Outside the Bubble

Communicating with Our Communities

52nd Annual Cal-Neva AFS Meeting San Luis Obispo, CA

Feb 28 – Mar 2, 2018

Table of Contents

Schedule in Brief

Time	Event	Location
Wednesday Feb 28, 2018		
8:00 am – 5:00 pm	Registration	Lobby
8:00 am – 5:00 pm	Trade Show/Vendor Set Up	General Foyer
11:00 am – 5:00 pm	Poster Set Up	Los Osos
8:30 am – 5:00 pm	Continuing Education 1	SLO Center
8:30 am – 5:00 pm	Continuing Education 2	Edna
8:30 am – 5:00 pm	Continuing Education 3	SLO South
8:30 am – 12:30 pm	Continuing Education 4	SLO North
1:00 pm – 5:00 pm	Field Trip – 1	Offsite
8:30 am – 5:00 pm	Field Trip – 2	Offsite
5:30 pm – 7:00 pm	Poster Social and Tradeshow	Los Osos/SLO North
7:00 pm – 9:00 pm	Student Social	Offsite
Thursday March 1, 2018		
8:00 am – 5:00 pm	Registration	Lobby
8:00 am – 5:00 pm	Trade Show/Vendor Set Up	General Foyer
9:00 am – 11:50 am	Plenary Session	SLO Full
11:50 am – 1:05 pm	Lunch: On Your Own	
11:50 am – 1:05 pm	Cal-Neva Chapter Business Lunch	Edna
1:20 pm – 3:00 pm	Symposia and Technical Sessions	SLO North/Center/South
3:00 pm – 3:20 pm	Break	
3:20 pm – 5:00 pm	Symposia and Technical Sessions	SLO North/Center/South
6:30 pm – 11:00 pm	Grand Social/Banquet	SLO Full
Friday March 2, 2018		
6:45 am – 8:00 am	Spawning Run	
8:00 am – 12:00 pm	Registration	Lobby
8:00 am – 5:00 pm	Trade Show/Vendor Take Down	General Foyer
8:20 am – 10:00 pm	Symposia and Technical Sessions	SLO North/Center/South
10:00 am – 10:20 am	Break	General Foyer
10:20 am – 12:00 pm	Symposia and Technical Sessions	SLO North/Center/South
12:00 pm – 1:15 pm	Lunch: On Your Own	
12:00 pm – 1:05 pm	Student-Mentor Lunch	Atrium
1:20 pm – 3:00 pm	Symposia and Technical Sessions	SLO North/Center/South
3:00 pm – 3:20 pm	Break	General Foyer
3:20 pm – 5:00 pm	Symposia and Technical Sessions	SLO Center/South

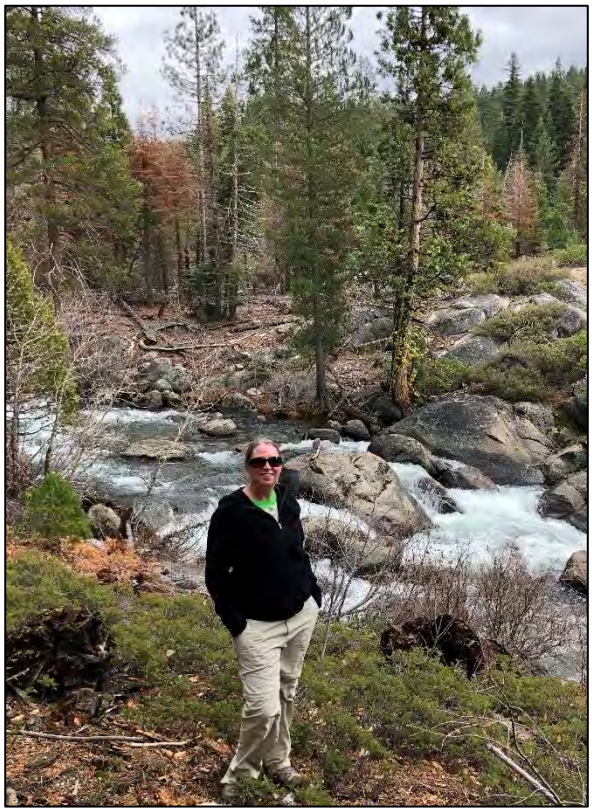
President's Message

Welcome to San Luis Obispo – The Happiest Place in America

52nd Annual Meeting of Cal-Neva Chapter of the American Fisheries Society

On the behalf of the California-Nevada Chapter of the American Fisheries Society, the 2018 Planning Committee, and the Executive Committee, I would like to welcome you to San Luis Obispo. This marks the 52nd Annual Meeting, and we are excited to be traveling to the Central Coast. The California-Nevada chapter is one of the largest chapters in the Society with over 350 members and we make it a point to travel to various locations within our chapter's boundaries. Coming from the Central Valley, it's always a treat for me to travel to the Coastal regions, but it also provides an opportunity to highlight the work and research from colleagues working in marine and estuarine environments. Not only do our meetings enable us to hear about the work in the local area, it provides a chance to learn more about the work going on throughout our diverse region. From the springs in the Great Basin to mountain streams in the Sierras and Cascades, reservoirs to coastal lagoons, our members work on a variety of issues in an effort to advance the science and improve the management of fisheries and aquatic resources.

Scientific meetings provide the perfect venue for disseminating information on the various disciplines within the fisheries profession. We as scientists need to be better communicators, not only with each other, but with those that live and play in the areas in which we work. Improving how we explain our work and present our scientific findings to our colleagues is only the tip of the iceberg. We need to find new ways to connect the public to the science and share how our discoveries are relevant to them. This year's theme*, "Outside the Bubble, Communicating with Our Communities"* will explore how we can be more engaging with the general public and how to get non-scientists excited about the resources we love.



I would like acknowledge that many of us have benefited from AFS and from participating in AFS related events during our careers, whether it was as a student, young professional, or numerous occasions throughout our careers. While you are here at this meeting, I challenge you to find a way to give back to the society. Attend the business meeting and see what issues the Executive Committee are trying to tackle or participate as a judge for the student oral and poster judging. Whether it is through mentoring a student or young professional or becoming more active in the Executive Committee, there are many ways to get involved.

I am proud to have been a part of the Cal-Neva's 52nd Annual Meeting. The Executive Committee officers, the planning committee and all the volunteers, have done a fantastic job in preparing for this conference. If you happen to run into a member of the planning committee, take a second to thank them for all their efforts.

Enjoy the next couple of days with your friends and colleagues, both new and old. Ask questions, reconnect with your passion and learn something new! Cheers!

Laurie A. Earley, M.S.
President, California-Nevada Chapter of AFS

Outside the Bubble – Communicating with Our Communities

We all have groups within which we feel safe, we are more comfortable, and communication comes a bit easier – our bubbles. The scientific community, and specifically the fisheries science community, is a bubble we all operate in. Conferences such as this provide an important forum for scientists to share their research, educate one another, and inspire one another. They allow us to collaborate with those who share our interests, educational background, and experiences. However, science is being questioned more now than ever in modern history. Academic, or simply scientific, is being taken by many to be synonymous to elitist. At this critical time, we must find ways to engage those outside our scientific bubble and relate our research to their lives. We must share how we strive to keep science objective, clearly explain why and how we use complicated math and models, be transparent about our assumptions and imperfections, and effectively convey the significance of our results to our communities. If we do not effectively communicate with people outside our bubble, then science-based policy will likely remain an ideal, rather than reality.

Planning Committee

Planning Committee Chair
Steve Brumbaugh

Fundraising and Donations
Maddelyn Harden

Arrangements and Accommodations
Kelly Souza

Audio/Visual
Sam Provins

Student Presentation/Poster Judging
Tom Keegan

Budget and Finance
Steve Brumbaugh
Jim Hobbs

Poster Session
Kirsten Sellheim

Raffle
Russell Barabe

Student Social
Nick Macias

Merchandise
Christina Parker

Photography
Kat Dale

Time and Place/Catering
Kelly Souza

Registration
Norm Ponferrada

Continuing Education/Workshops
Brian Mahardja

Volunteer Coordination
Claire Ingel

Student Symposium Coordinator
Grace Ghist

Trade Show
Maddelyn Harden

Field Trip Coordination
Julie Day

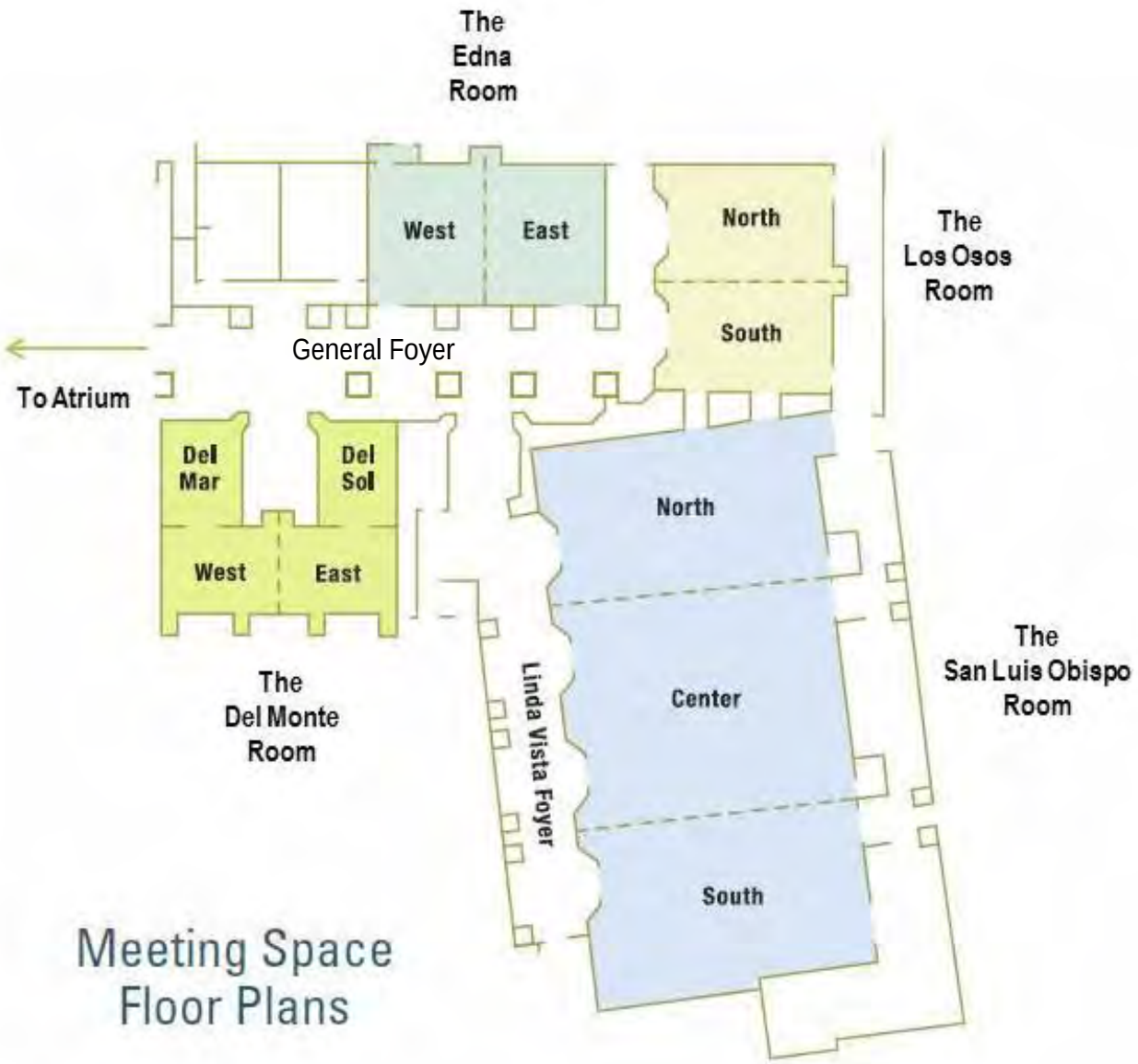
Student-Mentor Lunch
Ramona Swenson

Spawning Run
David Fryxel

Signage
Katie Kobayashi

Program
Steve Brumbaugh
Laurie Earley

Site Map



EMBASSY SUITES by HILTON

General Information

Registration

Registration will be open on Wednesday, February 28th, and Thursday, March 1st, from 8:00 am to 5:00 pm. The last day for registration will be Friday, March 2nd, from 8:00 am to 12:00 noon.

Poster Session

There will be 41 contributed posters on display in the Los Osos and SLO North rooms. Poster set up opens on Wednesday February 28th. Make sure to take a moment to attend the Poster Session Social scheduled from 5:30 pm to 7:00 pm on February 28th. Presenters will be available at this time to answer questions. Posters must be dismantled by 10:00 am on Friday March 2nd.

Student Social

The student social will be held from 7:00 pm to 9:00 pm on the evening of February 28th at Buffalo Wild Wings. This event is being led by the Santa Cruz-Monterey Bay Area student subunit, but is open to all AFS members, and provides an opportunity for students to engage with professionals in an informal setting. Please bring an ID if you plan on consuming alcohol.

Plenary Session

The Plenary Session begins February 28th at 9:00 am in the San Luis Obispo Room immediately following the opening remarks from Steve Brumbaugh (President-Elect, California-Nevada Chapter), Laurie Earley (President, California-Nevada Chapter), Jackie Watson (President-Elect of the Western Division of the American Fisheries Society), and Dan Cassidy (Deputy Executive Director of the American Fisheries Society).

Oral Presentations

There are 9 organized symposia with 79 session papers. Presentations begin on Thursday, March 1st at 1:20 pm. There are up to three concurrent sessions.

Raffle

Raffle items will be on display in the Linda Vista Foyer leading up to the Banquet on Thursday March 1st. The raffle includes many wonderful items including artwork, gift certificates, fishing gear, and a kayak!

Snack Breaks and Beverages

A variety of snacks and coffee will be available during the morning and afternoon breaks in the foyer near the Los Osos Room.

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 Wednesday from 5:30 pm to 7:30 pm, Thursday from 9:00 am to 6:00 pm, and on Friday from 9:00 am to 12:00 pm in the General Foyer. The Tradeshow/Poster Social is held on Wednesday from 5:30 pm to 7:00 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 General Foyer, Los Osos Room, and San Luis Obispo North Room, Wednesday, February 28th

Student Social – Students and professionals – do not miss the Student Social scheduled for Wednesday, February 28th from 7:00 pm – 9:00 pm. The venue will be Buffalo Wild Wings.

Student Mentoring Lunch – The student mentor lunch will be held in the Atrium on Friday, March 2nd , from 12:00 pm – 1:05 pm. This will be a great opportunity to expand your professional network.

Banquet – The Banquet will be held on Thursday, March 1st, in the San Luis Obispo Room from 6:30 pm to 10:30 pm. Dinner will be plated and delivered to your table, based on your pre-selected meal choice. Everyone is welcome at the social, raffle, and auction.

Cal-Neva Chapter Business Lunch

The luncheon meeting will be held from 11:50 am – 1:05 pm on Thursday, March 1st, in the San Luis Obispo Central Room.

Awards Ceremony

The awards ceremony will be held during the banquet on Thursday March 1st. Awards include:

- Best student paper/poster awards,
- The Chapter Award for Special Contribution
- The Chapter Award for Distinguished Professional Achievement
- The Conservation Achievement Award,
- The Chapter Award of Excellence, and
- The Chapter Award for Scientific Journalism

This is a great opportunity to congratulate the winners and their hard work!

Student Awards

AFS Student Oral Presentation and Poster Competition

The Student Oral Presentation and Poster judging competition at the 52nd 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 (16th straight year). Oral presentations will be judged during the Student Symposium, to be held the afternoon of Thursday March 1st. Posters will be judged during the Trade Show and Poster Session, Wednesday evening, February 28th. 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, March 1st.

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.

Katrina Martens 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.

Sponsors and Donors

Many thanks to our generous donors and supporters

ESA

Department of Water Resources · State of California

Tenera Environmental

Stantec

Desert Star Systems LLC

San Francisco Water Power Sewer
Operator of the Hetch Hetchy Regional Water System

Sonoma County Water Agency

AECOM

Lotek Wireless
Fish & Wildlife Monitoring

SFCWA
State & Federal Contractors Water Agency

Helix Environmental Planning

Oregon RFID

HDR

EBMUD East Bay Municipal Utility District

Floy Tag & Manufacturing Inc.

Balance Hydrologics, Inc.®

Plenary Speakers

Jesse Trushenski, Ph.D

Director of Animal Health and Welfare, Evaqua Farms

President-Elect of the American Fisheries Society

Dr. Jesse Trushenski is the Director of Animal Health and Welfare for Evaqua Farms and its sister company, Riverence. In this role, she leads fish health management for both companies, provides recommendations for improved operations, and ensures regulatory compliance. "Fish health management is just that—fish HEALTH management. It's not only about fish diseases and diagnostics," Trushenski says. "It's about understanding what fish need to perform, what the rearing environment can support, and striking a balance that keeps fish in the pink and accounts in the black."

She also provides science leadership and research project management support within the Spring Salmon group. Before joining the private sector, Trushenski was an Associate Professor at Southern Illinois University and Fish Pathologist Supervisor for the Idaho Department of Fish and Game. She holds a B.S. degree from Western Washington University and a Ph.D. from Southern Illinois University. Whether it's fish nutrition, physiology, or health, Jesse has always been driven by the practical applications of science, going from data to information and information to action. Jesse is currently the President-Elect of the American Fisheries Society and will begin her presidency in Fall 2018.

Dean Wendt, Ph.D

Dean of School of Science and Mathematics, Director of the Center for Coastal Marine Sciences, and Executive Director of the San Luis Obispo Science and Ecosystem Alliance at California Polytechnic State University

Dean Wendt is a Professor at California Polytechnic State University, San Luis Obispo. His research and teaching focuses on marine ecology and conservation. One of his longest standing research projects is working with the local fishing community to collect data to better understand the status of our nearshore fish populations. He served for two years on the Master Plan Science Advisory Team as part of California's Marine Life Protection Act and currently serves on the Governing Boards of the Central and Northern Ocean Observing System (CeNCOOS) and the Southern California Coastal Ocean Observing System (SCCOOS), who collectively monitor ocean conditions along California's entire coastline. He is on the Board of Directors of the Morro Bay Community Quota Fund, a non-profit established to hold catch shares under the west coast groundfish catch share program. Dean earned his B.S. in Biology from Cal Poly, San Luis Obispo (1993) and his Ph.D. at Harvard University (1999). He conducted postdoctoral research at the Kewalo Marine Laboratory at the University of Hawaii, Manoa, and held an assistant professorship at the University of North Carolina at Greensboro before arriving at Cal Poly, San Luis Obispo in 2002. He is also Dean of the College of Science and Mathematics at Cal Poly.

Steve Gaines, Ph.D

Dean, Bren School of Environmental Science and Management at University of California Santa Barbara

Steve Gaines is Dean of the Bren School of Environmental Science & Management at the University of California, Santa Barbara. He is a marine ecologist who seeks conservation solutions by linking innovations in ocean science to more effective marine policy and management. His science explores the design of marine reserve networks, climate change impacts on ocean ecosystems, sustainable fisheries management using market based reforms, and the role of aquaculture in meeting the future demand for food. In each of these science endeavors, he has been a strong promotor of more effective communication of ocean science to enhance its impact. Steve holds a PhD from Oregon State University. He has been awarded a Pew Fellowship, the inaugural Marc Hirshman Award for excellence in student mentoring, a fellow of the American Association for Advancement of Science, and the Peter Benchley Prize for Ocean Science.

Field Trips

Wednesday, February 28th

There will be two field tours available for Cal-Neva AFS attendees this year. With the recent fires and resulting mudslides affecting the region, we are grateful for these extra-curricular activities! We hope you will enjoy one of these great events!

Cal Poly Center for Coastal Marine Sciences – Avila Beach Pier Facility

California Polytechnic State University's (Cal Poly) Center for Coastal Marine Sciences (CCMS) was established to foster Cal Poly's 'learn by doing' educational philosophy and address pressing needs in marine resources and ocean health. Cal Poly's CCMS pier facility in Avila Beach provides over 40,000 sq. ft. of space offshore that supports laboratory and field-based research, field-testing of sensors and platforms, educational activities, and industry needs through fee-for-service arrangements. This field trip will visit Cal Poly's CCMS pier for a behind-the-scenes tour of the facility and ongoing projects. (half-day, afternoon). $5

Ocean to Headwaters: An Anadromous Journey Up San Luis Obispo Creek (February 28th, 2018)

This field tour will take an anadromous journey up San Luis Obispo Creek form the confluence with the Pacific Ocean to the headwaters on the Cuesta Grade. Multiple stops and discussions with various professionals along the way will include the estuary; past, present, and future restoration sites; DIDSON monitoring station for adult Steelhead trout; Urban stream issues and hurdles; a walk along Mission Plaza in downtown SLO; Steelhead spawning and rearing habitats; flow monitoring and augmentation; and much more. (full day, lunch not included). $15

Continuing Education

Wednesday, February 28th

Environmental DNA (eDNA) Techniques for Biological Assessment

INSTRUCTORS: Scott Blankenship (scott.blankenship@fishsciences.net) and Gregg Schumer (gregg.schumer@fishsciences.net)
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.

Fish Passage and Screening

INSTRUCTORS: Joseph E. Merz (jmerz@fishsciences.net) and Rocko Brown (Rocko.Brown@fishsciences.net)
Cramer Fish Sciences, West Sacramento, CA

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.

R Introduction

INSTRUCTORS: Brian Mahardja (brian.mahardja@water.ca.gov) and Pascale Goertler (pascale.goertler@water.ca.gov)
California Department of Water Resources, West Sacramento, CA

This course is designed for participants who wish to gain beginning to intermediate skills in using R for manipulating, visualizing, and analyzing their fisheries data. R is a programming language designed for statistical computing that is open source and free to download. R is a powerful and highly flexible tool for graphical display, data configuration, and statistical analysis. Today, R is one of the most widely used statistical software across various scientific fields.

This class will be taught using fishery data from the San Francisco Estuary collected by various agencies (e.g. California Department of Water Resources, California Department of Fish and Wildlife, etc.) and instructor-led examples from their own studies and manuscripts. It is applicable to anyone that conducts environmental monitoring or uses environmental data for research, management, or policy-making and is recommended for anyone needing to become proficient with R basics.

The goal of this workshop is to allow the attendees to understand the potential uses of R when working with fisheries and environmental data. Attendees will learn how to sort and aggregate data, create a variety of high quality and easily customizable graphical display, and perform common data diagnostic and statistical tests.

Please note that attendees will need to bring a laptop to class with the R software program installed. Instructions on how to download the program will be emailed out prior to the class. Instructors will also be available to help attendees with the download at the beginning of class if needed.

Surviving Peer-Review

INSTRUCTOR: Jesse Trushenski (jesse@evaquafarms.com)
Evaqua Farms, Filer, ID

In this workshop, we'll review the basics of technical articles and then launch into an in-depth discussion of the peer-review process, roles and responsibilities of reviewers and editors, and how constructive reviews can help authors achieve the goals of Surviving Peer Review. We will also provide recommendations on how to shepherd a manuscript through the revision and resubmission process.

Plenary Schedule

Thursday, March 1st

9:00 am - 9:15 am	**Welcome Address**	**Steve Brumbaugh, President-Elect, Cal-Neva AFS and Laurie Earley, President, Cal-Neva AFS**
9:15 am - 9:25 am	**WD Perspective**	**Jackie Watson, Western Division AFS President-Elect**
9:25 am - 9:35 am	**A Word from Bethesda**	**Dan Cassidy, AFS Deputy Executive Director**
9:35 am - 9:50 am	**Session Overview**	**Steve Brumbaugh**
9:50 am - 10:20 am		**Jesse Trushenski, Evaqua Farms, AFS President-Elect**
10:20 am - 10:40 am	***Break***	
10:40 am - 11:10 am		**Dean Wendt, California Polytechnic State University**
11:10 am - 11:40 am		**Steve Gaines, UC Santa Barbara**
11:40 am - 11:50 am		**Q&A**

Symposium and Technical Session Details

Session # 1 & # 2 **Student Symposium**
Organizers: Grace Ghrist and Maddie Halloran, Humboldt State University
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.

Session # 3 **The State of Fisheries Bioengineering and Ecohydraulics in 2018**
Organizers: Randy Beckwith, Department of Water Resources
Michael Garello, HDR Engineeering

The goal of the AFS Bioengineering Section is to promote excellence in the field of fisheries bioengineering through improved communication between biologists, engineers, other professionals working for the conservation of fisheries resources, and the public at large. In the fisheries world, bioengineering is the merging of biology and engineering for the benefit of fish species, typically through the construction of projects that enhance fish populations. Closely related is ecohydraulics, which is the study of the relationship between physical processes (hydraulics, hydrology, fluvial geomorphology) and aquatic ecosystems.

This session will provide informative presentations which span the breadth of bioengineering efforts in California and Nevada, including migration and habitat improvement projects, case-studies, lessons learned, project resiliency with respect to climate variability, and how new technologies and thinking may be applied to future projects. Presentations will discuss the full suite of technical and environmental challenges associated with these projects, why solutions are site-specific, and how experts collaborate to develop the best project possible. Also, there will be a focus on connections between project proponents and the public, agencies, politicians, NGOs, and other interested parties. A panel discussion will present various viewpoints on the state of bioengineering and where it might evolve to in the future. The panel discussion will be interactive and session attendees will be encouraged to engage in the conversation.

Session # 4 **Management of Resident Salmonids**

Session # 5 **Conservation Biology of California's Native Freshwater and Anadromous Fishes**
Organizers: Damon Goodman, U. S. Fish and Wildlife Service
Stewart B. Reid, Western Fishes
Andrew P. Kinziger, Humboldt State University
Alicia Seesholtz, Department of Water Resources

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 symposium 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 – native freshwater and anadromous fishes.

Session # 6 **Management of Anadromous Salmonids**

Session # 7 **Southern California Steelhead Trout**
Organizer: Candice Meneghin, CalTrout

In 2017 CalTrout and UC Davis Center for Watershed Sciences released *State of the Salmonids II: Fish in Hot Water*, an in-depth report that details the status of California's 32 native salmon, steelhead, and trout. At the current rate, 45% of California salmonids are likely to be extinct in the next 50 years. This includes 11 of 21 anadromous species (52%) and 3 of 10 inland species (30%). Once numbering in tens of thousands, Southern steelhead populations are now is danger of extinction within the next 25-50 years, due to dams, development, water extraction, pollution, and climate change all taking their toll. Despite being federally listed under the Endangered Species Act over 20 years ago, Southern steelhead abundance has continued to decline to precariously low levels. A level of concern score of critical was given in the report. Southern steelhead represent the southern edge of the species' range, and, as such, are critically vulnerable to climate change. The top three anthropogenic threats to the species include major dams, urbanization and estuary alteration.

Our session will cover several strategies currently underway to restore resilience to the species, which include: CalTrout led steelhead coalitions with a headwaters-to-ocean management approach, advocacy and litigation, research and monitoring, dam removal, enhancing instream flow, and habitat restoration that focusses on greater abundance, genetic diversity, and access to diverse habitats.

Session # 8 **Reconciliation Ecology and Novel Ecosystems: New Approaches to Understanding Fish Communities and Ecosystems**
Organizer: Denise Colombano, University of California Davis

In the past 200 years, California's aquatic ecosystems have been transformed into irreversibly altered into human-dominated systems supporting a diverse mixture of native and non-native species. In such novel ecosystems, traditional approaches to environmental management -- including conservation, preservation, and restoration -- are unlikely to significantly improve conditions for native species. In contrast, reconciliation ecology focuses on sustaining biodiversity and ecological services in novel ecosystems, recognizing that people are the dominant players. In particular, human alterations of the San Francisco Estuary make such traditional approaches both politically unviable and physically and biologically infeasible. In this symposium we introduce the concepts of reconciliation ecology and novel ecosystems and then show why they are important for management of the estuary's ecosystem, especially as a realistic path to conservation to native species. We then provide insights from recent research on how they apply to local floodplains, creeks, and freshwater, brackish and salt marsh habitats.

