Connecting the Mosaic

Cal-Neva AFS

57th Annual
Cal-Neva AFS Meeting
Long Beach, CA
Feb 28 – Mar 3, 2023

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Schedule in Brief

Time	Event
Tuesday February 28, 2023	
10:00am -12:00pm	Beach seine of nearshore fishes
1:00pm – 3:00pm	Salt Marsh Restoration Guided tour
1:30pm – 3:30pm	Fish Printing with Bruce Koike
4:00pm – 6:00pm	Fish Printing with Bruce Koike
Wednesday March 1, 2023	
8:00am – 4:00pm	Registration
12:30pm-2:40pm	Plenary Session
2:50pm-3:40pm	Concurrent Sessions (Pacific 1 and Pacific 2)
4:00pm – 6:00pm	Long Beach Aquarium Social Event
6:30pm – 9:00pm	Trade Show (Promenade)
6:30pm – 9:00pm	Poster Session at Hilton Long Beach (Promenade)
Thursday March 2, 2023	
8:00am – 4:00pm	Registration
8:00am – 4:00pm	Trade Show (first floor)
8:30am – 11:50am	Technical Concurrent Sessions (Gallery 1, Gallery 2/3, Mediterranean I/II)
12:10pm – 1:30pm	Networking Lunch or Lunch on your own
1:30pm – 3:30pm	Technical Concurrent Sessions (Gallery 1, Gallery 2/3, Mediterranean I/II)
4:30pm – 5:30pm	Larry Brown Trout Spawning Run & Walk
4:30pm – 6:00pm	Happy Hour @ Beachwood Brewery and Taproom
6:30pm – 10:30pm	Banquet at Hilton Long Beach
Friday March 3, 2023	
8:10am – 10:10am	Technical Concurrent Sessions (Gallery 1, Gallery 2/3, Mediterranean I/II)
12:20pm – 1:20pm	Cal-Neva Chapter Business Meeting

President's Message

Welcome to the 57th Annual Meeting of California-Nevada Chapter of the American Fisheries Society!

We are really excited to say this year's conference program has something for everyone! There are talks from the ocean (check out the shark talks!), lagoons and restoration to our freshwater native species session which we hope provides everyone with the opportunity to keep up with current science and management concerns across a broad area. I am also looking forward to catching up with colleagues and friends and making new connections, as I am sure you all are.

As we are coming out of the pandemic and into new routines of hybrid work schedules many of us are trying to decide where we want to re-engage, or maybe engage for the first time. If this is you, I would really encourage you to consider getting involved with Cal-Neva AFS. If you like fish and people who like fish, this is the fun group for you! If your friends look at you oddly when you talk about scales and caudal peduncles, otoliths and eDNA, this is the group to find support and understanding! And not least, if you want to throw a party about fish for fish folks, you can join the merry band of annual meeting planners! We have several Committee Chair positions open, and all are suitable for co-chairs if you want to bring a friend along, and we also have shorter term roles for meeting planning or throughout the year.

WDAFS Retreat 2023

So, if you want to be part of shaping and moving the Cal-Neva chapter forward into the future, come find, or ask for, a current ExCom member during our upcoming meeting.

Looking forward to seeing everyone in Long Beach!

Eva Bush
President, California-Nevada Chapter of AFS

Connecting the Mosaic

Cal-Neva AFS

Our 2023 theme is "Connecting the mosaic". Fish need a diverse habitat mosaic such from freshwater to the estuary and/or the ocean. But fish are not the only ones in need of diversity. We need a diverse set of voices in fisheries as well to confront the many challenges that fish are facing today. Connecting the mosaic is all about connecting with people of diverse backgrounds in order to connect the fish to their conservation needs.

Our conference goal is to promote understanding of the changes in our climate already occurring, the changes ahead and how we can promote diversity for the resilience of species and diversity of thoughts and ideas stemming from diversity in fisheries professionals.

Planning Committee

Planning Committee Chair

Miranda Bell-Tilcock

Time & Place

Kelly Souza

Fundraising and Donations

Andrew Hampton

Digital Communications

Kathleen Berridge

Student Presentation/Poster Judging

Caroline Newell and Matthew Young

Budget and Finance

Jose Setka

Poster Session

Chris Parker & Miranda Bell-Tilcock

Registration

Amanda Casby & Norm Ponferrada

Silent Auction & Raffle

Russell Barabe

Continuing Education/Workshops

Cynthia LeDoux-Bloom & Eva Bush

Student Symposium Coordinator

Caroline Newell & Matt Young

Student Volunteer Chair

Claire Ingel

Merchandise & Charity Coordination

Christina Parker

Spawning Run

Matea Djokic

Student Networking Lunch

Matea Djokic & Ramona Swenson

Awards

Zach Bess

Information Technology

JT Robinson

Student Awards

AFS Student Oral Presentation and Poster Competition

The Student Oral Presentation and Poster judging competition at the 57th Annual Meeting of the AFS California-Nevada Chapter is being co-organized and presided over by the Northern California District of the American Institute of Fishery Research Biologists (18th straight year!). Oral presentations will be judged during two sessions of the Student Symposium, to be held on Thursday, March 2nd. Poster presentations will be judged during the afternoon Poster Session, also held on Wednesday, March 1st.

Student presentations and posters will be in the running for cash prize awards; including $250 for Best Student Presentation, $100 for runner up, and $50 for third place. The award winners will be announced at the banquet and on the conference website.

Prospective judges for both competitions please contact Caroline Newell (clsnewell@ucdavis.edu) and Matthew Young (myoungafs@gmail.com) prior to the meeting. Judging forms will be provided as a link via email.

Katrina Martens Poster Award

Cramer Fish Sciences (CFS) 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.

Nina Jo Kogut Memorial Award

This award was created to honor the life of Nina Kogut, a fisheries scientist with a strong scientific curiosity, a unique way of seeing our world, an infectiously positive work ethic, and an in-depth interest in all life forms. Nina's passion was performing meaningful work on sturgeon.

This $500 award is presented annually to an exceptional fisheries student and special consideration will be given to those whose work focuses on sturgeon research.

Nominees must fulfill the following criteria:

- be a registered student in the biological sciences or similar field
- be a participating member of an AFS student chapter
- make an oral presentation at the annual Cal-Neva AFS meeting
- perform research that embodies important implications for future native fisheries management and conservation (preference given to sturgeon research)
- demonstrated initiative and curiosity to explore meaningful questions

The Kogut Award will be judged and presented separately from the AFS Student Oral Presentation Award. Special consideration will be given to those who embody strong leadership, scientific competence, and an interest in the welfare of others.

Sponsors and Donors

Many thanks to our generous donors and supporters!

<u>Sturgeon</u> ($1,000)

Sturgeon ***($1,000)***

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Raffle Items

Plenary Speakers

Chris Lowe, Ph.D

Professor, California State University, Long Beach

Dr. Chris Lowe is a Professor of Marine Biology and the Director of the Shark Lab at CSULB. He and his students have worked on a variety of fisheries-related projects over the years, particularly focusing on aspects of fish physiology, behavior and ecology. His research has employed a range of technologies (e.g., acoustic and satellite telemetry, biologging, drones, AUVs, BRUVs) used to address questions related to the physiological and behavioral ecology of marine fishes, especially elasmobranchs, with fisheries implications.

Paul Barber, Ph.D

Professor, University of California, Los Angeles (UCLA)

Paul Barber is a professor of Ecology and Evolutionary Biology at UCLA. He studied Ecology and Evolutionary Biology and Music at his home town University of Arizona, and then earned his PhD from UC Berkeley in 1998. Paul spent 3 years at Harvard as an NSF Minority Postdoctoral Fellow before joining the faculty at Boston University in 2002 and then UCLA in 2008. Paul's research program integrates genetics, genomics, ecology, and oceanography to understand the evolution of marine biodiversity, and uses this information to promote marine conservation. As a Latino committed to diversifying science, much of Paul's research is done in the context of programs like The Diversity Project, a research-intensive summer program focused on increasing diversity in marine science. Paul's integration of research and education and passion for mentoring diversity in science has been recognized by numerous awards, including the U.S. Presidential Early Career Award for Science and Engineering, the UCLA Distinguished Teaching award, the UCLA Diversity Equity and Inclusion Award, UCLA Gold Shield Prize, and the SACNAS Distinguished Student Mentor Award. In 2017 he was named an HHMI Professor, and in 2020 was elected to the California Academy of Sciences.

Priya Shukla

Ph.D Candidate, University of California, Davis

Priya Shukla is a Ph.D candidate in Ecology at UC Davis. As part of her dissertation research, she is working with the Hog Island Oyster Companies to explore strategies for improving oysters' survival in the face of climate change and marine disease. She is currently a UC Davis Dissertation Year Fellow and working with California Ocean Science Trust as a Science Engagement Specialist. An avid science communicator, Priya has a column with Forbes Science where she talks about climate change, ocean science, and the biodiversity crisis and has been featured in multiple outlets including Mother Jones, NPR, and The New York Times. She also recently published a children's book entitled *Marine Biology Activities for Kids*. Prior to beginning her Ph.D, Priya received her Master's in Ecology from San Diego State University and her Bachelor's from UC Davis in Environmental Science and Management.

Continuing Education & Field Tour

Beach Seine of nearshore fishes, February 28 from 10:00am - 12:00pm

Location: Cabrillo Marine Museum, 3720 Stephen M White Dr, San Pedro, CA 90731
Description: Join Cabrillo Marine Museum staff for a beach seine collection of near sandy shore fishes. Great opportunity to see common southern California marine species. Registration required.

Salt Marsh Restoration: Guided walking tour, February 28 from 1:00pm - 3:00pm

Location: Cabrillo Marine Museum, 3720 Stephen M White Dr, San Pedro, CA 90731
Description: Join Cabrillo Marine Museum staff for a walking tour of salt marsh restoration sites. Great opportunity to learn about restoration, salt marsh plants, and other related species. Registration required.

Fish printing, February 28 from 1:30pm - 3:30pm and 4:00pm - 6:00pm

Lead by: Bruce Koike
Location: Cabrillo Marine Museum, 3720 Stephen M White Dr, San Pedro, CA 90731
Description: This is a hands-on technique focused learning activity where participants will learn the art of Gyotaku. Supplies and fish are all included but participants are invited to bring their own thawed fish to print if desired. Each person makes numerous prints and has the opportunity for 1:1 interaction with the instructor. Registration required.

Hilton Long Beach Floor Plan

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Oral Presentation Schedule

Wednesday – March 1

	PLENARY SESSION International III	
12:30	**Opening Remarks – Miranda Bell Tilcock, UC Davis,** CalNeva AFS President Elect, 2023 Annual Meeting Program Chair	
12:40	**Dr. Chris Lowe, CSUMB**	
1:15	**Dr. Paul Barber, UCLA**	
1:50	**Priya Shukla, UCD**	
	BREAK	
	Pacific 1	**Pacific 2**
Session	**Southern California Steelhead**	**Native Fish of California - 1**
Moderator	**Kyle Evans**	**Wayne Lifton**
2:40	*Southern California Steelhead 5-Year Review* ***Mark Capelli – National Marine Fisheries Service***	*Effects of Native Fish Translocation on a Previously Fishless Food Web* ***Kate Boersma – UCSD***
3:00	*An Action Plan to Increase Demographic Resilience and Conserve Genetic Diversity within Southern California Steelhead* ***Stephen Drenner – Stillwater Sciences***	*Leveraging Citizen Science and Fin Ray Microchemistry to Understand the Impact of the 2022 San Francisco Bay Harmful Algal Bloom on California Sturgeon* ***Kirsten Sellheim – Cramer Fish Sciences***
3:20	*Practitioner's Guide to Fish Bulletin 182: Implementation Strategy for Monitoring Southern California Steelhead* ***Dane St. George - CDFW***	*Variability in Coastal Habitat Available for Longfin Smelt Spirinchus thaleichthys in the Northeastern Pacific Ocean* ***Matt Young - USGS***
	BREAK	
4:00-6:00	**Aquarium Social (admission ticket provided)** Aquarium of the Pacific	
6:30-9:00	**Poster Session and Trade Show** Hilton 2nd Floor Foyer/Promenade	

Thursday – March 2

	Gallery 1	Gallery 2/3	Mediterranean I/II
Session	**Ichthyochemistry: Elements and Isotopes as Tracers of Foraging, Climate, and Migration in Fishes**	**Student Symposium**	**Southern Native Fishes**
Moderator	**Levi Lewis**	**Caroline Newell**	**Russell Barabe**
8:10	*Powers and Pitfalls in the Use of Otolith Geochemistry to Reconstruct Salinity, Temperature, and Natal Origins in Estuarine Fishes* ***Levi Lewis – UC Davis***	*Are Hatchery Fish Good Surrogates for Wild Fish? Differences and Similarities in the Downstream Migration and Juvenile Life History of Winter-Run Chinook Salmon.* ***Emily Chen – UC Berkeley***	*Los Angeles River Watershed Fish Passage and Flows* ***Wendy Katagi – Stillwater Sciences***
8:30	*I Know What You Did Last Summer…Or Do I? Validating Salinity Reconstructions Based on Otolith Sr Isotope Analysis.* ***Christian Denny – UC Davis***	*Potential Effects of Pollution on Gut Microbiome and Physiology of Western Mosquitofish Gambusia affinis in San Diego Creek Watershed* ***Mattea Djokic – UC Irvine***	*Southern California Native Fishes Five-Year Population Assessment through Drought, Wildfire, and Post-Fire Debris Flows in the West Fork San Gabriel River* ***Jennifer Pareti – CDFW***
8:50	*Illuminating Complexity in Longfin Smelt Life Histories Using Otolith Sr Isotope Geochemistry* ***Alexander Scott – UC Davis***	*Night Smelt (Spirinchus starksi) Populations Have Decreased Significantly in Humboldt and Del Norte Counties in the Last Decade* ***Z Zenobia – Cal Poly Humboldt***	*Exploring Thermal Conditions Occupied by Lampreys in California* ***Stewart Reid – Western Fishes***
9:10	*Comparing Food Webs in Beaver Dam Analog and Traditional Stream Habitat Using Stable Isotope Food Web Reconstruction* ***Brandi Goss –UC Davis***	*Heat Stress Influences on Growth and Physiology of Black Rockfish (Sebastes melanops)* ***Haley Mapes – California Polytechnic State University San Luis Obispo***	*Managing Genetically Distinct O. mykiss and Associated Habitat in a Post-Fire Stream, Santa Ana Mountains, Santa Ana River Watershed* ***Kerwin Russel – Riverside-Corona Resource Conservation District***
9:30	*The Best of Growth Worlds: Reconstructing Salmon Movements and Growth Chronologies from Otoliths* ***Kimberly Evans – UC Davis***	*Silverside Gold Mine: Non-Native Fish Use in Suisun Marsh Tidal Restorations* ***Elsie Platzer – UC Davis***	*Genetic Structure and Historic Demography of Endangered Unarmored Threespine Stickleback* ***Jonathan Richmond – USGS***
9:50	**BREAK**		

	Gallery 1	Gallery 2/3	Mediterranean I/II
10:10	*Eye Lens Isotopes Reveal Off-Channel Habitats Key to Lifetime Survival in Endangered Salmon* ***Carson Jeffres – UC Davis***	*When Digestive Physiology Doesn't Match "Diet": Lumpenus sagitta (Stichaeidae) is an "Omnivore" with a Carnivorous Gut* ***Daniel Rankins – UC Irvine***	*Southern Tidewater Goby (Eucyclogobius newberryi) Status on Marine Corps Base Camp Pendleton* ***Antonette Gutierrez – Consultant***
10:30	*Phoenix Fish: A Look into the Diet History of Butte Creek Spring Run Chinook that Survived Extreme Environmental Challenges* ***Ally Li – UC Davis***	*Zoop There it Is: Zooplankton Trends in the Cache-Lindsey Slough Complexes from 2014-2021* ***Kim Luke – UC Davis***	*Interim Results from a Small-Scale, Low Impact In-Stream Habitat Enhancement Project, Santa Ana River, Southern California* ***Kai Palenscar – San Bernardino Valley Conservation District***
10:50	*Observing Thiamine Deficiency in California Central Valley Chinook Salmon Using Stable Isotope Analysis in Eye Lenses* ***Alexandra Chu – UC Davis***	*Fishes in Ditches: Are Agricultural Waterways Native Fish Habitat?* ***Brian Williamshen – UC Davis***	*Bringing Native Fishes into Large-Scale Collaborative Restoration Efforts* ***Damon Goodman – CalTrout***
11:10	*Otolith Geochemistry Reveals the Origins of Juvenile Chinook Salmon Preyed Upon by an Endangered Avian Piscivore* ***Sami Araya – UC Davis***	*One-Way Gene Flow Impacts Life History Evolution and Ecology in Steelhead/Rainbow Trout (O. mykiss)* ***Katie Kobayashi – UC Santa Cruz***	*Implementing a Translocation and Restocking Plan for Tidewater Goby in Malibu Lagoon* ***Rosi Dagit – RCD of the Santa Monica Mountain***
11:30			*Upper Santa Clara River UTS Population Management Plan – Connecting Project Permitting to Species Conservation and Management.* ***Andrew Hatch – Dudek***
12:00	**Lunch (on your own) or Networking Lunch (The Loft)**		

Thursday – March 2

	Gallery 1	Gallery 2/3	Mediterranean I/III
Session	**Monitoring and Evaluation**	**Student Symposium**	**Salmon of California**
Moderator	**Jan Walker and Eric Stein**	**Caroline Newell**	**Alexander Tasoff**
1:10	*Trends in Wetland Fish Density and Species Richness: Lessons Learned from the SONGS Mitigation Monitoring Program* ***Kathryn Beheshti – UC Santa Barbara***	*The Effect of Fluctuating Temperature and Diet on the Cardiac Thermal Performance of California Killifish (Fundulus parvipinnis)* ***Madison Heard – UC Santa Barbara***	*Sex-Specific Heritabilities for Length at Maturity Among Pacific Salmon and their Consequences for Evolution in Response to Artificial Selection* ***Madilyn Gamble – UC Santa Cruz***
1:30	*A Framework for Condition Assessment and Monitoring of Estuary MPAs in California* ***Brooke Fulkerson - MLML***	*Describing the Population Status of Redtail Surfperch in Sandy Beach Surf Zones in Northern California* ***Noah Angell – Cal Poly Humboldt***	*Role of Maturation and Mortality in Portfolio Effects and Climate Resilience* ***Paul Carvalho – UC Santa Cruz***
1:50	*Binational Monitoring for Fish Community Support and Indicators of Tropicalization* ***Jan Walker – Southern CA Coastal Water Research Project***	**BREAK** **Sharks and Marine Fishes** **David Lentz**	*Assessing Aqueous Thiamine as a Mitigation Tactic in the Spawning Habitats of California Chinook Salmon* ***Abbie Ward – UC Davis***
2:10	*Assessing Fish Community Structure through Multiple Capture Methods in Southern California Estuaries* ***Christine Whitcraft – CSU Long Beach***	*Using Satellite Tags and Fisher Surveys to Understand the Impact of a Changing Climate on Billfish in the Eastern Tropical Pacific* ***Danielle Haulsee – Hubbs-SeaWorld Institute***	*Tracking Floodplain Food Web Subsidies in the Sacramento River* ***Nicholas Wright – UC Davis***
2:30	**BREAK**	*The Ecological Relevance of Buoyancy Modification in Mahi Mahi (Coryphaena hippurus) Embryos* ***Christina Pasparakis – UC Davis Bodega Marine Lab***	**BREAK**
2:50	*What Happens to a Wetland Ecosystem When Hydrological Issues Meet*	*Describing the Diet of Juvenile White Sharks (Carcharodon carcharias) in Southern*	*Comparing Fall-Run Chinook Salmon Escapement Estimation Methods from the*

	Gallery 1	Gallery 2/3	Mediterranean I/III
	Environmental Policy Limitations? ***Chloe Van Grootheest – Huntington Beach Wetlands Conservancy***	*California Through Stable Isotopes Analysis and DNA Fecal Swabs as a Complementary Tool.* ***Yamilla Samara – CSULB***	*Stanislaus and Tuolumne Rivers* ***Tyler Pilger – FISHBIO***
3:10	*Ichthyofauna of the Middle and Lower Los Angeles River* ***Andres Aguilar – CSU Los Angeles***	*Quantifying Thermal Cues that Initiate Mass Migrations in Juvenile White Sharks* ***Emily Spurgeon – CSULB***	*Fates of Yearling Spring-Run Chinook Salmon Released Near California's Largest Water Pumps: Initial Summary of the Observed Data* ***Jasmine Williamshen – Cramer Fish Sciences***
3:30	*The Reach of the Devil Weed (Sargassum horneri)* ***Mitch Wayman – Quad Knopf dba QK***	*Leopard Shark Life History with Novel Application of Stable Isotopes in Eye Lenses* ***Jon Kuntz – UC Merced***	*Behavioral Cues Enable Native Fishes to Exit a California Floodplain While Leaving Non-Native Fishes Behind* ***Mollie Ogaz – Cramer Fish Sciences***
3:50	**Sessions Adjourn**		

4:30	**LARRY BROWN TROUT SPAWNING RUN & WALK** Long Beach Shoreline Marina
4:30	**HAPPY HOUR (no host)** Beachwood Brewery and Taproom
6:30 – 10:30	**BANQUET** Hilton Catalina

Friday – March 3

	Gallery 1	Gallery 2/3	Mediterranean I/II
Session	**Lagoon Management and Restoration Symposium**	**Restoration Revisited: Lessons learned from past projects foreshadow future efforts**	**Native Fish of California - 2**
Moderator	**Ramona Swenson**	**JD Wikert**	**Norm Ponferrada**
8:10	*Potential Responses of California Coastal Lagoons to Sea-Level Rise and Future Runoff* ***Dane Behrens – ESA***	*The Evolution of Salmonid Spawning Habitat Restoration on the Lower Mokelumne River: 30 Years of Implementation and Monitoring* ***Michelle Workman – East Bay Municipal District***	*Effects of Turbidity, Temperature, and Predation Cues on the Stress Response of Juvenile Delta Smelt* ***Christina Pasparakis – UC Davis Bodega Marine Lab***
8:30	*Ocean Connectivity Drives Trophic Support for Consumers in an Intermittently Closed Coastal Lagoon* ***Matt Young – USGS***	*Ten Years After: Revisiting Restoration and Learning Lessons (Stanislaus: Honolulu Bar)* ***J.D. Wikert – USFWS***	*Genetic Species Identification from Formalin-Fixed Larval Delta Smelt (Hypomesus transpacificus)* ***Hilary Starks – Cramer Fish Sciences***
8:50	*Conservation and Metapopulation Management of the Federally Endangered Tidewater Gobies (Genus Eucylogobius)* ***Brenton Spies – CSU Channel Islands***	*Clear Creek - A Story of Success and More Potential* ***Charles Chamberlain – USFWS***	*The Importance of Place; Fish Diversity Observed Using DNA Metabarcoding* ***Scott Blankenship – Cramer Fish Sciences***
9:10	*Ormond Beach Wetlands Restoration and Public Access Planning* ***Ramona Swenson – ESA***	*How Monitoring and Adaptive Management Improved the Trinity River Restoration Program, 2000-2022* ***James Lee – USFWS***	*Priming the Pump: Meins Landing Managed Food Web Experiment* ***Bobbie Flores – Cramer Fish Sciences***
9:30	**BREAK**		
9:50	*Bar Built Estuary Dynamics and Fish Passage in the Santa Monica Bay* ***Rosi Dagit – Resource Conservation District of the Santa Monica Mountains***	*Dry Creek (Sonoma County, CA) Habitat Enhancement Project: Results, Ratings, Lessons Learned, and Future Directions* ***Neil Lassettre – Sonoma Water***	*Exploring the Reproductive Biology of Longfin Smelt in the San Francisco Estuary* ***Nikolas Floros – UC Davis***
10:10	*Topanga Lagoon Restoration Fish Passage and Refuge Habitat Suitability Analysis* ***Nick Garrity – ESA***	*If You Build It, Will They Come? And How Long Will They Stay?* ***Joseph Merz – Cramer Fish Sciences***	*Steelhead Trout (Oncorhynchus mykiss) Egg to Fry Survival on a Highly Regulated California Central Valley River*

