



2026 CONFERENCE

Oral Abstracts

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MONDAY, SEPTEMBER 28, 2026 - SESSION 01 · 5 PRESENTATIONS

Data to decisions: Tools to support management despite uncertainty



Speakers: Ash Zemenick, Delta Stewardship Council; Abby Lawson, U.S. Geological Survey New Mexico Cooperative Fish and Wildlife Research Unit; Brian Healy, U.S. Geological Survey Southwest Biological Science Center; Corey Phillis, The Metropolitan Water District of Southern California; Laura McMullen

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Synthesizing 15 Years of Independent Scientific Peer Review Informing Delta Management



Independent scientific peer review is an essential tool to ensure the quality and integrity of scientific information used to inform natural resource decision-making. The Delta Stewardship Council's Delta Science Program (DSP) is a leading coordinator of peer review in the Sacramento-San Joaquin Delta (Delta). Since 2010, the DSP has coordinated over 38 independent review and advice efforts on topics including water operations, fish, habitat restoration, modeling, and monitoring. The goal of this study is to synthesize the key recommendations put forth by DSP peer reviews to understand major themes and trends in peer review recommendations for Delta science and management.

DSP staff read 47 documents corresponding to 38 completed peer reviews to identify the key recommendations put forth by the review panelists. Key recommendations include any recommendation that was overtly emphasized through repetition, language, and inclusion in the report's executive summary.

Then, conventional qualitative content analysis was utilized to classify key recommendations to inductively derived themes describing the nature of the recommendation. Two staff independently assigned a theme to each key recommendation, and upon disagreement, came to final consensus on a single final theme. We analyzed this data to determine the most common themes of recommendations, whether themes have changed through time, and factors that influence themes (e.g. public input, topic of review, etc.).

The 38 peer reviews contained 763 key recommendations that were assigned to 13 themes. The five most common key recommendation themes were Methodology Revision, Conduct an Additional Study, Provide Further Explanation, Perform an Additional Analysis, and Refine Adaptive Management. Further results will be shared identifying the factors that influence key recommendation themes of DSP peer reviews to find potential science and management gaps in the Delta, and to inform the DSP peer review process.

Speaker: Ash Zemenick, Delta Stewardship Council

Co-authors: Rachael Klopfenstein, Delta Stewardship Council; Brayden Wiley, Delta Stewardship Council; Dylan Stern, Delta Stewardship Council; Hollis Jones, Delta Stewardship Council; Kim Luke, Delta Stewardship Council; Elizabeth Brusati, Delta Stewardship Council; Lisamarie Windham-Myers, Delta Stewardship Council

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Constructed value of information to prioritize critical uncertainties for water management in the San Francisco Bay Delta watershed



Uncertainty is a common impediment to decision making in natural resources, though some uncertainties, if resolved, are more likely to improve management outcomes than others. Constructed value of information (CVol) is a newly developed decision analysis tool that prioritizes alternative uncertainties using three simple attributes: the magnitude of the uncertainty, the likelihood that resolving the uncertainty will lead to improved management outcomes, and the feasibility of reducing the uncertainty through research and monitoring.

Each attribute can be elicited from experts or stakeholders in participatory settings using a simple, customizable rubric tailored to the decision problem.

CVol results are then visualized to highlight tradeoffs among attributes in a transparent way that is easy to interpret. Here we describe a novel use of CVol, for identifying research topics to be included within a request for proposals.

The sponsoring agency, State Water Contractors, is a nonprofit organization that seeks research projects that could result in improvements to the reliability of the water deliveries to municipalities and the status of imperiled fishes in the Bay Delta System. Using these objectives, we worked with stakeholders and subject matter experts to elicit a set of alternative uncertainties from subject matter experts that were prioritized using CVol.

Speaker: Abby Lawson, U.S. Geological Survey New Mexico Cooperative Fish and Wildlife Research Unit

Co-authors: Corey Phillis, The Metropolitan Water District of Southern California; Darcy Austin, State Water Contractors (SWC); Brian Mahardja, US Bureau of Reclamation

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Value of Information Analysis to Prioritize Research to Improve Delta Smelt Conservation Outcomes– How Much Does Uncertainty Really Matter?

Natural resource managers often face difficult resource allocation problems – they may allocate their limited resources to research, or direct resources towards on-the-ground conservation actions. Research becomes particularly relevant when reducing sources of uncertainty leads to different management decisions and improved outcomes. Structured decision-making and value of information analysis (VOI) can be used to quantify the value of resolving uncertainty to improve outcomes.

We used these tools to assist the California Department of Water Resources (DWR), California Department of Fish and Wildlife, and State Water Contractors in prioritizing research for Delta Smelt (*Hypomesus transpacificus*) during Spring 2026. We identified Delta Smelt population growth, water availability, and implementation costs of non-flow actions as objectives for the analysis.

Ten alternatives were analyzed including combinations of summer or fall flow actions, operations of salinity control gates, aquatic weed removal, and wetland management to enhance prey production.

Using expert elicitation, we identified and weighted sources of structural or parametric uncertainty, including (1) sensitivity of Delta Smelt growth to monthly versus daily temperature variability, (2) contemporary population demography, and (3) variation in food quality. Consequences of the alternatives were based on known costs of implementation of non-flow actions, and results from a Delta Smelt individual-based model and a DWR water planning model. After eliciting objective weights from each organization, we scored alternatives and calculated VOI, which were sensitive to the organizations' objective weights.

For this hypothetical decision context, VOI indicated <1% improvement in management outcomes would be expected through additional research. Our results are consistent with other recent analyses, indicating values tradeoffs may be more important than resolving uncertainty to improve outcomes for Delta Smelt. <1% improvement in management outcomes would be expected through additional research. Our results are consistent with other recent analyses, indicating values tradeoffs may be more important than resolving uncertainty to improve outcomes for Delta Smelt.

Speaker: Brian Healy, U.S. Geological Survey Southwest Biological Science Center

Co-authors: Brock Huntsman, US Geological Survey, California Water Science Center; Matthew Young, U.S. Geological Survey

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

When does monitoring pay? Linking restoration monitoring design to population outcomes for Winter-run Chinook Salmon

Habitat restoration is a primary strategy for recovering threatened and endangered salmonids, yet the ecological benefits of restoration, particularly on juvenile survival and population dynamics, are rarely known prior to deciding if and where a restoration action should occur.

Monitoring can reduce this uncertainty, but at the expense of limited resources, and its value depends on whether the monitoring generates information that would change the restoration decision. We applied a value-of-information framework to quantify the decision-relevant value of monitoring the juvenile salmon survival response to freshwater habitat restoration for endangered Sacramento River winter-run Chinook salmon. Using the Winter-run Chinook salmon Life Cycle Model (WRLCM), we address four linked questions.

First, what is the maximum decision-relevant value of resolving uncertainty about restoration effectiveness, and how does that value depend on prior beliefs in the competing hypothesized benefits of restoration on juvenile survival?

Second, how does monitoring value change as a function of monitoring accuracy and prior state of knowledge?

Third, what study designs (i.e. sample size, detection rate, life-stage monitored) are required to generate decision-relevant information?

And fourth, how does monitoring value evolve over time as data accumulate, and what does that trajectory imply about when monitoring is no longer needed?

Together, our analyses link monitoring design to population outcomes and management choices, providing a quantitative and generalizable framework for if—and how much—to invest in monitoring management actions, and how long the monitoring investment is warranted.

Speaker: Corey Phillis, The Metropolitan Water District of Southern California

Co-authors: Ann-Marie Osterback, Fisheries Collaborative Program, University of California, Santa Cruz; Noble Hendrix, QEDA Consulting LLC

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Applying Ecosystem Diagnosis and Treatment (EDT) to the Bay-Delta: A Spatially Explicit Framework for Integrated Estuary Management



The Bay-Delta is a system defined by rapid environmental change, competing water demands, and the need to balance ecosystem resilience with human use. Addressing these challenges requires tools that integrate across disciplines, spatial scales, and knowledge systems. This work explores the potential application of the Ecosystem Diagnosis & Treatment (EDT) model as a unifying framework to support system-wide understanding and collaborative decision-making in the Bay-Delta.

EDT is a spatially explicit, habitat-based fish model that evaluates how environmental conditions influence species performance across interconnected aquatic systems.

It integrates system geometry, environmental attributes, and species life history trajectories to generate population-level metrics that align with NOAA's viable salmonid population metrics including abundance, productivity, and diversity. Building on prior applications in west coast watersheds and recent extensions into estuarine environments, we outline an approach for representing Bay-Delta habitats in the model, including tidal wetlands, distributary channels, and freshwater-estuarine transition zones.

We demonstrate how EDT can be used to evaluate restoration scenarios, climate change projections, and management tradeoffs, linking spatial habitat conditions to population outcomes. The framework enables comparison of alternative futures and identification of limiting factors across a highly modified and dynamic system. EDT has the potential to bridge disciplinary silos by providing a shared platform for exploring uncertainty, assessing tradeoffs, and integrating diverse data sources. By translating habitat conditions into population-relevant outputs, EDT supports more transparent and collaborative decision-making.

Speaker: Laura McMullen

Track: Decision Science & Adaptive Mindsets in a Dynamic System

MONDAY, SEPTEMBER 28, 2026 - SESSION 02 · 5 PRESENTATIONS

Foundations of the food web: Understanding phytoplankton and microphytobenthos across managed aquatic systems



Speakers: Kyle Leathers, U.S. Geological Survey; Schuyler Nardelli, U.S. Geological Survey, California Water Science Center; Timothy Mussen; Emily Richardson, CA Department of Water Resources

Track: Ecology, Food Webs, & Changing Ecosystems

Right place at the right time: Drivers of Sacramento-San Joaquin Delta phytoplankton across space-time

Understanding controls of phytoplankton in the Sacramento-San Joaquin Delta (Delta) is important given their ecological role in food webs and their potential to produce cyanotoxins, but phytoplankton drivers may be dynamic and difficult to estimate. Longterm monitoring programs and targeted studies in the Delta provide information to better understand linkages among flow, water quality, nutrients, and phytoplankton, but these efforts often have limited spatial coverage and typically focus on main channels.

Management and restoration decisions may be more effective if there is a better understanding of how nutrients and phytoplankton vary spatiotemporally. To address spatiotemporal variability and drivers of nutrients and chlorophyll, we collected high spatial resolution water quality, nutrient, and phytoplankton data across the Delta and Suisun Bay using a boat-based flowthrough system in spring, summer, and fall for six years (2018, 2020-2024), for a total of 18 Delta-wide spatial “snapshots”.

We used partitional k-medoids clustering to group the water quality time series of 244 one-mile reaches of the Delta into regions wherein drivers may act distinctly. Our preliminary results indicate that the influence of discharge on chlorophyll and nutrients varied by region and season, where discharge had the largest effect on chlorophyll in the summer and fall. These initial results suggest that alterations to Sacramento and San Joaquin River discharge affect the Delta dynamically over time and space. Additional analyses are planned using spatio-temporal modeling frameworks to assess the relative importance of flow, nutrients, and other drivers on phytoplankton distribution and abundance.

Authors: Kyle Leathers, U.S. Geological Survey; Katy O'Donnell, US Geological Survey; Leslie Troutman, U.S. Geological Survey; Brian Bergamaschi, U.S. Geological Survey; Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center; Tamara Kraus, U.S. Geological Survey

Track: Water Quality, Contaminants, & Aquatic Health

Assessing the dynamics of re-emerging spring phytoplankton blooms in the upper San Francisco Bay and Sacramento-San Joaquin Delta estuary, California

Upper San Francisco Bay and Sacramento-San Joaquin Delta (Bay-Delta) estuary, California, is important rearing habitat for native fish species. In the late 1980s, chlorophyll a (chl-a) concentrations declined by more than half, potentially contributing to declines of endangered fish species. Invasive clams and reduced managed river flows are hypothesized to have driven this chl-a decline. However, spring phytoplankton blooms have increased in magnitude and frequency since 2010, occasionally reaching historic levels. Recent blooms are mostly dominated by diatom species that live on shallow water sediments. Despite the emerging importance of microphytobenthos in the upper Bay-Delta estuary, little is known about community composition, benthic-pelagic coupling, or fisheries implications.

To address this, we conducted monthly sediment and water column sampling for 18S ribosomal RNA in spring 2024 and analyzed environmental and phytoplankton community data from 1987-2025.

18S results indicate *Entomoneis* sp. accounted for 0.3-35% of the microphytobenthos diatom community, with other prominent genera including *Cyclotella*, *Navicula*, and *Thalassiosira*. Overlap between benthic and pelagic communities indicated coupling. Long-term data revealed that bloom timing and magnitude varied with freshwater flow, which controls the seasonal salinity gradient and water column stratification, potentially allowing resuspended microphytobenthos cells to persist in surface waters.

Generally, dry years produced earlier blooms (March-April) and wet years produced later blooms (June-August). Bloom timing influenced chl-a and community composition: March-April blooms were *Entomoneis*-dominated with moderate chl-a; May blooms were co-dominated by *Entomoneis* and *Aulacoseira* with highest chl-a; and June-August blooms had lowest chl-a with mixed composition.

Understanding bloom sources and drivers can reveal how environmental change and flow management may impact Bay-Delta ecosystems and fisheries.

Speaker: Schuyler Nardelli, U.S. Geological Survey, California Water Science Center

Co-authors: Brian Bergamaschi, U.S. Geological Survey; Tamara Kraus, U.S. Geological Survey; Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center

Track: Ecology, Food Webs, & Changing Ecosystems

Treasure of the Benthos – Investigating microphytobenthos assemblages in the Sacramento River

Long-term phytoplankton monitoring of the pelagic zone in the Sacramento-San Joaquin Delta is often used as an estimate of food availability for lower trophic levels. However, this monitoring strategy may overlook a high microalgal biomass inhabiting the river's microphytobenthos.

Our research goal was to investigate the deposition, growth, and biomass of algal cells at the river bed, which could serve as a recruitment source for phytoplankton living in the pelagic water column. We deployed sediment traps, growth tiles, and artificial plants, and collected sediment core and rock periphyton samples to measure microalgae sedimentation and growth in the Sacramento River, within the northern Delta. Benthic samples, excluding periphyton samples, were collected from 0.6-2.4 m deep to evaluate potential effects of decreasing light with depth.

Preliminary results found that chlorophyll a (chl-a) concentrations were chl-a concentrations in settled sediment more than doubled those in core samples. Chl-a concentrations on the artificial plants and periphyton samples were roughly twice as high at stations downstream of the Sacramento Area Sewer District's discharge, possibly due to increased nitrate concentrations.

Chl-a on growth tiles was lower than in cores, suggesting that deposition is the dominant process of biomass accrual, rather than cell division. Chl-a on artificial plants and growth tiles was higher at shallower depths, likely due to light limitation. Similar diatom communities dominated all enumeration samples, suggesting a strong connection between the pelagic and benthic communities.

Further investigations into the mechanisms of deposition and resuspension of phytoplankton cells would enhance our understanding of the processes controlling pelagic phytoplankton biomass in the Delta.

Speaker: Timothy Mussen

Co-authors: Tim Mussen, Sacramento Area Sewer District; Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center; Ann Holmes, Sacramento Area Sewer District; Joy Foluso, Sacramento Area Sewer District; Rafael Zarinana, Sacramento Area Sewer District

Track: Ecology, Food Webs, & Changing Ecosystems

Three sides to the story: A comparison of San Francisco Bay phytoplankton community assemblage according to multi-channel fluorometry, phytoplankton enumeration, and 18S/16S metabarcoding



To document phytoplankton community assemblages, researchers and managers across the globe use a variety of methods that may produce conflicting results. Common sampling methods include phytoplankton enumeration, 18S and 16S ribosomal RNA metabarcoding, and in situ multi-channel fluorescence measurement.

Each of these sampling techniques has advantages and disadvantages. Phytoplankton enumeration can provide taxonomic identification down to the species level for many organisms; however, the method is costly, prone to human error and sample degradation, and results may be biased towards certain size classes based on technique. Metabarcoding is a more sensitive detection method, but it can only provide relative phytoplankton abundance and identification to the species level is dependent on reference database completeness.

Many in situ fluorometers can quantify chlorophyll pigmentation (a common proxy for phytoplankton biomass) along with accessory pigments, allowing users to estimate the broad composition of phytoplankton groups.

Multi-channel fluorometry is cost effective and provides rapid results, however, as with all optical instruments, calibration protocols and certain environmental conditions can impact data quality. As phytoplankton monitoring programs work to improve sampling methods used to characterize community assemblage, comparisons between the methods are important for hindcasting data quality and understanding the suitability of newer techniques.

Here, we describe phytoplankton community composition in the San Francisco Bay before, during, and after the 2022 *Heterosigma akashiwo* bloom using these three methods. We then compare how results may differ depending on the chosen method, identifying possible causations.

This analysis may help researchers understand the validity of their historical community composition data, as well as inform phytoplankton monitoring strategies, aiding the selection of one or more sampling techniques to best suit their needs.

Speaker: Emily T. Richardson, CA Department of Water Resources

Co-authors: Silvia Angles, California Department of Water Resources DWR; Dave Senn, San Francisco Estuary Institute; Katy O'Donnell, US Geological Survey; Brian Bergamaschi, U.S. Geological Survey; Daniel Killam, San Francisco Estuary Institute; Ariella Chelsky, San Francisco Estuary Institute; Daphne Gille, California Department of Water Resources

Tracks: Ecology, Food Webs, & Changing Ecosystems · Water Quality, Contaminants, & Aquatic Health

Understanding primary productivity dynamics in regulated rivers and its value as indicator for food availability in salmonid habitats



Aquatic primary productivity forms the basis of trophic structure within freshwater ecosystems, by providing energy and nutrients used by higher-order consumers, and being a dominant control over other ecosystem processes such as nutrient cycling.

This productivity varies widely across scales and locations, driven by the differences in the availability/presence of nutrients, solar radiation and/or the strength of cascading trophic interactions, among other factors. Monitoring stream metabolism (through Gross Primary Production, GPP, and Ecosystem Respiration, ER) has become more feasible with the availability of reliable and accessible dissolved oxygen (DO) probes. Literature has shown a positive relationship between GPP and aquatic invertebrate densities, as well as a strong correlation with densities of juvenile salmonids and their dietary resource limitations.

Hence, inferences on autochthonous reach productivity, food resource limitations and fish location could be obtained from GPP estimates, of great value to guide more effective fish and habitat management. Our pilot project aims to explore the potential of using stream primary productivity (GPP) estimates as a proxy for food-web resource availability since (i) it requires far less time and personnel resources than current monitoring efforts (e.g., macroinvertebrate sampling and sorting); and (ii) provides a continuous record of stream metabolism and productivity instead of discrete measurements.

Our work focuses on three different regulated rivers in California that support important salmonid populations: Sacramento River, Clear Creek and Stanislaus River. We installed 2-3 dissolved oxygen sensors within important spawning and rearing reaches characterized by having upstream regulating dams, and used the high-resolution data collected to model GPP, and ER. Preliminary results show significant differences in GPP, similar to differences in sampled macroinvertebrate densities between streams in 2021 and 2022.

Authors: Francisco Bellido-Leiva, University of California, Davis, Center for Watershed Sciences; Nicholas Corline, Center for Watershed Sciences, UC Davis; Lillian McCormick, USBR; Joshua Israel, United States Bureau of Reclamation; Michael Beakes, Environmental Protection Agency; Robert Lusardi, University of California, Davis

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

What we know, what we don't, and what we're guessing: updated conceptual models of Central Valley salmon life history (Part 1: causes and consequences of migration phenology)



Scientists and non-scientists involved in resource management all have informal mental conceptual models of species life histories. These mental conceptual models have been consciously and unconsciously pieced from prior experience to form a baseline of existing beliefs and values, and then are regularly updated by new exposure to published and unpublished studies, personal or anecdotal observations, personal values, and other disparate sources of related and seemingly unrelated information. Our mental conceptual models guide new research ideas, development of management actions, and personal or institutional reactions to and evaluations of proposed and existing management actions, at which point they sometimes become formalized in print or digital media by our scientific experts, but not always, and these formalized expressions often lag new understanding. As a result, we continue to rely on our personal underlying conceptual models, which drive both conversations and conflict.

In this session, salmon scientists share how new (and old) information informs their current updated conceptual models of various aspects of Central Valley salmon life histories, highlighting what we know, don't know, and are guessing at, including speculations and hypotheses where uncertainty exists. The goal of this sharing is to provide a clearer and potentially more integrated understanding of what's going on with Central Valley salmon, particularly where new information and uncertainties have broader implications for salmon recovery and related resource management.

Mgmt Relevance: Management frameworks and scientific consensus typically lag behind current thinking. The purpose of this session is to bring new insights to a wider audience to stimulate discussions that lead to broadener consensus and more clearly defined areas of disagreement and uncertainty, eventually speeding the dissemination and incorporation of updated conceptual models into updated management frameworks.

Session Chair: Brett Harvey, California Department of Water Resources

Speakers: William Pine, ICF; Rachel Johnson, NOAA Fisheries, Southwest Fisheries Science Center and UC Davis, Center for Watershed Sciences; John Brandon, ICF; Miles Daniels

Tracks: Ecology, Food Webs, & Changing Ecosystems · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration

Using hierarchical models to estimate spring-run Chinook Salmon outmigration timing and abundance from a network of rotary screw traps in the Sacramento River Valley

Reliable estimates of juvenile salmonid outmigration timing and abundance are essential for evaluating population status, recovery planning, and water operations in regulated river systems. Outmigration dynamics remain difficult to estimate from the network of rotary screw traps (RSTs) operated across the Sacramento River Valley because capture efficiency is often low, variable, and unevenly sampled. Our objective was to develop a coherent framework for estimating spring-run and total Chinook Salmon outmigration abundance and timing from long-term RST data while propagating uncertainty across model components.

With support from monitoring teams across agencies and watersheds, we integrated long-term RST datasets from major spring-run producing tributaries and mainstem Sacramento River sites. We developed hierarchical Bayesian models to estimate capture probability, weekly and seasonal abundance, and migration timing across sites and years.

We also compared estimates from tributary and mainstem RSTs to evaluate how monitoring location and capture efficiency influence inference.

Across more than 200 site-year combinations, estimated Chinook Salmon fry and smolt abundance varied by several orders of magnitude, from thousands to tens of millions of individuals, with similar variability within spring-run. Capture probability was the primary constraint on inference, varying widely among tributary sites and remaining substantially lower at mainstem sites. Discharge had a consistently negative effect on capture probability, with tributary sites generally showing declining capture efficiency as flow increased. Migration timing was concentrated early in the year, with most peak weekly abundance estimates occurring in January and February, although substantial spatial variation occurred among sites. By jointly modeling capture probability across years and sites, this framework produced coherent abundance and timing estimates from sparse and heterogeneous monitoring data.

Speaker: William Pine, ICF

Co-authors: Josh Korman, Ecometric Research; Brett Harvey, California Department of Water Resources; Liz Stebbins, FlowWest; Ashley Vizek, FlowWest; Noble Hendrix, QEDA Consulting LLC

Track: Ecology, Food Webs, & Changing Ecosystems



Investigating Environmental and Genetic Drivers of the Yearling Ecotype through Experimental Releases of Spring-run Chinook Salmon

Phenotypic plasticity in early life history traits, particularly the timing of juvenile outmigration, is well documented in Central Valley Spring-run Chinook Salmon *Oncorhynchus tshawytscha*. Although the late-migrating yearling phenotype occurs more frequently in certain populations, the mechanisms underlying this variation remain poorly resolved.

To examine the influence of habitat conditions and lineage on juvenile life history expression, we conducted experimental translocations during fall 2025 to assess potential heritable components of life history. Adult Spring-run Chinook Salmon originating from Butte Creek, a system in which over-summering yearling juveniles are uncommon and early outmigration predominates, were spawned at Livingston Stone National Fish Hatchery. Their fertilized eggs were then introduced using incubation boxes to Deer Creek, one of the last known tributaries in the Sacramento River basin with suitable conditions to reliably support the yearling ecotype.

From Floods to Fishery Closures: Drought-Driven Erosion of Wild Salmon Production and Life History Diversity

Life history diversity stabilizes Chinook salmon populations by spreading risk across migration strategies and environmental conditions, but recent droughts and fishery closures in California's Central Valley suggest this resilience is declining. Actions to rebuild this resilience and work with [and not against] potential shifts in salmon phenology will become increasingly important as hydroclimate volatility or 'whiplash weather' is predicted to increase the frequency of extreme droughts and floods. Using otolith strontium isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$), we quantified natal origin and juvenile life history diversity of fall-run Chinook salmon emigrating through the Sacramento-San Joaquin Delta across wet and dry years.

Dry years (2014–2015, 2020–2022) were dominated by hatchery-origin juveniles, whereas wet years (2017, 2019, 2023) had greater contributions from wild populations, especially from the Sacramento, American, and Feather rivers. Wild-origin fish comprised up to ~50% of outmigrants exiting the Delta at Chipps Island in wet years but <20% during drought. Wet years also showed broader migration timing and size distributions, while drought compressed these diverse strategies. Population-specific catch dynamics revealed strong portfolio effects, with wild populations responding asynchronously to hydrologic variability. The loss of wild production and life history diversity during drought likely reduced stock resilience and contributed to recent declines in adult returns and California salmon fishery closures. These findings highlight the importance of conserving diverse wild populations and hydrologic conditions that sustain multiple juvenile migration pathways under climate change.

Speaker: Rachel Johnson, NOAA Fisheries, Southwest Fisheries Science Center and UC Davis, Center for Watershed Sciences

Co-authors: Kohma Arai, Center for Watershed Sciences, UC Davis / Japan Fisheries Research and Education Agency; Anna Sturrock, University of Essex; Miranda Bell Tilcock, UC Davis Center for Watershed Sciences; George Whitman, Center for Watershed Sciences, UC Davis; Rachael Ryan, University of California Davis; Carson Jeffres, University of California, Davis

Track: Ecology, Food Webs, & Changing Ecosystems

An Eco-Evolutionary Population Dynamics Model for Feather River Chinook Salmon

Conceptual models that explicitly integrate ecological and evolutionary processes are critical for understanding management implications in aquatic systems. California Central Valley Chinook salmon persist in a system where ecological dynamics, genetic composition, and hatchery operations interact through time. In the Feather River, the Feather River Fish Hatchery was established to mitigate habitat loss following construction of Oroville Dam (ca. 1967), and management has continued to evolve as new information on fall-run and ESA-listed spring-run Chinook has emerged. To evaluate how management actions interact with ecological and genetic processes shaping population dynamics, we developed an eco-evolutionary population model that links demographic and genetic processes within a unified framework.

The model tracks abundance by age, run-timing genotype, and origin (natural versus hatchery), and incorporates eco-evolutionary feedback where demographic change alters genotype frequencies and, in turn, genetic composition influences population trajectories. These bidirectional processes extend beyond classical population models by embedding genetic inheritance directly within population dynamics. A genomic region strongly associated with migration timing explains a substantial fraction of run-timing variation, supporting representation of run timing as a structured genetic trait. Genotype mixing emerges from interactions among run timing, hatchery broodstock selection rules, and broader environmental drivers, including migration barriers and altered outflow regimes. A key uncertainty is how these factors have structured genotype composition and how they may influence future dynamics under alternative management actions. This model provides a tool for evaluating how hatchery practices and flow-mediated demographic processes (e.g., survival and recruitment) influence population dynamics and the maintenance of run-timing diversity.

Speaker: John Brandon, ICF

Co-authors: Michael Tillotson, ICF; Kim Brewitt, ICF Environmental; Kelly Mistry, ICF; Brett Harvey, California Department of Water Resources

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration



Diluting risk: predicting and managing pathogen infection in outmigrating Central Valley Chinook salmon

Outmigrating juvenile Chinook salmon in California's Central Valley are susceptible to *Ceratonova shasta*, a pathogen whose effects emerge from fine-scale interactions among host, pathogen, and environment yet can scale upward to shape salmon population health. While infection severity is known to depend on environmental conditions, the degree to which targeted management actions can mitigate that risk has remained difficult to quantify. To begin to address this, we conducted sentinel field exposures of juvenile Chinook at sites on the Sacramento and Feather rivers, pairing *C. shasta* detection in fish with concurrent measurements of waterborne pathogen density, water temperature, and exposure duration.

From these data we developed a dose-response model that predicts infection probability from environmental conditions. Applying the model in a management case study, we explored how increasing reservoir discharge—which dilutes pathogens and accelerates outmigration—and lowering water temperature could reduce infection risk, and found that combined actions can meaningfully lessen infection during the spring period of peak exposure. Building on this foundation, we are beginning to integrate the dose-response relationship into dynamic disease transmission models, allowing infection risk to be simulated continuously in space and time rather than at fixed exposure sites. This talk will present these findings and discuss how coupling empirical exposure data with predictive models can link individual-scale infection processes to basin-scale management strategies for conserving Central Valley salmon.

Speaker: Miles Daniels

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health

What have we learned and how do we advance collaborative science in the Bay Delta?



Collaborative Science forums can be an ingredient for building sustainable policies and practices but what has our success been in the Bay Delta over the years and how can we leverage the values of collaboration to build and be the future?

Objectives Statement: To examine what we've learned over decades of collaborative science in the Delta and discuss how we can apply that knowledge to create durable solutions for the future.

Approach: Engage a panel of managers, policy makers and scientists with direct experience working on science and collaboration in the Delta in a facilitated dialog around lessons learned from past and ongoing science collaborations and ways to work together to shape the future of management relevant science in the Bay Delta. The panel will be asked to share their perspectives on the questions posed by the conference theme and how collaboration can advance durable solutions to the multiple challenges of water and ecosystem management that is the Delta.

Results: The panel will offer insights on what has worked and not worked in the past and what the opportunities are for finding solutions together moving forward.

Session Chair: Bruce DiGennaro

Speakers: Rene Henery, Trout Unlimited and University of California, Reno; Darcy Austin, State Water Contractors (SWC); Louise Conrad, California Department of Water Resources; Lisamarie Windham-Myers, Delta Stewardship Council; Letitia Grenier, PPIC

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Scaling natural climate solutions in the Sacramento-San Joaquin Delta: Integrating science, policy, and community resilience



Over the last 175 years, the Sacramento-San Joaquin Delta has transitioned from a dendritic marsh to a reclaimed agricultural hub. This conversion triggered the oxidation of carbon-rich soil, resulting in the loss of 2.5 billion cubic meters of soil and land subsidence up to 9 meters below sea level. Today, the region emits 1.2 million metric tons of CO₂e annually, threatening California's water supply and levee infrastructure. While rewetting the landscape—through wetland restoration and rice cultivation—stops soil oxidation, scaling these solutions requires navigating complex economic, regulatory, and social landscapes.

This session reviews Delta carbon management progress, highlighting key advancements and lessons learned. Lisamarie Windham-Myers frames the Delta at the watershed and estuary scale, while Campbell Ingram provides a historical overview of the policy and management strategies that have driven progress to date.

The technical foundation is established in a panel by Patty Oikawa, Steve Deverel, and Kyle Delwiche, discussing advancements in carbon modeling, monitoring, and the role of methane in restoration trade-offs. Shifting to implementation, Tyler Anthony shares 15 years of longitudinal data, lessons learned, and adaptive management strategies in wetlands to optimize emissions and ecosystem resilience, which serves as the foundation for future Delta restoration and carbon management projects. Michelle Leinfelder-Miles discusses research and grower engagement essential to making rice a viable, climate-smart alternative for Delta farmers.

Finally, we address the economic and human dimensions of land use. Malinda Stalvey and Sydney Chamberlin discuss the financial feasibility of owning subsided land and the impact of streamlined regulatory processes on restoration. Closing the session, a TBD panel highlights community dynamics, focusing on bridging the communication gap between agencies, communities, and ensuring equitable access to natural resources.

Session Chair: Lauren Damon

Speakers: Campbell Ingram, Sacramento-San Joaquin Delta Conservancy; Lisamarie Windham-Myers, Delta Stewardship Council; Kyle Delwiche, UC Berkeley; Patty Oikawa, California State University East Bay; Steven Deverel, HydroFocus Inc.; Tyler Anthony, California Department of Water Resources; Michelle Leinfelder-Miles, UC CE San Joaquin County; Sydney Chamberlin; Malinda Stalvey; Morgen Snyder

Track: Nature-Based Solutions & Landscape Resilience

Decadal adaptation of subsidence mitigation in the Sacramento-San Joaquin Delta



Concerns about threats to California's water supply associated with Delta peatland subsidence prompted research in the 1980s which set the stage for experimentation and progressive adaptation of wetlands and rice. Concomitant with land-surface elevation change measurements in the 1990s, flux measurements provided estimates of carbon losses associated with peat oxidation. This and wetland accretion research of the pre-development Delta led to mesocosm experimentation on peat soils that indicated the carbon sequestration potential of permanently flooded wetlands and the carbon neutrality of reverse flooded seasonal wetlands. This resulted in the creation of the Twitchell 14-acre pilot wetland in 1997 where long-term accretion and greenhouse-gas emissions and removals have been quantified.

This was the stage setting for creation of 2700 acres of managed non-tidal wetlands on State-owned islands. The carbon flux data for reverse flooded wetlands prompted experimentation with rice which demonstrated subsidence stoppage. Work on Staten Island that began in 2011 demonstrated the viability of a land use mosaic that includes traditional agriculture, rice and wetlands.

The early subsidence measurements provided a foundation for additional data collection and subsidence modeling during the Delta Risk Management Strategy project authorized by Assembly Bill 1200 in 2005. These and additional elevation and GHG data collected since then led to improved ability to estimate spatially variable subsidence and GHG emissions. This and ongoing quantification of subsidence induced levee risks will enable prioritization of implementation of nature base solutions for improved Delta sustainability.

Speaker: Steven Deverel, HydroFocus Inc.

Tracks: Nature-Based Solutions & Landscape Resilience · Interdisciplinary Science & Cross-Knowledge Integration

Quantifying the nature-based climate change potential of restored Sacramento-San Joaquin Delta wetlands



Restored wetlands, particularly on degraded peatlands such as in the Sacramento-San Joaquin Delta, are increasingly recognized as a potential nature-based climate change solution. Wetland restoration helps the climate by stopping ecosystem carbon loss due to peat degradation and taking up carbon from the atmosphere in the form of plant growth. Using eddy covariance measurements in the Delta, we have recorded some of the largest carbon emissions from agricultural sites and largest carbon uptake at restored wetlands reported anywhere in the world.

Our meso-network of eddy covariance sites covers the wide-ranging mosaic of Bay-Delta ecosystems, from tidal salt marsh to tidal freshwater marsh, native and restored ecosystems, impounded subsidence-reversal wetlands, and agriculture on drained Delta peatlands. This diversity of sites allows us to quantify the potential of wetland restoration in the California Delta to combat climate change. While carbon uptake can be large, restored wetlands also emit methane, a potent greenhouse gas that offsets some of the climate benefit of wetland restoration in the near-term. Our long-term data records allow us to quantify the tradeoff between carbon uptake and methane emissions, and develop models to predict wetland carbon dynamics.

Speakers: Kyle Delwiche, UC Berkeley; Patty Oikawa, California State University East Bay

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System

Rice cultivation in the Sacramento-San Joaquin Delta to support economically-viable and climate-smart farming



Soil carbon oxidation and land subsidence have occurred in areas of the Sacramento-San Joaquin Delta with organic soils. Keeping soil wet mitigates these effects, but most crops cannot grow under flooded conditions. Rice is one exception because of its unique cellular structure that allows gas diffusion through the plant, even under flooded conditions. Rice has been cultivated in the Sacramento-San Joaquin Delta for decades, but acreage has been steadily increasing in recent years, quadrupling over the last decade. Most of the Delta acreage is in San Joaquin County, but rice is also cultivated in areas of Sacramento and Contra Costa counties as well as the Yolo Bypass. Delta acreage represents about two percent of the California rice industry, with most of the acreage in the Sacramento Valley.

Delta rice production practices differ from those in the Sacramento Valley and have been adapted through grower experimentation and research collaboration to address unique Delta conditions, such as cooler temperatures and high organic matter soils. This presentation will describe applied research that is developed through local needs assessment. Annual variety evaluations serve to identify varieties with good agronomic and quality characteristics that can mature under cool conditions. Plant nutrition and integrated pest management practices have been studied to help ensure that economic viability and environmental sustainability are both served. Evaluations of soil health practices like cover cropping and crop rotation are nascent but support successful production and longevity. This presentation will describe how community engagement and applied research on private lands supports Delta resilience.

Speaker: Michelle Leinfelder-Miles, UC CE San Joaquin County

Track: Nature-Based Solutions & Landscape Resilience

Science-Informed Adaptive Management to Maximize Benefits in Restored Sacramento-San Joaquin Delta Wetlands

Objectives Statement

This work aims to present lessons learned on how restored wetlands in the Sacramento-San Joaquin Delta (Delta) can reliably deliver long-term climate and subsidence reversal benefits. Specifically, it seeks to understand how adaptive management decisions can influence greenhouse gas fluxes, subsidence reversal, and develop scalable management strategies and market mechanisms to support effective carbon sequestration and project implementation.

Approach

The California Department of Water Resources (DWR) has conducted more than two decades of research and long-term monitoring across restored Delta wetland sites.

This work includes field measurements of carbon stocks and greenhouse gas fluxes and trials of active management strategies such as cultural burning, biomass removal, and water table management. In parallel, the department is collaborating with partners to apply these findings to improve carbon accounting and inform carbon market frameworks tailored to Delta wetlands.

Results

Research shows that without adaptive science-based management the climate value of restored wetlands. Targeted management strategies are exploring the potential to increase carbon sequestration, limit methane emissions, and strengthen ecosystem resilience. Continued long-term scientific monitoring is helping shape approaches for effective adaptive management strategies and generating rigorous, high-value carbon credits from Delta wetlands. Results from long-term datasets, pilot adaptive management projects, and lessons learned will be presented.

Speaker: Tyler Anthony, California Department of Water Resources

Tracks: Nature-Based Solutions & Landscape Resilience · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Managing Subsiding Delta Lands: Comparative Approaches to Large-Scale Wetland Restoration and Financial Sustainability



Managing subsiding land in the Sacramento-San Joaquin Delta is a complex, high-stakes challenge. Balancing financial viability, stakeholder values, flood risk, and ecological benefits requires collaborative, nature-based solutions and compelling justifications for funding. This panel addresses the complexities of landscape-scale restoration through the distinct approaches of two major landowners: The Nature Conservancy (TNC), a global non-profit, and The Metropolitan Water District of Southern California (Metropolitan), a public agency. Both entities own islands where they are actively working to halt or reverse subsidence to support the Delta's coequal goals and "Delta as Place" directive.

The session highlights two major initiatives utilizing different management models:

Staten Island (TNC): A 9,200-acre working farm that integrates wildlife- and climate-friendly agriculture, including 4,500 acres of rice, with the restoration of nearly 1,000 acres of wetlands.

The island serves as a living laboratory to advance nature-based climate solutions while enhancing habitat for migratory birds and other native species.

Webb Tract (Metropolitan): A nearly 5,500-acre former agricultural and grazing tract being converted into a mosaic of habitat and rice, featuring approximately 2,500 acres of wetlands and 1,300 acres of rice. This demonstration project offers a unique opportunity to evaluate whole-island stabilization and ecological scaling.

While both initiatives have successfully leveraged state funding, long-term project viability depends on securing ongoing investments for construction, management and monitoring, and levee maintenance. Panelists will discuss the practical realities of project development, regulatory permitting, and strategic frameworks for financial sustainability. Attendees will gain insights into how diverse organizations navigate the operational and economic challenges of transforming subsided Delta islands into resilient, climate-smart landscapes.

Speakers: Sydney Chamberlin; Malinda Stalvey

Tracks: Nature-Based Solutions & Landscape Resilience · Finding Collaborative Solutions



Tribal and Community Perspectives: The Importance of Inclusive Decisionmaking Processes and Access to Natural Resources

The Sacramento-San Joaquin Delta is a diverse ecosystem that supports 4 million Delta County Residents, a nearly \$7 billion annual economy, and is the ancestral homeland of numerous Tribal Nations. California's history of racist policies formed the foundation of the CA water management system, excluding Tribes and communities of color. Inclusive decisionmaking with impacted communities and Tribal Nations is crucial to ensure equitable access to natural resources across the Delta region.

Tribal Nations. Speakers from Shingle Springs Band of Miwok Indians and the Winnemum Wintu Tribe (speakers TBD) will open the session, sharing perspectives on Tribal beneficial uses and the importance of access to natural resources.

The Tribal speakers will share information on what meaningful consultation and inclusive decision making means for Tribal Nations, and how existing policies and regulations can do more to ensure this bar is met. The speakers will also discuss current challenges to access, including water quality concerns, harmful infrastructure proposals, and existing regulations.

Restore the Delta's Policy Team (speakers TBD) will close the session, sharing environmental justice perspectives on decisionmaking processes and barriers to access to natural resources. Restore the Delta will briefly share background on the organization's involvement with sustainable agriculture, and challenges within the Delta agricultural community. The team will discuss current barriers to access, including water quality, air quality, and declining infrastructure concerns, highlighting the importance of having a seat at the table when decisions are made about the Delta. The most impacted communities are most often left out of the conversation, and engagement early and often ensures equitable outcomes.

Speakers: Morgen Snyder; Krystal Moreno; Max Gomberg

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem

The 2026 Delta Science Plan: Advancing social science, governance, and Traditional Knowledge to tackle the Delta's grand challenges



The 2026 Delta Science Plan provides the vision, principles, and approaches for conducting, coordinating, and communicating science in the Sacramento-San Joaquin Delta. This “how to” document for Delta science rallies disparate entities to work together to address the increasing, new, and persistent challenges ahead. Released in summer 2026, this third iteration is composed of 24 Actions structured around four grand challenges facing the Delta: anticipating new conditions, rapid environmental change, decentralized flows of information, and siloed decision-making.

This session opens with two presentations from the Delta Stewardship Council. The first introduces the Delta Science Plan and what's new in the 2026 iteration; the second explores how responsive, targeted science funding is critical to advancing the 2026 Delta Science Plan and increases our capacity to solve complex problems as early, efficiently, and effectively as possible.

Next, a panel will share about how effectively addressing these challenges requires new collaborations, novel techniques, and approaches that have historically been underleveraged in Delta science such as the social sciences, Traditional Knowledge, and governance. The social sciences provide critical insight into the human dimension of resource management while governance research can highlight pathways forward among the decentralization of Delta science, and Traditional Knowledge offers valuable insights into biodiversity, restoration, and sustainable futures.

This panel brings together practitioners representing each of these underleveraged areas of Delta science: Anecita Agustinez (Traditional Knowledge; CA Department of Water Resources Office of Tribal Affairs), Dr. Sasha Harris-Lovett (social sciences; San Francisco Estuary Partnership), and Dr. Tara Pozzi (governance; California Sea Grant & Delta Stewardship Council). Each panelist will briefly share how their work advances implementation of the Delta Science Plan toward a more connected, collaborative, and resilient Delta, followed by a moderated discussion and audience questions.