Session # 9 **General Session**
Organizers: Steve Brumbaugh, California Department of Water Resources
Jim Hobbs, University of California Davis

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

Session # 10 **Fish Reintroduction Efforts**
Organizer: Laurie Earley, U.S. Fish and Wildlife Service

With recent declines in populations across the world, various conservation measures are being implemented in an effort to recovery them. Species reintroduction and translocation are options used when working with species that have a high risk of extinction, because of a reduced range, limited gene flow, or have been extirpated from historical habitat. Reintroduction efforts are conducted to reestablish populations in former habitats; while translocation efforts are made to introduce animals to new environments with high quality habitat. The primary goal of any reintroduction or translocation project is to establish a genetically diverse and self-sustaining population. Reintroduction and translocation is an important species management tool that has been applied in both terrestrial and aquatic environments. Recently there has been a focus in reintroducing and translocating fish populations in California and Nevada, especially during and after the recent drought. These actions focus both on the anadromous species and resident endemics found within the region. As more reintroduction and translocation projects are completed and get underway, it is important for scientists and managers to share their experiences in order to improve future efforts. This session will provide the opportunity to share information about considerations, planning, implementing, and monitoring fish reintroduction and translocation efforts in watersheds throughout California.

Oral Presentation Schedule

THURSDAY AFTEROON ✠ MARCH 1, 2018

Session Name	Student Symposium 1	The State of Fisheries Bioengineering and Ecohydraulics in 2018	Student Symposium 2
Moderator(s)	Grace Ghrist	Randy Beckwith/Mike Garello	Maddie Halloran
Room Name	SLO North	SLO Center	SLO South
1:20	Does Freshwater Life History affect Marine Survival Rate of Coho Salmon? Grace Ghrist	River Restoration Value: Examples from a Single-Species Approach on a Large, Urban River Joe Merz	Estuarine Fish Movements in a Natural Brackish Marsh Denise Colombano
1:40	Movement and Survival of Reintroduced Juvenile spring-run Chinook Salmon in the San Joaquin River and Delta Gabriel Singer	Rescaling Central Valley Rivers: Reconciling Theory with Practice Rocko Brown	Migration Decisions Made Under the Risk of Predation for Wild and Hatchery Salmon Megan Sabal
2:00	Isotope Tools to Track Floodplain Rearing of Native Fishes Miranda Tilcock	Spawning and Rearing Habitat Restoration – from Moving Papers to Moving Rocks and Soil John Hannon	Winter Movement and Survival of Juvenile Coho Salmon *Oncorhynchus kisutch* in Freshwater Creek, California Nick Van Vleet
2:20	The Use of Ultrasounding to Assess the Gonadal Maturation of Steelhead and Cutthroat Trout Jasmine Iñiguez	Engineered restoration on Coon Creek for the Re-Colonization of Steelhead trout *Oncorhynchus mykiss* Freddy Otte	Application of Wind Fetch and Wave Models for a Proposed Conservation Bank in Suisun Bay, California Jacob Vander Meulen
2:40	Feeding Responses of Prey Under Predation Threat: Effects of Developmental Plasticity Emerge in Mismatched Environments Rebecca Robinson	Climbing Above the Competition: Innovative Approaches and Recommendations for Improving Pacific Lamprey Passage at Fishways Damon Goodman	Morphology Affects Dispersal of Eel Larvae in the Eastern Pacific Katherine Dale
	BREAK		
Session Name	Student Symposium 1	The State of Fisheries Bioengineering and Ecohydraulics in 2018	Management of Resident Salmonids
Moderator(s)	Grace Ghrist	Randy Beckwith/Mike Garello	Dave Lentz
Room Name	SLO North	SLO Center	SLO South
3:20	Poor Oceanographic Conditions Likely to Reduce Reproductive Output in Multiple Brooding Rockfishes Sabrina Beyer	Anticipating Maximum Channel Fill During Sedimentation Pulses Following Episodic Events Barry Hecht	The Salmonid Population Viability Project: Modeling Trout Viability in a Desert Landscape Daniel Dauwalter
3:40	Drifting into the Future: Advancing Methodology for Quantifying Invertebrate Drift in Lotic Ecosystems Utilizing Next-Gen Camera Technology Nicholas Macias	Floodplain Reconnection and Fish Passage Improvement on Butano Creek Chris Hammersmark	Entrainment Risk for Rainbow Trout at a Hydroelectric Turbine Intake in the South Fork Rubicon River, California Ethan Bell
4:00	Insulin-like Growth Gactor-1 (Igf1) as a Hormone Biomarker for Assessing Growth Rates of Rockfish in Marine Protected Areas Nicole Hack	Bedrock Coho Barrier Mitigation Through Roughened Channel Construction and Natural Gravel Recruitment Brad Job	CDFW Trout Management: Evolving Directions from the Past to the Future Dave Lentz
4:20		Mill Creek Riparian Restoration in Ukiah – Design of Fish Passage in a High-Flow Backwater of the Russian River Denis Ruttenberg	Pre-Stocking Evaluation Protocols and Trout Allotment Development in the Information Age Michael Mamola
4:40		PANEL	

FRIDAY MORNING ✠ MARCH 2, 2018

Session Name	**Conservation Biology of California's** Native Freshwater and Anadromous Fish	Management of Anadromous Salmonids	Southern Steelhead
Moderator(s)	Damon Goodman/Alicia Seesholtz/Stewart Reed	Javier Linares	Candice Meneghin
Room Name	SLO North	SLO Center	SLO South
8:20	Unraveling Range-wide Extinction-Colonization Dynamics in an Endangered Fish Using Occupancy Modeling and Environmental DNA Chad Martel	Seven Decades of Chinook Salmon Hatchery Releases at the Edge of the Species Range: Spatiotemporal Trends and Management Implications Anna Sturrock	Matilija: Breaking the Barrier Paul Jenkin
8:40	Rangewide Tidewater Goby Occupancy Survey Using Environmental DNA Michael Sutter	Effects of Straying and Variable Cohort Success on the Sacramento Basin Fall-Run Chinook Salmon Stock as Seen in River Sport Fishery Monitoring Rob Titus	Working Toward Instream Flow Enhancements: Modeling Surface Water, Groundwater, and Water Use to Inform Policy Development in Critical Salmonid Streams in the Ventura River Watershed Kevin DeLano
9:00	Range Fluctuations in Pacific Lamprey Along the Arid Pacific Coast of Southern California and Baja California Stewart Reid	Restoration on a Small Stream Provides Home for Chinook Salmon Eric Chapman	Integrated Strategies for Enhanced Instream Flow in Santa Barbara and Ventura Counties Mauricio Gomez
9:20	Abundance and distribution of native fishes in the Santa Ana River, California, an effluent-dominated urban river, 2015-2017 Larry Brown	JSATS Study: Emigration Survival of Spring-Run Chinook Salmon Juveniles in the Lower Feather River, 2013-2015 Jada-Simone White	Evolutionary Restoration of Southern California Steelhead Devon Pearse
9:40	Rescue, Captivity and Translocation: Recovery Challenges of the Unarmored Three-spine Stickleback *Gasterosteus aculeatus williamsoni* Tim Hovey	Evaluation of Long-Term Mark-Recapture Data for Estimating Abundance of Juvenile Chinook Salmon on the Stanislaus River from 1996 to Present Tyler Pilger	The Effects of a Prolonged Drought on Southern Steelhead Trout Ethan Bell
	BREAK		
Session Name	**Conservation Biology of California's** Native Freshwater and Anadromous Fish	Management of Anadromous Salmonids	Reconciliation Ecology and Novel Ecosystems: New Approaches to Understanding Fish Communities and Ecosystems
Moderator(s)	Damon Goodman/Alicia Seesholtz/ Stewart Reid	Javier Linares	Denise Colombano
Room Name	SLO North	SLO Center	SLO South
10:20	Lacustrine Habitat of the Clear Lake Hitch Frederick Feyrer	Effects of Flow-Related Variables on Juvenile Coho Salmon Oversummer Survival in Intermittent Coastal California Streams Mariska Obedzinski	Reconciliation Ecology and Novel Ecosystems: New Approaches to Understanding Fish Communities and Ecosystems. Peter Moyle
10:40	An Exploration of the Threats Facing Downstream Migrating Pacific Lamprey in California Damon Goodman	Empirical Model of In-Redd Temperature and Discharge Dependent Mortality: Spring-Run Chinook Salmon on Clear Creek (Shasta County, CA) Samuel Provins	Environmental variability and fish community structure among tidal saltmarshes of San Francisco Bay Arthur Barros
11:00	Testing Hypotheses for Low Capture Rates of Juvenile Green Sturgeon at Fish Protection Facilities: Louver Efficiency under Various Conditions Anna Steel	Piscivore Dynamics and Diet below a Low-Head Dam on the Lower Yuba River, California Loren Stearman	Accelerated Growth of Juvenile Salmon in a Managed Wetland Relative to Historic and Leveed Sloughs in Suisun Marsh Nicole Aha
11:20	Experimental Assessment of Predation Risk for Juvenile Green Sturgeon *Acipenser medirostris* by Two Predatory Fishes: Striped Bass *Morone saxatilis* and Largemouth Bass *Micropterus salmoides* Sarah Baird	Assessment of Juvenile Chinook Salmon Rearing Habitat Potential Along the Lower San Joaquin River Jesse Wiesenfeld	Reconciled Floodplains in the Central Valley: Understanding Process for Species Management Carson Jeffres
11:40	Notable Sturgeon Discoveries in the Feather River During 2017 Alicia Seesholtz	Recovered PIT tags in an *Oncorhynchus mykiss* Study: Patterns and Implications for Future Research Kate McLaughlin	

Session Name	**Conservation Biology of California's** Native Freshwater and Anadromous Fish	General Session	Fish Reintroduction Efforts
Moderator(s)	Damon Goodman/Alicia Seesholtz/Stewart Reid	Jim Hobbs	Laurie Earley
Room Name	SLO North	SLO Center	SLO South
1:20	Evidence for the genetic-basis and inheritance of ocean- and river-maturing life histories of Pacific Lamprey (Entosphenus tridentatus) in the Klamath River, California Keith Parker	The 2015 Columbia River Salmon Run-an Omen of the Future in a Warming World? Jeffrey Fryer	There's No Place Like Home – Reintroductions to Historic Habitats as a Tool for Fish Recovery Jonathon Ambrose
1:40	A tale of missing fins: evidence for a rapid phenotypic shift in Amargosa Pupfish following an increase in habitat temperature Sean Lema	Bursting Bubbles: Lessons from an Interactive Information Integration System for Enhancing Communication and Science on Central Valley Salmonids Joshua Israel	Strategies for Reintroduction of Salmon and Steelhead into Newly Available or Restored Habitat Carlos Garza
2:00	"One ear to the ground": Using isotopic analysis of otoliths to investigate the life history of Delta Smelt Malte Willmes	Better Together: Fisheries Technology and Communication Erin Loury	Utility of Genetics in the Reintroduction of Chinook Salmon to the San Joaquin River Anthony Clemento and Carlos Garza
2:20	A Bayesian hierarchical model of postlarval delta smelt entrainment: integrating transport, length composition, and gear efficiency in estimates of abundance William Smith	Comparing observed fish density, and community structure between an ROV and a stereo-video lander Christian Denney	Coho Salmon Reintroduction and Monitoring in the Russian River as a Recovery Tool Nicholas Bauer et al.
2:40	Juvenile Green Sturgeon migration from the upper Sacramento River to the legal Delta: 2016-2017 Chad Praetorius	Opportunities and Limitations of Pop-Up Satellite Tags in Fresh Water Environments Marco Flagg	Reintroduction of Sacramento River Winter-run Chinook Salmon to Battle Creek Kevin Niemela
3:00	BREAK		
Session Name		General Session	Fish Reintroduction Efforts
Moderator(S)		Jim Hobbs	Laurie Earley
Room Name		SLO Center	SLO South
3:20		Spatial and Temporal Patterns of Variation in Nearshore Ichthyoplankton in Santa Monica Bay, California John Steinbeck	Evaluating Feasibility of Winter-run Chinook Salmon Reintroduction Upstream of Shasta Dam John Hannon et al.
3:40		Genomic Analysis of Disjunct Marine Fish Populations of the Northeastern Pacific and Sea of Cortez Eric Garcia	Reintroducing Arroyo Chub to the Arroyo Seco Wendy Katagi
4:00		A Tale of Two Gobies: Non-native Tridentigers in San Francisco Bay Daniel Chase	Miller Lake Lamprey: The Return Home, One Bucket at a Time. Stewart Reid
4:20		The environmental drivers of habitat use by Silicon Valley's estuarine fishes Levi Lewis	Owens Pupfish: 49 Years of Management by Translocation Nick Buckmaster and Steve Parmenter
4:40		Stream Size and Network Position Affect Diversity in Different Ways in Stream Fishes Loren Stearman	

FRIDAY AFTERNOON ✠ MARCH 2, 2018

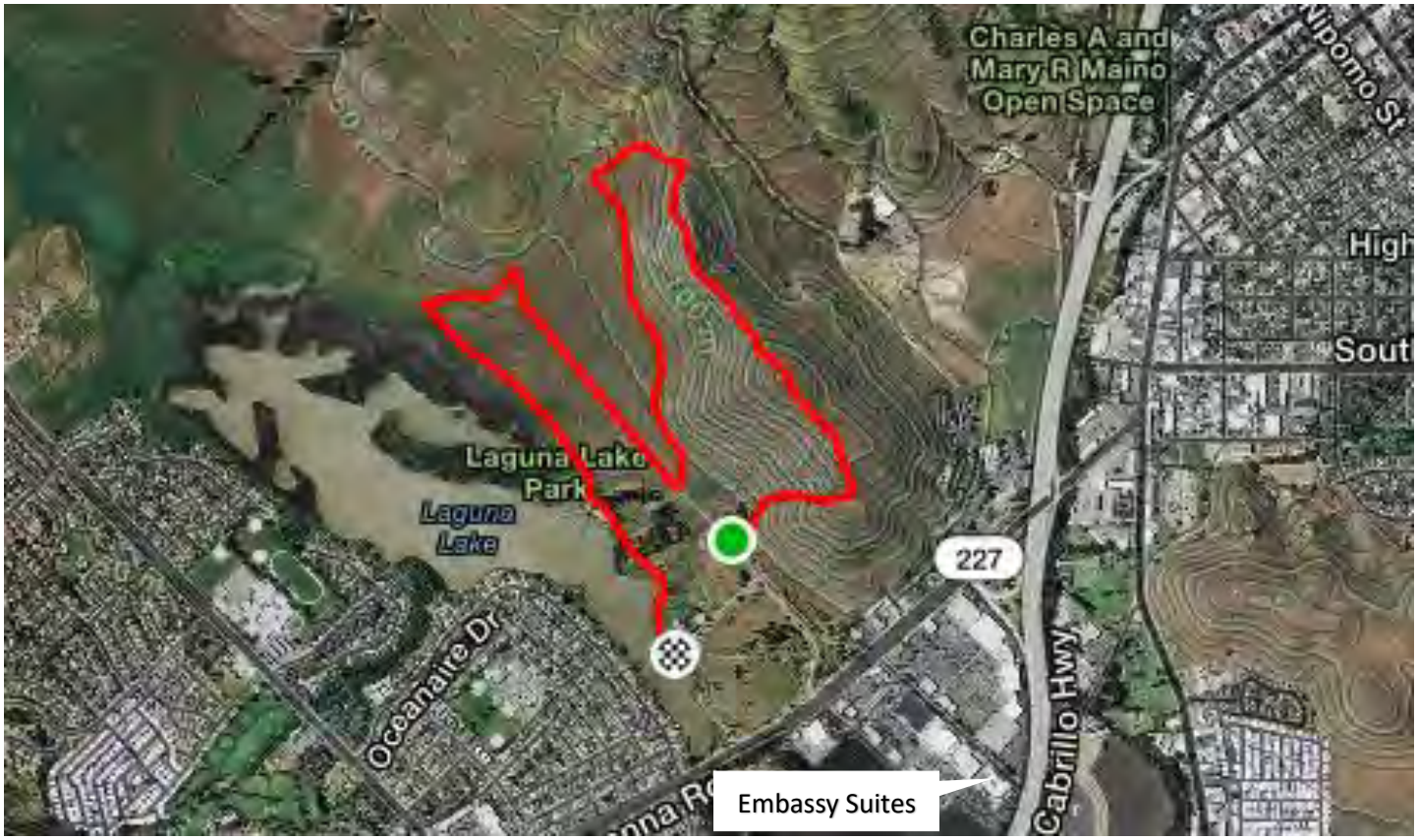
Poster Presentations

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

Number	Abstract Title	Lead Author
1*	Growth Rate Variation Among Juvenile Chinook Salmon Cohorts and Rearing Conditions	Elianna Rosenthal
2*	The Effect of Juvenile Life History on the Marine Survival Rate of Coho Salmon	Grace Ghrist
3*	Is El Niño Driving Poleward Range Expansion of Marine Organisms	Justin Palmer
4*	Environmental Impacts of Deepwater Floating Offshore Wind and Wave Energy Facilities	Hayley Farr
5*	Juvenile Coho Salmon Life History Variants in Humboldt Bay Tributaries	Madison Halloran
6*	Eye Lenses as an Alternative to Otoliths for Reconstructing Life Histories of Juvenile Salmon	Miranda Tilcock
7*	Investigating Physical Drivers of Straying Behavior in Hatchery-origin Adult Chinook Salmon Through Ecohydralic Analysis	Sean Luis
8*	Ontogenetic Shift in Long-term Habitat Preference of Blue Rockfish	David Hernandez
9*	Evaluating Insulin-like Growth Factor-1 (Igf-1) as a Hormonal Biomarker for Growth Rate in Copper Rockfish	Kasey Cordova
10*	Ontogenetic Niche Shift in Early Life-stage Sturgeon	Sarah Mehl
11*	Contribution of Juvenile Estuarine Residency to Chinook Salmon Recruitment in Redwood Creek, California	Emily Chen
12*	Thermal Variation in Juvenile Chinook Habitats in their Pacific Range	Dalia Dull
13*	Spatial Variation in Juvenile in the Prey Availability and Production Potential of Juvenile Chinook Salmon Along the San Joaquin River Restoration Area During Drought Conditions	Karen Boortz
14*	The Role of Disturbance on San Joaquin River Macroinvertebrate Assemblages: Implications for Chinook Salmon Survival and Growth	Emily Ramirez
15*	Habitat-specific Diet Analysis of Sacramento Pickeminnow and Striped Bass in the Sacramento River	Dylan Stompe
16	Effects of Fasting on the Insulin-like Growth Factor-1 (Igf-1) System of Juvenile Cabezon	Jackson Strobel
17	A Potential New Source of Groundfish Age and Length Data: A Pilot Study of Pre- and Post-Fillet Length from Commercial Passenger Fishing Vessels	Chandler Skinner-Horne
18	Using Environmental DNA to Detect Pacific Lamprey in Water Samples in Northern California	Ely Boone
19	The California Collaborative Fisheries Research Program: Implementation and Expansion of a Statewide Marine Protected Area Monitoring Program	Dante DeLany
20	Impact of Increased Incubation Temperature and Thermal Stress on the Aerobic Scope and Thermal Tolerance of Juvenile Rainbow Trout	Nicholas Balfour
21	Life History of Juvenile Chinook Salmon in the Yolo Bypass	Rachel Fichman
22	Variation in Growth of Juvenile Chinook in the Yolo Bypass	Rachel Fichman
23	2017 McCormack-Williamson Tract Fish Rescue and Relocation Project	Eric Sommeraur
24	Efficacy of Collapsible Minnow Traps in Removing Black Bullhead from a Remote Trout Stream	Russell Barabe
25	Striped Bass Response to Carbon Dioxide in the Tracy Fish Collection Facility Primary Channel	Brandon Wu
26	Use of Acoustic Telemetry to Estimate Juvenile Chinook Salmon Facility Efficiency at the Tracy Fish Collection Facility	Branden Wu
27	Investigations of Predator Effects on Hatchery Smolts in the Lower Feather River	Andrew Hampton
28	Improvements to Pacific Lamprey Video Monitoring at Coleman National Fish Hatchery Barrier Weir Fish Ladder	J. Ryan Cook
29	Locating Aquatic Refugia During Prolonged Drought in Santa Barbara and Ventura Counties	Kyle Evans
30	Comparing Pre- and Post-project Monitoring Data for Merced River Salmonid Habitat Restoration Projects	Philip Colombano

Number	Abstract Title	Lead Author
31	Comparison of Three Sampling Methodologies to Estimate Numbers of Juvenile Coho Salmon in Two Russian River Tributaries	Andrew McClary
32	Spatiotemporal Differences in Juvenile Salmon Condition and Diet in the Sacramento-San Joaquin Delta Across Extreme Hydrologic Conditions	Mollie Ogaz
33	Extended Rearing of Juvenile Chinook Salmon After Habitat Restoration on the Merced River	Kirsten Sellheim
34	Planning Infrastructure Improvements at Coleman National Fish Hatchery to Aid in Restoration Efforts of Natural Salmonid Runs in Battle Creek	Javier Linares
35	Identifying Drivers of Fish Assemblage Dynamics in a Hydrologically Altered Lagoon	Baker Henry
36	Ghost PIT tag Distribution and Movement from Water Year 2015, WY 2016, and WY 2017	Rosealea Bond
37	Optimizing Semi-autonomous eDNA Sampling for Fisheries Applications	Yekaterina Karpenko
38	Environmental Factors Effecting Hourly Juvenile Chinook Salmon Emigration Patters in Two Northern California Creeks	Mike Schraml
39	From 40 to 50 Fathoms: A Size Comparison of Commonly Caught Rockfish off San Luis Obispo County, California After the Extension of Recreational Fishing Depth in 2017	Matt McKechnie
40	Beyond the Noise: Sound Fisheries Management in the 21st Century	Kevin Kumagai
41	CDFW Proposition 1 Restoration Grant Program Funding Opportunities for Fisheries and Watershed Restoration	Gena Lasko

Spawning Run



The course this year will be beautiful and is just a short walk from the hotel. The course starts with a big hill climb, then it mellows out. It is almost exactly a 5 K (3.1 miles).

Ideally, participants should download the free Strava Running App to stay on course. Once that is done:

1. Find the Spawning Run Coordinator's profile (Dave Frxl) and view his course entitled "**Laguna Lake Spawn Run 2018**."
2. Click "**Use Route**" and you can track the route on your phone as you run.

**There will be NO signs marking the route since this is not an official city event, and more an informal CalNeva AFS running club.

Alternately, spawners can email Dave Fryxell (dcfryxell@gmail.com) for additional maps including a .gpx file which can be opened with google earth, and photos of the route, but these probably shouldn't be used for navigation.

The clock will start at exactly the same time for everyone. Dave Fryxell will be at finish line giving people numbers in the order they finish.

The first male finisher and the first female finisher will each get a gift card to REI!

City of San Luis Obispo

Eats

Nautical Bean Coffee House
11560 Los Osos Valley Rd #150
(805) 543-3559

Madonna Inn Copper Café
100 Madonna Rd
(800) 543-9666

Panera Bread
229 Madonna Rd
(805) 547-1800

Buffalo Wild Wing
309 Madonna Rd.
(805) 785-0490

Sushiya
11560 Los Osos Valley Rd., Ste 160
(805) 595-1500

Laguna Grill
11560 Los Osos Valley Rd., Ste 110
(805) 547-1485

Rib Line BBQ and Grill
12308 Los Osos Valley Rd
(805) 543-7427

High Street Market and Deli
350 High St
(805) 541-4738

Mama's Meatballs
570 Higuera St #130
(805) 544-0861

Goshi's Japanese Restaurant
570 Higuera St #155
(805) 543-8942

Ciopinot Seafood Grill
1051 Nipomo St
(805) 547-1111

Drinks

Spikes Pub
570 Higuera St
(805) 544-7157

Barrel House Brewing SLO
1033 Chorro St., Basement Level
(805) 296-1128

McCarthy's Irish Pub
600 Marsh St.
(805) 544-0268

Black Sheep Bar and Grill
1117 Chorro St.
(805) 544-7433

SLO Brew
736 Higuera St.
(805) 543-1843

Creeky Tiki
782 Higuera St.
(805) 544-2200

The Library
721 A and B Higuerra St.

Marston's Bar and Grill
673 Higuerra St.
(805) 544-3668

Bull's Tavern
1040 Chorro St.
(805) 543-2217

Sidecar
1127 Broad St.
(805) 540-5340

Oral Presentation Abstracts

#1. Student Symposium

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

Does Freshwater Life History affect Marine Survival Rate of Coho Salmon?

Grace Ghrist and Darren Ward, Humboldt State University

Juvenile Coho Salmon *Oncorhynchus kisutch* in coastal California streams exhibit various life history strategies during their freshwater development. One strategy of interest to managers and conservationists is the early emigrant. This juvenile type migrates from natal habitat into lower parts of the watershed or estuary during the winter, where it rears before migration to the ocean in spring. By contrast, the more prevalent life-history type resides in natal reaches over the winter and emigrates the following spring. Salmon monitoring programs generally estimate juvenile production and demographic rates using only spring emigrants. In a Northern California stream, we PIT tagged juvenile Coho Salmon in the fall and detected their movements throughout the stream and estuary over their first winter, and then as they returned to spawn as adults. With the use of a multistate mark recapture model, we tested for distinct marine survival rates between these emigration periods. Our model allowed us to incorporate multiple life history strategies onto a single platform which can be used to report unbiased survival estimates of juvenile Coho Salmon.

Movement and Survival of Reintroduced Juvenile Spring-run Chinook Salmon in the San Joaquin River and Delta

Gabriel Singer, Eric Chapman, Colby Hause, Chris Bolte, Nann Fangue, and Andrew Rypel, University of California, Davis

The construction of Friant Dam (completed in 1942) and associated water abstractions from the San Joaquin River resulted in the extirpation of what was historically one of the largest Chinook Salmon *Oncorhynchus tshawytscha* runs in the California's Central Valley. Roughly sixty miles of dry river and a dam without fish passage prevented spring-run Chinook Salmon from accessing their spawning grounds. Nearly two decades of litigation resulted in the San Joaquin River Restoration Settlement, which mandated that the dry portion of the river be restored and the reintroduction of Salmon between Friant Dam and the confluence of the San Joaquin and Merced Rivers. In March of 2017, 700 juvenile spring-run Chinook Salmon (Mean Fork Length: 81mm) were implanted with 0.217g acoustic transmitters and their emigration from the restored reaches of river to the Pacific Ocean was tracked. High flows provided access to floodplains and the juvenile fish delayed outmigration for 6-11 weeks from the upper reaches of the study area. A Cormack-Jolly-Seber mark-recapture model was used to estimate reach specific survival and detection probabilities at receiver stations. Survival in the San Joaquin River through the restoration area to the entrance to the Sacramento San Joaquin Delta was relatively high, however survival through the Delta to the Pacific Ocean was very low. These results suggest that restoration efforts are benefiting newly introduced juvenile salmon in years with ample runoff, and that regardless of high observed river discharge, the Bay-Delta estuary remains a perilous place for juvenile Chinook Salmon.

Isotope Tools to Track Floodplain Rearing of Native Fishes

Miranda Tilcock, Carson Jefferies, Andrew Rypel, University of California, Davis
Rachel Johnson, National Marine Fisheries Service, Southwest Fisheries Science Center
Ted Sommers and Louise Conrad, California Department of Water Resources

Previous research shows that juvenile salmon *Oncorhynchus spp.* and other native fishes that gain access to floodplains grow faster than those that remain in the river. This is due to a relatively productive food web created by a longer residence time of water, lower water velocities, and the decomposition of plant matter compared to the extremely channelized Sacramento River, California, USA. We observed fish from the Yolo Bypass floodplain having isotopically light and distinct sulfur isotopes (34S/32S) in their prey content and muscle tissue. Juvenile salmon on the floodplain were depleted in 34S/32S (δ34S= -1.7±2.9,1999; δ34S=-1.67±1.1, 2016) in muscles relative to salmon collected in the Sacramento River (δ34S 4.3±4.7, 2012; δ34S=7.2±1.04, 2016), consistent with the trend in particulate organic matter between the two adjacent habitats. Microbial decomposition of plants (e.g., rice) fractionates sulfur isotopes which are incorporated into the invertebrate prey

items of salmon, their muscle tissue, and permanently recorded in their eye lenses and otoliths. Here, we investigate the feasibility of using sulfur isotopes in juvenile salmon eye lenses and/or otoliths to link the extent to which floodplains have population-level benefits to multiple salmon populations and other native fishes.