	Gallery 1	Gallery 2/3	Mediterranean I/II
			Whitney Thorpe – Cramer Fish Sciences
10:30	*Adaptive Management of Reductions in Effluent Discharge to a Southern California Bar-Built Estuary* ***Sarah Mulder – City of Ventura***	*Canceled* ~~*Decades of River Corridor Restoration on a Regulated California River – What Has it Yielded?*~~ ~~***Rocko Brown – Cramer Fish Sciences***~~	*Drought and Fire Effects on O. mykiss in Southern California Streams* ***Shelley Hunter-Shatsnider - CDFW***
10:50	*Fish Assemblage in the Santa Clara River Estuary: Recent Surveys and Monitoring* ***Stan Glowacki – Stantec***	*A Decade of Data and Lessons Learned from Restoring a Sierra Meadow Complex* ***David Shaw – Balance Hydrologics***	*Migration Fatigue Modeling of a Hypothetical Steelhead Population in the Los Angeles River* ***Nate Butler – Stillwater Sciences***
11:10	*Predicting Fish Assemblages in California Estuaries to Inform Management* ***John Olson – CSUMB***	*Dry Creek (Sonoma County, CA) Habitat Enhancement Project: Results, Ratings, Lessons Learned, and Future Directions* ***Neil Lassettre – Sonoma Water***	*Temperature Effects the Endurance Swimming Performance of Juvenile Green Sturgeon (Acipenser medirostris)* ***Kelly Hannan – UC Davis***
11:30			*Integrating Multiple Surveys into a Population Viability Analysis for Native Fishes of the Santa Ana River, California* ***Brock Huntsman – USGS***
12:00 – 1:00	**BUSINESS LUNCHEON (ticketed)** Hilton, Catalina Room		

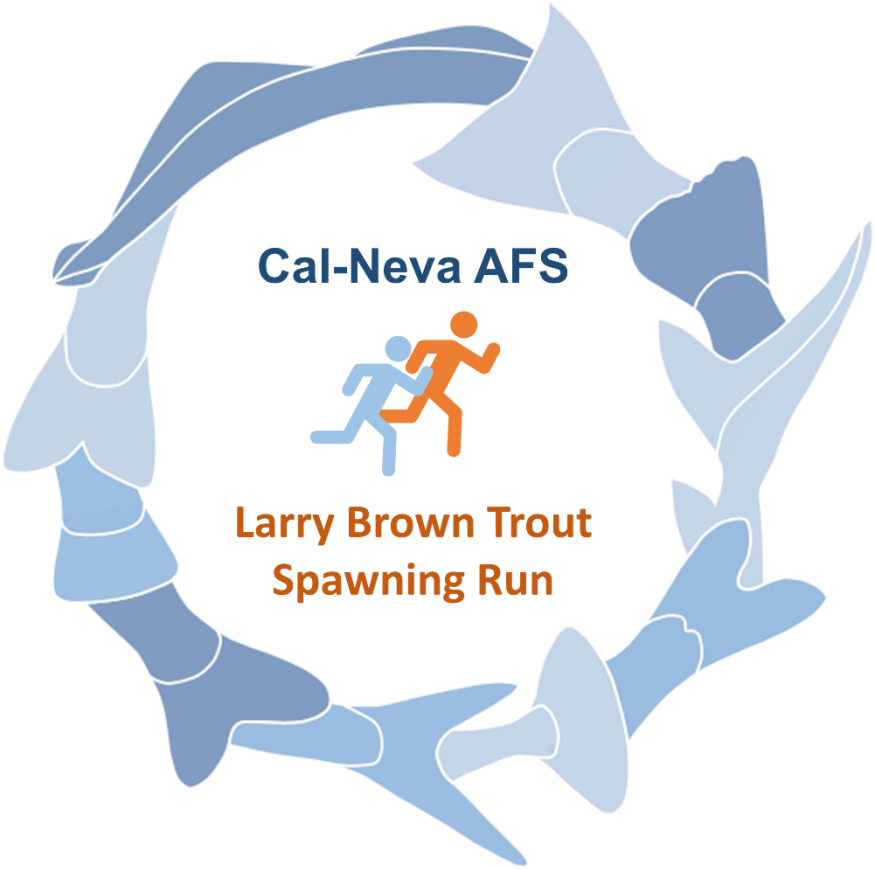
Poster Presentations

**Student poster*

Number	Abstract Title	Lead Author
1	Population Assessment of Unarmored Threespine Stickleback in Soledad Canyon, Santa Clara River Watershed	Jennifer Pareti and Andrew Aitken
2	Dead Zone: Investigating the Consequences of a Hypoxia Event in the Yolo Bypass in Fall of 2021	Mitch Olinger
3	California Mitigation and Conservation Banking: How RES is contributing to Fisheries and Aquatic Resources Conservation and Recovery	Amanda Casby
4*	Factors that attract Yellowfin tuna, *Thunnus albacares*, to fixed fish aggregating devices (FADs) in the Galapagos Islands	Sarah Moreau
5*	Investigating the Status of Razor Clam Populations at Clam Beach in Humboldt County, CA	Gabriel Irribarren
6	Are established morphometrics appropriate for identifying hatchery supplemented Delta Smelt?	Kate Erly
7	Parasites of Cypriniform Fishes of the Santa Clara River	Max Murray
8	Combining Datasets to Determine Age & Growth Rates of Juvenile Green Sturgeon in the Sacramento River	Kathryn Sykes
9	Foster Park Fish Passage Improvement Project – Phase 1	Sarah Mulder
10	Chinook Salmon Redd Enumeration on the Lower American River using Aerial Imagery	Mollie Ogaz
11	Size Selectivity Among Gears During Predatory Fish Removals	Alexander Tasoff
12	Collaborative Development of Fish Monitoring Recommendations for the Wetlands Regional Monitoring Program in San Francisco Bay	Alison Weber-Stover
13	Surveying an endangered species in California's eastern Sierra – methods and initial findings	Kathleen Berridge
14	Using eDNA to Detect Endangered Tidewater Goby, *Eucyclogobius newberryi*, in Northern California's Lost Coast	Madison Richardson
15*	Stress inhibition of fish growth: cortisol effects on insulin-like growth factor-1 (Igf1) pathways in a Pacific rockfish	Henry Marden
16	Juvenile Chinook Salmon Life History Variation and Phenotype Success on The American River	Jamie Sweeny

17	From Eyes to Origin: Using Eye Lenses to Differentiate Hatchery vs. Wild Chinook Salmon	Matt Ernard
18	Hatch date distributions and spawn timing success in winter run Chinook salmon in a changing climate	Francheska Torres
19	The Sampling Platform: A Standardized Passive Sampling Method for Effectively Monitoring Complex Habitats	Matthew Ziemer
20*	Stressed Out: Longfin Smelt & their physiological response to changes in turbidity and temperature	Francine De Castro
21*	Assessing biodiversity in Northern California Marine Protected Areas using environmental DNA	Ann Holmes
22*	Searching for signatures of selection in gametophytes of the giant kelp *Macrocystis pyrifera*	Richard Baker-Strader
23*	Do we need a bigger boat? - Comparing the catch efficiency between 6-pack vessels and party-boats	Jordan Colby
24	Growth and food resources for Winter run Chinook salmon reintroduced to the McCloud River after 70 years	Matt Salvador
25	Impact of Large Scale Habitat Restoration on Non-native Juvenile Salmonid Predators	Spencer Lejins
26	Contaminated or Conserved: Experimentally assessing the effects of different chemical fixatives on otolith appearance, otolith microchemistry, body morphometrics, and tissue histology	Alex Lama
27*	California Leopard Shark Parturition through Stable Isotopes	Russel Ly
28*	Co-occurrence of juvenile white shark (*Carcharodon carcharias*) aggregations and recreationally important fishes detected by environmental DNA	Zachariah Merson
29	The Lower Tule River Native Aquatic Species Management Plan: Small Rivers can Provide Big Habitat for Native Species	Chris Hogle
30	Protecting Southern California steelhead from extinction with landscape level actions	Russell Marlow
31	Developing otolith tools for salmonid species identification from archaeological sites	Pedro Valencia Landa

Larry Brown Trout Spawning Run



Welcome to our 2023 AFS Cal-Neva Larry Brown Trout Spawning Run!

This event has been renamed in honor of a talented scientist, past AFS Cal-Neva president, and long-time participant of the Spawning Run who made regular and impactful contributions to the annual meeting and the greater scientific community.

This year we will are offering two options: a 1 mile and 5k event on Thursday afternoon before the Banquet for a nice afternoon run or walk. So, lace-up those running shoes and come hit the trails/pavement with us for a walk, jog, or run! If you haven't registered yet, you can still do so at the conference.

Oral Presentation Abstracts

Session I – Southern California Steelhead, Wednesday March 1

Southern California Steelhead 5-Year Review
Author: Mark Capelli, National Marine Fisheries Service
Co-author(s):

NOAA Fisheries has released the 2022 5-year review for steelhead populations in southern California listed under the U.S. Endangered Species Act. The review found the southern California steelhead populations—ranging from the Santa Maria River in Santa Barbara County to the Tijuana River in San Diego County at the U.S. border with Mexico—should retain their current endangered listing status. The last 5 years have been challenging for West Coast salmon and steelhead as climate change and related impacts to the environment continue to degrade fish habitats, reducing summer flows and warming water temperatures. Lower rainfall has also reduced the accessibility to upstream steelhead spawning and rearing habitats by delaying or shortening the breaching of sandbars at the mouths of coastal estuaries. A series of marine heatwaves have also reduced steelhead ocean survival and growth in the North Pacific Ocean by increasing algal and diatom blooms that effect the productivity of steelhead prey or shift the species to less suitable prey. Increasing ocean acidification and projected changes in coastal upwelling along the California Current is expected to create additional stresses on the growth and maturation of steelhead in the marine environment, and the size and condition of steelhead returning to their freshwater habitat to reproduce.

The review highlighted the declining population trends in response to the drought and the effects of wildfires in all nine of the Biogeographic Population Groups within southern California. Prior to the era of large dam construction, periodic local extirpation and regeneration of steelhead runs likely occurred naturally. Currently nearly all the drought refugia that would help steelhead abundance rebound is located above impassible barriers, underscoring the importance of restoring fish passage between lower and upper reaches of core recovery watersheds.

Significant research on southern populations of steelhead have been undertaken since the last 5-year review. Recent work has improved our understanding of the genetic architecture underlying mixed coastal populations of steelhead and rainbow trout, including how the relationship between the anadromous and non-anadromous form of the species contributes to the persistence of both forms. New research has also documented dispersal of steelhead from their natal watersheds to non-natal watersheds—potentially an important mechanism for naturally re-colonizing steelhead habitats that have been de-populated as a result of physical modification of habitats (e.g., construction of artificial barriers such as dams or road crossings) or natural environmental perturbations (e.g., wildfire, debris flows, droughts, or catastrophic floods).

Recovery actions in NOAA Fisheries' recovery plan for the southernmost steelhead populations assign a high priority to reconnecting upper and lower watersheds by removing or modifying dams and other fish passage barriers, restoring flows in mainstems and tributaries, riparian and estuary restoration, controlling non-native invasive plants and aquatic predators, reducing excessive groundwater extractions, and preventing the loss of local remnant steelhead populations.

An Action Plan to Increase Demographic Resilience and Conserve Genetic Diversity within Southern California Steelhead
Author: Stephen Drenner, Stillwater Sciences
Co-author(s): Matt Drenner, Stillwater Sciences; Rosi Dagit, Resource Conservation District of the Santa Monica Mountains; Ethan Bell, Stillwater Sciences; Danielle Yaconelli, Stillwater Sciences

Southern California steelhead numbers have been declining at alarming rates with many populations becoming extirpated by recent disturbance events such as wildfire and drought, which are increasing in frequency and intensity due to climate change. Existing recovery plans and policies aim to increase steelhead numbers through habitat restoration and barrier removals among other strategies. While these recovery actions are critical to recovery, these approaches can take decades to implement and there is need for additional immediate action. The Southern California Steelhead Action Plan (Action Plan)

describes approaches, primarily rescues and translocations, that can be implemented in the near term to protect existing populations and increase demographic resilience of steelhead in Southern California. Watershed specific Action Plans are being developed based on guiding principles developed by CDFW and NMFS and using existing information and local knowledge. The Action Plan goes further by evaluating genetic conservation strategies to conserve Southern California steelhead genetic diversity, which may contain important adaptations, such as the ability to tolerate high temperatures, that could aid conservation of more northern populations as temperatures increase in the future.

Practitioner's Guide to Fish Bulletin 182: Implementation Strategy for monitoring southern California Steelhead

Author: Dane St. George, CDFW
Co-author(s): Casey Horgan, CDFW

Fish Bulletin 182 (Boughton et al. 2022) provides updated guidance for population trend monitoring of steelhead trout (Oncorhynchus mykiss) in the South-Central and Southern California Coastal Regions. The publication is an expanded version of the original California (Coastal) Monitoring Program for salmon and steelhead originally outlined in Fish Bulletin 180 (Adams et al. 2011) and offers region-specific development of sampling strategy, field methods, and data collection and reporting. We present a summary of core tenets of Fish Bulletin 182 and a roadmap from inception to implementation for local practitioners. This should enable organizations to identify appropriate targets of estimation and provide practical, data-rich methods for achieving them. By standardizing approaches throughout the region, we can ensure that monitoring data integrates seamlessly with recovery documents and allows for reliable tracking of steelhead trout recovery progress.

Session II – Native Fishes of California part 1 – Wednesday, March 1

Effects of native fish translocation on a previously fishless food web

Author: Kate Boersma – UCSD
Co-author(s): Russell Barabe, Janelle Doi, Bryan Kelly, Isaiah Blanco, Ozichukwu Obiamalu

Due to urbanization, anthropogenic water extraction, and climate change, native freshwater fishes of the American Southwest are among the most threatened vertebrates on earth. When historical habitats are degraded or destroyed beyond repair, resource managers often rely on fish rescue and translocation as the only remaining option to conserve at-risk populations. Although effective, in many cases, these species-specific conservation efforts ignore the potential impacts of translocation on the receiving ecosystems. In this study, we examined the effect of the translocation of endangered unarmored threespine stickleback (Gasterosteus aculeatus), on the aquatic invertebrate food web in a previously fishless stream. During July and August 2019, 365 stickleback were introduced to Upper San Felipe Creek, San Diego County, CA. We sampled invertebrates seasonally from 2018-2021, and identified over 60,000 individuals from 163 taxa. Contrary to expectations, taxonomic richness per sample increased after fish introduction (on average 4 more taxa per sample after July 2019 than before). Despite this change in richness, there were no consistent differences in invertebrate community composition following fish introduction, suggesting that the taxa contributing to the increase in richness differed in each sample. An indicator species analysis found that the abundance of the mayfly Paraleptophlebia (Leptophlebiidae) increased following fish introduction, whereas the mayfly Fallceon (Baetidae) decreased. Both mayflies are herbivorous, and the consequences of this species replacement are currently unknown. Overall, we identified surprisingly few changes following stickleback introduction, suggesting that the aquatic invertebrate food web in Upper San Felipe Creek was highly resistant to this novel predator. While the generalizability of these results to other species and locations is uncertain, our study provides hope that some fish translocations may have minimal effects on receiving ecosystems.

Leveraging citizen science and fin ray microchemistry to understand the impact of the 2022 San Francisco Bay harmful algal bloom on California sturgeon

Author: Kirsten Sellheim – Cramer Fish Sciences
Co-author(s): James Hobbs, CDFW; Dylan Stompe, CDFW; Jamie Sweeney, Cramer Fish Sciences

Like most sturgeon populations worldwide, California sturgeon populations are in decline and threatened by numerous anthropogenic impacts including habitat loss, contaminant exposure, over-fishing and climate change. This was brought to the forefront in late summer 2022, when an extensive harmful algal bloom (HAB) of Heterosigma akashiwo occurred throughout the lower San Francisco Estuary (SFE), resulting in mass mortality of sturgeon and other fish species. Potential acute causes of mortality are neurotoxins associated with the algae and asphyxiation due to observed low dissolved oxygen during the bloom (<2mg/l during September 1-5). Due to the rapid and widespread nature of the event, resource agencies could not collect data to accurately estimate the death toll associated with the event as it unfolded. However, citizen science reports of sturgeon carcasses and targeted sampling by California Department of Fish and Wildlife and other research groups provided information on the spatial extent and number of sturgeon impacted. Green and white sturgeon carcasses were reported throughout the lower SFE and the Marin and San Francisco coasts, with over 850 reports between August 23 and September 23 across all reporting platforms. Researchers also collected data on sturgeon species, size distribution, and carcass density for some locations. Total length for carcasses ranged from 70-260cm, and carcass densities along beach transects ranged from 0-28 carcasses per km. Since many of the fish killed likely did not float or were not washed ashore, actual mortality is almost certainly greater than that reported here. Fin rays were collected from nearly 100 carcasses, which will help determine whether particular life history types were disproportionately impacted by the event and further increase our knowledge of California sturgeon. We also explored previously collected white sturgeon fin ray microchemistry data to better understand the proportion of the population that may have been exposed to the HAB.

Variability in Coastal Habitat Available for Longfin Smelt (*Spirinchus thaleichthys*) in the Northeastern Pacific Ocean

Author: Matt Young, USGS
Co-author(s): Frederick Feyrer, USGS; Steven Lindley, NOAA; David Huff, NOAA

Oceanographic conditions and processes are well known drivers of marine animal distribution and population dynamics and understanding how they affect species of management concern is fundamental to the development of effective management and conservation actions. Longfin Smelt Spirinchus thaleichthys is a pelagic forage fish found in coastal and estuarine waters along the Pacific Coast of North America from Alaska to central California. Substantial declines in abundance in California's San Francisco Estuary, where Longfin Smelt is listed as Threatened under California's Endangered Species Act, have prompted evaluation of Longfin Smelt population trends and drivers. Estuarine factors associated with the decline have received extensive study in the San Francisco Estuary, but coastal factors that affect up to two-thirds of the Longfin Smelt life cycle are poorly understood and may be important drivers of population dynamics and connectivity. We examined the distribution and habitat associations of Longfin Smelt in the northeast Pacific Ocean to better understand coastal factors affecting Longfin Smelt populations. We compiled coastal observations from numerous sources, including non-profit, local, state, and federal entities to estimate the range-wide coastal marine distribution of Longfin Smelt. Longfin Smelt distribution was correlated with bathymetry, distance from the nearest estuary, sea surface temperature, and sea surface chlorophyll. Generally, Longfin Smelt were found in shallow, higher productivity coastal waters closer to estuaries, with bathymetry and temperature the most consistent factors influencing Longfin Smelt distribution. Habitat suitability was highly variable at the southern extent of the range, particularly off the coast of California, largely driven by habitat contractions associated with warm-water conditions. Study results provide insights into the habitat and range-wide distribution of an at-risk estuarine-reliant forage fish and are the first step towards identifying processes that affect the marine portion of the Longfin Smelt life cycle.

Session I – Ichthyochemistry: elements and isotopes as tracers of foraging, climate, and migration in fishes – Thursday, March 2

Powers and pitfalls in the use of otolith geochemistry to reconstruct salinity, temperature, and natal origins in estuarine fishes

Author: Levi Lewis
Co-author(s): Malte Wilmes, UC Santa Cruz; James Hobbs, CDFW

Otolith geochemistry is a powerful tool for reconstructing the life history of teleost fishes in order to inform and improve management and conservation efforts. However, each analytical approach, and the associated ecological applications, has important limitations that can act as pitfalls if they are not acknowledged and addressed during analysis and interpretation. This is particularly true in complex and highly dynamic environments like those of the San Francisco Estuary. Here we reflect on the results of several recent studies that can be used to address key assumptions in the application of (1) Sr isotopes to reconstruct salinity histories, (2) oxygen isotopes to reconstruct salinity histories, (3) oxygen isotopes to reconstruct temperature histories, and (4) elemental concentrations (e.g., Sr:Ca, Ba:Ca, Li:Ca) or 'fingerprints' to infer natal origins. By highlighting the limitations and pitfalls of each approach, we simultaneously can highlight their respective strengths, thus further improving the value and application of otolith geochemistry to address key fisheries management and conservation needs.

I know what you did last summer…or do I? Validating salinity reconstructions based on otolith Sr isotope analysis

Author: Christian Denney, UC Davis
Co-author(s): Malte Willmes, UC Santa Cruz; Leticia Cavole, UC Davis; Wilson Xieu, UC Davis; Rachel Fichman, UC Davis; James Hobbs, CDFW; Levi Lewis, UC Davis

Tracking animal movements is a powerful tool for understanding behaviors, populations, and ecosystems. However, some organisms are too small for traditional tracking methodologies. In such cases, we can use natural "tags" consisting of environmental signals incorporated into hard parts. The strontium isotope ratio (87Sr/86Sr) is one such signal that is incorporated into otoliths (small bones in the ears of fishes) as they grow. The Delta Smelt (Hypomesus transpacificus) is a critically endangered species endemic to the San Francisco Estuary (SFE) towards which an increasing amount of effort has gone to understand its behavior, populations, and ecology. Given a strong, persistent gradient in Sr isotope ratios from freshwater to brackish habitats, and conservative incorporation into otoliths, Sr isotopes are commonly used to reconstruct salinity history of fishes in the SFE. However, key assumptions in the application of this tool haven't been validated experimentally. Here we present data on the validation of this method to estimate environmental salinity as well as the timing of changes between different salinities. We demonstrate that Sr isotope ratios, when combined with otolith age profiles, can estimate salinity to within 1 practical salinity unit (PSU) in the range of 0 to 6 PSU and can discern a transition from freshwater (0.5 PSU) to brackish water (3 PSU) to within approximately ten days. This level of accuracy in both salinity and timing of changes suggests that this technique can be used for tracking movements of wild fish that are unable to be tracked using other techniques.

Illuminating complexity in Longfin Smelt life histories using otolith Sr isotope geochemistry

Author: Alexander Scott
Co-author(s): Levi Lewis, UC Davis; Malte Willmes, UC Santa Cruz; Christian Denney, UC Davis; James Hobbs, CDFW

There is a strong correlation between freshwater outflow through the San Francisco Estuary and recruitment of the federally endangered Longfin Smelt. However, the mechanisms that drive this relationship are not well understood. To better understand the relationships between outflow and life history, Strontium stable isotope ratio (87Sr/86Sr) was analyzed along the growth trajectory of otoliths from age-0 Longfin Smelt caught over two decades. Chemistry profiles were paired with otolith-based age estimates to characterize the movements of individuals across salinities over time. Results revealed at least four broad clusters in the early migratory life history of Longfin Smelt. Longfin smelt appeared to hatch or rear in a variety of

different salinities (0 to >6 ppt), and migrated downstream to higher salinity habitats at various times, including some that exhibited prolonged residency in freshwater. Saltwater migrants typically began migration between 50-100 days-post-hatch, and had completed the migration to saltier water by 150 days-post-hatch. During periods of drought, a higher proportion of age-0 individuals hatched and remained in freshwater, whereas in wet years, a higher proportion of fish hatched and remained at higher salinities. These results highlight the diversity of life histories expressed by this imperiled species, and suggest that freshwater outflow is important for downstream dispersal of recruits to higher-salinity rearing habitats, possibly affecting growth, survival, and recruitment success.