Session Chair: Hollis Jones, Delta Stewardship Council

Speakers: Anecita Agustinez; Sasha Harris-Lovett, San Francisco Estuary Partnership; Tara Pozzi; Jessie Patzlaff

Tracks: Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration · Policy & Management Showcase

MONDAY, SEPTEMBER 28, 2026 - SESSION 07 · 4 PRESENTATIONS

Watershed-wide fish communities across space and time



Speakers: Matea Djokic, FISHBIO; Rob Eckelbecker, FISHBIO; Brock Huntsman, US Geological Survey, California Water Science Center; Evan Carson, US Fish and Wildlife Service

Spatial and Temporal Dynamics of Native and Non-native Fish Occurrences in California's Central Valley



Non-native fishes are prevalent throughout Central Valley watersheds, restructuring food webs through predation and other biotic interactions. However, the spatial and interannual variability of these dynamics is poorly understood, limiting the development of effective and targeted management strategies across large, heterogeneous river systems. We collected and identified diet samples from native and non-native predators along the gradient from the Stanislaus River to the Sacramento-San Joaquin Delta (2019-2023).

Using generalized additive models, we investigated how spatial (river kilometer) and temporal (day of year, year) variables influence species occurrence and co-occurrence patterns. Preliminary results indicate strong spatial structuring of predator distributions, with non-native predators more likely to occur in downstream reaches near the Delta, and native predators more prevalent upstream.

Native fishes were frequently found in diets of native and non-native predators. Non-native predators more frequently consumed native species, highlighting strong predation pressure on native fishes. Non-native striped bass consumed native fishes on average nearly 10 times more frequently than non-native fishes in the river portion of the study area, though this shifted with increasing distance downstream.

Native fish prey included Chinook salmon, lamprey, hitch, Sacramento sucker, sculpin, splittail, Sacramento pikeminnow, and threespine stickleback with Sacramento sucker, Chinook salmon, and lamprey being the most frequently consumed. These findings demonstrate how spatial gradients and temporal variability may shape interactions between native and non-native species in highly altered ecosystems.

High occurrence of non-native predators and their reliance on native prey in riverine habitats suggest that spatially targeted management across the river-delta gradient, especially where predators and native prey overlap, may improve outcomes for native fish conservation.

Speaker: Matea Djokic, FISHBIO

Co-authors: Matt Peterson, FISHBIO; Dana Lee, FISHBIO

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

Survival and Abundance of Black Bass (*Micropterus* spp.) in the Lower Stanislaus River and South Sacramento-San Joaquin Delta



Large-scale flow modifications have been proposed to aid in the recovery of anadromous salmonids in California's Central Valley, yet few studies have evaluated how non-native piscivores may respond to these modifications. Black bass (*Micropterus* spp.) are widely distributed across the across the Sacramento-San Joaquin Delta (Delta) and prey upon native species, including juvenile salmonids.

We have conducted long-term mark-recapture studies in the lower Stanislaus River and South Delta to estimate abundance and survival of *Micropterus* spp. under varying hydrologic conditions. Fish were captured with boat electrofishing, PIT tagged, and released within their capture locations. In the lower Stanislaus River, primary and secondary sampling events allowed for estimation of annual abundance and survival between years, and a Robust Design model was used to account for movement and temporary emigration.

Annual survival rates ranged from 0.30 to 0.60 for fishes measuring 80 mm to 600 mm. Annual abundances ranged from 2,807 (2,150–3,724; 95% CI) in 2020 to 7,361 (6,474–8,413; 95% CI) individuals in 2021.

Strong recruitment of *Micropterus* spp. was observed in 2021, marked by a pronounced increase in individuals measuring 90–120 mm. Preliminary results from the Stanislaus River suggest that variation and magnitude of flows had little effect on apparent survival, while relatively high annual survival was observed, even during years with elevated flows. Ongoing efforts integrating PIT antenna detections with additional mark-recapture data collected throughout the South Delta, and analyzed under multiple parameterizations of the Robust Design model, may further clarify movement patterns, site fidelity, and the extent to which hydrologic effects on black bass populations differ between riverine and estuarine habitats.

Speaker: Rob Eckelbecker, FISHBIO

Co-authors: Emily Jonagan, FISHBIO; Matt Peterson, FISHBIO; Tara Lamb, FISHBIO; Dana Lee, FISHBIO; Andrea Fuller, FISHBIO

Track: Ecology, Food Webs, & Changing Ecosystems

Consumption of juvenile Chinook salmon out-migrating through channels of the Sacramento-San Joaquin Delta by black basses



Chinook salmon (*Oncorhynchus tshawytscha*) that outmigrate from Central Valley waterways must navigate a complex network of interconnected natural and manmade channels once reaching the Sacramento-San Joaquin Delta (Delta). Salmon mortality rates vary among these channels, being relatively high within interior Delta channels where predation has been hypothesized to be a potential reason for these elevated rates. We used boat electrofishing and gastric lavage to evaluate the potential effects of piscivorous fishes on juvenile salmon within three interior Delta channels: Sacramento River, Georgiana Slough, and Steamboat Slough.

We applied a multinomial hurdle model to quantify diet composition of predator diets, finite normal mixture models to characterize predator cohort size structure, bioenergetics to estimate predator consumption rates, and multinomial N -mixture models to estimate total predator abundance among channels.

Together these models provide an integrated assessment of potential top-down pressure across channels, months (January-April), and years (2020-2022).

Preliminary results found that salmon were consumed most frequently by smallmouth bass (*Micropterus dolomieu*), followed by largemouth bass (*Micropterus salmoides*), and rarely encountered in spotted bass (*Micropterus punctulatus*) diets. Salmon occurrences in predator stomachs peaked in March and were highest in Steamboat Slough, followed by Georgiana Slough, and lowest in the Sacramento River.

Predator abundance also varied by channel and month, with the greatest numbers in the Sacramento River in February and Steamboat Slough during March and April. When combined with bioenergetics modeling, these results could enable quantitative estimates of the number of outmigrating salmon consumed by non-native and native piscivorous fishes among these interior Delta channels. This information provides critical context for interpreting spatial differences in salmon mortality rates across interior Delta channels.

Speaker: Brock Huntsman, US Geological Survey, California Water Science Center

Co-authors: Frederick Feyrer, U.S. Geological Survey, California Water Science Center; Matthew Young, U.S. Geological Survey; Veronica Violette, US Geological Survey; Russell Perry, U.S. Geological Survey - Western Fisheries Research Center; Adam Pope, US Geological Survey Western Fisheries Research Center

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

Spatial and temporal changes in wakasagi abundance in the San Francisco Estuary



Japanese smelt or wakasagi *Hypomesus nipponensis* was introduced to California reservoirs in 1959. It was first detected in San Francisco Estuary (SFE) in 1990, after which it quickly gained a wide but patchy distribution and was found to hybridize, to some extent, with native delta smelt *Hypomesus transpacificus*. Wakasagi recruited locally by 2000 but remained uncommon for decades, with catch low, sporadic, and concentrated in Sacramento Deep Water Ship Channel (DWSC). Over much of this period, delta smelt was in steep decline before its population collapsed around 2021, when supplementation was initiated to avert extinction in the wild. By this time, the Enhanced Delta Smelt Monitoring (EDSM) program had begun catching wakasagi more regularly, in greater numbers, in more areas, and year-round. This renewed concerns about its potential for ecological and genetic interaction with the endangered delta smelt.

We used EDSM program data to quantify changes in wakasagi abundance and distribution in SFE. Catch data were compiled from Phase 3 (P3, juvenile + adult, Jul–Nov) and Phase 1 (P1, adult, Dec–Mar) surveys from December 2016 (EDSM est.) through March 2026. Phase 2 (larval) data were excluded because high morphological similarity between larval *Hypomesus* precluded confident identification to species. For comparison, we included hatchery-released and wild-born delta smelt captured in P3 and P1 over the same period.

Total wakasagi catch by cohort (P3 + P1) increased from 261 in 2017/2018 to 2259 in 2021/2022 and stayed elevated, at 4421, through 2025/2026. Catch remained concentrated in DWSC but seasonal (summer–fall) abundance in Suisun Marsh increased over time. Since supplementation began, total wakasagi catch (19751) exceeded that of hatchery-released (319) and wild-born (34) delta smelt by > 1 and > 2 orders of magnitude, respectively. These findings help advance understanding of conditions that govern wakasagi survival, recruitment, and influence on delta smelt

Speaker: Evan Carson, US Fish and Wildlife Service

Co-authors: Claudia Macfarlane, US Fish and Wildlife Service, Lodi Fish and Wildlife Office

Track: Invasive Species & Novel Ecosystems

What we know, what we don't, and what we're guessing: updated conceptual models of CV salmon life history (Part 2: Flow pulses and floodplains)



Scientists and non-scientists involved in resource management all have informal mental conceptual models of species life histories. These mental conceptual models have been consciously and unconsciously pieced from prior experience to form a baseline of existing beliefs and values, and then are regularly updated by new exposure to published and unpublished studies, personal or anecdotal observations, personal values, and other disparate sources of related and seemingly unrelated information. Our mental conceptual models guide new research ideas, development of management actions, and personal or institutional reactions to and evaluations of proposed and existing management actions, at which point they sometimes become formalized in print or digital media by our scientific experts, but not always, and these formalized expressions often lag new understanding. As a result, we continue to rely on our personal underlying conceptual models, which drive both conversations and conflict.

In this session, salmon scientists share how new (and old) information informs their current updated conceptual models of various aspects of Central Valley salmon life histories, highlighting what we know, don't know, and are guessing at, including speculations and hypotheses where uncertainty exists. The goal of this sharing is to provide a clearer and potentially more integrated understanding of what's going on with Central Valley salmon, particularly where new information and uncertainties have broader implications for salmon recovery and related resource management.

Management Relevance

Management frameworks and scientific consensus typically lag behind current thinking. The purpose of this session is to bring new insights to a wider audience to stimulate discussions that lead to broadener consensus and more clearly defined areas of disagreement and uncertainty, eventually speeding the dissemination and incorporation of updated conceptual models into updated management frameworks.

Speakers: Nicholas Som, California Polytechnical Institute, Humboldt; Eric Holmes, California Department of Water Resources

Tracks: Ecology, Food Webs, & Changing Ecosystems · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration



Lessons learned from 3 years of Sacramento River Spring Pulse Flows

Spring pulse flows have been touted as a way to temporarily recreate natural spring-season river conditions so as to restore ecological and geomorphological processes in highly regulated rivers. From 2024 to 2026, 7 unique spring pulse flow events were generated on the Sacramento River through increased releases from Keswick Reservoir, with the goal of boosting overall spring outmigration success for juvenile Chinook salmon (*Oncorhynchus tshawytscha*). Acoustic telemetry and rotary screw trap captures were used to measure pulse flow performance, and indicated a gradient of success across the 7 events. This gradient can provide insight into the elusive mechanistic underpinning for the flow-survival relationship, and thereby better inform pulse flow implementation in the future.

We take a hypothesis based approach and attempt to accept or refute different potential mechanisms, including 1) pulse flows increase salmon migration rates, thereby reducing temporal exposure to river stressors, 2) pulse flows decrease water temperatures, thereby increasing aerobic scope of salmon while slowing activity levels of predators, 3) pulse flows increase water turbidity, thereby decreasing the visual acuity of potential predators, 4) pulse flows alter striped bass (*Morone saxatilis*; a major salmon predator) latitudinal and cross-sectional distribution in the river during their spring spawning migration, thereby decreasing spatial-temporal overlap with migrating salmon, and 5) pulse flows increase the number of daily salmon migrants, thereby ensuring a larger portion of upper Sacramento River juvenile salmon initiate their migration during more suitable conditions. Finally, in light of the growing adoption of spring pulse flows in Central Valley rivers, we provide management recommendations based on the lessons learned on the Sacramento River.

Authors: Cyril Michel, University of California, Santa Cruz; Jeremy Notch, University of California Santa Cruz / NOAA Fisheries; Benjamin Burford, University of California, Santa Cruz; Brendan Lehman, University of California, Santa Cruz; Flora Cordoleani, NOAA - Southwest Fisheries Science Center; William Poytress, US Fish and Wildlife Service; Joshua Israel, United States Bureau of Reclamation

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System

A new method to implement natural flow regimes in regulated rivers: impacts to juvenile salmon habitat availability and movement

Rivers throughout the world have been dammed for flood control, irrigation, hydropower, and water storage for centuries. Dams service the economic and development needs of societies, but degrade the ecology of rivers. To conserve diminishing aquatic species and their habitats, methods are needed to help managers implement flow releases with timescales and patterns that are relevant to aquatic species and physical processes. We present a method to synchronize flow releases from dams with local hydrology, while ensuring constraints of flood control and water allocations are met. We demonstrate an optimization technique that scales flows of a proximal unregulated river and results in discharges that are synchronized with natural hydrologic patterns.

Importantly, our method preserves operational and regulatory requirements such as water allocation volumes and flood control thresholds. This technique can be used at various timescales, and can incorporate many system-specific constraints. We selected the Trinity River, California as an example, and scale flows according to a proximal gage on the Salmon River in California. We evaluate our technique using an array of flow regime metrics from the literature, and our method produced hydrographs with greater flow variation throughout a larger portion of the water year than current management strategies. These hydrographs yielded flow metrics more similar to those from unimpaired flow patterns, including those measuring within and among year flow variability. We finish with predictions of how RTM flows might impact aquatic species.

Speaker: Nicholas Som, California Polytechnical Institute, Humboldt

Track: Managing Competing Demands for Water

Partitioning Floodplain Productivity: Quantifying In-Situ Hot Spots and Allochthonous Inputs in the Yolo Bypass

Floodplains are widely understood as highly productive, dynamic environments which can provide increased lower-trophic resources to downstream food webs. Managed floodplains like the Yolo Bypass and the ecosystem services it provides remain critically important for species of concern such as juvenile Chinook salmon. Current monitoring of lower trophic productivity in the Yolo Bypass focuses on one site at the southern terminus, documenting output without investigating sources of productivity within the floodplain.

With the implementation of restoration efforts such as the Big Notch Project and the Lower Elkhorn Basin Levee Setback (LEBLS), illuminating the mechanisms that structure productivity in the Bypass has the potential to inform management decisions to maximize benefits for species of interest. An enhanced lower trophic sampling regime was designed with a focus on spatial variation, source attribution, and frequency. Weekly zooplankton sampling throughout the Yolo Bypass provided a comprehensive census of

community composition and productivity hotspots in the floodplain. Point and continuous water quality data were collected and analyzed with heat maps, principal components analysis (PCA), and end member mixing analysis (EMMA). Live zooplankton and Diptera were taken for stable isotope analysis at key sites. Juvenile salmon were monitored and subsampled for diets and stable isotopes across the Bypass. Our results emphasized the importance not just of inundation and residency time for production, but also of upstream water source constituents as a significant influence.

We documented significant zooplankton productivity at off-channel restoration sites like LEBLS, which were attributed to water source mixing and residency time. Finally, water quality monitoring revealed habitat-quality tradeoffs at some productive off-channel sites, emphasizing the importance of understanding gradients in connectivity and the varied impacts of management efforts.

Authors: **Amanda Niemela**, California Department of Water Resources; **Eric Holmes**, California Department of Water Resources; **Kristina Nguyen**, California Department of Water Resources; **Spencer Breining-Aday**, California Department of Water Resources; **Sydney Stark**, University of California, Davis; **Daniel Consolvo**, University of California, Davis; **Soffia Ramsey**, University of California, Davis; **Carson Jeffres**, University of California, Davis

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems · Water Quality, Contaminants, & Aquatic Health

Sentinel Fish: Revealing Landscape Scale Floodplain Habitat Dynamics for Juvenile Chinook Salmon Through Field Observations and Remote Sensing

Chinook Salmon face persistent declines driven by reduced habitat quality and quantity across life stages, with ecological and economic consequences for California. In the Sacramento Valley, agencies and stakeholders have invested heavily in floodplain restoration and flow management to improve juvenile salmon rearing conditions. Yet quantifying juvenile salmon responses across dynamic floodplain landscapes remains challenging.

We conducted a multi-year study in the Sutter Bypass and adjacent Sacramento River using a combination of controlled cages, lower trophic monitoring, diet analysis, and wild fish sampling to evaluate juvenile salmon growth potential/benefit under variable hydrologic conditions. Field measurements included water quality, zooplankton quantity, salmon growth response, and habitat occupancy across a range of inundation scenarios.

We then integrated these observations with Sentinel 2 satellite imagery to scale site-level habitat assessments to landscape-scale patterns. Our results reveal strong interactions between floodplain connectivity, water source attributes, water residence time, zooplankton production, and salmon growth response. High-connectivity conditions increased access to floodplain habitats but often reduced residence time, limiting growth potential. Conversely, longer residence times supported higher growth potential but occurred under more restricted connectivity.

These tradeoffs highlight the inherently dynamic nature of floodplain habitats and the importance of flood timing, duration, and spatial configuration in shaping juvenile salmon growth outcomes. By linking field observations with remote sensing, our approach identifies when and where floodplain habitats provide the greatest benefits for juvenile Chinook Salmon. These findings offer actionable guidance for land and water management aimed at restoring ecologically functional floodplain processes at landscape scales.

Speaker: Eric Holmes, California Department of Water Resources

Co-authors: Flora Cordoleani, NOAA - Southwest Fisheries Science Center; Fernando Romero Galvan, Department of Water Resources; Matthew Salvador, Center for Watershed Sciences, UC Davis; Rachel Johnson, NOAA Fisheries, Southwest Fisheries Science Center and UC Davis, Center for Watershed Sciences; Carson Jeffres, University of California, Davis

Track: Ecology, Food Webs, & Changing Ecosystems

Alternative underlying mechanisms of salmon movements in tidal habitat: implications for salmon and water management.

Talk is part of special oral session: What we know, what we don't, and what we're guessing: updated conceptual models of Central Valley salmon life history

We understand very little about how salmon move around and navigate across the channel network and habitats in tidal environments. This is especially true of juvenile salmon that migrate to the estuary soon after emergence and must rear in tidal habitat for extended periods until large enough to survive ocean entry.

Never-the-less, when high winter flows carry large numbers of juvenile salmon into the south Delta, water exports are managed based on untested and poorly defined conceptual models of how salmon movement and navigation respond to changes in south Delta tidal flow. Fundamental to these conceptual models is the expectation that movement responses to altered tidal flows will culminate in increased or decreased probability of salmon surviving and exiting the south Delta. This talk explores alternative conceptual models and hypotheses regarding mechanisms underlying salmon movement and navigation in tidal environments, and available information that supports or refutes each. It then considers the implications of these hypotheses for the potential effectiveness of managing tidal flows in the south Delta. Given the speculative nature of this talk, audience response and discussion is expected and welcomed to help further refine or refute presented alternative conceptual models.

Speaker: Brett Harvey, California Department of Water Resources

Tracks: Ecology, Food Webs, & Changing Ecosystems · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration

Lost in translation: Connecting water policy and science through a common language



In a complex and quickly evolving Delta system, scientists can benefit from learning and speaking the language of water policy to better inform decision-making. This abstract proposes a special oral session to highlight how information can flow most effectively from the science community to the Legislature and policymakers. This session will feature a moderated, fireside-chat-style discussion, followed by an opportunity for audience questions and panelist answers.

The panel will be asked to provide a look into the recent legislative session, highlighting key topics and emerging challenges relevant to the Bay-Delta such as invasive species control and flood risk.

The panel will be asked to reflect on ways in which scientific input, research, and products can be translated more effectively for those working in a fast-paced policymaking environment. Panelists with scientific backgrounds will also be asked to share perspectives on how to best communicate across discipline silos, and relevant lessons learned across their careers.

This session will be particularly relevant for scientists, aspiring or experienced science communicators, those working in the science-policy nexus, students, and early career individuals.

Session Chair: Audrey Cho

Speakers: Sonja Petek; Pablo Garza; Sean Clair; Keith Cialino

Track: Interdisciplinary Science & Cross-Knowledge Integration

Science for Communities: Community-driven research projects



The Delta Stewardship Council's Science for Communities program facilitates partnerships to explore environmental and social challenges in the Sacramento-San Joaquin Delta. Three groups are participating in the 2025-2026 cohort, each led by a Tribal representative or a community-based organization. Shingle Springs Band of Miwok Indians is promoting Tribal land and water stewardship through engaging Tribal youth members in hands-on environmental learning and community-based data practices.

Through the Indian Creek Science Blitz Youth Event, participants explored water quality, stream health, and safe fish consumption. The team is also creating a Tribal data portal that will support stewardship by enabling Tribal members to collect, share and apply environmental knowledge for managing the land. Valley Improvement Projects (VIP) is compiling information on three Stanislaus County groundwater basins in the San Joaquin Valley, including regulatory frameworks governing those basins and water quality conditions affecting disadvantaged communities.

This is shared in formats useful for residents, advocates, and decision makers to support community-driven solutions to reduce pollution. VIP is working to elevate agricultural and land management practices that reduce pollution, including composting, regenerative agriculture, and vegetative buffers. Sacramento Regional Coalition to End Homelessness is identifying and analyzing river health indicators at the confluence of the American and Sacramento Rivers in a report to understand and uplift the discourse related to pollutant sources, mitigation efforts, and the role of humans living in and managing the environment with a focus on encampment management.

The report will summarize river health indicators and data availability for the confluence in the context of local management actions and community narratives. Teams will share project objectives, approach, products, and barriers faced. Each group invites conference attendees to visit their exhibition hall booths.

For more information, see - <https://sciencetracker.deltacouncil.ca.gov/activities/science-communities>

Session Chair: Hannah Chaney, Delta Stewardship Council

Speakers: Niki Jones; Gavin Bruce; Zachary Gigone

Tracks: Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Exploring California water futures through interactive scenario learning and data visualization (WORKSHOP)



As climate change intensifies pressures on California's water system, there is a growing need for tools that help diverse audiences explore how different management strategies could shape our water future. This interactive workshop session will introduce COEQWAL (COLlaboratory for EQuity in Water Allocations), a collaborative research initiative that combines statewide water modeling, scenario analysis, visualization tools, and educational resources in a public-facing web platform to support more inclusive water planning and dialogue.

The session will combine short presentations with guided exploration of the platform. Participants will receive an overview of COEQWAL, review interactive water stories and focal project themes, and learn about exploratory water management scenarios, future hydroclimates, and approaches used to interpret modeled outcomes across ecosystem, agricultural, and community water objectives.

The session will also showcase Bay-Delta photography by Kike Arnal integrated on the platform to help connect modeled outcomes with lived landscapes and communities.

Participants will then engage directly with the platform through guided exercises focused on trade-offs, distributional equity, and resilience across scenarios. Interactive activities will allow attendees to investigate how alternative management strategies shape outcomes for the Bay-Delta ecosystem and the communities that depend on it.

The session is designed to foster collaborative learning and dialogue across scientists, practitioners, community members, and decision-makers while demonstrating how stories and interactive visualization tools can support more accessible and transparent interpretation of complex water modeling results. Participants will be asked to bring laptops for guided exploration activities. The workshop would ideally be held in a room with tables to support interaction and discussion.

Session Chair: Wietske Medema

Speakers: Ted Grantham; Nancy Thomas; James Gilbert, Institute of Marine Sciences, UC Santa Cruz, NOAA Southwest Fisheries Science Center; Morgan Levy

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Interdisciplinary Science & Cross-Knowledge Integration

Nature-based solutions in California and beyond: Cross-system learning on co-benefits and adaptive management



California has a long history of implementing innovative nature-based solutions (NBS) across the San Francisco Bay, the Delta, and upstream watersheds. Although terminology has evolved over the past 50 years, NBS have remained central to the state's efforts in restoration, water management, and climate resilience. As climate change and biodiversity loss accelerate globally, California has expanded its commitment to NBS through major landscape scale investments designed to reduce emissions, enhance ecosystem function, and strengthen long term resilience.

This work also creates a valuable opportunity for mutual learning both for California to benefit from the experience of other systems and for those systems to draw from the innovative approaches being advanced here.

The Delta Independent Science Board (ISB), mandated to provide scientific oversight of adaptive management, is scoping a review of how NBS are being implemented in the Delta.

To inform this effort, the ISB launched a panel series to explore the opportunities, challenges, and science needs associated with NBS, ensuring that any future review is both meaningful and useful to the Delta community.

Building on insights from the State agency panel in May 2026, this panel will examine how organizations within and beyond California apply NBS to achieve multiple co-benefits, and how adaptive management triggers and actions can be identified at scale.

To address these challenges, the panel will bring together practitioners and researchers from the Bay and Delta, as well as experts from outside the region, including Chesapeake Bay, Coastal Louisiana, and Puget Sound.

Discussions will focus on how co-benefits such as carbon sequestration, habitat enhancement, and flood risk reduction are being generated, measured, and communicated through NBS projects. These cross-regional insights help advance NBS and accelerate learning about what works, under which conditions, and at what scale.

Session Chair: Peter Goodwin

Speakers: Louise Conrad, California Department of Water Resources; Cindy Palinkas, University of Maryland; Denise Reed, LSU New Orleans; Tracy Collier, NOAA Fisheries (retired)

Co-authors: Evyan Sloane, California State Coastal Conservancy

Tracks: Nature-Based Solutions & Landscape Resilience · Interdisciplinary Science & Cross-Knowledge Integration

TUESDAY, SEPTEMBER 29, 2026 - SESSION 13 · 5 PRESENTATIONS

Adaptive management at work: Practitioner perspectives, restoration planning, and ecological outcomes



Speakers: Stephen Elser, Delta Stewardship Council; Mackenzie Miner, California Department of Water Resources DWR; Jordan Buxton, US Geological Survey; Phillip Street, U.S. Fish and Wildlife Service; Elsie Platzer, University of California, Davis

Towards Closing the Loop on Adaptive Management: Case Studies from Across the Delta

Objectives Statement:

Adaptive management (AM) is often hailed as an approach to addressing uncertainty in complex environmental decision-making scenarios to enable long-term success as changes unfold. It is required by the Delta Plan, which outlines three step-wise phases – “Plan,” “Do,” and “Evaluate and Respond” – to iteratively guide AM. Despite its theoretical promise, research has shown that there are relatively few examples in the peer-reviewed literature of projects and programs fully implementing all the elements of AM. The Delta Independent Science Board’s 2016 review of adaptive management in the Delta was consistent with this general finding in the academic literature, showing a meager use of AM in the system. Ten years later, there has been substantial AM progress in the Delta, but all steps of AM implementation may not be documented clearly. This study highlights examples of AM implementation in the Delta and explore what has enabled its widespread adoption.

Approach:

In 2025- 2026, Delta Stewardship Council staff interviewed staff from State agencies that are implementing AM and reviewed related literature to understand the full scope of AM across the Delta and Suisun Marsh. We identified how programs across various mission areas used AM to pursue their project and program goals. We mapped what we learned onto the AM cycle to highlight how AM is being implemented across different scales and project-types.

Results: What are your main findings?

We show that AM is widespread in the Delta with ten case studies demonstrating how AM is being used to pursue diverse goals. We found that the main pillars of success that have enabled widespread AM in the Delta are collaboration and coordination, best available science, regulatory frameworks, technology and infrastructure, and funding.

Speaker: **Stephen Elser**, Delta Stewardship Council

Co-authors: **Dylan Chapple**, Delta Stewardship Council; **Elizabeth Brusati**, Delta Stewardship Council; **Xoco Shinbrot**, Delta Stewardship Council; **Jonathan Huang**, California Sea Grant

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

From Mismatch to Management: Designing future flood regimes that work for fish and food webs

River-floodplain connectivity supports diverse ecosystem services, yet ecological responses to flood variability in managed floodplains remain difficult to predict because different trophic levels respond to distinct components of the flood regime. We analyzed 25 years of ecological data from the Yolo Bypass (California, USA), where the flood regime is driven primarily by existing infrastructure rather than natural hydrological processes.

We classified the existing flood regime in the Yolo Bypass to determine how it structures ecological communities, determine how these relationships may be impacted by flow restoration efforts, and how managers may operationalize ecosystem benefits.

Preliminary results indicate that primary producers and secondary consumers were most abundant during low-level flooding conditions, indicating that prolonged drainage of the floodplain and adjacent tributaries promote productivity of lower trophic levels. In contrast, Chinook salmon (*Oncorhynchus tshawytscha*) responded to discrete flood events in alignment with their phenology and life history.

These preliminary results demonstrate that the food web is impacted by different components of the flood regime, and that low-level flooding is critical for sustaining basal productivity.

Speaker: Mackenzie Miner, California Department of Water Resources DWR

Co-authors: Brock Huntsman, US Geological Survey, California Water Science Center; Matthew Young, U.S. Geological Survey; Nicole Kwan, FlowWest

Track: Ecology, Food Webs, & Changing Ecosystems



You Are What (and Where) You Eat: How Managed Shallow Water Habitats Shape Productivity and Potential Delta Smelt Growth

Conservation efforts for delta smelt (*Hypomesus transpacificus*) increasingly rely on hatchery supplementation, creating a need to expand rearing capacity and explore semi-natural conditioning environments to improve post release survival. Managed shallow-water habitats, such as carbon sequestration wetlands and artificial impoundments, may provide productive environments that support delta smelt conservation and reintroduction efforts.

To evaluate their potential, we assessed habitat suitability and productivity at two carbon sequestration wetlands on Sherman Island and four impoundments on Bacon and Bouldin Islands. Water quality conditions and zooplankton abundance and biomass were monitored monthly to quantify temporal variability of lower trophic levels for one year starting in April 2025.

We then implemented additional weekly sampling in spring 2026 to quantify carbon availability in the planktonic and detrital pathways, estimate primary and secondary productivity, estimate zooplankton grazing rate, and model daily net ecosystem productivity. We estimated delta smelt daily growth rates using a bioenergetics analysis framework, and modeled maximum habitat-specific population size using input-output bioenergetic rates driven by zooplankton production, water temperature, and turbidity.

Our findings can be used to optimize food web productivity to support delta smelt and diversify wetland management actions to deliver ecological benefits (including supporting imperiled species) while minimizing conflicts with water supply reliability.

Speaker: Jordan Buxton, US Geological Survey

Co-authors: Matthew Young, U.S. Geological Survey; Frederick Feyrer, U.S. Geological Survey, California Water Science Center; Brock Huntsman, US Geological Survey, California Water Science Center; Shawn Acuna, Metropolitan Water District of Southern California; Darcy Austin, State Water Contractors (SWC)

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

Near-term Restoration Strategy for the Central Valley Project Improvement Act Fish Resource Area, Fiscal Years 2026–2030



The Near-Term Restoration Strategy (NTRS) for Fiscal Years 2026–2030 provides a science-driven framework to advance the Central Valley Project Improvement Act's (CVPIA) goal of doubling anadromous fish populations in California's Central Valley. NTRS aims to enhance population resilience, connectivity, and spatial diversity, with a focus on prioritizing information needs and habitat restoration actions for Chinook salmon (four runs), Steelhead trout, and Green sturgeon.

To inform the development of this strategy, the CVPIA implementing agencies formed the Science Integration Team to participate in a structured decision making (SDM) process that integrates quantitative models, stakeholder input, and adaptive management principles. Decision support models (DSMs) were developed and refined to predict responses and identify key uncertainties to candidate restoration actions. Restoration priorities were informed by model simulations, expert judgment, and stakeholder engagement.

The SDM framework explicitly links restoration activities to measurable objectives.

Of the strategies considered, simulations highlight habitat restoration as the most effective strategy for Chinook salmon, with potential increases of up to 77% in adult production and 79% in juvenile biomass compared to the no-action alternative. For *O. mykiss*, habitat enhancement combined with temperature management in tributaries such as the Feather and Mokelumne Rivers offers the greatest benefit, while flow pulses alone provide minimal improvement. Green sturgeon recovery is best supported by thermal management in the Sacramento and Feather Rivers during spawning and rearing periods. Inter-taxa analyses underscore the need for integrated planning, as temperature increases for *O. mykiss* and sturgeon may negatively impact Chinook salmon.

The NTRS reaffirms the commitment to science-based decision making and collaborative efforts to restore Central Valley fisheries for long-term ecological resilience.

Speaker: Phillip Street, U.S. Fish and Wildlife Service

Co-authors: Rod Wittler, Reclamation; Daniel Levish, U.S. Bureau of Reclamation; Steve Whiteman, U.S. Fish and Wildlife Service; Adam Duarte, Forest Service; James Peterson, Oregon Cooperative Fish and Wildlife Research Unit

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Practitioner attitudes and approaches towards adaptive management in Bay-Delta tidal wetlands



Main body: In Bay-Delta wetland habitat restoration, adaptive management is a key framework that guides practitioner decisionmaking and project implementation. Adaptive management involves four discrete steps – planning, execution, evaluation, and response – which advance cyclically, allowing past outcomes to inform future site design and management. Yet in practice, regulatory constraints, time lags, and logistical hurdles disturb the idealized progression of the adaptive management “wheel.” Our study seeks to investigate how adaptive management is actually conceptualized and applied by wetland habitat practitioners working in the California Bay-Delta.

We conducted 36 semi-structured interviews with practitioners involved in some capacity with the planning, design, management, or evaluation of wetland habitats in the Bay-Delta region. Participants selected a single habitat restoration or management project of greatest familiarity, and were asked to detail project goals, describe the type and extent of on-site monitoring, and evaluate project outcomes through subjective, qualitative assessments. Interview responses were assessed through thematic coding. Though our results are preliminary, we will explore how practitioners varied broadly in their goal-setting processes, and how their perceptions of progress towards desired outcomes was at times unrelated to initial goals.

Speaker: Elsie Platzer, University of California, Davis

Co-authors: John Durand, UC Davis; Brett Milligan, University of California, Davis

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

TUESDAY, SEPTEMBER 29, 2026 - SESSION 14 · 5 PRESENTATIONS

Climate-driven water management and integrated modeling



Speakers: Michelle Stern, Delta Stewardship Council; Lindsay Murdoch, University of California, Davis Center for Watershed Sciences; Iftikhar Islam

Delta Modeling Collaboratory: facilitating integrated modeling to tackle complex management issues in the Delta



The Delta is a complex social-ecological system influenced by multiple environmental and social drivers, including precipitation, tides, climate change, agriculture, and urban water operations. Managing this system requires assembling vast data using modeling, synthesis science, and decision-support tools.

In 2025, the Delta Science Program launched three use-case projects to assess integrated modeling feasibility for key management themes:

- 1) predicting cyanobacterial harmful algal blooms;
- 2) evaluating salinity intrusion and management actions; and
- 3) restoring tidal wetland food webs. Diverse teams from academic institutions, government, and NGOs created project "profiles" identifying potential modeling approaches, existing leverageable resources, and critical gaps.

Operating these three projects simultaneously provides unique benefits by highlighting synergies, facilitating resource sharing, and enabling prioritization of activities supporting multiple initiatives. This holistic approach generates benefits for each individual project while establishing the foundation for the Delta Modeling Collaboratory—an intentional community of modelers and modeling resources supporting integrated modeling projects.

The Collaboratory's overarching vision is establishing a geographically based community centered on collaboration, innovation, and resource sharing. This framework not only advances individual project goals but creates a sustainable platform for ongoing Delta modeling efforts, enhancing the region's capacity for integrated environmental management and decision-making through coordinated scientific resources and expertise.

This talk shares updates and key findings from the Delta Modeling Collaboratory use cases focused on using modeling to address complex management challenges in the Delta.

Speaker: Michelle Stern, Delta Stewardship Council

Co-authors: Lisamarie Windham-Myers, Delta Stewardship Council; Maggie Christman, Delta Stewardship Council; Stephen Elser, Delta Stewardship Council; Nicholas Rowlands, Delta Stewardship Council; Denise Colombano, Delta Stewardship Council; Dave Senn, San Francisco Estuary Institute; Josue Medellin-Azuara, UC Merced; Steve Culberson, Delta Stewardship Council (Retired); Lisa Lucas, U.S. Geological Survey (Emeritus)

Tracks: Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Flow and Salinity Trends and Change Attribution in the San Joaquin River at Vernalis: WY 1922 - 2025



San Joaquin River (SJR) flow and salinity measured at Vernalis, a SWRCB D-1641 compliance location, are key indicators used to evaluate M&I, agricultural, and fish and wildlife beneficial uses of water entering the southern Delta. The purpose of this work is to evaluate how Vernalis flows and salinity (including major ions) have changed over the past century (WY 1922-2025) and identify key drivers associated with these changes.

The study's "how" question narrowly focuses on Vernalis; however, the "why" question necessarily requires an examination of upstream watershed conditions. Therefore, continuous and discrete data measured at Vernalis and several upstream locations were assembled and examined. Monthly averaged flow and salinity time series were created, and statistical methods were used to quantify trend and evaluate significance. Using these series, evolving relationships between flow and salinity were examined and modeled.

The magnitude and seasonal timing of flows and salt loads entering the Delta at Vernalis have continued to change over time since the early 1920s, with many of these change being nonlinear and statistically significant. The study period reflects extensive anthropogenic drivers of change throughout the watershed, including reservoir construction, CVP exports and imports, expansion of irrigated agriculture, introduction of wetlands management, capping of gas wells along the Tuolumne River and population growth. Recent drivers of change include the Grassland Bypass Project, the SJR Improvement Program, and the SJR Restoration Program.

The study period does not extend sufficiently far back in time to measure change from pristine or natural conditions, as substantial irrigated areas existed by the 1920s. Regardless, by closely examining how and why Vernalis flow and salinity have changed over time, findings from this work will inform and provide needed context to ongoing deliberations on water management in the SJR basin and the southern Delta.

Speaker: Paul Hutton, DWR

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Water Quality, Contaminants, & Aquatic Health

Beyond Water Year Types: Operationalizing interannual variability with environmental flow regimes



Environmental flows are managed flows that support resilient river ecosystems in altered and heavily managed systems. Resilient systems depend on temporal flow variability and spatial habitat heterogeneity to create opportunities for a diverse range of ecological functions and responses.

Yet implemented environmental flows in the Bay-Delta watershed often rely on a discrete set of water year types and fixed flow prescriptions that can be difficult to reconcile with the range of flow patterns that historically supported native ecosystems. Such coarse flow prescriptions are further challenged by altered landscapes, hydrologic uncertainty, and real-time operational constraints.

This presentation explores approaches for operationalizing environmental flow regimes in real-time that preserve patterns of seasonal- and interannual-variability using annual flow budgets that vary with hydrologic conditions.

Using a Functional Flows approach (see the California Environmental Flows Framework) as the basis for environmental flow designs, this work presents water year percentiles as a tool to translate unimpaired flow estimates into flow prescriptions that preserve the return intervals and interannual variability of ecological flow functions. This work further demonstrates how variability itself can become an objective of policy development and reservoir operations by using holistic environmental flow regimes as the basis for determining annual flow requirements and operating adaptively in real-time under hydrologic uncertainty.

Speaker: Lindsay Murdoch, University of California, Davis Center for Watershed Sciences

Co-authors: Sarah Yarnell, University of California, Davis, Center for Watershed Sciences; Francisco Bellido-Leiva, University of California, Davis, Center for Watershed Sciences; Jay Lund, University of California, Davis

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Which Decision Levers Matter? A Scenario-based Sensitivity Framework for Operational Tradeoffs in the Bay-Delta Water System of California's Central Valley



California's water management system relies on models whose applications are constrained by operational rules and water rights, yet it remains challenging to isolate how operational decisions interact across multiple objectives. Two questions guide this work: how do operational strategies shape system effectiveness, and which decision levers most significantly influence diverse and often competing objectives?

This study develops a sensitivity analysis framework for CalLite model outputs (1921 to 2003) to evaluate operational trade-offs among reservoir storage, water distribution, river flows, and Delta salinity. The operational structure encompasses both categorical factors, such as regulatory protection and priority allocation, and numeric drivers, including carryover storage targets, demand management, and minimum flow requirements, which complicate the assessment of diverse water resource measures.

To address this, we developed a scenario-driven framework that integrates full-factorial design, rank-biserial correlation, and variance ratio into a Combined Sensitivity Score (CSS) to quantify sensitivities across these five operational drivers. Results clarify the relative influence of operational policies: CSS varies over time and across conditions, with drier years showing higher sensitivity, indicating the system's vulnerability to drought. Demand reduction consistently has a significant ($p < 0.05$) impact on storage and deliveries, whereas removing D-1641 protections severely degrades salinity and outflow during drought, despite modest delivery gains.

Three-way interactions among demand reduction, minimum flow, and carryover targets produced the strongest system responses, underscoring the value of coordinated multi-lever strategies. The study provides a framework for evaluating management alternatives to enhance water resilience and serves as a transparent decision-support tool for adaptive and equitable practices in the Central Valley and the Bay-Delta system.

Speakers: Iftikhar Islam; James Gilbert, Institute of Marine Sciences, UC Santa Cruz, NOAA Southwest Fisheries Science Center

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Groundwater thresholds to protect riparian groundwater-dependent ecosystems



Groundwater supports many ecosystems globally, yet environmental groundwater needs are rarely acknowledged in water policy and management initiatives. Without adequate consideration of environmental groundwater needs, key groundwater-dependent ecosystems (GDEs) are at risk, as well as their biodiversity, provisioning, and climate protection functions. Over the last several decades, the integration of transdisciplinary research has greatly enhanced our ability to quantify how GDEs respond to groundwater decline, drought, and hydroclimatic variability.

Here we synthesize emerging approaches and innovations on traditional methods—from high-frequency groundwater monitoring, isotopic tracers, and tree-ring studies to multi-sensor airborne and satellite platforms — to reveal thresholds of ecological impairment and offer operational metrics for management. To address remaining challenges in resolving early warning indicators and incomplete monitoring frameworks, we outline a practical roadmap to incorporate ecological thresholds into sustainable management of groundwater and linked surface water, with specific recommendations for monitoring networks, indicators, and management triggers.

We discuss applications of these guidelines to policy and management challenges, including the California Sustainable Groundwater Management Act.

Tracks: Nature-Based Solutions & Landscape Resilience · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration

TUESDAY, SEPTEMBER 29, 2026 - SESSION 15 · 5 PRESENTATIONS

Decision support and modeling innovations for salmonid management



Speakers: Adam Witt, Stantec; Brian Mahardja, US Bureau of Reclamation; Patti Wohner, Stillwater Sciences; Adam Pope, US Geological Survey Western Fisheries Research Center

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Rapid Structured Decision Making to Explore Salmon Reintroduction Prototype Strategies in the Sacramento Valley



Reclamation coordinated a rapid Structured Decision Making (SDM) effort to identify and evaluate habitat, facility, hatchery, and reintroduction actions that could improve outcomes for endangered Sacramento River winter-run Chinook salmon (WRCS) while operating Shasta Dam under existing operational regimes. Reclamation initiated this SDM process as a transparent, repeatable, and science-informed approach to broaden the solution space for improving WRCS outcomes beyond coldwater pool management and identify actions that could be explored in future planning and regulatory discussions.

The SDM followed the PrOACT framework (Problem, Objectives, Alternatives, Consequences, Tradeoffs) and was implemented through 14 workshops over 12 weeks with participation from 26 organizations representing 12 participant groups, including Tribal interests, public water agencies, state and federal resource agencies, non-governmental organizations, and the commercial fishing community.