The Use of Ultrasounding to Assess the Gonadal Maturation of Steelhead and Cutthroat Trout

Jasmine Iñiguez, Aubrey Arevalo, and Rafael Cuevas-Uribe, Humboldt State University

Ultrasonography is a noninvasive method that can be used to examine the internal anatomy, gonadal maturation, and the reproductive status of the fish. The goal of this study was to examine the feasibility of using ultrasound images to sex and determine oocyte maturation for Steelhead *Oncorhynchus mykiss* and Cutthroat Trout *O. clarkii* at the Humboldt State University Fish Hatchery. Forty individuals of Cutthroat (182-291 mm TL and 0.07-0.19 kg BW) and Steelhead (202-453 mm TL and 0.09-0.55 kg BW) trout were tagged for identification. They were then scanned using an ultrasound (EchoSphere ver. 2.1.0) with a 7.5 MHz linear probe during the winter spawning season. To setup the ultrasound, we reviewed previous literature but few studies reported their settings. To determine the settings we evaluated 80 individuals and some fish were euthanized to verify their sex due to uncertainty of determination. The settings that were selected were B mode, 14-88 mm focus depth, 40 mm depth, 72 dynamic range, and 100% gain. Throughout December to January, ultrasound images were collected once a week to monitor progression of oocyte development. We conducted a separate examination to test the efficiency of sex determination. For this examination, two ultrasound technicians sexed 30 randomly chosen Cutthroat Trout in two separate trials. It was determined that the technicians' sexing efficiency was 100%. It can be concluded that despite facing complications in standardizing the ultrasound settings, using an ultrasound can be successful for sexing and predicting the ovulation of fish. This allows for females to be spawned at the most optimal time. Ultrasonography provides the ability to identify sex, reproductive readiness, gonad volume, fecundity, and egg condition. This versatile and noninvasive technology has shown to be an effective and accurate tool in the field of aquaculture by contributing to the future of fisheries science, management, and conservation.

Feeding Responses of Prey Under Predation Threat: Effects of Developmental Plasticity Emerge in Mismatched Environments

Rebecca Robinson, University of California, Davis

Behavioral plasticity can allow an organism to shift its behavior in response to environmental cues such as predation risk, however, when facing a novel predator, prey may fail to respond appropriately. We examined the effect of developmental plasticity and evolutionary history on the feeding response of prey under predation threat. We collected mosquitofish *Gambusia affinis* from three predator regimes: no predator, bluegill predators (intermediate predation), and largemouth bass predators (high predation). Wild caught fish were common reared to the F1 generation and exposed to either largemouth bass cues or no predator cues during development. Once mature, we conducted feeding trials in either the presence or absence of bass, and, at the end, measured mosquitofish gut fullness. We found that developmental plasticity played a significant role in determining female mosquitofish fullness when in mismatched environments, an environment opposite (in regard to predation risk) from an individual's evolutionary history. Naïve fish under predation threat, when compared to fish run in predator free trials, did not significantly decrease their fullness. However, when reared with bass, we saw a significant decrease in the fullness of individuals run in trials with largemouth bass predators. Furthermore, we found that, in trails with bass, the fullness of bass populations was not significantly different from the fullness of no bass populations reared with bass. This suggests that, in the absence of evolutionary history with a predator, developmental plasticity can allow individuals to recognize and respond appropriately to predator cues.

Poor Oceanographic Conditions Likely to Reduce Reproductive Output in Multiple Brooding Rockfishes

Sabrina Beyer, University of California, Santa Cruz
Susan Sogard, National Oceanic and Atmospheric Administration,
Timothy Hogan, University of Miami

It is well known that variability in oceanographic conditions, such as temperature and primary productivity affect growth in marine fishes; what is less known is how these factors affect reproductive success. Here, we use Rosy Rockfish *Sebastes rosaceus* as a model for multiple brooding rockfish species, to test the effects of temperature and food availability on female energetic reserves, fecundity, larval quality and plasticity in the

number of annual broods. Captive females fed a high ration diet had higher brood fecundity and produced a greater number of annual broods in comparison with females fed an intermediate or low ration diet. Warmer water temperatures did not affect fecundity, but shortened the interval of time between brood releases, suggesting that eggs and larvae develop more quickly at warmer temperatures. Larval length was positively correlated with maternal size and larvae were thinner in warmer water treatments. Maternal body condition of captive females, measured by the Fulton's K index (body weight * length-3), was within the range observed in wild females collected from Central California. These findings suggest that declines in body condition during years of poor ocean feeding conditions, such as El Niño, are likely to reduce reproductive output in rockfishes and warrants further studies of reproductive patterns in wild populations. This is of concern to fisheries management, as climate models for the California Current predict an increase in the frequency and intensity of warm water, low productivity climate events that could result in declines in reproductive output and recruitment of rockfishes economically important to both commercial and recreational fisheries.

Drifting into the Future: Advancing Methodology For Quantifying Invertebrate Drift in Lotic Ecosystems Utilizing Next-Gen Camera Technology

Nicholas Macias, Liam Zarri, and Eric Palkovacs, University of California, Santa Cruz

Over the past century, standard methods for quantifying invertebrate drift include drift-nets, pump-net systems, and plankton-nets towed behind a boat. These standardized methods all are constrained by the cost and time associated with outsourcing sample processing. A new prototype camera technology, the Scripps Plankton Camera (SPC), can autonomously provide invertebrate abundance counts and identify invertebrate taxa within various spatial scales of lotic ecosystems. We coupled the SPC with a 0.1 m2 drift-net and allowed natural flow to pass by the camera lens for 40-min trials while simultaneously catching all drifting invertebrates at the back end of the net. We report here the Sorting Efficiency (SE) and the Taxonomic Resolution (TR) of images (High, Low, and Zero) based on various (1, 3, 5, 7) frame rate per second (FPS) settings of the SPC. Preliminary results suggest 3 FPS to have the highest SE and TR with a setting of 7 FPS having the lowest. These results advance drift collection through the development of new technologies that are more cost efficient and would greatly reduce the costs of sample processing for wildlife managers and freshwater ecologists.

Insulin-like Growth Factor-1 (Igf1) as a Hormone Biomarker for Assessing Growth Rates of Rockfish in Marine Protected Areas

Nicole Hack, G.T. Waltz, D.E. Wendt, and S.C. Lema, California Polytechnic State University
M. Journey and B.R. Beckman, National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center

Marine protected areas (MPAs) were created to protect the marine environment and sustain fisheries, yet monitoring of these areas has been difficult as current methods for quantifying growth rates of wild fish require terminal sampling (otolith analysis) or time-consuming tagging (mark-recapture). The development of rapid, non-lethal methods for quantifying fish growth rates is needed to better evaluate the performance of MPAs and manage the incorporated fish stocks. Blood concentrations of the hormone insulin like growth factor-1 (Igf1) relate positively with individual growth rate in several fishes, including Pacific rockfishes. Given the relationship between plasma Igf1 and growth, we explored spatial and temporal patterns of Igf1 concentrations in Blue Rockfish *Sebastes mystinu*, one of several Sebastes rockfishes important to commercial and recreational fisheries. By quantifying circulating Igf1 concentrations in fish within and outside MPAs on the Central California coast, we were able to test whether Igf1 concentrations varied in patterns associated with habitat protection status, which would imply differences in fish growth rates between MPA and non-MPA sites. Blue Rockfish were caught by hook-and-line within and adjacent to the Piedras Blancas and Point Buchon MPAs in August and September 2016. Circulating Igf1 concentrations in Blue Rockfish associated positively with body size regardless of habitat protection status, as has been observed in other fishes. After controlling for size variation, we detected higher Igf1 concentrations in Blue Rockfish within the Piedras Blancas MPA compared to its non-MPA reference site. Point Buchon MPA, however, showed no difference in fish Igf1 concentrations. We also observed declining IgfI levels from August to September at both locations. These patterns of Igf1 variation imply spatial patterns of growth in Blue Rockfish that do not link simply to protection status and suggest that this hormonal 'bioindicator' approach might help identify local habitats supporting faster fish growth.

discounted for larger larvae. Our results also support the hypothesis that there are distinct and important differences between deep-water and shallow-water species, and that more empirical data is needed on larval dispersal range.

#2. Student Symposium

Moderators: Maddie Halloran – Humboldt State University, and Tom Keegan – HELIX Environmental Planning

Estuarine fish movements in a natural brackish marsh

Denise Colombano, John Durand, and Peter Moyle, University of California Davis
John Donovan and Dave Ayers, United States Geological Survey

Estuarine fishes are mobile organisms that use tidal habitats across varying time and tide scales, including semidiurnal, diurnal, spring-neap, and seasonal cycles. In the Suisun Marsh, San Francisco Estuary, California, a coastal stronghold for native fish and marsh transgression, life histories of fishes are well-studied. Yet little is known about drivers of fish movement in natural tidal marsh habitat, comprised of extensive marsh platform and intertidal channels, because it only represents a small proportion of total land area. To address this knowledge gap we designed a study to examine fish movement patterns in relation to hydrodynamics in an intertidal marsh. Our analysis was carried out using TidalTrend, a new software application developed to distill long periods of cyclical environmental data into ecologically relevant parameters. By coupling these metrics with contemporaneous fish detection data collected via Passive Integrated Transponder (PIT) arrays, we found that Sacramento Splittail *Pogonichthys macrolepidotus*, Tule Perch *Hysterocarpus traskii*, and Striped Bass *Morone saxatilis* all had unique circadian or circatidal rhythms that coincided with different times or tides, respectively. Generalized Linear Mixed Models revealed the relative effects of model parameters (i.e., time of day, month, tidal stage or direction, diurnal range, and light availability) on fish detections for each species. Our continuous sampling approach provides evidence for fine-scale temporal partitioning of marsh resources that traditional methods would fail to detect. Results from this study refine our understanding of natural history of estuarine fishes in California and also support the restoration of habitat variability in tidal marshes.

Migration Decisions Made Under the Risk of Predation for Wild and Hatchery Salmon

Megan Sabal and Eric Palkovacs, University of California Santa Cruz
Joe Merz, University of California Santa Cruz and Cramer Fish Sciences

Evasive behavior in response to predators may affect migration speed. Animals alter behaviors in ecological time relative to predation risk to maximize fitness. The trade-off between foraging and predation has been heavily studied, however migrating animals must also consider travel speed in their decision-making. Juvenile Chinook Salmon *Oncorhynchus tshawytscha* face high predation en route migrating from rivers to the ocean. We used behavioral experiments to examine migration rates in juvenile wild and hatchery salmon in the presence of predator cues. We also compared wild salmon that were rearing upstream on the floodplain (wild-rearing) with wild salmon that were actively migrating downstream (wild-migrating). Salmon were timed moving downstream in an experimental flume in the Mokelumne River, CA with and without visual and olfactory cues of a Largemouth Bass *Micropterus salmoides* predator. The presence of predator cues reduced the rate at which wild salmon descended the flume, whereas hatchery salmon did not change their behavior. Wild-migrating salmon reacted more strongly to predator cues than did wild-rearing salmon. Salmon with higher body condition were bolder and traveled further down the flume. Our results indicate a trade-off between migration speed and predator evasion that is dependent on salmon origin and migratory stage.

Winter Movement and Survival of Juvenile Coho Salmon in Freshwater Creek, CA

Nick Van Vleet and Mark Henderson, Humboldt State University

Life history diversity of juvenile Coho Salmon *Oncorhynchus kisutch* has not been documented until relatively recently, and can have important implications for population production. Recent studies have identified multiple patterns of downstream movement into estuaries, including spring fry migrants, fall and winter parr migrants, and spring smolt migrants. The most typical pattern are spring smolt migrants, and Coho Salmon juveniles that migrate into estuaries as fry or parr, typically

referred to as nomads, can make significant contributions to adult returns. Previous research in Freshwater Creek and other northern California streams, has estimated winter movement and survival rates with mark-recapture models that utilize passivate integrated transponder (PIT) tag technology. Both movement and survival have been typically estimated in two separate Cormack-Jolly-Seber (CJS) models. Typically, these models ignore temporal variations in survival (i.e., detection date is irrelevant) in order to estimate movement and survival rates at particular locations within the study area over a period of time. In contrast to CJS models, multi-state models use mark-recapture data to estimate survival and movement within the same model framework. The multi-state model can also be used to separately estimate survival rates in space and time by having time-varying occasions paired with discrete spatial states that animals can transition between. This project uses a multi-state model to provide estimates of early emigration rates for fall/winter migrant juvenile Coho Salmon, as well as survival rates for spring smolt migrants. Preliminary simulation trials have been conducted to validate model structure, explore potential parameter biases, and test the effects of violations of model assumptions. Based on the results from these simulations, I developed models to examine the effect of various individual and environmental covariates (e.g., streamflow, gradient, fork length at fall tagging) on survival and migration probabilities.

Application of Wind Fetch and Wave Models for a Proposed Conservation Bank in Suisun Bay, California

Jacob Vander Meulen, University of San Francisco, HDR, Inc., GreenLeaf Conservation and Mitigation Services

The present study aids a Suisun Marsh landowner in sponsoring a new fisheries conservation bank by using geospatial wind fetch and waves models to address stakeholder concerns about wind wave-driven impacts associated with constructing the proposed bank. The models were used to predict wind fetch lengths and wave characteristics such as significant height, length, peak period, maximum orbital velocity, and shear stress during specified environmental scenarios under both baseline and proposed conditions. Although wind fetch lengths and wave characteristics are systematically over-estimated due to model limitations, it is determined that strategic placement of levee breaches can significantly limit differences between baseline and proposed breach conditions due to a predominance of wind from the west.

Morphology Affects Dispersal of Eel Larvae in the Eastern Pacific

Katherine Dale, M.T. Tinker, and R.S. Mehta, University of California, Santa Cruz

The persistence of marine fish populations is strongly influenced by the extent to which larvae disperse and recruit to adult populations. Larval mobility is influenced by both extrinsic and intrinsic factors, such as current patterns, geographic features, growth rate, sensitivity to environmental cues, and swimming ability. Here, we examine body shape as a potential factor influencing dispersal. Eels (order Anguilliformes) possess a unique, leaf-shaped, flattened larval form called a leptocephalus. These larvae exhibit the largest maximum body sizes and longest pelagic duration times of any fish. Although adult eel species may look markedly different from one another, the general leptocephalus body shape has been conserved across taxa. However, leptocephali still exhibit wide variation in body characteristics. The Eastern Pacific hosts many of these diverse anguilliform taxa. Here, we used morphological data provided by NOAA's Southwest Fisheries Science Center to examine scaling patterns of 17 eel species across two depth patterns. Additionally, we examined if body shape could predict latitudinal species ranges. Species that were more closely related did exhibit similar body shapes but did not cluster by depth pattern. Further, even related species diverged in growth pattern over ontogeny. Morphological characteristics successfully predicted both larval and adult range. Tail length, aspect ratio, and head width were found to be the strongest factors, although the direction and strength of trends varied between depth pattern. Our results show that body shape may influence the ability of a larvae to disperse, whether passively or actively, and should not be

#3. The State of Fisheries Bioengineering and Ecohydraulics in 2018

Moderators: Randy Beckwith – California Department of Water Resources, and Michael Garello – HDR Engineering

River Restoration Value: Examples from a Single-Species Approach on a Large, Urban River

Joe Merz, Cramer Fish Sciences and University of California, Santa Cruz

Rivers have attracted humans for millennia due to fresh water, floodplains, transport, mineral extraction, temperature mediation, waste removal, organism diversity/productivity, and power generation. This attraction has facilitated dramatic anthropogenic changes to productivity and capacity of riverine systems, and ultimately the delivery and sustainability of associated ecosystem services (ES). Although nationwide expenditure on waterway restoration is now measured in billions ($US), there is conflict in the perception of how this money is spent because we (1) put little value on measuring restoration success, and (2) have not consistently conceptualized ES delivery to society. Many questions persist over how ES relate to each other or how to compare ES with well-defined financial value against poorly-measured services and new, emerging values. While restoration focused on target species or processes has demonstrated some success, these focused values often pit ES users against each other in a perceived "zero-sum choice." Furthermore, many projects are done without evaluating actual benefits as they relate to costs, even when specific biological or physical outcome goals have been identified. In this presentation, I will share methodologies we developed to measure ES change, resulting from habitat degradation and restoration, in terms of quantifiable societal values. My goal is to provide a better understanding of the interconnectedness among social, physical, and biological systems to support stakeholder goals and management success. I will provide examples from a program focused on Chinook Salmon *Oncorhynchus tshawytscha* habitat restoration on the highly managed and urbanized American River, California. Quantification of restoration actions as they relate to project cost, habitat created, fishery value, and water and carbon storage will be discussed.

Rescaling Central Valley Rivers: Reconciling Theory With Practice

Rocko Brown, Cramer Fish Sciences

In regulated rivers flow hydrology is often modified, removing or diminishing peak floods that drive channel change and the maintenance of aquatic habitats. The temporal aspect of flow re-regulation has gained considerable traction of the past 2 decades, with environmental flows being increasingly adopted for the management of aquatic organisms. The spatial synchronicity associated with the newly managed river corridor is often addressed through specification of newly scaled peak flows, which are designed to occur with similar timing and have similar shapes to pre-regulation floods. While, it is understood that both environmental and channel maintenance flows are necessary for managed flow regimes, often river corridors have a plethora of impacts associated with flow regulation and land use development, necessitating active restoration of river corridor geometry and topography so that the physical template of the river corridor is more synchronous with newly prescribed flows. The idea of rescaling river corridor geometry is recognized as important, yet there are few case studies that illustrate the challenges and opportunities in rescaling river geometry in human modified landscapes. This goal of this paper is illustrate the challenges and opportunities associated with rescaling river corridor geometry in human modified settings. Examples from California's Central Valley are used to illustrate how flow scaling is performed in practice.

Spawning and Rearing Habitat Restoration – From Moving Papers to Moving Rocks and Soil

John Hannon, U.S. Bureau of Reclamation

Restoration teams conduct annual salmonid spawning and rearing habitat projects in the American and Sacramento rivers (among others) in furtherance of provisions of the Central Valley Project Improvement Act to replenish gravel, re-establish meander belts, and limit bank protection activities. CVPIA funds activities based on basin-wide assessments of the factors believed to be limiting the target fish populations. Individual projects take into account the riverwide assessment and consider site specific opportunities and constraints to develop conceptual designs for permitting. Rearing habitat enhancements are integrated with spawning habitat projects to provide habitat where the fry emerge. Standalone rearing habitat projects are focused downstream of spawning areas. They include side channel reconnection and creation, floodplain connection, woody material and boulder additions, and planting. Spawning gravel injections occur in areas deficient in coarse sediment with high sediment transport potential and we also create immediately usable spawning habitat in less contained channel reaches. Within the permitting processes we strive to include multiple projects together to provide coverage for multiple years of enhancement activities and reduce repetitive and time consuming processes. The local stakeholder groups evaluate potential restoration site alternatives to arrive at a preferred scenario for design. Working with local entities such as watershed groups, water districts, and landowners

through cooperative agreements allows for flexibility in contracting and adaptive management. Specialists with cross discipline experience collaborate on the ground with heavy equipment operators for desirable implementation outcomes. Effectiveness monitoring tailored to the project goals and objectives provides lessons learned for application to upcoming projects. The presentation will highlight specific projects with the project objectives, implementation outcomes, and lessons learned.

Engineered Restoration on Coon Creek for the Re-colonization of Steelhead Trout

Reddy Otte, City of San Luis Obispo

Coon Creek is a small coastal creek located on the border of Montana de Oro State Park and PG&E's Diablo Canyon property. Pecho Valley Road (approximately 3,000 ft upstream from the estuary) crosses Coon Creek for the ranch and alternate access to the power plant but the culvert carrying Coon Creek plugged in the late 1990's after high flow events and in the subsequent years turned into an 8-foot perched barrier. As mitigation for another San Luis Obispo City project, the culvert was removed, 24 rock weir step-pools were installed, the steep gradient was distributed over 400-feet, a new free-span bridge installed, and complete passage was restored. Access to over 7 miles of pristine spawning and rearing habitat was opened up after this project was completed in October 2004 and the transformation to date is phenomenal. To ensure complete passage was restored, in accordance with NOAA Fisheries, Thomas R. Payne and Assoc. (TRPA) developed a monitoring program that was carried out over the next three years to chart the progress of steelhead trout *Oncorhynchus mykiss* re-colonization, abundance, structure (weir) integrity and effectiveness monitoring. The surveys were ground-truthing exercises in documenting the return of true anadromous steelhead and distinguishing their redd's from the residualized rainbow trout that exist in the upper watershed to better estimate the steelhead population in Coon Creek. Snorkel surveys were also employed to serve two purposes; inspection of weir integrity and visual estimates of fish utilizing the newly created habitat. Restoring the hydraulic capacity of the creek to a more natural pattern has allowed this creek to become one of the Central Coasts true wild systems. Long term monitoring of this location is providing good feedback for subsequent projects where an engineered stream restoration project can be successful in different settings.

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

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

We evaluated the behavior and capabilities of upstream migrating adult Pacific Lamprey *Entosphenus tridentatus* using a series of experimental trials in relation to existing and novel fishway designs using Passive Integrated Transponder (PIT) telemetry. Five treatments were evaluated with PIT telemetry of 164 upstream migrating Pacific Lamprey. Experimental treatments included an existing pool and weir fishway, two in-situ modifications of the existing fishway and two treatments 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 treatment. The existing pool and weir fishway provided the lowest predicted passage efficiency at 0.44 (95% CI 0.29–0.59), while tube and culvert treatments had perfect efficiencies. For individuals that successfully ascended trials, passage time was also related to treatment. Lampreys ascending the pool and weir structure had the longest predicted passage time at 5.2 h (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 h (95% CI 0.21–0.30). Lamprey ranged from 52 to 66 cm TL, however length did not influence passage success or migration time. Over 200 h of night-time observations were used to improve our understanding of how lampreys pass barriers and where they encounter particular challenges. Our results and observations of lamprey migration behavior confirm that pool and weir fishways and design features common to other fishways types 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, should significantly improve the opportunity for Pacific Lamprey to pass existing and future manmade structures.

Anticipating Maximum Channel Fill During Sedimentation Pulses Following Episodic Events

Barry Hecht, Balance Hydrologics, Inc.

Planning for episodic events is now understood to be an important part of habitat management in many rain-dominated watersheds throughout California and the

American West, particularly in sub-arid and sub-humid catchments with high relative relief. Typically, these have steep slopes which support scrub and chaparral vegetation. Deposition downstream following regional flooding, wildfires, large seismic events with related landsliding, prolonged drought, woodland blight, and possibly extreme winds can amount to more than half of long-term bedload sediment transport and streamwood delivery. Massive accumulation of sediment in whole stream systems following these events reaches a maximum following several storms, and then attenuates over time until returning to a configuration often approximating pre-event bed elevations, bed-material sizes and pool-riffle articulation. Frequently, these "fire-flood epicycles" play out over periods of one year to six or seven years, gradually resuming a more muted range of 'chronic conditions' during which much more subdued or 'normal' fluctuations affect aquatic habitat and riparian woodlands.

By identifying how much the channel and adjoining riparian floodplain is likely to aggrade following episodes, geomorphologists and valley scientists can allow sufficient room on the floodplain and in the main channel for the pulse to store sediment and large wood, to renew the floodplain's suitability for colonization and growth of woody riparian vegetation, and provide access to alluvial corridors where needed for public safety. The Probable Maximum Aggradation Level (PMAL) can also be used to guide locations of utilities, wells, and bridge abutments so that they remain more or less above the level to which the channel is likely to rise during the storm peaks following the episode – preventing unnecessary disturbance to the floodplain or the recovering channel. Guidelines for empirically estimating PMALs will be provided.

Floodplain Reconnection and Fish Passage Improvement on Butano Creek

Chris Hammersmark and Ben Taber, cbec eco engineering
Jarrad Fisher, San Mateo Resource Conservation District
John Klochoak, U.S. Fish and Wildlife Service
Jim Robins, Alnus Ecological

Butano Creek drains 23 mi2 of the Santa Cruz Mountains, San Mateo County, CA. Land use and channel management practices in the last two centuries have doubled sediment input, disconnected channels from their floodplains through incision, eliminated floodplain sediment storage in parts of the watershed, and the increased sediment has completely filled the creek channel, leading to flooding, water quality and fish passage issues in the lower watershed. Incision and floodplain disconnection not only eliminated sediment storage in the valley but also transformed floodplain storage areas into sources substantially contributing to elevated sediment loads. Removal of large wood, channel incision, and floodplain disconnection are the primary causes of a significant reduction in the complexity and function of habitats. Channel change and sediment budget analyses revealed that, historically, the lowland valley functioned as a wet meadow and included an extensive well-connected floodplain that provided diverse habitats. The lowland floodplain also provided sediment storage upstream of the Pescadero estuary, which is a key nursery habitat for anadromous fish species.

Multiple rehabilitation projects have been undertaken, implemented, or are currently in planning phases to address the sedimentation, flooding, water quality and fish passage issues. A project was implemented in 2016, that reconnects the floodplain along a mile reach of Butano Creek and restores approximately 100 acres of the historical floodplain. Project elements include a roughened channel/rock ramp grade control structure, two constructed engineered log jams, two jams constructed by induced recruitment of live bankside alders into the channel, and bankside berm breaches. Another channel modification project located downstream in the Butano Marsh is planned for implementation in 2018 to address fish passage, water quality issues and flooding. The watershed context used to understand the problem and to develop a solution will be discussed along with a discussion of select completed and planned projects.

Bedrock Coho Barrier Mitigation Through Roughened Channel Construction and Natural Gravel Recruitment

Brad Job, Ryan Seng, Bill Weaver, Pacific Watershed Associates, Inc.
Michael Garello, HDR, Inc.

James Creek is a tributary to the North Fork of the Big River located in Mendocino County, California, approximately 13 miles west of Willits on Highway 20. James Creek drains approximately 6.9 square miles, mostly within Jackson Demonstration State Forest, and supports runs of listed salmonids, including Chinook Salmon *Oncorhynchus tshawytscha*, Coho Salmon *O. kisutch*, and steelhead *O. mykiss*. A migration barrier on James Creek was created in the 1970's when the California Department of Transportation (CalTrans) armored the steep fillslope from Highway 20 down to the left-bank of James Creek with a mixture of boulders and concrete. This narrowed

the active channel, increased stream power, caused scour that exposed a nine foot high bedrock falls. Currently, the site is a complete barrier to Coho Salmon, and a partial barrier for steelhead with only the strongest adults able to negotiate the falls during a restricted winter flow regime. The falls prevent all Coho and most steelhead from accessing 3.4 miles of prime upstream habitat.
The CDFW-funded fish barrier mitigation design involves construction of about 250 feet of roughened, stepped channel comprised of a total of eight boulder bands constructed with 2,600 tons of angular quarried stone and filled with 2,500 tons of engineered streambed material. As initially conceived, the project was to be constructed in one phase. To potentially reduce construction costs, allow adaptive management during construction, and limit the amount of imported alluvium required to construct the project, the project proponents proposed to phase the construction over two seasons. It was expected that normal winter flow events would result in mobilization of upstream channel-stored coarse sediment and recruit that material into the project reach. The anticipated benefits include saving up to 50% of the imported gravel costs, reducing transportation related impacts, lowering the risk of introducing non-native species, and allowing the design to "settle in" during the winter between the two construction seasons. Moreover, the project could beneficially sequester up to 1000 cubic yards of course sediment in a system that is already water-quality limited by sediment. The first phase of the project was successfully implemented in 2017 and the project team is now anxiously awaiting significant bedload mobilizing flow events.

Mill Creek Riparian Restoration in Ukiah – Design of fish passage in a high-flow backwater of the Russian River

Denis Ruttenberg, Balance Hydrologics, Inc.

Timing is everything for peak flows in rivers and their tributaries, and for fish passage conditions. After years of planning, a fish passage barrier at the confluence of the Russian River and Mill Creek in the City of Ukiah was removed and replaced with a free span bridge in 2017, opening up more than 8 miles of habitat for salmonids. The setting required additional study to design a restoration that would remove the leap, depth, and velocity barrier, while considering FEMA flood mapping, backwatering from the Russian River, and geomorphic changes from sediment moving up Mill Creek. Typical fish passage projects utilize fish-friendly instream grade controls and roughened channels to compensate for abrupt drops in profile grade, but the potential for backwater and an aggraded profile at this site allowed a lesser effort, via a 1.5% to 1.7% sloped profile and a rough graded channel. Construction cost savings were applied to enhancing the streambed and streambank habitat by removing legacy waste concrete, planting willow poles within rock bank protection, and riparian tree planting. Innovative solutions were implemented, such as using sand-filled cardboard tubes as placeholders within large placed rock for future willow pole planting. Hydraulic modeling combined geometry and results from multiple models to simulate boundary conditions, estimate passage conditions, and distinguish final design geometry. Site challenges were addressed, including no interruption to crossing the creek during peak construction season with the landowner's cement trucks and heavy equipment. In addition, the end goal of a permanent heavy-duty bridge for the landowner's operations was fulfilled.