Comparing food webs in beaver dam analog and traditional stream habitat using stable isotope food web reconstruction

Author: Brandi Goss, UC Davis
Co-author(s): Ethan Baruch, CDFW; Robert Lusardi, UC Davis; Erich Yokel, Scott River Watershed Council

Beaver dam analogs (BDAs) are thought to mimic many of the benefits to fish of natural beaver dams, including trophic benefits. While some research has indicated changes in aquatic macroinvertebrate communities in the presence of BDAs, this is the first study to examine resulting changes to food webs. Our study focuses on impacts to coho salmon trophic pathways and uses carbon and nitrogen stable isotopes and the MixSIAR package to reconstruct these pathways via dietary percentage contributions. Similar to previous work we found greater invertebrate density but reduced local invertebrate diversity in the BDA habitat. Additionally, we found increased reliance on predatory invertebrates by coho salmon, with feeding rates on predatory invertebrates of 2.14 and 4.45 times the relative abundance of predatory invertebrates in the traditional steam and BDA habitats, respectively. These findings may indicate that the invertebrate communities in BDAs facilitate more optimal foraging for coho, supporting the increased growth rates found for fish in this BDA system. Paired with the abiotic benefits to fish that have been identified with BDAs, these results indicate that BDAs may serve as an important refuge habitat for threatened salmonids in areas where beaver reintroduction is challenging.

The best of growth worlds: Reconstructing Salmon movements and growth chronologies from otoliths

Author: Kimberly Evans, UC Davis
Co-author(s): George Whitman, UC Davis; Malte Willmes, UC Santa Cruz; Eric Holmes, UC Davis; Flora Cordoleani, UC Santa Cruz; Carson Jeffres, UC Davis; Rachel Johnson NOAA Fisheries, Southwest Fisheries Science Center and University of California Davis, Center for Watershed Sciences

Chinook Salmon (Oncorhynchus tshawytscha) are a keystone species of Western North America that are threatened by habitat loss and climate change. As juveniles, they utilize a variety of freshwater habitats before migrating to the ocean. Understanding which habitats provide better growth opportunities is crucial for their conservation; however, tracking fish across habitats is difficult because field observations only provide a snapshot into their life. Otoliths (ear stones) are calcium carbonate structures that form daily layers that can be used to reconstruct fish growth rates and movements among different watersheds. We evaluated three different models (Fraser-Lee, Biological Intercept, Modified Fry) that are commonly used to reconstruct growth rates from otolith ring widths using salmon reared in experimental enclosures in California's Central Valley. We found that the Modified Fry (MF) model provided the most accurate growth rate reconstructions. However, bias remains for slow growing fish, where otolith material continues to accumulate despite fish growth ceasing during poor environmental conditions. Then we applied the MF model to wild caught fish to reconstruct their growth histories. To place these fish in the landscape we also analyzed their strontium isotope ratios and classified them to different habitats in the upper Central Valley. We found that growth rates varied among different habitats and that wild fish made use of floodplain habitats in a year of high-water availability. This tool can be used to reconstruct the mosaic of growth opportunities available to Chinook Salmon in the Central Valley and thus provide critical information for salmon conservation.

Eye lens isotopes reveal off-channel habitats key to lifetime survival in endangered salmon

Author: Carson Jeffres, UC Davis
Co-author(s): Rachel Johnson, NOAA Fisheries, Southwest Fisheries Science Center and University of California Davis, Center for Watershed Sciences; Miranda Bell-Tilcock, UC Davis; Anna Sturrock, University of Essex

Research has shown that there is enhanced food production and often faster fish growth rates in off-channel habitats compared to adjacent riverine habitats. One of the large unknowns has been if these enhanced food resources and faster growth translate to higher survival and a greater number of individuals from these habitats contributing to adult recruitment. Here, we used stable isotopes ($\delta^{34}S$, $\delta^{13}C$, and $\delta^{15}N$) in sequential lamina in salmon eye lenses to identify off-channel versus riverine food webs. We reconstructed food web and habitat use in adult Sacramento River winter-run Chinook salmon in escapement years 2018, 2019, and 2020. All fish out-migrated in either 2016 (Below Normal) and 2017 (Wet), 2018 (Below Normal), or 2019 (Wet) water years. Results provide valuable insight into how returning adult salmon utilized off-channel habitats during juvenile out-migration. The majority of natural origin winter run adults that survived to spawn used off-channel habitats as juveniles. Percentages of returning adults that used off-channel habitats as juveniles were 2018 (116/146; 74%), 2019 (117/139; 84%) and 2020 (79/80; 99%). Timing of migration among salmon runs, flow events, and off-channel inundation all play important roles in determining the extent to which salmon have access to off-channel resources. This study demonstrates the applicability of this technique as a new tool to quantify population-level benefits of off-channel habitats for juvenile salmon to adult recruitment. It also highlights the ability to use $\delta^{34}S$, $\delta^{13}C$, and $\delta^{15}N$ to identify specific rivers and/or floodplains based on their unique isotopic signature incorporated into individual eye lens lamina.

Phoenix Fish: A look into the diet history of Butte Creek Spring Run Chinook that survived extreme environmental challenges

Author: Danhong Ally Li
Co-author(s): Miranda Bell-Tilcock, UC Davis; Rachel Johnson NOAA Fisheries, Southwest Fisheries Science Center and University of California Davis, Center for Watershed Sciences; Flora Cordeoleani, UC Santa Cruz; Eric Holmes, UC Davis; Carson Jeffres, UC Davis

Butte Creek is home to the largest self-sustaining spring-run Chinook Salmon (Oncorhynchus tshawytscha) population in the California Central Valley. This is partly due to recent habitat restoration efforts as well as Butte Creek's direct surface water connection with off-channel habitats in the Butte Sink and the Sutter Bypass. These off-channel habitats provide abundant food resources for juvenile salmon which in turn allows for high growth rates. In November 2018, the Camp fire ravaged part of the upper Butte Creek watershed and raised concerns about the related impacts of high sediment loads and toxic runoff negatively affecting salmon that year. However, a surprisingly large number of spring-run salmon that reared in Butte Creek in winter 2018 and spring 2019 returned to spawn in 2021, earning them the title "Phoenix fish". To better comprehend the factors that led to the success of these Phoenix fish, we performed isotope analyses on their eye lens tissues, which emerged as an efficient tool to reconstruct the diet history of fish. Recent research shows that off-channel habitats have unique $\delta^{34}S$ values that are permanently archived in these tissues of fish that have used off-channel habitats as juveniles. To date, much of this work has focused on fall and winter-run Chinook Salmon, with both runs showing high fidelity to off-channel habitats as juveniles. In this study, we looked at adult spring-run Chinook Salmon that returned to Butte Creek in 2021 and used $\delta^{13}C$, δ14N and $\delta^{34}S$ isotope values in their eye lenses to better understand the extent of off-channel habitat use for this species. Results from the isotope analysis demonstrated that almost every fish sampled for this study (39 of 40) had used off-channel habitats for rearing as a juvenile. This study validates previous work that showed the importance of off-channel habitats for Central Valley Chinook Salmon.

Observing Thiamine Deficiency in California Central Valley Chinook Salmon using stable isotope analysis in eye lenses

Author: Alexandra Chu, UC Davis
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Thiamine Deficiency Complex (TDC) was first observed in California salmon in 2020 when Central Valley hatcheries noticed abnormal corkscrew-like swimming patterns among the juveniles coupled with high mortality. It is hypothesized that TDC is due to a shift in the salmon's marine diet. Historically, Chinook Salmon fed on a diverse ocean diet of anchovies, squid, sardines, krill, and juvenile rockfish. Diet data from 2020-2022 show Chinook salmon feeding almost exclusively on anchovies. Here, we used stable isotopes of $\delta^{13}C$, and δ14N recorded in sequential laminae of salmon eye lenses to reconstruct ocean diets in adult Winter run salmon before (2018) and after (2020) thiamine deficiency was observed. We hypothesize that individuals with low egg thiamine levels in 2020 fed on a diet that consisted primarily of anchovies. Using the marine isoscapes of prey in the California Current Ecosystem, we will evaluate the relationship between salmon egg-thiamine levels and their diet reconstructions. So far, our findings have demonstrated that prior to 2020, winter run Chinook salmon fed on anchovies in their first year at sea and prior to spawning consumed diet items with lower trophic positions-likely krill and juvenile rockfish. In contrast, winter run Chinook salmon with low egg thiamine levels consumed lower trophic diet items their first year in the ocean and switched to anchovies prior to spawning. These patterns are consistent with the abundance of different prey species collected of from the coastal pelagic surveys in these years.

Otolith Geochemistry Reveals the Origins of Juvenile Chinook Salmon preyed upon by an Endangered Avian Piscivore
Author: Sami Araya
Co-author(s): Levi Lewis, UC Davis; Malte Willmes, UC Santa Cruz; Meredith Elliott, Point Blue Conservation Science; Robert Lusardi, UC Davis

Wild Chinook Salmon (Oncorhynchus tshawytscha) in California have experienced sharp declines in population size due to an array of anthropogenic pressures. Chinook Salmon smolts (juveniles that are migrating to the ocean) are prey for numerous native species in California, including the endangered California Least Tern (Sterna antillarum browni). A large breeding colony of California Least Terns occurs in the San Francisco Estuary at Alameda Point each summer and coincides with smolt outmigration. However, interactions between this endangered avian piscivore and managed salmon stocks are poorly understood. From 2007 to 2018, Point Blue Conservation Science collected and maintained an archive of juvenile Chinook Salmon that were dropped by foraging Least Tern parents returning to the colony to feed their chicks. Here, we used otolith geochemistry to analyze the ratio of Strontium stable isotopes (87Sr:86Sr) in conjunction with extracted coded wire tags (CWTs) to determine the types (hatchery or wild), natal origins, and run timings of these dropped smolts. Our results call attention to a relatively understudied trophic pathway involving juvenile salmon and an endangered coastal avian piscivore. Detailing such interactions among managed species, and across years with different environmental conditions, can help improve future management strategies and, ultimately, the recovery of listed species.

Session I – Monitoring and evaluating fish community structure and nursery function as part of California's estuarine monitoring collaborative – Thursday, March 2

Trends in wetland fish density and species richness: lessons-learned from the SONGS Mitigation Monitoring Program
Author: Kathryn Beheshti, UC Santa Barbara
Co-author(s): Mark Page, UC Santa Barbara; Steve Schroeter, UC Santa Barbara; Rachel Smith, UC Santa Barbara

To mitigate for impacts to marine fish standing stocks in the Southern California Bight caused by the operations of the San Onofre Nuclear Generating Station (SONGS), the California Coastal Commission required Southern California Edison to create or substantially restore at least 150 acres of tidal wetlands in Southern California. San Dieguito Lagoon was chosen as the

wetland mitigation site. Annual monitoring began at the San Dieguito Wetlands Restoration Project in 2012 to evaluate the performance of the restored wetland relative to three reference wetlands in the region (Carpinteria Salt Marsh, Mugu Lagoon, and Tijuana River Estuary). Given the motivation for the out-of-kind mitigation for SONGS impacts to fish standing stock, and the value of wetlands as nursery habitat, four of the fifteen performance standards pertain to fish density and species richness. Monitoring has revealed a general underperformance of fish density and species richness relative to the reference wetlands over time. The drivers of fish underperformance are not yet understood, and we are investigating several hypotheses. These include exploring relationships between fish densities and species richness, tidal creek topography, and the encroachment of Spartina foliosa into restored tidal creek habitat.

A Framework for Condition Assessment and Monitoring of Estuary MPAs in California

Author: Kevin O'Connor
Co-author(s): Ross Clark, CCWG; Jan Walker, SCCWRP; Eric Stein, SCCWRP; Christine Whitcraft, CSULB; Brent Hughes, SSU; John Largier; David Jacobs; Christina Toms

The condition of California's diverse coastal lagoons and estuaries has the potential to significantly influence water quality and ecosystem functioning in nearby coastal habitats, including California's offshore Marine Protected Areas. Although California has invested significant funds over the past two decades to acquire and protect estuaries, the State lacks a coordinated, statewide monitoring program for assessing estuary health in a systematic, consistent manner. Answering key questions about the efficacy of the estuarine MPA program, stressor management, and resiliency to climate change requires long-term investment in a coordinated monitoring program. To address this challenge, we created a monitoring framework that enables estuaries across California to be systematically assessed and monitored. A key aspect of this program is a focus on ecological functions versus a single type of flora or fauna. This focus on function allows the framework to accommodate different estuary types and assimilate data from diverse existing monitoring programs, while maintaining an underlying comparability. In service of assessing functional performance, we have developed standard protocols to assessing key estuarine features across different estuaries, coupled with standard data templates and guidance on analysis, synthesis, and reporting, focused on four guiding principles – flexibility, comparability, interpretability, and practicality. Currently, our team is testing our monitoring framework in the field across three geographic regions and fifteen estuaries.

Binational monitoring for fish community support and indicators of tropicalization

Author: Jan Walker
Co-author(s): Julio Lorda, Universidad Autónoma de Baja California; Eric Stein, Southern California Coastal Water Research Project; Christine Whitcraft, University of California Long Beach

Coastal resource managers have long recognized that the health of coastal estuaries is integrally linked to the health of adjacent marine habitats. In many estuaries, certain species of invertebrates and fish often spawn and rear in estuaries, using them as critical nursery habitat or refugia before migrating to the ocean. However, there is a general lack of coordinated estuarine monitoring across international borders making it difficult to understand the relative health and condition of these interconnected systems. Recently, a statewide team of scientists and managers developed and tested a statewide framework for comprehensive assessment of California's estuaries. This innovative program is based on ecosystem functions and provides mechanisms for data synthesis that will allow for evaluation of fish nursery support (and other functions). In 2022, we expanded this assessment into two large coastal lagoons in Baja California, Estero Punta Banda and Bahía de San Quintín, to better understand the relative condition of Baja California estuaries to five southern California estuaries. By expanding monitoring into Baja California, we are able to better assess estuaries across a spectrum of disturbance, where Baja California lagoons have been less impacted and affected by anthropogenic disturbance, such as urbanization, as well as to track changes of tropicalization. These Baja California estuaries may act as the 'canary in the coal mine'- a warning for what southern California may soon face. We just finished the first year of monitoring. However, untangling the complexities of trends in functions and associated causative factors requires a commitment to long-term monitoring.

Assessing Fish Community Structure through Multiple Capture Methods in Southern California Estuaries

Author: Christine Whitcraft
Co-author(s): Sebastian Garia, CSU Long Beach; Jan Walker, SCCWRP; Eric Stein, SCCWRP; Kevin O'Connor, Moss Landing Marine Labs; Ross Clark, Moss Landing Marine Labs; Brent Hughes, Sonoma State University

Despite the recognized importance of estuaries, there is little consensus among managers and scientists as to which sampling methods should be used for monitoring projects. Of particular interest is how to best monitor estuarine marine protected areas (EMPAs). Our project goal is to obtain a more comprehensive measure of fish community composition by using a variety of complementary capture methods in five southern California estuaries. By utilizing a variety of capture methods (baited remote underwater videos (BRUVs), seines, hook and line observations) and a range of abiotic, biotic and habitat parameters, we hope to better understand community composition and potential correlates for fish communities within these estuaries. BRUVs documented rays, elasmobranchs, and a variety of finfish; however, the effectiveness of this method is limited by water clarity. Hook and line showed that anglers captured larger and more mobile fish than other methods; species included Sargo, Croaker, and Leopard Sharks. Seines were effective at capturing smaller, less mobile fish, and increased seine sampling effort yielded higher species richness. Using data from just two seasons, we built preliminary generalized liner models that showed correlations of fish abundance with abiotic factors (ammonia, nitrate, conductivity and dissolved oxygen) and estuary condition parameters (mouth condition and MPA type). Our goal is developing standardized protocols and analysis criteria that help increase understanding of the fish community composition within southern California estuaries, thus informing EMPA management.

What happens to a wetland ecosystem when hydrological issues meet environmental policy limitations?

Author: Chloe Van Grootheest
Co-author(s): Christine Whitcraft, CSULB; John Villa, CSULB

Wetlands are important ecosystems that support diverse communities, sequester carbon, provide nursery habitat for important fish species, and provide protection to our coastal cities from oceanic natural processes. Despite the numerous ecosystem services wetlands provide, they are vulnerable habitats and are often threatened by factors including habitat alterations, introduction of invasive species, and various natural or anthropogenic induced disasters. Huntington Beach Wetlands (HBW), located in southern California, consists of 180 acres of restored wetland habitat that was historically home to 3,000 acres that is now mainly urbanized. Unfortunately, HBW has experienced a variety of stressors throughout the year of 2022 that included an oil spill and an unexpected 5-month inlet closure. While periodic inlet closure due to seasonal swell patterns is a regular occurrence for HBW, the ocean connection inlet is maintained by Orange County Public Works in order to prevent degradation of the HBW ecosystem. However, the inlet closure that occurred in 2022 was unique in that it abruptly closed just before California Least Tern nesting season. Because the HBW inlet is adjacent to a protected California Least Tern nesting reserve, the inlet remained closed for 5 months before tidal inundation was reestablished to the HBW ecosystem in September. In response, Huntington Beach Wetland Conservancy partnered with researchers at the California State University, Long Beach and Moffatt and Nichol to understand the impacts of this inlet closure on HBW's ecosystem, and the events that followed. This included monthly fish community assessment and water quality monitoring throughout six locations of the wetland habitat. By the end of the project, we were able to draw associations with habitat condition and fish community and observed some interesting effects in the aftermath of the inlet reopening.

Ichthyofauna of the middle and lower Los Angeles River

Author: Andres Aguilar
Co-author(s): Sabrina Drill, UC Agriculture and Natural Resources; Jason Post, Tohono O'odham Community College; Rosi Dagit, Resource Conservation District of the Santa Monica Mountains;

The Los Angeles River is a highly modified urban system. Upper tributaries of the system are located in Angeles National Forest and are in a relatively natural state, but below the forest boundary the tributaries and the mainstem consist of a

series of impoundments, completely channelized sections with a concrete bottom that includes a low-flow channel and vertical walls, and sections where there are graded berms and a substrate that was either not stabilized with a concrete substrate, or where enough sediment has accumulated to provide a "soft-bottom" with vegetation, boulders, and variation in flow. Here we provide the results of observations and fish surveys conducted from 2007-2020 that document the presence of 29 species, of which six, found either in upper reaches (sections of the river with similar habitat and hydrologic characteristics) or in the estuary, are native to the river. To accompany this data, we also provide a novel classification schema identifying the unique reaches of the LA River.

The Reach of the Devil Weed (*sargassum horneri*)

Author: Mitch Wayman, Quad Knopf dba QK
Co-author(s): Jeffrey Erway, QK

Invasive species of all types threaten biodiversity in saltwater and freshwater environments. This presentation, featuring Environmental Scientist Mitch Waymen, will specifically focus on the impacts that Sargassum horneri (a.k.a. Devil Weed) has on coastal California environments. Mitch will explore the native environment of Devil Weed and the ways in which it spread to other areas of the world. The presentation will also illustrate the negative impacts that the plant has on native habitats and strategies to mitigate its spread and damage.

Session II – Student Symposium – Thursday, March 2

Are hatchery fish good surrogates for wild fish? Differences and similarities in the downstream migration and juvenile life history of winter-run Chinook salmon.

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Hatchery fish in the California Central Valley provide key monitoring information on the in-river conditions and vital rates for managing natural and hatchery Chinook salmon. Due to differences in early life growth and timing of release, their behavior and survival of hatchery-origin fish may differ from natural-origin fish, resulting in biases when applying the information to management of natural-origin populations. We characterized the downstream migration schedules of endangered hatchery and natural-origin Sacramento winter-run Chinook salmon. We analyzed the otolith microstructure and microchemistry of hatchery and natural-origin spawners to quantify freshwater habitat use and timing. Preliminary results comparing hatchery- and natural-origin life history suggest hatchery fish use a lesser extent of the watershed and have more homogenous outmigration behavior. Reduced variation in life history in hatchery fish can result in reduced stability and more amplified responses of hatchery fish to environmental conditions and events. This research serves to improve the accuracy and validity of models informing winter-run Chinook salmon conservation and regulations around California's water projects.

Potential effects of pollution on gut microbiome and physiology of western mosquitofish Gambusia affinis in San Diego Creek watershed

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Co-author(s): Donovan German, UC Irvine;

Many important watersheds in Southern California are unrecognizably altered from anthropogenic activities that negatively impact native fish. Water discharged from urban runoff contains metals and chemicals from various sources and impact fish health. Contaminants can affect fish gut microbiome bacterial composition. A fish's gut microbiome can influence their immune response and digestive efficiency, affecting overall performance of an individual. However, the interaction of the gut microbiome and physiology of fish in response to urban runoff is not well understood. I tested the effects of persistent

pollutants on the gut microbiome and physiology of mosquitofish in the San Diego Creek watershed by comparing measurements on populations from six sites of varying pollution levels. In the most polluted site, hepatosomatic index was elevated in females and gonopodium length, controlled for standard length, was lower in males when compared to other populations, including their source population. Preliminary investigations showed site fidelity of enteric microbial diversity that may also correlate with pollution level. Statistical analyses including non-metric dimensional scaling and indicator species analysis are in progress, as well as analyses of the relationships between gut microbial diversity and physiological metrics, which will be shared in the presentation.

Night smelt (Spirinchus starksi) populations have decreased significantly in Humboldt and Del Norte counties in the last *decade*

Author: Z. Zenobia
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Night smelt occurs from Central California to SouthEast Alaska and spawn on the shore of sandy beach surf zones at night. This species is a vital part of regional food webs and in California, is fished commercially, recreationally and for subsistence, primarily in Humboldt and Del Norte counties. To study the status of these populations we collected adult night smelt with an A-frame net at six beaches in Humboldt and Del Norte counties once a month from March to September 2021. We then statistically compared total length, weight, age, and sex ratio with data collected following the same methods and at the same beaches in 2014. Length, weight, and age averaged (±Standard Deviation) 11.7±0.8cm TL, 10.4±1.9 g, and 1.02±0.20 y were significantly lower than 2014 values (12.2±6.0 cm TL, 11.5±2.5 g, 1.24±0.45 y respectively, $p<0.01$). Most of the fish were males (96%), which was a significantly higher percentage of males than in 2014 (93%, $p<0.05$). Our study suggests that at present Humboldt and Del Norte night smelt are smaller, lighter, younger and more of them are males than they were a decade ago. These results suggest that these populations are in decline, potentially due to overfishing or unfavorable oceanographic conditions, and may require stricter regulations such as seasonal or annual closures. Collaboration with the Tolowaa Dee ni' Nation, the Resighini Rancheria and the California Department of Fish and Wildlife provided a unique opportunity to establish research methods and best practices for understanding how the night smelt population is doing along our coastline. As well as to reestablish cultural and dietary practices through community collaboration and tribal co-management of a culturally significant species.

Heat stress influences on growth and physiology of Black Rockfish (*Sebastes melanops*)

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Teleost fishes experiencing atypically high temperatures and shifts in nutritional input often show indications of energetic stress. While changes in nutrition and temperature have each been shown to alter profiles of growth- and stress-related hormones in fish, as well as plasma osmolality and glucose levels, less is known about how these stressors interact. Here, we examined how differential food availability ('high' and 'low' feed rations) influenced the growth and physiological responses of black rockfish (Sebastes melanops) exposed to a short-term heat stress event. Black rockfish were acclimated under a 'high' feed (9% g feed per g body mass per day) ration for 21 d under ambient ocean temperatures, after which subsets of fish were either transferred to a 'low' feed ration (1% ration) or continually maintained on 'high' ration. Following 21 d of exposure to these feed rations, fish were exposed to a 54-h heat stress event (increase of ~5°C above acclimation), after which temperature returned to ambient conditions. Fish in both ration treatments showed reduced mass-specific growth rate (SGR) during the 3-week period after the heat stress event, but then increased growth above pre-stressor rates 6 and 9 weeks after the temperature stress. Plasma Igf1 relationship to mass and length SGR had a significant, positive relationship the first 21 d of the experiment, however, the relationship was no longer present following the acute heat stress. Plasma glucose had

a significant increase after the heat stress event however, no differences were seen between ration treatments. Plasma osmolality significantly decreased 20 days after the heat stress event in both low and high ration feed groups and remained lowered in low ration fish. Our findings indicate that an acute temperature increase can affect the growth rate and physiology of black rockfish with possible compensatory growth observed weeks after the acute thermal stress.

