committee, and Program Subcommittee, hope you will value our efforts to combine the wealth of Annual Meeting information into this document. We extend our sincere gratitude to the AECOM, who through their generous sponsorship and additional in-kind support made possible the printing of this Program.

2017 Program Subcommittee

Laurie Earley
Joe Merz
Steven Brumbaugh
Kirsten Sellheim

Deer Creek, Tehama County, California (Photo Courtesy of Laurie Earley)

Metric Conversion Table

Quantity	To convert from metric unit	To customary unit	Multiply metric unit by	To convert to metric units, multiply customary unit by
Length	millimeters (mm)	inches (in)*	0.03937	25.4
	centimeters (cm) for snow depth	inches (in)	0.3937	2.54
	meters (m)	feet (ft)	3.2808	0.3048
	kilometers (km)	miles (mi)	0.62139	1.6093
Area	square millimeters (mm^2)	square inches (in^2)	0.00155	645.16
	square meters (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometers (km^2)	square miles (mi^2)	0.3861	2.590
Volume	liters (L)	gallons (gal)	0.26417	3.7854
	megaliters	million gallons (10*)	0.26417	3.7854
	cubic meters (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic meters (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekameters (dam^3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic meters per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	liters per minute (L/mn)	gallons per minute (gal/mn)	0.26417	3.7854
	liters per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megaliters per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekameters per day (dam^3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lbs)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb.)	1.1023	0.90718
Velocity	meters per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.33456	2.989
Specific Capacity	liters per minute per meter drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per liter (mg/L)	parts per million (ppm)	1.0	1.0
Electrical Conductivity	microsiemens per centimeter (µS/cm)	micromhos per centimeter (µmhos/cm)	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(9/5 x °C)+32	(°F - 32) x 5/9

Thank you for another great meeting and we'll see you in San Luis Obispo in February 2018