Through the dedication and many years of effort by the Mendocino County Resource Conservation District, multiple agencies, and planning partners, the project was completed on time and on budget in 2017 and is primed to reward anadromous residents for their travels.

#4. Management of Resident Salmonids

Moderator: David Lentz – California Department of Fish and Wildlife

The Salmonid Population Viability Project: Modeling Trout Viability in a Desert Landscape

Daniel Dauwalter and Helen Neville, Trout Unlimited
Doug Leasure and Seth Wenger, University of Georgia
Jason Dunham, U.S. Geological Survey

Many species of conservation interest exist solely or largely in isolated populations, where management priorities ideally would be guided by quantitative estimates of extinction risk. However, conventional methods of demographic population viability analysis (PVA) generally model each population separately and require temporally extensive datasets that are rarely available. We developed a new spatiotemporal population viability analysis (STPVA) that combines fish sampling data with remotely-sensed and other environmental data to deliver estimates of carrying capacity, inter-annual variability, and viability for all populations simultaneously. Remotely-sensed spatial covariates describe habitat size

and quality, while temporal variability is a function of temperature and flow. A hierarchical approach includes an observation model which calculates site- and pass-specific probabilities of detection and informs a sampling model, which feeds into a process (population dynamics) model. STPVA can leverage information from well-sampled populations to extrapolate to poorly sampled or even un-sampled areas; it also allows for evaluation of different management scenarios (e.g., barrier or non-native trout removal). We applied STPVA to Lahontan cutthroat trout *Oncorhynchus clarkii henshawii*, a federally threatened trout native to the Great Basin Desert, to generate simultaneous estimates of extinction probability and evaluate management action effectiveness across the sub-species' range.

Entrainment Risk for Rainbow Trout at a Hydroelectric Turbine Intake in the South Fork Rubicon River, California

Ethan Bell and Ken Jarrett, Stillwater Sciences

Little information exists on the risk of entrainment in hydroelectric turbine intakes for natural populations of riverine trout. This study focuses on the effects of a turbine intake in Robbs Forebay on a resident Rainbow Trout *Oncorhynchus mykiss* population in the upper South Fork Rubicon River. The goal of the study was to determine if entrainment is occurring, and if so, what the overall effect of entrainment is on the population of Rainbow Trout. Nearly 1,000 Rainbow Trout were tagged with Passive Integrated Transponders (PIT) tags, and monitored for 15 months in 2015 and 2016, using repeated sampling of riverine habitat, and multiple stationary PIT tag arrays positioned throughout the forebay; including antennas on the intake screen. Most fish that were detected or recaptured remained within the river (154 fish, 15.4% of all tagged fish), while only 33 (3.3%) of the tagged population migrated downstream to the forebay. The fish detected moving downstream into the forebay were substantially smaller (age-0 based on fork length) than fish that remained in the river. Of the Rainbow Trout PIT tagged in the South Fork Rubicon River, 9 were observed as entrained in the intake, with an extrapolated annual entrainment rate of 9.5 fish per year; equating to an estimated annual entrainment rate of 0.95%. Based on the low rate of downstream migration, and a robust population of Rainbow Trout in the South Fork Rubicon River, it does not appear that the measured low annual rate of mortality from entrainment at the Robbs Peak Intake has a substantial effect on the population in the South Fork Rubicon River.

CDFW Trout Management: Evolving Directions from Past to the Future

David Lentz, Brett Anderson, Michael Mamola, and William Somer, California Department of Fish and Wildlife

Trout fishing is one of the California Department of Fish & Wildlife's (CDFW) most popular and important programs. Throughout its history, CDFW's trout management has often reflected the prevailing values of the angling public and the larger society. When the values of the angling clientele and society have changed, the CDFW's management priorities have also been altered but, for some, changes do not happen as fast as needed. Californians have not been shy about using the courts, the legislature, and the ballot to achieve desired changes in resource management and conservation. For CDFW trout management this has resulted in both litigation and legislation shaping change and direction for trout management programs. Here we look at some of the events in recent history that have steered the state's changing trout management priorities. Also, we look at the federally listed Lahontan Cutthroat Trout for examples of how these priorities are implemented by CDFW trout managers.

Pre-Stocking Evaluation Protocols and Trout Allotment Development in the Information Age

Michael Mamola, David Lentz, and Brett Anderson, California Department of Fish and Wildlife

The California Department of Fish and Wildlife currently conducts Pre-Stocking Evaluations prior to the release of hatchery propagated trout into State waters. While this process has been in effect for nearly a decade, staff have recently begun the process of reviewing current trout stocking practices with an eye towards challenges and opportunities in the modern era. Staff have set out to incorporate angling related management objectives, increased angling opportunities, the promotion of native trout angling, limiting negative impacts to at-risk species, and increased data sharing into the State's existing Pre-Stocking Evaluation Protocol (PSEP). While this effort is still in its infancy, fisheries managers are optimistic that the PSEP process will prove an effective vehicle for achieving these objectives. This presentation will summarize some of the methods currently utilized in the PSEP process, as well as those under development as they relate to California's trout stocking efforts.

#5. Conservation Biology of California's Native Freshwater and Anadromous Fishes

Moderators: Damon Goodman – U.S. Fish and Wildlife Service, Stewart Reid – Western Fishes, Andrew Kinziger – Humboldt State University, and Alicia Seesholtz – California Department of Water Resources

Unraveling Range-wide Extinction-Colonization Dynamics in an Endangered Fish Using Occupancy Modeling and Environmental DNA

Chad Martel and Andrew Kinziger, Humboldt State University

Classical metapopulation dynamics involving extinction and colonization among isolated habitat patches can be difficult to assess owing to issues associated with imperfect species detection. Failure to detect a species may be the result of a true absence or an inability of the researcher to detect the species. The distinction is important, as confusing a non-detection with an extinction may lead to incorrect inference regarding the relative rates of extinction and colonization. Herein we estimated range-wide extinction and colonization rates for endangered Tidewater Goby *Eucyclogobius sp*. using a multi-season occupancy modeling approach that explicitly accounts for issues associated with imperfect detection. We used environmental DNA approaches, which have been shown have higher detection rates than traditional monitoring, to monitor 200 sites across coastal California (Del Norte County to San Diego County) in 2016 and 2017. We will present preliminary findings of our two year range-wide eDNA survey of tidewater goby; and how we intend to use that data to help us examine tidewater goby extinction and colonization dynamics and environmental factors that may contribute to extinction/colonization.

Rangewide Tidewater Goby Occupancy Survey Using Environmental DNA

Michael Sutter and Andrew Kinziger, Humboldt State University

Range-wide monitoring is critical for determining status and trends in abundance and distribution; however, implementation of large-scale surveys has generally been constrained by cost. This study uses environmental DNA (eDNA) to monitor the presence or absence of two endangered tidewater goby species, the Northern Tidewater Goby *Eucyclogobius newberryi* and the Southern Tidewater Goby *Eucyclogobius kristinae*, across their combined range that encompasses the entire California coast (1,350 km). A multi-scale occupancy model designed specifically for eDNA methods was used to account for imperfect detection and to estimate true site occupancy. A total of 210 sites were surveyed in coastal California from Del Norte to San Diego counties between May and September 2016. Among these, 12 were dry during the survey and assigned a status of non-detection. From the 198 sites with water present, a total of 432 water samples were collected, filtered and tested for the presence/absence of northern and southern tidewater goby using quantitative PCR (qPCR). The number of water samples collected per site ranged from one to six. Northern Tidewater Goby were detected at 81 out of 187 sites and Southern Tidewater Goby were detected at 4 out of 22 sites, resulting in a combined naïve occupancy of 0.43. In contrast, the multi-scale occupancy model estimated site occupancy at 0.55, indicating that tidewater goby were present but not detected at 23 additional sites. These findings indicate that imperfect detection rather than extinction-colonization dynamics are often at play Tidewater Goby are believed to be extirpated at a site. Tidewater Goby were detected at 6 sites where they have previously not been detected or were thought to be extirpated, including one site in San Francisco Bay. The covariate salinity was found to be the key process for affecting detection probability and tidewater goby DNA availability in a water sample. This finding implies that when using eDNA methods for species detection, more water samples and qPCR replicates might be needed at high salinity sites to achieve the desired level of detection. This study illustrates the power of eDNA for generating point-in-time snapshots of a species entire geographic distribution (e.g., field sampling for this study was completed in four months). This information is critical for management as it will serve as the foundation for determining if tidewater goby are expanding their range (colonizations > extinctions) or their range is contracting (extinctions > colonizations).

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*.

Abundance and Distribution of Native Fishes in the Santa Ana River, California, an Effluent-Dominated Urban River, 2015-2017

Larry Brown and Jason May, U.S. Geological Survey
Heather Dyer, San 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. 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*. These data are needed to support a Habitat Conservation Plan for the Santa Ana River watershed. 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 of 2015, 2016, and 2017, we sampled 20 (2015 and 2016) or 27 (2017) stream reaches using snorkeling, seining, and electrofishing. The reaches were 50 m long and enclosed with block nets. Estimated populations of Santa Ana Sucker for the entire study area ranged from 6,802 to 8,957 fish and Arroyo Chub ranged from 5,619 to 24,088 fish. Fish 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 12,080 suckers/km and 7,940 chubs/km. Santa Ana Suckers tended to be more abundant in reaches with limited canopy, which likely is related to production of benthic algae, their primary food source. The Santa Ana Sucker population has been fairly stable, based on three years of monitoring, despite a major migration of the channel in 2017. The Arroyo Chub population has been more variable. 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.

Rescue, Captivity and Translocation: Recovery Challenges of the Unarmored Three-spine Stickleback

Tim Hovey, California Department of Fish and Wildlife

The State and federally endangered unarmored three-spine stickleback *Gasterosteus aculeatus williamsoni* in southern California has been in sharp decline over the last decade. Three distinct populations in the upper Santa Clara River Drainage in Los Angeles County (San Fracisquito Creek, upper Santa Clara River and Soledad Canyon) have suffered habitat loss during the extensive California drought requiring various rescue and management efforts for these populations in recent years. In 2016, the Sand Fire burned 42,000 acres of upland habitat threatening the Soledad Canyon population. Anticipating heavy winter rains, a multi-agency collaborative rescue effort was planned for October 2016. A total of 171 unarmored three-spine stickleback (UTS) were collected and transported to the CDFW's Fillmore Trout Production hatchery in Fillmore, California. The fish were held in temperature-controlled, Recirculation Aquatic Systems (RAS) units for a total of six months. During captivity, UTS were treated for parasites, graded for size, evaluated for overall health and monitored daily. In April of 2017, 151 surviving UTS were transported from the hatchery and successfully released into Fish Canyon Creek in the upper Castaic Creek drainage in Los Angeles County. During the release, UTS were observed feeding on aquatic invertebrates. Post release monitoring conducted in May of 2017 revealed the presence of UTS 0.5 miles downstream of the release pool. In early June 2017 we documented the first successful reproduction of this introduced population with the discovery of juvenile UTS

ranging in size from 8-15 mm. In late June 2017 we documented the continued dispersal of UTS in Fish Canyon Creek with individuals located 0.7 miles from the main pool and recorded a second successful spawn in September 2017. Continued monitoring of this newly established UTS population will yield valuable information on the challenges for recovery of UTS.

Lacustrine Habitat of the Clear Lake Hitch

Frederick Freyrer and Matthew Young, U.S. Geological Survey

The Clear Lake Hitch *Lavinia exilicauda chi* is an imperiled fish species facing extinction that is endemic to Clear Lake, Lake County, California. It is listed as a threatened species under the California Endangered Species Act and is a candidate species for listing under the US Endangered Species Act. Formerly highly abundant and a staple food for the Pomo tribes of the Clear Lake region, abundance is believed to have declined a hundredfold. Threats to Clear Lake Hitch include alterations to the ecology and physical habitat of Clear Lake and its tributaries. The purpose of this study was to determine the lacustrine habitat of Clear Lake Hitch. This species occupies the lacustrine environment year-round except when undergoing spawning migrations into tributaries during spring. Clear Lake Hitch were intensively sampled within Clear Lake during spring and summer of 2017 to determine their spatial distribution and associations with key habitat features. The information generated from this study can contribute to the development of effective conservation and management strategies for this imperiled species.

An Exploration of the Threats Facing Downstream Migrating Pacific Lamprey in California

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

Herein, we explore threats facing Pacific Lamprey *Entosphenus tridentatus* in California during their emigration to the Pacific Ocean. First, we leverage our understanding of downstream migration behavior, spatial orientation and timing as a foundation to interpret the impact of potential threats. Successful emigration depends on connectivity from riverine rearing habitats and the Pacific Ocean during migration and avoidance of both diversion facilities and predators. Unsuccessful emigration represents loss and interruption at a critical life history stage that has survived a multi-year period of freshwater rearing. Our analysis suggests that loss of emigrants may pose a meta-population level threat to Pacific Lamprey in California by creating an ecological trap in some rivers. These results emphasize the importance of variation in streamflow regimes and provide insight for management practices that would benefit emigrating lampreys, such as synchronizing dam releases with winter and spring storms to reduce migration time, operating guidance for timing diversions to avoid emigration windows, and ensuring streamflows are sufficient to reach the ocean during migration events, thereby avoiding mass stranding events. Furthermore, we postulate that some of the primary threats facing Pacific Lamprey may occur during this brief and vulnerable stage in their complex life history.

Testing Hypothesis for Low Capture Rate of Juvenile Green Sturgeon at Fish Protection Facilities: Louver Efficiency Under Various Conditions

Anna Steel, Trinh Nguyen, Dennis Cocherell, Kara Carr, M. Levent Kavvas, and Nann Fangue, University of California, Davis

We studied bypass efficiency of age-0 Green Sturgeon *Acipenser medirostris* at a laboratory-based model louver system designed to simulate the system used at the fish protection facilities of the federal and state water projects in the California central valley. Low numbers of Green Sturgeon are obtained at these fish protection facilities, yet it is unclear whether this is due to low numbers near the pumping facility, low bypass efficiency of the louver guidance systems, or high pre-screen losses due to predation. To evaluate the species-specific louver bypass efficiency, juvenile Green Sturgeon in three size classes (range: 6 – 34 cm), spawned and reared by the UC Davis broodstock program, were exposed for 90-min to the model louver system under a variety of conditions. Treatments included two photophases (day and night), three water velocities (1, 2, and 3 ft/s), and two water temperatures (12°C and 19°C). Louver efficiency was estimated for each trial, and behaviors were recorded with underwater cameras. From these videos we quantified the proportion of sturgeon exposed to the louver, locations of sturgeon interactions with the louver, and rheotactic behavior of sturgeon at the louver face and upon entry to the bypass channel. Water velocity was a strong driver of louver efficiency, with the highest bypass rates (>98%) occurring at the highest velocities for all sturgeon >16 cm TL. However, for the smallest size class (6 - 12cm TL) the maximum bypass rate occurred at 2 ft/s because entrainment through the louver increased with increasing water velocities, resulting in entrainment rates up to 54% at the fastest water velocity. Overall, the louvers were very

efficient in guiding green sturgeon > 16 cm total length. This suggests that the mechanism driving low abundance of juvenile sturgeon in the fish protection facilities is not poor performance of the louver guidance system.

Experimental Assessment of Predation Risk for Juvenile Green Sturgeon by two predatory fishes: Striped Bass and Largemouth Bass

Sarah Baird, Anna Steel, Dennis Cocherell, Nann Fangue, University of California, Davis

We conducted laboratory-based predation experiments of juvenile Green Sturgeon to estimate predation mortality prior to salvage at the federal- and state-run water export facilities in California's Central Valley. Two predatory fish species were chosen due to their high abundances, generalist diet composition, and tendency to congregate in and around fish diversion structures. Wild Largemouth Bass *Micropterus salmoides*, and wild Striped Bass *Morone saxatilis* were captured at the pumping facilities, and subsequently separated into large and small size classes to be tested with larval Green Sturgeon of large (>10cm TL) and small (<10cm TL) size classes at UC Davis' J.A. Hydraulics lab. Green Sturgeon used in experiments are spawned and reared by the UC Davis broodstock program. Thirty prey were introduced to an experimental tank containing five predators, and exposed for 24-hour periods. Experimental trials with green sturgeon were interchanged with trials of an alternate prey species to confirm that predators were exhibiting normal feeding behaviors throughout the trials. Five or six replicate tanks contained Largemouth Bass or Striped Bass, respectively. The number of remaining prey at the end of the experiment was used to calculate predation rate (prey consumed per predator per day). In addition, daylight hours of each experiment were video recorded to examine behavior of both predator and prey. Overall, predation rate decreased with Green Sturgeon length and age, across both predator species. Largemouth Bass and Striped Bass consumed all alternative prey in most trials throughout each experimental period and displayed much lower rates of predation on juvenile Green Sturgeon. Predation risk of Green Sturgeon diminished to zero once sturgeon reached 20 cm TL for Largemouth Bass and 22 cm for Striped Bass. Future analysis of the video data will explore the mechanisms and timing of predation events by these two species on Green Sturgeon.

Notable Sturgeon Discoveries in the Feather River During 2017

Alicia Seesholtz, California Department of Water Resources
Matt Manuel, Darren Rocheleau, and Kevin McAllister, Pacific States Marine Fisheries Commision

The lower Feather River in California was designated critical habitat for the threatened southern Distinct Population Segment (sDPS) of the North American Green Sturgeon *Acipenser medirostris* (Green Sturgeon) on October 9, 2009 (74 FR 52300). White sturgeon *A. transmontanus* commonly use this same stretch of the river. Oroville Dam and its associated facilities provide an absolute barrier to upstream sturgeon migration in the Feather River. Understanding how the lower Feather River influences sturgeon will provide valuable information for future management and enhancement of the system for the species. The flow and temperature regimes resulting from project operations may have an important influence on the migratory and spawning behavior of both sturgeon; 2017 was an exceptionally eventful year. Previously, all attempts by various entities to sample sturgeon in the Feather River had been unsuccessful, and therefore, management decisions were based on anecdotal information from anglers and guides or from irregularly recorded observations of sturgeon seen by fisheries staff. However, the California Department of Water Resources (DWR) was able to successfully sample green sturgeon and document spawning for the first time in the lower Feather River during 2011. Since then, DWR has used egg mats, DIDSON, and acoustic telemetry to determine how often sturgeon spawn in the Feather River; identify spatial and temporal distribution of sturgeon; and evaluate potential adult migration barriers. To provide foundational information needed to manage and conserve sturgeon populations, information gathered in 2017 on sturgeon within the Feather River will be summarized and presented. This presentation will also discuss the newest evidence which suggests the lower Feather River has the potential to provide a viable second spawning area for Green Sturgeon during high water years. When considering species recovery efforts, it is imperative to determine when and how the sDPS of green sturgeon use the lower Feather River.

Evidence for the Genetic-basis and Inheritance of Ocean- and River-maturing Life Histories of Pacific Lamprey in the Klamath River, California

Keith Parker and Andrew Kinziger, Humboldt State University
John Hess and Shawn Narum, CRITFC

The objective of this study was to evaluate the genetic basis of ocean- and river-maturing ecotypes in anadromous Pacific Lamprey *Entosphenus tridentatus* in the Klamath River, California, and apply these findings to species conservation. In Pacific Lamprey the ocean-maturing ecotype can be distinguished by the relatively advanced maturity of female spawners (e.g., large egg mass) upon freshwater entry compared to the relatively immature river-maturing ecotype. We collected 219 (126 males, 93 females) returning adult Pacific Lamprey (Entosphenus tridentatus) at entry to the Klamath River over a 12-month period (2016-17) and genotyped them at 308 neutral and adaptive SNP loci and recorded morphological traits, including egg mass as an indicator of female sexual maturity. Mean egg mass in February-April was as much as twice as those for May-July, suggesting ocean-maturing ecotypes primarily enter during winter and river-maturing primarily enter during summer. However, both ecotypes were collected simultaneously in most months, and in April a one-day egg mass ranged 1.6 to 22.7 g. Phenotype-genotype association mapping identified sixteen SNPs with significant associations to egg mass occurring on two linkage groups. A Duplicate Dominant Epistasis was the likely inheritance model for the ecotypes with the ability of this model to accurately predict ecotype in 83% of our samples. Despite evidence for temporal genetic structuring reported for this species in a different river system, we found no evidence of genetic structuring at 148 neutral SNP loci. Unlike similar ecotypes characterized in a different anadromous species, such as ocean- and river-maturing steelhead, the two Pacific Lamprey ecotypes do not exhibit the same level of temporal isolation in entry time. Therefore, we recommend distinguishing the river-maturing and ocean-maturing ecotypes of Pacific Lamprey by naming them raayoh and tewol, respectively, using terms from the Yurok language, in recognition of the importance of Pacific Lamprey to Pacific Northwest fishing tribes.

A Tale of Missing Fins: Evidence for a Rapid Phenotypic Shift in Amargosa Pupfish Following an Increase in Habitat Temperature

Sean Lema, California Polytechnic State University

Rapid shifts in morphology and behavior are possible when environmental conditions change via either natural or anthropogenic causes. Recent data suggest that a population of Amargosa Pupfish *Cyprinodon nevadensis amargosae* in Tecopa Bore - an isolated, thermal spring in the Death Valley region of California - experienced a contemporary change in body morphology following an alteration to the structure and thermal profile of its habitat. Collections of fish from Tecopa Bore in 2008 indicated that pupfish in this habitat exhibited body sizes similar to conspecifics in the nearby Amargosa River. Collections in 2013-16, however, revealed a change in body size and morphology, with fish averaging 12-13% smaller in body length and ~50% less in body mass than in 2008. Those collections also revealed that ~34% of pupfish in Tecopa Bore now showed either complete (13-14% of fish) or partial (only 1 fin; 20% of fish) loss of the paired pelvic fins, a phenotype that contrasts both with pupfish collected in 2008 from Tecopa Bore and with the adjacent Amargosa River population, where >99% of fish have 2 pelvic fins. Further morphological analyses revealed that the Tecopa Bore and Amargosa River populations also differ in body shape. Body depth is sexually dimorphic in pupfishes, with males exhibiting a deeper body morphology than females. Since 2013, the Tecopa Bore population has exhibited reduced sexual dimorphism in body depth compared to the Amargosa River population. Based on experimental studies, this rapid shift in morphology in Tecopa Bore appears to have emerged in part from changes in the hormonal regulation of morphological development brought about by the increase in water temperature. Taken as a whole, this work illustrates how increases in the temperature of inland aquatic habitats can induce shifts in hormone regulation, energy balance, and growth that have consequences for fitness-related phenotypic traits in fish.

"One Ear to the Ground": Using Isotopic Analysis of Otoliths to Investigate the Life History of Delta Smelt

Malte Williams, Levi Lewis, Christian Denny, Eva Bush, Jim Hobbs, University of California, Davis
Randall Baxter, California Department of Fish and Wildlife

The Delta Smelt *Hypomesus transpacificus* is rapidly approaching extinction in the wild. This small, euryhaline fish is endemic to the tidal fresh and brackish waters of the San Francisco Bay Estuary (SFE). Extensive studies over the last decade have shown that this fish exhibits a diverse life history of both resident and migratory phenotypes within a genetically homogenous population, but the details of this life history remain unclear. We investigated the life history diversity utilizing the microchemistry of otoliths ("ear bones") from fish collected during monitoring surveys in the Fall of 2011 and Spring of 2012, the last abundant year-class. Otoliths consist of calcium carbonate and accrete continuously throughout the life of

a fish. Consequently, they can provide a life-long archive of physiological and environmental conditions that a fish has experienced. 87Sr/86Sr ratios and new statistical analyses (Discrete Wavelet Transformations) were used to reconstruct and cluster changes in salinity habitats throughout the lifetime of a fish. Delta Smelt exhibited three unique life history trajectories; residency (completing the lifecycle) in freshwater, residency in brackish water, and a migratory life history with changes in freshwater and brackish water use. Migratory fish could be further resolved into three contingents that can be characterized with a combination of three life history attributes; natal origin, adult rearing habitat and ontogenetic transition from fresh water to brackish water in the early life. This previously undescribed complex life history diversity provides Delta Smelt a diverse portfolio of behavioral phenotypes that may facilitate resilience within its dynamic and unpredictable estuarine environment. Understanding how management of freshwater flows affects fish with different life histories is paramount for conserving this endangered species.

A Bayesian Hierarchical Model of Postlarval Delta Smelt Entrainment: Integrating Transport, Length Composition, and Gear Efficiency in Estimates of Abundance

William Smith, Ken Newman, Leo Polansky, and Lara Mitchell, U.S. Fish and Wildlife Service

Hydrodynamic models are often used to describe the transport of ichthyplankton through marine and estuarine environments. Although this technique is common, it is rarely used to estimate population parameters aside from rates of entrainment. In concert with additional forms of data, more information about the population can be leveraged, such as abundance of entrained fish. Postlarval and juvenile Delta Smelt *Hypomesus transpacificus* entrainment by water export operations in the Sacramento-San Joaquin Delta during 1995–2015 was estimated by integrating several sources of information in a hierarchical model. The model described the sequence of events from entrainment into the South Delta to observation in water exports as fish facility salvage. DSM2 particle tracking, population and salvage length composition, mark recapture, and salvage count data informed models of juvenile delta smelt transport, salvage efficiency, and ultimately, observation in salvage. The model relied on assumptions that juvenile Delta Smelt experienced transport processes similar to passive particles and that Delta Smelt entrained into the South Delta are effectively removed from the population. Entrainment of postlarval and juvenile Delta Smelt during April–June ranged from 1,531 in 2014 to approximately 593 thousand in 1999. The model was sensitive to overall sampling efficiency, the weighting of transport information, and survival; the model was relatively less sensitive to length composition. Future research such as mark-recapture studies may help address model sensitivities.

Juvenile Green Sturgeon Migration from the Upper Sacramento River to the Legal Delta: 2016-2017

Chad Praetorius, William Poytress, and Josh Gruber, U.S. Fish and Wildlife Service

Until recently, monitoring of the juvenile (>45 days post-hatch) life-history stage of Green Sturgeon *Acipenser medirostris* has resulted in minimal information regarding the habitat use and spatial distribution of this critical life stage in the Central Valley of California. Capture of juvenile Southern Distinct Population Segment of the North American Green Sturgeon in fresh water beyond the larval stage in the upper Sacramento River at Red Bluff Diversion Dam has occurred sporadically from multiple salmonid monitoring stations and, intermittently, from entrainment at the South Delta Federal and State Pumping Facilities. These data have resulted in anecdotal observations of a species that is then primarily detected as sub-adults and adults which, in recent years, much information on their habits and habitat use has become available. The lack of basic information on juvenile sturgeon has resulted in the inability of managers to take actions to conserve or protect juvenile Green Sturgeon in the freshwater portion of their life with respect to Central Valley Project and California State Water Projects' operations. Through the use of a benthic trawl and micro-acoustic technologies, the Red Bluff Fish and Wildlife Office has developed a reliable method to consistently catch age-0 juvenile Green Sturgeon rearing in the upper Sacramento River. A multi-year collaborative study to investigate potential drivers of juvenile migration from fresh water to brackish water in relation to environmental cues including temperature, flow, and turbidity is in progress. Information from the 2016 pilot tagging efforts (n=21) and 2017 tagging efforts (n=50) will be presented detailing catch results and migration patterns to the legal Delta observed thus far.