Silverside gold mine: non-native fish use in Suisun Marsh tidal restorations

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In Suisun Marsh, a brackish wetland complex within the San Francisco Estuary (SFE), managers have begun restoring tidal action to gated managed wetlands, with hopes that increased hydroconnectivity will reverse recent declines of native fish populations. However, little research exists to quantify the functional benefits of tidal restoration on native fishes at the whole marsh scale. We sampled water quality, zooplankton, and nearshore fish assemblages at fifteen locations across three habitat types in Suisun: restored tidal marshes, managed seasonal wetlands, and historic slough channels. Overall, fish assemblages were dominated by invasive Mississippi silverside (Menidia audens) in restored marshes and historic sloughs, but rarely captured in managed wetlands, where the native resident threespine stickleback (Gasterosteus aculeatus) comprised the majority of catch. Managed wetlands also demonstrated higher average nutrient concentrations and zooplankton biomass compared to the other habitat types. Long residence times and seasonal flood-drain cycles in the managed wetland ponds mimic floodplain dynamics, which may increase productivity and create beneficial habitat for desirable fish species (Tung & Phillips 2021). Our results suggest that tidal restoration of managed wetlands may reduce habitat suitability for native species in highly invaded, novel ecosystems like Suisun Marsh. Further research should investigate the mechanisms underlying differential habitat preference and use by native versus abundant non-native fishes.

When digestive physiology doesn't match "diet": *Lumpenus sagitta* (*Stichaeidae*) is an "omnivore" with a carnivorous gut

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Based on economic principles, Chemical Reactor Theory, and the Adaptive Modulation Hypothesis (AMH), suggest that digestive enzyme activities in an animal's gut should match with diet to ensure efficient digestion. Elevated carbohydrase activities in the guts of herbivores and omnivores, and elevated aminopeptidase activity in some carnivores, all support the AMH in a rich literature. Thus, an animal's digestive physiology shows what the animal is capable of digesting from what it ingests. In this study, we found that the "omnivorous" Lumpenus sagitta (Perciformes: Stichaeidae) does indeed consume considerable algal content, but their amylase activities are lower than other algal-consuming stichaeid fishes. Moreover, all stichaeids that eat algae consume more of it as they grow, and show positive allometry of gut size relative to body size; L. sagitta does not show positive gut allometry, more like carnivorous stichaeids. The microbial diversity of the hindgut shows that L. sagitta has an enteric community dominated by Pseudomonodota and Planctomycetota, unlike the algivores that have more Bacteriodota and Bacillota. Coupled to elevated pepsin activity (digests protein) in the stomach and N-acetyl-glucosaminidase activity (digests chitin breakdown products) in the intestine, all aspects of the L. sagitta gut suggest it is carnivorous in what it digests. Transcriptomic analyses of intestinal tissues are underway, but the overall dataset shows the power of examining digestive physiology as opposed to only gut content analyses to determine what an animal can actually digest from what it ingests.

Zoop There it Is: Zooplankton Trends in the Cache-Lindsey Slough Complexes from 2014-2021

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Davis

In the past decade, the north Delta has been subject to drought, high flows, and record temperatures. Climate change will continue to exacerbate these events. To help understand how the food source of native Delta fishes may be impacted, we are analyzing monthly zooplankton samples collected since 2014 from the north Delta. The areas of focus are within the Cache-Lindsey Slough Complex (CLC), specifically upper slough sites. The CLC is influenced by agriculture, water export, artificial lakes, restoration sites, wetlands, and natural upland inputs. Cache and Lindsey Slough vary significantly in water input, flow, and nutrient load, and have very different plankton dynamics.
Our results build on previous studies that show higher densities of zooplankton near terminal ends of slough complexes, and abundance shifts in response to local flows from precipitation, irrigation and flood control districts, and agriculture. Our study compares the hydrodynamically different Cache and Lindsey Sloughs, and captures drought and very wet years to understand how flow affects nutrient dynamics and food web response. Our spatial, temporal, and hydrodynamic study will support management of adjacent landscapes to help offset impacts of climate change, and create optimal nutrient and flow dynamics for food webs.

One-way gene flow impacts life history evolution and ecology in steelhead/rainbow trout (*Oncorhynchus mykiss*)
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It has become well-recognized that fragmentation by instream barriers can impact species composition and abundance, disrupt gene flow, reduce genetic diversity, and drive adaptation to new environments. Barriers such as dams and waterfalls often exhibit asymmetry in their permeability—favoring downstream dispersal and gene flow while limiting the reverse direction. However, the evolutionary and ecological consequences of this imbalance remain relatively unexplored. Here, we use an eco-evolutionary framework to consider the evolutionary and ecological consequences of gene flow between phenotypically-divergent populations of steelhead/rainbow trout (O. mykiss). We use a combination of molecular and field-based methods to document unidirectional gene flow from resident-adapted populations above barriers to their founding anadromous population downstream; and corresponding changes in migration behavior, and juvenile abundance and size-structure across the landscape.

Fishes in Ditches: are agricultural waterways native fish habitat?
Author: Brian Williamshen, UC Davis, bowwilliamson@ucdavis.edu
Co-author(s): John Durand, UC Davis

Agriculture is a dominant feature of California's Central Valley landscape, including a vast network of canals and ditches used for irrigation. These man-made waterways often have turbid, nutrient-rich waters that are free of aquatic weeds and may resemble historic conditions of the Sacramento-San Joaquin River Delta (Delta), but little is known of which species of fish, if any, inhabit them. As the quality of habitat in the Delta continues to decline for native fishes, it is important to look beyond the legal bounds of the Delta for previously unrecognized habitat. I present a case study focused on the irrigation waterways that connect to the Cache Slough Complex in the North Delta – both native and nonnative fish were found to inhabit these waterways. Aspects of agriculture, such as pesticide use, can be harmful to fishes, so it is imperative to manage irrigation infrastructure to maximize benefit and minimize harm to California's unique native fish species.

The effect of fluctuating temperature and diet on the cardiac thermal performance of California killifish (*Fundulus parvipinnis*)
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Salt marshes are dynamic systems that are characterized by rapid and intense fluctuations in temperature. Because of this, the ectotherms residing in these environments must possess the ability to tolerate thermally variable environments. Mounting these plastic thermal responses requires energy and nutrients, which are acquired through diet. As the nutritional landscape shifts and temperatures continue to change, it is critical we examine the modulating effect of diet on the capacity of ectotherms to respond to thermal variability. Using the California killifish, we tested the influence of fluctuating temperatures and diet quality through two specific hypotheses: (1) static acclimation temperature will yield a narrower thermal breadth when compared to fluctuating acclimation temperatures and (2) mixed diets will yield higher cardiac thermal tolerance compared to a single-item diet. Killifish were acclimated for 3 weeks at one of five ecologically relevant temperature regimes (10, 10-20, 20, 20-30, 30°C) while providing either a single-item diet or a mixed-item diet. Cardiac thermal tolerance was measured using an Arrhenius Breakpoint Temperature test. Both maximum heart rate and cardiac upper thermal limits increased with increasing acclimation temperature. Diet quality had a stronger influence on cardiac thermal performance at colder fluctuating temperatures compared to warmer fluctuating temperatures. This work suggests that both diet and fluctuating temperatures influence species' thermal limits and thus their vulnerability to climate change.

Describing the Population Status of Redtail Surfperch in Sandy Beach Surf Zones in Northern California

Author: Noah Angell, Cal Poly Humboldt
Co-author(s): Jose Marin jarring, Cal Poly Humboldt

*The Redtail surfperch, Amphistichus rhodoterus, occurs in sandy beach surf zones along the US' west coast, including Northern California. They are a critical component of the ecology in this region, culturally important and popular recreational and commercial fishes, being the primary surfperch species caught from shore in Humboldt County. Despite their importance, this is a low information/data limited fisheries species in an ecosystem that has been historically under-represented in the literature. Marine Protected Areas (MPAs) have been recently implemented in northern California with the overarching goal of increasing biodiversity and productivity; however, their long-term conservation benefits have been poorly studied in this region or habitat. Therefore, I am comparing Catch per Unit Effort (CPUE), total length, weight, age and sex ratio of Redtails among years (2014-2016 and 2020-2022) and sites (two Marine Protected Area vs. two reference areas) in Humboldt County. Overall, the CPUE varied from 0 to 6.17 fish*angler*hour while the lengths varied from 12 to 38.5 cm. The population appears to have remained relatively stable throughout our time series, and no benefits of MPAs have been observed. However, 2022 did have a significantly higher CPUE than 2020 and 2014 ($p<0.05$). Lengths were also higher in 2021 than 2020. In addition, the two northernmost sites, (MPA and reference), had significantly higher total lengths when compared to the southern reference sites. This lack of an MPA effect could be a result of the low fishing pressure and or Redtails moving in and out of the MPAs due to the limited size of these preserves. In the near future, I will compare weights, ages, and sex ratios of these fish among the different sites and years. My study is important because I will help improve current management practices and gain insight towards the long-term benefits of MPAs.*

Session II – Sharks and Marine Fish – Thursday, March 2

The Ecological Relevance of Buoyancy Modification in Mahi Mahi (*Coryphaena hippurus*) Embryos

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Pelagic fish embryos are thought to float in or near the surface for the majority of their development and are presumed to have little to no control over their mobility, rendering them at high risk for damages associated with surface stressors such as ultraviolet radiation (UVR).We recently challenged these long-standing paradigms by characterizing a mechanism of stressor avoidance in early-life stage mahi-mahi (Coryphaena hippurus) in which embryos sense external cues, such as UVR, and

reduce their buoyancy and sink to reduce further exposure. Recovery of buoyancy, following termination of UV exposures, suggests this response is reversible and adaptive. To understand more about the energetic requirements of this process, oxygen consumption and yolk sac depletion were measured in developing embryos exposed to multiple stressors known to affect buoyancy. Specific gravity of control versus UVR exposed embryos were measured using density gradient columns. To test the ecological relevance of this mechanism, the Connectivity Modeling System (CMS) was employed to track the transport of mahi-mahi embryos and investigate how measurements of specific gravity collected in a laboratory setting translate to changes in the vertical position and UVR exposure of embryos in nature. Buoyancy modification due to UVR exposure resulted in embryos positioned significantly deeper in the water column with reduced UVR exposures, illustrating the ecological significance of this mechanism. This research was made possible by a grant from The Gulf of Mexico Research Initiative. Grant No: SA-1520; Name: Relationship of Effects of Cardiac Outcomes in fish for Validation of Ecological Risk (RECOVER).

Using Satellite Tags and Fisher Surveys to Understand the Impact of a Changing Climate on Billfish in the Eastern Tropical Pacific

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The Eastern Tropical Pacific (ETP) ocean supports vibrant fisheries targeting highly migratory species like billfish, however, the population status of these species is often unclear. Disentangling shifting distributions of populations due to environmental variability and climate change, from anthropogenic impacts on their populations, remains difficult because we lack basic understanding of the distribution for many of these species. To support more informed management efforts, we collated a long-term (2003-2021) tagging dataset to analyze movement patterns of Indo-Pacific sailfish (Istiophorus platypterus) and Pacific blue marlin (Makaira nigricans). Our dataset consists of 57 sailfish and 47 blue marlin outfitted with pop-off satellite archival tags (PSATs) within the ETP. Tag deployments ranged 5-273 days (mean = 63.4) for sailfish and 2-368 days (mean = 75.46) for blue marlin, although we limited analyses to tracks longer than 14 days. Average total distance travelled was slightly longer for blue marlin (mean = 1996.78 km, range = 13.785 - 8916.75 km) than sailfish (mean = 1867.16 km, range = 96.04 - 5255.21 km), however fish spent 93 and 92% of time within national Exclusive Economic Zones respectively. To capture the diverse perspectives of environmental, climatic, and anthropogenic stressors on these species and stakeholders, we also interviewed 50 experienced recreational fishers from Costa Rica. Understanding the distribution of these species over time and under different oceanographic and climatic conditions, and the perspectives from the fishers who depend on them, will help inform environmentally-driven species distribution models and dynamic ocean management efforts in the region.

Describing the diet of juvenile white sharks (Carcharodon carcharias) in Southern California through stable isotopes analysis and DNA fecal swabs as a complementary tool.

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Juvenile white sharks (JWS) tend to aggregate at coastal beaches along the southern California Bight. These beaches are visited by local fishers throughout the year; thus, the presence of young sharks can affect local tourism and recreational activities. Offshore, JWS are also caught as bycatch in commercial net fisheries targeting California halibut and white sea bass. Hence, a better understanding of JWS diet may help predict what public beaches are suitable for a shark aggregation. To describe the diet composition of JWS, muscle biopsy samples were taken from sharks at coastal aggregation sites for isotopic analysis and those incidentally caught in by commercial fisheries offshore were biopsied and cloacal swabbed for prey DNA analysis. Isotopic prey baselines for inshore and offshore JWS were built by collecting samples from potential prey species found at aggregation sites, and by taking isotopes values from the literature from those species detected in the DNA

swabs samples, respectively. Permanova tests revealed differences between inshore and offshore sharks' isotopic values (P= 0.001) and niche overlapping calculations resulted in low isotopic overlap. Mixing models showed that inshore sharks' diet is composed of teleost fishes and benthic elasmobranchs. Offshore sharks appear to be feeding lower in the food chain with pelagic schooling fishes describing their diet. This suggests that there are two groups of JWS that use different habitats and feed on different prey, at least during their early life history off California, and that recreational and commercial fisheries are likely interacting with different groups of JWS.

Quantifying thermal cues that initiate mass migrations in juvenile white sharks

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While the function of migration varies among species, environmental temperature is known to be one of the most important abiotic variables that drive animal migration; however, quantifying the thresholds and timing of the cues that influence a mass emigration is difficult, often due to lack of monitoring resolution, particularly for large, highly mobile species. We used acoustic telemetry tracking and high-resolution water temperature data over a relatively large spatial scale (5.5 km2) to identify and quantify a thermal threshold for mass emigration of juvenile white sharks. Sixteen tagged sharks were observed to initiate a search for warmer water within 10–12 hours of an upwelling event where water temperatures dropped below 14 °C. Eleven sharks traveled ~ 35 km away where they experienced similar cold temperatures before returning to the aggregation site within 24 hours. Five days following the upwelling event, most sharks emigrated from the site for the season. Quantifying movement patterns across different spatial and temporal scales is necessary to understand cues and thresholds influencing animal migration to better inform recreational and offshore gillnet fisheries about increasing or decreasing interactions with juvenile white sharks.

Leopard Shark Life History with Novel Application of Stable Isotopes in Eye Lenses

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Life history events are difficult to document in elasmobranchs (cartilaginous fishes; sharks, skates, and rays), like California's native Leopard Shark (Triakis semifasciata). Ecological studies in teleost fishes often use stable isotope analysis (SIA) of inorganic accretionary tissues (i.e., otoliths) to resolve detailed movement, trophic patterns, and natal origin. However, otoliths are not present in elasmobranchs. Eye lens layers (laminae) have been validated as a chronological tissue for SIA sampling in fishes, with isotopic composition (δ13C and δ15N) of laminae reflecting diet and movement across the entire lifetime of an individual. While this is true for some fishes, stable isotopic eye lens methodologies have yet to be resolved for sharks. To assess the viability in eye lens SIA methodologies for shark life history ecology, nine Leopard Sharks were collected from two Northern California sites each (n = 18). Eye lenses were measured during serial sampling from the outer lamina (death) to laminar core (birth). Samples were then analyzed via continuous-flow Isotope Ratio Mass Spectrometer coupled to an Elemental Analyzer (EA-IRMS). A Mann-Whitney U Test determined that C/N ratios between different compositions of eye lens laminae (i.e., cortex vs nucleus) were significantly different (p < 2.2e-16) in a subset of the Leopard Sharks (n = 10); though, after laminae had been treated with DI water and re-analyzed, cortex and nucleus C/N values were similar. In addition, δ13C and δ15N values showed clear life history patterns that hadn't previously been verified in Leopard Sharks, highlighting the importance of eye lens SIA in sharks.

Session III – Native fish of Southern and Eastern California – Thursday, March 2

Los Angeles River Watershed Fish Passage and Flows

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Ecological restoration in the Los Angeles (LA) River watershed is proceeding on multiple fronts with the support and engagement of diverse stakeholder groups. Pilot projects to restore habitat, reintroduce native species, and design science-based ecosystem enhancements have produced real benefits to nature and people and demonstrated the potential for additional benefits. The pilot projects, which are in various stages of collaborative planning and implementation, have generated increased interest and financial support to further their implementation and maximize socioecological co-benefits. This self-reinforcing positive feedback is an example of a virtuous cycle established through a combination of long-term environmental planning, community-building, and watershed-scale scientific study to gain the support of stakeholders and align ecological intervention (i.e., restoration) with the plans and policies of governments, resource managers, conservation groups, and grassroots advocacy groups. Conservation and restoration projects targeting iconic and protected focal species can be an effective means of leveraging these interests and building support. The LA River Fish Passage and Habitat Structures project addresses a critical limiting factor for the recovery of endangered steelhead trout (Oncorhynchus mykiss) while also enhancing flow regimes, urban biodiversity, and providing recreational opportunities and other beneficial uses (e.g., ecosystem services) for the surrounding communities. Through these efforts, our planners, ecologists, and engineers are using place-based conservation to demonstrate solutions to problems that affect people and nature in other urban landscapes.

Southern California Native Fishes Five-Year Population Assessment through Drought, Wildfire, and Post-Fire Debris Flows in the West Fork San Gabriel River

Author: Jennifer Pareti, CDFW
Co-author(s):

Native fish within Southern California are under extreme pressure from habitat loss, increased urban development, and a more variable climate. Recent wildfire and drought events have added additional stressors and challenges to management and recovery efforts of native fish species within Los Angeles County. The West Fork San Gabriel River (WFSGR), within the Angeles National Forest, supports native populations of federally threatened Santa Ana sucker (Catostomus santaanae), native coastal rainbow trout (Oncorhynchus mykiss irideus), and California Species of Special Concern Santa Ana speckled dace (Rhinichthys osculus ssp.) and arroyo chub (Gila orcutti). Following several years of unprecedented drought and high temperatures, a study was conducted in 2018 to provide an updated estimate of fish abundance, distribution, and stream habitat within a nine-mile section of the lower WFSGR. This section of stream receives managed flows from Cogswell Dam. The five-year study has been conducted annually (2018-2022), capturing native fish data through significant ecological stream events including the 2020 Bobcat Fire which burned 115,796 acres of the Angeles National Forest, including 93% of the lower WFSGR. Following the Bobcat Fire, heavy post-fire debris flows inundated the WFSGR with sediment, filling important fish refugia habitat as well as Cogswell Reservoir. An emergency construction project began to remove sediment from Cogswell Reservoir, impacting stream flows and water quality. Documenting Southern California native fish abundance over these stochastic and anthropogenic events provided important data used to inform species management and recovery actions and recommendations for construction mitigation during post-fire stream recovery through ongoing drought conditions.

Exploring Thermal Conditions Occupied by Lampreys in California

Author: Steward Reid, Western Fishes
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California is home to a diverse lamprey fauna that historically occupied streams throughout the state and into Baja California. Recent range fluctuations by anadromous Pacific Lamprey, Entosphenus tridentatus, in its southern range have caused concern with regard to anticipated climatic changes and warming of stream habitats. Examination of temperature tolerances in lampreys have generally been conducted in the laboratory. Here we associate modeled mean August temperatures of stream reaches currently occupied by lampreys in California for periods 2002–2011, 2040, 2080 and a +3.0

°C scenario. The nine lamprey taxa in California occupy a considerable range in temperatures, reflecting their broad elevational and latitudinal ranges, with mean August temperatures of 7.9–25.9 °C. This includes the current distribution of the anadromous Pacific Lamprey (10.3–25.9 °C). Under a projected relatively extreme +3 °C increase only eight streams state-wide are projected to have reaches exceeding mean August temperatures of 28.0 °C, accounting for 2.6% of currently occupied habitat. However, actual 2021 August water temperatures surveyed at selected higher temperature sites occupied by Pacific Lamprey ranged from 18.5–32.6 °C (mean 27.9 °C). Projected temperature increases suggest that future conditions will be generally within the range currently encountered or physiologically tolerated by Pacific Lamprey. Empirical observations of ammocoetes in warmer stream reaches suggest that lampreys are successfully reproducing and rearing in higher temperatures than suggested by laboratory studies. How they do this is not clear, but may involve both physiological tolerances and behavioral responses to high temperature conditions.

Managing Genetically Distinct O. mykiss and Associated Habitat in a Post-Fire Stream, Santa Ana Mountains, Santa Ana River Watershed, California

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Managing and assessing fish populations and associated habitat after catastrophic fire events in upper watershed tributary streams in Southern California is problematic at best. There are limited tools available to help determine the amount and timing of sediment movement through the system after a fire, while at the same time conducting monitoring, assessing streamside habitat, spawning substrates and fish reproduction in a changing system where spawning substrates and rearing habitat can change after high flow storm event. The population of O. mykiss at Coldwater Canyon was removed before stochastic flood events would have extirpated them from the creek and returned after conditions had stabilized enough to sustain a fish population. Since that time we have tracked changes in flow, water temperature, bed load, streamside vegetation recovery and fish reproduction over the last several years since the initial impacts of the fire and found rapid changes in both stream flow and fish reproduction. Results of surveys and data collection show that many high order streams can recovery rapidly based on their location, geohydrology, elevation and orientation, which allows for movement of cobble and gravel into areas that provide improved spawning sites and formation of pools over time without substantial impacts to the population or habitat, which provides a timelier reintroduction of rescued fish.

Effect of temperature on embryonic development of different California rainbow trout stains

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We are interested in examining whether wild southern California rainbow trout demonstrate different developmental thermal physiology compared to hatchery strains. An understanding of how temperature influences embryonic development can inform restoration and reintroduction efforts of native rainbow trout and could also be used to understand how climate change could impact existing populations. We compared embryonic thermal physiology of 'wild' eggs collected from spawning adults in Pauma Creek, San Diego County (Oncorhynchus mykiss) to embryos of the Mt Shasta hatchery strain (Oncorhynchus mykiss) and Eagle Lake strain (Oncorhynchus mykiss aquilarum). All strains were incubated in 5, 10, 15 and 17.5°C from two days post fertilization until hatching. Survival to 50% hatch was highest at 10°C in Mt Shasta and Pauma Creek embryos, whereas survival was lower across all temperatures in Eagle Lake embryos. Time to hatch decreased as temperature increased and was similar across strains. Similarly, hatchling mass and length was also similar across strains and mass-specific oxygen consumption rate of hatchlings was highest at 15°C with no clear strain differences. Overall, initial analyses suggest only subtle differences exist between the embryonic development of the different strains examined. This likely reflects the general thermally robust and eurythermal nature of rainbow trout and suggests hatchery strain physiology can inform restoration efforts for native populations.

Southern Tidewater Goby (Eucyclogobius newberryi) status on Marine Corps Base Camp Pendleton

Author: Antonette Gutierrez
Co-author(s):

The tidewater goby (Eucyclogobius newberryi) was once abundant in the lagoons and estuaries along the coast of California. The southern tidewater goby is now found isolated in only a few lagoons on Marine Corps Base Camp Pendleton (Camp Pendleton). It was federally listed as endangered in 1994 and the management falls under the United States Fish and Wildlife Service (USFWS) South Coast Recovery Unit of San Diego County.
Southern tidewater goby presence/absence at eight lagoon systems on Camp Pendleton has been monitored annually since 2002 with the exception of 2019 and 2020. The monitoring is intended to provide data for the management of this endangered species. Since 2016, water quality parameters including temperature and salinity and habitat composition have been monitored to help assess habitat suitability for tidewater goby. .
Tidewater goby positive detections on Camp Pendleton have fluctuated between three and six of the eight lagoon systems. From 2016 to 2018 southern tidewater gobies captured ranged from a high of 180 gobies detected in two systems in 2016 to a low of eight gobies captured in four systems in 2018. In 2021, a total of six gobies were detected from five systems and a total of five gobies were detected from three systems in 2022. Limited habitat suitability, presence of invasive species, and climate stressors (including severe drought and storm events) have likely contributed to the sparse numbers of tidewater gobies found on Camp Pendleton. Of the lagoon systems on Camp Pendleton where tidewater gobies intermittently persist, none are currently stable, leaving the southern tidewater goby highly susceptible to local extirpation or endangerment.