Participants articulated WRCS objectives and performance metrics spanning abundance, productivity, life-history diversity, and tributary support, as well as implementation time and cost and potential impacts to other listed fishes. Individual actions proposed by participants were consolidated into a set of 35 unique actions and combined into 14 portfolios representing distinct strategic themes (e.g., near-term “low-hanging fruit,” drought-focused actions, hatchery-focused actions).

Consequences were estimated using a combination of numerical modeling and expert judgment, with modeled metrics derived from an integrated framework linking CalSim 3, HEC-5Q, and a customized winter-run lifecycle model. Results showed higher scoring portfolios share common features like expanding access to, and use of habitat above Shasta Dam, while lower scoring portfolios increased supplementation without comparable increases in habitat access or availability.

Speaker: Adam Witt, Stantec

Co-authors: Cat Pien, FlowWest; Liz Stebbins, FlowWest; Mark Tompkins, FlowWest; Joshua Israel, United States Bureau of Reclamation; Kristen Hiatt, Reclamation; Karen Jenni, Insight Decisions; Stephen Maurano, Stantec

Track: Decision Science & Adaptive Mindsets in a Dynamic System

A structured decision-making framework for balancing salmon conservation and hydropower at Folsom Dam



Managing water temperature in regulated rivers requires navigating trade-offs between ecological conservation and economic demands. These competing objectives frequently result in conflict, which is typically resolved through positional bargaining between parties. Structured Decision Making (SDM) offers an alternative path by decomposing complex problems and incorporating stakeholder values.

We applied this SDM framework in fall 2025 to evaluate power bypass operations at Folsom Dam on California's American River, an action that provides cooler thermal regimes for Chinook salmon at the cost of forgoing hydropower generation. Our framework integrated a reservoir temperature model with a salmon life-cycle model to evaluate nine operational alternatives across four meteorological scenarios and three competing temperature-dependent mortality (TDM) formulations.

Assuming constant environmental conditions outside the targeted juvenile life stage, we found that power bypass alternatives could increase salmon abundance by up to 46% (from adult population index of 7,602 to 11,077), with associated replacement power costs ranging from \$111,422 to \$470,090. Multi-criteria decision analysis enabled transparent evaluation of these trade-offs. While a low replacement power cost alternative ranked highest, decision-makers ultimately selected an intermediate action that better balanced fisheries benefit against hydropower generation. Furthermore, value of information analysis revealed that uncertainty surrounding TDM models had low decision relevance, suggesting the management choice is robust despite unresolved scientific uncertainty.

This case study demonstrates how SDM can transform contentious deliberations into a more defensible, collaborative process, providing a scalable model for balancing competing public goods in regulated river systems.

Speaker: Brian Mahardja, US Bureau of Reclamation

Co-authors: Alex Vaisvil, Reclamation; Wes Harrison, U.S. Bureau of Reclamation; Kevin Thielen, U.S. Bureau of Reclamation; Vanessa Martinez, Kleinschmidt Group

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Finding Collaborative Solutions

Linking dam operations to Chinook salmon population dynamics: a life-cycle model for evaluating Folsom Dam power bypass alternatives



Reservoir power-bypass operations at Folsom Dam release deep cold water to reduce fall thermal stress on lower American River fall-run Chinook salmon (*Oncorhynchus tshawytscha*) but forgo hydropower generation. Evaluation of candidate bypass operations has been complicated by disagreement over temperature-dependent mortality (TDM) models, with different formulations predicting opposite effects on salmon production.

To provide a transparent quantitative basis, we developed an age-structured life-cycle model linking daily CE-QUAL-W2 reservoir temperatures to adult escapement through empirical relationships calibrated to 2011–2024 carcass surveys, redd counts, and escapement data. Spawn timing was modeled with a cumulative-link submodel driven by October–November temperatures, and pre-spawn mortality with a degree-day function.

Egg-to-fry survival used three competing TDM formulations: the linear-threshold model of Martin et al. (2017) and exponential models of Bratovich et al. (2020) and Bartholow & Heasley (2006). A flow-dependent Beverton–Holt capacity from weighted usable area imposed density dependence at the fry stage, followed by fixed juvenile survival and age-structured ocean returns parameterized from coded-wire-tag data.

We projected nine interest-holder alternatives across four historical meteorological scenarios and the three TDM models over 100-year horizons. Alternative rankings were broadly consistent: a sustained high-flow bypass yielded the highest projected adult index (11,073; 46% increase) versus 7,600 under no bypass.

The worst-performing alternative varied by TDM choice, with the linear-threshold model uniquely predicting net harm from several short-duration bypasses. Results informed 2026 fall-run management on the American River and provide insight into TDM model selection in regulated Central Valley rivers.

Speaker: Alexander Vaisvil

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Finding Collaborative Solutions

Decisions with Doubt: Using decision Support Models in Data-poor Systems

Establishing safe passage for migratory fish through water diversion facilities is often a priority for resource managers. Mitigation measures to reduce impacts of water diversions on migratory populations are often species and river specific and based on ad-hoc or trial and error.

Modelling-based approaches to decision-making can significantly reduce cost and time to achieve successful mitigation, but managers are often reticent to adopt a modelling approach due to concerns over lack of data. However, modelling approaches that have capacity to evaluate assumptions through a range of uncertainty through sensitivity analyses can allow decision-makers to assess both parameter uncertainty due to lack of data and how the inherent uncertainty affects alternative management decisions.

These modeling approaches can also highlight where future research effort and dollars are best spent, or whether implementing the decision immediately has the largest payoffs for the output of interest, typically survival.

Here, we explore such an approach by combining disparate and varying quality data on steelhead (*Oncorhynchus mykiss*) smolt migration and hydraulic modelling data. We illustrate that a perceived lack of data does not preclude using the best available science combined with assumptions based on expertise, or even hand-wavy guesses to make informed decisions.

We determined that in a southern California watershed with a few good studies on smolt migration integrated with missing or poor-quality data, sensitivity analysis enabled explicit evaluation of trade-offs across management scenarios. Even where parameter uncertainty was substantial, the relative costs and benefits of alternative actions remained stable. This allows managers to identify robust decisions without waiting for additional data collection.

This framework gives risk-averse managers a structured, transparent method for navigating uncertainty while still prioritizing outcomes that benefit the resource.

Speaker: Patti Wohner, Stillwater Sciences

Co-authors: Terra Dressler, Stillwater Sciences; Christopher Caudill, Stillwater Sciences; Matt Drenner, Stillwater Sciences; Randall McInvale, United water Conservation District

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Policy & Management Showcase

STARS for South Delta steelhead: Linking environmental and operational covariates to juvenile steelhead movement and survival in the Sacramento-San Joaquin Delta



Resource managers are charged with mitigating risks to the threatened steelhead (*Oncorhynchus mykiss*) population in the Sacramento-San Joaquin Delta ("Delta"), yet tools to predict San Joaquin-origin juvenile steelhead movement and survival remain sparse. In a prior study, we linked environmental and operational covariates to steelhead survival, routing, and travel time using 6 years of acoustic-tagged steelhead data.

However, we found that collinearity among 3 covariates (river discharge at Vernalis, total exports, and Old and Middle River index; OMRI) precluded modeling more than a single covariate in a given region. Thus, we fit 3 separate models, each with a single covariate for all parameters and regions (Pope et al. 2025).

The objective of the current study is to fit a single model, with one covariate chosen in each region of the Delta, that best explains steelhead movement and survival.

To determine which covariate was most important within each region of the Delta, we conducted an elicitation process adapted from the Delphi technique with subject matter experts across agencies and organizations. Elicitation resulted in consensus on covariates in 3 of 4 regions of the Delta, with opinion divided in the 4th region, representing the downstream San Joaquin River.

We then fit 3 models that included the covariates recommended by elicitation, and differing only in the covariate included for the downstream San Joaquin region. We present here results from model comparison of these 3 fits and recommendation for a final model, which will enable development of a STARS (Survival, Travel time, and Routing Simulation) type predictive tool for juvenile steelhead migrating through the Delta.

Pope, A.C., R.W. Perry, D.J. Hance, and R.A. Buchanan. 2025. Survival, travel time, and use of migration routes by juvenile steelhead in a modified river estuary. *Estuaries and Coasts* 48: 75.

Speaker: Adam Pope, US Geological Survey Western Fisheries Research Center

Co-authors: Cat Pien, FlowWest; Brian Mahardja, US Bureau of Reclamation; Russell Perry, U.S. Geological Survey - Western Fisheries Research Center

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Envisioning and evaluating Chinook Salmon recovery scenarios: from new insights to new futures



Session Abstract

Recovery actions for Central Valley salmon over the past several decades have not achieved recovery goals or even arrested continuing declines. To address growing frustration over this continued failure, two new efforts have taken a new approach to recovery planning by expanding participation beyond government agencies to diverse and often underrepresented parties that have social, cultural, or economic interests in how water and salmon are managed. These processes have likewise led to expanded perceptions of what salmon recovery and equitable outcomes for water management entail, and the kinds of actions that salmon recovery scenarios can or need to encompass.

This session describes outcomes from these efforts, including what successful salmon recovery will require both ecologically and socially, and what it will take to get us there.

Management Relevance:

Recovery of salmon and equitable use of water and other resources are inexorably linked, but only recently has this link been explicitly addressed through inclusive and equitable planning processes. While the outcomes of these processes provide clear guidelines for resources managers, the recommended recovery scenarios are not directed funded. However, currently funded government programs for recovering salmon can use these guidelines to organize existing recovery activities and to identify additional components that are still needed for success.

Session Chair: Brett Harvey, California Department of Water Resources

Speakers: Noble Hendrix, QEDA Consulting LLC; Rachael Ryan, University of California Davis; Natalie Stauffer-Olsen, Trout Unlimited; Carson Jeffres, University of California, Davis

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Finding Collaborative Solutions

Evaluating reintroduction quality with the winter-run life cycle model



Prior to the construction of the Shasta Dam, Chinook salmon spawned in the tributaries originating near Mount Shasta, including the McCloud River. Currently, there is interest in reintroducing Chinook to those spring-fed ancestral waters due the thermal refuge that such habitats can provide, particularly during the summer months.

Multiple designs for the reintroduction are being proposed, such as volitional, semi-volitional, or trap and haul, and we propose a conceptual model that defines biological reintroduction rates common to all designs. The common rates are adult routing, adult survival, juvenile routing, and juvenile survival, which are required to complete the life-cycle from below Keswick to the McCloud and back. Importantly, the reintroduction quality must achieve specific target rates to ensure that it has a positive population effect and does not cause a population sink. What should those targets be?

NOAA Fisheries Southwest Science Center has developed a winter-run life cycle model (WRLCM) to evaluate how management actions can facilitate the recovery of winter-run Chinook. We developed a reintroduction sub-model for the WRLCM and modeled the population as if there had been reintroduction to the McCloud from 1995-2020. The McCloud population varied asynchronously with the population below Keswick, indicating a buffering ability of the reintroduced population particularly during dry and critical water years.

Reintroduction quality with rates > 0.95 on average were required to achieve equivalent levels of escapement as a baseline condition in the absence of reintroduction. Reintroduction rates can covary to achieve similar levels of population response, and we developed a portfolio of rates to map the tradeoffs among them. Our findings support reintroduction as a recovery action for winter-run Chinook, and provide targets for biological rates that can facilitate the design of reintroduction alternatives.

Speaker: Noble Hendrix, QEDA Consulting LLC

Co-authors: Elizabeth Greene, Anchor QEA, LLC; John Ferguson, Anchor QEA, LLC; Doug Jackson, QEDA Consulting; Ann-Marie Osterback, Fisheries Collaborative Program, University of California, Santa Cruz

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Evaluating winter-run Chinook salmon population response to novel COEQWAL water allocation scenarios

Water allocation throughout California's Central Valley must balance municipal, agricultural, health and safety, and environmental demands. The Collaboratory for Equity in Water Allocation (COEQWAL) project evaluates how these competing needs are met under current practices and alternative futures with varying climate and management assumptions. As part of COEQWAL, we used the winter-run Chinook salmon life cycle model (WRLCM) to evaluate population responses of Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*). We ran the WRLCM across 24 distinct COEQWAL operational scenarios under historical hydrology. Our results suggest scenarios that maintain current practices fall short of supporting winter-run recovery. Although they still fall short of recovery goals, scenarios allocating water across multiple freshwater lifestages provide the largest population benefit.

Specifically, scenarios prioritizing both Shasta Reservoir storage and environmental flows outperform all others by lowering water temperature to maximize egg-to-fry survival while providing instream flows to support outmigration survival. However, under warmer or drier climate futures, scenario performance degrades across the board.

In these extreme futures, scenarios prioritizing reservoir storage perform best because summer egg-to-fry survival becomes the limiting factor. To explore solutions beyond hydrology alone, we evaluated these scenarios assuming a subset of eggs are reintroduced into the McCloud River, where spring-fed conditions remain cool. Ultimately, these findings suggest that hydrology actions alone may be insufficient for long-term recovery under changing climates and recovery will require pairing alternative water allocations with targeted habitat restorations, such as reintroduction to the McCloud River.

Furthermore, this case study demonstrates how biological models can integrate with the broader COEQWAL project to evaluate regional trade-offs and synergies.

Authors: Ann-Marie Osterback, Fisheries Collaborative Program, University of California, Santa Cruz; Noble Hendrix, QEDA Consulting LLC; James Gilbert, Institute of Marine Sciences, UC Santa Cruz, NOAA Southwest Fisheries Science Center; Eric Danner, Fisheries Collaborative Program, University of California, Santa Cruz

Track: Managing Competing Demands for Water



Beyond one basket: Scientific advances and emerging strategies for rebuilding a resilient winter-run Chinook salmon portfolio

Central Valley Winter-run Chinook salmon (WRCS) are one of the critically endangered species that rely on the Sacramento-San Joaquin Delta for key parts of their life cycle. Having evolved in the spring-fed, high elevation streams, the entire natural-origin spawning population is now concentrated outside of its historical range, within a relatively small reach below Keswick Dam. This is effectively forcing WRCS to put all their eggs in one basket, leaving the population highly vulnerable to drought, water management challenges, and other disturbances. The risk of extinction is further amplified by the increased contribution of hatchery-origin returns in recent years, underscoring the importance of supporting resilient, natural-origin populations in habitats where they can thrive.

Here, we synthesize recent scientific advances that have improved our understanding of WRCS ecology and inform a broader approach to recovery.

Specifically, we highlight research demonstrating (1) the importance of strategically managing cold-water resources during critical windows of development to support egg incubation and early-life survival; (2) the role of diverse rearing and migration habitats, including off-channel environments, in increasing juvenile growth opportunities and life-history diversity; (3) insights into differences between wild and hatchery-origin fish and their implications for population resilience; and (4) efforts to restore life-history strategies and create spatial redundancy through reintroduction to historical spring-fed habitats such as the McCloud River.

Collectively, this body of work reflects an evolution in WRCS management: from protecting a single remaining spawning population to rebuilding a more diverse and resilient portfolio across spawning, rearing, and migration stages. By connecting recent scientific findings with management actions, we highlight emerging opportunities to support winter-run recovery in an increasingly variable future.

Speaker: Rachael Ryan, University of California Davis

Co-authors: Kohma Arai, Center for Watershed Sciences, UC Davis / Japan Fisheries Research and Education Agency; Miranda Bell Tilcock, UC Davis Center for Watershed Sciences; Danhong Ally Li, University of California Davis; Carson Jeffres, University of California, Davis; Rachel Johnson, NOAA Fisheries, Southwest Fisheries Science Center and UC Davis, Center for Watershed Sciences

Tracks: Nature-Based Solutions & Landscape Resilience · Finding Collaborative Solutions

Reorienting to Recovery and Making the Future Full of Fish

The Reorienting to Recovery (R2R) effort set out to create a values-driven, scientifically robust, inclusive, and achievable pathway toward Chinook Salmon recovery in California's Central Valley. R2R engaged a diverse constituency over three years and three phases: first, recovery was defined through a scientifically transparent, inclusive process; second, relationship-building workshops used storytelling to characterize the social, cultural, ecological, and economic values tied to recovery; and third, Structured Decision Making and updated salmon life-cycle models evaluated and integrated recovery scenarios spanning habitat, hydrology, harvest, and hatchery actions (the 4H's). The result is a scientifically supported, broadly owned, achievable roadmap to recovery.

We learned that no single action, even an extreme one, can recover salmon, and that currently planned efforts, while essential, will fall short.

Only coordinated, multi-pronged scenarios, including dry-year actions and flows, can attain defined recovery thresholds. Just as important, R2R built a shared understanding and common story among participants, fostering durable trust across historically siloed interest groups. We also distilled transferable lessons: ground the work in trust and the collective wisdom of those concerned; weave science and Traditional Ecological Knowledge into a common story; meet people where they are; and use consensus, belonging-oriented decision-making. We are now advancing from collective vision to collective implementation by mapping modeled actions to real-world efforts, including in the Upper Columbia Basin.

By moving beyond silos toward shared dreams, R2R offers a replicable approach for reimagining how we envision, evaluate, and pursue salmon recovery.

Speaker: **Natalie Stauffer-Olsen**, Trout Unlimited

Co-authors: **Rene Henery**, Trout Unlimited and University of California, Reno; **Darcy Austin**, State Water Contractors (SWC); **Erin Cain**, FlowWest; **Alison Collins**, California Department of Water Resources; **Brian Crawford**, Compass Resource Management; **Sherri Norris**, California Indian Environmental Alliance; **Rafi Silberblatt**, Kearns and West

Tracks: Systems Thinking for the Whole Ecosystem · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

California - A Salmon Society?

Historically, California was a land of abundant natural resources. Indigenous communities from time immemorial lived in reciprocity with the land and water. One of these resources was prolific populations of Chinook salmon. People cared for the salmon, and the salmon provided for Northern California's peoples.

The diversity of rivers and habitats throughout Northern California led to the evolution of 4 distinct runs of Chinook salmon (winter, spring, fall, and late-fall) named for the time of year that they arrived in freshwater to begin their upstream migration toward spawning grounds. This life-history diversity meant that there were adult salmon in the Central Valley rivers almost every month of the year. The diversity of life histories and habitats resulted in one of the largest Chinook salmon populations in the world.

Yes, California was once a “salmon society” - meaning a society of people that relied on and valued healthy rivers and the fishes that lived within them, but following the arrival of European settlers, that changed rather quickly. Alterations of rivers, changing priorities, changing climate, and a society that no longer recognizes the historical connection with their local resources led to precipitous declines and lack of recovery in Central Valley Chinook populations. One question that remains is: can we have recovery without societal connection?

Biologists, resource managers, and interest groups need the support of the general public to realize meaningful change. This talk will focus on the history of salmon and people in Northern California, how that changed following European settlement and what we are doing now through science, management and outreach to help salmon populations recover and reconnect communities with their local ecosystems.

Speaker: Carson Jeffres, University of California, Davis

Tracks: Ecology, Food Webs, & Changing Ecosystems · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Just Transitions in the Delta: Co-designing, modeling, visualizing and assessing salinity and climate adaptation scenarios



The Sacramento-San Joaquin Delta (Delta) is increasingly vulnerable to salinization of its waters (salinity intrusion). Contributing factors include upstream water diversions, reservoir operations and water exports; tidal forces; and the aggregating effects of climate change, including warmer temperatures, rising seas, shifts in precipitation patterns, more intense droughts). Changes in Delta salinity impact fresh water supplies, Bay-Delta Estuary health, recreation, and multiple economic sectors. Managing Delta salinity is a “wicked problem” of complex interrelated phenomena, competing values and concerns, and the pressing need for climate adaptation.

Just Transitions in the Sacramento-San Joaquin Delta: Drought, Salinity and Sea Level Rise (Just Transitions) is a UC MRPI research project that addresses salinity management through a transdisciplinary participatory scenario planning process.

The project hypothesizes that trust and co-learning (across social, technical and scientific domains) can be fostered through a transparent and collaborative public process of designing, modelling and assessing multiple adaption scenarios for the Delta.

Through a transdisciplinary approach, robust public and diverse expert engagement has been integral to project research and outcomes, including participation with vulnerable and less represented groups. This session is organized into (2) 100-minute interactive sessions to share project results:

Session 1: Co-Designing, Modeling and Visualizing Future Scenarios: Details the six Delta adaptation scenarios and how they were co-designed, modeled and creatively visualized in publicly accessible formats.

Session 2: Assessing and Comparing Scenarios: Details how the scenarios were scientifically evaluated across 5 prioritized criteria: ecology, environmental justice, eco-cultural restoration and Indigenous sovereignty, recreation, and economy.

Please see full list of presentation titles and speaker names separately provided to

Session Chair: Brett Milligan, University of California, Davis

Speakers: Stacie Carter; Maggie Gallagher, UC Davis; Sam Yu-Te Lee, UC Davis; Lynette Williams Duman, University of California, Davis; Ashley DePew, UC Davis; Jeff Jenkins; Josue Medellin-Azuara, UC Merced

Tracks: Nature-Based Solutions & Landscape Resilience · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Designing Delta Climate Adaptation Scenarios through a Transdisciplinary and Participatory Scenario Planning Approach

The Sacramento-San Joaquin Delta (Delta) is increasingly vulnerable to salinization of its waters (salinity intrusion), with many complex factors contributing to this vulnerability. Changes in salinity impact fresh water supplies, Bay-Delta Estuary health, recreation, and many economic sectors. *Just Transitions in the Sacramento-San Joaquin Delta: Drought, Salinity and Sea Level Rise* is a research project addressing salinity management through a transdisciplinary participatory scenario planning (PSP) process.

This presentation details how the *Just Transitions* project's set of adaptation scenarios were co-designed and iteratively refined through PSP research methods, including the application of semi-structured interviews, public workshops and expert forums.

Results of this process are six scenarios and prioritized criteria for their comparative assessment.

The scenarios include *Business as Usual* (current baseline); *Calling on Reserves*, which entails strategic changes in upstream reservoir operations. Four scenarios that entail physical changes to the Delta include *A Tunnel* (the Delta Conveyance Project), *Bolster and Fortify* (a reinforced through-Delta corridor), *Eco Machine* (strategically located tidal marsh restoration), and *New Green Watershed*, a scenario that entails systemic restoration and subsidence-reversing land uses with the Delta, as well as habitat restoration at the watershed scale and land co-management/land back to tribes. Scenarios will be illustrated through narratives, maps and diagrams, along with a description of the comparative scenario evaluation criteria.

The presentation will also share the results of surveys from public workshops synthesizing participants' qualitative responses to the project's co-design process, which demonstrate increased trust and co-learning.

This presentation is the first session in a special session focused on the *Just Transitions in the Delta* project and serves as a foundation for subsequent presentations.

Speaker: Brett Milligan, University of California, Davis

Tracks: Nature-Based Solutions & Landscape Resilience · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Comparative Hydrodynamic Modeling of the Just Transitions in the Delta Scenarios



The Just Transitions water quality modeling study presents two-dimensional water quality modeling results developed to assess how major restoration and operations concepts within the Just Transitions framework influence estuarine salinity and water age under present conditions and with sea level rise. Four geometry scenarios—Base, Eco Machine, New Green Watershed, and Bolster and Fortify—and two operations scenarios—Tunnels and Calling on Reserves—represent a range of potential future Delta configurations and management.

The geometry changes were evaluated over a two-year simulation period using common boundary conditions with and without sea level rise to isolate scenario-driven effects. The operations changes were evaluated with and without sea level rise over the same two-year period using the Base geometry to isolate operations-driven effects.

Salinity dynamics were assessed using electrical conductivity (EC), summarized through spatial heat maps, time-series analyses, and monthly averages. Initial findings indicate that large restored areas modified Delta operations can reduce EC in key channels, shift salinity gradients, and enhance connectivity between restored and adjacent regions.

In parallel, the study evaluates water age as an indicator of hydrodynamic residence time and the relative influence of Delta inflows. Simulation results for all scenarios reveal how restoration footprints and modified Delta operations affect retention and exchange.

Together, these results provide a comparative technical foundation for evaluating ecological performance, operational flexibility, and systemwide trade-offs among the Just Transitions alternatives. The completed scenario set supports ongoing planning discussions and informs future decision-making for Delta management.

Speaker: Stacie Carter

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health

Quantifying the Benefits of Watershed-Scale Upland Restoration through Scenario-Based Modeling



The Just Transitions in the Delta project envisions, models, and evaluates six future management scenarios and their effects on salinity in the Delta. Through participatory scenario planning, the public expressed that modeling the effects of upper watershed habitat restoration on the Delta was a top research priority. This aligns with growing understandings that landscapes like montane forests, wet meadows, and riparian areas constitute “natural infrastructure” supporting California’s water system.

This research responds to public interest by asking, what are the holistic benefits of restoring montane forest, wet meadow, and floodplain habitats, and what are the effects of implementing restorations at watershed scale? We address these questions through an extensive scientific literature review and scenario-based modeling approach.

Through a review of research evaluating benefits of upland restorations, we established a holistic understanding of hydrological, ecological, ecocultural, carbon, and water quality benefits. We developed quantitative metrics reflecting benefits received per area restored through cross-comparison of results. Scenario-based modeling evaluated nine restoration scenarios, varying based on levels of investment and habitat prioritized, and generating estimates of the benefits of implementing restorations at watershed scale.

We find that forest restorations generate additional runoff due to reduced evapotranspiration, ranging from an additional 65 - 570 TAF/year in minimal restoration scenarios to 1,900 - 3,970 TAF/year in maximal scenarios - a meaningful portion of the 9 million AF additional water supply called for in DWR’s 2028 Water Plan. Restorations also store carbon, with annual soil carbon storage ranging from 2,200 - 7,700 MG/year in minimal scenarios and from 22,000 - 123,000 MG/year in maximal scenarios.

Expanding floodplain and meadow area also provides essential habitat and refugia from climate change, wildfire and other threats.

Speaker: Maggie Gallagher, UC Davis

Co-authors: Brett Milligan, University of California, Davis

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Interdisciplinary Science & Cross-Knowledge Integration

Communicating Delta Adaptation Scenarios through Interactive Visualization



The Just Transition project employs participatory planning to co-design and evaluate climate adaptation strategies with the public in the Sacramento-San Joaquin Delta. To scientifically reason across diverse trade-offs, interdisciplinary teams generate scientific findings spanning hydrodynamics, ecology, environmental justice, recreation, and economic outcomes. These findings vary in spatial extent, temporal scale, disciplinary framing, and technical depth, making it challenging to communicate them back to the public. Consequently, we aim to develop an interactive web platform that transforms interdisciplinary findings into intuitive visualizations.

To ensure public-facing visualizations are scientifically faithful, the data visualization designers employ various strategies such as co-designing and co-learning with interdisciplinary scientists. As a result, key findings are identified, translated into visualizations, and integrated into a coherent narrative on the web platform, while allowing readers to explore specific details of the findings in depth.

In this talk, we will present the iterative design process behind the platform and discuss the visual communication strategies used to organize complex research findings for non-expert audiences. In doing so, we demonstrate how visualization can assist participatory planning of complex scenarios by making interdisciplinary findings accessible to diverse public audiences.

Speaker: Sam Yu-Te Lee, UC Davis

Co-authors: Yun-Hsin Kuo, University of California, Davis; Kwan-Liu Ma, University of California, Davis

Tracks: Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

TUESDAY, SEPTEMBER 29, 2026 - SESSION 19 · 5 PRESENTATIONS

Multi-benefit wetlands spanning carbon, subsidence, ecology, and indigenous stewardship



Speakers: Diane McKnight, Delta Independent Science Board; David Julian; Adan Barrera, California State University East Bay; Nick Christen, HydroFocus Inc.; Ramona Swenson, Environmental Science Associates

Track: Interdisciplinary Science & Cross-Knowledge Integration

Science to Inform Management of Subsided Lands in the Sacramento-San Joaquin Delta



Across the Sacramento-San Joaquin Delta, draining of historic freshwater tidal wetlands for agricultural cultivation has resulted in degradation of carbon-rich peat soils and associated loss of land surface elevation – a phenomenon known as subsidence.

Consequently, subsidence in the Delta contributes to greenhouse gas (GHG) emissions and increases hydrologic pressure on more than 1,100 miles of levees, which enhances flood risk and requires costly management action to maintain the viability of agricultural lands. A key tool for mitigating subsidence involves re-inundation, such as wetland restoration, rice cultivation, floating tule wetlands, and wetland-crop mosaics.

The Delta Independent Science Board (ISB) conducted a review to understand science advancements and gaps related to efforts to a) slow or reverse subsidence and b) reduce or reverse GHG emissions from the Delta.

This review was based on the ISB's reflections from a 2023 workshop, discussions with subject matter experts, public comments, and a literature review.

This presentation will detail key findings and recommendations from the review. For example, evidence shows that managed wetland restoration, rice cultivation, and floating tule wetlands can help slow or reverse subsidence in areas of the Delta while generating co-benefits such as carbon sequestration, habitat restoration, and potential economic opportunities for farmers when shifting to rice production. To build on these lessons, the ISB recommends continued investment in long-term monitoring to track outcomes of rewetting projects and understand rates of methane and nitrous oxide emission with different management practices.

Additionally, more coordinated efforts to incentivize landscape-scale projects and reduce technical or financial barriers to land conversion are needed. Despite these gaps, the Delta has a strong scientific foundation and regional expertise to advance subsidence research and land management practices moving forward.

Speaker: Diane McKnight, Delta Independent Science Board

Co-authors: Alyssa Burns, Delta Stewardship Council; Tanya Heikkila, Delta Independent Science Board; Thomas Holzer, Delta Independent Science Board; Kristine Grace Cabugao, California Sea Grant, Delta Independent Science Board; Edmund Yu, Delta Stewardship Council

Track: Nature-Based Solutions & Landscape Resilience

It Takes a Village: A Model for Managing Subsidence Reversal Wetlands in the Delta



The CA Department of Water Resources (DWR) has developed over 3,000 acres of managed wetlands projects on Sherman and Twitchell Islands in the Delta with goals of subsidence reversal, carbon sequestration, and habitat. The wetlands projects require long-term and adaptive management to achieve these goals. Management activities are coordinated by the West Delta Program (WDP), a State Water Project program within DWR. The WDP relies on a portfolio of partners to achieve its management objectives.

The WDP primarily partners with local Reclamation Districts (RDs) for each island to maintain the wetlands. However, this work is not in the RDs' primary purview, which is maintaining the islands' levees and internal drainage. As a result, there can be gaps in delivering the wetland's water and vegetation management needs.

Under DWR's current management construct, other entities are needed to fill these gaps, including local Resource Conservation Districts, Sacramento/Yolo Vector Control District, and CA Department of Fish and Wildlife among others. UC Berkeley and Cal State East Bay provide scientific research monitoring that informs water and vegetation management decisions. Recently, engagement with Tribes to expand co-stewardship opportunities has also become part of the management portfolio. There is also coordination that occurs between different Divisions within DWR.

Implementation of these wetlands demonstrates that successful restoration depends on collaboration and joint decision-making among multiple entities. Utilizing partners has created a nimble management approach capable of adaptively managing these projects, as well as a common purpose to ensure these wetlands achieve their various goals. However, it requires resources and extensive coordination. At the same time, persistent resource constraints and the need for frequent coordination highlight limitations that may challenge this approach's ability to scale to future wetland projects across the Delta.

Speaker: David Julian

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Measuring indigenous fire effects on soil, water, vegetation and atmospheric flux measurements in Sacramento-San Joaquin Delta wetlands

Indigenous groups in Northern California have historically used fire as a land stewardship practice in the Sacramento–San Joaquin River Delta. Indigenous fire stewardship is used to both reduce fuel loads and promote the growth of fresh tules, a culturally important species.

While fire temporarily reduces the biomass carbon pool, the “black carbon” left behind is recalcitrant and can increase long-term soil carbon storage. Reducing dead biomass may also promote new vegetation growth by allowing more light penetration into the canopy.

However, very little is known on the carbon cycling impacts of Indigenous fire stewardship in wetlands in the Delta today. On February 27, 2026, researchers in California conducted a prescribed burn to approximately 30 acres of restored wetland in the East End section of Twitchell Island in the Sacramento-San Joaquin Delta.

The wetland was restored as part of the Twitchell Island East End Wetland Restoration Project, which has restored approximately 750 acres of wetland habitat across Twitchell.

The burned wetland was dominated by *Schoenoplectus pungens* (Tule) and *Typha spp.* (cattail). Adjacent to the burned wetland is another wetland of similar characteristics that served as a control site. Both sites were equipped with eddy covariance towers monitoring carbon dioxide, methane and water vapor exchange. In addition, soil cores and biomass clip plots were collected. We hypothesize that enhanced light penetration will lead to higher gross primary productivity (GPP) and overall higher net carbon sequestration.

As the burn was conducted under high water table conditions, we do not expect the burn to have combusted any peat material. Therefore, we hypothesize that soil cores will be similar between sites. Results from this study will improve understanding of how cultural burning influences wetlands in the Delta and help shape future policy on ecosystem management on ecosystems in the Delta and across California.

Speaker: Adan Barrera, California State University East Bay

Co-authors: Patty Oikawa, California State University East Bay; Tyler Anthony, California Department of Water Resources; Dennis Baldocchi, UC Berkeley; Molly Ferrell, California Department of Water Resources; Don Hankins, California State University, Chico; Tony Marks-Block, California State University, East Bay; Kyle Delwiche, UC Berkeley

Track: Interdisciplinary Science & Cross-Knowledge Integration

Interdisciplinary Assessment of implementation of alternate land uses on subsided peatlands, Sacramento-San Joaquin Delta



Consequences of Delta peatland subsidence include decreased arability, increased threat to levee stability which can jeopardize California's water supply, significant greenhouse gas emissions, and ecosystem degradation. The 2024 Delta Plan calls for increased area of land uses that stop subsidence and sequester carbon to support California's 2050 carbon emission reduction goals. Our overall objective was to employ an interdisciplinary assessment of alternate land uses on subsided farmed lands through evaluation of 7 land-use mosaics and a corn/rice rotation on Staten Island. We quantified greenhouse gas emissions (GHG) reductions, subsidence mitigation, economics, and ecosystem and wildlife effects. Using biogeochemical modeling, micrometeorological, soil, land surface and hydrologic data, we quantified spatially variable GHG emissions and removals and land-surface elevation changes. We quantified ecological and economic effects of land use changes through modeling, data collection and analyses.

Eddy covariance (EC) and temporally and spatially variable soil and hydrologic data illustrated the interaction of available organic matter, soil temperature and water content, and depth-to-groundwater in determining the GHG emissions and removals for current conditions which played an important role in determining gross primary productivity and ecosystem respiration rates and the consequences of a rice/corn rotation. Mosaics with large areas of wetlands resulted in the largest estimated GHG emissions reductions while scenarios with primarily rice emissions reductions were less.

We demonstrated the profitability of mosaics that include rice and wetlands. For most waterbirds we observed increased foraging and roosting habitat potential with a greater extent of managed flooding. Across all species, post-harvest field management was a driving factor in bird response. Wetlands, especially tidal wetlands, offer the greatest potential ecosystem benefits.

Speaker: Nick Christen, HydroFocus Inc.

Co-authors: Steven Deverel, HydroFocus Inc.; Savannah Haas, HydroFocus Inc.; Robert Walsh, Point Blue; Greg Golet, The Nature Conservancy; Alison Whipple, San Francisco Estuary Institute; Spencer Cole, University of California, Merced; Marc Olds, Hydrofocus Inc.

Track: Nature-Based Solutions & Landscape Resilience

Rethinking Restoration and Compensatory Mitigation in the Sacramento–San Joaquin Delta: From Expectations to Realistic Outcomes



Ecological restoration in the Sacramento–San Joaquin Delta is increasingly expected to support multiple habitat functions and multiple listed and sensitive species, each with distinct and sometimes conflicting requirements. Realizing these objectives in implementable projects is constrained by site availability, geomorphic setting, levee infrastructure, invasive species, long-term management, and growing competition for land across restoration and water management programs.

This presentation examines the gap between idealized frameworks, regulatory expectations, and real-world feasibility. Conceptual designs often depict integrated habitat mosaics that co-locate multiple habitat types within a single footprint. While visually compelling, these representations can imply broad compatibility and transferability of restoration objectives, assumptions that are rarely supported in highly altered Delta landscapes, particularly where species-specific needs diverge.

At the same time, compensatory mitigation is often framed as replacing specific habitat types within narrowly defined geographies, even where underlying processes no longer support those conditions.

We present a typology-based approach that emphasizes discrete but complementary habitat configurations, rather than attempting to replicate all functions and species requirements at a single site. This framework supports a shift from prescriptive habitat targets to a more flexible, function-based approach that allows innovative designs to achieve ecological objectives where exact habitat replication is not feasible.

Restoration and mitigation are best approached as a coordinated, landscape-scale portfolio supporting ecological function and resilience. Key themes include aligning objectives with achievable conditions, incorporating flexibility to address site-specific constraints, and setting realistic expectations where mitigation assumptions may overestimate the ability to co-locate functions and species needs.

Speaker: Ramona O Swenson, Environmental Science Associates

Co-authors: Chris Fitzer, Environmental Science Associates; Erich Fischer, Environmental Science Associates; Paul Stumpner, ESA

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem

TUESDAY, SEPTEMBER 29, 2026 - SESSION 20 · 5 PRESENTATIONS

Which way to go? Influencing juvenile salmon migration at Georgiana Slough



Speakers: Steven Brumbaugh, California Department of Water Resources; Summer Burdick, U.S. Geological Survey - Western Fisheries Research Center; Paul Stumpner, ESA; Aaron Blake, Environmental Science Associates

Track: Managing Competing Demands for Water

Georgiana Slough Salmonid Migration Barrier Effectiveness Studies – Assessing Behavioral Fish Guidance in the North Delta



Losses of listed juvenile salmonids in the interior Sacramento-San Joaquin Delta have long been a concern for fish and water managers. The combination of a highly altered system, an abundance of introduced species, and fisheries that have been built around these introduced species adds complexity to what is already a challenging problem.

One proposed solution to this problem is to route fish away from the interior Delta, through the mainstem Sacramento River, thereby reducing their exposure to predation and water diversions in the interior Delta and improving their through-Delta survival. In 2011 and 2012, a Bio-Acoustic Fish Fence (BAFF) was investigated as a way to keep juvenile salmonids out of the interior Delta by guiding them away from Georgiana Slough, and the results indicated that it was successful at re-routing fish.

Based on results from the previous BAFF studies, the barrier was re-aligned to address some of the hydrodynamic complexity and observed fish behavior at the head of Georgiana Slough and re-configured for improved reliability. DWR began operation of the Georgiana Slough Salmonid Migratory Barrier (GSSMB) project in the fall of 2023.

In parallel with installation and operation of the GSSMB, DWR has conducted an annual effectiveness study to evaluate the performance of the GSSMB, delta survival, and north Delta routing of juvenile Chinook Salmon. This study has used acoustic telemetry to assess survival and routing from Freeport, CA, through the Sacramento-San Joaquin Delta to Chipps Island during barrier operations. Here we will present the study design, implementation, and preliminary routing results from the first three years of the GSSMB operation.

Speaker: Steven Brumbaugh, California Department of Water Resources

Co-authors: Shahid Anwar, California department of Water Resources; Roger Padilla, CA Department of Water Resources

Tracks: Managing Competing Demands for Water · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Bioacoustic Fish Fence Design Effects on Juvenile Chinook Routing and Survival



Pacific salmon face substantial challenges when migrating through anthropogenically modified river systems, such as the Sacramento-San Joaquin River Delta (the Delta). The bioacoustic fish fence (BAFF) is a non-physical barrier that uses lights, sound, and a bubble curtain to guide fish away from hazards without obstructing water flow.

However, the BAFF's effectiveness depends on factors like barrier design, environmental conditions, and fish behavior. At Georgiana Slough in the Delta, there have been multiple BAFF deployments that vary in shape and stimulus composition to deter juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from migrating into the interior Delta, a region associated with low survival. We leveraged nearly two decades of acoustic telemetry data collected across run types — late fall-run and fall-run — to evaluate BAFF performance on routing across flow conditions and three BAFF designs (2011/2012, 2024, and 2025).

BAFF designs varied in shape and the 2025 BAFF lacked a bubble curtain. We then compared observed 2025 routing and survival to model-estimated outcomes under two counterfactual scenarios using the same flow conditions: no BAFF and a 3-stimuli BAFF design based on the 2024 configuration. We found that BAFF, regardless of design, significantly reduced routing into Georgiana Slough for all run-types, but the 2025 BAFF was significantly less effective for fall-run fish. Through-Delta survival reflected these differences in routing, with the full BAFF scenario resulting in the highest survival, especially for fall-run fish.

Our results provide valuable insights into how barrier design, run type, and environmental conditions interact to influence barrier effectiveness, and inform future management strategies for protecting migrating juvenile Chinook salmon in the Sacramento River Basin.

Speaker: Summer Burdick, U.S. Geological Survey - Western Fisheries Research Center

Co-authors: Maggie Raboin, U.S. Geological Survey; Russell Perry, U.S. Geological Survey - Western Fisheries Research Center

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Multistate models reveal how flow dynamics affect juvenile Chinook salmon movement at the Georgiana Slough junction

Juvenile Chinook salmon migrating through the Sacramento-San Joaquin River Delta encounter a highly altered river network where migratory route strongly influences survival. At the Georgiana Slough junction, fish are routed either into the interior Delta — where survival is comparatively low — or continue along the Sacramento River toward the ocean. Complex hydraulic conditions at this junction, including flow reversals during flood tides, can cause fish to move back and forth through the junction multiple times before committing to a single route.

Despite this complexity, most prior analyses have condensed each fish's full movement history into a single routing event, potentially obscuring the hydraulic and behavioral mechanisms that drive routing.

We addressed this limitation by applying a continuous-time multistate Markov model to acoustic telemetry data from 5 different years that span nearly two-decades. Our model incorporated the complete detection history of individual smolts across three receiver arrays representing distinct junction states: the Sacramento River above the junction, the Sacramento River below the junction, and Georgiana Slough.

This framework allowed us to estimate transition rates among states as a function of hydraulic conditions, behavioral factors, and non-physical barrier operations, decomposing each driver's contribution to fish movement. By modeling the full sequence of fish movements rather than a single routing outcome, we gained greater insight into the effects of management actions and environmental covariates on smolt behavior.

Our results advance understandings of the hydraulic and behavioral processes governing routing at a critical junction in the Delta and inform ongoing management of juvenile Chinook salmon.

Speaker: Maggie Raboin, U.S. Geological Survey

Co-authors: Summer Burdick, U.S. Geological Survey - Western Fisheries Research Center; Russell Perry, U.S. Geological Survey - Western Fisheries Research Center

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Novel methods to generate velocity fields for use in an Individual-Based Model (IBM) of fish movement in the Bay-Delta



Models that assess fish movement, routing, and survival are critical for planning and designing water conveyance and fish passage infrastructure in the tidally influenced Sacramento–San Joaquin Delta. Understanding how fish interact with velocity patterns is essential for effective passage design.