#6. Management of Anadromous Salmonids

Moderator: Javier Linares – U.S. Fish and Wildlife Service

Seven Decades of Chinook Salmon Hatchery Release at the Edgle of the Species Range: Spatiotemporal Trends and Management

Anna Sturrock, University of California, Davis
Kristina Yoshida, Eric Huber, Sébastien Nusslé, and Stephanie Carlson, University of California, Berkeley
William Satterthwaite, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center
Hugh Sturrock, University of California, San Francisco

Hatcheries have become a controversial tool for recovering salmon stocks, given potential impacts of hatchery fish on wild stocks. The California Central Valley contains the southernmost populations of Chinook Salmon *Oncorhynchus tshawytscha* within their extant native species range. The region experiences substantial hydroclimatic variability, giving rise to diverse salmon life histories and complex water management projects. To mitigate extensive habitat loss and supplement the fishery, millions of hatchery salmon are released each year, often trucked downstream or directly to the Bay. Understanding trends in hatchery release strategies and straying rates has been hampered by unpublished records, and limited or inconsistent tagging and recovery efforts. Here, we synthesize historical trends in hatchery release locations and timing since 1941, and examine the long-term implications. Over the last seven decades, releases have been at increasing distances from the source hatchery (averaging 0rkm in 1946 to 295rkm in 2015), initially multi-directional, now almost exclusively downstream. Pre-2000, planting of fry in non-natal watersheds increased release site spatial diversity, but recent releases have been clustered in the Bay, particularly during droughts. Variation in ocean arrival timing has decreased through time, leaving outmigrants vulnerable to temporal mismatch with ocean feeding opportunities. Straying rates of hatchery fish (brood years 2006-12) varied among hatcheries, averaging 0-6% for on-site releases and 7-84% for Bay releases. Straying rate increased with transplant distance and return age, and decreased with higher natal stream flows at release and return. The simplification of the Central Valley portfolio by narrowing the ocean entry window and synchronization of population dynamics through hatchery strays could increase vulnerability of the entire stock complex to future perturbations.

Effects of Straying an Variable Cohort Success on the Sacramento Basin Fall-run Chinook Salmon Stock as Seen in River Sport Fishery Monitoring

Rob Titus, Erin Ferguson, Lea Koerber, and James Lyons, California Department of Fish and Wildlife

Fall-run Chinook Salmon *Oncorhynchus tshawytscha* produced in the Sacramento Basin support ocean fisheries of high economic value from California to Washington, as well as a highly productive sport fishery in the Sacramento River itself. The recent 5-year drought in California resulted in extraordinarily low flow and high water temperature conditions that were unsuitable for both spawning adult and emigrating juvenile Chinook in the Sacramento. These conditions prompted fishery managers to truck most of Sacramento Basin hatchery production of fall run to the San Francisco Estuary to enhance recruitment to the ocean. Sport fishery monitoring conducted by California Department of Fish and Wildlife during 2016 and 2017 provided a first glimpse of the effects of unsuitable habitat conditions and trucking on the distribution, abundance, and composition of the spawner resource, which is typically dominated by 3-year-old adults. While estimated harvest followed a deterministic relationship with spawner abundance, the distribution of salmon fishing effort and harvest was highly skewed toward the lower Sacramento, American, and Feather rivers in the lower Sacramento Basin, and in the lower Mokelumne River in the northern San Joaquin Basin. Fishery activity on the upper Sacramento was very low. While also low in relative abundance, composition of known-origin Chinook harvested on the upper Sacramento was dominated by salmon produced at Coleman National Fish Hatchery (CNFH). However, 2-year-old grilse comprised up to 80% of the harvest in 2017, suggesting a very high stray rate of 2014 brood year salmon, 100% of which had been trucked. Harvest of known-origin Chinook on the Feather was dominated by in-basin salmon, but 50%-75% of known-origin harvest on the American were out-of-basin salmon, about a third of which were of CNFH origin and all 3- and 4-year olds. These results are discussed relative to the challenges of balancing production to support fisheries with maintenance of stock integrity.

Restoration on a Small Stream Provides Home for Chinook Salmon

Eric Chapman, Emily Jacinto, Gabriel Singer, and Peter Moyle, University of California, Davis

Lower Putah Creek in the Central Valley of California flows from Lake Berryessa through Yolo and Solano counties, into the Yolo Bypass. The number of adult fall-run Chinook Salmon *Oncorhynchus tshawytscha* spawning in Putah Creek has increased from fewer than 10 in 2013 to over 500 in each of the past three years. Restoration efforts have provided access to habitat that was not available to salmon for decades. Attraction flows and minimum flows were established, and spawning gravel that had been buried by years of siltation and compaction were uncovered. During the drought of 2012-2016, Central Valley hatcheries trucked juveniles downriver for release in the estuary to increase the number of fish surviving to the ocean. This action increased straying across the waterways of the region when these "trucked" fish returned as adults. Coded wire tag recoveries from adult carcasses in Putah Creek show that all of the marked fish sampled in Putah Creek were trucked to locations far downstream from hatcheries. Otolith microchemistry has revealed that unmarked adult salmon in 2016 originated from at least five hatcheries and that some fish may have been the result of natural spawning in Putah Creek. A rotary screw trap deployed in the spring of 2017 has confirmed that spawning is successful and Putah Creek offers the habitat necessary for producing large, healthy juveniles when floodplains are available during high water years. These findings indicate the potential for re-establishing salmon in a creek that hasn't supported one since the mid-twentieth century.

JSATS Study: Emigration Survival of Spring-run Chinook Salmon Juveniles in the Lower Feather River, 2013-2015

Jada-Simone White and Andrew Hampton, Pacific States Marine Fisheries Commission
Arnold Ammann, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center
Ryon Kurth, California Department of Fish and Wildlife
Jason Kindopp, California Department of Water Resources

For many years, fifty percent of the Feather River Fish Hatchery-derived spring-run Chinook salmon *were trucked* to the San Francisco bay prior to release. This management practice occasionally increased survival and returns; however, stray rates also increased. This study was conducted to inform the best in-river release strategies of federally-listed spring-run Chinook salmon from the Feather River Fish Hatchery. We used the Juvenile Salmon Acoustic Telemetry System (JSATS) to evaluate the impact of release location and several different release treatments on the survival of spring-run smolts within the lower Feather River. Two release locations (i.e., upstream and downstream) were used to evaluate a different release treatment each year. The release treatments included: 1) type of release (i.e., direct vs. net pen); 2) time of release; and 3) seasonal timing of release. We used Cormack-Jolly-Seber models to evaluate survival by release treatment, location, and their interaction (i.e., release treatment x location). Survival was estimated per river kilometer to allow comparisons among years and release locations.

Evaluation of Long-term Mark-recapture Data for Estimating Abundance of Juvenile Chinook Salmon on the Stanislaus River from 1996 to Present

Tyler Pilger and Matt Peterson, FISHBIO

Conservation and management of culturally and economically important species rely on monitoring programs to provide accurate and robust estimates of population size. Rotary screw traps are often used to monitor populations of anadromous fish, including Chinook Salmon *Oncorhynchus tshawytscha* in California's Central Valley. Mark-recapture techniques are used to estimate a trap's efficiency, or the proportion of the population being sampled. Paired with catch of unmarked fish, efficiency is used to estimate abundance using numerical estimators, the simplest of which is the Lincoln-Petersen estimator. Recognition that trap efficiency is influenced by a myriad of factors has led to development of more complex estimation methods that allow for heterogeneity in efficiency. We used long-term mark-recapture data and catch of juvenile fall-run Chinook Salmon on the Stanislaus River, California, to investigate how choice of estimation method influences annual juvenile production estimates. Our primary objectives were to assess environmental covariates of trap efficiency for the Stanislaus River, and evaluate the robustness of annual juvenile abundance and trends in juvenile production using multiple estimation methods. Similar to other studies, river flow had the strongest effect on trap efficiency, followed by fish length. Generally, different estimation methods produced similar results, and discrepancies in specific years were indicative of assumption violations or low-quality mark-recapture data. A recently developed method that incorporates Bayesian statistics and spline regression appeared to be the least subjective approach that provided the most precise estimates. Given that trends in abundance were not

influenced by estimation method, and because the Bayesian method offers researchers flexibility in mark-recapture experiments for minimizing estimated uncertainty, we recommend that this approach be used with future juvenile monitoring on the Stanislaus River.

Effects of Flow-related Variables on Juvenile Coho Salmon Oversummer Survival in Intermittent Coastal California Streams

Mariska Obedzinski and Sarah Nossaman Pierce, California Sea Grant
Gregg Horton, Sonoma County Water Agency
Mathew Dietch, University of Florida

While many studies have established the importance of streamflow as a driver of fish population dynamics, few have examined relationships between survival of juvenile salmonids and flow-related variables in intermittent streams. With predictions for higher frequency of drought conditions due to climate change, and the associated increasing human demand for water during the dry season, understanding fish-flow relationships is becoming increasingly important for the protection of sensitive aquatic species. To examine the effects of low streamflow on juvenile salmonids rearing in small intermittent streams, we estimated survival and collected environmental data in four coastal California watersheds from 2011 to 2013. We used an individual-based mark-recapture modeling approach to evaluate the influence of flow-related variables on oversummer survival of PIT-tagged juvenile Coho Salmon *Oncorhynchus kisutch* stocked into eight stream reaches. Survival was positively associated with streamflow magnitude, wetted volume, and dissolved oxygen, and negatively associated with days of disconnected surface flow (days of disconnection), and temperature. Days of disconnection best explained survival, though the relationship varied by geomorphic reach type. Survival was lower in alluvial reaches as compared to bedrock and clay reaches, and showed a faster rate of decline with increasing days of disconnection and drought condition. In all reaches, the onset of pool disconnection represented a turning point at which water quality, water quantity, and survival declined. For this reason, we suggest that days of disconnection (or the flow magnitude at which pools become disconnected), is a useful metric for identifying flow-impaired reaches, informing streamflow protection strategies, and prioritizing streamflow enhancement efforts designed to benefit sensitive salmonid populations in intermittent streams.

Empirical Model of In-redd Temperature and Discharge Dependent Mortality: Spring-run Chinook Salmon on Clear Creek (Shasta County, CA)

Sam Provins, U.S. Fish and Wildlife Service

In dam controlled water systems where threatened and endangered anadromous species spawn, temperature criteria are sometimes developed to reduce thermal stress during holding, spawning and embryo incubation. These temperature criteria are often based on physiological data from lab and aquaculture investigations. A recent empirical modeling effort by Martin et al. (2017) explored the nature of thermal stress in situ on endangered winter-run Chinook Salmon *Onchorhynchus tshawytscha* spawning in the Sacramento River. Parameters describing temperature dependent mortality were fit to data on the temperature through incubation at identified redd locations, and estimates of juvenile downstream migration. In this study, we used similar methods to explore fertilization to outmigration survival of threatened spring-run Chinook Salmon on Clear Creek (Shasta County, CA). We tested models assuming fixed thermal tolerance through incubation, and models that allowed thermal tolerance to vary though incubation. Spring-run Chinook Salmon in Clear Creek did not mimic the same response to thermal history as described for winter-run Chinook Salmon by Martin et al. (2017). The best fitting model with our data incorporated exposure to extreme high or low creek discharge with varying thermal tolerance through incubation. Further investigations into additional factors influencing fertilization to outmigration mortality are needed.

Piscivore Dynamics and Diet Below a Low-head Dam on the Lower Yuba River, California

Lauren Stearman and Duane Massa, Pacific States Marine Fisheries Commision

Juvenile salmonids face many challenges in anthropogenically modified freshwater environments. Low-head dams in particular may relate not only to difficulties in navigation and passage, but also to increased concentrations of and levels of predation from native and introduced piscivorous fishes. While this phenomenon is thoroughly studied at a small number of localities in the Sacramento-San Joaquin river system, many anthropogenic structures have received limited formal attention. We examined the dynamics and diet of a native piscivore (Sacramento Pikeminnow, *Ptychocheilus grandis*) and an introduced piscivore (Striped Bass, *Morone saxatilis*), downstream of Daguerre Point Dam on the

lower Yuba River. We collected fishes using hook-and-line sampling, and gut contents via nonlethal gastric lavage. We tagged all fishes using Passive Integrated Transponder (PIT) tags for mark-recapture efforts. Striped bass CPUE was highest during warm months, while Sacramento Pikeminnow CPUE showed no clear temporal pattern. Recapture efforts proved unsuccessful for Striped Bass (n = 0 recaptures) and too infrequent for Sacramento Pikeminnow (n = 1 recapture) for population estimation. Both species predominately concentrated on benthic prey items. Sculpins *Cottus spp.*, Speckled Dace *Rhinichthys osculus*, introduced signal crayfish *Pacifastacus leniusculus*, and large benthic macroinvertebrates comprised the majority of diet items for Striped Bass. Signal crayfish were the dominant prey item for Sacramento Pikeminnow, although lamprey ammocoetes, sculpins, and benthic macroinvertebrates were also consumed. Neither Chinook Salmon *Oncorhynchus tschawytscha* nor rainbow trout *Oncorhynchus mykiss* were a major diet component for striped bass, and neither salmonid species was recovered at all from Sacramento Pikeminnow guts. Data from temperature loggers deployed at the sampling locality indicates that the mean daily temperature may cause low metabolic rates in both piscivores during anticipated juvenile Chinook Salmon migration timing. Our results suggest that at this locality, neither piscivore is utilizing salmonids as a major prey item.

Assessment of Juvenile Chinook Salmon Rearing Habitat Potential Along the Lower San Joaquin River

Jesse Wiesenfeld, Steven Zeug, Kirsten Sellheim, Annie Brodsky, and Joseph Merz, Cramer Fish Sciences

To recover Pacific salmon *Oncorhynchus spp.* populations in watersheds that have been impacted by anthropogenic activities, it is essential to first understand the range of habitats and environmental conditions to which particular life stages are adapted, the seasonal timing of habitat use, and the flow regimes that support such habitat. This is especially true when previously extirpated salmonid stocks are targeted for reintroduction, as is the case for spring- and fall-run Chinook Salmon *O. tshawytscha* in the Lower San Joaquin River, California. To assess rearing habitat along the longitudinal river gradient and across time, we reared juvenile Chinook Salmon in net pens within three reaches representing, alluvial, transitional, and lowland habitats of the lower San Joaquin River. Juvenile Chinook Salmon successfully reared in all three reaches until the final two weeks of the study (late April), when water quality declined and some net pens experienced mortality. We found significant spatiotemporal variation in Chinook Salmon growth rates and habitat conditions during the study. The highest growth rates were observed early in the rearing period within the Lowland Reach. Prey densities during the early period were highest in the Lowland Reach and environmental conditions were within species' tolerance limits. In the late period, growth declined in the lowland reach as environmental conditions became stressful, whereas growth was moderate in the Alluvial and Transitional reaches and prey densities were lower. High water events at Alluvial and Transitional reaches during the early period precluded a comparison of growth during that time; however, prey densities were low relative to the Lowland Reach. Our results suggest that San Joaquin River floodplain can provide quality rearing habitat and growth benefits early in the rearing season before environmental conditions become stressful. Resource managers considering juvenile salmonid habitat should target flows early to provide access to floodplains when environmental conditions are optimal.

Recovered PIT Tags in Steelhead Study: Patterns and Implications for Future Research

Kate McLaughlin, California Department of Fish and Widlife

Taking advantage of low water conditions during the drought, we used a mobile PIT tag scanner on a 2.3-mile reach of Topanga Canyon (Los Angeles County). This reach is part of a long-term PIT tagging study of southern California steelhead *Oncorhynchus mykiss*. Seventy-six half duplex (HDX) passive integrated transponder tags were recovered during the summer of 2016. This presentation will look at (1) tag movement between time of tagging and recovery, (2) patterns between recovered tags, size and age of fish at tagging and habitat features, and (3) implications for future PIT tag studies.

#7. Southern California Steelhead Trout

Moderator: Candice Meneghin – CalTrout

Matilija: Breaking the Barrier

Paul Jenkin, Surfrider Foundation

The Matilija Dam Ecosystem Restoration project includes dam removal and watershed management intended to restore fish passage to the upper watershed and natural

sediment transport to nourish coastal beaches. Project design constraints include water supply and floodplain management as well as environmental considerations.

Planning for the removal of Matilija Dam is based upon the fundamental objective of restoring the natural sediment transport regime. This has significant implications in the semi-arid climate of southern California, where consideration is required for sediment management without disruptions to water supply.

The Matilija Dam Ecosystem Restoration project includes extensive re-engineering of water diversion facilities as well as modification of levees and bridges. Although the federal project was approved by Congress in 2007, it unfortunately stalled in 2008 due to escalating costs.

In 2016, the Matilija Dam stakeholders group reached consensus on the "low level outlet" approach to dam removal, clearing a path forward that greatly reduces the cost of the project. Funding has been secured through a State Proposition 1 grant which, combined with additional private funding, will support the necessary engineering and environmental permitting work required to get the project "shovel ready."

Working Toward Instream Flow Enhancements: Modeling Surface Water, Groundwater, and Water Use to Inform Policy Development in Critical Salmonid Streams in the Ventura River Watershed

Kevin DeLano, Valerie Zimmer, Daniel Worth, Adam Weinberg, Rajaa Hassan, and Robert Solecki, California State Water Resources Control Board

To support Action 4 of the California Water Action Plan, to "Protect and Restore Important Ecosystems", the State Water Resources Control Board (State Water Board) and the California Department of Fish and Wildlife (CDFW) are implementing a suite of actions to enhance flows statewide in at least five stream systems that support critical habitat for anadromous fish. These actions include developing defensible, cost-effective, and time-sensitive approaches to establish instream flows using sound science and a transparent public process. This effort is underway in Mark West Creek (Russian River), South Fork Eel River, Shasta River, Mill Creek (Sacramento River), and the Ventura River. In the Ventura River watershed (VRW), the State Water Board is developing an integrated groundwater-surface water hydrology model using GSFLOW, a public domain model developed by the US Geological Survey. We are using available land use, water use, geology, land surface, and climate (measured or estimated precipitation, air temperature, and solar radiation) datasets to characterize the impact of surface and groundwater diversion on instream flows and water availability. In partnership with the State Water Board, CDFW is conducting an instream flow study to characterize the flows required to maintain fish passage, spawning, and summer rearing habitat in the VRW. The State Water Board will consider CDFW's flow recommendation as it develops a water management policy. The State Water Board recognizes that local agencies and stakeholders in the VRW have relevant subject matter expertise and are undertaking water management and conservation actions. The State Water Board would prefer to coordinate with all interested parties to develop cooperative water management actions that enhance instream flows and make local water supplies more resilient to future drought. The State Water Board is conducting regular public outreach, leading a technical advisory committee, and coordinating with interested local agencies and stakeholders.

Integrated Strategies for Enhanced Instream Flow in Santa Barbara and Ventura Counties

Mauricio Gomez, South Coast Habitat Restoration
Stephanie Wald, Central Coast Salmon Enhancement
Regina Hirsch, Sierra Watershed Progressive
Tom Hicks, Hicks Law
Nick Weigel, Northstar Engineering

The project goal is to enhance stream flow for anadromous steelhead *Oncorhynchus mykiss* in Santa Barbara and Ventura Counties. The project, via a planning and feasibility study, will frame and geographically identify and prioritize water conservation and reduced consumptive use opportunities that promote the highest potential for instream flow contributions in five different watersheds in Santa Barbara and Ventura. The project team will quantify the opportunity in water savings to the user as well as multiple benefits to watershed processes and landowner. This study will scope and measure the individual and cumulative potential for geographically significant conservation projects. Based on the crucial "time value" of water in already recognized and prioritized fragile steelhead habitats, new projects will be assessed and rated by their local instream flow benefits such as: 1. On-site recycled water opportunities; 2. Ornamental and agricultural irrigation best management strategies; 3. Low Impact Development storm water infiltration; 4. Water Conservation Best Management Practices; 5. Voluntary

water right transactions such as acquisition, lease, and donations. The project will develop conceptual plans in the geographic area in order to begin the process of enhancing stream flows for steelhead trout.

Evolutionary Restoration of Southern California Steelhead

Devon Pearse and John Carlos Garza, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center
Alicia Abadía-Cardoso, Anthony Clemento, Travis Apgar, Ethan Campbell, and Eric Palkovacs, University of California Santa Cruz
Maeva Leitwein, Universite de Brest, France

The recovery of Southern California steelhead *Oncorhynchus mykiss* faces significant challenges. Widespread stocking of hatchery rainbow trout (resident form) strains has impacted populations throughout California for over 100 years, primarily using trout strains derived from the Central Valley lineage. Genetic analysis has shown introgression by stocked hatchery rainbow trout strains is widespread among above-barrier populations in Southern California, and many populations appear to have been completely replaced by hatchery rainbow trout. Nevertheless, these genetically introgressed populations represent potentially critical genetic resources for the persistence and restoration of Southern California O. mykiss populations. Variation in expression of anadromous migration in O. mykiss is influenced by a combination of environmental and genetic effects. Local adaptation to novel environments, such as above barrier dams, may be accompanied by changes in specific genomic regions that are linked to genes under divergent natural selection. A genomic region on the chromosome Omy5 is strongly associated with life-history traits in resident and anadromous populations, but other genomic regions are also important. However, genetic variation at the population scale cannot predict any individual's probability of expressing anadromy. I will discuss how accurate identification of regions in the genome that are under divergent selection contributes to our understanding of migratory life-history variation, and provides useful information for the management of this species in Southern California.

The Effects of Prolonged Drought on Southern Steelhead Trout in a Coastal Creek, Los Angeles, California

Ethan Bell, Stillwater Sciences
Rosi Dagit, RCD of the Santa Monica Mountains

Long-term lifecycle monitoring of federally endangered southern steelhead trout *Oncorhynchus mykiss* in Topanga Creek provides a unique opportunity to examine the health and abundance of a steelhead population before (2008–2011) and during (2012–2016) a prolonged drought. We found that the five-year drought resulted in a substantial and significant decline in available wetted habitat suitable for rearing and upstream migratory access for anadromous adults. The response of the steelhead population has been a significant reduction in anadromous spawning, distribution of rearing, and abundance of all life stages of anadromous and resident steelhead. After five years of drought a population that exceeded 325 individuals in 2008, now numbers fewer than 50 fish, and appears to be at extremely high risk of extirpation. Acknowledging the possibility of increased drought regionally and globally, the need to bolster southern steelhead resiliency to additional disturbance is paramount.

#8. Reconciliation Ecology and Novel Ecosystems: New Approaches to Understanding Fish Communities and Ecosystems

Moderator: Denise Colombano – University of California Davis

Reconciliation Ecology and Novel Ecosystems: New Approaches to Understanding Fish Communities and Ecosystems

Peter Moyle, University of California, Davis

In the past 200 years, California's aquatic ecosystems have been transformed into irreversibly altered, human-dominated systems supporting a diverse mixture of native and non-native species. In such novel ecosystems, traditional approaches to environmental management -- including conservation, preservation, and restoration—are unlikely to significantly improve conditions for native species. In contrast, reconciliation ecology focuses on sustaining biodiversity and ecological services in novel ecosystems, recognizing that people are the dominant players. In this symposium we introduce the concepts of reconciliation ecology and novel ecosystems as applied to the San Francisco Estuary. We then show why they are important for management of the estuary's ecosystem, especially as a realistic pathway to conservation to native

species. We then provide insights from recent research on how they apply to floodplains, the North Delta habitat arc, Suisun Marsh, and marshlands of San Francisco Bay.

Environmental Variability and Fish Community Structure Among Tidal Saltmarshes of San Francisco Bay

Arthur Barros, Levi Lewis, Malte Willmes, Micah Bisson, Christina Parker, Pat Crain, Jon Cook, James Ervin, and Jim Hobbs, University of California, Davis

Coastal salt marshes and wetlands are among the most productive, economically important and threatened aquatic habitats worldwide. The San Francisco Estuary (SFE) is the largest estuary on the west coast of the United States, and with 7 million people along its shores, the SFE has experienced myriad perturbations including loss of > 90% of historic wetland habitats, reduced freshwater flows, altered food webs, elevated nutrient loading, and invasion by alien species; together, these impacts have dramatically altered the functioning of the estuary. Though previously viewed as resilient to such impacts, recent changes–including declining turbidity, fall phytoplankton blooms, and declines in the abundance of fishes–suggest the system is becoming increasingly degraded. To improve function and suitability for native species, large-scale restoration of industrial salt ponds in North Bay and South Bay has been implemented and is planned for the tidal freshwater region of the Delta. However, limited monitoring of these aquatic communities post restoration has occurred in these marshes. Without high-quality physical and biological assessment of restored habitats, great uncertainty remains for the efficacy of our restoration efforts in the SFE. Here we examined variation in habitat quality and fish communities in four salt marsh complexes in the North Bay and South Bay over three consecutive years of highly variable freshwater flows. These surveys have allowed us to describe spatial variation (among and within marsh complexes) and temporal patterns (among seasons and years) in community structure and habitat utilization by native and invasive fishes in these restoring salt marsh habitats.

Accelerated Growth of Juvenile Salmon in a Managed Wetland Relative to Historic and Leveed Sloughs in Suisun Marsh

Nicole Aha, John Durand, Nann Fangue, and Peter Moyle, University of California, Davis

Suisun Marsh, the largest contiguous marsh on the west coast of the United States, has been altered by urban development and the creation of managed wetlands for waterfowl. Currently, these managed wetlands comprise forty-five percent of Suisun Marsh's total acreage. To understand how this novel ecosystem affects native fish of special concern, juvenile Chinook Salmon *Oncorhynchus tshawytscha* were reared in cages for seven weeks between March and April in three discrete habitat types: a slough surrounded by historic marsh, a leveed slough adjacent to managed wetlands, and within a small managed wetland. Growth rates over the seven-week study differed significantly between the slough sites and the managed wetland. Both sloughs saw low or negative growth (-0.4 – 1.0 mg/day), whereas fish reared in the managed wetland demonstrated positive growth (7.7 mg/day). This study found temperature and productivity to be important drivers of these differences. As the managed wetland was tidally muted, there was less observed diel fluctuation in temperature compared to the sloughs, helping reduce thermal stress. Additionally, the managed wetland had the highest zooplankton density and fish with the fullest stomachs, which may have helped offset the costs of the wetland's low dissolved oxygen levels. Overall, stable temperatures and food accessibility aided fish in the managed wetland, contributing to faster growth rates than their counterparts in the historic and leveed sloughs. These results highlight the potential of managed wetlands as valuable rearing habitats and productive food export systems for juvenile native fishes.

Reconciled Floodplains in the Central Valley: Understanding Process for Species Management

Carson Jefferies, University of California, Davis
Jacob Katz, California Trout

Fishes in the interior of California evolved to take advantage of the vast seasonally inundated floodplains in the Central Valley. As the lowlands were developed for agriculture and urban uses and levees were erected to protect those investments, fish that historically had access to the productive floodplains had been disconnected from the habitat. Research has shown the importance of floodplains to species such as Chinook Salmon *Oncorhynchus tshawytscha* and Sacramento Splittial *Pogonichthys macrolepidotus*. Floodplains in the Central Valley currently take one of two forms, "restored" or managed. Since the 1990's a variety of studies have looked at the restoration of floodplain process on the Cosumnes River via levee breaching. Through study on the Cosumnes River, we have learned what floodplain processes benefit the aquatic food web and the native

fishes that utilize the river. A better understanding of a relatively natural floodplain has also helped to better understand how managed floodplains function. The 59,000-acre Yolo Bypass is part the flood control system that protects the urban and agricultural lands in the Central Valley. Over the past 20 years, various studies have provided a better understanding of how during both large and small floods the flood bypasses can better provide habitat for juvenile Chinook salmon and other native fishes. The combination of research on relatively intact floodplains as well as heavily managed floodplains can allow for a better understanding of how society can incorporate ecosystem function on a human dominated landscape to provide multi-benefit outcomes in reconciled ecosystems.

#9. General Session

Moderator: Jim Hobbs – University of California Davis

The 2015 Columbia River Salmon Run-An Omen of the Future in a Warming World?

Jeffery Fryer, Columbia River Inter-Tribal Fish Commission

Low snowpack and hot weather in 2015 resulted in unprecedented Columbia River temperatures exceeding 22.2C for almost three weeks, just past the peak of the third largest Sockeye Salmon *Oncorhynchus nerka* run on record and during a period when large numbers of Chinook Salmon *O. tshawytscha* passed. For weeks, the region saw pictures and videos of dead and dying Sockeye Salmon and speculation that runs would be devastated. Tagging studies conducted at Bonneville Dam, although halted during peak temperatures, provide data on their impact. For Chinook Salmon, survival from Bonneville Dam to McNary Dam dropped from 78.9% to 36.4% in the two weeks prior to water temperatures at Bonneville Dam exceeding 22.2C. However, immediately after temperatures dropped, survival rates rebounded. For Sockeye Salmon, the survival rate from Bonneville Dam to McNary dropped from 82.4% to 31.7% but then increased to 46.2% once tagging resumed.

Climate models suggest that events such as occurred in 2015 may become the norm in the future. A question of concern to the region is whether Columbia Basin salmon can adapt to climate change. Sockeye Salmon bound for the Okanagan Basin in Canada may provide insights as they may be a stock already adapting to climate change. This stock is reaching the Okanagan River 12 days earlier than in the late 1970's, possibly due to a warming Columbia River as well as habitat improvements in the Okanagan Basin that have made an earlier migration more advantageous.