Interim Results from a Small-Scale, Low Impact In-Stream Habitat Enhancement Project, Santa Ana River, Southern California

Author: Kai Palenscar, San Bernardino Valley Water Conservation District

Two native fish species currently occupy the lowland reaches of the Santa Ana River, an urbanized southern California stream. These include the Santa Ana sucker (Catostomus santaanae) and arroyo chub (Gila orcuttii). Many attempts to enhance the lower river for use by the sucker (foraging and spawning) have failed to provide benefit to the species. The Upper Santa Ana River Habitat Conservation Plan proposes to enhance conditions for sucker and chub. Results from early efforts to test the efficacy of small scale, low impact (i.e., construction impact) habitat enhancement methods during the fall and winter of 2022-23 hold promise to provide short and long-term in-stream habitat uplift for native fishes. These methods embed wooden stakes into the streambed in order to increase water turbulence and fine sediment transport, which result in the formation and maintenance of a coarsened streambed associated with experimental plots. Interim results testing these methods in the Santa Ana River will be presented.

Bringing native fishes into large-scale collaborative restoration efforts

Author: Damon Goodman, CalTrout
Co-author(s): Stewart Reid, Western Fishes; Josh Boyce, USFWS

Ecosystem-level restoration is widely promoted as a preferred approach to reverse species declines. It inherently incorporates the beneficial interrelationships among native species. However, misapplication of conservation mandates often leads to management tailored to the needs of a single priority species and can at times be detrimental to other native species. In this presentation, I discuss a large-scale collaborative river restoration project designed to promote success of not only federal ESA-listed anadromous spring-run Chinook Salmon and steelhead, but the entire native fish fauna, including resident non-game species. Big Chico Creek is a tributary of the Sacramento River where migratory fishes have lost access to the upper 8.5 mi of their historical distribution. In addition, non-game native fishes were systematically eliminated from the upper reaches using rotenone in 1986 as an attempt to reduce competition for salmonids - ultimately ineffective. This project aims to restore anadromy throughout Big Chico Creek while promoting re-establishment of the nine fish species native to its upper reaches. We expect the approach applied in this project will improve conditions for all members of the native fish fauna, restoring ecosystem function, and will provide an example for consideration of native fishes in other river restoration efforts.

Implementing a Translocation and Restocking Plan for Tidewater Goby in Malibu Lagoon
Author: Rosi Dagit, RCD of the Santa Monica Mountains
Co-author(s): Jamie King, RCDSMM

Tidewater gobies are federally endangered in southern California and a variety of efforts since the 1990's has strived to implement recovery actions. In 1991, a total of 51 individuals were collected under direction of Dr. Camm Swift from the Ventura River and released into Malibu Lagoon. The population in Malibu Lagoon peaked in the late 1990's and began to decline by 2005 when a formal survey was conducted prior to pending lagoon restoration. In addition to regular monitoring in Malibu, the RCDSMM initiated monitoring in Topanga lagoon in 2001, where a colonization event was documented, and DNA evidence revealed that founders of this new population came from Malibu. Starting in 2005 and continuing to date, the RCDSMM began annual monitoring and seining of all the lagoons from Big Sycamore in the north to Topanga in the south in 2005 to document presence/absence of Tidewater gobies throughout the North Santa Monica Bay. Following the restoration of Malibu Lagoon in 2012, where only eight tidewater gobies were observed, the population in Malibu continued to be sparse while the population in Topanga continued to grow. From 2019 – 2022, California State Parks funded a study to investigate why. Results from that study recommended translocation of tidewater gobies from Topanga back to Malibu which was implemented in September 2022 in coordination with USFWS.

Upper Santa Clara River UTS Population Management Plan – Connecting project permitting to species conservation and management.
Author: Andrew Hatch, Dudek
Co-author(s):

The Upper Santa Clara River Unarmored Threespine Stickleback (UTS, Gasterosteus aculeatus williamsoni) Population Management Plan was prepared as part of the permitting process associated with the periodic dewatering, inspection, maintenance, modification, or repair of a key water conveyance pipeline serving the Los Angeles Basin referred to as the Foothill Feeder. The Foothill Feeder is a primary conduit connecting the State Water Project to the Southern California region served by the Metropolitan Water District of Southern California (Metropolitan), which provides water to more than 19 million people in Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. The endangered species permitting required to authorize potential UTS take connected with the necessary maintenance activities on the Foothill Feeder included an Act of the California Legislature (AB-2488) and California Department of Fish and Wildlife and U.S. Fish and Wildlife Service Incidental Take Permits. The conditions of these permits required preparation of a UTS Population Management Plan in addition to acquisition, restoration, and long-term management of UTS habitat in Soledad Canyon near Acton, California. Beyond just providing for permit compliance and mitigating this important project that maintains critical water infrastructure, Metropolitan's Upper Santa Clara River UTS Population Management Plan provides direct conservation actions and future recommendations that will benefit UTS.

Current Status of Desert Pupfish (*Cyprinodon macularius*) in the Salton Sea Basin
Author: Brett Daniels, CDFW
Co-author(s): Sharon Keeney

Evidence from past and present sources shows that the distribution of the state and federally endangered desert pupfish, (Cyprinodon macularius), has declined in the Salton Sea basin. Once a wide-ranging endemic along the Colorado River and various springs throughout the Salton Sea basin, desert pupfish currently occur in tributaries (Salt Creek, Hot Mineral Spa Creek, and San Felipe Creek) and associated waters (intermittent washes, shoreline pools), irrigation drains and associated waters (outflows, shoreline pools, furrows), USFWS ponds, Varner Harbor, North Shore Marina, and refuges. To better understand the distribution and relative abundance of desert pupfish, surveys are conducted during spring and summer months in the Salton Sea Basin, focusing on natural tributaries and associated washes irrigation drains/canals and associated waters, Varner Harbor, North Shore Marina, USFWS ponds, and refuges. The limited distribution and numbers observed by California Department of Fish and Wildlife (CDFW) staff in recent years is likely due to habitat loss or alteration, and interactions with non-native fish and other fauna, especially crayfish. However, desert pupfish continue to persist and

may be abundant in some habitats. New habitat projects have been initiated at the Salton Sea as part of the Salton Sea Management Program. These habitats will replace habitat that is fragmented or lost entirely as the Salton Sea elevation drops further. Ongoing cooperation between County, State, and Federal governments, and the development of new partnerships will be required to prevent this iconic survivor from becoming extirpated in the Salton Sea Basin.

Session III – Salmonids of California – Thursday, March 2

Sex-specific heritabilities for length at maturity among Pacific salmon and their consequences for evolution in response to artificial selection

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Artificial selection is a common result of conservation policies and natural resource management. To reduce unintended consequences of artificial selection, conservation practitioners must understand both artificial selection gradients on traits of interest and how those traits are correlated with others that may affect population growth. We investigated how artificial selection on male length in Pacific salmon (Oncorhynchus spp.) may influence the evolution of female length and fecundity. While hatchery managers often assume that selection for large males will also produce large females, this may not be true: because the fastest growing males mature early and small, while female age at maturity varies little, small males may produce larger females if growth rate is heritable between sexes. We estimated sex-specific heritabilities of and selection gradients on length at maturity in four wild Pacific salmon populations and used the multivariate breeder's equation to project how artificial selection on males may affect female evolution.

Role of maturation and mortality in portfolio effects and climate resilience

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The portfolio effect plays a critical role in population productivity and stability. Age structure of spawning salmon represents an example of portfolio effects such that the risks of experiencing unfavorable conditions are spread across time. However, the distribution of maturation ages for Pacific salmon (Oncorhynchus spp.) is increasingly concentrated into fewer and younger ages, which may impact population resilience to climate change. We explored the population dynamics of Sacramento River fall-run Chinook salmon (O. tshawytscha) under different age structure scenarios using a life-cycle model and compared two mechanisms that can underlie these changes – mortality and maturation. In addition, we tested whether age structure promotes resilience to drought. We found that high age structure diversity increased the stability of population size and harvest compared with low diversity. However, mean population size responded differently depending on the underlying mechanism. Reduced mortality of adult fish ages 4-5 increased escapement whereas delayed maturation decreased escapement. Overall, high age structure diversity was able to buffer against the adverse effects of droughts by reducing the variability of population size and harvest compared with low diversity. Our results suggest that age structure promotes stability of salmon in an increasingly variable climate.

Assessing aqueous thiamine as a mitigation tactic in the spawning habitats of California Chinook Salmon

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Thiamine (vitamin B1) Deficiency Complex (TDC) is a nutritional deficiency well-documented in salmonids globally that has been recently linked to early life stage mortality in California Chinook salmon (Oncorhynchus tshawytscha). Thiamine is an essential coenzyme for central metabolic processes, however salmon cannot biosynthesize this compound endogenously and must depend on dietary intake or absorption for their needs. Originating in the lowest levels of the food web, particular species of bacteria, fungi, and plants are capable of de novo thiamine synthesis. The production of aqueous thiamine by microbial communities has been measured in marine systems, yet, despite the increasing occurrence of TDC in freshwater systems, dissolved thiamine concentrations have not been assessed. We hypothesized that the microbial communities present in freshwater systems could be a source of aqueous thiamine available to eggs and developing embryos after deposition in the gravel and could function to "rescue" eggs depleted in thiamine. As a first step towards testing this hypothesis, we placed eyed eggs from thirty-two fall run Chinook salmon families into caged egg boxes along the Feather River in three separate locations of varied spawning density (high, medium, and low). Concentrations of dissolved thiamine and its related biosynthetic precursor moieties and degradation products were measured in the water column and sediments within these three locations. Eggs from each family were separated into three egg boxes and deployed into each location for a month and collected prior to exogenous feeding, with controls for each female retained at an aquaculture facility. Here we explore the associations between egg thiamine concentrations and aqueous B1 during the spawning season while eggs were buried. These results could have significant influence over management practices as we begin to understand the role of the microbial communities in mitigating against poor ocean nutrition in California salmon.

Tracking Floodplain Food Web Subsidies in the Sacramento River

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Floodplains are critical habitats for many fish species due to the highly productive food webs they produce when flooded. Less understood are the benefits floodplains can provide in the form of subsidies, as the water drains back into rivers and exports floodplain-derived food web resources (i.e, zooplankton). In California, much of the historic floodplain habitat available to juvenile Chinook Salmon (Oncorhynchus tshawytscha) has been disconnected from rivers by levees and converted to agriculture. However, these fields are still inundated in the winter to decompose remaining plant material and provide habitat for waterfowl. When drained, the zooplankton within these fields could potentially provide a valuable food subsidy to fish in mainstem rivers. To test this, we deployed cages of hatchery-origin juvenile Chinook Salmon in the Sacramento River both above and up to six miles below the point where water was returned from a series of flooded fields in the Colusa Basin. Sites were sampled weekly for zooplankton community composition and abundance using net tows to assess the density and dilution distance of the floodplain zooplankton subsidy. Caged fish were weighed and measured weekly and three fish per site were removed for stomach contents and isotopic analyses. Zooplankton sampling, fish measurements, stomach contents, and isotopic analysis demonstrated that salmon reared downstream of floodplains consumed floodplain-derived food resources and grew at a faster rate than those reared upstream. This will enable us to document the trophic benefits that managed agricultural floodplain subsidies can provide to fish in less productive river habitats.

Comparing Fall-run Chinook Salmon Escapement Estimation Methods from the Stanislaus and Tuolumne Rivers

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Monitoring adult escapement of salmonids is a fundamental component in fisheries stock assessment and evaluating recovery goals. Whereas there are multiple methods for estimating escapement, there are trade-offs between degree of accuracy and implementation expenses and effort. Various methods are used throughout the Central Valley to estimate

escapement of the four Chinook Salmon runs, but few rivers have more than one escapement monitoring program. Fall-run Chinook Salmon escapement on the Stanislaus and Tuolumne rivers is estimated by two independent monitoring programs. Since 1952, California Department of Fish and Wildlife has performed carcass surveys that provide an index of escapement. Beginning in 2003 (Stanislaus River) and 2009 (Tuolumne River) private contractors have seasonally installed and operated weirs with fish counting devices to estimate absolute spawner abundance. We used the overlapping time series to evaluate the relationship between estimates. With few exceptions, estimates from counting adult spawners entering the spawning grounds were greater than estimates from carcass surveys on both rivers. Escapement estimates from the Stanislaus weir were about 60% (+/- 5%) greater than estimates from carcass surveys, while estimates at the Tuolumne weir were 40% (+/- 4%) greater than estimates from carcass surveys. Estimates from both methods were highly correlated and estimates of absolute abundance accounted for > 96% of variation in index estimates. The high degree of covariation between methods indicates estimates from both can be used in population models that incorporate additional data sources, such as juvenile production from rotary screw trapping. Having multiple sources of data on fall-run Chinook Salmon will be increasingly useful for guiding and evaluating management actions in these heavily managed rivers.

Fates of yearling spring-run Chinook Salmon released near California's largest water pumps: initial summary of the observed data

Author: Jasmine Williamshen, Cramer Fish Sciences
Co-author(s): Myfanwy Johnston, Cramer Fish Sciences; Matt Espe, One Straw Consulting; Bradley Cavallo, Cramer Fish Sciences

The combined capacity of the State Water Project (SWP) and Central Valley Project (CVP) to export 15,000 cubic feet per second (cfs) of water from the Sacramento-San Joaquin River Delta (Delta) can have massive impacts on the aquatic ecosystem and its inhabitants, particularly the survival of outmigrating juvenile Chinook Salmon (Oncorhynchus tshqwytscha). Acoustic telemetry studies suggest the likelihood of survival through the Delta is typically greater for juvenile salmonids exiting through the North Delta (Sacramento River) than those in the South Delta (San Joaquin River). However, survival has not been well studied for fishes that enter the Interior Delta (Old River) and encounter the SWP and CVP water export facilities. This experimental study implanted 1,600 hatchery-reared yearling spring-run Chinook Salmon with predator-detecting acoustic tags for release in Grant Line Canal, where release events (n= 8) occurred during a randomly assigned water export treatment. A network of stationary autonomous acoustic receivers and active mobile tracking were used to maximize our ability to assign "fates" (predation, entrainment, survival) to tagged fish – this initial summary of the observed data will explore whether fate varied between the two treatment groups. Since SWP and CVP must balance water deliveries for many purposes, the results from this study may provide insight for managing water operations to balance benefits for human consumption with the recovery of salmon populations.

Behavioral cues enable native fishes to exit a California floodplain while leaving non-native fishes behind

Author: Mollie Ogaz, Cramer Fish Sciences
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Floodplains are highly productive environments that provide critical rearing habitat and increased growth for diverse native fishes, including juvenile Chinook salmon (Oncorhynchus tshawytscha). Yet, stranding during the flood recession is a potential negative outcome in restored ecosystems where environmental cues are not always present as they were under historical conditions. Outmigration cues of native and non-native fishes from a restored floodplain were evaluated along the Cosumnes River, CA USA. This river is the only remaining major unregulated river in the Sierra Nevada that flows into the Central Valley. It remains unclear how native and non-native fishes utilize spatiotemporally heterogeneous habitats in the Cosumnes River; however, a better understanding of these dynamics could yield insight into how degraded river ecosystems in the region could be rehabilitated to benefit native fishes. In 2018 and 2019, daily fyke net surveys of fish assemblages were conducted within the floodplain and in outmigration corridors, along with collection of environmental data to identify possible cues. Bayesian modeling showed that temperature increases, along with rate of floodplain drawdown and the average flow over a rolling seven-day period were important triggers cuing native fishes to exit the floodplain. We conclude

that the numerous benefits to the aquatic food web and growth of native fishes justifies the risk of stranding that floodplain restoration poses, particularly when supplemented with outmigration cues.

Session I – Lagoon Management and Restoration Symposium – Friday, March 3

Potential responses of California coastal lagoons to sea-level rise and future runoff

Author: Dane Behrens, ESA
Co-author(s): Nick Garrity, ESA; Amber Inggs, ESA; James Jackson, ESA; Lindsey Sheehan, ESA; Bob Battalio, ESA; Yashar Rafati, ESA

Small, sandy coastal lagoons in California provide vital habitat for native estuarine fish species, which have adapted to variable back-barrier conditions that result from the fluctuating mouth state. With the imminent threats of sea level rise, coastal development, nutrient loading, and changing climate, the adaptability and durability of these systems in the near-term is far from certain. A large number of planning studies in the past decade have started to examine the response of these systems to sea-level rise and future runoff conditions, and the expected response varies widely from system to system. This has major implications for future species use of these systems, which often compete with the needs of overlapping land uses at each site. This talk uses modeling results from a number of sites in California to compare and contrast trajectories for southern California lagoons, and identifies some of the drivers that may cause changes in response between systems.

Ocean connectivity drives trophic support for consumers in an intermittently closed coastal lagoon

Author: Matt Young, USGS
Co-author(s): Frederick Feyer, USGS; Darron Fong, NPS; Rachel Johnson, NOAA/NMFS Southwest Fisheries Science Center; Tamara Kraus, USGS; Veronica Violette, USFS; Elizabeth Stumpner, DWR; Megan Young, USGS

Estuarine food webs are complex, as marine, freshwater, and terrestrial inputs combine and contribute variable amounts of organic material. Seasonal fluctuations in precipitation amplify the dynamism inherent to estuarine food webs, particularly in lagoonal estuaries, which can be seasonally closed and disconnected from the ocean in low-runoff periods (bar-built lagoons). Despite their abundance along coastlines in Mediterranean climates, the organic matter sources fueling bar-built lagoon food webs are poorly understood, particularly with respect to seasonal hydrologic variability, episodic marine connections, and internal nutrient cycling. In this study, we evaluate the food web of a bar-built lagoon with respect to seasonal differences in lagoon water quality, the sources of organic matter which support consumers, and the trophic ecology of resident fishes. Observed water quality conditions reflected biogeochemical processes associated with salinity-driven stratification and high lagoon residence times and were associated with strong seasonal differences in the contribution of different organic matter sources to lagoon consumers. A variety of organic matter sources supported consumers; marine inputs were important to lagoon food webs in spring when the lagoon was open, while summer food webs were largely driven by phytoplankton which was likely fueled by internal nutrient cycling. Fish diets were largely comprised of crustaceans and fish eggs, with clearly defined trophic niches in spring but high overlap in summer. This study demonstrates that the seasonal changes in bar-built lagoon food webs are largely dependent on ocean connectivity and internal cycling within the lagoon, rather than watershed processes as is typical for many estuaries.

CONSERVATION AND METAPOPULATION MANAGEMENT OF THE FEDERALLY ENDANGERED TIDEWATER GOBIES (*GENUS EUCYCLOGOBIUS*)

Author: Brenton Spies, CSU Channel Islands
Co-author(s): Dave Jacobs, UCLA

The federally endangered northern tidewater goby (E. newberryi) and the newly described southern tidewater goby (E. kristinae) are currently in review for reclassification, despite the shortage of thorough population surveys needed to conduct the appropriate metapopulation viability analysis (MVA) listed in the USFWS Recovery Plan for reclassification. Given the

recent extreme and volatile weather patterns that have occurred in California over the past decade ranging from severe drought to record rains, many coastal estuaries and lagoons where the tidewater gobies occur continue to be heavily impacted and degraded. Therefore, we conducted annual population surveys (2014, 2015, and 2017-2018) in 117 estuaries and lagoons to assess the current health and status of the tidewater gobies in five of the six Recovery Units, spanning from Bodega Bay to San Diego, CA. This massive effort has provided continuous coastal surveys over four years, and over 300 observations, which helped create the framework for a robust and comprehensive presence/absence dataset to help inform metapopulation management and recovery actions. Surveys revealed a high degree of endangerment of both species, mainly in Southern California – south of Point Conception, due to habitat desiccation and the presence of invasive species. Additionally, surveys revealed a range expansion of the microsporidian parasite Kabatana newberryi in 24 localities south of Rodeo lagoon, Marin County to Topanga Canyon, Los Angeles County.

Ormond Beach Wetlands Restoration and Public Access Planning

Author: Ramona Swenson, ESA
Co-author(s): Bob Battalio, ESA; Nick Garrity, ESA; Dane Behren, ESA; Amber Inggs, ESA; Eve Pier Kieli, ESA

The Ormond Beach Wetlands (Ventura County) is one of the largest and most important wetland restoration opportunities in southern California. Although large areas of the wetlands have been drained, filled, and degraded over the past century, this is one of the few places with an intact dune-transition zone–marsh system, including a small lagoon perched behind the dunes. Sensitive species at the site include tidewater goby, California least tern, Western snowy plover and rare dune plants. Ormond Beach has endured various industrial uses including a power plant and the EPA Halaco Superfund Site. Ormond Lagoon receives inflow from the Ormond Waterway, which passes along the former Halaco smelter property, and tšumaš Creek. South Oxnard, a nearby disadvantaged community, bears the brunt of this legacy. The California Coastal Conservancy, the Nature Conservancy, and the City of Oxnard have been working to protect the Ormond Beach wetlands complex. In 2019 the project partners released the Ormond Beach Restoration and Public Access Plan for the 650-acre wetland complex. Hydrological monitoring is ongoing to fill data gaps, and the partners are commencing early restoration actions such as invasive species control and fencing to protect nesting birds. The EPA is working on a feasibility study to determine how to address remediation, a key precursor to larger scale restoration.

Bar built estuary dynamics and fish passage in the Santa Monica Bay

Author: Rosi Dagit, RCD of Santa Monica Mountains
Co-author(s): Jamie King, RCDSMM

Small bar built coastal estuaries have been identified as critical habitat linkages to restore in order to support recovery of federally endangered southern steelhead trout (Oncorhynchus mykiss) in southern California. These barrier removal efforts have been implemented widely over the past ten years but few studies have integrated storm event ocean connection monitoring (duration of passage opportunities) with snorkel surveys to look at whether habitat and passage improvement resulted in increased occupancy by steelhead. Since 2012, we have monitored eight watersheds in the Santa Monica Bay that historically supported steelhead to document changes associated with habitat restoration as well as impacts from drought and wildfires. Duration of passage opportunity was associated with lagoon size with smaller lagoons remaining connected longer than larger lagoons that retained more volume. This information has provided important validation data for breach and fish passage models and its value in refining lagoon restoration design will be discussed.

Topanga Lagoon Restoration Fish Passage and Refuge Habitat Suitability Analysis

Author: Nick Garrity, ESA
Co-author(s): Rosi Daggit, RCDSMM; Amber Inggs, ESA; Alicia Juang, ESA; Dane Behrens, ESA; Ramona Swenson, ESA; Weixia Jin; Qing Wang; and Chris Webb, Moffat & Nichol

The fish passage and refuge habitat suitability modeling for the Topanga Lagoon Restoration combined the results of two-dimensional hydraulic modeling performed, lagoon mouth modeling, and biological criteria to assess how proposed restoration alternatives would potentially affect adult steelhead passage as well as refugia and habitat improvements for tidewater goby and juvenile steelhead. This novel approach hindcasts passage and habitat conditions at high and low tide on a daily time step over a 10-year hindcast from 2011 to 2022, which allows for quantitative comparison of existing conditions and restoration alternatives over a range of conditions.

Based on modeling and analysis, restoring the lagoon by expanding wetland habitat increases storm flow conveyance and storage in the lagoon. Expanding and increasing storage in the lagoon increases lagoon mouth closure, but increasing storm flow conveyance and storage decreases velocities during and after storm events. Decreased velocities benefit adult steelhead passage by increasing the time and opportunity for passage during and after storm events when adult steelhead are most likely to be able to migrate upstream, despite the lagoon mouth being closed more often during other times. Modeling also indicates that lengthening the Pacific Coast Highway (PCH) bridge over the lagoon in conjunction with expanding the lagoon improves conditions for passage at the PCH bridge.