We present novel methods for generating velocity fields across the Delta. These approaches combine publicly available data—such as gage station records and digital elevation models—to produce two-dimensional (2D) velocity fields suitable for multi-year, Delta-wide simulations of fish movement. Traditional hydrodynamic models at this scale can be computationally intensive, particularly when evaluating multiple long-term scenarios.

To address this, we developed efficient methods that generate representative velocity fields with complexity matched to required output detail. In hydrodynamically simple regions we use 1D velocity measured at reach boundaries with hydraulic scaling to construct 2D fields along the channel. In more complex areas—such as bends, junctions, and proposed infrastructure sites—higher spatial resolution and accuracy are required. In these regions, targeted data collection captures key features (e.g., secondary circulation, jets, and eddies), and a novel interpolation approach is used to produce high-resolution 2D velocity fields.

These velocity fields are integrated into an IBM to simulate fish movement and provide estimates of fish travel time, spatial distribution, and entrainment. The methods have been calibrated and validated at multiple Delta locations. While further work is needed for full Delta-wide application, initial results suggest these approaches can provide resource managers with practical and reliable tools for decision-making in complex aquatic systems, such as the Delta.

Speaker: Paul Stumpner, ESA

Co-authors: Aaron Blake, Environmental Science Associates; Jon Burau, USGS

Track: Managing Competing Demands for Water

An extension of the STAIRS-IBM that simulates juvenile salmon movement in Delta channels based on water velocity gauge data and bathymetry data



Individual based models (IBMs) of fish movement have been used in the Delta to simulate the effects of management actions and infrastructure construction on the routing, survival, and travel time of outmigrating juvenile salmonids. One of the downsides of most IBMs is that they require the output of extensive hydrodynamic model simulations as inputs to the IBM.

To overcome this limitation, the USGS developed the STAIRS-IBM to simulate the movement of juvenile salmon in tidally forced junctions utilizing water velocity maps derived from field measurements that could be generalized to the full range of hydraulic forcing in north Delta river junctions.

The STAIRS-IBM allowed researchers to simulate interactions between juvenile salmonids and potential fish guidance structures over a 15-year historic Sacramento River hydrograph as part of the design process for the 2024 Georgiana Slough BAFF.

In this talk we present an extension of the STAIRS-IBM that utilizes a novel method for estimating water velocity patterns in Delta reaches using publicly available water velocity gauge data and Delta bathymetry surveys. This approach to estimating water velocity makes it possible to simulate two dimensional movements of juvenile salmon in rivers throughout the Delta using historic gauge data with no new data collection or hydrodynamic modeling required.

We demonstrate application of the model by simulating the movement of juvenile salmon in the Sacramento River from Ryde, CA to downstream of Isleton, CA. Using this simulation we explore potential models of outmigration behavior by comparing modeled travel time distributions to observed travel time distributions for acoustically tagged juvenile salmon.

Speaker: Aaron Blake, Environmental Science Associates

Co-authors: Paul Stumpner, ESA

Track: Managing Competing Demands for Water

Through the looking glass: A conversation between regional high school students and state leaders in science and resource management



In this facilitated conversation, State Natural Resource science and stewardship leaders Dr. Lousie Conrad, Lead Scientist for the CA Department of Water Resources and Meghan Hertel, Director of the CA Department of Fish and Wildlife engage with regional high school students around their respective perspectives on the challenges and opportunities that lie ahead for the greater Central Valley, Bay-Delta ecosystem. The group discussion, moderated by Conference Co-Chair Dr. Rene Henery, will span topics ranging from present day challenges in resource management to generational orientations to the climate crisis and social-political polarization with a focus on co-thinking solutions, connecting across differences, and exploring possibilities for greater intergenerational collaboration moving forward.

Session Chair: Rene Henery, Trout Unlimited and University of California, Reno

Speakers: Louise Conrad, California Department of Water Resources; Meghan Hertel; Delta Youth Representatives

Just Transitions in the Delta: Co-designing, modeling, visualizing and assessing salinity and climate adaptation scenarios



The Sacramento-San Joaquin Delta (Delta) is increasingly vulnerable to salinization of its waters (salinity intrusion). Contributing factors include upstream water diversions, reservoir operations and water exports; tidal forces; and the aggregating effects of climate change, including warmer temperatures, rising seas, shifts in precipitation patterns, more intense droughts). Changes in Delta salinity impact fresh water supplies, Bay-Delta Estuary health, recreation, and multiple economic sectors. Managing Delta salinity is a “wicked problem” of complex interrelated phenomena, competing values and concerns, and the pressing need for climate adaptation.

Just Transitions in the Sacramento-San Joaquin Delta: Drought, Salinity and Sea Level Rise (Just Transitions) is a UC MRPI research project that addresses salinity management through a transdisciplinary participatory scenario planning process.

The project hypothesizes that trust and co-learning (across social, technical and scientific domains) can be fostered through a transparent and collaborative public process of designing, modelling and assessing multiple adaptation scenarios for the Delta.

Through a transdisciplinary approach, robust public and diverse expert engagement has been integral to project research and outcomes, including participation with vulnerable and less represented groups. This session is organized into (2) 100-minute interactive sessions to share project results:

Session 1: Co-Designing, Modeling and Visualizing Future Scenarios: Details the six Delta adaptation scenarios and how they were co-designed, modeled and creatively visualized in publicly accessible formats.

Session 2: Assessing and Comparing Scenarios: Details how the scenarios were scientifically evaluated across 5 prioritized criteria: ecology, environmental justice, eco-cultural restoration and Indigenous sovereignty, recreation, and economy.

Session Chair: Brett Milligan, University of California, Davis

Speakers: Stacie Carter; Maggie Gallagher, UC Davis; Sam Yu-Te Lee, UC Davis; Lynette Williams Duman, University of California, Davis; Ashley DePew, UC Davis; Jeff Jenkins; Josue Medellin-Azuara, UC Merced

Tracks: Nature-Based Solutions & Landscape Resilience · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Using Scenario Planning and Hydrodynamic Modeling to Inform Suitability Models for Stakeholder-Selected Species of Interest in the Sacramento-San Joaquin Delta

Just Transitions in the Delta (Just Transitions) combines a scenario-planning framework with hydrodynamic modeling to explore how future landscape configurations of the Sacramento-San Joaquin Delta may impact salinity within the greater estuary.

Using hydrodynamic outputs for temperature and salinity at strategic point locations throughout the San Francisco Estuary, we seek to assess future changes that widespread landscape reconfiguration will have on economics, recreation, water quality, and the ecology of the region. The ecology subteam surveyed public workshop participants in June 2025 to select aspects of Delta ecology that were of particular interest.

Participants outlined several invasive species (*Egeria densa* and *Potamocorbula amurensis*), native fish (longfin smelt and Chinook Salmon), and non-native fish (striped bass) that were of interest, in addition to larger scale processes such as food web production and aquatic habitat availability.

We took these species and processes of interest and constructed a series of habitat suitability models using pre-existing long-term monitoring data and pre-existing abiotic thresholds established in the literature.

Using the hydrodynamic outputs, we used daily maximum salinity and temperatures to construct suitable days during critical time periods for the species of interest and used the proportion of suitable days in specific regions of the San Francisco Estuary to establish where, when, and how different potential future landscape configurations will impact each species. We found that Suisun Marsh consistently had the highest amount of variation under different scenarios, aligning with our current understanding of hydrodynamic patterns.

Our method establishes a framework that can be followed with future hydrodynamic modeling efforts to directly connect species' abiotic constraints to salinity and temperature outputs to better understand how landscape and flow can interact to expand or contract species distributions.

Speaker: Lynette Williams Duman, University of California, Davis

Co-authors: Elsie Platzer, University of California, Davis; John Durand, UC Davis

Tracks: Invasive Species & Novel Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration



Comparing Delta Adaption Scenarios through Environmental Justice, Ecocultural Restoration and Tribal Sovereignty Criteria

Environmental justice (EJ) communities are those who bear disproportionate, undue burdens of climate change and a degraded environment. In the Sacramento-San Joaquin Delta, all communities, to varying degrees, are vulnerable due to the interplay of environmental and social conditions. Further, Indigenous groups have historically been marginalized and are inherently also EJ communities. Transformative change requires intentional consideration of these communities, and outcomes that align with their values; the Just Transitions participatory scenario planning project scenarios were assessed through these lenses.

The Just Transitions project extensively engaged EJ and Tribal communities via interviews, surveys, and workshops to create and assess future salinity and climate management scenarios for the Delta. EJ, ecocultural restoration and Indigenous sovereignty scenario evaluation criteria were developed based on values and concerns important to these communities.

EJ metrics assessed included salinity impacts to drinking water systems, flood risk, and harmful algal blooms. Each metric considered spatial aspects of outcomes in terms of Delta locations classified as moderate, high, and highest vulnerability; these classifications were derived from Delta Adapts' Vulnerability Index.

Ecocultural restoration and Indigenous sovereignty metrics included restoration of native ecosystems and ecosystem functions; increased access to landscapes for stewardship, subsistence, ceremony, and cultural practices; implementation and application of Indigenous science/traditional ecological knowledge; and recognition and application of Indigenous sovereignty, Tribal governance, and rights.

This presentation will share methods and results of the application of this assessment to modeled scenarios yielded comparative rankings highlighting the benefits and tradeoffs across potential management actions, which, in turn, facilitates informed decision-making through an EJ perspective.

Speaker: Ashley DePew, UC Davis

Co-authors: Brett Milligan, University of California, Davis

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Recreational response to runoff and salinity levels in the Delta

Climate variations can affect access to outdoor recreational opportunities through different mechanisms that influence the provisioning of water and ecosystem services. For instance, ecological resources that underpin fisheries and waterfowl vary between drought and wet years, and salinity typically increases when runoff is lowest during the drier parts of the season.

Landscape restoration and infrastructure projects also influence opportunities for recreational access in site-specific ways. Our objective is to compare recreation activities in the Delta that are directly (boating, birding) or indirectly (day use, waterfowl hunting) dependent on water resources to inform future scenarios related to hydrology, restoration, and infrastructure. We assess seasonal differences in monthly visitor volume and timing among dry- and wet-runoff classes and across a salinity gradient.

Data on hydrologic runoff from the Sacramento River and San Joaquin River watersheds and modeled in-Delta salinity are used to assess the hydroclimatic influence on publicly accessible recreational sites throughout the Delta. Visitor data at state parks and wildlife areas were obtained for activities with peak use in summer (boaters, day use) and winter (birding, waterfowl hunting).

We find that in summer, dry runoff conditions are associated with substantially lower-than-average levels of boaters (-61.6%) at state park units, while for day users, visitation drops on average (-13%) for critical runoff conditions. In winter, for birders, dry runoff conditions were associated with significantly lower access (-29.8%), and for waterfowl hunters, critical runoff was associated with significant increases in takes (50.2%).

There are substantially less boaters under a -10% runoff scenario, associated with increased salinity, compared to the baseline at Suisun Bay and Central Delta marinas, particularly in late summer. Through monthly EC/salinity averages we assess recreation use by exceedance thresholds.

Authors: Jeffrey Jenkins, University of California, Merced; Isaac Sanchez, University of California, Merced

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration

Assessing Impacts of Future Delta Salinity Management Scenarios on Delta Agricultural Production

The Sacramento–San Joaquin Delta faces converging pressures from climate change, sea-level rise, and freshwater competition. As droughts intensify, reduced outflow allows salinity to migrate farther into the Delta, raising irrigation water salinity and reducing farm productivity. These losses extend beyond the farm gate, displacing workers and weakening a regional economy dependent on Delta agriculture.

Yet the economic magnitude of salinity-induced damage, which crops and communities are most affected, and how impacts vary across management alternatives remain poorly understood. This study measures these damages under the Delta Just Transition scenarios, historical baseline, Eco Machine, New Green Watershed, and others, to place agricultural costs alongside ecological and water-supply benefits on a common scale.

The framework links four models in sequence.

CalSim 3 scenarios drive the SCHISM hydrodynamic model, producing scenario-specific salinity estimates across Delta agricultural lands mapped from the 2020 LandIQ dataset. Salinity is converted to root-zone concentrations using drainage-efficiency adjustments, then entered into crop-specific tolerance functions to estimate yield losses. Yield losses feed OpenDAP, an optimization model that calculates revenue changes and least-cost crop mixes under land and water constraints. Revenue changes pass through IMPLAN to measure downstream effects on employment, value added, and total output.

Preliminary results from three outflow baseline runs bracket the current operating range. Losses are small but spatially concentrated: almonds experience the greatest damage, the South Delta suffers five to six times the losses of the North Delta, and a small number of western islands account for most total production loss.

A 30 percent outflow increase cuts aggregate yield loss roughly in half; a 10 percent reduction raises it by 45 percent. Full results across the Just Transition scenarios will be presented.

Speaker: Josue Medellin-Azuara, UC Merced

Co-authors: Yu Cai, University of California, Merced

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Water Quality, Contaminants, & Aquatic Health

Delta Trivia Showdown



You've been learning non-stop at the Bay Delta Science Conference and now it's time to put that knowledge to the test! Can you identify a slough from an aerial photo alone? How well do you know your Delta fishes? What initiatives help California plan for the future?

Join us for a 1-hour game of Delta Trivia over lunch, where teams will compete for grand prizes across themes like Delta ecology, history, planning, and more.

One special round will spotlight the 2026 Delta Science Plan. This "how to" document for Delta science is structured around the four grand challenges facing the Delta: anticipating new conditions, rapid environmental change, decentralized flows of information, and siloed decision-making.

To address the grand challenges of Delta science, and of Delta trivia, we will have to work together. Grab your lunch, join a team, and learn something new from your co-hosts at the Delta Stewardship Council and more!

Session Chair: Hollis Jones, Delta Stewardship Council

Tracks: Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

TUESDAY, SEPTEMBER 29, 2026 - SESSION 24 · 4 PRESENTATIONS

The making of a marsh: How science shapes tidal wetland restoration in the San Francisco Estuary



Speakers: Susan De La Cruz, U.S. Geological Survey; Lyndsay Rankin, University of California, Davis, Center for Watershed Sciences; Kyle Stark, San Francisco Estuary Institute; Cassie Pinnell

Track: Nature-Based Solutions & Landscape Resilience

Structural and functional recovery of the benthic community after a shallow-water sediment placement in South San Francisco Bay



Rising sea levels and declining sediment supply threaten tidal marsh resilience, prompting interest in nature-based solutions such as strategic sediment placement to sustain mudflats and marshes that can help protect wildlife habitat and shoreline infrastructure. In 2023, the U.S. Army Corps of Engineers placed 73,000 cubic meters of dredged sediment offshore of Eden Landing Ecological Reserve, creating a series of morphologic features, or mounds, on the Bay floor that were finer, less dense, and contained less shell material than the surrounding native sediment.

The USGS evaluated the response of the benthic community at the placement site using a Before-After-Control-Impact design to quantify effects of the placement on the benthos, including potential structural effects on invertebrate densities and community composition and functional effects on prey energy availability for commercially important fish species and essential fish habitat.

Additional sampling at 6 and 12 months was included to understand community recovery and the duration of effects. Preliminary results from a subset of samples suggested that invertebrate density was significantly lower immediately following the placement but largely rebounded by 6 months.

Community composition differed significantly among treatment periods, mainly due to early colonizing taxa like Cumacea and Amphipoda, which appeared in high densities shortly after dredge placement. Larger, more energy dense invertebrates such as bivalves that provide important prey for demersal fish had not returned by 12 months post placement, suggesting that functional recovery of the benthic community at the placement site may take longer than structural recovery.

Our results can help inform decisions about the frequency, magnitude, and spatial extent of future strategic placement projects in the Bay to help maximize benefits to mudflats, marshes, and infrastructure while minimizing unintended consequences to essential fish habitat.

Speaker: Susan De La Cruz, U.S. Geological Survey

Co-authors: Laurie Hall, U.S. Geological Survey; Stacy Moskal, USGS Western Ecological Research Center; Tanya Graham, USGS Western Ecological Research Center; Isa Woo, USGS Western Ecological Research Center; Julie Beagle, U.S. Army Corps of Engineers, San Francisco District

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems

Tidal marsh restoration design can maximize potential climate benefits



The Sacramento-San Joaquin River Delta supplies fresh water to millions of acres of farmland and two-thirds of California's population. Fresh water from the Delta mixes with saltwater from the San Francisco Bay forming the largest estuary on the Pacific Coast. It is an extensive agriculture, recreation, and species rich habitat that is threatened by changes in freshwater availability, flooding, sea level rise, and invasive species.

Located at the confluence of the Sacramento and San Joaquin Rivers, Dutch Slough was purchased by the CA Department of Water Resources in 2003. The restoration from agriculture land to a tidal marsh was designed to provide habitat for native species, contribute to scientific understanding of ecological restoration under an adaptive management framework, and provide shoreline access and educational opportunities. After extensive planning, site engineering, and native vegetation planting, the restoration was breached to tidal waters in 2021.

Our team monitored marsh development and ecosystem function by assessing geomorphic processes, water quality, plant community response, and carbon sequestration/cycling. We documented variable changes in marsh elevation based on the geomorphic structure of the site as well as expansion of native marsh vegetation. Water quality monitoring continues to record tidal influence in water level, salinity, and temperature. Greenhouse gas emissions varied spatially and temporally across the site.

Seasonal carbon flux patterns were more similar to reference tidal marshes compared to pasture and impounded lands. Lower elevation areas recorded greater CO₂ uptake while mid elevation areas recorded greater methane emissions one year following the breach, mirroring vegetation coverage at the different elevations. Site design and vegetation planting resulted in net positive carbon uptake across the site. Dutch Slough is continuously monitored as a living laboratory and used to inform future restoration in the Delta.

Speaker: [Lyndsay Rankin](#), University of California, Davis, Center for Watershed Sciences

Co-authors: [Scott Jones](#), University of North Florida; [McKenna Bristow](#), USGS; [Karen Thorne](#), U.S. Geological Survey

Track: Nature-Based Solutions & Landscape Resilience

An Updated Conceptual Model of Sediment Transport Processes in San Pablo and Suisun Bay



The San Francisco Bay baylands (tidal marshes and mudflats) provide enormous benefits including shoreline protection, water filtration, and recreation opportunities. Sediment is a critical resource that is required for maintaining these baylands over time. This is especially true for San Pablo Bay and Suisun Bay, the two northern subembayments of San Francisco Bay where existing and planned baylands restoration require more than 94 million tons of sediment to maintain and expand healthy baylands habitats through 2100.

We developed a comprehensive conceptual model of sediment dynamics in San Pablo and Suisun Bay that synthesizes existing data and identifies transport and deposition dynamics at varying spatial and temporal scales.

Sediment transport processes were assessed through three focus areas:

(1) a summary of upstream sediment delivery and embayment boundary conditions, including an in-depth review of several recent studies of sand dynamics;

(2) an investigation of the major processes governing open bay and tidal slough sediment transport; and

(3) an analysis of the dynamic connections between the open bay and tidal wetlands occurring within the bay margin.

Our analysis revealed that new coarse sediment inputs to the Bay are from local tributaries, not the San Joaquin Delta (which was a dominant coarse sediment source historically). In the open bay, windy conditions resuspended sediment in spring and summer. This sediment deposits toward the San Pablo Bay margin and into Suisun Marsh through a network of tidal sloughs during flood (incoming) tides.

As resuspended sediment moves towards the shore, it supplies the marshes and mudflats with a consistent source of sediment. However, our analysis showed that mudflats have broadly eroded over the last 40 years as the open bays have depleted their reservoirs of sediment that persisted as a result of Sierra Nevada gold mining.

Speaker: Kyle Stark, San Francisco Estuary Institute

Co-authors: Scott Dusterhoff, San Francisco Estuary Institute; Emma Sevier, San Francisco Estuary Institute; Lester McKee, San Francisco Estuary Institute; Alex Braud, San Francisco Estuary Institute

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Interdisciplinary Science & Cross-Knowledge Integration

Montezuma Wetlands Project: Beneficial Sediment Reuse for Tidal Marsh Restoration

The Montezuma Wetlands Project is a multi-phase restoration project that uses dredged sediment to raise elevations in diked, subsided baylands to restore ~2,000 acres of tidal wetlands. These include sediments not suitable for unconfined aquatic disposal, then buried and isolated in an anoxic environment under at least 3 feet of cleaner sediments.

The project owns the highest rate sediment offloading system west of the Mississippi, and has operated successfully since 2003 by placing over 11 million cubic yards of dredged sediment. The project is on target to accomplish its restoration goals in support of the Long-Term Management Strategy (LTMS), established by a joint effort of the Corps and other federal, state and regional agencies to maximize the safe beneficial reuse of sediment dredged from SF Estuary.

Montezuma breached its first phase of over 500 acres in October 2020, and has been monitoring development of the new marsh system.

Post-breach monitoring data includes fish, bird and special-status wildlife use, vegetation development, water quality, and tidal channel formation. Monitoring indicates the breach was successful, with encouraging physical (tidal flows matching with target site elevations), chemical (water quality), and biological (wildlife use) results.

Ongoing monitoring over the coming years will provide important data on early marsh development. Pre-breach data includes detailed elevation and habitat surveys and over 15 years of biological and chemistry sampling results, which documented safe handling of the sediments. The extensive data collected has allowed Montezuma to adaptively manage and improve its restoration methods to increase resiliency for sea-level rise and changing needs and conditions.

By working in collaboration with regulatory agencies, project partners, and the Technical Review Team, Montezuma has pioneered many new scientific and engineering approaches and methods for large-scale tidal marsh restoration.

Speaker: Cassie Pinnell

Track: Nature-Based Solutions & Landscape Resilience



Playing with complexity: What gamification can teach us about collaborating on complex environmental challenges

Salmon recovery in the Sacramento-San Joaquin Delta is not only a scientific and ecological challenge, it is a collaborative one. Success depends on the actions and decisions of many actors with diverse perspectives and competing priorities. While collaboration is widely recognized as essential, opportunities to safely explore how collaboration succeeds, fails, and adapts remain limited. Research on gamification has shown that games can foster collective learning and systems thinking. Games create environments where participants can experiment with decisions, test assumptions, and better understand the perspectives and constraints of a decision. By lowering the stakes of real-world conflict, they provide space for creativity, curiosity, and productive dialogue around complex and sometimes contentious issues.

This interactive session uses a prototype board game focused on salmon recovery in the Delta to explore the human dimensions of collaboration.

Drawing inspiration from civic engagement games such as *The Game of Homes* and *The Game of Rent*, participants will play a new board game and work through recovery challenges that no individual player can solve alone. As environmental conditions shift and competing priorities emerge, players must negotiate, build alliances, share resources, and balance individual interests with collective outcomes. The purpose of the session is not to identify the "right" recovery strategy, but to examine how collaboration unfolds under conditions of uncertainty, complexity, and competing objectives.

Through facilitated reflection and discussion after playing the board game, participants will consider what the game reveals about trust, communication, decision-making, and collective action in the Delta. By combining play with reflection, this session offers an opportunity to test a novel engagement approach while highlighting new insights into how collaborative processes can support more resilient and effective salmon recovery efforts.

Session Chair: Kimberly Horndeski

Tracks: Managing Competing Demands for Water · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Genetics in action: How the adoption of genetic tools is enhancing management of the Bay-Delta ecosystem



Genetics is frequently regarded as an emerging field within the Bay-Delta community when in truth, genetic tools have been available for decades but have only recently been widely adopted for natural resource management. In this session, we will take a closer look at how molecular methods are being integrated into the management of the Bay-Delta ecosystem, and where they have directly contributed to management decisions or actions. Oral presentations will take the form of compelling lightning talks that cover a broad range of genetic topics such as use and improvement of rapid species identification (via SHERLOCK), fish hatchery genetic management, parentage-based tagging, environmental DNA (eDNA) sampling for rare and invasive species detection, and metabarcoding pipeline development.

***To fill the 100-minute Special Oral Session block, we propose: five minutes for moderator introduction and comments, 10 eight-minute lightning talks, and 15 minutes for collective questions at the end to fill the 100-minute session block. The speakers we suggest are listed below and the presenters have agreed to take part in the Special Oral Session. We have listed 11 speakers, in case there are any last-minute conflicts or if speakers drop out. If all 11 speakers are available, we will draw extra time for that talk from the proposed collective question time. The speakers are: Silvia Angles, Shannon Blair, Leigh Sanders, Christina Burdi, Ravi Nagarajan (x2), Hannah Miller, Aviva Fiske, Pachia Lee, Bryan Nguyen, and Scott Blankenship. For each of these 11 lightning oral presentations, we are ready to provide titles and the full author line.

Session Chairs: Daphne Gille, California Department of Water Resources; Melinda Baerwald, California Department of Water Resources

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration



Implementing Multi-Trophic Metabarcoding for Ecosystem-Based Management in the San Francisco Estuary

Effective ecosystem-based management of complex aquatic environments such as the San Francisco Estuary (SFE) requires a comprehensive understanding of biodiversity across multiple trophic levels. Because aquatic ecosystems function as interconnected webs, monitoring across multiple trophic levels is needed to capture ecological relationships. Traditional monitoring methods are labor-intensive and taxonomically constrained, limiting our capacity to detect ecosystem changes.

By contrast, DNA metabarcoding offers a scalable approach that captures biodiversity across different trophic levels at a fine scale. The California Department of Water Resources (DWR) performs biological monitoring in the SFE for long-term operation of the State Water Project.

In this talk, we present the Multi-Trophic Level Metabarcoding project, a new monitoring program focused on the development and validation of integrated, multi-trophic metabarcoding protocols designed to provide a holistic view of the SFE food web.

Our approach aims at characterizing bacterial, archaeal, phytoplankton, zooplankton, and fish communities simultaneously from DNA isolated from discrete water samples. We present our integrated workflow for the lower trophic food web component, from sampling collection through bioinformatic analysis, including technical and analytical challenges. A key bottleneck is the uneven completeness of reference databases; we discuss the integration of culturing efforts and reference barcode DNA sequencing of common organisms to ground-truth molecular data and fill critical knowledge gaps.

By comparing metabarcoding with traditional methods, we evaluate their complementarity and illustrate how metabarcoding fills critical gaps in traditional monitoring to provide a high-resolution, integrated dataset that enhances DWR's long-term monitoring programs.

Speaker: [Silvia Angles](#), California Department of Water Resources DWR

Co-authors: [Emily T. Richardson](#), CA Department of Water Resources; [Kristina Nguyen](#), California Department of Water Resources; [Leigh Sanders](#), Genomic Variation Laboratory GVL, Dept of Animal Science, UC Davis; [Morgan Maly](#), Cramer Fish Sciences; [Cheryl Dean](#), Cramer Fish Sciences; [Ravi Nagarajan](#), Genomic Variation Lab, University of California Davis; [Daphne Gille](#), California Department of Water Resources

Track: Ecology, Food Webs, & Changing Ecosystems

Determining the grandparentage of wild-caught Delta Smelt

The annual supplementation release of the endangered Delta Smelt (*Hypomesus transpacificus*) into the San Francisco Estuary (SFE) is a key part of the Delta Smelt conservation strategy. Every year since 2021, Delta Smelt have been produced and reared at the Fish Conservation and Culture Laboratory prior to release into the SFE. To determine the long-term efficacy of this strategy, it is vital to assess the impact of supplementation on the remaining wild population — including the extent to which hatchery-derived fish are reproducing with the wild population. Doing so requires the ability to determine the provenance of any wild-caught Delta Smelt. Currently, wild-caught fish can be tracked back to the hatchery within a single generation: supplementation fish that are subsequently recaptured can be identified using molecular parentage assessment.

However, the offspring of released fish — whose grandparents were hatchery fish but whose parents were released into the wild — could not be identified until now. Here we present ongoing work to develop and validate a microhaplotype-based GT-seq panel to identify wild-caught fish with hatchery grandparentage. We identified a set of markers robust enough to assign grandparentage to fish of unknown provenance when challenged against up to 500 potential mate pairs.

Statement on Applied, Management or Policy Relevance (150 words)

This work will be a key tool to allow managers to assess the Delta Smelt supplementation program. It will also allow wild-caught broodstock to be integrated into the genetically-managed hatchery without the possibility of incidental close-kin crosses of hatchery-derived fish.

Authors: **Amanda Finger**, University of California, Davis; **Shannon Blair**, University of California Davis; **Nate Campbell**, GTSeek; **Evan Carson**, US Fish and Wildlife Service; **Serra Perry**, Genomic Variation Lab, UC Davis; **Joseph Sweeney**, Genomic Variation Lab, UC Davis

Tracks: Nature-Based Solutions & Landscape Resilience · Managing Competing Demands for Water

Genetic Tool Development for Biological Monitoring: Integrating Tow-Net Sampling with Fish eDNA Metabarcoding in the San Francisco Estuary



The San Francisco Estuary (SFE) is the second largest estuary along the west coast of North America and is a heavily modified system. Managing natural resources in the SFE requires monitoring across wide spatial scales and highly variable aquatic habitats. The California Department of Water Resources (DWR) conducts mandated biological monitoring programs for long-term operation of water export facilities.

However, the traditional gear-based surveys used in these programs can be invasive and inherently biased against specific fishes. Environmental DNA (eDNA) and metabarcoding may offer a more sensitive approach for detecting rare and listed fishes that are becoming increasingly difficult to capture through these conventional survey techniques. Therefore, there is a need to validate a non-invasive, high-throughput genetic monitoring tool that can complement the established gear-based surveys and fill in the gaps to fulfill regulatory monitoring mandates in the SFE.

As part of a multi-trophic genetic tool development by DWR, this study focuses on the optimization and validation of an eDNA metabarcoding pipeline targeted at fish communities in the SFE. To validate our pipeline, we are conducting a proof-of-concept study within the Yolo Bypass, a seasonal floodplain in the upper SFE, by collecting tow-net eDNA samples alongside the Yolo Bypass Fisheries Monitoring Program (YBFMP), a gear-based monitoring program created by DWR in 1998. Initial laboratory validation confirms successful target amplification using the 12S MiFish-U primers, and sequencing will help to evaluate the pipeline's taxonomic resolution and detection probabilities across sample replicates.

By comparing these results with YBFMP catch surveys, we will be able to assess this pipeline's capacity to detect core fish assemblages and its sensitivity for detecting species-of-interest to deliver a validated, non-invasive genetic tools that can complement and scale existing fisheries monitoring in the SFE.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/activities/non-invasive-environmental-dna-monitoring-support-tidal-wetland-restoration>

Speaker: Leigh Sanders, Genomic Variation Laboratory GVL, Dept of Animal Science, UC Davis

Co-authors: Ravi Nagarajan, Genomic Variation Lab, University of California Davis; Andrea Schreier, University of California, Davis; Silvia Angles, California Department of Water Resources DWR; Mackenzie Miner, California Department of Water Resources DWR; Eric Holmes, California Department of Water Resources; Daphne Gille, California Department of Water Resources

Track: Interdisciplinary Science & Cross-Knowledge Integration

Clean Sampling on a Fishy Boat: Adding eDNA Sampling to Trawl Monitoring with No Contamination

Environmental DNA (eDNA) is a robust tool for monitoring rare species because detection methods are sensitive and non-lethal. Pairing eDNA with traditional sampling can improve detections and capitalize on existing efforts but is complicated by potential contamination and limited staff capacity. In the San Francisco Estuary (SFE), monitoring data for two rare species, Longfin Smelt and Delta Smelt, are needed to assess the impacts of water operations. To improve detection of larval smelt with minimal added effort, we tested the utility of pairing eDNA passive sampling with larval fish trawling by the California Department of Fish and Wildlife's Larval Entrainment Survey (LES) in 2025. We used a sampling convoy consisting of three boats: 1) a boat towing a positive eDNA control, 2) a 'clean' boat sampling eDNA actively via Sterivex filtering and a tow net, and 3) a 'contaminated' boat co-sampling eDNA via passive samplers with traditional trawling.

We compared eDNA results from all methods on the LES and clean boats to the fish caught in the trawl net. We found that 1) passive eDNA samplers can be successfully deployed on a 'contaminated' boat during monitoring without contaminating the eDNA sample, 2) detections varied with some methods detecting what others missed, 3) tow net eDNA sampling was highly successful, and 4) not one method is appropriate for all monitoring needs.

This study was the first instance utilizing passive samplers for eDNA detection in the SFE, and we showed that it was successful, easy to implement, and lacked contamination. These results allowed us to co-sample using passive samplers on CDFW trawl vessels without a separate clean boat in 2026 to continue to refine methods for feasibility.

This study presents a new eDNA sampling approach that enables straightforward pairing of eDNA methods with existing long-term monitoring programs for management needs.

Authors: Christina Burdi, California Department of Water Resources; Serra Perry, Genomic Variation Lab, UC Davis; Daphne Gille, California Department of Water Resources; Brian Schreier, California Department of Water Resources

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Finding Collaborative Solutions

Rapid genetic species verification to support real-time and published monitoring data for delta smelt

Monitoring for delta smelt (*Hypomesus transpacificus*) provides critical data that inform management decisions in the Bay-Delta, but morphological differentiation from wakasagi (*Hypomesus nipponensis*) remains challenging in some contexts, including earlier life stages. Morphological identification might become more challenging with ongoing supplementation of earlier life stage delta smelt without tags. All juvenile through adult delta smelt captured in fish monitoring surveys eventually undergo nuclear genotype-based analysis. However, those results are not usually available when monitoring programs release catch data in near real-time or even when data that has completed the quality assurance and control process is released for use in potential publications. The SHERLOCK method can be used outside of genetics laboratories to provide rapid species verification with subsequent cross-checking with other more comprehensive nuclear genotype methods.

Here we report results from multiple years of rapid SHERLOCK analysis of delta smelt and wakasagi performed on site at the U.S. Fish and Wildlife Service (USFWS) laboratory in Lodi, CA. SHERLOCK provided near real-time data on maternal species lineage to compare to morphological identifications, which was incorporated into real-time and published monitoring data products to management partners. Non-invasive external mucus swabs were taken from adult/subadult and juvenile specimens caught in USFWS Enhanced Delta Smelt Monitoring (EDSM) Kodiak trawls in 2023–2025. Protocols for sample collection and SHERLOCK were developed collaboratively by USFWS staff and the Genomic Variation Lab at UC Davis. We also highlight areas of ongoing protocol refinement, including mitigating possible cross-contamination between specimens, sample collection and running SHERLOCK, interpreting results from hybrid individuals, and the potential for applying SHERLOCK on early life stages of delta smelt and wakasagi.

Speaker: Ravi Nagarajan, Genomic Variation Lab, University of California Davis

Co-authors: Denise Goodman, US Fish and Wildlife Service; Evan Carson, US Fish and Wildlife Service; Serra Perry, Genomic Variation Lab, UC Davis; Joseph Sweeney, Genomic Variation Lab, UC Davis; Amanda Finger, University of California, Davis; Natalie Kolm, Genomic Variation Lab, UC Davis; Andrea Schreier, University of California, Davis

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Exploring the potential for genetic biocontrol of golden mussels in the Bay-Delta and beyond

The invasion and continuing spread of golden mussels (GM, *Limnoperna fortunei*) presents an unprecedented challenge to ecosystems and water operations in California. Due to their high fecundity and ability to thrive in a range of environmental conditions, the efficacy of mitigation and removal efforts is currently very low. The urgency of the situation offers an opportunity to explore bold new biocontrol approaches including innovative methods that have not been seriously considered for previous invasions. Genetic biocontrol involves identifying and targeting specific GM genes by either reducing their expression or introducing loss of function mutations. Here we present an overview of non-gene drive strategies that only affect somatic cells, requiring ongoing treatments, but not affecting the germline.

For other invasives, including some Dreissenid mussels similar to GM, RNA interference (RNAi) is the most common mechanism being explored, but CRISPR-based gene editing approaches are also possible. For either RNAi or CRISPR, there are some existing genomic and transcriptomic resources, but additional work is likely needed to identify candidate genes that are essential for functions like attachment or reproduction. To facilitate candidate gene testing, it will be essential to develop local expertise and resources for culturing GM. Methods to deliver the RNAi or CRISPR constructs into GM in situ will also be needed. Perhaps most importantly, a careful development plan that prioritizes safety, regulatory compliance, maintaining public trust, and scientific transparency is essential. There are many challenges and hurdles to actually implementing genetic biocontrol of golden mussels, and it will take time, but a bold and creative response to GM invasion could make a difference in blunting their impact.

Speaker: Ravi Nagarajan, Genomic Variation Lab, University of California Davis

Co-authors: Brian Mahardja, US Bureau of Reclamation; Andrea Schreier, University of California, Davis

Track: Invasive Species & Novel Ecosystems

Development of a Multiplexed SHERLOCK Genetic Reaction for Rapid, Simultaneous Detection of Early and Late Chinook Salmon Run Types

Thousands of Chinook salmon are genotyped every year in California's Central Valley. One primary purpose is to distinguish early-migrating, listed (spring/winter) from late-migrating, non-listed (fall/late fall) runs. Specific High-Sensitivity Enzymatic Reporter UnLOCKing (SHERLOCK) genetic assays, in conjunction with GT-seq, are used to identify run types for the spring-run Juvenile Production Estimate (JPE) and at fish salvage facilities. SHERLOCK relies on CRISPR/Cas technology and is simple to use, fast, and field-deployable. Currently, two separate SHERLOCK assays are run on each sample to differentiate between early- and late-migrating run types.

While still faster and cheaper than using other genetic methods, combining these two assays into a single reaction (multiplexing) will reduce labor, time, and cost – particularly with the large volume of samples being processed. We developed a new multiplexed SHERLOCK reaction that can detect and differentiate between both early and late run types simultaneously by using Cas12 and Cas13 enzymes together. Overall, the multiplexed assay was found to be 94.5% concordant with early and late run type assays performed separately. Furthermore, when examined independently, the multiplexed early run type results were 96.7% concordant and the late run type results were 97.8% concordant. By combining two assays into one reaction, multiplexed SHERLOCK has the potential to significantly reduce the time, labor and cost of distinguishing Chinook salmon runs or other species of interest. To our knowledge, multiplexing SHERLOCK reactions is a novel development for conservation management, expands the genetic tools available for use in an ecological setting and can be adapted for use in other systems.

Speaker: [Hannah Miller](#), University of California, Davis / California Department of Water Resources

Co-authors: [Andrea Schreier](#), University of California, Davis; [Melinda Baerwald](#), California Department of Water Resources

Track: Ecology, Food Webs, & Changing Ecosystems



Using environmental DNA to track the invasion of Golden mussels in the San Francisco Bay Delta

The Golden mussel (*Limnoperna fortunei*), an aggressive invader known to cause negative economic and ecosystem impacts, was first detected in North America near the Port of Stockton in October, 2024. The California Department of Water Resources (DWR), along with collaborators, is tracking the spread of the invasion using environmental DNA (eDNA).

DWR is responsible for the operation and maintenance of water infrastructure throughout California, and as such is tasked with assessing and mitigating the impacts caused by water transport infrastructure to the Bay Delta ecosystem, including the potential transport of invasive species between habitats. DWR utilizes cutting edge science by complementing traditional monitoring with eDNA, which can facilitate species detection when physical observation may be unlikely or challenging. eDNA sampling can be integrated into existing research and monitoring efforts to assess both the temporal characteristics and spatial spread of the Golden mussel invasion. This work demonstrates the power and utility of eDNA in the fight against invasive species in the Bay Delta.

Speaker: **Aviva Fiske**, California Department of Water Resources

Co-authors: **Sarah Stinson**, California Department of Water Resources; **Sarah Brown**, California Department of Water Resources; **Daphne Gille**, California Department of Water Resources; **Melinda Baerwald**, California Department of Water Resources

Track: Invasive Species & Novel Ecosystems

Clam and Collected: Simultaneous Genetic Detection of Golden Mussels and Corbicula Clams

Rapid and accurate detections of aquatic invaders are critical for ecological monitoring and management. Golden mussels and Corbicula clams are invasive filter feeding bivalves that pose a significant threat to the Sacramento-San Joaquin Delta. They disrupt aquatic food webs by consuming large amounts of phytoplankton from water and pose a threat to water infrastructures. Golden mussels can form dense colonies that can clog water pipes and facilities. Their ability to spread rapidly through connected waterways increases the risk of widespread impacts. In the Department of Water Resources Genetic Monitoring Lab, we often genetically determine if a submitted environmental DNA (eDNA) or veliger sample contains either Corbicula and Golden mussel DNA.

Currently, we conduct two different reactions per sample (one for each species) to determine if it is either a Golden mussel or a Corbicula clam. To increase sample processing efficiency, we are developing a multiplexed reaction that will genetically assay both the Golden mussel and Corbicula clam simultaneously. We will be testing for the optimal primer and probe concentrations to minimize cross amplification and reactivity interference while ensuring sensitivity similar to the current independent assays. This multiplexed reaction is intended to be used on environmental DNA (eDNA), tissue, and veliger samples. We aim to increase operational efficiency by shortening turnaround times, particularly for time-sensitive samples that are critical for informing real-time water management decisions.

Speaker: **Pachia Lee**, California Department of Water Resources

Co-authors: **Scott Meyer**, California Department of Water Resources; **Sarah Stinson**, California Department of Water Resources; **Aviva Fiske**, California Department of Water Resources; **Sarah Brown**, California Department of Water Resources; **Melinda Baerwald**, California Department of Water Resources

Track: Invasive Species & Novel Ecosystems



Operational Use of SHERLOCK CRISPR Improves Real-Time Management of Endangered Chinook Salmon at Salvage Facilities

The California Central Valley's rivers are home to three distinct Evolutionarily Significant Units (ESUs) of Chinook salmon (*Oncorhynchus tshawytscha*), which have major life history differences and protection statuses but are usually morphologically indistinguishable. Identifying Central Valley Chinook salmon ESUs requires the use of genetics, which has historically been slow and technically-demanding.

Following three years of pilot study data, SHERLOCK, a rapid CRISPR-based detection platform, has been incorporated into the genetic identification workflow for Chinook salmon salvaged at the Central Valley Project and State Water Project fish facilities starting in Water Year 2026. Laboratory and process improvements, such as the preparation and cold storage of ready-to-go assay mixes and pre-incorporated controls, simplify the assay process without sacrificing performance. The efficiency of SHERLOCK for the identification of salvaged Chinook salmon has already resulted in many hours and tens of thousands of dollars saved. We expect the value of SHERLOCK for rapid and accessible identification of Chinook salmon to continue to increase as further improvements are made and SHERLOCK deployment broadens.

Speaker: Bryan Nguyen, California Department of Water Resources

Co-authors: Sean Canfield, California Department of Water Resources; Pachia Lee, California Department of Water Resources; Sarah Brown, California Department of Water Resources; Melinda Baerwald, California Department of Water Resources

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions



Parentage-Based Tagging in Practice: How a single genetic sample becomes a monitoring record

Parentage-based tagging, or PBT, is often communicated through genetic methods: broodstock genotyping, parentage assignment, statistical matching algorithms, algorithms, and related analytical tools. This lightning talk will take a different approach. Rather than focusing on the technical details, it will follow a single fish through the information process. Thereby indirectly illustrating the PBT approach via connecting an initially anonymous fish to increasingly useful biological and management information.