Bursting Bubbles: Lessons from an Interactive Information Integration System for Enhancing Communication and Science on Central Valley Salmonids

Joshua Israel, U.S. Bureau of Reclamation
Jim Anderson, University of Washington

As part of the Drought Contingency Biological Monitoring Plan for Water Year 2015 and Beyond, we developed a website (http://www.cbr.washington.edu/sacramento/) and models to aggregate and visualize descriptive, diagnostic, and predictive information regarding Central Valley biological and physical data. The effort's goal is to provide web-based services to link data and science to in-season water and fish management. Data analytics are a norm is most sectors affecting society- the stock market, transportation, and public safety, yet the natural resources the we aim to protect, restore, and maintain have not been afforded similar emphasis. As part of the extensive data queries and alerts numerous biological and physical monitoring datasets are available in descriptive and diagnostic formats to assess performance of various criteria useful for characterizing ecological mechanisms affecting ESA-listed salmonids. The fish model provides a collaboratory for interested participants to evaluating flow and temperature effects from spawning to Delta migration. These predictions are useful for considering user-defined flow and temperature scenarios that relate fish passage to these environmental conditions and provide resources for evaluating the effects of river management and environmental conditions on salmon passage and survival. We will present some lessons learned through our trials with this web-accessible system including the value of rapid prototyping and importance of extensive interagency interaction. We will also share some of the challenges we have faced with "open data" innovation in our collaborative science enterprise and suggestions for how to advance beyond these in the future.

Better Together: Fisheries Technology and Communication

Erin Loury, Dee Thao, and Doug Demko, FISHBIO

The intersection between technology and communication offers rich possibilities for sharing stories about fisheries

science with broad audiences. Many automated, imaging, or video technologies regularly employed in fisheries research provide a window into the world of fish that can then be shared with the public. This presentation describes how fisheries technology can be used to create outreach content and can also be explored as a communication topic. It also describes the diverse array of communication technologies that FISHBIO uses to tell stories about our work. Fall-run Chinook Salmon *Oncorhynchus tshawytscha* passage data from the Riverwatcher automated fish counter on the Stanislaus River are used to create a salmon migration tracking activity with fourth grade students. GoPro footage used to document the timing of salmon spawning was turned into a blog post and a time-lapse video for YouTube. Video footage of beavers from a fish-counting weir on the Tuolumne River was selected for a film festival intended to connect San Francisco Bay Area water users with their water supply. Collecting fisheries data provides many opportunities to communicate the process and importance of fisheries research, and scientists have many options for helping research results speak for themselves.

Comparing Observed Fish Density, and Community Structure Between a ROV and a Stereo-video Lander

Christian Denney, University of California, Davis
Rick Starr, Moss Landing Marine Lab
Andy Lauermann, Marine Applied Research and Exploration
Mary Gleason, The Nature Conservancy

Increasing use of ecosystem-based management strategies, often applied to broad geographic areas, and preclude extractive activities, are creating a need for rapid, cost-effective monitoring of large areas. Visual surveys are increasingly being used to meet this need. As visual tools improve and new techniques are developed, however, it is necessary to understand how data collected with new tools compare and contrast with previously used methodologies, and to understand how different tools can be used for various applications. Towards this end, I compared a new tool: the video lander with a Remotely Operated Vehicle (ROV), the most commonly used visual tool for deep-water surveys and evaluated the strengths and weakness of each technique. In comparing the lander and the ROV, both provided similar densities and mean length estimates for most species of interest. The differences in length distributions were likely not a function of the tool, but rather the measurement technique employed by each in the post-processing phase. Furthermore, I found that estimates of the variance in fish density were similar for the two tools given a comparable sampling effort (i.e., number of sites surveyed). Differences in community assemblage were found to be significant but may be related to different levels of effectiveness on different habitat types. Because of the similarity in results and ability to quickly perform surveys and move on to new areas, the lander represents a new option when considering visual tools for deep-water research.

Opportunities and Limitations of Pop-up Satellite Tags in Fresh Water Environmentsl

Marco Flagg and Jacob Wolf, Desert Star System LLC

Pop-up satellite tags (PSAT), typically reporting via the Argos satellite constellation, have long been a staple for the research of marine species such as sharks, tuna, billfish and many others. Here, tag observations such as light and sea surface temperature are used to estimate migratory tracks, while depth sensing provides detailed information on vertical habitat utilization. Applications involving freshwater species however have been limited, as light and surface temperature based migratory track sensing was generally not accurate enough or applicable at the scale of inland waters, the galvanic corrosion based pop-up release mechanism commonly used by the tags was not suitable for fresh water and cost at upward of $3000 per tag were too high. In recent years however, innovations such as the introduction of geomagnetic sensing are allowing sufficiently accurate horizontal position estimation in some inland waters, accelerometer returns measure fish activity cycles, physical tag recovery yields large, high-resolution time series data and the economics of PSAT use has improved through the introduction of re-usable and lower cost tags. In this presentation, we are reviewing the PSAT work of researchers in inland waters involving species including sturgeon, trout, catfish and salmon, and topics ranging from vertical habitat utilization to spawning migration and evaluation of boat strike risk. The presentation concludes with a summary of the opportunities and limitations of PSAT for tagging in lakes and rivers.

Spatial and Temporal Patterns of Variation in Nearshore Ichthyoplankton in Santa Monica Bay, California

John Steinbeck, Chris Ehrler, and Andrew Harmer, Tenera Environmental
Shane Beck, MBC Aquatic Sciences

Ichthyoplankton samples were collected along the north central coast of Santa Monica Bay from El Segundo downcoast past Redondo Beach. The sampling locations extended along approximately 15 km of the coast along the 10, 20, and 30 m depth contours. The samples, which were collected monthly, represent a unique dataset for exploring the spatial and temporal patterns of variation in nearshore ichthyoplankton assemblages. A total of 124 different taxonomic categories of fish larvae comprising a minimum of 35 families, were enumerated from the monthly samples from all of the stations. These categories were combined into 101 distinctive taxonomic groups for analysis. The three most abundant larval taxa collected during this study were Engraulidae (23.2%), *Genyonemus lineatus* (21.7%), and *Parophrys vetulus* (5.7%). The results showed patterns of variation associated with the depth gradient and changes in adult habitat that were likely sources for the larvae. This was especially apparent in the samples collected offshore from King Harbor where taxa more commonly associated with protected harbor habitats were common. Despite the considerable variation in composition among stations, the major source of variation in the data was seasonality. Information from these types of studies are critical in the permitting process for coastal facilities that may affect marine resources.

Genomic Analysis of Disjunct Marine Fish Populations of the Northeastern Pacific and Sea of Cortez

Eric Garcia and Giacomo Bernardi, University of California, Santa Cruz

Disjunct populations are formed after a physical barrier separates the populations of a species, which then has the potential to remain the same species or diverge depending on how effectively the barrier impedes gene flow. Disjunct populations provide an excellent opportunity to study the evolutionary processes of allopatric speciation. The Sargo *Anisotremus davidsonii* (Haemulidae), and the Longjaw Mudsucker *Gillichthys mirabilis* (Gobiidae), have disjunct distributions with populations in the Pacific coast of California and Baja California and isolated populations in the upper half of the Sea of Cortez. These distributions have resulted in groups of populations with different levels of gene flow as the Pacific populations cross known phylogenetic breaks and the disjunct populations have been suggested to be at the initial phases of allopatric speciation. Here, restriction site-associated DNA (RADSeq) is utilized to produce a highly confident connectivity analysis of populations sampled across the Pacific and Sea of Cortez ranges of these species. The goals of this project are to (1) characterize the genomic structure of these populations and assess divergence levels across the Baja California peninsula, (2) determine the connectivity within each region and (3) explore the molecular signatures of incipient allopatric speciation. This study sheds light into the processes in the speciation continuum in these species and provides a deeper understanding of how populations are connected and how biodiversity might be shaped in these regions.

A Tale of Two Gobies: Non-native Tridentigers in San Francisco Bay

Daniel Chase, WRA, Inc.
Erin Flynn and Anne Todgham, University of California, Davis

The establishment of non-native species creates unique challenges for recovery efforts of native fishes and can alter regional ecosystems by creating novel assemblages of organisms. San Francisco Bay, an estuarine ecosystem that is one of the most invaded aquatic regions in the world, supports several non-native goby species. Two of these species from the genus *Tridentiger*, Shimofuri Goby *T. bifasciatus* and Chameleon Goby *T. trigonocephalus*, have become widely established within the San Francisco Bay. The phenotypic similarity between these two species has resulted in confusion with identification and distribution for each, yet these species present different threats to native fishes due to their physiological capabilities. Shimofuri Goby had become widely distributed throughout San Francisco Bay, the Sacramento-San Joaquin Delta, and has even used the state water infrastructure to invade Southern California. Chameleon goby on the other hand, has a more restricted range in the state. This talk will provide an overview of Shimofuri and Chameleon Goby, their history and distribution in California, along with some of the unique challenges these species pose for resource managers. Initial findings investigating the genetic relationship of these two species in San Francisco Bay, along with preliminary findings from field sampling that may update Shimofuri Goby habitable areas, will be presented.

The Environmental Drivers of Habitat Use by Silicon Valley's Estuarine Fishes

Levi Lewis, Jim Hobbs, Malte Willmes, and Christian Denney, University of California, Davis

Wetlands provide numerous important ecological functions, yet are also the most impacted habitats in California with 90% being drained, dredged, or developed

over the past century. For this reason, major marsh restoration projects throughout San Francisco Bay, California have been the central focus of habitat and species conservation plans; however, many of these projects lack data on baselines for, and restoration impacts to, associated native and non-native fish communities. We conducted a 7-year study of fish abundance and community structure in the Alviso Marsh Complex in South San Francisco Bay, near Silicon Valley. We sampled fishes using a standard otter trawl and modeled abundances as functions of trawl-specific environmental conditions (dissolved oxygen, salinity, and temperature) using negative binomial Generalized Additive Mixed-effects Models (GAMMs). Over 50 resident and transient fishes used these habitats throughout the survey period, including: marsh residents (e.g., sticklebacks, mudsuckers); forage species (e.g., silversides, anchovies, herring, and shad); predators (sharks, rays, bass, and halibut); and a severely threatened osmerid (Longfin Smelt *Spirinchus thaleichthys*). The fish community showed remarkable diversity in responses to environmental conditions, corresponding with both temporal and spatial variation in habitat use. Habitat use by estuarine species remains a focal metric for assessing human impacts (e.g., eutrophication, pollution, fishing, marsh restoration); therefore, our results provide valuable information with direct relevance to ongoing management efforts and policy decisions for Silicon Valley's impacted marshlands.

Stream Size and Network Position Affect Diversity in Different Ways in Stream Fishes

Loren Stearman, Pacific States Marine Fisheries Commission
Ginny Adams and Reid Adams, University of Central Arkansas

Longitudinal patterns of biodiversity in watersheds have a long history of study, and patterns relating to the dendritic nature of streams have received much attention recently as well. Current research suggests that both stream size and network position relate to increases in fish diversity. In other taxonomic groups such as invertebrates and riparian plants, a gradient between local controlling factors in the headwaters and regional controlling factors near the base of systems is mediated by dendritic connectivity. This raises the question of whether similar patterns might be observed in stream fishes. We examined headwater assemblages representing a range of stream sizes and network positions in three watersheds in the eastern Interior Highlands to address this question. These systems drain a rugged upland region and confluence with major river systems with diverse main channel and off-channel habitats, and are marked by high biodiversity. Stream size was positively related to most species-level diversity metrics, but family level diversity was related only to network position. Diversity within two common taxonomic groups (darters and minnows) was related to stream size, and metrics of function within these groups related similarly. However, sunfish diversity related to both stream size and network position, and functional metrics of this group and of assemblages as a whole tended to relate to network position alone. Our results suggest that stream size and network position influence fish assemblages in fundamentally different manners. When considering only stream size, functional diversity appears to remain similar but specialization within functional groups varies; however, when considering network position overall functional diversity appears to vary. Our data support that these patterns are trait-mediated, although the link to dispersal capacity may function in a different manner than in invertebrates and riparian vegetation. We explore the broader conservation consequences of these relationships.

#10. Fish Reintroduction Efforts

Moderator: Laurie Earley – U.S. Fish and Wildlife Service

There's No Place Like Home – Reintroductions to Historic Habitat as a Tool for Fish Recovery

Jonathon Ambrose, National Oceanic and Atmospheric Administration, Fisheries

Reintroducing species to areas from which they have been extirpated is one of the most important conservation tools available. A large majority of recovery plans for threatened and endangered fish in the United States call for introduction or reintroduction. Many species simply cannot be recovered without successfully reintroducing them to formerly occupied habitats. The efficacy of reintroduction efforts can be greatly improved by relying upon a recent proliferation of literature that examine the success or failure of salmonid reintroduction efforts and provide scientifically based management principles for reintroductions. These principles are currently being applied in the Central Valley of California, where extensive extirpation of historical populations has placed winter-run Chinook salmon, spring-run Chinook salmon, and

steelhead in danger of extinction. The proximate problem afflicting these species is that their historical spawning and initial rearing areas are largely inaccessible due to the presence of large dams. In addition to habitat loss, substantial habitat degradation also contributes to the dire status of these species, and anthropogenic climate change is exacerbating conditions. California recently experienced its worst drought on record and mean annual air temperatures in the State in recent years have been at or near all-time highs. Because many anadromous salmonid populations have been extirpated in the Central Valley due to dams, and climate change is further constraining the ability of resource managers to provide suitable water temperatures and flows downstream of the dams, NMFS believes it is necessary to work with our partners in pursuit of reintroducing winter-run, spring-run, and steelhead to historical habitats upstream of at least a few key dams. The Central Valley Technical Recovery Team recommends just such an effort. This presentation will cover reintroduction planning guidelines and apply them to demonstrate that salmon and steelhead reintroductions are needed to recover listed salmonids in the Central Valley.

Strategies for Reintroduction of Salmon and Steelhead Into Newly Available or Restored Habitat

John Carlos Garza, National Marine Fisheries Service, Southwest Fisheries Science Center, and University of California, Santa Cruz

Multiple dam removal or passage projects are either underway or planned for imminent implementation in California. In addition, aquatic habitat restoration projects are ubiquitous, with the primary goal of restoring populations of salmon and steelhead where they are either reduced or extirpated. However, the path to repopulation of this extensive, newly available spawning, rearing and migratory habitat is far from clear and will be unique for the different anadromous salmonid species that are expected to utilize them. I will present an overview of strategies for facilitating the reemergence of self-recruiting populations of Coho Salmon, Chinook Salmon, and steelhead in areas made available by restoration or passage projects. I will discuss general repopulation strategies, from volitional recolonization to translocation, as well as release strategies and the role of captive propagation. Finally, I will discuss strategies for the selection of both donor stocks and individual fish, and how they need to differ for the different species of fish. Throughout, I will draw on the current state of science surrounding such repopulation and stock reconstitution projects, and on experience from restoration projects in California and further afield.

Utility of Genetics in the Reintroduction of Chinook Salmon to the San Joaquin River

Anthony Clemento and John Carlos Garza, National Marine Fisheries Service, Southwest Fisheries Science Center

With the construction of Friant Dam in 1942 and the subsequent explosion of agriculture in the San Joaquin River basin, the large populations of Chinook Salmon that once thrived there rapidly declined and ultimately went extinct. Today, spurred on by judicial action, state and Federal entities are working to restore both the river and its populations of spring-run and fall-run Chinook. Modern genetic tools are providing a wealth of information to inform management and effectively target restoration activities. This talk will highlight how genetic data is being used to guide program goals such as broodstock selection, hatchery practices, including feeding regimes and mate selection during spawning, and genetic tagging via parentage. These data are also being used to efficiently assess the outcomes of both adult and juvenile releases into the newly restored river.

Coho Salmon Reintroduction and Monitoring in the Russian River as a Recovery Tool

Nicolas Bauer, Andrew McClary, Mariska Obedzinski, Sarah Nossaman-Pierce, and Andrew Bartshire, California Sea Grant

Coho Salmon populations in California have been on a precipitous decline since the 1940s. In the Russian River, Coho Salmon were listed by the federal government as “threatened” in 1996 and later reclassified as “endangered” in 2005. Since 2001, a collaborative partnership has been breeding Coho Salmon from local genetic stock and releasing their offspring into historic Coho Salmon streams in the Russian River watershed with the goal of re-establishing a self-sustaining population.

Juvenile fish releases, when paired with comprehensive multi-stage lifecycle monitoring, have been an invaluable tool for recovery of Coho Salmon in the basin. Monitoring results are used to evaluate the effectiveness of different stocking strategies and help adaptively manage the conservation hatchery program. Seasonal survival and abundance estimates of juvenile fish released into multiple streams have helped managers determine the appropriate number, location, and timing of fish releases each year.

The combination of stocking and intensive monitoring is also helping to identify survival bottlenecks within the watershed and inform long-term recovery efforts such as habitat enhancement projects, barrier removals, conservation easements, instream flow enhancement, fish rescues, and angling regulations.

Since the reintroduction program began in the early 2000s, we have seen a marked increase in the number of returning Coho Salmon adults to Russian River tributaries. In 2005, no adult Coho Salmon were observed in the entire watershed, while in 2017, 533 adult Coho Salmon were estimated to have returned to Russian River streams. Juvenile Coho Salmon were detected in as few as one stream in the early 2000s, but were observed in 28 streams in 2017. We anticipate that the success of the Russian River Coho Salmon reintroduction program will continue as long as empirical evidence from the intensive monitoring effort is used to adapt our stocking strategies and inform recovery efforts throughout the basin.

Reintroduction of Sacramento River Winter-run Chinook Salmon to Battle Creek

Kevin Niemela, U.S. Fish and Wildlife Service

Currently, Sacramento River Winter-run Chinook Salmon (winter-run Chinook) *Oncorhynchus tshawytscha* exist as a single population, which is restricted to spawn in the Sacramento River downstream of Shasta Dam - an area completely outside of the geographical range of historic spawning. As a result, the persistence of Winter-run Chinook is precariously dependent on the release of cold water from Shasta Dam and the population remains extremely vulnerable to catastrophic events (such as drought) and climate change. National Marine Fisheries Service (NMFS) has determined that lack of spatial diversity is a primary threat to the continued existence of the federally- and state-listed, endangered winter-run Chinook. The historic spawning distribution for winter-run Chinook included Battle Creek, the only historic habitat downstream of Shasta Dam. Battle Creek is a unique watershed mainly because of its cold water springs and high year-round base flows. These features have made it an ideal stream for the recovery of Central Valley salmonids, specifically for winter-run Chinook. Agency agreement for restoration of Battle Creek was solidified with the signing of a Memorandum of Understanding in 1999 and currently construction for the Battle Creek Salmon and Steelhead Restoration Project is underway. Battle Creek is a key component of the NMFS Recovery Plan for Winter-run Chinook, which will require reintroduction of this run into the watershed. In preparation for the completion of the Restoration Project, resource agencies along with Pacific Gas and Electric and ICF, developed a plan to guide the reintroduction of winter-run Chinook to Battle Creek concurrent with the completion of the Restoration Project. However, following the recent drought, winter-run Chinook populations continue to decline and in Summer 2017, resources agencies determined that it was necessary to “jumpstart” the Reintroduction Project. This presentation will highlight the considerations and technical aspects that were included in the Battle Creek Winter-run Chinook Reintroduction Plan, and will provide an update on the current status of the Jumpstart Project.

Evaluating Feasibility of Winter-Run Chinook Salmon Reintroduction Upstream of Shasta Dam

John Hannon and Carolyn Bragg, U.S. Bureau of Reclamation
Jon Ambrose and Alice Berg, National Oceanic and Atmospheric Administration, Fisheries
Randy Beckwith, California Department of Water Resources

The Shasta Dam Fish Passage Evaluation is an effort to determine the feasibility of successfully reintroducing anadromous Chinook Salmon into habitats upstream of Shasta Dam after an absence of more than seventy years. Federal and State agencies with jurisdiction in the project area developed a fish passage pilot plan describing studies designed to inform a feasibility determination.

The 2009 NMFS biological opinion on long term CVP and SWP water operations predicted increased future temperature related survival effects on ESA listed salmonids and called for a phased evaluation of the feasibility of reintroduction. NMFS identified winter-run Chinook as the top priority for reintroduction at Shasta due to their endangered status and limited freshwater range, spawning only in a confined reach of the Sacramento River immediately below Keswick Dam. We conducted a habitat evaluation of the mainstem McCloud and upper Sacramento rivers to estimate the current habitat quality and spawning habitat potential. The habitat information forms the foundation for studies to determine: survival and spawning success for fish transported to these rivers, migratory timing down the rivers to the confluence with Shasta Reservoir, juvenile collection options near the river/reservoir interface, and survival and migratory patterns within Shasta Reservoir for potential juvenile collection in the reservoir. Pre-pilot

studies in Shasta Lake with surrogate runs are underway to help determine migration patterns and survival within Shasta Reservoir.

Low winter-run abundance and concerns over low survival in drought conditions resulted in the loss of the only approved source of test fish so a winter-run captive broodstock program was re-initiated at Livingston Stone National Fish Hatchery to provide a source of test fish for the project. Collaboration with local stakeholders is ongoing and is critical to successfully completing this evaluation.

Reintroducing Arroyo Chub to the Arroyo Seco

Wendy Katagi, Stillwater Sciences

The Arroyo Seco Watershed, a tributary to the Los Angeles River, has been a hub for utilizing integrated watershed management approaches to address issues of native fish recovery efforts while addressing TMDLs, post-fire recovery, water resource management, and recreation objectives. Stream restoration efforts in the Central Arroyo Seco provide habitat for native fish and amphibians, including reintroduction of approximately 300 Arroyo Chub *Gila orcutti*, a California Species of Special Concern, and water quality improvements. Habitat restoration components incorporated vegetation management, such as removal of non-native/invasive plant species in upland and aquatic habitats and revegetation with native plant species; sediment management, including bank stabilization, trail upgrades, and erosion control; and fish and wildlife habitat creation, including scour holes, backwater pools, snags, spawning areas, and riffles. In addition to these ecosystem benefits, the project also provided full capture trash inserts in every storm drain in the City of Pasadena, native plant community/stormwater islands in the Rose Bowl Parking Lot I adjacent to the creek, and education/stewardship opportunities to assist with stream monitoring. Targeted efforts to improve native fish habitat demonstrate that science-based approaches that mimic or restore natural processes and conditions provide the greatest opportunity for restoration and renewal of our urban streams.

Following reintroduction, Arroyo Chub progeny have been observed in the backwater pools of the southern restoration area. Fishery biologists were encouraged to see young Arroyo Chub in this stream. Other native fish, such as trout and stickleback, may be introduced in the future as the stream regains its natural form and function. The restoration project has attracted statewide interest due to the success of this stream restoration within an urban setting. Native fish, as target species for ecosystem restoration projects in this watershed and nearby southern California watersheds, have become more prevalent in recent years.

Miller Lake Lamprey: The Return Home, One Bucket at a Time

Stewart Reid, Western Fishes

The Miller Lake Lamprey *Entosphenus minimus* was believed extinct after treatment in 1958 with Toxaphene of its type and only known locality, Miller Lake (Upper Klamath Basin, OR). In the 1990s, a few Miller Lake Lampreys were 're-discovered' in the Williamson River and Miller Creek, downstream of the lake. Subsequent exploration in 1997-98 found substantial local populations in two additional sub-drainages (upper Williamson and Sycan rivers). Unfortunately, no lampreys were found in Miller Lake itself, which was isolated by a lamprey barrier in 1959. Since 2005, the Miller Lake Lamprey Conservation Plan (ODFW) has guided conservation goals, one of which is to re-establish lampreys in Miller Lake. The Miller Lake Lamprey Working Group is formed of individuals representing agencies, universities and private biologists. We camp annually at Miller Lake to discuss conservation needs, monitor the population and perform needed work, including barrier removal, surveys and reintroduction into the lake. The barrier was removed in 2005 with sledge hammers, crowbars and enthusiasm. All work, including excellent fireside meals, has been done without funding. Reintroduction of about 600 ammocoetes (mixed year classes) annually to the lake and tributaries from the downstream population in Miller Creek since 2010 demonstrates that ammocoetes successfully settle in available habitat. Following reintroductions, introduced ammocoete populations have been easily detected at two reintroduction sites. In 2015, a spawned out female was found in Evening Creek, the main inlet to the lake. In 2017, for the first time, we found locally spawned young of the year ammocoetes at the outlet of the lake and larger ammocoetes in the lake itself.

Owens Pupfish: 49 Years of Management by Translocation

Nicholas Buckmaster and Steve Parmenter, California Department of Fish and Wildlife

The Owens Pupfish *Cyprinodon radiosus* is the largest and one of the most genetically distinct pupfish species in the American Southwest. Despite a wide range of physiological tolerances and an omnivorous diet, the Owens Pupfish is

limited to five small refuge habitats, and occupies less than 0.5 acres of habitat due to its extreme susceptibility to predation by introduced piscivorous fishes. Since rediscovery in 1964, the continued persistence of this species has been dependent on extensive, and occasionally emergent, translocation and reestablishment efforts by the California Department of Fish and Wildlife (in partnership with other agencies). While translocations and the establishment of new populations ultimately has resulted in species persistence, the majority of pupfish translocations have failed to result in long-term success, and the median time to pupfish refuge failure is eight years. Cycles of population establishment, loss, and reestablishment ultimately threaten the continued existence of the species and result in erosion of species' genetic integrity. Here we present a history of Owens Pupfish translocation since 1964, highlight the reasons for unsuccessful translocations, and discuss the lessons learned from over five decades of Owens Pupfish management. We will also present a synopsis of future Owens Pupfish management in the Owens Basin, including the establishment of new populations.

Poster Presentation Abstracts

***Growth Rate Variation Among Juvenile Chinook Salmon Cohorts and Rearing Conditions**

Elianna Rosenthal and Steve Blumenshine, California State University Fresno

The construction of Friant Dam and its water diversion canals in 1942 has caused degradation of extended portions of the San Joaquin River (SJR), and has eliminated one of the largest Chinook salmon runs on the West Coast. Water diversions mainly for agricultural purposes resulted in reduced flows to the SJR, causing stretches of the San Joaquin River to run dry. The anadromous life cycle of salmon is dependent on a connected river for migration. The San Joaquin River Restoration Program was created in 2006 to mitigate the negative effects. To ensure successful Chinook reintroduction into the SJR, it is crucial to know the optimum diet and hydrological conditions for fish growth to create a sustainable population. Fish growth rates from otoliths are useful integrators of habitat conditions. How different river hydrology influences growth rates of SJR cohorts from 2014 and 2016 will be compared. Juvenile Chinook growth rates will also be compared to other populations, including from the adjacent Merced River. Growth rates of juveniles from the Salmon Interim Research Facility in Friant were also processed to serve as a control with known parameters. This information can help us inform bioenergetics models for SJR population and water policy management.

***The Effect of Juvenile Life History on the Marine Survival Rate of Coho Salmon**

Grace Ghrist and Darren Ward, Humboldt State University

Juvenile Coho Salmon *Oncorhynchus kisutch* in coastal California streams exhibit various life history strategies during their freshwater development. One strategy of interest to managers and conservationists is the early emigrant. This juvenile type migrates from natal habitat into lower parts of the watershed or estuary during the winter, where it rears before migration to the ocean in spring. By contrast, the more prevalent life-history type resides in natal reaches over the winter and emigrates the following spring. Salmon monitoring programs generally estimate juvenile production and demographic rates using only spring emigrants. In a Northern California stream, we PIT tagged juvenile Coho Salmon in the fall and detected their movements throughout the stream and estuary over their first winter, and then as they returned to spawn as adults. With the use of a multistate mark recapture model, we tested for distinct marine survival rates between these emigration periods. Our model allowed us to incorporate multiple life history strategies onto a single platform which can be used to report unbiased survival estimates of juvenile Coho Salmon.