Model results for tidewater goby and juvenile steelhead refugia in the lagoon show that the existing lagoon provides refugia when the lagoon is closed and during low flow conditions when the mouth is open. During storm flows, flow velocities in the lagoon increase and can exceed criteria for refugia. Compared to existing conditions, model results show that expanding the lagoon improves refugia for tidewater gobies and juvenile steelhead during storm flows because the expanded lagoon provides lower velocity areas.

Adaptive Management of Reductions in Effluent Discharge to a Southern California Bar-Built Estuary
Author: Sarah Mulder, City of Ventura
Co-author(s): Tom Barnes, ESA; Ramona Swenson, ESA; Stan Glowacki, Stantec; Tamara Klug, Cardno now Stantec;

The Santa Clara River Estuary is a seasonally-closed lagoon-type estuary, also known as a bar-built estuary that supports special-status wildlife including tidewater goby and southern California steelhead. Tertiary-treated wastewater from the Ventura Water Reclamation Facility is currently discharged into the estuary. The City of Ventura will be implementing the VenturaWaterPure Program to recycle and beneficially reuse portions of this treated water to augment potable water supply and to improve estuary ecological function by reducing unnaturally high water levels, unseasonal (summer) berm breaches, and nutrient loading (that contributes to eutrophic and hypoxic conditions). The City has completed the first of three years of baseline estuary monitoring prior to wastewater discharge reductions. When discharges to the estuary are reduced, monitoring will continue for five additional years to assess anticipated benefits: (1) establishment of a more "natural" hydrological pattern including seasonal berm breaching, (2) improved water quality, particularly reductions in nutrient loads and periods of very low dissolved oxygen concentration, (3) ability of habitats to support foraging and provide refugia for listed species; and (4) increased estuarine habitat types. An adaptive management decision process was developed with discrete triggers and key indicators of habitat quality, to identify if negative effects occur instead of anticipated benefits, and to specify how such effects would be addressed with management actions. This talk will discuss the adaptive management designed to ensure the project's multiple benefits of water reuse and protection of estuarine ecology are realized, including improved habitat quality for steelhead and tidewater goby.

Fish Assemblage in the Santa Clara River Estuary: Recent Surveys and Monitoring
Author: Stan Glowacki, Stantec
Co-author(s): Evan Davies, Cardno now Stantec

The Santa Clara River Estuary (SCRE) supports special-status fish species, including federally-endangered tidewater goby and endangered southern California steelhead. As part of the proposed reduction of tertiary-treated wastewater discharged into the SCRE under the VenturaWaterPure Program, the City of Ventura is performing monitoring studies within the SCRE to understand the fish assemblages and fish community diversity. This talk will discuss the results of past and current

monitoring of fish species within the SCRE, discuss ongoing fish survey methods including eDNA monitoring, discuss habitat preferences of focal fish species, discuss native and non-native fish species interactions in the SCRE, and discuss future monitoring efforts that will be implemented during the Pre-Construction Assessment Program (PCAP) and the Monitoring, Assessment, and Adaptive Management Plan (MAAMP) portions of the VenturaWaterPure Program.

Predicting fish assemblages in California estuaries to inform management

Author: John Olson, California State University Monterey Bay
Co-author(s): Caleb Yakel, CSUMB; Michael Biedebach, CSUMB; Michelle Tarian, CSUMB

Estuaries are critical habitat for many fish species in California, including Salmon and Steelhead. Tidal inlet bar-built estuaries are common along the California coast and are important to coastal sediment balance and controlling the depth of estuarine ecosystems. Bar-built estuaries are often managed by breaching sandbars, but the timing of when this is done is guided only by conventional wisdom and the impacts of bar opening on fish abundances is not well understood. To understand how the fish assemblage changes in response to chemical and physical changes in the estuary, including opening of sandbars, we modeled fish abundances by species in three California estuaries varying in size: Redwood Creek, the Carmel River, and the Russian River. Using both environmental factors and abundance of other fish as predictors, we developed random forest models that successfully predicted abundances of 5 fish species (coho, chinook, steelhead, starry flounder, and three-spine stickleback). Models explained 36–69% of variation in fish abundances in Redwood Creek, 33-55% of variation in the Russian River, and 93% in the Carmel River. We found that fish assemblages were most influenced by both local and upstream water chemistry and temperature, day of the year, and location in the estuary. Sandbar status (open/closed) had limited predictive ability, but management of upstream dams can potentially improve estuary conditions. To allow managers to use these models we developed a web application using Shiny to allow users to adjust parameters to see how abundances of fish change in response.

Session II – Native Fish of California Part 2 – Friday, March 3

Effects of Turbidity, Temperature, and Predation Cues on the Stress Response of Juvenile Delta Smelt

Author: Christina Pasparakis, UC Davis –Bodega Marine Lab
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The delta smelt (Hypomesus transpacificus) is a small semi-anadromous fish endemic to the San Francisco Estuary (SFE) and an indicator species of ecosystem health. Once one of the most abundant species in the SFE, the delta smelt is now on the brink of extinction. We measured whole-body cortisol prior to and following exposure to a sublethal and significant netting stress at 17 and 21°C. Understanding the magnitude and kinetics of cortisol induction in delta smelt provided valuable information to help interpret the degree of stress induced by other environmentally-relevant stressors, such as warming, reduced turbidity and predator exposure. Juvenile delta smelt were exposed to two temperatures (17 and 21°C) and two turbidities (1-2 and 10-11 NTU) for two weeks. After the first week of exposure, delta smelt were exposed to a largemouth bass (Micropterus salmoides) predator cue at the same time every day for seven days. Fish were sampled on the first (acute exposure) and final (chronic exposure) day of predator cues and later analyzed for whole-body cortisol, glucose, lactate, and total protein. Turbidity had the greatest effect on juvenile delta smelt and resulted in reduced cortisol, increased glucose and lactate, and greater condition factors. Elevated temperatures reduced available energy in delta smelt, indicated by reduced glucose and protein, while predator cue exposure had negligible effects. Multi stressor experiments are necessary to understand the capacity of delta smelt to respond to the multivariate and dynamic changes in their natural environment and results from this study should be considered for management-based conservation efforts.

Genetic species identification from formalin-fixed larval Delta Smelt (Hypomesus transpacificus)

Author: Hilary Starks, Cramer Fish Sciences

Co-author(s): Andrew Goodman, Lodi Fish and Wildlife Office; Vanessa Tobias, Lodi Fish and Wildlife Office; Chris Hart, Caltrans; Morgan Gilbert; Gregg Schummer, Cramer Fish Sciences

Although formalin is commonly used as a preserving reagent for tissue specimens, the fixation process itself damages DNA, which can be detrimental to most downstream genetic analyses. It may still be possible to confirm species identification from archived specimens by targeting short, species-specific genic regions. In this study we genetically verified species identification from 150 larval hatchery Delta Smelt (Hypomesus transpacificus) that were preserved in 10% phosphate buffered formalin and Rose bengal at room temperature (20-22°C) for up to 928 days with 50 fish per test at 611 days, 732 days, and 928 days. We targeted a region of the mitochondrial cytochrome b (Cyt-b) gene using a quantitative PCR (qPCR) assay designed to specifically amplify Delta Smelt environmental DNA (eDNA). Using this method, we were able to confirm species ID in 100% of our 150 samples, although detection strength appeared to decline over time. We hypothesized that the short DNA target size (84 base pairs) of the Delta Smelt specific qPCR assay allowed for successful identification, and we confirmed this by Sanger sequencing with the qPCR assay forward and reverse primers. To our knowledge, no other study has demonstrated close to 100% success when amplifying extracted DNA from larval fish specimens preserved for up to 928 days in formalin. We believe our findings to be of significant value to the scientific community as formalin remains commonly used as a fixative in the preservation of fish, reptiles, amphibians, and various invertebrate taxa. Additional testing with both Sanger and Illumina based sequencing methods on a subset of the larval extracts did not successfully produce positive identification.

The importance of place; Fish diversity observed using DNA metabarcoding

Author: Scott Blankenship, Cramer Fish Sciences
Co-author(s): Katie Karpenko, Genidaqs; Cheryl Dean, Genidaqs; Gregg Schumer, Genidaqs

The importance of place cannot be overstated in biology, as place often drives the principal partition in genetic variance, is correlated with abundance, and underlies biodiversity. This project describes fish biodiversity observed using DNA metabarcoding within an evolving tidal wetland engineered as a living laboratory for habitat restoration (Dutch Slough Tidal Marsh Restoration Project). DNA metabarcoding approaches were incorporated into the Dutch Slough project performance assessment, as reticulated tidal habitat is challenging to survey effectively with nets. An EDNA sampling designed was executed pre and post breaching of levees surrounding the engineered habitat exposing the habitat to the San Francisco Estuary. The fish community observed at each survey event contributes to base condition assessment of 1) fish community trends as habitat evolves over time, 2) the presences of protected, native, and non-native species, and 3) seasonal differences in habitat use. Comparing pre and post breach eDNA surveys, fish biodiversity increased within restored habitat post breach. Fish in the project vicinity appeared to colonized habitat once access was provided. Non-native species outnumbered native species by approximately 2-to-1, reflecting the background condition of the Estuary. Among the 42 fish species observed during ongoing eDNA surveys, five protected native fish species have been observed within restored habitat (Chinook Salmon, Green Sturgeon, Longfin Smelt, Pacific Lamprey, and Rainbow Trout).

Priming the Pump: Meins Landing Managed Food Web Experiment

Author: Bobbie Florres, Cramer Fish Sciences
Co-author(s): Whitney Thorpe, Cramer Fish Sciences; Kai Ross, Cramer Fish Sciences; Lis Cordner, Cramer Fish Sciences; Randall Mager, CDFW; Joseph Merz, Cramer Fish Sciences

The Department of Water Resources (DWR) has planned strategic purchases of historic San Francisco Estuary lowlands, including Suisun Marsh, with the intent to reflood such areas to promote habitat connectivity and exchange between tidal marsh and adjacent sloughs. The ultimate goal is to reintroduce habitat variability, salinity and tidal processes for the benefit of native fauna. Unfortunately, many aspects of the historic Delta landscape have been permanently lost, making it impossible to restore all natural conditions. A workable restoration alternative is to reconcile current land uses with desirable land management outcomes. These actions offer potential opportunities to recapture lost ecological functions that support threatened species through creative management of the current landscape to balance fish, waterfowl, food webs, and

human use benefits. The Meins Landing experiment was designed with this reconciliation approach in mind, by combining control of invasive yellow star thistle (Centaurea solstitialis) with floodplain activation of a retired duck club. Environmental, spatial, and biological data were collected using the passive sampling Single-Platform Aquatic Species Habitat Sampling System (Platform) in combination with drone surveys. In this presentation we will discuss how pumping water from the flooded-up island back into Montezuma Slough affected adjacent Suisun Marsh water quality, nutrient load, and biota (fish and zooplankton). We will also share observations of some of the complex environmental and biological processes that took place and recommendations for future experimentation needed to fully understand these interactions.

Exploring the reproductive biology of Longfin Smelt in the San Francisco Estuary

Author: Nick Floros, UC Davis
Co-author(s): Sami Araya, UC Davis; Tien-Chieh Hung, UC Davis; Nann Fangue, UC Davis; James Hobbs, CDFW; Richard Connon, UC Davis; Levi Lewis, UC Davis

The genetically distinct population of Longfin Smelt (Spirinchus thaleichthys) in the San Francisco Estuary (SFE) faces increasing risk of extinction. Although many studies have aimed to inform conservation and management for this species, little remains known regarding maturation and variation in its reproductive biology. Here, we assessed the ontogenetic, temporal, and spatial variation in wild Longfin Smelt using fish collected throughout the SFE between 2011–2022. Results indicate that Longfin Smelt begin to mature at ~70 mm standard length and that maturing Longfin Smelt migrate from high-salinity habitats into low salinity wetland habitats such as Alviso Marsh during the rainy spawning season (November-March). Furthermore, results indicate that female Longfin Smelt may contain 2,000–10,000 eggs and that ovaries may contain eggs at multiple developmental stages, indicative of multiple clutches and repeated spawning. Ultimately, results of maturation and fecundity analyses will be combined with otolith aging and environmental data to develop an improved understanding of the reproductive biology and population dynamics of this imperiled anadromous forage fish.

Steelhead trout (*Oncorhynchus mykiss*) egg to fry survival on a highly regulated California Central Valley River

Author: Whitney Thorpe, Cramer Fish Sciences
Co-author(s): Steve Zeug, Cramer Fish Sciences; Mike Beakes, USBR

The Stanislaus River, which drains west from the Sierra Nevada and into the Central Valley of California, historically supported a successful steelhead/rainbow trout (Onchorynchus mykiss) spawning run. Modifications to flow and addition of water management infrastructure has negatively impacted O. mykiss populations, prompting the Bureau of Reclamation to implement a life cycle monitoring program for them on the Lower Stanislaus River (LSR) in 2019. To better understand how environmental factors and management decisions might influence anadromy and adaptive potential of the existing population, the population of O. mykiss needed to be evaluated at specific life stages. One important life stage in this evaluation is egg to fry survival. In 2022, a proof-of-concept study was designed and implemented in the LSR to evaluate egg to fry survival of ~1,200 steelhead embryos. Green O. mykiss embryos from the Feather River Hatchery were put in modified Whitlock-Vibert egg incubation boxes and buried in artificially constructed redds at three sites on the river, four egg boxes per site. Temperatures were monitored to calculate the expected 50% hatch date, and the egg incubation chambers were retrieved at that time. Individuals were then identified as alive or dead, and the exact developmental stage they were in at the time of recovery. Observations from this study suggest that survival was highly variable within and between locations on the river, and between the developmental stages from fertilization to hatch. The results were then used to design a more robust study for 2023 that will focus on substrate size effects (and other covariates) with appropriate replication and power.

Drought and Fire Effects on *O. mykiss* in Southern California Streams

Author: Shelley Hunter-Shatsnider, CDFW

Southern California rainbow/steelhead trout (Oncorhynchus mykiss) within the southern California Distinct Population Segment are listed under the federal Endangered Species Act and are currently a state candidate species for the California Endangered Species Act. O. mykiss are the only anadromous salmonid native to southern California and due to

anthropogenic barriers, habitat loss, introduction of invasive species, and land use practices, have declined dramatically. Inland and coastal populations, separated by barriers to anadromy, face similar challenges to their survival (i.e., wildfire and prolonged drought) yet both remain key components of southern steelhead recovery. This presentation will discuss the California Department of Fish and Wildlife Drought Program's current monitoring methods, observations of O. mykiss within southern California streams, and rescue efforts. Case studies will outline pre- and post-fire conditions as well as current drought impacts and demonstrate the challenges and the resiliency of the species. We will review past actions taken by the department to mitigate impacts of fire and drought and explore strategies to further help the recovery of O. mykiss.

Migration fatigue modeling of a hypothetical steelhead population in the Los Angeles River

Author: Nate Butler, Stillwater Sciences
Co-author(s): Matt Drenner, Stillwater Sciences

A significant re-imagining and restoration of the Los Angeles (LA) River is underway to reconnect populations of Southern California steelhead Oncorhynchus mykiss with spawning and rearing habitat in streams within the upper reaches of the LA River watershed. In order to better estimate the relative connectivity of the river under potential restoration scenarios, a steelhead migration fatigue model for the LA River was developed. The steelhead migration fatigue model quantified the ability of a hypothetical population of migrating adult steelhead to move upstream under three flow scenarios, based on published swim speed-fatigue relationships for steelhead and simulated hydraulic conditions in a potential restoration of the LA River from the 6th Street bridge to Highway 101. Modeling indicated that 100% of the hypothetical steelhead population would be able to pass through the restored reach at 25 cubic feet per second (ft3/s) and 128 ft3/s, but only 77% of the population would pass at 830 ft3/s without any additional resting areas. Additionally, modeling provided a tool to refine potential restoration designs for steelhead by indicating where additional resting habitat was needed to improve passage at different flows. Evaluating the spatial patterns in modeled fatigue change indicated an additional 19 resting areas with a spacing of approximately 300 feet would enable 100% of the hypothetical steelhead population to pass through the restored reach at 830 ft3/s.

Temperature effects the endurance swimming performance of juvenile green sturgeon (Acipenser medirostris)

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Co-author(s): Anna Steel, UC Davis; Dennis Cocherell, UC Davis; Nann Fangue, UC Davis

Sturgeon are threatened by anthropogenic changes to river systems including water diversions, but there are no established protocols for determining entrainment risk. Previous studies on sturgeon suggest that laboratory evaluations of swimming performance are an effective way to describe susceptibility to entrainment or other passage challenges. Thus, the swimming performance of juvenile green sturgeon, Acipenser medirostris, was quantified after a 2wk exposure to two different temperatures (13 and 18°C) using fixed velocity endurance tests of water velocities ranging from 25 to 55cm s-1. Time-to-fatigue and station holding behaviours were recorded and time-to-fatigue was used to separate fish into different swimming types, sustained (>200 min), prolonged (5–200 min), rapid (<5 min), or non-swimming controls. Green sturgeon were found to have reduced endurance swimming ability upon exposure to decreased temperature compared to fish exposed to elevated temperatures. Regardless of temperature, immediately after the swim trials, juvenile green sturgeon had increased lactate and cortisol when utilizing prolonged swimming strategies compared to control non-swimming fish, rapid swimming fish, and sustained swimming fish. These results suggest that fish exposed to elevated temperatures able to sustain endurance swimming longer than fish exposed to decreased temperatures, and fish utilizing prolonged swimming were experiencing stress and relying on anerobic metabolism prior to failure. The time to fatigue data suggests that the risk of entrainment was reduced to zero at water speeds ≤ 25cm s-1 regardless of temperature exposure.

Integrating multiple surveys into a population viability analysis for native fishes of the Santa Ana River, California

Author: Brock Huntsman, USGS
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Municipal Water District; Brett Mills, Riverside-Corona Resource Conservation District; William Ota, University of California Riverside; Kurt Anderson, University of California Riverside; Fitsum Abadi, New Mexico State University

The Recovery Plan for the Santa Ana Sucker (sucker; Pantosteus santaanae) identified a need for a population viability analysis (PVA) as a tool to assess sucker extirpation risk. However, PVAs can be data intensive and are subject to multiple sources of bias as sampling methodologies and researching entities change. We compiled more than 20 years of native fish surveys that included sucker and arroyo chub (Gila orcuttii) and have used different methodologies into an integrated hierarchical multi-population PVA to estimate trends in abundance and extirpation probability of these native fishes from the Santa Ana River. Using our PVA model, we found similar patterns in sucker and arroyo chub abundance along the Santa Ana River, with the highest abundance of both species upstream of the Riverside Avenue Bridge during the early 2000s and downstream in recent years (2018-2022). Extirpation risk was estimated to be greatest near the Rapid Infiltration and Extraction wastewater treatment facility, where abundance estimates of both native fishes have been zero since 2018. Alternatively, extirpation probability was much lower downstream of the wastewater treatment facility, predicted to be less than 60% for both species during the next 100 years. As the model evolves and more data are collected, the PVA could be used as a tool to assess the effects of various management actions on Santa Ana Sucker and arroyo chub persistence.

Session III – Restoration Revisited: Lessons learned from past projects foreshadow future efforts – Friday, March 3

The evolution of salmonid spawning habitat restoration on the Lower Mokelumne River: 30 years of implementation and monitoring

Author: Michelle Workman, consultant
Co-author(s): Casey Del Real, EBMUD

The lower Mokelumne River supports anadromous salmonid populations in the Central Valley of California. Since 1993, East Bay Municipal Utility District fisheries and wildlife staff, in collaboration with state and federal fish agencies, have been working to improve the spawning environment for fall run Chinook salmon (Oncorhynchus tshawytscha) and federally threatened Central Valley Evolutionary Significant Unit (ESU) steelhead (O. mykiss) with an overarching goal to meet the Central Valley Project Improvement Act Doubling Goal targets. Over the past three decades over two million dollars have been spent to place 53,000 cubic yard of gravel and there has been an evolution of methods and applications for both implementation and monitoring. The use of best available science, paired with a well-structured long-term monitoring program, has led to a number of successful outcomes. We will highlight the methods used for restoration and monitoring, describe successes, and provide our insights on the issue of habitat degradation of these mobile habitats.

Ten Years After: Revisiting Restoration and Learning Lessons (Stanislaus: Honolulu Bar)

Author: J.D. Wilkert, USFWS
Co-author(s): Chris Hammersmark, cbec; Jason Guignard, Fishbio

We implemented a floodplain and side-channel restoration project in 2012 on the Stanislaus River. The project goals were to reduce stranding of adult salmonids in the existing side-channel and to convert perched floodplain into annually inundated habitat for rearing juvenile salmonids. A multi-year drought and beaver herbivory hampered revegetation success above the floodplain, while the floodplain facilitated natural recruitment of native vegetation. Regulatory design constraints (elderberry set-backs) resulted in a more dynamic floodplain evolution but also reduced the opportunity for additional floodplain creation (concerns over water surface elevation increases). Ten years later, gravel mobilization in the main-channel has reduced flows to the side channel under low-flow conditions. Maintenance of projects, especially gravel augmentation projects, is essential in watersheds without a suitable bedload of mobilized sediments upstream of the project site. Designing for diversity and evolution of the project as well as conducting periodic evaluations are highly desirable in river restoration, which in some instances benefit from some level of maintenance.

Clear Creek - A story of success and more potential
Author: Charles Chamberlain, USFWS

Clear Creek downstream of Whiskeytown Dam in Shasta County California has a nearly three-decade long history of restoration and monitoring. Adult salmon populations have responded favorably to the commitment of water back to the Creek for anadromous populations, channel restoration, gravel injection, and temperature management. Chinook Salmon populations in Clear Creek, especially fall-run, have largely met or exceeded creek-specific Central Valley Project Improvement Act doubling goals. Trends demonstrate that the salmon spawning in Clear Creek make up an increasingly large proportion of fish returning to spawn in natural areas of the Sacramento River Basin upstream of Red Bluff. Even so, salmon populations in Clear Creek can be wildly variable, and the juveniles produced are small such that they're highly dependent on rearing in the Sacramento River downstream of Redding. Frequent fire and sediment input impact Clear Creek habitats, and conditions in the Sacramento River and other environments influence Clear Creek populations. Floodway restoration efforts to date were largely designed for a hydrograph that included managed high flow releases that have not been realized. We believe rearing habitat in Clear Creek is limited by a channel oversized for our current flow regime that contribute to limited floodplain connectivity, and that Clear Creek could make larger contributions toward basin production goals with restoration and flow management that emphasizes floodplain connectivity.

How Monitoring and Adaptive Management improved the Trinity River Restoration Program, 2000-2022
Author: James Lee, USBR
Co-author(s): Josh Boyce, USFWS

Since 2000, the Trinity River Restoration Program has endeavored to increase anadromous fish populations through adaptively managing channel rehabilitation projects, sediment augmentation, flow management, and watershed restoration activities. Monitoring of habitat, outmigrating juvenile fish, and the movement of injected gravel has led to many changes over the last two decades. In particular, investigations of the interactions between flows and the Trinity River's physical shape (topography and bathymetry), and how these interactions translate to fish habitat, have led to new approaches in channel rehabilitation project design, post-project evaluation, and flow management. This presentation highlights how adaptive management, informed by monitoring, has led to important changes over the life of the Program.

If you build it, will they come? And how long will they stay?
Author: Joseph Mertz, Cramer Fish Sciences
Co-author(s): Kirsten Sellheim, Cramer Fish Sciences; Jamie Sweeney, Cramer Fish Sciences; Erica Bishop, Water Forum

Restoration is the process of assisting ecosystem recovery from damage or destruction. The process considers ecosystem trajectory through time with a range of development pathways progressing toward a desired recovery state. The goal is ecosystem repair with respect to its integrity and health, including ecological function, vigor, organization, and resilience. However, in regulated rivers with numerous societal demands, recovery is often impossible and, due to chronic disturbance from dam presence and operation, restoration requires maintenance of desired habitat quantity and quality in perpetuity. Therefore, to develop long-term ecological success it is imperative to track regulated river response to restoration actions and determine the longevity of successful outcomes to plan for continued maintenance. Here, we will demonstrate physical and biological response to habitat restoration focused on native Chinook Salmon and steelhead in the highly regulated Lower American River of the California Central Valley. We will describe several cutting-edge monitoring techniques as well as long-term studies tracking use of restored habitat features by spawning and rearing salmonids. We will also discuss population benefits including juvenile salmon production and benthic invertebrate colonization, and potential long-term goals for maintaining and improving river ecosystem function and target population resiliency.