The narrative begins with a juvenile fish collected during routine monitoring. This individual fish is identified only by where and when it was sampled.

A genetic sample connects that fish to its parents. The parent records then connect this juvenile to additional information, potentially including spawning location and date, brood year, hatchery or natural origin, release group, and cohort membership. As similar records accumulate, individual assignments can support broader evaluations of emigration timing, survival, recruitment success, straying, fishery contribution, and program performance.

The central idea is that PBT does more than identify a fish's parents. It turns a genetic sample into a relational monitoring record. The genotypes are the tags, and the offspring's DNA is the key that opens the associated information system.

Speaker: Scott Blankenship

Patterns and processes in tidal wetland food webs



Restoration of tidal wetland habitats is one of the most positive changes currently underway in the Sacramento-San Joaquin Delta and Suisun Marsh. While thousands of acres of wetland habitat are currently being restored, scientists are working to understand how these wetland habitats function. We are changing our approach to studying these habitats -- rather than focusing on one or two at-risk species, we are developing and applying approaches for quantifying how wetlands alter productivity, food availability, and habitat for a range of native species. This collaborative effort will help us address the future challenges of building new wetland restoration sites, and also drive forward our basic understanding of ecosystems in the estuary.

Session Chairs: Rosemary Hartman, California Department of Water Resources; Matthew Young, U.S. Geological Survey

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

Primary Productivity and Nutrient Exchange During Daytime Tidal Cycles at Four Tidal Wetlands



Historical connectivity between wetlands and pelagic channels in the San Francisco Estuary was broken starting in the mid-1800s, when wetland draining and channel diking began. As mitigation for water operations, the 2019 Federal Biological Opinions on the Coordinated Operations of the Central Valley Project and State Water Project and the 2020 California Department of Fish and Wildlife SWP Incidental Take Permit require the Department of Water Resources to restore 8,000 and 8,400 acres, respectively, of intertidal and associated subtidal habitat in the legal Delta, Yolo Bypass, and Suisun Marsh. Restorations are intended to support native fish food webs via enhanced productivity.

While many wetland benefits to native fishes are known, it is much less clear how reconnected wetlands impact the availability of nutrients, carbon, and resulting pelagic primary productivity. Understanding how tidal wetlands support productivity pathways will help align restoration designs with desirable ecological outcomes for native fishes. To characterize tidal wetlands, we analyzed discrete water grabs collected repeatedly during flood-ebb cycles at four wetlands (three restored and one remnant). Alongside discrete grabs, we used continuous sonde data to infer transformational properties occurring on wetlands between discrete sampling events. In this talk we will discuss how water connectivity with wetlands impacts phytoplankton primary productivity potential via multiple pathways. We will describe how wetlands might support enhanced productivity for native fish food webs both on and off restoration sites. We will conclude with management-relevant guidance gleaned from our analyses.

Speaker: Daniel Ellis, California Department of Fish and Wildlife

Co-authors: Elsie Platzer, University of California, Davis; Danny Cox, CA Department of Water Resources; Gina Darin, California Department of Water Resources; Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center

Track: Ecology, Food Webs, & Changing Ecosystems

Understanding the influence of aquatic macroinvertebrates on the recovery of tidal wetland food webs



Extensive wetland loss in the San Francisco Bay-Delta has likely resulted in an ecosystem shift from marsh-derived to pelagic-supported food webs. As such, studying the mid- and lower trophic levels of aquatic food webs is important to understand how ecosystem productivity can benefit predators.

We examined stable isotope signatures ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{34}\text{S}$) of aquatic macroinvertebrate consumers and their basal resources (terrestrial and aquatic vascular vegetation, filamentous algae, and phytoplankton). Additionally, we assessed how food-web metrics that were used to compare reference and restored sites differed when based on fish vs. aquatic macroinvertebrate assemblages. We found that floating aquatic vegetation contributed 2.8% - 5.9% of aquatic macroinvertebrate diets, emergent vegetation contributed 14.3% - 25.4%, phytoplankton contributed 20.4% - 58.9%, and SAV/Algae contributed 13.2% - 61%. We also found high variation across taxa in how they rely on each food source, which potentially indicates that future tidal marsh restoration actions may have 'winners' and 'losers'.

In support of our hypothesis that filter-feeding macroinvertebrates such as bivalves would have stronger reliance on phytoplankton compared to collector gatherers (e.g., amphipods, isopods, mysids), we found that *Gammarus* sp. and *Gnорimosphaeroma oregonense* relied less on phytoplankton and more on marsh-derived vegetation than other taxa.

Finally, we found that fish-based metrics tracked differences between reference and restored tidal marshes in a more consistent way than macroinvertebrate-based metrics, possibly due to macroinvertebrates encompassing many different trophic strategies. Our results show that aquatic macroinvertebrate diets integrate a wide range of basal resources and show high variability over space. We contend that understanding the intermediate levels of production is key to restoring tidal marsh food-web functioning in a way that ultimately supports endangered fish.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/activities/restoring-tidal-marsh-foodwebs-assessing-restoration-effects-trophic-interactions-and>

Speaker: Megan Pagliaro, Department of Water Resources

Co-authors: Susan De La Cruz, U.S. Geological Survey; Isa Woo, USGS Western Ecological Research Center; Theodore Flynn, Department of Water Resources; Albert Ruhi, University of California, Berkeley

Track: Ecology, Food Webs, & Changing Ecosystems

Investigating the efficacy of tidal wetland restoration in enhancing aquatic food web resources for native fishes: an update on Fish Restoration Project (FRP) wetlands



Tidal wetland restoration is an important mitigation action for endangered fish species through the creation of new habitat and foraging areas. However, the efficacy of tidal wetland restoration is not well quantified in the Sacramento-San Joaquin Delta and the Suisun Region. The Fish Restoration Program (FRP) Monitoring Team is tasked with assessing the effectiveness of restoration efforts through the sampling of invertebrate communities across a range of aquatic habitats. Here we present updated data with nine years of monitoring data collected in six restoration projects and their reference sites. Using a Bayesian hierarchical model, we analyzed changes in invertebrate data using a before-after-control-impact design.

Our results indicate that restoration of tidal action to managed or muted wetlands did not increase invertebrate densities relative to those in surrounding reference wetlands. However, invertebrate densities within restored tidal wetlands are comparable or higher than those in reference wetlands. This same pattern holds true for the subset of invertebrates that are known Delta Smelt prey items. These results suggest that restoration projects benefit native fish by increasing access to foraging areas rather than by increasing invertebrate densities in pre-existing wetlands. These benefits are only realized if native fish are nearby to take advantage of new foraging areas. Further research is necessary to determine if fish are using restored tidal wetlands and whether invertebrates produced within the wetlands are exported to surrounding areas.

Speaker: Gabriel Ng, Water Branch - California Department of Fish and Wildlife

Co-authors: Stacy Sherman, California Department of Fish and Wildlife; Christy Bowles, California Department of Fish and Wildlife; Michelle Avila, California Department of Fish and Wildlife

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

Data limitations of Sacramento-San Joaquin Delta food webs: incorporating uncertainty to inform ecosystem monitoring



Conservation management often emphasizes preventing species-level extinction through targeted interventions such as captive breeding, habitat restoration, and flow manipulation. While necessary, these strategies can overlook the ecological context in which species are embedded. Food web models provide a framework for understanding the system-level consequences of management by explicitly representing trophic structure, predator–prey interactions, competition, and cascading indirect effects. These models enable forecasting beyond direct responses to interventions, yet their development is constrained by extensive data needs across trophic levels, including abundance, biomass, and diet composition. Because truly comprehensive ecosystem monitoring is cost-prohibitive, identifying which ecosystem components most influence model behavior and ecological dynamics is essential.

We applied this perspective to the intensively monitored San Francisco Bay and Sacramento-San Joaquin Delta (Bay-Delta). Despite major investment in long-term monitoring, significant data gaps remain in understanding ecosystem function, particularly for littoral and restored wetland habitats. Using a widely applied mass-balance food web model (EcoPath with EcoSim), we conducted a sensitivity analysis to evaluate how uncertainty in model parameters propagates through ecosystem predictions. We developed a representative restored-wetland model, assessed sensitivity of nodes to parameter uncertainty, identified data-precision targets for highly influential groups, and used simulated parameter space to infer potential biases. This framework identifies the monitoring priorities and precision thresholds needed to detect ecosystem-wide change, ultimately supporting more efficient, ecologically grounded monitoring targets.

Speaker: Matthew Young, U.S. Geological Survey

Co-authors: Brian Mahardja, US Bureau of Reclamation; Brock Huntsman, US Geological Survey, California Water Science Center; Marissa Wulff, US Geological Survey, California Water Science Center; Frederick Feyrer, U.S. Geological Survey, California Water Science Center

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

The tangled web we weave – developing a food web model of tidal wetlands in the Delta



Objective: Over 8000 acres of tidal wetlands have been restored in the Delta and Suisun Marsh over the past 10 years, most of which were designed specifically to provide increased food for smelt, salmon, and other native fishes. But how much do we know about how wetlands provide food for fishes? The Interagency Ecological Program Wetland Food Web Synthesis team has been working on it.

Approach: We have integrated a massive dataset of chlorophyll, vegetation, and aquatic invertebrates to parameterize a wetland food web model to determine how primary and secondary production in wetlands differs from open-water habitat.

We have developed a set of Bayesian linear regressions modeling differences in abundance of invertebrates across regions of the Delta and habitat types, focusing on groups of taxa important to the diets of Delta smelt (*Hypomesus transpacificus*), longfin smelt (*Spirinchus thaleichthys*), Chinook salmon (*Oncorhynchus tshawytscha*), and Sacramento splittail (*Pogonichthys macrolepidotus*). We are using these models along with a literature review of growth and feeding rates to parameterize a mass balance model of a wetland food web.

Results: There are more macroinvertebrates inside wetlands, and their abundance changes with vegetation and region of the estuary. Importance of season and habitat varies by taxon. The results of these models are likely to not only increase our understanding of wetland ecosystem function, but also provide a framework for addressing other food web questions in the estuary.

Speaker: Rosemary Hartman, California Department of Water Resources

Co-authors: Matthew Young, U.S. Geological Survey; Kristin Arend, U.S. Fish and Wildlife Service; Denise Colombano, Delta Stewardship Council; Daniel Ellis, California Department of Fish and Wildlife

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

San Francisco Estuary Wetlands Regional Monitoring Program: inaugural multi-indicator monitoring results to inform and streamline tidal wetland restoration implementation



The San Francisco Estuary Wetlands Regional Monitoring Program (WRMP) began bay-wide data collection in 2024 after more than a decade of collaborative planning with state, federal and regional agencies, tidal wetland managers, restoration implementers, and academic institutions. These surveys represent the inaugural data collection efforts of what will become a long-term source of information for informing tidal wetland restoration efforts and increasing permitting and regulatory efficiency throughout the estuary.

The WRMP team brings together technical experts representing a range of disciplines, which work together to inform understanding of the status and trends of the Estuary's tidal wetlands using consistent methods. These WRMP collaborators will be presenting their findings on topics including: fish and fish habitat, vegetation surveys, sediment accretion and elevation change, the estuary-wide lidar and the Baylands Habitat Map, as well as online tools the WRMP has developed to support restoration practitioners, managers, and regulators conducting tidal wetland restoration. The results from these surveys are already being incorporated into regional planning efforts, discovering new fish nurseries, tracking how tidal wetlands are adapting to environmental change including sea-level rise and more.

Session Chair: Lisa Beers, San Francisco Estuary Institute

Co-authors: Aviva Rossi, San Francisco Estuary Institute; James Hobbs, Otolith Geochemistry and Fish Ecology Lab, UC Davis; Christopher Janousek, Oregon State University; Karen Thorne, U.S. Geological Survey; Alex Braud, San Francisco Estuary Institute

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration



From program planning to online tools: how the San Francisco Estuary Wetlands Regional Monitoring Program is supporting consistent monitoring for the restoration community

The San Francisco Estuary Wetlands Regional Monitoring Program (WRMP) is a regional monitoring program that informs science-based decision-making for wetland restoration and adaptive management, and increases the cost-effectiveness of permit-driven monitoring associated with wetland restoration projects.

We are highlighting the tools and triumphs after launching a tidal wetland monitoring program spanning 400 miles of shoreline, adjacent to 100+ cities, nine large counties and hundreds of special districts and government agencies whose wetlands and waterways provide habitat for a multitude of wetland species and several endemic and federally threatened and endangered species.

The WRMP provides critical information on the status and trends of the San Francisco Estuary's tidal wetlands and collects data that supports understanding of environmental change impacts. This talk will provide a brief introduction to the WRMP, setting the stage for the following talks in this session and highlight the tools that have been developed to provide information to regional project implementers, planners, and regulatory agencies and to support tidal wetland restoration planning.

These tools include: WRMP EcoAtlas Profile Tool, dashboards for displaying landscape-level metrics, interactive data maps, an interactive indicator alignment website to track regional collaboration, and more.

Speaker: Aviva Rossi, San Francisco Estuary Institute

Co-authors: Lisa Beers, San Francisco Estuary Institute

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration



Regional Monitoring Across Restoring Tidal Wetlands of the San Francisco Estuary: Results from Year One of Fish and Fish Habitat Monitoring

Tidal wetlands are among the most productive aquatic habitats on Earth, yet widespread habitat loss and degradation have impaired ecosystem functions and reduced native species viability globally. In the San Francisco Estuary (SFE), over 90% of historic tidal wetlands have been lost, contributing to declines of native fishes and wildlife and motivating some of the largest tidal wetland restoration efforts on the U.S. West Coast.

Long-term ecological monitoring is essential for evaluating restoration outcomes and informing adaptive management. UC Davis has conducted fish, macroinvertebrate, and water quality monitoring in Suisun Marsh since 1980 and the Alviso Marsh since 2010. Building from these efforts, the Wetland Regional Monitoring Program (WRMP) expanded regional tidal wetland monitoring in 2025 to support science-based restoration assessment and coordinated permit-driven monitoring across the estuary.

The WRMP Fish and Fish Habitat Team is implementing standardized monitoring across nine Operational Landscape Units (OLUs) sampling among benchmark, reference and restoring wetlands distributed across environmental gradients. Monitoring quantifies fish and macroinvertebrate abundance, diversity, habitat use, and environmental conditions to evaluate restoration progression and support robust regional comparisons.

Fish and macroinvertebrate abundance, measured as catch-per-unit-effort (CPUE), varied substantially among OLUs, with Belmont-Redwood exhibiting the highest fish abundance and Petaluma the lowest, while fish richness was greatest in Santa Clara. Abundance and diversity tended to be greater at stations near benchmark and reference sites relative to restoring wetlands. These early findings demonstrate that coordinated regional monitoring can detect ecological differences across restoration landscapes and establish critical baselines for long-term assessment.

Speaker: Jim Hobbs

Co-authors: James Hobbs, Otolith Geochemistry and Fish Ecology Lab, UC Davis; Sami Araya, Otolith Geochemistry and Fish Ecology Lab, UC Davis; Nikolas Floros, Otolith Geochemistry and Fish Ecology Lab, UC Davis; Christian Denney, UC Davis; Alex Lama, Otolith Geochemistry and Fish Ecology Laboratory, UC Davis; Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA

Track: Ecology, Food Webs, & Changing Ecosystems

Tracking spatial and temporal change in the San Francisco Estuary's tidal wetland vegetation through the Wetlands Regional Monitoring Program

Vascular plants and algae are foundation species in tidal marshes of the San Francisco Estuary, providing important wetland functions including productivity, sediment accretion, and physical habitat for fauna. Plant and algal communities can also be important indicators of changing wetland conditions. In 2025 we launched field-based vegetation surveys at 17 sites in the estuary as part of the Wetlands Regional Monitoring Program (WRMP) to characterize spatial and temporal patterns in marsh vegetation status including plant and algal cover, plant height, and plant species composition and diversity. We co-located monitoring of vegetation with elevation, soil salinity, and groundwater measurements.

Sites comprised three classes – least-disturbed ‘benchmark’ sites, developing ‘reference’ sites, and recently restored ‘project’ sites.

While the central goals of the vegetation network is to assess change to inform restoration and adaptive management, and assess the impacts of environmental change, baseline sampling in 2025 provided insight into spatial patterns and environmental drivers. In 2025 sampling, we identified over 50 plant species across marshes in the estuary. Native plants were most frequent, but non-native species occurred in both brackish and high salinity sites.

Macroalgae were relatively less common. Benchmark and reference sites tended to have similar total plant cover and species richness, but project sites had varying vegetation conditions, suggesting a suite of factors affects restoration site vegetation including age, elevation, and hydrology. Salinity was also an important spatial factor – the most diverse marshes were in the lower salinity areas of Suisun Bay and far south San Francisco Bay.

These baseline data provide important information to track vegetation responses to environmental change, long-term development of restoration projects, and the potential spread of non-native species.

Speaker: Chris Janousek, Oregon State University

Co-authors: Lisa Beers, San Francisco Estuary Institute; Aviva Rossi, San Francisco Estuary Institute; Trevor Williams, Oregon State University

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems



Using a monitoring network to track marsh elevations and accretion in San Francisco Bay

Sea-level rise, changes in storm frequency and intensity, and shifting patterns in freshwater flow and precipitation are increasingly impacting marsh ecosystems and local wildlife communities. Understanding how marshes respond to these drivers is critical for informing management strategies aimed at minimizing habitat loss and maintaining ecosystem function over the coming decades. Marsh elevation change is governed by the balance among mineral sediment delivery, organic matter production, and tidal inundation. To assess marsh response over both near- and long-term timescales, Surface Elevation Table–Marker Horizon (SET-MH) monitoring stations were deployed across 19 marshes throughout the San Francisco Bay (SFB) estuary. Between 2014 and 2026, a total of 84 SET-MH stations were installed across a range of historic and restored marshes, establishing a comprehensive monitoring network to evaluate marsh development and resilience to sea-level rise.

Results to date show notable spatial variability in elevation dynamics. Substantial increases in accretion (10–15 mm/year) and elevation have been measured at South Bay sites, including Guadalupe, Triangle, and Calaveras marshes. Restored marshes, such as Ravenswood (R4), have also experienced significant elevation gains following tidal breaching. Elevation relative to the tidal frame emerges as a key control on both accretion and elevation change rates. All monitored sites are currently keeping pace with local sea-level rise rates (approximately 2 mm/year), although resilience varies within and across sites. These data contribute to the Wetlands Regional Monitoring Program, providing managers with timely science-based data. Continued long-term monitoring will be essential for informing adaptive management under accelerating environmental change.

Authors: Karen Thorne, U.S. Geological Survey; McKenna Bristow, USGS; Lyndsay Rankin, University of California, Davis, Center for Watershed Sciences

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Finding Collaborative Solutions



WRMP Level 1 Monitoring: Baylands Habitat Mapping and Elevation Data Across the San Francisco Bay

Monitoring habitat change across a large, dynamic estuary requires consistent, repeatable methods and a shared data foundation. The San Francisco Estuary Wetlands Regional Monitoring Program (WRMP) has established two Level 1 monitoring efforts that work together to provide that foundation: the Baylands Habitat Map (BHM) and a collaborative, estuary-wide lidar collection.

The BHM 2020 is the first complete map of San Francisco Bay wetland and aquatic habitats produced since 2009 and is built to support the WRMP in consistent, repeatable monitoring of habitat change and restoration progress across the Bay. To support long-term consistency and change detection, SFEI employed automated, repeatable approaches using object-based image analysis, aerial imagery, and lidar-derived elevation products.

These automated workflows reduce subjectivity and ensure results are comparable across space and time.

In addition, a hierarchy of spatial units groups bayland habitats by hydrological connectivity and management context, allowing metrics to be applied consistently while remaining flexible for different analytical and planning needs.

Repeated mapping allows us to measure gains in wetland habitats from restoration, track losses related to sea level rise or erosion, and evaluate how patterns of change vary across the landscape. This effort represents a major advancement for tracking habitat change across the Bay and is being applied in development of BHM 2025.

High-quality elevation data strengthens BHM updates and expands what the mapping can resolve. The WRMP led the coordination to establish a collaborative, estuary-wide lidar collection covering approximately 1.25 million acres. By pooling resources across agencies, this effort avoided duplicative collections and achieved significant cost savings, providing a current, standardized elevation baseline supporting BHM 2025 and a range of monitoring and planning applications across the Estuary.

Speaker: Alex Braud, San Francisco Estuary Institute

Co-authors: Cristina Grosso, San Francisco Estuary Institute; Pete Kauhanen, San Francisco Estuary Institute; Kat Palermo, San Francisco Estuary Institute

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Use of a new academic-agency collaborative training program to advance modeling capabilities in the Bay Delta (Part 1)



Models and their underlying data serve as the backbone of understanding how the Bay-Delta system functions and are used regularly for management of the system. These hydrological and biological models are typically based on historic data that has been collected and observed from the past 40 years. However, extreme variability in the system and changing baselines challenge the existing fundamental assumptions and relationships used in these models. This session will explore/showcase how evaluating management actions requires an interdisciplinary set of tools from broad hydrologic to mechanistic biological models. These lines of evidence benefit from updated understanding of environmental drivers and attributes gained through new observation.

For this session, we will require two, 100 minute time slots. The session will begin with an overview of how numerical models are used as decision support tools for managing the Bay-Delta system. This will be followed by a series of companion talks contrasting current modeling approaches with potential future developments. The specific models slated for discussion include: ECO-PTM, CalSim, and a Zooplankton-Salinity Submodel; the presenters will include experts in these approaches along with early career scientists working to further advance these tools. This sequence of talks will be followed by a presentation which synthesizes across the various models and associated management needs. The session will then conclude with a panel discussion where presenters answer questions about the next generation of models.

Session Chair: Miranda Bell Tilcock, UC Davis Center for Watershed Sciences

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

An introduction to the academic-agency collaborative training program to advance modeling capabilities in the Bay Delta



The Bay-Delta has more than 40 years of observations that have been used for decades to train many models to inform management decisions. As the need for more data and improved models grows, so does the need for training programs and collaborations between the many different institutions and decision makers. The Multidisciplinary Water Training and Operations Program is a cooperative effort between the US Bureau of Reclamation and the Center for Watershed Sciences at UC Davis.

As part of the training program, early career scientists develop, enhance, and improve the science-based tools used to provide actionable information on high-priority questions in water operations, fisheries, and aquatic ecosystem management. Tools developed through this project will work to improve water management, fish and wildlife conservation in the California Bay-Delta watershed, promote effective use of water within the system, help prevent species extinctions, and provide scientific information to support recovery efforts.

This will be the first talk in a session to introduce the training program between the US Bureau of Reclamation and Center for Watershed Sciences as well as the various tools managers across the Bay-Delta use in real time operations and planning approaches and how the early career scientists are working to further advance them.

Speaker: [Miranda Bell Tilcock](#), UC Davis Center for Watershed Sciences

Co-authors: [Rachel Alsheikh](#), UC Davis Center for Watershed Sciences; [Joshua Israel](#), United States Bureau of Reclamation; [Karrigan Bork](#), UC Davis Center for Watershed Sciences; [David Ayers](#), UC Davis Center for Watershed Sciences; [Andrea Hamilton](#), United States Bureau of Reclamation; [Lillian McCormick](#), USBR

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration



ECO-PTM v0.0.0-beta: An Enhanced Fish Movement and Survival Modeling Framework for Evaluating Delta Management Alternatives

ECO-PTM is an individual-based ecological particle tracking model that simulates juvenile salmon behavior, migration, and resulting routing and survival outcomes. It has been calibrated and validated using thousands of acoustic telemetry tag observations and has been extensively applied to evaluate the ecological impacts of SWP/CVP operational changes, new infrastructure projects, and a wide range of water resources management actions in the Delta. ECO-PTM also provides managers with a cost-effective framework for exploring and comparing alternative management strategies prior to implementation, reducing reliance on expensive and time-consuming field studies while supporting informed decision-making.

We present ECO-PTM v0.0.0-beta, which includes several major enhancements.

New capabilities include simulations of juvenile Chinook salmon fate and survival for fish entering the Delta from the San Joaquin River at Vernalis, improved representation of fish responses to leakage flows at barriers, and a modular architecture that allows users to incorporate specialized routing models. The model is now platform-independent, with legacy C/C++/Fortran components replaced by Java. Additional improvements include tools for visualization and animation of fish particle fate, comparison of simulation results across management alternatives, and utilities for converting legacy input files to the new format.

Model outputs were evaluated against published survival estimates for outmigrating Chinook salmon smolts. ECO-PTM reproduces the general magnitude and spatial variation of through-Delta survival across multiple conditions. While some discrepancies exist relative to empirical estimates, these are expected for a hydrodynamics-driven particle tracking model. Overall, the agreement with observed patterns supports the model formulation, implementation, and calibration, and provides confidence in ECO-PTM-derived survival estimates for evaluating alternative management scenarios.

Speaker: **Xiao Wang**, California Department of Water Resources

Co-authors: **Doug Jackson**, QEDA Consulting; **Adam Pope**, US Geological Survey Western Fisheries Research Center; **Russell Perry**, U.S. Geological Survey - Western Fisheries Research Center; **Michael Dodrill**, US Geological Survey Western Fisheries Research Center

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration

Improving fish survival modeling in the Delta using predation experiments



Decades of acoustic telemetry studies in the Delta have led to sophisticated tools for simulating behavior, routing, and ultimately survival of emigrating Chinook salmon. One prominent example is ECO-PTM which uses behavior-enabled particles to overcome many of the practical limitations that stymie field telemetry studies. For example, this approach can obviate a range of issues including small sample sizes, a limited range of hydrodynamic conditions, and collinearity between water inflow and exports. Thus, ECO-PTM and similar tools hold great promise for anticipating the effects of various management actions on the survival response of emigrating Chinook salmon. However, the spatial resolution of fish survival variation in ECO-PTM is constrained by its associated acoustic telemetry network.

As a result, ECO-PTM currently generates survival estimates that are aggregated across tens of kilometers, obscuring the influence of finer-scale environmental features known to shape predator abundance and behavior. We seek to improve this paradigm by measuring the survival of juvenile Chinook salmon using alternative approaches, namely GPS-enabled predation trials of tethered smolts. We anticipate that this field technique, along with novel water velocity metrics, can be used to enhance the spatial resolution of ECO-PTM.

Ultimately, this could enable more detailed and accurate predictions of outmigration success and facilitate targeted management interventions that balance species conservation with water project operations. Our study also highlights a broader point, that observational data can be used to generate powerful analytical tools, yet they will likely propagate underlying data limitations and require complementary inputs to achieve full model potential and management utility.

Speaker: David Ayers, UC Davis Center for Watershed Sciences

Co-authors: Cyril Michel, University of California, Santa Cruz; Anna Steel, University of California, Davis; Josh Isreal, USBOR; Andrea Hamilton, United States Bureau of Reclamation; Jon Walter, University of California, Davis

Track: Ecology, Food Webs, & Changing Ecosystems

Evaluating Hydrologic Forecast Performance and Operational Impacts Within the CalSim3 Framework



This study evaluates the performance of operational hydrologic forecast products within the CalSim3 framework to better understand how forecast uncertainty influences water management decision-making in California.

Forecast products from the California-Nevada River Forecast Center (CNRFC), California Department of Water Resources (DWR), and CalSim3 Hydroforecasts are compared across multiple major California reservoirs using metrics including forecast bias, calibration, and interannual predictive skill.

The research further examines how differences in forecast structure and conditioning affect modeled system operations when incorporated directly into CalSim3 simulations. By evaluating both forecast performance and operational impacts under varying hydrologic conditions, this work aims to support the development of more reliable forecast-informed water management strategies for California's increasingly variable climate.

Speaker: Krystle Catamura, UC Davis Civil and Environmental Engineering & UC Davis Center for Watershed Sciences

Track: Finding Collaborative Solutions

An Overview of the California-Nevada River Forecast Center and the Role They Play in Supporting the Water Management Community



The California-Nevada River Forecast Center (CNRFC) is a field office of the National Weather Service (NWS), and is co-located with the California Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR) at the Joint Operations Center in Sacramento, CA. River forecasts are issued jointly by the CNRFC and DWR daily, and more frequently during high water events. Forecasts are issued for over 390 locations throughout California and Nevada including 100 reservoir inflow forecast locations.

The primary streamflow forecast services include

- 1) short-range probabilistic and single-value forecast products spanning 5-10 days, and
- 2) long-range 365-day probabilistic ensemble forecast products. The ensemble forecasts are created using the Hydrologic Ensemble Forecast Service (HEFS). CNRFC's water management partners utilize these products and services to help manage water more efficiently.

This presentation will provide an overview of the CNRFC forecasting system as well as their products and services.

Speaker: Brett Whitin, CNRFC/NOAA

Co-authors: Krystle Catamura, UC Davis Civil and Environmental Engineering & UC Davis Center for Watershed Sciences

Track: Finding Collaborative Solutions

TUESDAY, SEPTEMBER 29, 2026 - SESSION 30 · 5 PRESENTATIONS

Carbon, water, and the Delta landscape: Rethinking land use for a resilient future



Speakers: Savannah Haas, HydroFocus Inc.; Yanxin Xie, UC-Davis Biomicrometerology Lab; Eric Romero; Katherine Heidel, Tetra Tech, Inc.

Tracks: Nature-Based Solutions & Landscape Resilience · Managing Competing Demands for Water

Improving Subsidence and Carbon Emissions Modeling

The oxidation of Delta organic soil releases about 1.2 million metric tons of CO₂-equivalents annually and causes land subsidence which can result in under-seepage that threatens levee stability, water supply reliability, biodiversity, and agriculture. The SUBCALC model estimates subsidence rates and CO₂ emissions and is being used for scenario-based projections, carbon offset verification, and land-use decisions.

SUBCALC can help prioritize areas for alternate land uses such as rice and wetlands to mitigate subsidence. First developed in 2010, SUBCALC was updated in 2024 using available elevation and eddy covariance data from 2019-2022. The objective of the current work is to improve the SUBCALC model to better estimate subsidence rates and CO₂ emissions of drained Delta peat soils using recent data and improved understanding of subsidence processes. There is increasing need for improved subsidence and GHG estimates to support carbon market participation and inform implementation of sustainable land management practices.

To improve the model, we recalibrated parameters using recently collected data from subsiding islands, including soil organic matter and depth-to-groundwater to estimate carbon substrate available for oxidation in the unsaturated zone, LiDAR and RTK data to estimate recent elevation change, and eddy covariance-measured GHG fluxes for model calibration and validation. Model improvements also included increasing the maximum reaction velocity with time as soil temperature increases. The model was modified from one to two layers based on data indicating that 67% of subsidence occurs in the upper 80 cm.

The improved model is being used to develop updated Delta-wide estimates of present-day and future CO₂-e emissions and subsidence from oxidizing organic soils and exit gradients for levee vulnerability assessment. Interaction with stakeholders will ensure model results are helpful for implementation of alternate land uses and carbon market participation.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/activities/improving-subsidence-and-carbon-emissions-modeling>

Speaker: Savannah Haas, HydroFocus Inc.

Co-authors: Steven Deverel, HydroFocus Inc.; Nick Christen, HydroFocus Inc.

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Comparing CO₂ Exchange Across Water Management and Land Use Conditions in the Sacramento–San Joaquin Delta



The Sacramento–San Joaquin Delta includes diverse land use and water management settings, from agricultural fields to wetlands. These differences shape ecosystem CO₂ exchange and influence whether landscapes function as seasonal carbon sources or sinks. Comparing flux observations across sites helps place individual measurements in a broader Delta context and clarify how management conditions affect carbon dynamics.

This study compares CO₂ exchange across Delta landscapes by combining eddy-covariance observations from the Delta Drought Response Pilot Program with regional AmeriFlux records. As part of the program, six micrometeorological stations were established in 2023 to measure evapotranspiration and CO₂ fluxes across agricultural sites with different crop types and without irrigation.

AmeriFlux records broaden the comparison to include Delta sites with additional water-management settings and a wider range of agricultural and wetland ecosystems.

We compare cumulative and temporal patterns of CO₂ exchange across sites and examine how these patterns vary with meteorological conditions for multiple years, soil types, and land management. This regional perspective helps determine whether observed CO₂ patterns are site specific or part of broader Delta scale trends. Initial results indicate carbon sink for the seasonal atmospheric CO₂ fluxes observed during wet season when crops were grown, and potential carbon source during the bare soil conditions. The results can provide new knowledge on how agricultural management, water conservation, and wetland restoration influence CO₂ exchange, and how these effects may change under increasingly dry and variable hydroclimatic conditions. And provide valuable insight into future strategies for the region in choosing flooding or water saving agricultural practices.

Speaker: Yanxin Xie, UC-Davis Biomicrometerology Lab

Co-authors: Olmo Guerrero Medina, University of California Davis; Emma Ware, UC-Davis Biomicrometerology Lab; Rex Dave Pyles, UC-Davis Biomicrometerology Lab; Kyaw Tha Paw U, UC-Davis Biomicrometerology Lab; Michelle Leinfelder-Miles, UC CE San Joaquin County; Kosana Suvocarev, UC-Davis Biomicrometerology Lab; Toby Brown, University of California Davis

Track: Nature-Based Solutions & Landscape Resilience

A discerned hierarchy of environmental conditions driving wetland carbon assimilation using multi-sensor remote sensing

Wetlands are critical for carbon sequestration and coastal resilience, yet they have experienced widespread loss over the past century, primarily due to human-driven land reclamation. In highly reclaimed regions, this has contributed to land subsidence and increased vulnerability to sea-level rise. In response, state agencies in California's Sacramento-San Joaquin Delta have initiated wetland restoration efforts to recover lost ecosystem services, especially carbon sequestration and subsidence reversal, both of which are closely linked to gross primary productivity (GPP).

This study aims to improve understanding of how environmental conditions influence wetland GPP at landscape scales by integrating multi-sensor satellite remote sensing with eddy covariance measurements.

This fusion overcomes long-standing challenges in studying wetland productivity, particularly the spatial heterogeneity and limited field accessibility of these environments. Using multi-sensor imagery (optical NDVI, thermal data, and microwave backscatter) alongside footprint-weighted GPP flux maps from eddy covariance, we developed a Bayesian generalized additive model (GAM) to quantify the relative and interactive effects of vegetation vigor, canopy structure, and surface temperature on GPP at 10-meter resolution over a five-year period.

The model explained 66% of observed GPP variability, with peak productivity in warm, water-rich, and densely vegetated zones. These results demonstrate a scalable, open-access framework for monitoring wetland carbon fluxes and inform restoration design, carbon accounting, and coastal adaptation strategies in blue carbon ecosystems.

Speaker: Eric Romero

Track: Nature-Based Solutions & Landscape Resilience

Nighttime evapotranspiration in wetlands: not negligible, not uniform



Evapotranspiration (ET) is a primary pathway of the wetland water cycle. However, nighttime ET is often assumed negligible due to reduced solar radiation and plant activity, leading to major biases in wetland water budgets.

Because wetlands exhibit complex surface and biophysical properties, including varying fractions of open water and vegetation, tidal influences, and high heat capacity that sustains ET, direct in-situ measurements offer a transformative benchmark for resolving these complexities.

Using eddy covariance observations spanning 284 site-years, we evaluated nighttime ET across the Continental United States, revealing the coupled controls of thermodynamic conditions and atmospheric dynamics in regulating nighttime ET and explaining its spatial-climatic variability. Our findings expose a systematic oversight: nighttime ET is a substantial term that cannot be ignored in wetland water budgets.

Authors: Carlos Wang, University of California, Berkeley; Dennis Baldocchi, UC Berkeley; Kanishka Mallick, Centre d'Etudes Spatiales de la Biosphère CESBIO, CNRS, CNES, IRD, INRAE, University of Toulouse

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Interdisciplinary Science & Cross-Knowledge Integration

Making Sense of Delta Island Water Use: A Sensor Network on Bouldin Island

The Metropolitan Water District of Southern California has collaborated with the State Water Board's stakeholder group to improve understanding of net channel depletions from islands in the Sacramento–San Joaquin Delta. This information is essential for meeting in-Delta water use reporting requirements, complying with D-1641 flow and salinity standards, and supporting biological opinions for coordinated operations of the State Water Project and Central Valley Project.

Historical studies and more recent salinity-based analyses indicate that island channel depletions do not simply match evapotranspiration at shorter time scales; instead, changes in island water storage appear to influence these patterns. However, limited data exist on how the island water balance varies by season or water year type.

Better temporal information would enhance both regulatory and management policy decision-making.

In the current phase of this effort, Metropolitan is implementing a monitoring program on Metropolitan's Bouldin Island in San Joaquin County to characterize island-scale water balance dynamics. Environmental sensors have been deployed at five sites to record soil moisture, groundwater level, groundwater conductivity, and precipitation. Initial results from the first months of monitoring will be presented, along with a modeling framework that will be further refined as additional data become available.

By improving estimates of the island's water balance, this work will generate new quantitative insights into Delta island water use. The goal is to advance understanding of net channel depletions at the island scale and lay the groundwork for applying this approach to other Delta islands in the future.

Speaker: Katherine Heidel, Tetra Tech, Inc.

Co-authors: Sujoy Roy, Tetra Tech Inc.; Hai Huang, Tetra Tech, Inc.

Track: Managing Competing Demands for Water

TUESDAY, SEPTEMBER 29, 2026 - SESSION 31 · 5 PRESENTATIONS

Delta Smelt survival and the promise and challenges of supplementation



Speakers: Vanessa Tobias, California Department of Fish and Wildlife; Florian Mauduit, UC Davis; Marissa Wulff, US Geological Survey, California Water Science Center; Veronica Violette, US Geological Survey; Rick Wilder, ICF

Track: Ecology, Food Webs, & Changing Ecosystems

Building and assessing graphical models to explain patterns in Delta Smelt survival



The Delta Smelt life cycle models (DSLCLMs) are state-of-the-art tools for estimating vital rates such as seasonal survival and annual recruitment. Analysis of vital rates using DSLCLM2 showed that when the annual population growth rate was less than one, fall survival was most often the lowest vital rate.

This suggests that fall conditions may be a survival bottleneck for Delta Smelt in some years, but it is unclear what specific actions managers could take to improve their survival through the fall months. Integrating the DSLCLM2 results into a causal inference process can help translate the information gained by using the DSLCLMs into actionable information by connecting relevant biological covariates and management actions.

I developed graphical causal models that link potential management actions, physical habitat conditions, biological observations, and fall survival based on relationships described in the literature. I then tested the causal models using monitoring data to assess whether they adequately represent the processes that generated the data and whether they allow unbiased estimation of the effects of management actions.

The results suggest that management actions such as hydrological controls and wetland restoration affect survival through habitat attributes. This work forms the first steps toward counterfactual analyses that allow comparisons of predicted survival outcomes from different management actions.

Speaker: Vanessa Tobias, California Department of Fish and Wildlife

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Rearing Environment Shapes Stress Tolerance and Release Readiness in Delta Smelt



The critically endangered Delta Smelt (*Hypomesus transpacificus*) is endemic to the San Francisco Estuary, and hatchery supplementation has become central to efforts to prevent extinction. However, post-release outcomes remain difficult to evaluate, recapture rates are very low, and recent analyses suggest releases have not produced detectable population-level effects. These challenges highlight the need to test whether rearing strategies can improve release-readiness traits.

We compared hatchery-reared Delta Smelt with fish held under semi-natural impoundment conditions. A group of 1,400 fish at approximately 250 days post-hatch was transferred for one month into an enclosure within an impoundment on Bouldin Island, where fish experienced fluctuations in temperature, dissolved oxygen, and prey. A control group of 600 fish was maintained at the Fish Conservation and Culture Laboratory under standard protocols. Survival at the end of the impoundment period was 80%.

Fish from both groups were transported to our campus facility and reacclimated to common laboratory conditions at 12°C for three weeks before assessment of hypoxia tolerance, thermal susceptibility, swimming performance, and anti-predator avoidance.

After reacclimation, impoundment-reared fish still showed higher thermal and hypoxia tolerance than hatchery controls, while swimming performance did not differ between groups. This suggests that semi-natural rearing enhanced tolerance-related traits without measurably altering locomotor performance. Anti-predator avoidance trials are ongoing.

Together, these findings suggest that semi-natural impoundment rearing can induce persistent improvements in stress-tolerance traits while maintaining swimming performance. This work provides management-relevant information for refining supplementation strategies and producing Delta Smelt better prepared for natural environmental conditions after release.

See the Delta Science Tracker for more information:

<https://sciencetracker.deltacouncil.ca.gov/node/54457>

Speaker: Florian Mauduit, UC Davis

Co-authors: Dennis Cocherell, UC Davis; Jack Gunst, UC Davis; Tiffany Huynh, UC Davis; Shawn Acuna, Metropolitan Water District of Southern California; Amelie Segarra, University of California, Davis; Nann Fangue, UC Davis

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Water Quality, Contaminants, & Aquatic Health

Integrating sampling methods to inform fish community composition at delta smelt release sites



Conservation efforts for the endangered delta smelt (*Hypomesus transpacificus*) increasingly rely on releasing hatchery-raised individuals into the wild. To better understand post-release predation risk and fish community composition at release sites in the Sacramento-San Joaquin Delta, we paired Adaptive Resolution Imaging Sonar (ARIS) cameras with traditional gillnet sampling during delta smelt releases.

ARIS cameras provided continuous, low-disturbance sampling, and detected smaller size classes, though with limited species-level identification. Gill nets offered direct observations of species composition and size structure but over a narrower temporal window.

Preliminary results indicate that combining these methods improves characterization of the fish community, revealing spatial differences in species dominance.

As such, native fish were most abundant near the boat ramp at Lookout Slough, while striped bass (*Morone saxatilis*) dominated adjacent sloughs. Together, these early findings highlight the value of integrating complementary datasets to assess community structure and predation risk at delta smelt release sites.

Expanding data analysis to additional release sites and incorporating data from multiple study years provides the opportunity for broader comparisons of gillnet and ARIS results across spatial and temporal scales. These efforts may reveal new insights into fish community dynamics and inform adaptive management strategies for delta smelt conservation.

Speaker: Marissa Wulff, US Geological Survey, California Water Science Center

Co-authors: Veronica Violette, US Geological Survey; Jeff Gronemyer, U.S. Geological Survey, California Water Science Center; Danielle Palm, U.S. Geological Survey - California Water Science Center; Trishelle Tempel, Department of Water Resources; Katherine Osborn, California Department of Water Resources; Brian Schreier, California Department of Water Resources; Colin Smith, USGS

Track: Ecology, Food Webs, & Changing Ecosystems

Evidence of Delta Smelt Predation During Experimental Releases from Gill Net Sampling and Gastric Lavage



Survival of hatchery-released Delta smelt (*Hypomesus transpacificus*) following supplementation efforts is highly variable, and the factors driving early mortality remain poorly understood. While past studies have examined interactions between Delta Smelt and piscivorous fish, direct consumption in the wild has generally been difficult to quantify. Recent experimental releases provide a unique opportunity to assess predation under real-world conditions and inform both short-term management and long-term understanding of top-down controls.