***Is El Nino Driving Poleward Range Expansion of Marine Organisms?**

Justin Palmer, Marilla Lipper, Maurice Goodman, Emily Spurgeon, Grant Waltz, Jason Felton, Jenny Palo, Katherine Rodriquez, Parker Kalan, Katherine Grady, and Crow White, California Polytechnic State University
Amanda Bird, Danielle Zacherel, California State University Fullerton
Megan Wilson, Oregon State University
Nur Dalmau, Roberto Calderon, Zaida Parra, Cira Gabriela Montaño Moctezuma, Guillermo Torres Moye, and Rodrigo Beas Luna, Universidad Autónoma de Baja California

The aim of this project was to test if El Niño oceanographic conditions drive poleward recruitment of marine species along the California coast. We focused on the case study species Kellet's Whelk *Kelletia kelletii*, a predatory marine snail and the target of an escalating fishery. Kellet's Whelk is one of numerous species implicated in the hypothesis that warm northward-flowing ocean currents generated by El Niño transport pelagic larva up the coast from Mexico and southern California to central California. We conducted SCUBA-based transect surveys to assess Kellet's Whelk size frequency distribution at 36 in sites along the Baja and California coast before, during and after the 2015-16 El Niño. We observed strong recruitment of young-of-year Kellet's Whelk in the species' expanded range immediately following the El Niño, and lower recruitment following the non-El Niño periods. These observations statistically support our hypothesis that El Niño drives recruitment of Kellet's Whelk in the species' expanded range. We observed moderate recruitment in 2015 following the atypically warm non-El Niño period, strong recruitment in 2016 following the warm strong El Niño, and weak recruitment in 2017 following the cooler non-El Niño period. Collectively, these observations suggest that oceanographic currents, not just temperature, are associated with El Niño in driving poleward range expansion of marine organisms.

*Environmental Impacts of Deepwater Offshore Wind and Wave Energy Facilities

Hayley Farr, Yi-Hui Wang, Ben Ruttenburg, Ryan Walter, and Crow White, California Polytechnic State University

Increasing demand for clean energy has led to an ambitious plan by California to increase the State's current renewable portfolio standard to 60% by 2030 and 100% by 2045. Deepwater, floating offshore wind and wave energy facilities offer California a promising option for meeting these targets. However, along with the many undisputed benefits of renewable energy, such facilities may present numerous impacts to the environment that have not yet been extensively outlined or quantified. Herein, we draw from the available literature on currently employed offshore renewable energy facilities, conventional offshore energy facilities, and relevant impact assessment studies to estimate the types and relative magnitudes of impacts of deepwater, floating offshore wind and wave energy facilities on the environment. Major categories of impacts evaluated include alterations to air and water quality, shifts in atmospheric and wave dynamics, electromagnetic field emissions, and noise pollution, just to name a few. This study aims to provide an informed estimate of the potential environmental impacts of deepwater, floating offshore wind and wave energy, is intended to contribute to the global understanding of such facilities, and is aimed towards both the scientific community and the stakeholders whose decisions regarding the establishment of such facilities will have far-reaching implications in the coming future.

*Juvenile Coho Salmon Life History Variants in Humboldt Bay Tributaries

Madison Halloran and Darren Ward, Humboldt State University

The decline of Coho Salmon in California is the result of various anthropogenic effects across the landscape, affecting all stages of their anadromous life history. Monitoring a subset of the remaining populations is essential to evaluate the success of management plans and develop new restoration projects. Coho salmon life-cycle monitoring in California tracks abundance of juveniles and adults over time in selected focal watersheds. If individuals frequently leave these watersheds for rearing or spawning, the abundance estimates might not accurately reflect current conditions. Defining the appropriate scale for monitoring and restoration depends on the frequency and extent of dispersal of individuals across watershed boundaries. We are assessing movement among watersheds at the Freshwater Creek life cycle monitoring station on Humboldt Bay. Using PIT tags and mark-recapture multi-state modeling, we will evaluate the movement of juvenile and adult Coho among Freshwater Creek and two other Humboldt Bay tributaries. As salmon habitat becomes more fragmented through human actions, the need to better understand interactions between connected salmonid populations only grows. This research will quantify the frequency of juvenile dispersal between nearby streams to evaluate the need for changes in both management and monitoring. If there is significant movement between these watersheds, effective management and monitoring strategies of Freshwater Creek may need to be expanded to include nearby streams.

*Eye Lenses as an Alternative to Otoliths for Reconstructing Life History of Juvenile Salmon

Miranda Tilcock and Carson Jefferies, University of California, Davis
Rachel Johnson, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center

Traditional methods used to track movement and habitat/dietary shifts in fish have relied on measuring carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$) and sulfur ($\delta^{34}S$) isotopes in different tissues (gut content, blood, organs, muscle, bone, otoliths) with varying turnover rates (days, weeks, months, lifetime) to reconstruct diet over time. Fish eye lenses are a promising alternative for chronicling shifts in fish feeding ecology. Proteins (OMP-1 and Otolin-1) are small constituents in calcium-carbonate otoliths. In contrast, lenses, are made primarily of protein. Eye lenses are small, onion like spheres that lay within the eye of a fish. Each lens is comprised of layers that continue to accumulate throughout the life of a fish. Therefore, lenses represent an ideal tissue to measure light isotopes such as carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$) and sulfur ($\delta^{34}S$) typically derived from diet sources which are in high concentrations in body proteins. Here, we 1) investigate the relationship between fish fork length and eye lens diameter using juvenile Chinook Salmon *Oncorhynchus tshawytscha* of known rearing history and age, and 2) compare the CNS isotopes in fish eye lenses between fish rearing in floodplains compared to tributaries and mainstem rivers. We show that this method is a promising approach to

reconstruct the proportion of salmon that use and benefited from growth on floodplains.

*Investigating Physical Drivers of Straying Behavior in Hatchery-origin Adult Chinook Salmon Through Ecohydraulic Analysis

Sean Luis, University of California, Davis

A fundamental component of salmonid life history is their migratory behavior between the ocean and their natal stream. When this innate behavior is confounded by environmental cues, high rates of "straying" behavior may occur in which adults return to non-natal habitat. Although existing research indicates that olfaction is a primary physiological mechanism used by adult salmonids to navigate to their natal stream, some instances of straying are likely driven by other environmental cues such as flow and temperature. The adjacent Feather and Yuba Rivers in northern California provide an ideal study site to investigate influences on adult hatchery-origin salmonid migration by non-olfactory cues. A monitoring program from 2004 to 2011 showed that adult Feather River hatchery-origin Chinook Salmon *Oncorhynchus tshawytscha* exhibited high rates of straying when flows were higher, and temperatures were lower in the Yuba – indicating more favorable spawning conditions than in the Feather. Techniques developed in the field of ecohydraulics will be used to identify microhabitats located within the Feather/Yuba confluence area that act as drivers of straying behavior when encountered by returning adults. This will involve the use of a 2-D hydrodynamic model, observational flow and temperature data, and GIS software to spatially analyze patterns of flow and geomorphic habitat units within the confluence area. Snorkel surveys and DIDSON (duel-frequency identification sonar) surveys will be conducted to identify preferred lateral and longitudinal swimming positions of fish within the confluence area. Anticipated results include statistically significant relationships between flow and temperature ratios and microhabitat quality, quantity, and location. Additional anticipated results include significant relationships between lateral and longitudinal swimming positions of fish and microhabitat locations. These results will be used to infer relationships between habitat and behavior as a function of discharge and temperature.

*Ontogenetic Shift in Long-term Habitat Preference on Blue Rockfish

David Hernandez and Louis Botsford, University of California, Davis

In the California recreational fishery, Blue Rockfish *Sebastes mystinus* are the most commonly caught marine fish species and are one of many rockfish species that have been historically overfished. *S. mystinus* generally exhibits small home ranges (<9 km2) on short (<12 mo.) and intermediate (<36 mo.) time-scales. However, habitat shifts over longer time-scales are poorly characterized. Fisheries monitoring data for *S. mystinus* indicate that the species may exhibit ontogenetically induced long-term movement patterns. We hypothesize that *S. mystinus* shift long-term habitat preference when they sexually mature. This study utilizes long-term marine protected area monitoring datasets collected from visual dive surveys and hook-and-line surveys conducted along the coast of California. Together, these surveys detected over 45,000 individuals. The data have been converted to indices of abundance for each size class across various depths. Preliminary results show a decline in abundance of *S. mystinus* in kelp forests at sizes that correspond with sexual development. These results suggest that *S. mystinus* is shifting habitat preference at the onset of sexual maturity.

*Evaluating Insulin-like Growth Factor-1 (Igf-1) as a Hormonal Biomarker for Growth Rate in Copper Rockfish

Kasey Cordova, Frances Glaser, Nicole Hack, Emily Resner, Kristin Hardy, and Sean Lema, California Polytechnic State University
Meredith Journey and Brian Beckman, National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center

Commonly used methods for quantifying individual growth rates of wild fish require time consuming tagging (mark-recapture) or terminal sampling (otolith analysis), or may have only limited value as indicators of somatic growth (RNA:DNA ratios). Developing novel, non-terminal methods for both assessing and predicting growth rates in fish could therefore be of use in fishery management and aquaculture applications. Growth in fish is under control by the endocrine system. Blood concentrations of the hormone Igf-1 have been shown to correlate positively with growth rate in several teleost fishes, making Igf-1 a potential endocrine 'biomarker' for evaluating individual variation in growth rate. In this study, we tested the suitability of Igf-1 as a growth indicator in Copper Rockfish *Sebastes caurinus* a nearshore rockfish important for recreational and commercial fisheries. By regulating food rations (9% or 3% wet mass per day), we reared juvenile Copper Rockfish to have differing growth rates. After 140

d, some rockfish from both ration treatments were fasted for 12 d, while other fish continued to be fed. As expected, juvenile rockfish in the high ration treatment grew more quickly (avg. length specific growth rate [SGR]: 0.114% per d) than those in the low feed treatment (SGR: 0.055% per d). Fish from the high ration treatment had higher plasma Igf-1 levels and blood glucose concentrations than those under low ration, and fish from both ration treatments that were fasted had lower Igf-1 and glucose levels than those that continued to be fed. Individual variation in circulating Igf-1 concentrations correlated positively with variation in specific growth rate calculated with either mass (r = 0.69) or length (r = 0.60) measures, supporting the use of circulating Igf-1 hormone levels as a method for assessing growth rate variation in this species.

*Ontogenetic Niche Shift in Early Life-stage Sturgeon

Sarah Mehl, Liam Zarri, and Colton Deaver, University of California, Santa Cruz
Nann Fangue, University of California, Davis

Observational data from Sacramento River sturgeon (acipenserid) indicates a shift in larval diets from drifting to benthic prey items, and we hypothesize this shift coincides with the development of food acquisition and protective structures. Larval sturgeon were raised at UC Davis and 20 fish were culled biweekly to observe anatomical ontogenetic shift. Total length, weight, and scute developmental stage was assessed before double stained specimens were photographed to calculate jaw articulation angle. Dorsal scutes calcify before ventral and side scutes, and asymptote at 45mm total length. Preliminary analysis suggests ontogenetic development of jaw articulation angle. Developmental timing of food acquisition and protective structures can be an indicator of selective pressure throughout life history.

*Contribution of Juvenile Estuarine Residency to Chinook Salmon in Redwood Creek, California

Emily Chen, Humboldt State University

Diversity in life history among individuals distributes risk among the population and lowers the likelihood of extinction. In juvenile Chinook Salmon *Oncorhynchus tshawytscha*, diversity in habitat use and ocean entry timing may support the total population by expanding potential rearing habitats and varying the conditions the population encounters during ocean entry. Estuaries are the last habitat juvenile salmon encounter prior to ocean entry, and the duration of juvenile residency within estuaries can influence ocean growth and survival. Studies focused solely on juvenile rearing in estuaries are difficult to interpret on a population level without considering the effect of the estuary on survivorship in later stages. In this study, I will develop a life cycle model to investigate how different juvenile life history strategies relative to estuarine residency contribute to the recruitment of a cohort.

Using a northern California coastal river with a bar-built estuary as my study site, I will integrate a myriad of data collected from spawning ground surveys, dual-frequency identification sonars, rotary screw traps, and estuary seines to create a modified stage-structured matrix model. This model will incorporate the entirety of the Chinook Salmon's lifecycle, but emphasize juvenile life history variation regarding the estuary and early ocean survival. After completing the model, I will conduct a sensitivity analysis to investigate how further degradation or potential restoration in the estuary could affect recruitment. The goal of this study is both to understand the importance of estuarine use to a population of Chinook Salmon and to assist local managers in assessing the value of estuarine restoration.

*Thermal Variation in Juvenile Chinook Habitats in Their Pacific Range

Dalia Dull and Steve Blumenshine, California State University, Fresno

The San Joaquin River Restoration Program (SJRRP) aims to restore Chinook Salmon *Oncorhynchus tshawytscha* to the SJR by connecting the river with the SF Bay-Delta through enhanced water flows. These enhanced flows could potentially alleviate concerns about high water temperatures for this species at the southern-most extent of their range. The SJRRP Fisheries Framework (2017) cites an upper temperature threshold of 18ºC (7 day daily max average) for juvenile Chinook Salmon (JCS). However, this threshold is derived from EPA standards for Region 10, which includes AK, ID, OR, WA. Achieving this target temperature through enhanced water releases from Friant Dam could increase competition for water from municipal and agricultural entities in California's Central Valley. Recent laboratory (e.g. Poletto et al. 2017) and hatchery-based research (e.g. Plumb & Moffitt 2015) suggest that optimal water temperatures for Chinook Salmon in the southern end of their range may differ from their cold-water populations in northern rivers. A combination of otolith analyses and bioenergetics simulations based on

river-born JCS in the San Joaquin River showed that growth rates in the SJR are comparable, and in some cases, higher, than growth rates in northern rivers with colder water. Therefore, we compared the growth rate-temperature relationships from laboratory and field juvenile Chinook Salmon populations in the Central Valley and northern regions, and assessed the implications of these data on the temperature targets for the SJRRP. We will attempt to determine if this target temperature is indeed lower than necessary based on regional data and JCS growth rates, and if so, determine the impact this temperature difference could have on future conservation efforts.

*Spatial Variation in the Prey Availability and Production Potential of Juvenile Chinook Salmon Along the San Joaquin River Restoration Area During Drought Conditions

Karen Boortz and Steve Blumenshine, California State University, Fresno

A critical part of the San Joaquin River Restoration Project is estimation of juvenile Chinook Salmon *Oncorhynchus tshawytscha* (JCS) outmigration for each cohort, which depends on JCS growth and survival. This suggests the need to estimate the river's production potential for JCS with respect to prey and water temperature. However, understanding of the spatial and temporal variation of these critical habitat variables is relatively undeveloped. In cooperation with Cramer Fish Sciences, JCS net pens (4/site) were installed at sites representing a downriver gradient (Scout Island (SI), Gravelly Ford (GF), and the Mendota Wildlife Refuge (MWR)) to support a river mainstem and floodplain production study. Seston and benthic macroinvertebrate samples were taken outside and inside each net pen every two weeks from February 2016 through April 2016. Invertebrate abundances varied through an interaction between sites and sample location (in/out of net pens) with abundances from the downriver MWR sites ca. 2-10x greater than SI and GF respectively. Sample differences between inside and outside of net pens at GF could be indicative of the effects of JCS predation on invertebrates. However, we only observed differences in these sample types at GF, where prey abundances were relatively low and fish growth was correspondingly slow. The three main sites also varied greatly in invertebrate taxonomic assemblages, which along with temperature; affect the growth potential of JCS rearing in the various reaches of the restoration area. Overall, prey abundance and composition will be coupled with information on water velocity and temperature as well as disturbance events to help to guide project management in establishing realistic goals for the potential production of JCS cohorts.

*The Role of Disturbance on San Joaquin River Macroinvertebrate Assemblages: Implications for Chinook Salmon Survival and Growth

Emily Ramirez and Steve Blumenshin, California State University, Fresno

The San Joaquin River Restoration Program (SJRRP) was implemented in 2009 to restore a self-sustaining population of Chinook Salmon *Oncorhynchus tshawytscha* to the San Joaquin River. Since its implementation, the river has experienced years of irregular hydrology, characterized by dramatic fluctuations in water releases from Friant Dam that have resulted in some downriver stretches going dry over the summer when salmon are not present. These conditions have been exacerbated by years of drought. However, the winter storms of 2016/2017 resulted in flood releases that were thirty times greater than previous drought releases. These fluctuations in water flow represent sources of disturbance at both extremes of the hydrologic spectrum. We investigated whether or not disturbance caused by the San Joaquin River's irregular hydrology is related to spatial and temporal variation in the abundance and composition of the river's macroinvertebrate assemblages, which serve as the primary source of prey for juvenile Chinook Salmon.

The study design included monthly macroinvertebrate sampling (benthic and drift) at four sites along the San Joaquin River from June to December 2016, representing ongoing drought conditions, and post-drought sampling in October 2017. These sites represented a gradient of 'consistent' to 'variable' hydrology downriver from Friant Dam. Data prior to the flood releases showed a gradient of invertebrate abundances and diversity across the four sites, with lower abundances and diversity downriver. Differences in abundance between sites were significant, while differences between months were not. Post-drought data revealed substantial increases in macroinvertebrate abundances, with the most disturbed downriver site showing the largest proportional increase from drought conditions. Increases in abundance across sites can primarily be attributed to chironomid larvae. These patterns of spatial variation in prey supply and composition have important implications for understanding the carrying capacity of the SJRRP reaches and establishing realistic restoration goals.

*Habitat-specific Diet Analysis of Sacramento Pikeminoow and Striped Bass in the Sacramento River

Dylan Stompe, Nicholas Balfour, Amanda Banet, California State University, Chico
Jason Roberts, California Department of Fish and Wildlife

California native fish populations have experienced decline in recent years. One possible cause of decline is predation, which may be exacerbated by the presence of non-native predators, predator size class effects, the presence of man-made structures, and hatchery rearing effects. In an effort to quantify predation and identify associated factors, we examined the diets of non-native Striped Bass *Morone saxatilis* and native Sacramento Pikeminnow *Ptychocheilus grandis* within the lower Sacramento River. Sampling was conducted twice weekly during 2017 via hook-and-line sampling along a 22-mile section of the Sacramento River, in Butte County, California in addition to haphazard fyke trap sampling in Sacramento, California. Striped Bass and Sacramento Pikeminnow stomach contents were recovered via gastric lavage and are to be examined with the aid of shotgun metagenomics to determine habitat, size, season and species specific diets. Quantification and analysis of predator diets with the use of Pinka's Index of Relative Importance and non-parametric statistical methods will afford insight into factors associated with predation on vulnerable Sacramento River native fish populations.

Effects of Fasting on the Insulon-like growth Factor-1 (Igf-1) System of Juvenile Cabezon

Jackson Stobel, Kasey Cordova, Nicole Hack, Theresa Bersin, and Sean Leam, California Polytechnic State University
Meredith Journey and Brian Beckman, National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center

Food limitation alters the production of hormones that regulate growth, such as insulin-like growth factor-1 (Igf-1). In teleost fishes, blood concentrations of Igf-1 have been shown to correlate positively with individual growth rate, making Igf-1 a potential endocrine 'biomarker' to rapidly assess growth rates for fisheries and aquaculture applications. In this study, we examined how the Igf signaling system responds to nutritional stress in juvenile Cabezon *Scorpaenichthys marmoratus*, a species important to commercial and recreational fisheries. Juvenile Cabezon were collected off the central coast of California using a SMURF trap. Following acclimation to captivity, food was withheld from a subset of fish ('fasted' treatment), while other fish were maintained on a 'control' 6% ration (g feed mass/g wet mass*d). After 14 d, liver and white muscle samples were collected from each fish, and relative levels of mRNAs encoding the hormones Igf-1 and Igf-2 and select Igf binding proteins were measured using real-time quantitative PCR. We found that fasting elevated gene transcripts encoding the Igf binding proteins igfbp1a and igfbp1b in the liver, while concurrently reducing levels of igfbp2b mRNAs in both liver and white muscle. In teleost fishes, liver production of Igf binding proteins igfbp1a and igfbp1b inhibits Igf-1 action on peripheral tissues, thereby reducing fish growth, while binding protein igfbp2b facilitates Igf-1 transport to stimulate growth. While fasting did not alter mRNAs for either of the Igf hormones Igf-1 or Igf-2 in the liver, fasting decreased mRNAs encoding Igf-1 in white muscle and increased Igf-2 mRNAs in this same tissue. Taken together, these data point to coordinated inhibition of Igf-regulated growth pathways in juvenile Cabezon experiencing severe food deprivation, and point to the potential of using Igf signaling endocrine measures in this species as proxies for recent nutritional experience.

A Potential New Source of Groundfish Age and Length Data: A Pilot Study of Pre- and Post-fillet Length from Commercial Passenger Fishing Vessels

Chandler Skinner-Horne, Zachary Kucinski, Grant Waltz, and Dean Wendt, California Polytechnic State University
Melissa Monk, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center

Many groundfish stock assessments are data poor or data limited, because data on basic life history parameters are lacking. The National Marine Fisheries Service (NMFS) is looking to more accurately assess stocks by incorporating additional groundfish life history data into their stock assessment models. Since 2003 Cal Poly has conducted an on-board observer program aboard Commercial Passenger Fishing Vessels (CPFVs) from San Luis Obispo (SLO) county. Observers identify groundfish species, measure the total length, and record the fate of caught fishes from the SLO county CPFV fleet. Additionally, Cal Poly Observers record the sex and collect otoliths (ages) from fishes on CPFV trips. A substantial source of additional gonad, length, and otolith data is available from the discarded carcasses of fileted groundfish from CPFV trips. The California Department of Fish and Wildlife (CDFW) on-board observer program does not currently collect otoliths from the recreational fishing fleet. Accurate pre-filet length and

gonad data are needed to make otolith data usable in stock assessments, especially in species that have differential growth rates between sexes. Preliminary results show that pre-fillet length is different than post-fillet length. This project will be designed to develop a calibration curve for the difference in groundfish total length before and after the fish has been filleted. Doing so will allow CDFW to utilize filleted lengths to calculate intact length and collect otoliths and associated information, dockside, using filleted carcasses. This project will also keep track of the ratio of intact, identifiable gonads after an individual has been filleted by a deckhand. Preliminary results showed that pre-fillet fish length is different than post-fillet length. We are exploring whether a reliable conversion factor can be developed to get accurate pre-filet lengths from carcasses thereby greatly increasing the amount of available data for a number of groundfish species.

Using Environmental DNA to Detect Pacific Lamprey in Water Samples in Northern California

Ely Boone and Andrew Kinziger, Humboldt State University

The Pacific Lamprey *Entosphenus tridentatus* is one of the most broadly distributed freshwater fish in western North America and as such, the Pacific Lamprey is found in many Pacific streams. The habitat of the Pacific Lamprey is thought to be that of larger tributaries and excludes smaller coastal streams. Other research has supported this hypothesis in that samplers did not find Pacific Lamprey in the smaller coastal rivers when trying to detect them. In older sampling methods, a non-detection did not necessarily mean that the specimen was not there, but rather that the specimen was not detected. Environmental DNA (eDNA) is a modern detection technique that is more sensitive than traditional sampling methods and has a higher probability of detection than traditional methods. Using eDNA, which has a higher detection probability than traditional methods,, to compare large watersheds to smaller coastal rivers has provided even more supporting evidence to the hypothesis that Pacific Lamprey in Northern California only utilize large tributaries for spawning.

In this research, sampling took place in streams in Del Norte, Humboldt, and Mendocino counties. Sampled tributaries include: Tillas Slough, Klamath River, Redwood, Stone Lagoon, Big Lagoon, Little River, Mad River, Freshwater, Elk River, Salt River, Noyo River, and Big River. At each sample location, multiple samples were taken at each site from predetermined locations. The samples were taken using sterile whirlpaks. The whirlpaks were then filtered through a 3 micron polyethylene filter. After filtration, the DNA was extracted using Qiagen Dneasy extraction kit. Lastly, the DNA were prepared for qPCR using Pacific Lamprey-specific assay and qPCR was conducted to detect the presence or absence of Pacific Lamprey in the 12 sampled streams.

The California Collaborative Fisheries Research Program: Implementation and Expansion of a Statewide Marine Protected Area Monitoring Program

Dante DeLany, Grant Waltz and Dean Wendt, California Polytechnic State University
L. Bellquist, E. Mason, and B. Semmens, University of California, San Diego
J. Casell and C. Honeyman, University of California, Santa Barbara
J. Chiu, R. Fields, and R.S. Starr, Moss Landing Marine Laboratories
C. Dibble, S. Morgan, and E. Satterthwaite, University of California, Davis
I. Kelmartin, J. Mulligan, and J. Station, Humboldt State University
J. Tyburczy, California Sea Grant

The State of California mandated a statewide network of marine protected areas (MPAs) through the Marine Life Protection Act (MLPA) of 1999. The MLPA included a mandate for monitoring the performance of the MPA network. The California Collaborative Fisheries Research Program (CCFRP) was designed by a coalition of academic scientists, resource managers, commercial and recreational fishers, and local stakeholders to monitor the performance of the MPAs. CCFRP utilizes local fisher knowledge and standardized hook and line methods to monitor MPAs. The first suite of MPAs was established along the central coast of California in 2007 and primarily regulated extractive activities. CCFRP was initially implemented by Moss Landing Marine Laboratories and Cal Poly, San Luis Obispo (CPSLO) in 2007 along the central coast of California. In 2017, CCFRP expanded to include all of the MPA network regions: North, North Central, Central, and South. CCFRP now includes six academic institutions monitoring 14 MPAs across the entire State MPA network. To date, CCFRP has caught and released a total of 108,190 fishes from more than 35 different species. These data have been and will continue to be distributed to state and federal resource managers. In addition to the biological data CCFRP has collected,

science crews have interacted with commercial and recreational fishers from all California regions, working together to build a strong, lasting relationship between scientists and local stakeholders.

Impact of Increased Incubation Temperature and Thermal Stress on Aerobic Scope and Thermal Tolerance of Juvenile Rainbow Trout

Nicholas Balfour, Dylan Stompe, Carlos Estrada, and Amanda Banet, California State University, Chico

The ability of aquatic ectotherms to adjust to environmental disturbances is essential for their survival. With the advance of climate change and other anthropogenic stressors, marine and freshwater ecosystems are changing on much shorter time scales. Pacific salmonids in California are an example of this phenomenon. Populations of Pacific salmonids have declined sharply over the past century, resulting in widespread protection and concern for the species. These declines have been tied to extensive water management and development that have resulted in higher water temperatures and irregular flows throughout critical habitat. Recent research has investigated the impact of higher temperatures on Sockeye Salmon *Oncorhynchus nerka* and found that increased incubation temperatures resulted in lower thermal tolerance later in life by decreasing critical thermal maximum (CTmax). The oxygen and capacity limited thermal tolerance hypothesis (OCLTT) proposed by Pörtner provides one possible explanation for these results. This hypothesis suggests that the thermal tolerance of aquatic ectotherms is limited by insufficient oxygen delivery to the cells. Based on this, we hypothesize that fish exposed to high temperatures early in development will exhibit reduced aerobic performance later in life, as compared to fish incubated at lower temperatures. We also hypothesize that this difference will be magnified when fish are swimming in high temperature waters. To test this, we reared rainbow trout eggs in three temperature treatments: 50°F, 55°F and 60°F. After hatch, CTmax and aerobic performance of fish were measured across a range of swimming temperatures. The results of this study can provide valuable information on the optimal temperature ranges for Rainbow Trout *O. mykiss* in the Sacramento River. Furthermore, our conclusions provide support for further investigations into thermal stress on aquatic ectotherms and the need for similar studies to be applied toward conservation issues.

Life History of Juvenile Chinook Salmon in Yolo Bypass

Rachel Fichman and Jim Hobbs, University of California, Davis
Pascale Goertler, California Department of Water Resources

Life history diversity supports species resilience in dynamic systems. Chinook Salmon *Oncorhynchus tshawytscha* often exhibit this diversification through temporal shifts in breeding and emigration, and variation in juvenile growth. This growth variation can be crucial during prolonged periods of severe drought like that seen throughout the San Francisco Estuary between 2012 and 2015. The Yolo Bypass is a managed floodplain of the upper Estuary that predominantly functions as a rich, tidal slough during periods of limited rainfall and flow. It has been found to be advantageous rearing habitat that potentially produces heightened growth in juvenile fishes. We studied how rearing in the Yolo Bypass affects the growth of juvenile Chinook Salmon during a period of drought (2012-2015). We related otolith microstructure and growth measurements to elucidate patterns of growth.