Decades of river corridor restoration on a regulated California river – what has it yielded?
Author: Rocko Brown, Cramer Fish Sciences

The Merced River, California below Crocker-Huffman Dam is one the southernmost limits of Chinook Salmon (Oncorhynchus tshawytscha) in the world. Like most Central Valley rivers, this corridor has been highly altered from gold dredging, flow regulation, and agricultural development. Efforts by numerous entities including the California Department of Water Resources, United States Fish and Wildlife Service, California Department of Fish and Wildlife and the Merced Irrigation District have resulted in four completed large scale restoration projects, with more being planned. This talk will review these efforts, and where possible, share data that can inform the utility of these projects for enhancing suitable Chinook Salmon habitat and ultimately benefit population management.

A Decade of Data and Lessons Learned from Restoring a Sierra Meadow Complex

Author: David Shaw, Balance Hydrologics

Multiple agencies and other organizations have worked to restore degraded mountain meadows in California's Sierra Nevada to increase water supply and ecological resiliency to climate change and wildfire. Meadow restoration goals often relate to increasing groundwater storage and late summer baseflow, improving floodplain connectivity, re-establishing wetland and riparian functions and habitat. Balance Hydrologics, the Truckee River Watershed Council, the U.S. Forest Service, and other cooperating agencies have conducted a long-term program to monitor system response to various restoration approaches that were employed at Perazzo Meadows on the Tahoe National Forest in Sierra County, California. Prior to restoration, the channel meandered through the meadow in an incised, single-thread channel. Restoration approaches consisted of large-scale earthwork operations and wood structure placement to aggrade and revegetate the channel, spread flows across the valley floors, and re-activate relict channels. Data collected over the 10 years following implementation shows variability in system response, and we have learned that a) Initial increases in seasonal groundwater storage varied, averaging approximately 0.6 acre-feet per acre of restored meadow; b) Summer release of stored groundwater can increase late season baseflow by nearly 0.5 cfs or 1 ac-ft/day, c) channel and meadow adjustment over the decade following implementation can reduce some of the initial effects, d) wetland vegetation communities have become more vigorous. Machine learning tools are now being applied to the data to evaluate the effects of restoration on summer and drought period hydrology, offering insight to the climate change resiliency role that meadow restoration can serve.

Dry Creek (Sonoma County, CA) Habitat Enhancement Project: Results, Ratings, Lessons Learned, and Future Directions

Author: Neil Lassettre, Sonoma Water
Co-author(s): David Manning, Sonoma Water; Mark Goin, Sonoma Water; Celeste Melosh, Sonoma Water; Eric McDermott, Sonoma Water

The Dry Creek Habitat Enhancement Project is part of the Reasonable and Prudent Alternative of the Russian River Biological Opinion (RRBO). The goal of the Project is to restore six miles of juvenile coho and steelhead habitat along 14 miles of Dry Creek, a tributary to the Russian River. The programmatic RRBO outlines habitat goals (characteristics, area to be created, types of habitat) to be achieved over the life of the project, which relies on enhancing habitat through floodplain reconnection and creation of off-channel habitat.

Dry Creek Adaptive Management Plan details performance metrics, monitoring types (implementation, effectiveness, validation), scales (spatial, temporal), and rating criteria. Effectiveness monitoring focuses on the physical response to enhancement measures, while validation monitoring focuses on the biological response. Due to the expected lag time in biological response, physical response is a major driver determining short-term project success or failure.

The primary effectiveness metrics focus on optimal ranges of depth, velocity, and cover at baseflow (110-175 cfs). Sonoma Water evaluates project performance against these metrics using traditional survey and flow measurement tools to collect topographic and hydraulic data, and aerial photographs taken by drone. The data are integrated within a GIS to visualize, characterize, and quantify juvenile coho and steelhead habitat area by performance metric (singly and combined) to detect habitat change through time, and to detect physical change of in-channel and floodplain areas using geomorphic change

detection.

This presentation will distill data collected over the last seven years, discuss lessons learned, and future opportunities and challenges.

Poster Presentation Abstracts

1. Population Assessment of Unarmored Threespine Stickleback in Soledad Canyon, Santa Clara River Watershed

Author: Jennifer Pareti, California Department of Fish and Wildlife, Jennifer.Pareti@wildlife.ca.gov
Co-author(s): Andrew Aitken, CDFW; Jonathon Richmond, USGS; Adam Backlin, USGS; Eric Morrissette, USFWS; Chris Dellith, USFWS

The unarmored threespine stickleback (Gasterosteus aculeatus williamsoni; UTS) is state and federally endangered and a state fully protected species due to its restricted distribution in the upper Santa Clara River watershed, Los Angeles County. UTS is a small, scaleless fish that inhabits slow moving microhabitats in freshwater streams. Soledad Canyon, a headwater tributary in the upper Santa Clara River, is the only remaining location supporting a reliable UTS population. The Soledad Canyon UTS population has been a successful donor for wild-to-wild translocations to supplement and establish UTS populations due to its stability and low genetic variation. The UTS Recovery Team, composed of researchers and resource agencies, determined wild-to-wild translocations to be an important recovery action. However, there is concern if the Soledad Canyon UTS population could continue to act as the donor site for future translocation recovery actions without negatively impacting the population. The resource agencies developed a study to assess the population abundance and distribution across multiple reaches of Soledad Canyon to help answer that question. The study utilized a low-impact method of passive, un-baited trapping and observation to capture and record UTS across defined reaches of the stream. Size class was documented to understand reproduction and seasonality of abundance over multiple years. Our data show which reaches of Soledad Canyon contain the most stable and abundant numbers of UTS throughout the year. These data provide key information for UTS recovery management decisions including wild-to-wild translocations and emergency fish rescues due to drought and wildfires.

2. Dead Zone: Investigating the Consequences of a Hypoxia Event in the Yolo Bypass in Fall of 2021

Author: Mitch Olinger
Co-author(s): Luke Olson

An ecologically damaging phenomena that appears to be increasing in frequency in estuarine ecosystems is low dissolved oxygen resulting in hypoxia. We studied a small channel within the Yolo Bypass, known as the Toe Drain, that was hit by a long period of hypoxia following an atmospheric river event in late October 2021. Utilizing fish data from the Yolo Bypass Fish Monitoring Program (YBFMP) and continuous water quality data provided by the California Data Exchange Center (CDEC), we investigated the following question: What were the water quality and fish community responses in the Toe Drain following the atmospheric river? By comparing water quality and fish data in water year 2022 to historical data from water years 2014-2021, our results show that: (1) DO concentrations at Lisbon Weir in the Toe Drain averaged 2.06 mg/L during November 2021, dropping to a low of 0.71 mg/L on 11/19/2021, 2) there was a significant change in composition in catch noticeably in Black Crappie (Pomoxis nigromaculatus) going from a mean CPUE of 1.74 to 3.76 and White Catfish (Ictalurus catus) going from a mean CPUE of 22.31 to 0.29 shifting the dominance of catch to Black Crappie after the 2021 event. While further research is needed to identify the mechanisms responsible for the low oxygen conditions observed in the fall of 2021, long term monitoring efforts allows managers to better understand ecological responses to unprecedented events likely to become more common in the face of California's changing climate.

3. California Mitigation and Conservation Banking: How RES is contributing to Fisheries and Aquatic Resources Conservation and Recovery

Author: Amanda Casby
Co-author(s): John Lang, Caitlin Boise, and Daniel Chase

Mitigation and Conservation Banks offer effective methods for offsetting impacts to fish and aquatic habitats while also providing unique opportunities for resource conservation and recovery that may not be available with traditional restoration projects. These methods of restoration often bring private land into the conservation space that may otherwise have been excluded and emphasize the connectivity of large habitat corridors in conjunction with surrounding protected lands. These banks provide for the preservation, enhancement, and/or creation of high-quality aquatic habitat, including tidal and non-tidal wetlands, off-channel habitats, and riparian corridors, all of which are critical to the conservation of imperiled fish and aquatic organisms. The establishment of a bank involves a rigorous regulatory process that includes greater agency oversight than traditional restoration projects. In addition, banks are required to create a non-wasting endowment to fund their management in perpetuity, which typically includes regular site visits, biological monitoring, and annual reporting requirements. In this poster, we highlight several banks in California that are proposed, owned, operated, and/or managed by RES. We also share several positive outcomes of the banks, resource and species protection afforded, and challenges facing the banking process.

4. Factors that attract Yellowfin tuna, *Thunnus albacares*, to fixed fish aggregating devices (FADs) in the Galapagos Islands

Author: Sarah Moreau
Co-author(s): Jose Marin Jarrin,

The Galapagos Islands have a history of productive artisanal, recreational, and commercial fisheries. However, in 1998 the Galapagos Marine Reserve (GMR) was implemented, prohibiting commercial and recreational fishing leaving only the artisanal form, a practice known to be done by individual households using low-technology and smaller-scaled catch. Despite the size of the catch, artisanal fishing has had a significant impact on coastal resources, particularly endemic and slow growing fish. Therefore, managers saw the need to redirect fishing effort within the GMR, leading to the possible solution of incorporating fishing aggregating devices (FADs), which can attract faster growing and cosmopolitan species such as Yellowfin tuna. In 2016 four fixed FADs were deployed off the coasts of Isabela, Santa Cruz, and San Cristóbal, island, located on the central and southeast side of the GMR. These fixed FADs are buoy-like structures that were anchored to the sea floor and contained sensors with solar panels that collected total biomass of Yellowfin tuna from roughly December 24, 2017, through May 10, 2019, at depths of approximately 8.6 meters to 109.4 meters. As part of my masters project I will be (a) determining if there are spatial (FAD location, depth) or temporal (year, season, moon phase, time of day) variation of large pelagic fish biomass at Galapagos FADs, (b) exploring what environmental variables (e.g., temperature, upwelling strength, chlorophyll a, bathymetry) could have caused biomass variability, and (c) developing predictions for how the biomass will be influenced by climate change in the near future. This study is important because it will illuminate whether FADs are deemed a useful resource for attraction of these fast-growing fish and a positive redirection in fishing effort. In addition, this study will also aid predictions of how climate change and environmental variables can directly impact this species of tuna.

5. Investigating the Status of Razor Clam Populations at Clam Beach in Humboldt County, CA

Author: Gabriel Irribarren

The Pacific Razor Clam, Siliqua patula, is an important invertebrate species of sandy beach surf zone ecosystems. Humboldt County, in California, contains one of the southernmost populations. Keeping Razor Clam populations healthy is important for recreational, commercial, and cultural practices. Despite this importance, razor clams are not monitored in northern California. The main objective of this study is to evaluate the north and south populations of Razor Clams at Clam Beach in Humboldt County by comparing their abundance, length, and age between 1960 (Sims 1960) and 2022. This comparison is not exact, as Sims used live clams while I am using shells. Data is collected by carrying out 3 km long transects parallel to the

shoreline, and collecting only whole shells and half shells that include the umbo and edge. I measure the length of the whole shells (cm) and determine their age (half and whole shells) by counting growth rings that develop under the periostracum (skin) of the shell. During these walks, I also measure water temperature, sediment samples and count the number of clam fishers to explore the potential reasons for changes in the population. At present, I have carried out 2 transects and collected 131 shells. More clams were collected on the northern than southern side of Clam Beach (86 vs. 45, respectively). The length and ages of the clams varied from 8 to 14.5 cm and 2 to 6 y and were positively related to each other (n = 42, r2 = 0.66) suggesting that longer clams should be older. This next semester I will continue collecting shells, compare my data with Sims (Sims 1960), and explore if these differences correlate with the environmental variables collected. This study is important because it allows us to start monitoring an important but poorly studied species.

6. Are established morphometrics appropriate for identifying hatchery supplemented Delta Smelt?

Author: Kate Erly, USFWS
Co-author(s): Adriana Arrambide, USFWS; Lauren Yamane, USFWS

The Delta Smelt Hypomesus transpacificus (DSM), a native fish species to the San Francisco Estuary (SFE), is a federally (threatened) and state listed (endangered) species. Proper identification of DSM at all life stages is important to estimate the abundance and distribution of DSM, primary goals of the U.S. Fish and Wildlife Service's Enhanced Delta Smelt Monitoring Program. DSM are identified primarily by morphometric characteristics, as identification via genetic assay is still developing and lacks certainty. Starting in 2022, experimental releases of cultured DSM occurred and morphological differences between hatchery and wild DSM have been observed in adult specimens. Differences among larval wild DSM morphometrics have also been observed. Staff are now faced with the identification of larval fish with differing morphometrics due to wild and cultured fish parentage. To address this new challenge, we are exploring the suite of morphometrics needed to identify larval DSM. We conducted a discriminant analysis for morphometrics of larval DSM captured in 20-mm surveys to determine if hatchery larval DSM have the same morphometrics as wild DSM. Our preliminary results will improve species identification of larval DSM.

7. Parasites of Cypriniform fishes of the Santa Clara River

Author: Max Murray; Dudek

Freshwater fishes in the southwestern United States live in some of the most highly modified habitats in the country. As a result, the relatively small number of native fish species have been impacted in many ways including the introduction of nonnative fishes and their parasites. 35 Catostomus santaane (Santa Ana sucker), 61 Catostomus santaanae x Catostomus fumeiventris F2 hybrids, 18 Pimephales promelas (fathead minnow), and 214 Gila orcutti (arroyo chub) were collected and necropsied in the summers of 2017 and 2018. Ten species of macroparasites were collected from these fishes including six native and four nonnative parasites. The most abundant species of native parasite was Rhadbochona sp. while the most abundant nonnative parasite was Lernaea cyprinacae (anchor worm). The prevalence of Rhabdochona sp. was highest in G. orcutti (69%) and lowest in C. santaanae (5%). The prevalence of L. cyprinacae is highest in G. orcutti (29%) and lowest in P. promelas (5%).

8. Combining Datasets to Determine Age & Growth Rates of Juvenile Green Sturgeon in the Sacramento River

Author: Kathryn Sykes, USFWS
Co-author(s): Michael Thomas, USACE; Marc Beccio, CDFW; Josh Gruber, USFWS

The sDPS of green sturgeon, Acipenser medirostris, is federally listed as Threatened under the ESA. During their spawning migration, adults travel up the Sacramento River to their historic spawning grounds in the upper reaches. The hatched larval sturgeon remains within the upper river system, using this freshwater habitat to rear as juveniles into the early winter period, before increases in river discharge and turbidity cue their downstream migration into the San Francisco Bay Delta as age-0 juveniles. Information on the ages and growth rates of young-of-year green sturgeon in their natural environment

remain understudied. Given the relatively few data points for larval and juvenile sDPS green sturgeon within the upper and lower Sacramento River, we investigate methods for estimating age and quantifying growth rates. Sampling efforts by the USFWS and CDFW utilize numerous techniques (i.e., rotary screw traps, benthic trawls, and gill nets) to collect morphometric data over different age classes within the upper and lower reaches of the Sacramento River, and the San Francisco Bay Delta. Datasets from various studies and monitoring projects were compiled and shared between the USFWS and CDFW, and with analytical contributions from the USACE, we have identified patterns in size frequency among sDPS green sturgeon cohorts. Biometric indices suggest an estimated timing of larval emergence and a periodicity of developmental growth rates in young-of-year sturgeon. By collaborating in a multi-agency effort and sharing datasets, we have gained insight into the species' different life stages and provided each agency with a broader context for studying habitat use, growth, and migration of juveniles. Further cooperation among agencies can be used to guide future management decisions for additional monitoring needs, water conservation, and ESA-listed species conservation within the region.

9. Foster Park Fish Passage Improvement Project – Phase 1
Author: Sarah Mulder, Ventura Water

The City of Ventura completed a fish passage project at Foster Park on the Ventura River, which is a Core 1 southern California steelhead recovery stream. The project notched a subterranean diversion dam that had become exposed in previous flood events. The notch is passable by steelhead at all flow conditions. It consists of a 4-foot-wide by 1-foot-deep low flow channel set into a larger 15-foot-wide by 2-foot-deep channel, with a depressed section where jumping fish can land. Edges were chamfered to also allow for Pacific lamprey passage, protect aquatic life, and facilitate sediment and debris transport.

10. Chinook Salmon Redd Enumeration on the Lower American River using Aerial Imagery
Author: Mollie Ogaz, Cramer Fish Sciences
Co-author(s): Kirsten Sellheim. Cramer Fish Sciences; Jamie Sweeney, Cramer Fish Sciences

The American River is one of the major rivers draining the western Sierra Nevada in California and historically supported a successful Chinook Salmon spawning run. Construction of dams has drastically reduced available spawning habitat for returning adults and has contributed to population declines. The Lower American River (LAR), or the reach below Nimbus Dam, is the last accessible area for adult Chinook Salmon to spawn and is a focus for spawning habitat restoration. In order to help understand redd construction of adult Chinook Salmon in the LAR, aerial imagery has routinely been used to identify locations and enumerate redds during in the spawning season (October to January). However, there is no standardized protocol for this method and it is often done by a single reader, potentially introducing error and a false sense of precision, since there is no error estimate. Accounting for variability due to differences in reader perception is very important since the images can be difficult and subjective to interpret. Areas with high levels of superimposition, common in newly restored sections, are challenging and often the main source of disagreement when two readers analyze the same image. Having a standardized protocol for image processing, redd identification, training, and QA/QC will improve data quality and ultimately support more informed management decisions.

11. Size Selectivity Among Gears During Predatory Fish Removals
Author: Alexander Tasoff, DWR
Co-author(s): Steven Brumbaugh, DWR

The California Department of Water Resources (DWR), in coordination with the resource agencies, developed the Enhanced Predatory Fish Removal and Relocation Study. This multi-year study involves removing predatory fish from Clifton Court Forebay (CCF) to decrease the predation risk for juvenile Chinook Salmon (Oncorhynchus tshawytscha) prior to reaching the John E. Skinner Delta Fish Protection Facility (i.e., pre-screen mortality). In the 2022 season, we removed predatory fish from CCF by using four gears: a 2,000 ft beach seine, e-fishing boats, tapered hoop traps, and a Kodiak trawl. Gears were fished for a total of 52 days from January to mid-May. Crews randomly selected and measured the total length of up to 30

individuals per species in the catch. The remaining catch was subsequently sorted and enumerated by species. We conducted a post hoc analysis to determine whether different gears selected for different sized predatory fish. Samples of predatory fish from each gear were compared using multiple Kruskal-Wallis tests and summary statistics. The average total lengths of Striped Bass (Morone saxatilis) and catfish (Ictalurid spp.) significantly differed among gears (p <0.05). E-fishing frequently caught larger predatory fish, most likely due to the greater vulnerability of large fish to electrotaxis. Therefore, e-fishing may be a more effective method for removal of larger, more piscivorous fish. However, CPUE was low overall, and results of related tagging studies have shown no significant decrease in pre-screen mortality.

12. Collaborative Development of Fish Monitoring Recommendations for the Wetlands Regional Monitoring Program in San Francisco Bay

Author: Alison Weber-Stover, NOAA Fisheries
Co-author(s): Levi Lewis, UC Davis; Elizabeth Campbell, USACE; Jeff McLain, USFWS; Jeff McLain, USFWS; Zack Duckworth, Ocean Associates; Lu Wang, NOAA Fisheries; Christina Toms, Water Board; Stephen Randall, SFSU

The densely populated and highly modified San Francisco Estuary supports an astonishing mosaic of wetland habitats and species. However, 95% of the historic tidal marsh habitats have been lost or degraded, resulting in impaired ecological functions that impact humans and wildlife. In the face of a rapidly changing climate, there is an urgent need to accelerate the pace of restoration to restore and preserve these valuable habitats and associated ecological services. Long-term, standardized monitoring is also needed to better understand the spatial and temporal dynamics of aquatic species in wetland habitats of the San Francisco Estuary and quantify restoration outcomes. The Wetlands Regional Monitoring Program (WRMP) is a collaborative effort to enhance wetland restoration efforts throughout the San Francisco Bay by establishing regional-scale monitoring to better inform science-based management and restoration actions. The Fish and Fish Habitat (FFH) Workgroup of the WRMP, consisting of federal and state agencies, nonprofits, and universities, has established and completed a process for developing monitoring recommendations to inform the fisheries-related management questions of the WRMP Plan. Key steps included (a) identifying FFH-specific monitoring goals, (b) reviewing and summarizing prior monitoring efforts, and (c) collaboratively evaluating and ranking a comprehensive suite of monitoring options. The final recommendations included a suite of gears and approaches that were optimized to provide standardized long-term data on the broadest diversity of wetland fishes and associated habitats throughout the lower San Francisco Estuary.

13. Surveying an endangered species in California's eastern Sierra – methods and initial findings

Author: Kathleen Berridge, Environmental Science Associates
Co-author(s): Cameron Reyes, Environmental Science Associates; Paul Bergman, Environmental Science Associates

The Owens tui chub (Siphateles bicolor snyderi) is listed by the State of California and federal government as an endangered species. The Owens tui chub has a restricted habitat range limited to the southern portion of the Long Valley Caldera. Two of the habitats include the springs at the Hot Creek State Fish Hatchery, managed by the California Department of Fish and Wildlife and owned by the Los Angeles Department of Water and Power, and springs that feed Little Hot Creek Waterfowl Pond managed by Inyo National Forest.

Fisheries biologist with Environmental Science Associates surveyed Owens tui chubs and the habitat features in these two areas to assess potential impacts from the development of a geothermal reservoir. Baseline sampling was conducted prior to operation in 2020, and monitoring in subsequent years is ongoing to track the health of fish and their habitat.

14. Using eDNA to Detect Endangered Tidewater Goby, *Eucyclogobius newberryi*, in Northern California's Lost Coast

Author: Madison Richardson, Cal Poly Humboldt
Co-author(s): Andrew Kinziger, Cal Poly Humboldt

Understanding the processes of metapopulations and the dynamics within them, such as extinction-colonization, are critical to analyzing the evolution and conservation of these populations. This research project focuses on detecting the presence or absence of endangered Eucyclogobius newberryi in the Lost Coast in Northern California in order to assess the existence of extinction-colonization dynamics. Environmental DNA will be collected through water samples from the mouth of the Mattole River and the Bear River along the Lost Coast as these are the most likely water bodies that will support E. newberryi. These samples will be analyzed for the presence or absence of Northern tidewater gobies. Northern populations of E. newberryi were previously sampled from Del Norte to Mendocino County, yet bypassed along the Lost Coast due to difficult terrain, and were analyzed for extinction-colonization dynamics using temporal genetic analysis. No occurrence of these dynamics was found within the study, however sampling the Lost Coast for E. newberryi could alter the conclusions of extinction-colonization dynamics in the northern range of E. newberryi. For this project we plan to (1) collect water samples from multiple estuarine habitats for eDNA, (2) extract eDNA from water samples, (3) assess for presence or absence of E. newberryi, and (4) conduct genetic analysis if presence is detected. If presence is detected, their population dynamics will be studied for any existence of extinction-colonization dynamics and provide another opportunity to understand metapopulation dynamics in tidewater gobies, thereby aiding in the conservation efforts of this species.