To quantify predator abundance and consumption, we combined Adaptive Resolution Imaging Sonar (ARIS) to detect large, predator-sized fish at release sites with gill nets and gastric lavage to identify piscivorous species and confirm predation events. Observations revealed that the number of predators at release sites is highly variable, but multiple species consume hatchery-released Delta Smelt.

Striped bass was the primary predation concern, responsible for the majority of consumption, and predation frequency on released smelt was high.

Results indicate that many released Delta smelt are consumed by predators within the first 24 hours following release, highlighting predation as a major source of early mortality. These findings indicate that while smelt tolerate the release process well, early post-release survival is strongly influenced by the presence and activity of predators.

By combining sonar-based monitoring with field sampling and gut-content analysis, this study provides one of the first targeted evaluations of post-release predation pressure on hatchery-reared Delta smelt. The results offer actionable insights to inform release strategies to reduce early mortality, improve supplementation outcomes, and support recovery efforts.

Speaker: Veronica Violette, US Geological Survey

Track: Ecology, Food Webs, & Changing Ecosystems

Feasibility of Acoustic Telemetry in Delta Smelt: Results from Four Years of Refinements and Next Steps



Cultured Delta smelt have been released annually into the San Francisco Bay-Delta since 2021 as a management action intended to supplement the population and reduce extinction risk. Information on post-release dispersal, habitat use, and survival is key for evaluating the success of this action.

Although some of this information has been collected using Visible Implant Elastomer (VIE) tags, acoustic telemetry offers a more advanced approach by enabling remote, nonlethal detection of individuals and estimation of survival, movement, habitat use, and distribution.

Our objective was to evaluate the feasibility of implanting an experimental miniaturized acoustic transmitter ("Shad Tag"; 0.05 g) in Delta smelt while minimizing mortality and sublethal effects and maximizing tag retention.

Through iterative refinements to traditional salmonid surgical techniques and to pre- and post-surgical conditions, we were able to reliably tag cultured Delta smelt as small as 60 mm (FL) with 89% relative survival, >95% tag retention, and minimal sublethal effects over 30 days post-tagging.

These results indicate that tagging Delta smelt with acoustic transmitters is feasible and could provide resource managers with key information to boost the efficiency of existing monitoring programs, optimize habitat restoration efforts, and support species recovery.

Ongoing and next steps include field testing of the Shad tag by evaluating detection range and efficiency in two-dimensional and three-dimensional arrays at multiple sites.

Speaker: Rick Wilder, ICF

Co-authors: Sebastian Gonzales, UC Davis; Eric D. Chapman, ICF; Anna Steel, University of California, Davis; Jason Hassrick, ICF Environmental, Inc.; Dennis Cocherell, UC Davis; Daniel Deng, Pacific Northwest National Laboratory PNNL; Nann Fangue, UC Davis

Tracks: Ecology, Food Webs, & Changing Ecosystems · Finding Collaborative Solutions

Evidence-based monitoring of progress toward the coequal goals to galvanize actions, investments, and partnerships



The Delta's natural resources are critical to the wellbeing of California both ecologically and economically. The coequal goals establish equal importance of managing for a reliable water supply, and healthy natural and human ecosystems. Delta governance is highly complex due to its overlapping management goals. Establishing measurable program goals and success metrics rooted in science and communicated with clarity is essential for effective and transparent government. Evidence-based monitoring and program review is a systematic process to evaluate that long-term plans are effective, based on rigorous science, and result in improvements. This session brings together major California water and ecosystem management programs with established environmental targets to facilitate a discussion exploring opportunities to leverage and amplify transparent program assessments, reporting, and communications, and share lessons learned to galvanize collective actions, investments, and partnerships.

Programs to be featured: California Water Plan, 30x30 California, Natural and Working Lands Climate Smart Strategy, Central Valley Flood Protection Plan, Delta Plan, and others applicable to the Bay-Delta.

The session will start with an overview of each program to establish a shared knowledge that sets the stage for panel discussion. Panel members will dive deeper on how progress is monitored and reported, and how data are used to review and inform progress. A moderated panel discussion will explore: use of science for tracking progress and informing actions; role of peer review in program assessments; where are opportunities to improve coordination, enhance accountability, increase engagements, and accelerate actions; how to address barriers and secure at-scale investments; and what is needed from science to increase resilience planning and horizon scanning. The moderated panel will engage with audience and will respond to audience questions.

Session Chair: Martina Koller, Delta Stewardship Council

Speakers: Henry DeBey; Jay Ziegler; Jonathan Wachter; John Cain; Laura Feinstein

Co-authors: Jeff Henderson, Delta Stewardship Council; Rachel Wigginton, Delta Stewardship Council; Hannah Chaney, Delta Stewardship Council

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Unexpected food web dynamics from historic, restored, and managed wetland habitats in Suisun Marsh and the Delta



Much of the Delta and Suisun is a mosaic of different types of functional wetlands. Very few historic "natural" wetlands remain, and those are affected by extraneous factors like water management, mosquito control, invasive species, and climate change. In the push to restore wetlands to a more natural state, many managed wetlands have been overlooked, even though they have effectively preserved many wetlands from intensive agriculture or development, and offer unique protective features.

These managed wetlands were created in the late 19th century to support declining waterfowl for recreation. While managed wetlands lack a natural tidal flow regime, they provide many benefits to the aquatic ecosystem, providing both habitat and aquatic food for fishes and other vertebrates.

In this session, we present a decades' worth of research into the function of both managed, restored, and historic wetlands in an effort to understand and compare the relative contributions of each to Suisun Marsh, and epicenter of estuarine fish habitat.

Session Chair: John Durand, UC Davis

Co-authors: Kyle Phillips, UC Davis; Alice Tung, University of California, Davis; Elsie Platzer, University of California, Davis; Lynette Williams Duman, University of California, Davis; Jake Sousa, UC Davis; Kimberly Evans, UC Davis; Daniella Davis, UC Davis

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems · Finding Collaborative Solutions

From flood-up to drawdown: flood-pulse effects on phytoplankton productivity in managed wetlands of Suisun Marsh



Phytoplankton are a critical food resource supporting aquatic food webs in the San Francisco Estuary. In this presentation, we examine flood-pulse effects on phytoplankton production following fall flood-up across multiple managed wetlands in Suisun Marsh from 2022–2024, alongside observations from a spring leaching cycle in a managed wetland during 2018.

Across the 2022–2024 study, phytoplankton biomass generally peaked rapidly after fall flood-up and declined as the flood cycle progressed. Flood days were identified as a significant predictor of chlorophyll *a*, with biomass decreasing over time following inundation. Elevated nutrient availability during fall flood-up has been largely attributed to decomposition of senesced terrestrial vegetation accumulated during summer dry periods.

During the 2018 spring leaching-cycle study, phytoplankton biomass and productivity also increased following reflood events before declining during subsequent flood cycles. However, production was substantially lower than that observed during fall flood-up. Nutrient limitation appeared to constrain spring productivity, as supported by nutrient enrichment experiments conducted during the study. Unlike fall flood-up, where nutrients are thought to originate largely from decomposition of wetland vegetation, nutrient inputs during spring appeared more closely linked to exchange with adjacent tidal sloughs.

These findings suggest that hydrologic management strongly influences phytoplankton dynamics in Suisun Marsh and that the mechanisms supporting production may differ between seasonal flood pulses. Understanding how hydroperiod and flood-pulse timing influence phytoplankton production can help inform wetland management strategies aimed at enhancing food-web support in the San Francisco Estuary.

Speaker: Alice Tung, University of California, Davis

Co-authors: Kyle Phillips, UC Davis; Steven Sadro, UC Davis; John Durand, UC Davis

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

Under-recognized Managed Wetlands Support Native Fishes and Local Habitats



The San Joaquin-Sacramento River complex and the San Francisco Bay Delta have been markedly reduced due to human activities and invasion by exotic species. Local agencies and conservation groups have funded numerous restoration projects, scientific study, and conservation easement to support remaining habitat and native species. There already exist, however, thousands of acres of managed wetland consisting of large, shallow ponds that function similarly to historic floodplains that support fish food production and populations of native fishes. In an effort to document the variability and productivity of managed wetlands, and restored sites, we took monthly fish samples across multiple sites at two managed wetlands and one restoration site, formerly a managed duck hunting pond.

We also collected zooplankton samples from these on-pond as well as adjacent slough sites accompanied by measurement of a suite of environmental variables. Our study has found that these managed wetlands support orders of magnitude higher levels of primary and secondary productivity than adjacent tidal sloughs. Furthermore, we have found that these under-recognized fish habitats tend to contain a higher proportion of native fishes than their relict or restored counterparts. Areas within our restoration site did contain high levels of productivity relative to open sloughs or bays, as well as high diversity of fishes and presence of listed species. Our research aims to quantify the potential benefits of active management in the Suisun Marsh, to help stakeholders and managers better target restoration efforts and preserve productivity where it exists already and support native fish populations.

Speaker: Jake Sousa, UC Davis

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems · Finding Collaborative Solutions

Using Citizen Science to Quantify Prey Types of Piscivorous Birds in the San Francisco Estuary



The impact of piscivorous birds on fish populations is poorly known in the San Francisco Estuary (SFE). Within the SFE, birds are known to feed upon juveniles of native fish species, such as Sacramento splittail (*Pogonichthys macrolepidotus*) and Chinook salmon (*Oncorhynchus tshawytscha*), but the extent of their impact is not well-understood.

Bird predation has been highlighted as a potential conservation challenge for native fish species, but the proportion and spatial distribution of native fish predation by birds has not been analyzed in the region. Using abundant citizen science data in eBird, we sought to fill the gap in knowledge regarding what species piscivorous birds are preying upon and the differences in those prey items across different sub-regions of the SFE.

Using seven focal species of piscivorous bird, we collated photos from the Macaulay Library that documented feeding events; we then identified prey items to the most specific taxonomic group possible.

We were interested in prey distributions by habitat types, region, and assess use versus availability of fish prey items. Among all focal species, gobies (*Gobiiformes*) were the most abundant prey item (~18% of prey).

An abundance-based indicator species analysis using orders of prey items showed that Great Blue Herons (*Ardea herodias*) and Great Egrets (*Ardea alba*) were significantly associated with rodents (*Rodentia*) as prey, Pied-billed Grebes (*Podilymbus podiceps*) with sticklebacks and pipefish (*Gasterosteiformes* and *Syngnathiformes*), Double-crested Cormorants (*Nannopterum auritum*) with toadfish (*Batrachoidiformes*), and Osprey (*Pandion haliaetus*) with striped bass (*Acanthuriformes*). Out of our seven focal species, Great Blue Heron had the most diverse diet, and Pied-billed Grebe had the least diverse diet.

Our study helps create a baseline regarding how piscivorous birds in the SFE interact with prey items to better understand the impact that birds have on fish populations.

Speaker: Daniella Davis, UC Davis

Co-authors: Lynette Williams Duman, University of California, Davis; John Durand, UC Davis

Track: Ecology, Food Webs, & Changing Ecosystems

The Story Splittail: Drivers of Distributions and Abundances for a Native, Migratory Fish in Suisun Marsh



Suisun Marsh is a dynamic landscape that acts as a model system for observing the impacts of environmental changes; as a result, long-term monitoring efforts have been deemed to be a priority to evaluate the efficacy of restoration. We analyze the trends in fishes and water quality variables in Suisun Marsh from 1995-2024 at 24 sites, specifically honing in on an obligate floodplain-spawning fish (Sacramento Splittail) to contextualize what influences its distribution and abundance. We employ methods in taxonomy to investigate where splittail in Suisun Marsh occupy and what similarities they hold with respect to environmental conditions.

Water quality samples were taken at each of the sites alongside biotic surveys once a month, including salinity, dissolved oxygen, turbidity, depth, and temperature, which were compared to calculations of monthly Delta Outflow (a metric representing the approximate quantity of freshwater entering the system). We then use Normalized Difference Water Index (NDWI) as a proxy for floodplain availability in key spawning habitat compared to Age-0 fish abundances within Suisun Marsh. Our preliminary results reiterate the importance of small, productive sloughs in splittail distributions, though there is variability depending on water year type. A slight positive association was found between NDWI and splittail abundances, seeming to imply that it is an important driver, but the relationship is more complex than often described.

Speaker: Kimberly Evans, UC Davis

Co-authors: Fushing Hsieh, University of California, Davis; Avidane Ceana Caballero, University of California, Davis; John Durand, UC Davis

Track: Ecology, Food Webs, & Changing Ecosystems

Flood pulses in seasonal managed wetlands enhance zooplankton abundances in Suisun Marsh



Much of the land area in Suisun Marsh is dominated by managed wetlands, which are diked and culverted ponds that are seasonally flooded for migratory waterfowl and recreational hunting. Managed wetlands have recently been shown to support high densities of zooplankton, a critical resource for pelagic fishes declining region wide, but little is known about the mechanisms that drive increased abundances in these novel habitats. We sampled zooplankton in managed wetlands and tidal habitats spread across Suisun Marsh over a 6-year period to assess (1) when managed wetlands support high zooplankton abundances, (2) how zooplankton assemblages vary between managed and tidal habitats, and (3) how abundances respond to seasonal flood operations. When flooded, managed wetlands supported twenty times more zooplankton biomass than adjacent tidal habitats.

Managed wetlands supported increased densities of *Acanthocyclops* spp., *Eurytemora affinis*, and *Daphnia magna* relative to tidal habitats, while densities of other taxa did not differ between habitat types. On average, peak copepod abundances in managed wetlands occurred two months after flood onset while peak cladoceran abundances occurred after four months. Findings suggest that managed wetlands function as floodplain analogues whereby primary and secondary production is driven by seasonal flood pulses. Flood operations in managed wetlands could likely be timed to enhance fish-food production at known critical periods. Future work will explore whether flood operations implemented in summer could provide localized plankton subsidy for smelt and other pelagic fishes when food is otherwise scarce in the estuary.

Speaker: Kyle Phillips, UC Davis

Co-authors: Alice Tung, University of California, Davis; Elsie Platzer, University of California, Davis; John Durand, UC Davis

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

Social indicators in the Bay-Delta: Where we are and where we're headed



Social indicators are increasingly recognized as important for capturing the human dimensions of water and environmental management, and efforts to develop and measure them are gaining momentum across the Bay-Delta. This session brings together five active social indicator efforts (one in the Bay, three in the Delta, and one Estuary-wide) to build a shared understanding, surface common challenges, and explore opportunities to improve coordination and potentially expand social indicator work across the region. The session will open with an overview presentation of current efforts mapping the geographic and topical landscape of social indicator work across the Bay-Delta.

This includes the San Francisco Estuary Wetlands Regional Monitoring Program's Human Dimensions Monitoring, State of Our Estuary's Thriving Communities, the Delta Protection Commission's Socioeconomic Indicators Report, the Delta Plan's Social Performance Measures, and the Delta Residents Survey. This will also include examples of how social indicators inform environmental management in other regions. Five lightning talks will then highlight each effort, covering: the partnerships essential to data collection and reporting; what is being measured and how; the current status of data collection and planned measurement intervals (if relevant); the purpose of the indicators and how they inform management and policy goals; and what's on the horizon. Together, these presentations will establish a shared knowledge base that sets the stage for a panel discussion. We will then have a moderated panel discussion, beginning with prepared questions before opening to audience participation. Discussion will likely explore how these efforts connect to one another, what barriers are slowing progress on social indicator work, coordination opportunities, and how social indicators can be more meaningfully integrated into management and policy decisions. We will also reserve time for audience questions.

Session Chair: Tara Pozzi

Speakers: Sasha Harris-Lovett, San Francisco Estuary Partnership; Annie Merritt, Delta Stewardship Council; Megan Thomson, Delta Stewardship Council; Amanda Bohl, Delta Protection Commission

Co-authors: Alex Thomsen, San Francisco Estuary Partnership; Martina Koller, Delta Stewardship Council

Tracks: Systems Thinking for the Whole Ecosystem · Interdisciplinary Science & Cross-Knowledge Integration

Use of a new academic-agency collaborative training program to advance modeling capabilities in the Bay Delta 2/2



Models and their underlying data serve as the backbone of understanding how the Bay-Delta system functions and are used regularly for management of the system. These hydrological and biological models are typically based on historic data that has been collected and observed from the past 40 years. However, extreme variability in the system and changing baselines challenge the existing fundamental assumptions and relationships used in these models. This session will explore/showcase how evaluating management actions requires an interdisciplinary set of tools from broad hydrologic to mechanistic biological models. These lines of evidence benefit from updated understanding of environmental drivers and attributes gained through new observation.

For this session, we will require two, 100 minute time slots. The session will begin with an overview of how numerical models are used as decision support tools for managing the Bay-Delta system. This will be followed by a series of companion talks contrasting current modeling approaches with potential future developments. The specific models slated for discussion include: ECO-PTM, CalSim, and a Zooplankton-Salinity Submodel; the presenters will include experts in these approaches along with early career scientists working to further advance these tools. This sequence of talks will be followed by a presentation which synthesizes across the various models and associated management needs. The session will then conclude with a panel discussion where presenters answer questions about the next generation of models.

Session Chair: Miranda Bell Tilcock, UC Davis Center for Watershed Sciences

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Follow the food: Modeling relationships of Delta smelt prey taxa with salinity

Zooplankton serve as the primary food source for the endangered Delta smelt (*Hypomesus transpacificus*), one of the fishes central to the California water conflict. Management actions designed to aid Delta Smelt often hypothesize that zooplankton transport is a key benefit.

Yet, until recently, the primary decision support tool used to evaluate these actions (the individual-based life cycle model in R; IBMR) lacked a component to allow zooplankton abundance to vary.

Here, we describe a set of Generalized Additive Models that predict density changes for key zooplankton taxa based on salinity. This modeling framework offers a better understanding of how flow changes subsidize Delta smelt prey, while directly providing the necessary dynamic inputs for the IBMR.

As a result, zooplankton subsidies can now be formally integrated into regulatory decision-making, such as evaluating changes to X2/outflow actions, and Suisun Marsh Salinity Control Gate operations. Finally, we will provide an overview of how this tool has been applied in recent years, discuss the limitations of the current models, and explore critical pathways for future model improvements.

Speaker: Lillian McCormick, USBR

Co-authors: Brian Mahardja, US Bureau of Reclamation; Rosemary Hartman, California Department of Water Resources

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Understanding the Drivers of Zooplankton Abundance and Spatial Patterns in the San Francisco Bay–Delta



The San Francisco Bay–Delta is a heavily modified estuarine system supplying water for 30 million Californians and numerous state and federally listed fish species. Over recent decades, the system has experienced significant pelagic organism declines, including reductions in zooplankton communities that form a critical trophic link between primary producers and fish such as Delta Smelt and juvenile salmonids. Despite extensive monitoring, contributions of environmental conditions, bottom-up productivity, and top-down predation to zooplankton dynamics across Bay-Delta subregions remain uncertain.

We aimed to quantify environmental and bottom-up drivers of zooplankton abundance and spatial distribution across the Bay–Delta.

We leverage long-term monitoring datasets from the Interagency Ecological Program (IEP), including integrated zooplankton, environmental, and water quality records spanning the Enhanced Delta Smelt Monitoring Program (EDSM) subregions, alongside flow data from the DWR Dayflow dataset. Using generalized additive and hierarchical statistical models, we evaluate how flow, salinity, turbidity, temperature, and chlorophyll-a interact to shape zooplankton communities across space and time. We extend existing modeling frameworks used in decision-support tools limited to subregions where salinity varies with management actions, leaving freshwater portions of the Delta unrepresented in food web forecasting. By examining bottom-up effects and environmental drivers across EDSM subregions, we characterize how driver strength and direction vary between freshwater and estuarine environments. This component of a larger project incorporating top-down effects of fish and non-native bivalves to fill a critical gap in tools like the Individual-Based Life Cycle Model in R (IBMR), where zooplankton prey density is the most influential input for projecting Delta Smelt population outcomes.

Speaker: Alyse Lacey, UC Davis Center for Watershed Sciences

Co-authors: Jon Walter, University of California, Davis; John Durand, UC Davis; Andrea Hamilton, United States Bureau of Reclamation; Joshua Israel, United States Bureau of Reclamation; Lillian McCormick, USBR

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water



New Insights into old challenges: Incorporating the past's information into tomorrow's tools

The San Francisco Bay-Delta and Central Valley are well-studied aquatic ecosystems due to many decades of monitoring to understand how the significant modification of habitat, flows, and water quality have affected its waterways and fish populations.

Perceived and real scarcity of water and fish resources in the Bay-Delta and Sacramento and San Joaquin river impact Californians. An almost insurmountable amount of information exists for us to understand recent (e.g. 50+ years) ecological changes, and integration of these data into models and decision support tools to understand the potential ecological changes likely to occur in the future are prerequisite to ensure relevant and translational science is incorporated into planning tools.

Yet, planning tools used for understanding and predicting how Central Valley Project and State Water Project storage, releases, blending, diversion, and routing of water impacts environmental drivers and habitat attributes that result in changes in the food web and species responses are slow to adapt to new information. Recent independent reviews of the CVP and SWP have made recommendations regarding the models and decision support tools used to improve fish actions and water operations.

The UC Davis Multidisciplinary Water Training aims to align new scientists to work on a range of fish and water operation topics to support addressing these recommendations. This presentation will highlight Reclamation interest in translational science to broaden participation in relevant, transparent, and innovative projects that efficiently enhance and expand the management tools we use. This framework provides a context and series of questions for our panel of emerging and current scientists working at this frontier.

Speaker: Josh Israel

Co-authors: Joshua Israel, United States Bureau of Reclamation; Miranda Bell Tilcock, UC Davis Center for Watershed Sciences; Andrea Hamilton, United States Bureau of Reclamation; Karrigan Bork, UC Davis Center for Watershed Sciences

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water



Conclusion and discussion

The San Francisco Bay-Delta and Central Valley are well-studied aquatic ecosystems due to many decades of monitoring to understand how the significant modification of habitat, flows, and water quality have affected its waterways and fish populations. Perceived and real scarcity of water and fish resources in the Bay-Delta and Sacramento and San Joaquin river impact Californians. An almost insurmountable amount of information exists for us to understand recent (e.g. 50+ years) ecological changes, and integration of these data into models and decision support tools to understand the potential ecological changes likely to occur in the future are prerequisite to ensure relevant and translational science is incorporated into planning tools.

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Recent independent reviews of the CVP and SWP have made recommendations regarding the models and decision support tools used to improve fish actions and water operations. The UC Davis Multidisciplinary Water Training aims to align new scientists to work on a range of fish and water operation topics to support addressing these recommendations. This presentation will highlight Reclamation interest in translational science to broaden participation in relevant, transparent, and innovative projects that efficiently enhance and expand the management tools we use. This framework provides a context and series of questions for our panel of emerging and current scientists working at this frontier.

Speaker: Josh Israel

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 36 · 5 PRESENTATIONS

Bird and mammal perspectives on habitat use and restoration in Delta landscapes



Speakers: **Amanda Kindel**, Museum of Wildlife and Fish Biology, University of California, Davis; **Billy Abbott**; **Sarah Peterson**, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station; **Jason Riggio**, Museum of Wildlife and Fish Biology, University of California, Davis; **Katie Smith**, WRA, Inc., UC Davis

Assessing Bat Occurrence and Habitat Use in the California Delta

Bats are important insect predators in the California Delta, yet little is known about species distributions and habitat associations across this highly modified agricultural landscape. To address this knowledge gap, we conducted passive acoustic surveys at 34 sites in the north and west Delta from April 2021 through April 2022. Acoustic detectors were deployed for four nights per month at each site, yielding 1,496 survey nights. Recordings were processed using SonoBat automated call-classification software and manually vetted to confirm species identifications.

We recorded and confirmed calls for eight bat species: Big Brown Bat (*Eptesicus fuscus*), California Myotis (*Myotis californicus*), Hoary Bat (*Lasiurus cinereus*), Little Brown Bat (*Myotis lucifugus*), Mexican Free-tailed Bat (*Tadarida brasiliensis*), Silver-haired Bat (*Lasionycteris noctivagans*), Western Red Bat (*Lasiurus frantzii*), and Yuma Myotis (*Myotis yumanensis*).

Multi-season occupancy models were used to evaluate the influence of seasonality and habitat characteristics on species occurrence across the Delta. Seasonal patterns varied among species, with migratory species, such as Hoary and Silver-haired bats detected primarily during spring and fall migration. Other resident species, like Mexican Free-tailed Bat, were detected year-round. Occupancy modeling revealed species-specific patterns of occurrence across Delta habitats.

Notably, Little Brown Bats were detected frequently across the study area, especially in the north Delta. This species is listed as endangered on the IUCN Red List and has experienced severe population declines across eastern North America due to White-Nose Syndrome, while also subject to significant mortality at wind energy facilities. Our findings provide one of the most comprehensive assessments of bat occupancy in the California Delta to date and establish a baseline for future monitoring, conservation, and habitat management in this rapidly changing ecosystem.

Speaker: [Amanda Kindel](#), Museum of Wildlife and Fish Biology, University of California, Davis

Co-authors: [Jason Riggio](#), Museum of Wildlife and Fish Biology, University of California, Davis

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

Scaling a Habitat Incentive Program: Obstacles, Opportunities, and Lesson Learned from 12 Years of BirdReturns



For over a decade, the BirdReturns habitat incentive programs have implemented a market-based approach to providing habitat for migratory waterbirds in California's Central Valley. Initiated by The Nature Conservancy (TNC) in 2014 to provide shorebird habitat in Sacramento Valley rice fields, BirdReturns has expanded spatially and temporally through the collaborative efforts of the Migratory Bird Conservation Partnership (TNC, Audubon California, Point Blue Conservation Science), the California Department of Fish and Wildlife and private landowners.

BirdReturns applies science-based decision-making to allocate limited resources toward habitat creation where ecological return is maximized.

The program utilizes species distribution models, bioenergetics-based habitat objectives, and timely environmental data to inform seasonal habitat selection. This framework enables flexible habitat deployment aligned with habitat need, hydrologic conditions, and agricultural constraints.

Consistent monitoring and ecological study provide guidance to refine habitat targets and quantify outcomes. Implementation at scale has exposed challenges and tradeoffs, spurred creative solutions, and evolved program design.

Lessons learned and research from scaling an incentive-based conservation program will be highlighted, with emphasis on how adaptive management and multi-stakeholder partnerships can improve the efficiency and resilience of working-land habitat strategies.

Speaker: Billy Abbott

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Wetland characteristics in Suisun Marsh influence dabbling duckling habitat use and movements



The availability of inundated wetlands, near upland nesting habitats, during the brood-rearing period is critical to dabbling duck brood survival and population recruitment. Yet, in some breeding areas, wetland habitats often are drained or dry out during the waterfowl breeding season, which can limit the habitat available for ducklings.

In Suisun Marsh, we evaluated the specific types of wetlands and quantified the habitat variables that affected wetland selection by dabbling duck hens and their broods from 2016–2019. Mallard (*Anas platyrhynchos*) and gadwall (*Mareca strepera*) broods selected semi-permanent wetlands (flooded in the fall and winter and remained inundated until at least August 1) and avoided permanent wetlands (inundated year round). Gadwall broods also selected summer flooded seasonal wetlands (flooded in the spring and summer and remained inundated through August).

Mallard and gadwall broods demonstrated selection for intermediate to larger sized wetlands, wetlands with lower salinity concentrations, and wetlands with intermediate levels of vegetation cover. Ducklings of both species moved rapidly away from the nest during the first week after hatch (mean distance from the nest for 5-day old ducklings: 0.8–1.4 km for the four study years), after which ducklings exhibited limited additional movement away from the nest (14-day old ducklings: 1.0–1.6 km among the four study years).

Increasing the availability of semi-permanent wetlands and summer-flooded seasonal wetlands within 1.4 km of upland nesting sites could decrease the distance ducklings would need to travel to reach preferred wetland types. Decreased travel distance may reduce risk of duckling mortality and improve both duckling survival rates and population recruitment.

Speaker: Sarah Peterson, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station

Co-authors: Joshua Ackerman, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station; Brady Fettig, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station; Andrew Greenawalt, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station; Alex Hartman, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station; Meghan Keating, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station; Mark Herzog, U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station

Track: Ecology, Food Webs, & Changing Ecosystems

Multiple Restoration Pathways Yield Distinct Avian Communities Across the Sacramento–San Joaquin Delta



The Sacramento–San Joaquin Delta is undergoing extensive restoration to recover ecosystem functions and support native species. Restoration projects employ diverse approaches, including conversion of agricultural lands to managed wetlands, tidal marshes, and riparian-floodplain habitats. While these efforts are often evaluated based on hydrologic or fisheries outcomes, less attention has been given to how restoration pathways influence terrestrial wildlife communities. Birds respond rapidly to habitat change and indicate restoration success.

We evaluated avian community responses across restored and managed habitats across the Delta, including Dutch Slough, Sherman Island, Twitchell Island, the Cosumnes River Preserve, and Lookout Slough. Using standardized breeding-season point counts and winter surveys conducted from 2020–2026, we compared species richness, community composition, and native bird density among tidal marsh, managed marsh, riparian-floodplain, and non-restored pasture habitats.

Restoration pathway strongly influenced avian community composition and biodiversity outcomes. Tidal and managed marsh habitats supported high densities of native marsh-associated birds, while tidal marshes exhibited the greatest waterbird diversity. Riparian-floodplain restoration supported the greatest species richness. In contrast, non-restored pastures supported a distinct assemblage of grassland specialists at greater densities than restored habitats. Across restoration types, habitat heterogeneity emerged as a key driver of avian diversity, with mosaics of open water, emergent vegetation, and woody cover supporting the most diverse bird communities.

Our findings demonstrate that different restoration pathways produce distinct ecological outcomes for birds, with no single approach maximizing benefits for all species. Maintaining diverse restoration strategies may therefore be necessary to conserve avian biodiversity while meeting broader ecosystem restoration objectives.

Speaker: Jason Riggio, Museum of Wildlife and Fish Biology, University of California, Davis

Co-authors: Daniel Fradet, Museum of Wildlife and Fish Biology, University of California, Davis; Amanda Kindel, Museum of Wildlife and Fish Biology, University of California, Davis; Molly Ferrell, California Department of Water Resources; Andrew Engilis Jr., Museum of Wildlife and Fish Biology, University of California, Davis

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

Ecological Considerations in Habitat Restoration for the Salt Marsh Harvest Mouse



The salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris*), a wetland endemic of the Bay-Delta, is highly threatened by sea-level rise, making tidal marsh restoration a key recovery strategy. However, there is relatively little data on SMHM response to restoration and enhancement activities as many restoration sites are devoid of habitat before restoration and restorations often develop over decades making it difficult to track when SMHM colonize restored areas.

These challenges are further complicated by differing salinities and tidal ranges within the major parts of the SMHM range, which impact design strategies. Limited knowledge of SMHM use of microhabitats and built features further constrains restoration design. For example, for decades it was believed that adjacent upland grasslands were essential for SMHM to escape high tides. Recent research has shown, however, that SMHM avoid upland habitat during extreme tides, likely due to competition with aggressive upland rodents.

Similarly, while marsh islands have never been specifically investigated, preliminary data indicates SMHM may be excluded by competitors. Further, recent monitoring has shown SMHM populations in marsh areas closer to uplands recover more slowly from disturbance, likely due to eruptions of upland competitors which disperse into adjacent marsh.

While uplands remain important for long-term habitat resilience under future sea-level rise, this calls into question the optimal balance between low and high elevation microhabitats in restoration design. Using data from the 2022 Rangewide survey and ongoing monitoring data from throughout the San Francisco Bay Delta we explore SMHM associations with specific habitat characteristics and features (e.g., marsh elevation, refuge types).

We will also discuss how tidal restoration interacts with small-mammal community dynamics, how to promote SMHM colonization, and how to minimize competition on SMHM in their core habitat areas.

Speaker: Katie Smith, WRA, Inc., UC Davis

Co-authors: Carla Angulo, WRA, Inc.; Melissa Riley, CDFW, U.C. Davis; Dajanae Stitts, California Department of Fish and Wildlife; Rayna Fitzgerald, California Department of Fish and Wildlife; Rhona McChesney, WRA Inc.; Sarah Estrella, California Department of Fish and Wildlife; Laureen Barthman-Thompson, California Department of Fish and Wildlife

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 37 · 5 PRESENTATIONS

Movement, migration, and modeling: Advances in tracking salmon, steelhead, and sturgeon



Speakers: Russell Perry, U.S. Geological Survey - Western Fisheries Research Center; Andrea Odell, California Department of Fish and Wildlife; Bryan Matthias, US Fish and Wildlife Service; Jonathan Walter; Amy Hansen, US Geological Survey

Putting time back into space-for-time mark-recapture models: developing next-generation modeling tools for juvenile salmon telemetry data

Over the past decade, acoustic telemetry has become the tool of choice for monitoring how juvenile salmon survive and migrate through Central Valley, Delta, and Bay. However, analytical methods for quantifying factors affecting survival lag technological advances in telemetry.

The problem is that existing analysis software was developed for terrestrial applications where survival is estimated over time (e.g., monthly or annually), not for aquatic applications where survival is estimated through discrete spatial regions (e.g., river reaches). The most serious limitation of existing software is its inability to accommodate the effect of time-varying covariates (e.g., flow, temperature) on survival because an individual's covariate value is unknown if it is not detected.

Although recent methodological advances have overcome this limitation, these methods remain inaccessible to most practitioners.

Therefore, our objective was to develop modeling tools that make advanced models more widely accessible to the community of scientists and managers in the Bay-Delta. Here we introduce the nimbleTIMS package, an R package for fitting time-integrated migration and survival (TIMS) models.

TIMS models jointly estimate migration parameters from travel time data and survival and detection probabilities from capture-recapture data, while allowing for time-varying covariates on all model parameters. NimbleTIMS provides utility functions for processing model input data and modeling functions allowing users to flexibly specify alternative model structures. We illustrate application of nimbleTIMS by working with Bay-Delta telemetry practitioners to analyze a publicly available telemetry data set from the Central Valley.

By making next-generation analytic tools more widely available to scientists and managers, we hope to accelerate discovery and learning to better inform management actions that support healthy fish populations and ecosystems.

Speaker: Russell Perry, U.S. Geological Survey - Western Fisheries Research Center

Co-authors: Adam Pope, US Geological Survey Western Fisheries Research Center; Dalton Hance, U.S. Geological Survey, Western Fisheries Research Center; Michael Dodrill, US Geological Survey Western Fisheries Research Center; Arnold Ammann, National Oceanic and Atmospheric Association

Tracks: Ecology, Food Webs, & Changing Ecosystems · Managing Competing Demands for Water

Using machine learning to predict the timing of winter-run Chinook salmon migration through the Delta



Juvenile winter-run Chinook salmon (*Oncorhynchus tshawytscha*) out-migrate through the Sacramento-San Joaquin Delta, a highly modified and regulated environment where they face numerous challenges. Understanding the timing and ecology of their outmigration can improve their survival through the Delta. We used machine learning to predict the timing of winter-run Chinook salmon outmigration, measured as the cumulative proportion of the population that has entered or exited the Delta on a given day, and evaluated the role of environmental variables.

We compiled cumulative daily catch of length-at-date juvenile winter-run Chinook salmon between 2004-2024 from Knights Landing and Chipps Island to represent the entrance and exit of the Delta and fit regression trees using the eXtreme Gradient Boosting (XGBoost) algorithm. We found significantly greater interannual variability in the timing of entry into the Delta compared to the timing of exit. Delta entry was best predicted by flow, whereas temperature emerged as the primary predictor of their exit. Our model's ability to predict winter-run Chinook salmon presence in the Delta on a daily timescale could serve as a valuable tool for supporting real-time management decision-making.

Speaker: Andrea Odell, California Department of Fish and Wildlife

Co-authors: Jereme Gaeta, California Department of Fish and Wildlife

Track: Ecology, Food Webs, & Changing Ecosystems



Assessing survival, movement, and migration rates of wild *Oncorhynchus mykiss* in the Stanislaus River

A limited knowledge of California Central Valley Steelhead (*Oncorhynchus mykiss*) hinders our ability to quantify the effects of Central Valley Project (CVP) operations since there is a lack of status and trend information regarding the Distinct Population Segment in CVP-operated rivers. The goal of the acoustic study is to support and integrate into *O. mykiss* life cycle and juvenile production estimate (JPE) modeling efforts.

The associated objectives are to 1) estimate the rate at which juvenile *O. mykiss* initiate migration relative to remaining resident fish, 2) estimate reach-specific survival of migrants within the Lower Stanislaus River (LSR), and 3) monitor migratory movements and rates within and out of the LSR.

Between water year 2023-2025, 611 wild *O. mykiss* have been tagged with acoustic transmitters and tracked using both active tracking in the Stanislaus River and autonomous receivers located in fixed sites throughout the Stanislaus River, California Delta, and out to the Golden Gate Bridge.

Of the tagged fish, many were detected via active tracking multiple times post-release, 28 initiated outmigration, and three made it to Golden Gate Bridge. Telemetry data were used in a multistate mark-recapture model. The model integrated data from both fixed receivers and active tracking to estimate both resident and outmigration survival, movement rates within the Stanislaus River and along the outmigration route to the Pacific Ocean, and tag detection rates.

Model results show that resident survival is high, with most fish surviving beyond the battery life of the tags. Survival along the outmigration corridor indicate highest mortality in the lowest reaches of the Stanislaus River and in the Delta. We were unable to link the timing of outmigration with covariates (e.g., flow, rain, temperature, etc.) due to the low outmigration rates.

Speaker: Bryan Matthias, US Fish and Wildlife Service

Co-authors: Lauren Yamane, US Fish and Wildlife Service; Jordan Besson, USFWS; Taylor Senegal, USFWS; Joshua Israel, United States Bureau of Reclamation

Track: Ecology, Food Webs, & Changing Ecosystems

Flows effects on green sturgeon spawning migrations in the Sacramento River

Flows shape habitat quality for aquatic organisms and provide cues that shape movement behavior, such as the timing and route of spawning migrations.

Flow regime alteration is among the most pervasive threats to freshwater ecosystems, and large, long-lived migratory species such as green sturgeon (*Sinosturio medirostris*) are particularly vulnerable to these impacts. We analyzed records from long-term (2007-2017) monitoring of green sturgeon movements via acoustic telemetry to quantify how flows shape success, timing, and route selection during upriver spawning migrations in the Sacramento River system.

Adapting a Bayesian multi-state survival and routing modeling framework originally developed for out-migrating juvenile Chinook salmon to upstream spawning migrations of green sturgeon, we show that higher Sacramento River flows were associated with more direct migrations to upriver spawning areas.

Survival and detection probabilities were high, as expected for large, long-lived, adult fish moving through a well-instrumented telemetry array.

On an annual basis, $\approx 10\text{-}60\%$ (mean $\approx 38\%$) of fish appeared to initiate a spawning migration (i.e., entered the river system) but were not detected at the spawning grounds, and such “incomplete migrations” were more common in years with low spring flows and among younger fish.

Our findings offer a new quantitative assessment of how flows shape green sturgeon spawning migration behavior that supports water management scenario planning.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/activities/analyzing-flow-regime-effects-adult-green-sturgeon-migration-central-california-rivers>

Speaker: Jonathan Walter

Co-authors: Jon Walter, University of California, Davis; Erin Tracy, University of California Davis; Francisco Bellido-Leiva, University of California, Davis, Center for Watershed Sciences; Scott Colborne, Michigan State University; Sarah Yarnell, University of California, Davis, Center for Watershed Sciences; Karrigan Bork, UC Davis Center for Watershed Sciences

Tracks: Ecology, Food Webs, & Changing Ecosystems · Managing Competing Demands for Water

Adult Green Sturgeon Movements in the Lower Sacramento River Relative to River Construction Projects During Water Years 2021–2025



Construction of riverine flood control structures may negatively affect the spawning migrations of vulnerable fish populations. The U.S. Army Corps of Engineers initiated several construction projects under the American River Watershed Common Features (ARCF) Project to reduce flood risk for the City of Sacramento, California, and surrounding areas, connect fish habitat to the Yolo Bypass, improve fish passage at the Sacramento Weir, and reduce fish stranding. The project reach lies within the Sacramento River migration corridor for the federally threatened southern Distinct Population Segment (sDPS) of North American green sturgeon (*Acipenser medirostris*).

As part of a multiyear study to characterize migratory behavior patterns and inform management strategies that minimize sturgeon interactions with construction activities, we examined the movements of 121 acoustically tagged adult green sturgeon transiting the Sacramento River between Verona (rkm 79) and Rio Vista (rkm 21). Data were summarized for pre-construction water years (WY 2021–2022) and construction years (WY 2023–2025). Travel times between detection sites, residence times at detection sites, and diel movement patterns will be presented by water year and season. Compared to the spawning reach in upper Sacramento River, green sturgeon moved rapidly through the study area.

Results from fish tagged prior to and outside the construction period suggest a low probability of construction-related impacts on green sturgeon movements within the ARCF project area during the in-water construction window (July–October). By characterizing diel and seasonal movement patterns, this study improves understanding of how project construction may affect sDPS green sturgeon migration timing and provides information that can be used to adapt construction activities to potentially reduce impacts.

Speaker: Amy Hansen, US Geological Survey

Co-authors: Summer Burdick, U.S. Geological Survey - Western Fisheries Research Center; Michael Thomas, US Army Corps of Engineers

Track: Ecology, Food Webs, & Changing Ecosystems

Machine learning and AI for the future of the Delta: Integrated, interpretable, and operational tools for adaptive management



The Delta is undergoing rapid hydrologic and ecological change. Sea level rise, prolonged droughts, harmful algal blooms, declines in listed species, and large-scale restoration are reshaping the questions that managers must answer, often faster than traditional modeling workflows can support. Over the past three decades, machine learning (ML) has evolved from a research approach into a practical complement to physics-based models, real-time monitoring systems, and operational decision support in the Delta. This special oral session brings together five integrated presentations that describe the evolution of ML in Delta science, its current operational applications, and emerging directions. The session begins with a 30-year retrospective and a forward-looking roadmap for ML and emerging AI approaches for Delta management.

The next four presentations focus on pilot and operational applications addressing key management challenges: (1) transfer-learning-based surrogate models that emulate Delta salinity under drought, sea level rise, restoration, and climate scenarios for integration with CalSim; (2) ML models for predicting cyanobacteria harmful algal blooms to support adaptive water-quality management; (3) a hydrodynamically informed multi-ion forecasting system providing real-time and 7-day predictions for the South Delta through an operational dashboard; and (4) rapid-assessment emulators and hydraulic-footprint metrics for evaluating entrainment risk and salmonid responses under Central Valley Project and State Water Project operations. Collectively, these presentations demonstrate how ML can enable faster, more transparent, and more integrated decision support across water supply, water quality, and ecosystem objectives. They also highlight how coordinated development of these tools across agencies and disciplines supports co-production of knowledge and aligns with the conference theme of co-creating the future of the Delta.