Variation in Growth of Juvenile Chinook Salmon in the Yolo Bypass

Rachel Fichman, University of California, Davis
Pascale Goertler and Naoaki Ikemiyagi, California Department of Water Resources
Mariah Meek, Michigan State University

For over 25 years, the Length-at-Date approach (LAD) has been used to identify federally listed runs of juvenile Chinook Salmon *Oncorhynchus tshawytscha* throughout California, criteria based on a temporal isolation, and a uniform growth rate for all runs. 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 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. Accurate differentiation of the four runs found in the Central Valley greatly impacts species recovery and water management regulatory decisions. However, several studies 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,

and simplification of salmon landscape use (both spawning and rearing). Growth is a common metric for fitness consequences to individuals and has been shown to vary between different types of habitat, such as off-channel habitats like the Yolo Bypass. The Yolo Bypass floodplain is a critical habitat for Chinook salmon, with individuals exhibiting heightened growth compared to those in neighboring riverine habitats (Sommer et al. 2001). In this poster, we use otolith microchemistry and growth increment analysis to describe within-run variability in growth and natal origin for juvenile Chinook Salmon captured in the Yolo Bypass, to explain the mismatch between LAD and genetic assignments

2017 McCormack-Williamson Tract Fish Rescue and Relocation Project

Eric Sommerauer, Stillwater Sciences

During the morning of February 11, 2017, the Mokelumne River overtopped the McCormack-Williamson Tract (MWT) levee system, creating a failure on the northeast levee and flooding the 1,400-acre farming island. A relief notch was excavated on the opposite side of the island along Snogdrass Slough, however despite this the impounded floodwater overtopped the levee system along Deadhorse Cut. The interior of MWT remained connected to the river system until the Mokelumne River breach was repaired on May 31, 2017. During this time, aquatic species, including several special-status fish species (e.g., Delta Smelt, Longfin Smelt, Green Sturgeon, Central Valley steelhead, Central Valley fall- and late-fall run Chinook Salmon, and Sacramento Splittail), had the potential to enter MWT. Dewatering pumps installed at the southern end of the island began operating on June 8th, 2017 and continued operating until July 6, 2017. In an effort to save fish stranded at MWT, a rescue and relocation effort was conducted from July 6-14, 2017. Approximately 168,000 fish were rescued and relocated during the MWT Fish Rescue and Relocation Project, comprised of five native and 16 non-native species. The rescue and relocation strategies and methods employed during this effort are applicable to future large-scale flooding events at locations comparable to MWT.

Efficacy of Collapsible Minnow Traps in Removing Back Bullhead from a Remote 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 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, versatile omnivorous feeding habits, the ability to withstand a wide range of 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 the last remaining native population of coastal *Oncorhynchus mykiss* in San Diego County. The traps captured 35 Black Bullhead, indicating a potential problem. Four removal efforts occurred where a total of 228 Promar 24”x12” collapsible minnow traps were baited with Temptations © Tempting Tuna Flavored Cat Treats, set, and soaked overnight. The traps captured 1,315 Black Bullhead, 18 Rainbow Trout, 9 adult Bullfrogs, and 319 Bullfrog Tadpoles. Only the Rainbow Trout were returned to the WFSLRR. The total population of Black Bullhead was estimated using the Leslie method (1,361) (95% CI 1,079 and 1,641). A follow up snorkel and trapping survey was conducted in 2017, and zero Black Bullhead were trapped or observed. Based on the follow up survey data, baited collapsible minnow traps are effective in removing Black Bullhead from a remote trout stream.

Striped Bass Response to Carbon Dioxide in the Tracy Fish Collection Facility Primary Channel

Brandon Wu, Rene Reyes, Scott Porter, and Michael Trask, U.S. Bureau of Reclamation
Kevin Kumagai, HTI-Vemco USA, Inc.

Action IV.4.1(1)(a) of the 2009 National Marine Fisheries Service Biological Opinion mandates that the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) complete studies to determine methods for removal of predators in the primary channel at the Tracy Fish Collection Facility (TFCF). In an effort to fulfill this requirement, Reclamation is investigating the use of carbon dioxide (CO2), in the form of dry ice, as a predator removal technique in the TFCF primary channel. Initial efforts have focused on determining the response of acoustically tagged (HTI, Model 795X) Striped Bass *Morone saxatilis* to elevated CO2 concentrations. The injection of 2,268 kg (5,000 lbs) of dry ice in the upstream north side of the TFCF primary channel resulted in a maximum CO2

concentration of approximately 192 mg/L at this location, although there was evidence of a vertical concentration gradient in the water column. Carbon dioxide bubbles did not appear to interfere with acoustic detections. Carbon dioxide concentrations in the upstream south side of the TFCF primary channel did not increase during this experiment. Elevated CO2 concentrations (≥ 20 mg/L) were evident in the north side of the TFCF primary channel for up to 30 mins after CO2 injection. During this period, acoustically tagged Striped Bass were observed to avoid this portion of the facility. These results suggest effective CO2 concentrations can be achieved in the TFCF primary channel and that acoustically tagged Striped Bass appear to exhibit an avoidance response to elevated CO2 concentrations. It is recommended that Reclamation further investigate the use of CO2 to remove predatory fish from the primary channel at the TFCF.

Use of Acoustic Telemetry to Estimate Juvenile Chinook Salmon Facility Efficiency at the Tracey Fish Collection Facility

Brandon Wu and Cathy Karp, U.S. Bureau of Reclamation
Kevin Kumagai, HTI-Vemco USA, Inc.
Javier Miranda, California Department of Fish and Wildlife

Acoustically tagged juvenile Chinook Salmon *Oncorhynchus tshawytscha* were released and tracked at the Bureau of Reclamation's (Reclamation) Tracy Fish Collection Facility (TFCF) under varying pumping conditions at the C.W. "Bill" Jones Pumping Plant (JPP) to determine fate and estimate facility efficiency, as well as primary louver efficiency, secondary louver/screen efficiency, predation, pre-screen loss to predation, participation (number of fish that entered the TFCF), and passage time of salvaged fish. In general, facility efficiency, participation, and primary channel louver efficiency increased with increased pumping/flow, while passage time, predation, and pre-screen loss to predation decreased with increased pumping/flow. Secondary channel louver/screen efficiency is not dependent on the number of pumps in operation at the JPP, although estimates ranged from 85.7–100.0%. Results suggest Reclamation is likely not meeting the 75.0% facility efficiency for juvenile Chinook Salmon that is mandated by the 2009 National Marine Fisheries Service Biological Opinion. It appears that low pumping periods at the JPP may be more detrimental to the salvage of juvenile Chinook Salmon at the TFCF and that facility efficiency is impacted most by predation losses. Due to this, it is recommended that Reclamation continue to develop techniques to manage predators within and near the TFCF. In addition, it is recommended that Reclamation use acoustic tags capable of detecting predation events, as well as an expanded hydrophone array upstream of the TFCF, to further investigate juvenile Chinook Salmon facility efficiency at the TFCF and verify apparent trends described in this study.

Investigations of Predator Effects on Hatchery Smolts in the Lower Feather River

Andrew Hampton, Pacific States Marine Fisheries Commission

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 *Oncorhynchus tshawytscha* and Central Valley Steelhead *O. mykiss*(CVST) 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 out-migrating smolt survival in the Feather River. To better understand the role of predation, we conducted a fish predator study, focusing on movements and diet. Predators such as striped bass, largemouth bass, smallmouth bass, white catfish, channel catfish and Sacramento pikeminnow 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.

Improvements to Pacific Lamprey Video Monitoring at Coleman National Fish Hatchery Barrier Weir Fish Ladder

J. Ryan Cook, Ryan Schaefer, RJ Bottaro, and Laurie Earley, U.S. Fish and Wildlife Service

Coleman National Fish Hatchery is located on Battle Creek, an east-side tributary to the Sacramento River. At the hatchery, there is a barrier weir and fish ladder used to route fish into holding ponds to capture returning hatchery-origin fall and late-fall Chinook Salmon *Oncohrynchus tshawytscha*, and California Central Valley steelhead trout *O. mykiss*. All fishes are trapped and sorted in the hatchery; non-target species are passed upstream from September-February and natural-origin salmonids are passed upstream from December-February. From March-July, natural-origin salmonids are monitored via video monitoring station in the fish ladder. The barrier weir and fish ladder were remodeled in 2009, which included designs that accommodated the monitoring of Pacific Lamprey *Entosphenus tridentatus* passage. Processing video footage is labor intensive, as all footage must be reviewed in order to record fish passage. A Honeywell® DVR system with motion detection capabilities was implemented to decrease the time required to process footage. The Honeywell® software creates a copy that contains only video where motion was detected, in addition to the continuous footage. A sub-sample of the continuous footage is compared to the motion detection footage to determine the accuracy of the motion-detection tool. The accuracy of Pacific Lamprey captured by motion detection varied from 5-32% the first three years of monitoring and was eventually attributed to the limitations of the viewing window. A "lamprey ramp" was designed and installed, which guided Pacific Lamprey higher in the water column where the motion detection software could capture the movement. The implementation of motion detection software decreased the time required to process video by up to 80% while the implementation of the "lamprey ramp" increased detection of Pacific Lamprey up to 100%. These innovative measures increased the effectiveness and efficiency of monitoring and increased the accuracy of Pacific Lamprey passage estimates on Battle Creek.

Locating Aquatic Refugia During Prolonged Drought In Santa Barbara and Ventura Counties

Kyle Evans, California Department of Fish and Wildlife
Lisa Rachel, Watershed Stewards Program

Prolonged and intense drought has had a significant impact on the streams of Santa Barbara and Ventura counties. As climate change is predicted to exacerbate periodic drought in southern California, areas of aquatic refuge may become increasingly important. Monitoring conducted by the California Department of Fish and Wildlife has been analyzed through GIS to identify areas of perennial water. By identifying stream systems containing aquatic refugia we may help prioritize future restoration work. Alternatively, we are able to highlight areas more susceptible to drought impacts which may assist future monitoring and rescue efforts on any threatened or endangered species present.

Comparing Pre- and Post-project Monitoring Data for Merced River Salmonid Habitat Restoration Projects

Philip Colombano, Kirsten Sellheim, Jesse Anderson, Michael Beakes, and Joseph Merz, Cramer Fish Sciences

Salmonid spawning and rearing habitat quality and quantity in the lower Merced River has been impacted by anthropogenic activities, particularly dredge mining and flow regulation. Salmonid spawning and rearing habitat restoration projects within the dredger tailings reach of the lower Merced River were completed in 2013 (Merced River Ranch) and 2015 (Henderson Park). These restoration projects included multiple years of pre-and post-project monitoring set up using a before-after-control-impact design. Fish monitoring was focused on juvenile salmonids and included snorkel surveys conducted from February through May from 2011-2016 to document fish presence, relative abundance/density, and community composition. We compared pre- and post-project juvenile salmonid density and fish community composition to determine whether the restoration projects were effective at restoring habitat for salmonids and other native fishes, and reduced non-native fish density. Performing pre- and post-project monitoring is important for restoration projects to demonstrate that they are performing as designed, providing benefits to the target species, and to provide the basis for improving the design of future restoration projects.

Comparison of Three Sampling Methodologies to Estimate Numbers of Juvenile Coho Salmon in Two Russian River Tributaries

Andrew McClary, William Boucher, Zachary Reinstein, Nicolas Bauer, and Mariska Obedzinski, California Sea Grant

We compared the efficiency of snorkeling, electrofishing, and PIT tag wanding for estimating juvenile Coho Salmon *Oncorhynchus kisutch* abundance and oversummer survival in 500 m study reaches of Dutch Bill and Mill creeks, two tributaries of the Russian River in central California. In 2016 and 2017, each reach was stocked in

June with 500 age-0 PIT-tagged Coho Salmon as part of a long-term oversummer survival study. Each year, we sampled pool and flatwater habitat units using two-pass snorkel surveys and paired PIT tag wanding surveys between June and October, and depletion electrofishing surveys were conducted in late September or early October. PIT tag wanding surveys were conducted on consecutive days and entailed wading each habitat unit from downstream to upstream waving a portable PIT tag detection wand through the water column to detect PIT tagged fish. Habitat unit-level maximum counts and bounded count estimates from two-pass snorkel surveys were highly correlated to depletion electrofishing abundance estimates. Reach-level abundance estimates from snorkeling, electrofishing, and paired PIT tag wanding were all similar. Reach-scale survival estimates generated from wanding using both Robust Design models and CJS models were similar to survival estimates based on abundance estimates from snorkel counts. For abundance estimates, snorkel surveys have the advantage of low cost (17.5% of electrofishing costs) and reduced impact on fish. However, wanding and electrofishing surveys provide opportunities to estimate additional population metrics such as individual survival and growth. Because of these tradeoffs, the selection of technique depends on both the objectives of a study and the resources available.

Spatiotemporal Differences in Juvenile Salmon Condition and Diet in the Sacramento-San Joaquin Delta Across Extreme Hydrologic Conditions

Mollie Ogaz, Kelly Neal, Dana Myers, George Whitman, Keiki Mertz, Krista Schmidt, Rachel Johnson, Carson Jeffres, Anna Sturrock, University of California, Davis

This study aims to fill critical data gaps regarding the extent to which juvenile Chinook Salmon *Oncorhynchus tshawytscha* from California's Central Valley are able to rear successfully in the Sacramento-San Joaquin Delta during extreme drought and flood events. The Delta has lost more than 95% of its historical floodplain, riparian and wetland habitats, and the degree to which it can now support juvenile salmon rearing is unknown. While Delta rearing is often assumed negligible, otolith reconstructions have shown that it can be a successful strategy for winter, spring and fall run outmigrants. Here, we compare recent diet and condition of fall and late-fall run sized juvenile Chinook Salmon collected by the Delta Juvenile Fish Monitoring Program within the Delta and from upstream locations (e.g. Sherwood Harbor, Mossdale) in 2014-17. Stomach contents were identified and the frequency and Index of Relative Importance of prey items were calculated. Fulton's condition factor and diet composition were compared among regions and years to examine spatiotemporal patterns in fish health, focusing on extreme drought (2014-15) vs. extreme wet year (2017) comparisons. To refine our interpretations, we used preliminary otolith isotope data to identify individuals that recently arrived at the capture region from those that had reared there for multiple weeks. With future climate change, extreme weather events are predicted to increase in frequency and severity. Understanding how Delta conditions and food resources influence fish growth and condition under these extreme conditions is critical to making informed management decisions integral to the long-term persistence of salmon populations.

Extended Rearing of Juvenile Chinook Salmon After Habitat Restoration on the Merced River

Kirsten Sellheim, Jamie Sweeney, and Joe Merz, Cramer Fish Sciences

Anthropogenic impacts from mining, flow regulation, agriculture, and urban development have reduced salmonid habitat in California, resulting in a precipitous decline in salmonid populations. In response to this habitat loss, restoration projects have been implemented to enhance rearing and spawning habitat. Two juvenile and adult salmonid habitat restoration projects were implemented on the Merced River, creating a total of approximately 21 acres of seasonally inundated off-channel habitat to provide refuge from predation and high flows in the main channel and increase habitat complexity and prey productivity. This study used seining, fyke traps, and PIT tag antennas to compare habitat use, residence time, and growth rates of juvenile Chinook Salmon *Oncorhynchus tshawytscha* rearing in restored and unrestored reaches of the Merced River. We conducted seining surveys between 8 February and 7 July 2017. We captured and PIT tagged a total of 832 wild juvenile salmonids during seining events in March and April. In addition, we released 987 hatchery Chinook Salmon in late April. At restored sites, 13.9% of all tagged fish (n = 693) were recaptured at the site of original capture; average minimum rearing duration was 14.9 days (SD ± 9.8, range 1-48 days). At unrestored sites, 3.4% of tagged fish (n = 139) were recaptured at the site of original capture; all fish recaptured at unrestored sites had a 7 day minimum rearing duration. Growth rates were similar in restored reaches (0.82mm/day ± 0.11) as unrestored reaches (0.79mm/day ± 0.14). Chinook Salmon densities remained

high later in the rearing season in the restored reaches as compared to unrestored reaches. This study demonstrates that off-channel habitat restoration projects can extend in-river juvenile Chinook Salmon rearing duration. Because larger juvenile salmon body size at outmigration is correlated with higher survival to adulthood, longer rearing duration may improve Chinook Salmon population viability.

Planning Infrastructure Improvements at Coleman National Fish Hatchery to Aid in Restoration Efforts of Natural Salmonid Runs in Battle Creek

Javier Linares, Brett Galyean, Kevin Niemela, Matt Brown and Laurie Earley, U.S. Fish and Wildlife Service

Battle Creek, a tributary to the upper Sacramento River, is important for the conservation and recovery of ESA listed salmonids in California's Central Valley. Ongoing restoration efforts in Battle Creek are nearing completion and will restore and improve access to 48 additional stream miles of prime salmonid habitats. Plans to re-introduce ESA endangered Winter Run Chinook Salmon (CS) *Oncorhynchus tshawytscha* are also underway. The Coleman National Fish Hatchery (NFH) and adjacent Coleman fish barrier-weir are located downstream of the restoration area on lower Battle Creek. The barrier-weir is essential for operation of the hatchery; it functions by blocking upstream migration of fish and directing them into a fish ladder. The fish ladder remains closed while the hatchery collects returning adult salmon and steelhead *O. mykiss* for broodstock and all fish are directed into holding ponds for processing. This operation delays natural migrating fish stocks and increases the risk of fish injury. To reduce hatchery impacts on natural salmonids and to facilitate monitoring of fish populations, a new facility for automated sorting and trapping of fish is being planned at the Coleman NFH. The sorting and trapping facility is being designed with capacity to support multiple purposes, including operation of the Coleman NFH, the reintroduction of Winter-run CS to Battle Creek, and implementation of the adaptive management plans for Battle Creek Steelhead and Salmon Restoration Program. The sorting and trapping facility will be controlled by an SCADA system and will be equipped with CWT and PIT tag readers, overrides, switch-gates, and traps to enable automatic fish monitoring and trapping as well as volitional passage of natural migrating salmonids. We present the goals, objectives and biological requirements for the new infrastructure, describe the system components and conceptual functioning, and report on the progress to date and next steps.

Identifying Drivers of Fish Assemblage Dynamics in a Hydrologically Altered Lagoon

Henry Baker and Noah Hume, Stillwater Sciences

The Santa Clara River Estuary (SCRE) near Ventura, California has historically supported a variety of native fishes including the federally endangered Tidewater Goby *Eucyclogobius newberryi* and southern California steelhead (anadromous Rainbow Trout *Oncorhynchus mykiss*). Based upon long-term monitoring data collected by the City of Ventura, a number of non-native species have been identified in the estuary. Fish assemblage composition in the SCRE, including the relative abundance of native vs. non-native fishes, appears to be highly dynamic. A common sense hypothesis is that this high variability in assemblage composition can be attributed to the variable hydrologic nature of the SCRE. In normal water years (i.e. when annual precipitation approximates long-term average), the SCRE is a closed-mouth lagoon during the summer, with tertiary-treated effluent from the adjacent Ventura Water Reclamation Facility (VWRF) as the predominant input, and little to no input from the Santa Clara River. Depending on upstream dam operations, the Santa Clara River is typically the dominant source of water to the SCRE during winter, with larger precipitation events carrying flows sufficient to breach the beach berm at the mouth of the Santa Clara River. This flashy hydrology results in seasonally variable habitat quantity and water quality in the SCRE due to the interactions between river flows, VWRF flows, and ocean water exchanges. Similarly, annual variations in precipitation can result in interannual variability in habitat conditions. However, univariate analysis of environmental parameters fails to sufficiently explain seasonal and annual variability in fish assemblage composition. Using previously reported and novel data, we performed multivariate analysis of a suite of environmental parameters to identify key drivers of fish assemblage dynamics in the SCRE. Implications for management of native species are discussed.

Ghost PIT Tag Distribution and Movement from Water Years 2015, WY 2016, and WY 2017

Rosaalea Bond, Alexander Hay, and Jeff Perez, University of California, Santa Cruz and National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center

Brian Spence and Joseph Kiernan, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center

Interpretation of Passive Integrated Transponder (PIT) tag detection data from fixed and mobile antennas is 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 fish movement, survival, and abundance if detections are incorrectly assumed to represent living individuals. We conducted a multi-year study to assess the distribution, abundance, and movement of ghost tags originating from annual releases of hatchery-origin Coho Salmon *Oncorhynchus kisutch* smolts to Scott Creek, Santa Cruz County, CA. Ghost tags were identified and georeferenced in a 10-km reach using mobile PIT antennas. During five surveys conducted over three water years (WY), we documented 1,044 unique ghost tags from hatchery brood year (BY) 2011-12 and another 1,329 tags representing BY 2012-13. The distance ghost tags moved in a given water year appeared to be a function of the frequency and magnitude of high-flow events. In WY 2015, during the height of California's most recent drought, ghost tags moved a median distance of 65 m and a maximum distance of 538 m. In contrast, WY 2017 was one of the wettest years on record with precipitation in the Santa Cruz Mountains of ~1.2 times the annual average, and several rivers had 5- to 10-year flow events. Ghost tags moved five to six times further in WY 2017 than WY 2015, with median and maximum movement distances of 326 m and 3076 m, respectively. Nearly half of the tags detected after the WY 2017 winter (149 tags) were not detected on any previous surveys indicating that tags were buried beyond the range of our antennas and later re-emerged during high-flow events. Mobile PIT antennas are a useful tool for differentiating between live fish and ghost tags and documenting the fate of loose PIT tags.

Optimizing Semi-autonomous eDNA Sampling for Fisheries Applications

Yekaterina Karpenko, Gregg Schumer and Scott Blankenship, Cramer Fish Sciences

Environmental DNA (eDNA) is an innovative sampling method that has been successfully implemented as a non-invasive genetic monitoring tool to determine species presence or absence in aquatic ecosystems. With increasing demand for eDNA applications in fisheries, there is a clear need to enhance sampling capabilities and expand sampling capacity through automation. This need is particularly evident when round-the-clock monitoring is required or, when sampling must occur in remote areas. The current study aims to test and deploy the semi-autonomous McClane phytoplankton sampler (FAS). The FAS was designed for sampling in the marine environment and has not been tested in a freshwater estuarine environment for sampling eDNA. Protocol for sampling eDNA in the Central Valley exist, yet these have not been adapted for use on the FAS. In order to effectively deploy the FAS in Sacramento San Joaquin Delta, we conducted several experiments under controlled conditions to determine the optimum sampling parameters. Four separate experiments were conducted to quantify (1) probability of detection at various sampling volumes; (2) optimum volume of on-board DNA preservative for DNA stabilization; (3) sample stability in relation to time; and (4) potential of cross-contamination from on-board and exogenous sources of DNA. The results of these experiments provide key information needed to adapt existing eDNA protocols for use on the FAS. Potential management applications include a standardized method to detect presence of species of concern to help influence water management decisions and determine relative distributions of sensitive or cryptic aquatic species.

Environmental Factors Effecting Hourly Juvenile Chinook Salmon Emigration Patterns in Two Northern California Creeks

Mike Schraml, Sam Provins and Charlie Chamberlain, U.S. Fish and Wildlife Service

Investigations have shown that emigrating juvenile Chinook Salmon *Oncorhynchus tshawytscha* respond to light intensity, flow, and other environmental factors. The USFWS in Red Bluff, CA operates three 5-ft diameter rotary screw traps in Clear and Battle Creeks, Shasta and Tehama Counties, California, for estimating juvenile salmon emigration. Occasional trap failures result in missing data for days when a trap malfunctions between sample days. To better understand the temporal distribution of passage and to develop a method for interpolating passage when the traps fished only for a partial day, we conducted 58 twenty-four hour sampling events from December 2011 to December 2016. During these twenty-four studies the traps were sampled and environmental data were collected at hourly intervals. Data analysis demonstrated that the data from different traps were not unique data sets. To characterize the relationships of salmon emigration, 15 environmental and

astronomic variables from 48 of the sample events were analyzed using generalized linear and additive models in R. We demonstrate that three of the 15 variables were significant factors effecting hourly juvenile salmon outmigration: sun angle, moon angle, and flow. We suggest that using these relationships helps generate more accurate juvenile passage estimates for days when a trap failure occurs partway through a 24 hour period.

From 40 to 50 Fathoms: A Size Comparison of Commonly Caught Rockfish off San Luis Obispo County, California After the Extension of Recreational Fishing Depth in 2017

Matt McKechnie, Grant Waltz, and Dean Wendt, California Polytechnic State University

The Rockfish Conservation Area (RCA) was established to protect overfished groundfish species along the West Coast of the United States in 2002. In Central California, the RCA established a spatial closure from the 40-fathom bottom contour seaward, restricting the recreational fishing fleet to fishing in waters shallower than 40 fathoms. In 2017, the California Department of Fish and Wildlife (CDFW) extended the recreational fishing depth to 50 fathoms for six months. Since 2003, the Cal Poly Observer Program (CPOP) has collected catch data aboard commercial passenger fishing vessels (CPFVs) along the coast of San Luis Obispo County (SLO). CPOP was established using methods similar to the CDFW CPFV on-board observer surveys to monitor groundfish populations out of Morro Bay and Port San Luis. Cal Poly observers record individual fish species and length as well as other metrics used to calculate catch per unit effort. In this study, we compared the length frequency distribution among commonly targeted groundfish species using data from shallower than 40 fathoms relative to deeper than 40 fathoms. We expected the size frequency distribution of some commonly targeted species from waters deeper than 40 fathoms to be different than those same species from waters shallower than 40 fathoms. Because the RCA has been closed to recreational fishing for fifteen years, we expected to see an increase in size for some species of groundfish that were occupying the RCA. These data will provide information about groundfish populations within the RCA and how these areas relate to shallower areas open to fishing. Resource managers may be able to incorporate these data into estimates of population size structures as they relate to the RCA.

Beyond the Noise: Sound Fisheries Management in the 21st Century

Kevin Kumagai and Colleen Sullivan, HTI-Vemco USA, Inc.

Noise, as defined by Webster's dictionary, is irrelevant or meaningless data or output occurring along with desired information. But as they say, "one person's trash is another person's treasure" or put another way "one person's noise is another person's signal". In underwater sound transmission, sound waves travel in multiple directions. However, for "passive" acoustics and acoustic telemetry specifically, the most important desired information is conveyed by the direct signal path. The non-direct or reflected signals are irrelevant and often misleading.

For other hydroacoustic applications, specifically "active" acoustics using scientific echo sounders the reflected signals (echoes) are the important desired information. Often extracting information from these signals can be difficult and subject to misinterpretation.

In this poster, we highlight fisheries acoustic techniques that reveal the most important information. Ultimately, this information is applied to sound fisheries management decisions.

CDFW Proposition 1 Restoration Grant Program Funding Opportunities for Fisheries and Watershed Restoration

Gena Lasko, James Croft, Daniel Burmester, and John Downs, California Department of Fish and Wildlife

California voters approved Proposition 1 in November 2014, amending the California Water Code to add Sections 79737 and 79738, authorizing the Legislature to appropriate $372.5 million to the California Department of Fish and Wildlife (CDFW) to fund multi-benefit ecosystem and watershed protection and restoration projects through competitive grants under two programs. The Watershed Restoration Grant Program focuses on water quality, river, and watershed protection and restoration projects of statewide importance outside of the Sacramento-San Joaquin Delta. The Delta Water Quality and Ecosystem Restoration Grant Program focuses on water quality, ecosystem restoration, and fish protection facilities that benefit the Sacramento-San Joaquin Delta.

CDFW began awarding projects under these programs in 2015. The grant programs are investing $285 million in projects of statewide importance outside of the Delta and $87.5 million in projects that benefit the Delta. The programs expect to award approximately $31 million

annually over a period of 10 years. Both grant programs include priorities for funding projects that benefit California fish and watershed restoration.

This poster provides prospective applicants an understanding of the eligibility requirements, an overview of the application process, and identifies critical application components that may help applicants improve their proposal applications.

2018 Meeting Program

Your 2018 Planning Committee, and Program Subcommittee, hope you will value our efforts to combine the wealth of Annual Meeting information into this document.

2018 Program Subcommittee

Steven Brumbaugh
Laurie Earley
Kirsten Sellheim

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 at the AFS National Meeting in Reno in 2019

Downtown Reno, Truckee River (Reno Tahoe USA)

Anchorage is a bustling metropolis surrounded by wilderness and minutes from adventure in any direction. Join us in May for conversations about change, challenge, and opportunity from across the West to the Last Frontier!

Socials! Sessions! Film Festival! Networking!

For all your meeting information needs visit our website:
www.wdmtg.fisheries.org

Or contact the meeting co-chairs:
Brian Missildine (Western Division AFS President)
Brian.Missildine@dfw.wa.gov
Jeff Falke (Alaska Chapter AFS President-Elect)
afs.alaska.presidentelect@gmail.com