15. Stress inhibition of fish growth: cortisol effects on insulin-like growth factor-1 (Igf1) pathways in a Pacific rockfish

Author: Henry Marden, California Polytechnic State University, College of Science and Mathematics

Fish experiencing stressful conditions increase production of the glucocorticoid hormone cortisol, which alters energy intake, turnover, and allocation with the aim of recovering physiological homeostasis. When cortisol remains elevated for a prolonged period, however, those stress-induced changes in energy allocation impair fish growth. As in other vertebrates, the provisioning of energy toward growth in fish is regulated by the growth hormone (GH)/insulin- like growth factor-1 (Igf1) endocrine system. While it is known that cortisol inhibits anabolic growth processes in part via changes in GH/Igf1 signaling, it is not fully clear in fish which components of GH/Igf1 pathways are regulated by cortisol during the stress response. Here, we explored how cortisol influences the GH/Igf1 system in blue rockfish (Sebastes mystinus) by treating adult fish with exogenous cortisol and then examining the effects on Igf1 signaling pathways. Rockfish treated with cortisol experienced a decline in plasma Igf1 concentrations despite no change in levels of igf1 gene transcripts in liver, the primary tissue of Igf1 hormone synthesis. Cortisol-treated rockfish also showed higher liver gene expression for Igf binding proteins (Igfbps) 1a and 1b, two transport proteins that inhibit Igf1 stimulation of somatic growth. Cortisol-treated fish also expressed reduced mRNA levels of Igfbp3a, which promotes growth by facilitating Igf1 transport. These findings point to a role for cortisol-mediate modulation of Igfbp expression as a mechanism underlying growth inhibition in rockfish experiencing stressful conditions.

16. Juvenile Chinook Salmon Life History Variation and Phenotype Success on The American River

Author: Jamie Sweeney, Cramer Fish Sciences
Co-author(s): Anna Sturrock, University of Essex, University of California Davis; Kirsten Sellheim, Cramer Fish Sciences; George Whitman, University of California Davis; Joseph Merz, Cramer Fish Sciences, University of California Davis; Rachel Johnson, University of California Davis, NOAA

Chinook Salmon exhibit complex life histories shaped by a variable array of environmental conditions. For instance, fall run juveniles in the California Central Valley, typically rear in natal streams for 2-4 months before migrating to the ocean; however, winter and spring flows are often coupled with large fry pulses. As survival is typically correlated with body size, these fry are generally assumed to perish; however, this has not been explicitly tested due to the limitations of tagging small fish. To address this question, we collected otoliths from adult Fall-run Chinook Salmon carcasses with adipose fins intact (unclipped) on the Lower American River between 2014 – 2021. We analyzed data from 2014 – 2017 using otolith 87Sr/86Sr and radius measurements to reconstruct the origin and early life histories of spawning (i.e. "successful") adults. Two dominant migration strategies were observed in these cohorts: 1) non-natal rearing: early dispersal from the natal stream as newly emerged fry then rearing in the freshwater Delta before entering the ocean, or 2) natal rearing: rearing in the natal stream then emigrating rapidly to the ocean as smolts. Frequencies of other life history strategies varied among cohorts and

water year types. In addition, we observed that a high percentage of the unclipped adults were of hatchery origin in the 2014-2017 dataset. To prevent unnecessary cost and effort associated with processing and analyzing hatchery origin fish otoliths for the 2018-2021 samples, we are using diet isotopes recorded in eye lenses to screen out unclipped hatchery origin fish before preparing otoliths. In a changing environment, management actions that promote viable and resilient fish populations require multi-tool approaches to quantify and monitor processes that support stock diversity.

17. From Eyes to Origin: Using Eye Lenses to Differentiate Hatchery vs. Wild Chinook Salmon

Author: Matthew Enard, UC Davis
Co-author(s): Jamie Sweeny, Kramer Fish Sciences; Anna Sturrock, University of Essex; Carson Jeffres, UC Davis Center - for Watershed Sciences; Rachel Johnson, UC Davis Center For Watershed Sciences/NOAA NMFS; Miranda Bell-Tilcock, UC Davis – Center for Watershed Sciences

In the California Central Valley (CCV), hatchery-origin Chinook Salmon (Oncorhynchus tshawytscha) and wild-origin Chinook Salmon are difficult to differentiate due to only a fraction of the hatchery population being tagged. The majority of juvenile and adult fall-run Chinook salmon surveyed in rivers could be unmarked hatchery fish, making investigations linking environmental conditions in the freshwater to the success of progeny from naturally-spawning salmon difficult to study. The diet differences ($\delta^{34}S$) between hatchery and natural-origin juveniles is recorded in archival tissues, such as otoliths. Young wild salmon feed on a diet predominantly of freshwater invertebrates and young hatchery salmon consume feed that is predominantly marine based protein until they are released. Here, we explore the extent to which $\delta^{13}C$, δ14N and $\delta^{34}S$ in the early formation of fish eye lenses can be used as a rapid method to assess the source origin of salmon in adult carcass surveys.

We tested two different lens peeling methods referred to as "high-resolution" and "low-resolution". High-resolution involved peeling every individual eye lens laminae and analyzing their isotopic values while low resolution involved testing the portion of the lens between 0.8mm and 1.2mm in diameter. We found that $\delta^{34}S$ isotopes were best at discriminating between hatchery and wild fish compared to $\delta^{13}C$ and δ14N. Our study also found that the low-resolution method was both accurate and cost efficient in differentiating hatchery vs wild origin. We then applied our low-resolution method and our understanding of $\delta^{34}S$ isotope values to identify hatchery and natural-origin adults spawning on the lower American River. This method in combination with otoliths will allow for accurate reconstructions of the growth, survival, and life history diversity of naturally-spawned salmon linked to conditions on the freshwater landscape.

18. Hatch date distributions and spawn timing success in winter run Chinook salmon in a changing climate

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Sacramento River Winter-Run Chinook Salmon (Oncorhynchus tshawytscha) are blocked from their historical spawning habitat that provided their eggs with cold reliable water in the summer. They now spawn downstream of Shasta Dam leaving their eggs vulnerable to lethal water temperatures, especially during droughts. It is unclear whether water operations from Shasta Dam influences the survival of eggs that are deposited early versus later in the summer. Otoliths (fish earbones) keep a chronological record of the age of a fish and visual marks associated with key life stages transitions (hatching and exogenous feeding). There are visual increments between the hatch and exogenous feeding landmarks but their accuracy as a chronometer of age has not been previously validated. In order to estimate the hatch dates for wild-caught fish, we counted the number of increments between hatch and exogenous feeding in sixteen juvenile fall-run Chinook salmon from Coleman National Fish Hatchery that had known ages and transition days. The average number of increments

counted was 29.63 ± 4.91 and is within error of the actual 30 days observed between these two stages in the hatchery. Next, we back-calculated hatch dates from otoliths in wild-caught fish that perished at Red Bluff Diversion Dam (RBDD) during the 2021 outmigration year. We provide the observed hatch dates and ages for the juveniles that survived to RBDD. This observed hatch date distribution will be compared to the predicted distribution based on redd and carcass survey spawn dates and degree day calculations to reveal the magnitude and direction of selection that occurred based on the time/location of egg incubation, hatch, and early life in the river.

19. The Sampling Platform: A Standardized Passive Sampling Method for Effectively Monitoring Complex Habitats

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The Sacramento-San Joaquin Delta is California's largest and most important freshwater estuary comprised of many habitat types. Sampling the variable and complex habitats characteristic of this type of ecosystem presents unique challenges that can make studying them difficult if not impossible. Traditionally, multiple sampling methods would be employed (e.g., seining shallow nearshore habitats and trawling deeper pelagic habitats), but these are not comparable to each other for analysis. In response, the Sampling Platform, an integrated aquatic species and habitat sampling system, was developed. It is a novel sampling method that allows for optimization across habitats in a variety of conditions, providing the ability to make comparisons across habitat types (e.g., open water, nearshore, or tidal). The Sampling Platform effectively samples fish and invertebrates and reveals habitat associations while having minimal handling and take of organisms using a pass-through video chamber. Dutch Slough, a large tidal marsh restoration in the Sacramento San Joaquin Delta was sampled with the Sampling platform in a BACI (before-after-control-impact) study design to test changes in aquatic community and habitat use due to large scale ecosystem changes. Historically used for grazing and dairy operations, the breaching of 3 levees would create thousands of acres of habitat for native fish. The Sampling Platform adapted to unique situations such as pre-breach sampling in sloughs, post-breach sampling in narrow channels, and tidally changing depths throughout the sites. Utilization of the Sampling Platform in such a diverse ecosystem allowed us to collect data which is easily comparable pre and post restoration.

20. Stressed Out: Longfin Smelt & their physiological response to changes in turbidity and temperature

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Longfin smelt (Spirinchus thaleichthys) are widely considered an indicator species and over the past 50 years, threatened populations in the San Francisco estuary have decreased to less than 1% of historic population sizes. Water diversions and climate change have significantly altered longfin smelt habitat contributing to population declines. Remaining populations of this chronically understudied species must deal with ongoing changes to their ecosystem, including higher temperatures, reduced turbidities, greater prevalence of invasive species, decreased freshwater outflows, and increased contamination. With the goal of better understanding their physiological responses to both changes in turbidity and temperature, we exposed juvenile longfin smelt to two temperatures (11 & 14C) and three turbidities (0-1, 3-4 & 10-12 NTU) for a month. After two and four weeks of exposure, experimental fish were sampled and later analyzed for whole-body cortisol, glucose, lactate and total protein. CTMax trials began around a month after experiment inception and indicated that fish raised at 14C had both a significantly higher CTMax and better CTMax survival than those raised at 11C, while turbidity had no effect on CTMax for fish in either temperature treatment. Measuring the response these fish have to stress in different conditions will help us better understand their ideal ecological parameters. This data can inform ongoing aquaculture efforts to rear these fish in captivity and also conserve and protect this threatened species and the habitats within which they reside.

21. Assessing biodiversity in Northern California Marine Protected Areas using environmental DNA

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Environmental DNA (eDNA) metabarcoding is a sensitive and non-invasive approach for marine biodiversity monitoring, and can detect species not captured using other methods. The full capabilities of this emerging method for assessing Marine Protected Area (MPA) efficacy in Northern California are poorly characterized. We collected samples from tanks housing Northern California marine fishes and from field sites paired with the California Collaborative Fisheries Research Program (CCFRP), an annual community angling survey used to evaluate MPAs. We used a multi-locus eDNA metabarcoding approach to identify fish species, with a focus on rockfish (Scorpaenidae: Sebastes spp.). Nineteen species were identified in the tank samples: 7 rockfish, 6 Scorpaeniforms (Gasterosteidae, Hexagrammidae, Pholidae, Stichaeidae), 3 surfperch (Embiotocidae), 2 flatfish (Paralichthyidae, Pleuronectidae) and 1 blenny (Clinidae). Four of 11 rockfish species listed as present in the tanks were not identified by eDNA. In addition, 4 of the 11 rockfish species had a barcode sequence identical to at least one other species. Cabezon (Scorpaenichthys marmoratus), a key species in coastal Northern California, was listed as present in the tanks, but not identified by eDNA; preliminary analysis does not indicate a methodological bias (i.e., significant mismatch in primer regions). These results show that eDNA metabarcoding can provide species-level identification of taxonomically diverse fishes in coastal Northern California. Apparent limitations of this method include lack of taxonomic resolution for some closely related rockfish species and potential false negative detections. Ongoing work will evaluate additional primer sets and analyze field samples paired with the CCFRP angling surveys.

22. Searching for signatures of selection in gametophytes of the giant kelp Macrocystis pyrifera

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The giant kelp Macrocystis pyrifera is noteworthy for forming expansive underwater "forests" along the western coasts of the Americas and the higher latitudes of the Southern Hemisphere (Graham et al. 2007). Due to its large size (reaching 40m or more above the seafloor) and growth habit, M. pyrifera populations can exert influence on local water movements, light and nutrient distributions, and sedimentation while forming a complex habitat for other marine organisms; as such, it is considered a keystone species (Bushing 2000; Butler et al. 2020).

M. pyrifera struggles to survive in environments above 20°C and is therefore vulnerable to rising ocean temperatures caused by climate change (Butler et al. 2020). Short-term events such as marine heat waves can have dramatic effects including population collapse (Cavanaugh et al. 2019). Identification of genes conferring thermal tolerance is therefore a matter of urgency for conservationists.

If such mutations are present in a population, they may cause a selection sweep: a phenomenon in which neutral alleles that are in close proximity to a favorable allele "hitchhike" along, causing a measurable loss in genetic diversity along a section of genome surrounding the locus of interest (Schaffner and Sabeti 2008; Booker et al. 2017).
One candidate population near Newport Harbor has been identified for analysis based on its health relative to nearby populations (N. Caruso, Get Inspired, private communication). Given the selective pressures previously discussed, it is possible that a mutation or favorable allele exists in the NH population conferring a reproductive and/or survival advantage.

23. Do we need a bigger boat? - Comparing the catch efficiency between 6-pack vessels and party-boats

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The California Collaborative Fisheries Program (CCFRP) was created in 2007 by Moss Landing Marine Laboratories and Cal

Poly, San Luis Obispo and has been a key tool to monitor local marine groundfish populations inside and out of Marine Protected Areas for yearly assessments and monitoring of the ocean floor. Aside from yearly monitoring assessments, the program gets people excited to support fisheries management by utilizing recreational anglers and captains to collect the data on their own home waters. The North-Central chapter of CCFRP, run out of UC Davis' Bodega Marine Lab (BML) has been with CCFRP since 2017 and since then has exclusively chartered a 53-foot fishing vessel, the New Captain Pete, out of Half Moon Bay to conduct research. During our most recent field season in the fall of 2022, the BML chapter set out to adapt the program to incorporate smaller local fishing charters in addition to the standard larger vessel from Half Moon Bay, in an effort to take advantage of sporadic weather windows and get more engagement from the local fishing community. Using this year's catch data from the Stewarts Point and Bodega Head State Marine Conservation Areas we present and compare how vessel size and type affected our ability to estimate stock assessments. This analysis will help inform future CCFRP field sampling efforts and assure that we are doing the best we can to steward our natural resources.

24. Growth and food resources for Winter run Chinook salmon reintroduced to the McCloud River after 70 years

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Consecutive droughts in California created dangerously warm summer conditions for endangered Winter-run Chinook salmon eggs below Shasta Dam motivating urgent actions to reduce their risk of extinction. Approximately 40,000 fertilized winter run eggs representing ~80 genetic families were reintroducted to their ancestral waters in the McCloud River in early June of 2022 marking a historic return of a culturally important species to the Winnemem Wintu. For thousands of years, winter run laid their eggs during the summer months in the cold and reliable spring-fed water emanating from the volcanic soils of Mt. Shasta before Shasta Dam blocked their passage for 70 years. With the return of winter run to their ancestral habitat, efforts were initiated to understand the current food resources, fish growth, and survival. We developed a comparative time series of the available food from invertebrate samples collected at Ah Di Na monthly from September-December 2022 with previously published studies from 1974 and 2013. We conducted a concurrent in-situ enclosure study at the point of reintroduction of newly emerged fry into the McCloud River to assess early life-stage growth of a subset of the winter-run juveniles over 6 weeks. Apparent growth and survival of the reintroduced winter-run was assessed via individuals caught in a rotary screw trap located 20 miles downstream at the confluence with Shasta Reservoir. Our investigation of the invertebrate food resources and assessment of juvenile growth and survival in the McCloud River provides critical information needed for winter-run recovery.

25. Impact of Large Scale Habitat Restoration on Non-native Juvenile Salmonid Predators

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Historic mining operations heavily altered many of the rivers within California's Central Valley, increasing suitable habitat features for non-native fish species. Predation by non-native piscivorous fish species is hypothesized to be one of the major factors contributing to population decline of native salmonids in California. Located on the Lower Yuba River in northern California, the Hallwood Project Site encompasses a large area of mining remnants, creating slow-moving, deeply channeled backwater features capable of maintaining predator populations. The restoration project converted backwater conditions at the site to the side channel habitat favorable for juvenile salmon rearing. A Before-After-Control-Impact study design was implemented to document restoration effects on fish communities and predation. Seine surveys were conducted in tandem with a mark-recapture study of juvenile hatchery Chinook salmon to estimate non-native predator abundance and to sample predator stomach contents. Although predators decreased at both sites post-restoration, the decrease was more

pronounced at the Project site where no predators fish were observed post-restoration. Few instances of salmonid predation were directly observed, but anecdotal observations suggest predation remained high at the Control site. Stomach contents of several non-native fish species (sunfish, black bass) overlapped with invertebrate prey taxa observed in Chinook Salmon stomachs, suggesting potential for competitive interactions in addition to direct predation. Preliminary results suggest the Project has successfully reduced habitat suitability for salmonid predators at the Project site. Three additional years of monitoring are planned to document predation across a range of conditions.

26. Contaminated or Conserved: Experimentally assessing the effects of different chemical fixatives on otolith appearance, otolith microchemistry, body morphometrics, and tissue histology

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When preserving specimens of endangered species, it is vital to have reliable methods that can satisfy multiple research needs from a limited supply of wild individuals. Key considerations include the effects of preservation methods on body size, otolith structure, and otolith chemistry. Here, we experimentally tested how preservation in four different fixatives (95% ethanol, 100% ExCell Plus, 10% buffered formalin, and liquid nitrogen) affected the weight, length, otolith structure, and otolith chemistry of endangered Delta Smelt (Hypomesus transpacificus) across four time increments (1 week, 1 month, 6 months, and 1 year). Our results demonstrate that preservation in ethanol led to significant declines in body weight, minimal reduction of body length, and effective preservation of otoliths. Formalin gradually increased body weight, slightly reduced body length, and degraded otoliths. Excell Plus reduced body weight, slightly reduced body length, and severely eroded the otoliths. Finally, liquid nitrogen exhibited little effect on body weight, slightly reduced body length, and preserved the structure of the otoliths similarly to those fixed in ethanol. The chemistry of otoliths preserved in liquid nitrogen and ethanol were most similar to controls, whereas those preserved in ExCell Plus exhibited significant degradation and abnormal chemistry within 1 month of fixation. Our results highlight key tradeoffs between fixative choice, with important and conflicting tradeoffs between those that better preserve calcified versus soft tissues.

27. California Leopard Shark Parturition through Stable Isotopes

Author: Russel Ly
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The California coastline has been a critical habitat for many elasmobranchii (i.e., sharks, skates, and rays). This includes California's native Leopard Shark (Triakis semifasciata), which utilizes estuaries and bays as nursery habitat. Energy flow from pregnant ovoviviparous Leopard Shark females to their offspring in the Californian bays and estuaries has yet to be explored. Stable isotopes (e.g., δ13C and δ15N) have been used as tracers for nutrient and energy flow within trophic systems. To understand energy flow between pregnant female Leopard Sharks and their respective developing embryos, two pregnant females were collected and dissected for muscle from Tomales Bay and south San Francisco Bay (n=2). Between the two females, nineteen and sixteen formed embryos were collected and dissected for muscle, respectively (n=35 total). Muscle biopsies were lipid and urea extracted before being freeze dried and analyzed for δ13C and δ15N using an Elemental Analyzer coupled to an isotope ratio mass spectrometer. Similar δ13C values were observed between the pregnant female and respective embryos, while embryos were observed to have higher δ15N values than their respective mother. These results will aid in our understanding of maternal to offspring energy transfers in sharks and their conservation.

28. Co-occurrence of juvenile white shark (Carcharodon carcharias) aggregations and recreationally important fishes detected by environmental DNA

Author: Zachariah Merson - CSULB
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Juvenile white sharks (Carcharodon carcharias) aggregate at particular beaches along the Southern California Bight coastline. Environmental factors contribute to aggregation site selection, but the effects of prey community are unknown. We use environmental DNA, specifically metabarcoding, from water samples at aggregation and non-aggregation sites to compare the relative biomass of potential prey teleosts. Two current and two former aggregation sites were measured for May and June. DNA from the 12S gene sequences were amplified using the MiFish-U/E primer pairs. Raw sequences were processed in R with the dada2 package and a coastal California reference library. 70 operational taxonomic units at the family level or below were detected across all sites. Some of the species detected are of recreational importance (e.g. Paralichthys californicus, Sciaenidae, Sebastinae, Paralabrax spp.) and are common in aggregation sites, suggesting they may be prey species for juvenile white sharks. While many species were common across all sites, community composition between months and sites differed significantly. Understanding the co-occurrence of juvenile white shark aggregation sites and recreational prey fishes helps to identify areas where the risk of incidental white shark catch is possible. Data describing the overlap between white sharks and recreational fisheries is necessary for more effective management of white sharks as a protected species in California as well as targeted prey species.

29. The Lower Tule River Native Aquatic Species Management Plan: Small Rivers can Provide Big Habitat for Native Species

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The Tule River is a geologically dramatic watershed draining the west slope of the southern Sierra Nevada into the San Joaquin Valley near Porterville, California. Due to its small size relative to other Sierra Nevada watersheds or perhaps due to cultural factors such as low socioeconomic wealth in the surrounding area; the biological and recreational value of aquatic resources in Tule River may be under- appreciated. Southern California Edison has conducted monitoring of aquatic and riparian species in the Lower Tule Project area since 2007. Long-term data trends indicate that the Tule River continues to provide important habitat for western pond turtle (Actinemys marmorata), native fish, benthic macroinvertebrates, and riparian communities. Furthermore, the Tule River provides an abundant managed rainbow trout (Oncorhynchus mykiss) fishery and some of the best swimming holes in California. Innovative studies to document the distribution of foothill yellow-legged frog (Rana boylii) in the watershed are ongoing.

30. Protecting Southern California steelhead from extinction with landscape level actions

Author: Russell Marlow, CalTrout

Southern California steelhead, federally listed as endangered in 1997 and state listed as a candidate species in 2022, face immense challenges to their long-term survival. This species is a key indicator of the function and integrity of Southern California coastal watersheds. Southern steelhead are culturally significant to tribal communities. They are central to the long-term survival of steelhead on the west coast of North America in the face of accelerating climate crisis impacts. CalTrout has developed a landscape level conservation program with the goal of recovering resilient Southern steelhead populations in Southern California. We have advanced this goal through leadership of watershed restoration projects, coordinating restoration efforts through regional coalitions and advocacy for fully warranted species protection at the state level. CalTrout is currently leading the Santa Margarita Bridge Replacement, I-5 Trabuco Fish Passage Project, Harvey Diversion Fish Passage Remediation, Rose Valley Creek Restoration Project. These projects put in place nature-based solutions which pivot the landscape back to process. The Southern Steelhead Coalition and Santa Clara River Steelhead Coalition provide a stakeholder forum to increase the pace and scale of restoration projects. Landscape level change can be achieved through statutory protections as well. CalTrout has led the effort presently in front of the Fish and Game Commission, with a broad coalition of partners, to fully protect this iconic species under the California Endangered Species Act. These efforts provide species protection and ecosystem resiliency, while improving the infrastructure essential for coastal community resilience to impacts of climate crisis.

31. Developing otolith tools for salmonid species identification from archaeological sites

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Our current framework for recovering salmon in California is based on data collected after significant population declines and extirpation from large fractions of historic habitat. Consequently, long-term pre-decline data are needed to better understand the effects of climate change and anthropogenic alterations and degradation in the San Francisco Estuary and the Central Valley. Samples collected from archaeological sites can provide insights into key life history metrics of salmonids, but methods first need to be evaluated before they can be broadly applied. Here we present initial results in developing otolith tools to reconstruct Chinook Salmon life histories using archaeological samples. We test life history reconstruction using otolith morphometrics. Specifically, this study aimed to reconstruct fish otolith shape, size and identify salmonid species based on otolith morphometric data.

To first evaluate salmonid species identification, based on morphology of otoliths in archaeological sites, we built a reference collection of salmonid otoliths from the Pacific Northwest. We found distinct inter-species characteristics in otolith shape that reliably identify Chinook salmon. Furthermore, we show otolith length and weight are accurate predictors of fish size, with Chinook salmon having the heaviest and largest otoliths. To dive deeper into salmonid species identification capabilities, we recreated the mean shape of otoliths from different archived samples of Chinook Salmon, Coho Salmon, and Steelhead fish, using the ShapeR software package on the R platform from different populations as a classification tool. Our future applications include evaluating life-history reconstruction using otolith morphometrics, stable isotope analysis (SIA), and ancient DNA (aDNA).

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

2023 Meeting Program

Your 2023 Planning Committee, and Program Subcommittee, hope you will value our efforts to combine information into this document.

2023 Program Subcommittee

Miranda Bell-Tilcock
Eva Bush
Kelly Souza

Thank you for another great meeting and we'll see you at the 2024 Cal-Neva AFS Meeting in Redding, CA