Session Chair: Kevin He, California Department of Water Resources

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health · Interdisciplinary Science & Cross-Knowledge Integration

Machine Learning in the Delta: A 30-Year Retrospective and Future Prospects



The Sacramento–San Joaquin Delta (Delta) is a critical component of California’s water supply and ecological system, requiring timely and reliable modeling tools to support water and environmental management. This study aims to review the evolution of machine learning (ML) applications in the Delta over the past three decades, identify current limitations to broader operational adoption, and outline future directions for ML-enabled decision support.

To achieve these objectives, we conducted a comprehensive review of published studies, technical reports, and operational modeling efforts related to ML applications in the Delta.

The review traces the progression from early artificial neural network (ANN) models developed in the 1990s for salinity estimation to more recent deep learning, hybrid physics-informed ML, and data-driven forecasting frameworks integrated with operational tools such as CalSim. Applications examined include hydrodynamic and water quality prediction, ecosystem monitoring, toxigenic and disaster risk assessment, and infrastructure resilience.

The review shows that ML approaches have substantially expanded in both scope and capability, providing faster prediction, improved pattern recognition, and enhanced integration of large and heterogeneous environmental datasets. However, broader operational deployment remains limited by challenges associated with model interoperability, generalizability, interpretability, transparency, and long-term operationalization. Based on these findings, this paper proposes a strategic roadmap emphasizing standardized ML development protocols, multi-modal data fusion, explainable Artificial Intelligence (AI), digital twins, generative AI, and AI agents to support more adaptive, transparent, and integrated water and environmental management in the Delta.

Speaker: Kevin He, California Department of Water Resources

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health · Interdisciplinary Science & Cross-Knowledge Integration

Transfer Learning for Multi-Fidelity Surrogate Modeling of Delta Salinity Under Extended Drought and Climate Scenarios

Salinity management in the Sacramento–San Joaquin Delta increasingly requires evaluation under extended drought, sea level rise, climate change, and large-scale landscape restoration scenarios. High-resolution hydrodynamic models can represent these processes, but their computational expense limits direct integration with statewide operational models such as CALSIM. This work develops transfer-learning-based artificial neural network (ANN) surrogate models to efficiently emulate Delta salinity responses across multiple future scenarios.

We expanded ANN architectures and training methods to treat alternative Delta futures as a multitask machine learning problem, enabling shared learning across climate, restoration, and operational conditions with varying data fidelity. Model performance was evaluated in terms of both overall predictive accuracy and the ability to preserve contrasts among management interventions and climate scenarios.

We also examined signal-to-noise limitations and assessed how strongly scenarios must differ before surrogate models can reliably reproduce their contrasts.

Results show that multitask transfer learning can improve surrogate robustness across diverse Delta futures while maintaining skill in representing scenario-specific salinity differences. The approach performed particularly well at several remote and hydrodynamically challenging monitoring stations, where contrast fidelity was often strongest. These findings demonstrate the potential for efficient multi-fidelity surrogate modeling to support integrated Delta planning and statewide water operations under evolving climate and management conditions.

For more information see the Delta Science Tracker:
<http://sciencetracker.deltacouncil.ca.gov/node/53501>

Authors: Sabi Can Ruso, University of California Berkeley / Incoming PhD at Stanford; Eli Ateljevich, Department of Water Resources; Lily Tomkovic, California Department of Water Resources

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health · Interdisciplinary Science & Cross-Knowledge Integration

Intuitive Quantitative Metrics for Rapid Assessment of Entrainment Risks and Salmonid Responses in The Delta

Operations of the Central Valley Project (CVP) and State Water Project (SWP) affect the movement and survival of threatened and endangered species in the Sacramento–San Joaquin Delta (Delta), California. CVP and SWP operations are regulated to minimize their impacts on listed species in the Delta. Balancing water supply and species protections requires timely and scientifically defensible assessment of alternative operations. In recent decades, the net Old and Middle River flow (OMR) has been used as an indicator for such purposes.

However, OMR does not capture tidal advective-dispersive transport and is spatially constrained, and ill-supported real-time adjustments of target OMR levels leads to uncertainties for the water users and the regulating agencies. On the other hand, physics-based hydrodynamic models capture the underlying mechanisms more completely, but their setup and execution require substantial technical preparation that limits their use in routine operational decisions.

Our research objective is to develop tools that account for the tidal advective-dispersive transport and the spatial heterogeneity of entrainment risk in the Delta, have considerably lower requirements for input data and computational resources than Delta hydrodynamic models do, and are intuitive and implementable in the context of real-time operations management and regulation.

We applied machine learning to develop two sets of tools: (1) the machine-learning-based hydrodynamic model emulators that estimate key hydrodynamic model outputs most relevant in the context of operations management, and (2) hydraulic footprints, which are spatially-informed summary metrics for transport and entrainment risk in the central and south Delta.

These tools allow for rapid assessment of hydrodynamic scenarios and are compatible with contextual ecological, biological, and environmental information, setting the ground for mechanistic, proactive, and adaptive operation management strategies.

Speaker: Ching-Fu Chang, Contra Costa Water District

Co-authors: Lu Han, Contra Costa Water District; Deanna Sereno, Contra Costa Water District

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Managing Competing Demands for Water · Policy & Management Showcase

Machine Learning-Based Prediction of Cyanobacteria Harmful Algal Blooms in the Sacramento–San Joaquin Delta for Water Quality Management



Cyanobacteria harmful algal blooms (CHABs) are an increasing threat to ecosystem in the Sacramento–San Joaquin Delta (Delta). Improved CHAB predictions can support more proactive bloom management opportunities in the Delta. This study developed machine learning (ML)-based models to predict CHAB conditions using associated environmental variables. Microcystis Visual Index (MVI) was used as representative indicator of CHAB severity. A dataset consisting of 1,006 discrete daily MVI samples was used to develop and evaluate models. These data were collected from 35 sites across Delta during summer and fall seasons from 2014 to 2022. The original five-level MVI classes were reorganized into two operational categories: Nominal Management (MVI 1–2) and Necessary Management (MVI 3–5). Eight environmental variables were used, including water temperature, antecedent flow and velocity, turbidity, specific conductivity, and nutrient concentrations.

Eight ML models were developed and evaluated, including Random Forest, Boost, three versions of Artificial Neural Networks (ANNs), LightGBM, CatBoost, and Support Vector Machines.

Model optimization incorporated custom combined-score metrics emphasizing accuracy and recall of Necessary Management. Ensemble prediction and uncertainty analyses were conducted to improve prediction reliability and operational interpretability.

Results demonstrated strong predictive capability across all ML approaches, with test combined scores ranging from 0.76 to 0.83. CatBoost achieved the highest overall combined score (0.833). ANN-based models achieved the highest recall for Necessary Management conditions (0.90 - 0.96).

About 194 out of 302 samples (used during ML models' testing) demonstrated low to medium uncertainties from the ensemble prediction uncertainty analysis. Feature-importance and SHAP analyses consistently identified water temperature and antecedent hydrodynamic conditions as dominant drivers associated with elevated CHAB severity.

Authors: Gourab Saha, California Department of Water Resources; Kevin He, California Department of Water Resources; Ellen Preece, California Department of Water Resources; Prabhjot Sandhu, California Department of Water Resources

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Interdisciplinary Science & Cross-Knowledge Integration · Water Quality, Contaminants, & Aquatic Health · Policy & Management Showcase



Real-Time Multi-Ion Forecasting in the South Delta Using Hydrodynamically Informed Machine Learning

Accurate prediction of ion concentrations in the South Delta is essential for managing agricultural diversions and drinking water supplies. Previous modeling approaches primarily relied on lumped predictors such as X2 position and Water Year Type (WYT), which oversimplify the complex hydrodynamics governing salinity intrusion in the Delta. This study addresses these limitations by developing a Multi-output Random Forest (Multi-RF) model using physically meaningful, high-resolution hydrodynamic predictors, including electrical conductivity (EC) measurements from 13 monitoring stations and the San Joaquin River boundary, flow conditions, export pumping rates at the Banks (HRO) and Tracy (TRP) facilities, and seasonal barrier operations.

To preserve tidal dynamics, grab sample collection times were aligned with continuous 15-minute monitoring data across a 15-day lag window.

Principal Component Analysis was used to reduce predictor dimensionality while retaining dominant hydrodynamic variability. The model simultaneously predicts seven ion constituents with strong performance, achieving nowcast $R^2 = 0.949$ and 7-day forecast $R^2 = 0.831$, outperforming both Artificial Neural Network (ANN; average $R^2 = 0.928$) and Parametric Regression (PR; average $R^2 = 0.617$) approaches from prior studies. Leave-One-Station-Out cross-validation further demonstrated strong spatial generalization across core South Delta stations ($R^2 > 0.89$).

An operational dashboard was developed that automatically downloads real-time data from CDEC and USGS, generates nowcast and 7-day forecasts three times daily, and distributes results through interactive maps, tables, and email alerts. This system represents the first live multi-ion forecasting framework for the South Delta, providing actionable information for water quality management and operational decision-making.

Speaker: Peyman Namadi

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health · Interdisciplinary Science & Cross-Knowledge Integration

Research to results: Re-envisioning scientists as policy partners



This abstract proposes a special oral session to examine the evolving role of scientists and the importance of a strong science-policy interface when addressing Bay-Delta challenges. This session, featuring a moderated fireside-chat and audience Q&A, will draw upon panelist's diverse experiences to illustrate how scientific expertise informs, clarifies, and shapes policy decisions across multiple levels of government.

Panelists will discuss how to bridge gaps between technical scientific discovery and practical decision-making, and how to get the right information to the right people, faster. This session will also highlight the roles of adaptive management, iterative communication, and strong relationships with decisionmakers in achieving local, regional, and statewide environmental goals. This conversation will hold value for all scientists—from early-career to established—seeking to more effectively bridge the worlds of science and policy.

Session Chair: Audrey Cho

Speakers: Lisamarie Windham-Myers, Delta Stewardship Council; Andy Jones, California Natural Resources Agency; Darcy Austin, State Water Contractors (SWC)

Co-authors: Letitia Grenier, PPIC; Lenny Grimaldo, California Department of Water Resources

Track: Interdisciplinary Science & Cross-Knowledge Integration

Integrated tools for monitoring and managing harmful algal blooms across the Bay-Delta



Harmful algae occur across San Francisco Bay and the Sacramento–San Joaquin Delta (Bay-Delta). Toxins from freshwater and marine taxa can impact recreation, fishing and shellfish harvesting, and drinking water. In the Bay-Delta, new tools and strategies are being developed to support monitoring and managing harmful algal blooms (HABs).

In 2023, NOAA awarded a five-year MERHAB grant to researchers in the Bay-Delta to enhance monitoring and coordination for HABs.

The project team has been enhancing tools such as remote sensing algorithms to provide broad spatial coverage, DNA-based assays to track harmful algae, and community science monitoring to assess blooms in marinas and near-shore locations. The session will highlight recent advances in data collection, data sharing, and management tool development.

Collectively, this work is expanding the reach of HAB monitoring and coordination in the Bay-Delta. The session will conclude with an open discussion about the next steps for developing or implementing management tools and enhancing regional coordination.

Co-authors: Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center; Ellen Preece, California Department of Water Resources; Dave Senn, San Francisco Estuary Institute; Ariella Chelsky, San Francisco Estuary Institute

Track: Water Quality, Contaminants, & Aquatic Health

Decoupling Algal Biomass from Turbidity: Assessing the Impact of Suspended Particulate Matter on Satellite Chlorophyll-a Retrievals in San Francisco Bay



Monitoring harmful algal blooms in the San Francisco Bay is essential for managing the ecological impacts of mass fish kills and low dissolved oxygen events. While recent advances in satellite remote sensing have improved the detection of high-biomass events, the extreme turbidity of estuarine waters remains a primary challenge for accurate monitoring.

High suspended particulate matter concentrations can interfere with optical signals, introducing errors in chlorophyll-a retrieval. This study evaluates the sensitivity of regional chlorophyll-a algorithms to suspended sediment across the Bay's diverse turbidity gradients.

Using a multisensor approach, suspended matter concentrations were calculated at the same spatial and temporal coordinates used to develop the regional chlorophyll models, integrating satellite-derived reflectances and in situ validation data, to examine whether residual error in chlorophyll-a estimates corresponds to fluctuations in turbidity derived from either remote sensing or underway (shipboard) mapping.

The findings presented quantify the degree to which suspended matter variability is integrated into current empirical models and identify specific turbidity thresholds where algorithm accuracy may degrade. We demonstrate whether correlations exist between suspended matter concentrations and chlorophyll-a residuals, providing a clear assessment of whether an explicit suspended matter correction is required to fine-tune algorithm performance for near-real-time harmful algal bloom prediction in the San Francisco Bay-Delta system.

Speaker: [Aurpita Saha](#), Ocean Sciences Department, University of California Santa Cruz, Santa Cruz, CA, USA

Co-authors: [Raphael Kudela](#), University of California, Santa Cruz; [Daniel Killam](#), San Francisco Estuary Institute; [Dave Senn](#), San Francisco Estuary Institute

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Water Quality, Contaminants, & Aquatic Health · Policy & Management Showcase

Community Scientists on the Frontline of Harmful Algal Bloom Detection



Lethal harmful algal blooms (HABs) swept through the San Francisco Bay in 2022 and 2023. Volunteer community scientists led the effort to document the bloom spread and resulting fish kill. As a result, community science monitoring, led by San Francisco Baykeeper ("Baykeeper"), was built into a comprehensive bay-wide HAB monitoring network organized by a coalition of researchers, environmental groups, and government agencies.

For the past two years, Baykeeper trained volunteers to collect environmental data and phytoplankton samples year-round from nine monitoring sites around San Francisco Bay. Data is shared locally and contributes to a public national database run by NOAA's Phytoplankton Monitoring Network. This growing Community Science Program fills critical gaps left by other SF Bay HAB monitoring efforts.

Speaker: Cheryl Patel, San Francisco Baykeeper

Co-authors: Makayla Marquez, San Francisco Baykeeper; Jon Rosenfield, San Francisco Baykeeper; Ian Wren, San Francisco Baykeeper; Aundi Mevoli, San Francisco Baykeeper

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health · Finding Collaborative Solutions

Molecular monitoring and surveillance of harmful algae in SF Bay: Methodological and statistical approaches

In SF Bay, molecular-based monitoring of phytoplankton has proven to be a valuable tool, including 18S/16S metabarcoding and quantitative PCR-based approaches. Several of the candidate harmful algal taxa with the greatest hazardous potential are dinoflagellates, raphidophytes and other taxa of small cell size or problematic taxonomy, challenging traditional microscopy-based monitoring approaches. Since 2014, SFEI, USGS and Bend Genetics have collaborated in the collection of biweekly filter samples from a selection of channel cruise sites, as well as special collections of molecular data from the SF Bay shoals.

We have developed a novel application of a probabilistic pipeline called Anacapa to classify the metabarcoding data with greater confidence, drawing on improving global databases of phytoplankton taxonomy, and have developed statistical approaches to account for the stochastic nature of amplified metabarcoding data, including the use of conditional probability analysis to compare 18S and qPCR-based data to both mussel saxitoxin and chlorophyll-a data.

In synthesis efforts resulting from this work, we found relationships between Alexandrium molecular abundances and the concentration of saxitoxin in nearby mussels. We used this benchmark relative abundance threshold to investigate the chlorophyll-a levels where other known HAB organisms exceed their baseline metabarcoding abundance.

We found a group of HAB-forming organisms including Heterosigma, Heterocapsa, Dinophysis, Gonyaulax and Gyrodinium are likely to increase above their baseline relative abundance at around 4.9 µg/L chlorophyll-a in fall. Our molecular surveillance approach continues to evolve as global phytoplankton taxonomic databases improve, and we are also developing targeted qPCR assays of abundances of additional HAB-forming taxa, to inform future risk-based assessments.

Speaker: Daniel Killam, San Francisco Estuary Institute

Co-authors: Dave Senn, San Francisco Estuary Institute; Ariella Chelsky, San Francisco Estuary Institute

Tracks: Ecology, Food Webs, & Changing Ecosystems · Water Quality, Contaminants, & Aquatic Health

Freshwater and Marine Algal Toxin Co-occurrence Along the San Francisco Estuary's Freshwater-to-Marine Continuum



The transition zone between freshwater and marine environments in estuaries represents an understudied area where multiple harmful algal bloom (HAB) toxins can co-occur. In the San Francisco Estuary freshwater cyanotoxins and marine biotoxins can be transported and potentially accumulate along the freshwater-to-marine continuum. This study investigated spatial and temporal patterns of potentially toxic HAB genera and toxins between the Carquinez Strait and the confluence of the Sacramento and San Joaquin Rivers to understand toxin transport in this critical transition zone and assess risks to shellfish subsistence harvesters.

Three sampling methods were used: baited minnow traps for invertebrates, discrete water grab samples, and passive solid phase adsorption toxin tracking (SPATT) samplers. Microcystins, domoic acid, and saxitoxins were analyzed in invertebrates, water filters, and SPATT samplers. Water samples were analyzed for toxin biosynthesis genes using qPCR.

Sampling occurred monthly in winter (November–April) and bimonthly in summer (May–October) during 2024–2025 at four shoreline sites. Preliminary results show marine toxin producers *Alexandrium* and *Pseudo-nitzschia* declined up-estuary, while *Microcystis* declined down-estuary toward marine waters.

Toxins were detected more often in SPATT samples and invertebrate tissue than in water samples, suggesting time-integrated sampling approaches capture toxin presence more reliably than water grab samples. Multiple invertebrate species including shrimp, crab, and crayfish accumulated toxins across the salinity gradient. Domoic acid concentrations remained below safe consumption thresholds while microcystin concentrations sometimes exceeded recommended levels.

These findings demonstrate estuarine connectivity and toxin transport processes that expand HAB impacts spatially, highlighting the importance of monitoring multiple toxin types in estuarine transition zones.

Speaker: Ellen Preece, California Department of Water Resources

Co-authors: Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center; Crystal Sturgeon, U.S. Geological Survey; Timothy Otten, Bend Genetics, LLC; Raphael Kudela, University of California, Santa Cruz

Tracks: Ecology, Food Webs, & Changing Ecosystems · Water Quality, Contaminants, & Aquatic Health

Next Steps for Management Tools and Regional Coordination

Special Session:

Integrated Tools for Monitoring and Managing HABs across the Bay-Delta

Session Chairs:

Keith Bouma-Gregson, Ellen Preece, David Senn, Ariella Chelsky

Abstract:

Harmful algal blooms (HABs) in the San Francisco Estuary necessitate a coordinated strategy for rapid detection and management. The MERHAB Data Dashboard, an integrated decision-support tool for HAB monitoring in the San Francisco Estuary, was funded by a five-year Monitoring and Event Response Research Program (MERHAB) grant from NOAA. A multi-agency team is developing an online, estuary-wide HAB dashboard to centralize and optimize environmental tracking.

The MERHAB Data Dashboard functions as a comprehensive data management and visualization infrastructure that utilizes open data principles.

It serves to integrate a wide variety of existing and new data streams to facilitate improved understanding and decision-making. Key features of the dashboard include the integration of:

Data from continuous water quality sensors

Remote sensing chlorophyll data

Results from molecular DNA-based detection methods

Observations and information gathered from community science monitoring

This visualization infrastructure communicates HAB findings and tracks critical water quality changes across the estuary. By centralizing these data streams, the dashboard is designed to deliver data rapidly to managers, serving as a critical decision-support tool to inform HAB-related management and mitigation strategies. Furthermore, future iterations will function as a "one-stop shop" for the general public, allowing them to access the latest monitoring data. Ultimately, the MERHAB Data Dashboard bridges crucial data gaps to enhance the understanding of HAB transport dynamics and improve rapid event response across the region.

Speaker: **Tony Hale**, San Francisco Estuary Institute

Co-authors: **Lindsey Sim**, San Francisco Estuary Institute; **Gemma Shusterman**, San Francisco Estuary Institute

Tracks: Systems Thinking for the Whole Ecosystem · Water Quality, Contaminants, & Aquatic Health

Longfin Smelt Science Program: Improving our understanding of species ecology for improved management (Part 1)



We would like to submit for a triple session covering new scientific insights coming out of the Longfin Smelt Science Program. We are one talk short of a full 3 sessions, so we were hoping another relevant talk could be added (on monitoring design or LFS perhaps?). Also be submitting a companion poster cluster.

New insights into the reproductive biology of Longfin Smelt (Levi Lewis)

It takes a shoal: Status and goals of the Longfin Smelt Conservation Culture Program (Brianna Yetter)

Newly assembled genome provides insights into Longfin Smelt ecology (Matthew A. Campbell, Levi S. Lewis, James A. Hobbs, Christian T. Denney, Shannon R. Blair, Katherine Osborne, Nann A. Fangue, Amanda J. Finger)

Life cycle model insights on the effects of freshwater outflows on Longfin Smelt population dynamics (Lara Mitchell)

Variation in marine habitat suitability during estuarine-marine habitat transitions by Longfin Smelt in the San Francisco Estuary (Matt Young)

Mechanisms underlying the response of Longfin Smelt to freshwater flow in the northern San Francisco Estuary (Wim Kimmerer)

Simulating the Effects of Alternative Vertical Behaviors on Longfin Smelt Retention and Survival (Ed Gross)

Using echosounders to estimate northern anchovy abundance and associated predation risk to longfin smelt in the San Francisco Bay-Delta (Kim Brewitt)

Something's Fishy in the Napa River: An Abnormal Abundance of Longfin Smelt (Vanessa Mora)

Zooper Small, Zooper Important: Temporal Shift in the Zooplankton Community in the Napa River (Jessica Jimenez)

Effects of acoustic tagging surgery on survival and swimming performance in longfin smelt (Sebastian Gonzales)

An interactive online tool for in-season tracking of Longfin Smelt salvage and forecasting season-scale entrainment risk (Mike Tillotson)

A 5-year Narrative to Understand Detection Probability and the Risks of Entrainment (Tim Malinich)

The Value of Replication in Long Term Monitoring for Rare and Imperiled Species (Morgan Gilbert)

Session Chair: Brian Schreier, California Department of Water Resources

Co-authors: Adam Chorzyczewski, California Department of Fish and Wildlife

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

New Insights into the Reproductive Biology of Longfin Smelt



The UC Davis Longfin Smelt Conservation Culture Program (LFSCCP) has worked with the Department of Water Resources to develop and implement methods for the capture, transport, spawning, and culture of endangered Longfin Smelt over the past 6 years. During this period, live wild Longfin Smelt were collected via otter trawl in South San Francisco Bay wetlands and transported to culture facilities, with a subset being archived to further explore their reproductive biology. Here, we use these data to summarize patterns in the distributions of spawning Longfin Smelt in South San Francisco Bay and highlight new insights regarding maturation to help inform ongoing culture practices, population models, and management efforts.

Collection and transport of wild adult broodstock to UC Davis culture facilities has supported the production of Longfin Smelt larvae by the LFSCCP. Late-stage reproductive fish were typically observed mid-December through late January, though some evidence of spawning in November through March, including secondary clutches, was observed. Fish were generally captured at 1-4 m water depth, with spatial distributions varying in response to time of year, water quality, and tidal conditions. Distinct male and female aggregations were often observed in upstream vs. downstream regions of sloughs, respectively. Fecundity overall ranged from approximately 1000-15,000 eggs per female and was strongly correlated with fish size; however, most fish utilized by the culture program contained 2,500-5,000 eggs per female. Through the LFSCCP, we have gained a refined understanding of the reproductive biology and spawning behaviors of Longfin Smelt that are key to informing the culture and conservation of the species.

Speaker: Sami Araya, Otolith Geochemistry and Fish Ecology Lab, UC Davis

Co-authors: Nikolas Floros, Otolith Geochemistry and Fish Ecology Lab, UC Davis; Alex Lama, Otolith Geochemistry and Fish Ecology Laboratory, UC Davis; Christian Denney, UC Davis; James Hobbs, Otolith Geochemistry and Fish Ecology Lab, UC Davis; Tien-Chieh Hung, Department of Biological and Agricultural Engineering, University of California, Davis, Davis, CA; Nann Fangue, UC Davis; Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Interdisciplinary Science & Cross-Knowledge Integration



It Takes a Shoal: Status and Goals of the Longfin Smelt Conservation Culture Program

The San Francisco Bay-Delta Distinct Population Segment of Longfin Smelt (*Spirinchus thaleichthys*) was listed as a federally endangered species in 2024 due to its rapid population decline to less than 1% of historical levels. To address this population decline and fill in the current knowledge gaps on their life history, the Department of Water Resources and multiple University of California, Davis laboratories came together to form the Longfin Smelt Conservation Culture Program (LFSCCP).

This program includes three different facilities throughout Northern California, each with access to unique holding conditions and water sources ranging from fresh well water, Delta water, and seawater. Through this diverse fish production framework, the LFSCCP is able to vary water chemistries for life stage-specific culture needs while ensuring redundancy against catastrophic failure at any one facility.

These aspects of the program are what allows for the development of culture methods tailored specifically to this sensitive species, which in turn will enable the creation of a refugial captive population that reflects the genetic diversity currently found in the San Francisco Bay-Delta. The LFSCCP has been successfully adapting culture methods to suit the specific needs of Longfin Smelt, and is continually optimizing the aquaculture methodology based on what is learned as the program progresses.

This has resulted in a substantial amount of knowledge gained in areas such as how to best transport and acclimate adult and larval Longfin Smelt to maximize survival, as well as the optimization of feeding regimes across life stages.

See the Delta Science Tracker for more information:

<https://sciencetracker.deltacouncil.ca.gov/node/49799>

Speaker: Brianna Yetter, University of California, Davis

Co-authors: Dennis Cocherell, UC Davis; Tien-Chieh Hung, Department of Biological and Agricultural Engineering, University of California, Davis, Davis, CA; Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA; Brian Schreier, California Department of Water Resources; Nann Fanguie, UC Davis

Track: Finding Collaborative Solutions

First Flush: Looking Beyond Delta Smelt to Ecosystem-scale Responses



In the Sacramento-San Joaquin Delta (Delta), ecological first flush refers to the first major storm-driven flow event of the water year (defined as October 1 through September 30 of the following calendar year). This initial storm of the wet season washes a plume of sediment into the Delta, increasing flow and turbidity. First flush is thought to cue the spawning migration of Delta smelt (*Hypomesus transpacificus*), and it may also cue behaviors in other fishes native to the Delta, such as longfin smelt (*Spirinchus thaleichthys*) and winter-run Chinook salmon (*Oncorhynchus tshawytscha*).

Regulatory documents define trigger thresholds for first flush protective actions, but ecological first flush events have not previously been characterized. The effect of first flush on water quality parameters and native fishes merits exploration. We defined flow metrics to identify ecological first flush events and other major storm-driven flow events from 1930-2024. We selected hypotheses examining how first flush affects water quality parameters and several protected native fish species.

Here, we present our definition of ecological first flush and characterize the changes in turbidity following first flush. These results improve our understanding of the ecology of first flush. The next steps of this study are to use these analyses to explore how native fishes have adapted to major storm-driven flow events by analyzing patterns observed between first flush and three protected native fishes: Chinook salmon, Delta smelt and longfin smelt.

Speaker: Katie Osborn

Co-authors: Katherine Osborn, California Department of Water Resources; Rosemary Hartman, California Department of Water Resources; David Bosworth, California Department of Water Resources; Peter Nelson, California Department of Water Resources; Jordan Buxton, US Geological Survey; Matthew Young, U.S. Geological Survey; Brian Schreier, California Department of Water Resources

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Life Cycle Model Insights on the Effects of Freshwater Outflows on Longfin Smelt Population Dynamics



The population of longfin smelt (*Spirinchus thaleichthys*) inhabiting the San Francisco Estuary has declined in recent decades as the Estuary has undergone significant ecological alterations. This has sparked interest in understanding what factors drive the population dynamics of the species and how this information can be used to change its trajectory.

Spawning and early life stage survival are important processes in the life history because they occur within the estuary and its tributaries where habitat and flow conditions are highly variable between years and individuals have limited capacity to move while developing air bladders and swimming capabilities. While increased catch densities of larval longfin smelt in tributaries reflect the importance of these areas as rearing habitat, especially in wetter years, separating the effects of tributary flows from the effects of Delta outflows at a population level has remained challenging.

We address this topic using a state-space population model that tracks each cohort of longfin smelt across 30+ states and is fit with data from multiple monitoring programs.

Monthly recruitment and stage-based monthly survival processes, estimated as functions of environmental covariates, allow relatively detailed investigation into the strength and timing of these factors within the life cycle. We use the model to estimate recruitment and early life stage survival as functions of freshwater outflows in the Delta and tributaries with long-term discharge measurements, then calculate and compare annual population growth rates to quantify the strength of the relationship between growth rates and flows from different watersheds acting at different times within the spawning period. With this method we can investigate how changes at a relatively localized spatial level affect long-term population growth.

Speaker: **Lara Mitchell**, U.S. Fish and Wildlife Service

Co-authors: **Leo Polansky**, U.S. Fish and Wildlife Service; **Scott Meyer**, California Department of Water Resources; **Joseph Miller**, U.S. Fish and Wildlife Service; **William E. Smith**, US Fish and Wildlife Service; **Vanessa Tobias**, California Department of Fish and Wildlife

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water · Interdisciplinary Science & Cross-Knowledge Integration

Newly assembled genome provides insights into Longfin Smelt ecology



The effort to propagate Longfin Smelt (*Spirinchus thaleichthys*) in captivity has led to new genomic tools that facilitate insight into the species and its ecology. Here, we present a reference genome for the Longfin Smelt. We used this reference genome to identify the sex determination mechanism of Longfin Smelt and to create a set of loci that may be used for genetic sex identification. This is of particular utility as Longfin Smelt are suspected to form sex-biased aggregations at the pre-spawning staging period. It is unclear if these sex-biased aggregations of Longfin Smelt form at other times, and if so, how this might affect demography or life cycle modeling.

In addition to the sex marker, we identified a candidate chromosomal inversion using a previously published data set that includes samples from across the species' range (CA to AK). Recent research by Lewis et al. (2020) used otoliths to uncover early life history variation related to salinity levels in the SFE longfin smelt population, whereby a portion of the population rears in higher salinity zones while the remainder rears in fresher water. We related the frequency of the candidate chromosomal inversion to this early life history variation by generating genome-wide sequence data (RADseq) from fish of known life-history phenotypes. Captive propagation of Longfin Smelt should maintain this potential adaptive genetic variation as its relationship to phenotypes is clarified. Our findings provide foundational advancement in Longfin Smelt genomics with direct applications to basic biological and conservation research and management.

Authors: Mac Campbell, University of California Davis; Amanda Finger, University of California, Davis; Nann Fangue, UC Davis; Katherine Osborn, California Department of Water Resources; Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA; Shannon Blair, University of California Davis; Christian Denney, UC Davis; James Hobbs, Otolith Geochemistry and Fish Ecology Lab, UC Davis

Tracks: Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 42 · 5 PRESENTATIONS

Algal blooms and ecosystem impacts in the San Francisco Estuary



Speakers: Lauren Lui, Lawrence Berkeley National Laboratory; Jamie Sweeney, Cramer Fish Sciences; Perry Giron; Jacob Zwart, U.S. Geological Survey

The San Francisco Estuary Microbiome: Utilizing Complete Genomes and Machine Learning for Analysis and Ecosystem Monitoring

Objectives Statement

The San Francisco Estuary (SFE) faces chronic risks from intense anthropogenic nutrient loading and climate-driven stressors, as demonstrated by devastating ecological events like the 2022 *Heterosigma akashiwo* harmful algal bloom. While traditional monitoring tracks chemical water quality and macro-organisms, the estuarine microbiome is a foundational base of the food web and drives the biogeochemical cycles that underpin ecosystem health. However, a severe knowledge gap persists because the vast majority of SFE microbes remain unresolved by classic sequencing methods. The objective of this work is to bridge this gap by establishing a high-resolution, strain-resolved genomic baseline of the SFE microbiome and integrating it with machine learning (ML) models.

Approach

In partnership with the CA Department of Water Resources and the U.S.

Geological Survey, we used long-read metagenomics (Nanopore) to decompose complex SFE environmental samples into their constituent, strain-resolved genomes. To leverage this high-resolution genomic foundation for analysis of the microbiome data, we are training variational autoencoder ML models.

Results

Through this long-read metagenomic approach, the San Francisco Estuary Microbiome Project has successfully generated a reference catalog containing over 1,500 complete, circular genomes and we have also begun to see similarities to our other large estuarine microbiome dataset from the Baltic Sea. This database spans the entire microbial continuum, successfully resolving highly abundant but historically challenging bacterioplankton (e.g., *Pelagibacter*), picoeukaryotes, and mobile genetic elements like plasmids and phages. Early outputs from the variational autoencoder models demonstrate the ability to link viruses with their hosts.

Ultimately, we aim to use this data to develop methods to forecast HAB events and anticipate food web restructuring in the face of a changing ecosystem.

Speaker: Lauren Lui, Lawrence Berkeley National Laboratory

Co-authors: Torben Nielsen, Jorgmundir

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health

Evaluating Life History-Specific Vulnerability of Green and White Sturgeon to the 2022 Harmful Algal Bloom in the San Francisco Estuary



In summer 2022, a harmful algal bloom (HAB) caused by *Heterosigma akashiwo* triggered one of the largest fish mortality events recorded in the San Francisco Estuary. The bloom spread across more than 4,500 km² from San Pablo Bay to Lower South Bay, causing widespread fish die-offs, particularly among sturgeon. Nearly 700 carcasses were documented, including Green Sturgeon (*Acipenser medirostris*), a federally threatened species, and White Sturgeon (*Acipenser transmontanus*), currently under review for endangered species protection. Although hypoxia developed during later bloom stages, most sturgeon deaths occurred before oxygen levels declined, suggesting toxins and reactive oxygen species produced by *H. akashiwo* likely played a major role in sturgeon mortality.

Sturgeon are long-lived, late-maturing fish with diverse migratory behaviors adapted to California's variable aquatic environments.

The scale of mortality during the 2022 event raised concerns about population-level impacts, long-term viability, and whether certain migratory phenotypes or habitat-use strategies increased vulnerability to HAB exposure. To evaluate life history-specific vulnerability, we used geochemical analyses of sturgeon pectoral fin rays collected before and after the 2022 event to reconstruct age, residence, and migration histories. Comparing individuals across time periods allows us to identify migratory phenotypes or life history traits associated with increased susceptibility to HAB conditions.

This research highlights the need for real-time HAB and fish kill monitoring, targeted conservation strategies for vulnerable migratory groups, and improved understanding of how environmental stressors interact with species behavior. Findings will support adaptive estuary management and guide restoration, flow, and water quality decisions to improve sturgeon resilience under climate change and increasing HAB frequency.

Speaker: Jamie Sweeney, Cramer Fish Sciences

Co-authors: James Hobbs, Otolith Geochemistry and Fish Ecology Lab, UC Davis; Kirsten Sellheim, Cramer Fish Sciences; Miranda Bell Tilcock, UC Davis Center for Watershed Sciences; Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA

Track: Water Quality, Contaminants, & Aquatic Health

Effects of Antecedent Conditions on Harmful and Beneficial Algal Blooms in Upper San Francisco Estuary



Upper San Francisco estuary (USFE; Sacramento-San Joaquin Delta and Suisun Bay), California, has low productivity compared to other estuaries yet serves as rearing habitat for numerous native fish species. In the late 1980s, chlorophyll *a* (chl-*a*) concentrations declined by more than half in brackish waters, contributing to declines of endangered fish species. The chl-*a* decline is hypothesized to result from combined effects of invasive clams, wastewater contamination, and reduced managed river flows.

Additionally, cyanobacterial harmful algal blooms (CHABs) have become common each summer in recent decades. Resource managers are interested in understanding how flow and nutrient management could promote phytoplankton blooms beneficial to the food web while reducing CHABs. Most studies in USFE have focused on the effects of contemporary environmental conditions, but emerging evidence suggests antecedent conditions – flows and nutrients in seasons preceding blooms – may play an important role.

Our study sought to identify the major drivers of phytoplankton blooms and community composition across seasons and regions of USFE. We synthesized water quality, flow, grazer, chl-*a*, and phytoplankton community data collected from 1979-present. We then applied additive and structural equation models to identify drivers of blooms over the entire timeseries and harmful versus beneficial blooms from 2008-present.

Preliminary results show that, across regions and seasons, high temperatures and high dissolved ammonium concentrations drive blooms. Sacramento River inflow during the previous season was also an important predictor of chl-*a*, which was highest in the south Sacramento-San Joaquin Delta where CHABs are prevalent and lowest in the brackish water regions where diatom blooms dominate.

These results improve our understanding of how antecedent environmental drivers and water management impact phytoplankton bloom dynamics and food webs supporting native fish species within USFE.

Speaker: Perry Giron

Track: Water Quality, Contaminants, & Aquatic Health

National-scale probabilistic deep learning forecasts of riverine chlorophyll with application to the Sacramento-San Joaquin Delta



Algal blooms in rivers can threaten drinking water supplies, recreation, and aquatic ecosystems, yet operational forecasting tools for rivers lag behind those available for lakes and coasts. We developed a probabilistic deep learning framework that forecasts chlorophyll concentrations 0–10 days ahead across dozens of sites in U.S. rivers, including multiple sites in the Sacramento-San Joaquin Delta. The model pairs an encoder-decoder long-short term memory architecture with an asymmetric Laplace distribution head, ingests meteorological forecast uncertainty, and uses a two-stage autoregressive strategy to gap-fill missing lagged chlorophyll observations, enabling deployment at sites with intermittent monitoring.

Across all sites, the model reliably anticipated bloom onset a median of 7 days in advance and outperformed persistence baselines at all lead times by 30–80%. Expected-gradient attribution revealed that lagged chlorophyll drove short-range forecasts, while static watershed characteristics and meteorological forecast uncertainty became increasingly important at longer leads, offering managers interpretable signals about what drives bloom risk in their watersheds. Prediction intervals were well calibrated across lead times, giving decision-makers explicit confidence bounds for operational use. These results demonstrate that uncertainty-aware deep learning can provide actionable, interpretable early warning for riverine algal blooms at national scale, while remaining locally relevant for systems like the Delta where bloom timing directly affects water treatment operations and ecosystem management.

Speaker: Jacob Zwart, U.S. Geological Survey

Co-authors: Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center; Nicholas Framsted, U.S. Geological Survey; Tyler King, U.S. Geological Survey; Jennifer Murphy, U.S. Geological Survey; James Romano, U.S. Geological Survey; Rebecca Gorney, U.S. Geological Survey

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health

Sources and Environmental Fate of Microcystins Detected in San Francisco Bay



Understanding the fate of toxic compounds like microcystins (MCs) is crucial for effective management and public health protection. MCs are a class of cyanotoxins that negatively impact human and animal health through ingestion of contaminated water, fish and shellfish, or recreational exposure, and are often transported from freshwater sources into estuaries. In San Francisco Bay (SFB), MCs have been detected in mussel and anchovy tissues and the water column since 2011.

However, measurements over that time have not identified MC-producing cyanobacteria taxa in water samples. Our goals were to investigate potential sources of MC and MC fate in SFB. In this study, water samples collected throughout SFB in 2022 and 2023 were analyzed for dissolved MCs and the presence of cyanobacteria known to produce MCs. Potential sources, including deep channels, shoals, adjacent salt ponds, and microphytobenthos, were analyzed for the microcystin synthetase E (*mcyE*) gene.

The *mcyE* gene was only detected in 3 samples ($n = 220$), located in the south bay channel and freshwater delta.

Preliminary findings indicated that the occurrence of MC-producing cyanobacteria was rare and spatially limited. The environmental fate of MCs (MC-LR, MC-RR, MC-LA) was evaluated through experiments assessing adsorption, biodegradation, and indirect photodegradation. MC-RR and MC-LR exhibited 20% and 22% adsorption loss, respectively, while MC-LA showed no adsorption losses. Biodegradation did not significantly contribute to MC removal. Indirect photodegradation followed pseudo-first-order kinetics, with similar half-lives (3.41–3.88 days).

However, strong light attenuation in SFB suggests longer in situ photodegradation timescales, potentially extending half-lives from days to months. With a degradation half-life of a month and the lack of potential producers identified in SFB, these findings support external production and transport as a plausible explanation for recurring MC detections in SFB.

Authors: Keith Bouma-Gregson, U.S. Geological Survey, California Water Science Center; Ezekiel Israel, Wayne State University; Andrea Jaegge, Tennessee Department of Environment and Conservation; Dave Senn, San Francisco Estuary Institute; Raphael Kudela, University of California, Santa Cruz; Judy Westrick, Wayne State University

Track: Water Quality, Contaminants, & Aquatic Health

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 43 · 4 PRESENTATIONS

Building shared understanding: Representation, community science, and co-produced knowledge



Speaker: Jamari Robinson

Representation in Wetland Decision-Making in the San Francisco Estuary



Wetland restoration and management are vital for the health and resilience of the San Francisco Estuary. Decisions about wetland restoration and management fall under the purview of a range of different entities in a complex polycentric governance system. This project aims to understand: How representative are wetland decision-makers of the broader San Francisco Estuary population, and how do demographic factors correlate with their perceptions of power?

Using survey data collected from individuals participating in collaborative forums who plan, fund, permit, implement, and/or monitor tidal wetland restoration projects, we assessed representation in two ways: (1) the demographic composition of actors across forums, and (2) perceptions of power within these forums. We developed a dashboard to track representation in wetland decision-making over time, and are working with partners to conduct a Bayesian statistical analysis to test how individual demographics, organizational affiliation, forum participation, and forum-level roles were associated with perceived power and feelings of effectiveness in decision-making. Through both qualitative and quantitative analyses of the survey data, we identified actionable opportunities for improving representation in wetland decision-making in the San Francisco Estuary.

Speaker: Laurel Andrews

Co-authors: Alexandra Thomsen, San Francisco Estuary Partnership; Natalie Rossi, San Francisco Estuary Partnership; Ally Malilay, University of Hawai'i at Manoa; Sasha Harris-Lovett, San Francisco Estuary Partnership

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Community and Citizen Science as a Bridge Between Science and Community: Insights from the Youth-Engaged Salmon Monitoring Program

California's salmon face significant ecological pressures, including elevated mortality linked to Thiamine (B1) Deficiency Complex (TDC), first documented in 2020. Addressing challenges like these requires collaborative approaches connecting scientific research, stewardship, education, and community participation across interconnected watershed systems. Youth-focused Community and Citizen Science (YCCS) expands participation in environmental science while strengthening stewardship and local engagement.

The Fish and Rivers Youth Scientists (FRYs) Network brings together students, teachers, scientists, and community partners in collaborative salmon and watershed research across California, including communities connected to the Sacramento–San Joaquin Delta.

The FRYs Network equips classrooms with salmon aquaria, curriculum and research protocols that support authentic environmental monitoring related to salmon behavior, mortality, water quality, and ecosystem health.

The program has engaged 4,000+ students across 5 California counties in collaboration with over 50 scientists over the last 5 years through field investigations, classroom visits, and community engagement activities.

We here share findings from mixed-methods research over 2 years examining how participation in the FRYs Network supported youth engagement with scientific participation. Findings suggest that authentic participation in scientific practices strengthened students' science identity. Student-generated data also contributed to efforts examining relationships between egg thiamine concentrations and juvenile salmon survival.

The FRYs Network demonstrates how YCCS can bridge research, education, and community engagement while supporting watershed stewardship, science communication, and resilient Bay-Delta futures. In alignment with the conference theme, this work highlights how community-centered science can help build environmental resilience and stewardship.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/node/54197>

Speaker: Becca VanArnam, UC Davis

Co-authors: Peggy Harte, UC Davis Center for Community and Citizen Science; Rachel Johnson, NOAA Fisheries, Southwest Fisheries Science Center and UC Davis, Center for Watershed Sciences; Carson Jeffres, University of California, Davis; Heidi Ballard, UC Davis Center for Community and Citizen Science

Tracks: Systems Thinking for the Whole Ecosystem · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Knowledge Systems as a Common Good: Lessons from the SR JPE Program for Collaborative Science

The challenge of managing natural resources can be framed as a common pool resource problem; neither top-down regulation nor privatization fully succeeds, and collective action offers the most durable path forward. Elinor Ostrom's landmark work demonstrates that communities can self-organize effective governance institutions when trust, shared rules, and clear boundaries are established among stakeholders. Critical knowledge systems underpinning natural resource management face similar structural challenges, but this fact is often overlooked and thus inadequately addressed.

In complex, multi-agency ecosystems, data and scientific information are scattered across jurisdictional and departmental boundaries, fragmented in ways that impede the adaptive management they are meant to support. Like natural resources themselves, these knowledge systems are subject to redundancy and misalignment without deliberate governance. Ostrom's design principles apply as readily to shared scientific data as to shared fisheries or watersheds.

The Spring Run Juvenile Production Estimate Program offers a working demonstration of this premise. Faced with high-stakes, multi-agency science requiring coordination across competing mandates and institutional cultures, the SR JPE piloted a collaborative data governance framework that has served simultaneously as a practical infrastructure and a relationship-building platform. By establishing shared data standards, transparent access protocols, and collective stewardship of scientific assets, the program has cultivated the trust and accountability necessary for sustained collaboration.

We examine the SR JPE's data governance model through the lens of common pool resource theory, offering it as a transferable framework for the broader science community. As the region confronts accelerating ecological change, the integrity and accessibility of shared knowledge systems are foundational to the resilience of the physical resources they describe.

Speakers: Ashley Vizek, FlowWest; Sadie Gill, FlowWest

Tracks: Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Leveraging Citizen Science to Investigate Sturgeon Mortality in the San Francisco Bay Estuary



White sturgeon populations in California's San Francisco Bay-Delta Estuary have declined substantially in recent years, prompting increased concern among researchers and managers. While some fishing-related impacts are understood, non-harvest mortality within the estuary remains poorly documented, particularly potential ship-strike mortality within the heavily trafficked shipping channels of the Carquinez Strait. These mortality sources may represent an important but under-recognized threat to both white sturgeon and federally threatened green sturgeon populations.

To address this knowledge gap, we developed a citizen science-based monitoring program to expand reporting and sampling of sturgeon carcasses throughout the estuary.

This project integrates public outreach, community reporting, and scientific sampling through an online reporting network, public surveys, and targeted carcass collection efforts. Community-submitted reports have allowed us to document carcass locations, collect biological samples, and archive specimens for future analyses examining age structure, migration patterns, and mortality processes.

This project demonstrates how citizen science can augment fisheries monitoring while strengthening public engagement in fisheries conservation. Findings from this work will improve understanding of non-harvest mortality in California sturgeon populations and contribute to ongoing management discussions, including the current status review of white sturgeon under the California Endangered Species Act.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/node/54270>

Authors: Nicholas Demetras, NOAA Fisheries and University of California, Santa Cruz; Benjamin Burford, University of California, Santa Cruz

Tracks: Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 44 · 5 PRESENTATIONS

Data-driven insights into salmonid movement and habitat restoration



Speakers: Adam Witt, Stantec; Lauren Yamane, US Fish and Wildlife Service; Jereme Gaeta, California Department of Fish and Wildlife; Pete Moniz, Cramer Fish Sciences

Real-time Modeling of Delta Exports and Effects on Salmonids and Longfin Smelt



Reclamation provides information to agencies and interested parties to assess alternative Old and Middle River (OMR) flow management scenarios to ensure Central Valley Project (CVP) water delivery obligations are met while minimizing the negative effects of exports on protected fish species.

Existing OMR flow management uses take at the pumps, flow levels, and turbidity levels as triggers to limit export pumping and prevent the entrainment of threatened and endangered fish species, though uncertainties exist as to how well each trigger correlates with fish protection. During the 2026 OMR flow management season, Reclamation developed and applied a new line of evidence to evaluate the potential effects of CVP export operations by coupling Delta-wide hydrodynamic modeling with fish abundance estimates.

This method used a real-time DSM2 model application to support weekly assessments of Delta hydrodynamic conditions, including mapping of the spatial zone of influence of hydrologic alteration due to export pumping. Particle tracking models (ECO-PTM and PTM) were used to estimate through-Delta salmonid survival and the weekly fate of fish originating from different regions of the Delta.

Abundance estimates of larval LFS were made within the study area of the Smelt Larval Survey (SLS) and coupled to particle tracking model output to estimate LFS proportional entrainment risk for a range of potential Delta export scenarios. Results indicate proportional entrainment risk varied based primarily on Delta inflow conditions and Delta export levels.

Speaker: Adam Witt, Stantec

Co-authors: Joshua Israel, United States Bureau of Reclamation; Lillian McCormick, USBR; Grace Easterbrook, Reclamation; Alex Vaisvil, Reclamation; Michael Tillotson, ICF; Laura Manuel, Stantec; Sarah Hamilton, Stantec

Track: Interdisciplinary Science & Cross-Knowledge Integration

Estimating abundance of endangered winter run Chinook salmon entering and exiting the Delta



There is growing appreciation that a California Central Valley salmon monitoring network is needed to provide quantitative estimates of abundance and to improve our knowledge and resolution of life-stage success and movement across the landscape.

However, accurate expansion of catch to obtain population abundance requires estimates of sampling gear efficiencies and run classification. We describe ongoing efforts to estimate trawl efficiency in conjunction with genetic stock assessments to improve the accuracy and precision of population abundance estimates for winter-run and other races of juvenile Chinook Salmon entering the Delta at Sacramento (Sherwood Harbor) and exiting the Delta at Chipps Island.

We provide an overview of the initial seven-year effort and describe ongoing efforts for future work to generate run-specific estimates of juvenile Chinook Salmon entering and exiting the Delta.

Since 2016, over 11,000 fish were implanted with acoustic transmitters and paired with releases hatchery fish implanted with coded wire tags.

Additionally, over 8,200 genetic samples have been collected and analyzed from trawl samples at Sacramento and Chipps Island with over 400 being assigned as genetic Winter-run. Preliminary Winter-run abundance estimates at Chipps Island ranged from 7,900 –122,500 at Chipps Island and efficiency varied with Delta outflow, tow location, and tow direction. Finally, we focus on describing future efforts with the trawl efficiency project, which revolve around continued paired releases of Winter-run Chinook Salmon.

Additional efforts are focused on applying these methods to estimate the abundance of juvenile spring and fall-run Chinook entering and exiting the Delta.

For more information see the Delta Science Tracker:

<https://sciencetracker.deltacouncil.ca.gov/node/49904>

Speaker: Lauren Yamane, US Fish and Wildlife Service

Co-authors: Russell Perry, U.S. Geological Survey - Western Fisheries Research Center; Brian Pyper, Azimuth Consulting Group; Bryan Matthias, US Fish and Wildlife Service; Arnold Ammann, National Oceanic and Atmospheric Association; Joshua Israel, United States Bureau of Reclamation; Rachel Johnson, NOAA Fisheries, Southwest Fisheries Science Center and UC Davis, Center for Watershed Sciences; Patricia Brandes, US Fish and Wildlife Service

Track: Ecology, Food Webs, & Changing Ecosystems

Leveraging Deep Neural Network Machine Learning to Proactively Predict Genetic Winter-Run Chinook Salmon Salvage Before it Occurs



Conserving species in the face of water withdrawals from the California Delta requires information, cooperation, and the best available science. Endangered winter-run Chinook salmon are vulnerable to entrainment at the state and federal export facilities which can reduce survival during outmigration.

A machine learning model that predicts entrainment was previously developed to inform water operations to minimize take of winter-run Chinook salmon but was based on length-at-date run identification, which is known to misclassify runs and, thereby, limit the effectiveness of the tool.

We use genetic samples that have been taken on length-at-date identified fish over the last 15 years to develop an improved machine learning model focused on forecasting genetically confirmed salvage before it occurs.

However, genetically confirmed winter-run Chinook salmon salvage is highly sporadic; forecasting salvage given its highly zero-inflated nature poses a particular challenge using traditional or even advanced statistical methods. We present the early findings from a specialized deep neural network model with a hurdle architecture: long short-term memory modeling. We have designed this modeling framework to inform water operation decisions and support more effective species protections.

Speaker: **Jereme Gaeta**, California Department of Fish and Wildlife

Co-authors: **Brian Mahardja**, US Bureau of Reclamation; **Trinh Nguyen**, California Department of Fish and Wildlife; **Andrea Odell**, California Department of Fish and Wildlife; **Sean Fogenburg**, California Department of Fish and Wildlife

Track: Managing Competing Demands for Water

How individual variation in maze exploration behavior is associated with outmigration success in Chinook salmon smolts

Over two decades of research across the animal kingdom has shown that individuals of the same species can consistently behave differently from one another in response to the same environmental conditions. However, evidence that such individual behavioral variation (IBV) results in ecological consequences, like survival in the wild, is often mixed and context-dependent. Here, we explored how IBV was associated with the success of juvenile Chinook salmon outmigration to the ocean, currently a major bottleneck for imperiled populations in California's Central Valley, during a critically dry and wet water year. To accomplish this, we observed hatchery-origin fall-run smolts explore a maze, quantifying IBV in maze exploration using metrics that studies of other species have ascribed to boldness, exploration, activity, and spatial cognition.

We then surgically implanted observed fish with acoustic tags and monitored their outmigration through the Sacramento River using a vast array of acoustic receivers. While controlling for the potential impact of environmental factors, we found that IBV was associated with outmigration success, and that associations depended on water year type. However, while IBV explained more variation than body size, relatively little variation in outmigration success was explained by these factors alone.

Our results suggests that some population benefit for Central Valley Chinook salmon may result from raising fish with behavioral phenotypes that are more adapted to the wild. Moreover, IBV in hatchery-origin fish probably does not represent the full scope of potential variation due to the exceptionally high densities and featureless environments used in fish hatcheries.

Therefore, we recommend that future research compare behavioral variation between wild- and hatchery-origin fish, and assess the impact of social interactions and environmental complexity on IBV of hatchery-origin fish.

Authors: Benjamin Burford, University of California, Santa Cruz; Rebecca Robinson, University of California Santa Cruz; Jeremy Notch, University of California Santa Cruz / NOAA Fisheries; Cyril Michel, University of California, Santa Cruz

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

Restoring Chinook Salmon Spawning and Rearing Habitat in the Lower Feather River Low Flow Channel: Pre-Project Monitoring of the Oroville Wildlife Area River Restoration Project at Robinson's Riffle



The lower Feather River Low Flow Channel (LFC), located approximately two miles downstream of Oroville, California, has been heavily altered by historic gold dredging, dam construction, and regulated flows, leaving a simplified, confined channel with limited Chinook salmon *Oncorhynchus tshawytscha* spawning and rearing habitat. The Oroville Wildlife Area River Restoration Project at Robinson's Riffle aims to address these deficiencies through gravel augmentation and construction of off-channel rearing features including side channels and backwater alcoves within the adjacent dredge-tailings floodplain. To evaluate project effectiveness, we developed a Before-After-Control-Impact monitoring framework structured around nine hypotheses adapted from the Healthy Rivers and Landscapes Science Plan.

Pre-project baseline monitoring from September 2024 through August 2025 included water quality monitoring, redd surveys, benthic macroinvertebrate (BMI) sampling, and snorkel surveys at impact sites within the project footprint and at upstream and downstream control sites.

Water temperature and dissolved oxygen were generally suitable for spawning, incubation, and rearing throughout the monitoring period. Chinook salmon redds were confined to existing riffle habitat, with no spawning observed in areas proposed for new riffle construction. BMI prey biomass densities within the project footprint were three to five times lower than at the downstream control site and were dominated by taxa associated with low-velocity, fine-sediment conditions. Juvenile Chinook salmon densities were comparable across sites when fish were present but declined sharply through spring.

These baseline results document key habitat constraints the project is designed to address and establish the reference conditions for evaluating post-project effectiveness following planned construction in 2027.

Speaker: Pete Moniz, Cramer Fish Sciences

Co-authors: Jacob Taylor, Cramer Fish Sciences; Rocko Brown, Cramer Fish Sciences; Joseph Merz, Cramer Fish Sciences

Track: Nature-Based Solutions & Landscape Resilience

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 45 · 5 PRESENTATIONS

Salmonid life history diversity, survival, and response to water management



Going with the Flow—salmonid life-history variation and water management in the California Central Valley



Fish and other species that depend on rivers and freshwater flows require habitat availability and connectivity at critical stages in their lives. Our understanding of the distribution of neutral and adaptive genetic variation in steelhead and Chinook salmon has expanded dramatically over the past decade.

I will first present an overview of the distribution of genetic variation among salmonid migration life-history variants across landscapes and watersheds in the Klamath and California Central Valley.

These data reveal the impacts of dams and water operations on fish populations, the effects of which can be seen over time in steelhead sampled above and below dams and in delta water export operations, as well as among Chinook salmon life-history variants.

In keeping with the 'opportunity for change' theme of the conference, I will then transition to make new connections and show how science can support better landscape and river management for beneficial environmental flows. Together, this information can inform decisions about water management, restoration efforts, and other critical factors that ecosystems depend on, helping us re-imagine future river and delta landscapes for the benefit of all the life that depends on it, including our own.

Speaker: Devon Pearse

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems · Managing Competing Demands for Water

Winter-run Chinook Salmon early life history response to flow and density-dependence in a heavily altered tailwater

Diverse life-history strategies allow species to spread risk across a mosaic of habitat conditions. In Chinook Salmon (*Oncorhynchus tshawytscha*), particularly in the Central Valley of California, this is expressed through varied adult run timings and juvenile outmigration strategies.

Anthropogenic impacts, particularly dams, disrupt these fundamental life-stage transitions, often forcing managed populations to adapt to homogenized, less stochastic hydrologic regimes. This is exemplified in the Sacramento River, where the conservation of endangered Sacramento River winter-run Chinook salmon requires balancing complex water operations with the ecological needs of a population confined to a short stretch of suitable habitat downstream of Shasta Reservoir.

Using a 23-year dataset (2002–2024), we evaluated the combined effects of flow, temperature, and spawner abundance on juvenile production and life-history expression in this habitat.

We found that flow and spawner abundance best predicted juvenile passage at Red Bluff Diversion Dam while temperature had considerably less support. The proportion of juveniles migrating as smolts exhibited significant density dependence that was negatively correlated to both female spawner abundance and peak flows. These results suggest that while focusing on temperature management alone may be sufficient for population persistence, the strategy is insufficient for population recovery.

Effective management strategies should consider flow variability and habitat restoration to facilitate varying migration strategies and expand upstream rearing capacity. By addressing these physical and hydrologic constraints, managers can better support the full suite of life-history strategies necessary for the resilience of winter-run Chinook salmon.

Speaker: Chase Ehlo, Cramer Fish Sciences

Co-authors: Steve Zeug, Cramer Fish Sciences

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems · Managing Competing Demands for Water

Factors affecting egg-to-fry survival of Winter-Run Chinook Salmon in the upper Sacramento River.



Understanding the factors that affect the production of winter-run Chinook salmon from the Upper Sacramento River is limited by a paucity of in situ information at early life stages. Poor survival during egg development can limit the freshwater production and recovery of the population.

To evaluate factors that may be important to egg survival, we used Whitlock-Vibert boxes containing 100 fertilized eggs from winter run Chinook salmon of known parentage. Each egg box was set within an artificially constructed redd and coupled with a data logger that recorded temperatures and dissolved oxygen concentrations during incubation. The use of egg boxes also provided measurement of accumulated fine sediments.

A total of 40 artificial redds were constructed at seven sites spread over 36 km of river below Keswick Dam, providing measurement over a spatial gradient of environmental conditions that could be related to egg survival.

For analysis, we used a known-fate survival model and Bayesian methods to estimate coefficients for the effects of temperature, dissolved oxygen, sedimentation, and parentage on egg survival. River flows were historically high (~14,000 ft³/s) but decreased rapidly within 6 days (~9,500 ft³/s), causing three of our redd sites to become dewatered within the last two weeks of the study. We measured a linear decrease in egg survival with increased distance downstream of the dam, commensurate with higher temperatures, decreased dissolved oxygen concentrations, more sedimentation, and slower water velocities.

The measured effect of temperature was consistent with laboratory studies that show egg survival is zero above a threshold of 16° C. Below 16°C egg survival was also influenced by dissolved oxygen and sedimentation commensurate with temporal changes in river flows and spatial changes in water velocities. Our study provides insight into factors that may be limiting the productivity of this critically endangered population.

Speaker: John Plumb, US Geological Survey

Co-authors: Russell Perry, U.S. Geological Survey - Western Fisheries Research Center; Kevin Offill, US Fish and Wildlife Service; Kevin Niemela, US Fish and Wildlife Service

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

Using parentage-based tagging to identify origins of Chinook salmon (*Oncorhynchus tshawytscha*) returning to a restored creek



Climate change and anthropogenic impacts are leading to degraded ecosystems and the loss of native species. California is the only location where all four different run types of Chinook salmon co-occur, however, all four are listed under the Endangered Species Act.

Restoration of habitat is one of the most effective ways to address ecosystem degradation. Putah Creek, a stream in the Central Valley, has undergone 25 years of restoration resulting in reestablished perennial flows and native fish diversity. Recently, Chinook salmon have been observed spawning in Putah Creek. Previous research using otolith microchemistry found returning salmon are mostly hatchery origin with some individuals of Putah Creek origin.

However, exact contributions of Putah Creek origin fish to subsequent generations remains unknown.

I will use the genetic method of parentage-based tagging (PBT) via a validated SNP panel to 1) elucidate the natal origin of Chinook salmon spawning in Putah Creek; and 2) assess reproductive success. I first developed a novel parentage-based tagging genotyping assay to create a pedigree of the previous seven years of tissue collected from the creek, then I analyzed the constructed pedigree to understand the natal origins of the Chinook salmon in Putah Creek. Finally, I analyzed population dynamics and reproductive success.

Salmon are declining throughout California, however, confirmation of a new spawning run, initiated by hatchery strays, may be a model for recovering Chinook salmon in other previously degraded and rehabilitated ecosystems. Further, this work provides a key demonstration of PBT towards Chinook salmon management in California streams.

Speaker: Alana Luzzio, Genomic Variation Lab, UC Davis

Co-authors: Andrea Schreier, University of California, Davis

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems

Regional Variation in the Life History of Central Valley Steelhead



Key information gaps remain regarding our knowledge of threatened Central Valley Steelhead (*Oncorhynchus mykiss*) demographics and life histories across the Sacramento and San Joaquin River watersheds. Here we report results of a collaboration between the Otolith Geochemistry & Fish Ecology Laboratory at UC Davis, the Norwegian Institute for Nature Research, the US Bureau of Reclamation, and the CA Dept. of Fish and Wildlife.

For this project we are utilizing increment and geochemical analyses of archived otoliths from 600 *O. mykiss* to reconstruct the age structure, growth, and migratory life history of steelhead from the Upper Sacramento, Feather, American, Tuolumne, Merced, and Stanislaus Rivers. Annual ages are reconstructed using opaque and translucent banding patterns and migration history is reconstructed using strontium isotope analysis ($^{87}\text{Sr}/^{86}\text{Sr}$).

Preliminary results highlight potential region-wide variation in life history, including variation in anadromous and inter-river migrations. Variation in growth has also been noted, with migratory individuals often exhibiting elevated growth, but residents also obtaining large size through longevity. Such patterns are key to understanding regional variation and developing management practices that include and support life-history diversity.

Speaker: Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA

Co-authors: Feng Zhao, University of California, Davis; Miranda Bell Tilcock, UC Davis Center for Watershed Sciences; Erin Ferguson, CA Dept. Fish and Wildlife; Lea Korber, CA Dept. Fish and Wildlife; Steve Tsao, CA Dept. Fish and Wildlife; Michael Beakes, Environmental Protection Agency; Brian Mahardja, US Bureau of Reclamation

Track: Ecology, Food Webs, & Changing Ecosystems

Restoration, faster: Regulatory approaches to accelerate ecological restoration in a changing Bay-Delta estuary



This session will highlight regulatory pathways being applied in the San Francisco Bay-Delta Estuary to advance regional and statewide restoration and land use goals, including 30x30, the Delta Plan's restoration targets, the Estuary Blueprint, and the goals of the Natural and Working Lands Climate Smart Strategy.

California's ambitious restoration and conservation goals are often slowed by complex and time-intensive permitting and regulatory processes. In October 2020, Governor Newsom signed Executive Order N-82-20, launching the Cutting the Green Tape initiative, providing funding and support to develop and expand permitting tools for habitat restoration projects.

Regulatory improvements aim to accelerate restoration while maintaining environmental protection. This session will bridge the theory and practice of efficient restoration permitting by bringing together agency representatives to share program updates and project proponents to highlight how these tools directly impacted work.

The session will begin with a presentation from two restoration leaders from Sustainable Conservation and the Sacramento-San Joaquin Delta Conservancy. They will provide a whole-Estuary perspective on how efficient permitting can advance restoration and discuss what more can be done to cut green tape (20 minutes).

Next, the session will move to presentations from panelists (10 minutes each) and a panel discussion (30 minutes). Panel members will include representatives from the California Department of Fish and Wildlife (Cori Gray), San Francisco Bay Conservation and Development Commission (Harriet Lai Ross), California State Coastal Conservancy (Evyann Borghis Sloane), Environmental Science Associates (Jill M. Sunahara), and California Department of Water Resources (Judah Grossman).

Panelists will provide program and project specific updates, describe the advantages and challenges of applying existing permitting and compliance tools, and consider what challenges remain.

Session Chairs: Campbell Ingram, Sacramento-San Joaquin Delta Conservancy; Erika Lovejoy, Sustainable Conservation

Co-authors: Erika Lovejoy, Sustainable Conservation; Campbell Ingram, Sacramento-San Joaquin Delta Conservancy; Rachel Wigginton, Delta Stewardship Council

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Recent Advances in Restoration Regulatory Pathways and their Applications in the San Francisco Bay-Delta Estuary



California's ambitious restoration and conservation goals are often slowed by complex, overlapping, and time-intensive permitting and regulatory processes. Regulatory advances aim to accelerate the pace and scale of ecological restoration while maintaining environmental protection. This talk will summarize the work underway to modernize permitting and regulatory processes to implement important restoration work across the San Francisco Bay-Delta Estuary and California more broadly.

Achievements advancing this work include categorical and statutory exemptions to the California Environmental Quality Act, the State Water Resources Control Board's Statewide Restoration General Order, the United States Army Corps of Engineers Nationwide Permits, and many others. These innovations are the result of extensive collaborations with state and federal agencies.

This presentation will highlight some of these collaborative processes and demonstrate how those partnerships are key to continuing progress toward restoration that is faster, more cost effective, and more successful.

Last, this will then dive into the implementation of these approaches in the San Francisco Bay-Delta Estuary, previewing and making connections among the remaining talks in the session by representatives from the California Department of Fish and Wildlife, San Francisco Bay Conservation and Development Commission, California State Coastal Conservancy, Environmental Science Associates, and California Department of Water Resources.

This presentation will be a part of a session titled "Restoration, Faster: Regulatory Approaches to Accelerate Ecological Restoration in a Changing Bay-Delta Estuary" that will explore a suite of regulatory pathways being applied to advance regional and statewide restoration goals and discuss possible next steps to further accelerate restoration.

Authors: Rachel Wigginton, Delta Stewardship Council; Erika Lovejoy, Sustainable Conservation; Campbell Ingram, Sacramento-San Joaquin Delta Conservancy; Katie Haldeman, Sustainable Conservation

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Key Models for Regulatory Integration in Restoration and Resilience

It's no surprise that shoreline restoration and climate resilience are becoming increasingly challenging. Practitioners are working within constrained, highly fragmented landscapes shaped by overlapping jurisdictions, critical utilities, and escalating climate stressors. As if that weren't enough, the state prioritizes multi-benefit projects where habitat, public access, and climate resilience are treated as co-equal goals—an approach that often creates regulatory tension rather than clarity.

For the past decade, the Coastal Conservancy has been working with partners to address these regulatory challenges. From advancing top-down solutions like developing programmatic permitting pathways to supporting bottom-up strategies such as funding dedicated staff across six state and federal regulatory agencies, we've been building the tools needed to move shoreline restoration forward.

This presentation will be a part of a session titled "Restoration, Faster: Streamlining Regulatory Approaches in a Changing Bay-Delta" that will explore a suite of regulatory pathways being applied to advance regional and statewide restoration goals.

Restoration, Faster: Streamlining Regulatory Approaches in a Changing Bay-Delta



California's ambitious restoration, climate resilience, and 30x30 goals require regulatory pathways that can keep pace with urgent ecological needs. At the Bay Delta Region's Cutting the Green Tape (CTGT) Program at the California Department of Fish and Wildlife, we work to advance efficient, protective, and collaborative permitting approaches that accelerate habitat restoration while upholding environmental safeguards.

This presentation will provide an overview of the CTGT program's goals, scope, and recent progress supporting restoration projects across the Bay Delta Region.

I will highlight how streamlined regulatory tools—including new programmatic permitting mechanisms, improved interagency coordination, and early engagement pathways—are reducing processing timelines and increasing predictability for project proponents.

Drawing from real world examples in the region, I will describe how these tools have influenced project design, sequencing, and implementation, enabling restoration practitioners to deliver ecological outcomes more effectively. Persistent bottlenecks, limited staff capacity, and inconsistent processes across jurisdictions can slow restoration pace and scale. I will identify opportunities for expanding programmatic coverage, improving data-sharing, and strengthening alignment across regulatory agencies.

By sharing lessons learned from CTGT's implementation, this talk will contribute to shaping next generation approaches to efficient, ecologically sound restoration permitting in the Bay Delta Region.

Speaker: Corinne Gray

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions



From Permits to Projects: Unlocking Faster Climate Adaptation

California's ambitious restoration and conservation goals are often slowed by complex, overlapping, and time-intensive permitting and regulatory processes. In October 2020, Governor Newsom signed Executive Order N-82-20, launching the Cutting the Green Tape initiative, providing funding and support to develop and expand permitting tools for habitat restoration projects. Regulatory streamlining approaches aim to accelerate the pace and scale of ecological restoration while maintaining environmental protection.

The San Francisco Bay Conservation and Development Commission (BCDC) has been working on speeding up permitting for climate adaptation projects in the SF Bay through a number of approaches. These approaches include revamping the pre-application process, updating regulations and policies to improve adaptation outcomes, redesigning application materials, and using technology to reduce friction.

In addition, BCDC is modernizing their programmatic permitting approaches and creating new programmatic permits for small habitat restoration, enhancement and creation activities, as well as multi-benefit shoreline protection projects across San Francisco Bay. BCDC will also study different options and intends to develop a programmatic approach for larger restoration projects.

Speaker: Harriet Ross

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

From Concept to Construction: Cutting the Green Tape to Accelerate Restoration



Achieving the pace and scale of habitat restoration needed across the San Francisco Estuary requires not only strong project design and funding, but more efficient permitting pathways. This presentation offers a practitioner-focused perspective on how California's Cutting the Green Tape (CTGT) initiative and related regulatory streamlining tools are improving restoration delivery.

Drawing on recent San Francisco Bay Area project examples—including multi-benefit, nature-based solutions such as horizontal levees, floodplain and wetland restoration, and shoreline resilience projects—this talk will highlight how proponents are applying CEQA streamlining approaches, programmatic permits, and early multi-agency coordination to move projects from concept to construction more efficiently.

These tools are intended to reduce duplicative review, improve clarity in permitting expectations, and strengthen coordination across jurisdictions while maintaining environmental protections.

The presentation will focus on implementation outcomes, including improved schedule certainty, reduced permitting risk, and increased feasibility of delivering restoration at landscape scales. It will also describe real-world challenges with applying these tools, such as variability in agency interpretation, limitations for projects that fall outside programmatic coverage, and the learning curve for practitioners navigating evolving processes.

Finally, this talk will highlight remaining gaps in regulatory streamlining, including the need to expand programmatic applicability, better align state and federal permitting pathways, and sustain interagency coordination capacity.

Speaker: Jill Sunahara

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions



Streamlining Restoration at Tide's End: Applying Programmatic Permits to Accelerate Multi Benefit Implementation

The proposed Tide's End Multibenefit Restoration Project illustrates how existing and emerging regulatory innovations have the potential to facilitate ecological restoration in the Bay-Delta. Despite broad consensus on the need to increase the pace and scale of habitat restoration, permitting complexity remains a major barrier. Tide's End could leverage new and existing streamlined pathways to reduce permitting time while maintaining the environmental protections that drive those permit requirements.

For example, CEQA analysis of the proposed project is being conducted through a Supplemental Environmental Impact Report (SEIR) that tiers from Statewide Restoration General Order (SRGO) Program Environmental Impact Report (PEIR) prepared by State Water Board. The SEIR pathway allows CEQA review to focus on project-specific issues rather than general effects of restoration project, which are well understood.

For federal permitting, the project is pursuing a U.S. Army Corps of Engineers Regional General Permit for Section 404 compliance, aligning restoration actions with this well-established permitting pathway that has been in use for decades. For state permitting, Tide's End is exploring the Restoration Management Permit to consolidate California Department of Fish and Wildlife approvals into a single, integrated authorization.

These pathways are supported by coordinated early engagement with state and federal agencies, enabling alignment of design standards, avoidance and minimization strategies, and mitigation approaches. Together, these tools demonstrate how programmatic permitting and innovative thinking can reduce administrative burden, increase predictability, and support timely implementation of multi-benefit projects. Tide's End offers a case study in how restoration proponents can apply evolving regulatory mechanisms to meet ambitious statewide ecological resilience goals.

Speaker: Judah Grossman

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Longfin Smelt Science Program: Improving our understanding of species ecology for improved management (Part 2)



These three oral sessions cover a diverse range of research efforts that collectively comprise the Longfin Smelt Science Program. Co-chaired by DWR and CDFW, the Longfin Smelt Science Program, tasked with developing and implementing the Longfin Smelt Science Plan, serves as a venue for collaborating on new Longfin Smelt science, identifying science priorities to guide Longfin Smelt management, and guiding science investments in compliance with DWR's ITP for operating the State Water Project.

These activities are conducted in partnership with USFWS, USBR, and the State Water Contractors. The presentations in these three sessions provide updates to ongoing studies and new findings in Longfin Smelt ecology since the 2024 Bay Delta Science Conference.

Session Chair: Brian Schreier, California Department of Water Resources

Co-authors: Adam Chorazyczewski, California Department of Fish and Wildlife

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems



Variation in marine habitat suitability during estuarine-marine habitat transitions by longfin smelt in the San Francisco Bay and Sacramento-San Joaquin Delta estuary

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 population declines in California's San Francisco Bay and Sacramento-San Joaquin Delta (Bay-Delta) estuary, where longfin smelt are protected under California's Endangered Species Act, have prompted extensive study of estuarine factors associated with the decline.

However, coastal factors that affect the longfin smelt life cycle are poorly understood and may be important drivers of population dynamics.

Longfin smelt generally appear to leave the Bay-Delta estuary in late spring (April to June) and return in early fall (September to November).

Here, we present updated species distribution models that provide insights into habitat suitability during these crucial transition periods. Model updates include expansion of temporal extent, temporal resolution, and incorporation of prey density. Preliminary results indicate that habitat suitability was highly variable off the California coast and was largely driven by habitat contractions associated with warm-water conditions. We then generated an index of habitat suitability for longfin smelt in the California Current and related this index to longfin smelt populations in the Bay-Delta estuary.

Speaker: Matthew Young, U.S. Geological Survey

Co-authors: Frederick Feyrer, U.S. Geological Survey, California Water Science Center; Kelly Vasbinder, Southwest Fisheries Science Center, NOAA; Steve Lindley, Unaffiliated

Track: Ecology, Food Webs, & Changing Ecosystems

Mechanisms underlying the response of longfin smelt to freshwater flow in the northern San Francisco Estuary

The abundance index of longfin smelt *Spirinchus thaleichthys* (LFS) has the strongest response to freshwater flow of any species in the San Francisco Estuary. Our large study of larval LFS is centered on this relationship; here we present an overview of results to date (see abstracts by four co-authors).

Objectives: Determine 1) Larval abundance and size by depth, salinity, and day vs. night; 2) Diets by location, size, and prey abundance; 3) Effect of feeding on growth rate; 4) Change in feeding with size; 5) How larval salinity history matches predictions from a particle-tracking model; 6) How vertical distribution retains larvae in low-salinity waters; and 8) Predation risk by northern anchovy to LFS larvae in saline waters.

Approach: In spring 2024 and 2025 we conducted surveys to constrain the timing and mechanisms for the flow-abundance relationship.

We took 255 depth-stratified trawls along the salinity gradient by day and night, collecting > 10,000 LFS, mostly at low salinity and near the bottom. Acoustic surveys were conducted for LFS and anchovy (led by Hassrick and Brewitt). We are processing LFS for dietary DNA (led by Jungbluth), otolith fingerprints for growth rate and salinity history (Lewis), anchovies for gut contents (Slaughter), and zooplankton samples. Particle-tracking and statistical modeling (Gross) are used to test behaviors that result in observed distributions.

Results: We combine analyses of monitoring data, previous modeling, and our field results to refine our conceptual model of the population dynamics of LFS. The >100-fold decline over 4 decades is likely caused by food limitation following the sudden drop in primary production and copepod abundance in 1986. The strong effect of freshwater flow could be due to the interaction between larval behavior and estuarine circulation, and the delay in settlement of clams by high outflow in spring.

Speaker: Wim Kimmerer, San Francisco State University

Co-authors: Edward Gross, RMA/GEI Consultants; Jason Hassrick, ICF Environmental, Inc.; Michelle Jungbluth, San Francisco State University; Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA; Anne Slaughter, San Francisco State University; Toni Ignoffo, San Francisco State University; Kim Brewitt, ICF Environmental

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System

Simulating the Effects of Alternative Vertical Behaviors on Longfin Smelt Retention and Survival



The effect of Delta outflow on the distribution of small pelagic organisms in the San Francisco Estuary depends heavily on their vertical distribution. Early longfin larvae are observed to be positively buoyant, resulting in seaward transport. Later stage larvae must adopt behavior to be retained in the Low-Salinity Zone where they are caught in 20mm Survey trawls months after hatching.

Observations in our study indicate higher abundance of these larvae at depth than near the surface, particularly during the day. Previous modeling work has indicated that sinking organisms (represented by particles) can be retained in the Low-Salinity Zone.

Using a behavioral particle-tracking model driven by three-dimensional hydrodynamic simulations, we simulate spatial distributions for a range of alternative vertical behaviors. We translate the predicted time-varying distribution from each hypothesized behavior to predicted catch which we compare with 20 mm Survey catch data.

We conclude that vertical behavior influences both retention and the estimated losses associated with predation by anchovy. Ongoing work will evaluate how these predation losses may vary with freshwater outflow and potentially contribute to the observed relationship between X2 and longfin smelt abundance.

Authors: Edward Gross, RMA/GEI Consultants; Wim Kimmerer, San Francisco State University; Josh Korman, Ecometric Research

Tracks: Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

Using echosounders to estimate northern anchovy abundance and associated predation risk to longfin smelt in the San Francisco Bay-Delta

Longfin smelt (*Spirinchus thaleichthys*) abundance is highly responsive to freshwater outflow from the Delta, yet the mechanisms underlying its decline remain poorly understood. This study investigates predation risk to larval and post-larval longfin smelt by northern anchovy at higher salinities. We hypothesize that higher flow, which strengthens estuarine circulation and pushes X2 seaward, reduces the time that bottom-oriented longfin smelt larvae and post-larvae spend at high salinities, thereby limiting exposure to anchovy predation. We combined echosounder surveys for northern anchovy with depth-stratified day and night tows using a 20 mm net from March through June in 2024 and 2025.

Catches of larval and post-larval longfin smelt were highest near the bottom, consistent with downward movement that enhances estuarine retention. Echosounder surveys indicate that anchovies overlap with longfin smelt at the upper end of the smelt's salinity range, particularly in May and June as X2 shifted upstream. Anchovy densities also concentrated near the bottom during the day — where longfin smelt were most abundant — while anchovies dispersed throughout the water column at night. Finally, comparison of concurrent echosounder and trawl data demonstrates the echosounder's utility for detecting longfin smelt presence and relative abundance during late spring, when trawl catchability declines.

Speaker: **Kim Brewitt**, ICF Environmental

Co-authors: **Jason Hassrick**, ICF Environmental, Inc.; **Wim Kimmerer**, San Francisco State University; **Levi Lewis**, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA

Track: Ecology, Food Webs, & Changing Ecosystems

Something's Fishy in the Napa River: An Abnormal Abundance of Longfin Smelt



Longfin Smelt (*Spirinchus thaleichthys*), a species listed under both the federal and California Endangered Species Acts, has faced persistent population declines and high interannual recruitment variability throughout the San Francisco Estuary. Recent data from the California Department of Fish and Wildlife's (CDFW) Smelt Larva Survey (SLS) and 20-mm Survey have highlighted the Napa River as a site of significant productivity.

Catches from 2025 reveal a surge in Longfin Smelt abundance within the Napa River that has not been documented by the 20-mm Survey since 2000. Moreover, the catches of larval and juvenile Longfin Smelt far surpass those observed in any other region of the estuary. This 2025 anomaly likely resulted from a "Goldilocks" combination of favorable conditions. This presentation investigates potential environmental parameters behind this localized recruitment surge.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/activities/smelt-larva-survey>

<https://sciencetracker.deltacouncil.ca.gov/activities/20-mm-survey>

Speaker: Vanessa Mora

Track: Ecology, Food Webs, & Changing Ecosystems

[Placeholder: Flooding the Notch] - collaborative art making that connects students with land at Sac State Photo



[Placeholder: Flooding the Notch] is a collaborative social practice artwork that examines human relationships to land. In this iteration, Sacramento State photography students explored the Yolo Bypass guided by Professor Eliza Gregory alongside conservationist John Brennan and fish scientist Carson Jeffres. Through field trips, diverse creative research, and collaborative dialogue, this group of artists began the process of connecting with the land and investigating the floodplain ecosystems and infrastructure of the Sacramento Valley. In this collaborative work, the artists have transformed fieldwork into deeply personal narratives while coalescing their experiences into artwork in the form of photographs, books, a slideshow, and exhibitions with the goal of reconnecting people to the Sacramento Valley floodplains.

Speaker: Eliza Gregory

Track: Art

Water as Currency - Lunchtime Art Seminar

Hughen/Starkweather will discuss their 20-year visual arts collaboration, their research process, and present their most recent work, Water as Currency. This project highlights the interconnected and complex water systems of the San Francisco Bay Delta Estuary, mapping impacts of extraction (gold, salt, sand, water) and emerging landscapes of restoration using materials collected throughout the estuary watershed.

Speakers: Jennifer Starkweather; Amanda Hughen

Track: Art

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 49 · 5 PRESENTATIONS

Peering beneath the surface: Advances in monitoring using sound and sight



Use of Acoustic Cameras for Dredge Monitoring and Risk Evaluation



Dredging navigation channels must balance economic and operational demands with regulatory requirements protecting special-status fish species. Accurately quantifying entrainment risk is central to this balance, yet conventional monitoring provides limited resolution of fish presence and behavior during dredging operations.

The U.S. Army Corps of Engineers implemented studies to compare monitoring technologies for improving evaluation of entrainment effects and comparing risks from various dredge technologies.

One study utilized acoustic imaging using ARIS cameras to view the vicinity ahead of the dragarms of the Essayons hopper dredge. This non-invasive technology provides the capability to observe fish and conditions during dredge operations.

Direct quantification of fish at risk of entrainment using this method shows promise if uncertainty can be reduced. These imaging results can be compared with other monitoring results to help calibrate and estimate entrainment risk. This technology could be useful for project management and also applicable to other types of projects.

Speaker: Brian Mulvey, Retired - U.S. Army Corps of Engineers

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Acoustics versus Trawling: Using paired gear sampling to assess fish distribution in Suisun Bay



The San Francisco Bay and Sacramento-San Joaquin Delta (Bay-Delta) undergo substantial dredging to maintain shipping lanes, and these activities occur alongside rapid environmental change and ongoing fisheries management. To support resource managers in understanding how fall seasonal dredging operations affect fish communities, updated information on species presence, distribution, and relative abundance is warranted.

Bioacoustics is a valuable tool for detecting fish and has been applied across the Bay-Delta, yet few studies have evaluated its performance relative to other monitoring methods. To inform resource managers on fish behavior and to illuminate the efficacy of bioacoustics sampling in the deeply channelized Suisun Bay, we examined how bioacoustics alongside established trawling techniques can be used to assess fish distribution.

We paired bioacoustics surveys with trawl sampling during fall dredge operation windows in multiple years (2022-2024). We compared fish detections to habitat conditions using generalized linear models to examine environmental influences on species distributions. Gear performance was further evaluated using informed log-ratio modeling to identify factors driving differences between bioacoustic- and trawl-based detection.

Preliminary results found observed fish distribution based on bioacoustics surveys qualitatively similar to observed distribution based on trawl-based surveys; although, bioacoustics skewed towards detecting higher numbers of fish than trawling techniques and was contingent on sampled fish community. These preliminary findings can help resource managers refine future monitoring strategies and enhance informed decision-making in the intersection of shipping channel maintenance and management of native fish populations and habitats.

Speaker: Danielle Palm, U.S. Geological Survey - California Water Science Center

Co-authors: Matthew Young, U.S. Geological Survey; Brian Mulvey, Retired - U.S. Army Corps of Engineers

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

Using Real-Time 3D Environmental Forecasting to Provide Actionable Information: How Short-Term Forecasts Can Guide Management Decisions



Real-time forecasting of environmental conditions is conducted in large estuaries across the US. For example, LiveOcean in Puget Sound and the Chesapeake Bay Environmental Forecast System (CBEFS).

Short-term forecasts can provide actionable information for uses ranging from salinity/temperature early warning systems to seasonal summaries of habitat. In this talk we will provide an overview of our CBEFS and highlight how similar forecasts could benefit management and use of the San Francisco Bay-Delta. CBEFS is an automated 3D coupled hydrodynamic, biogeochemical, wave, and sediment transport model that runs daily and provides 5-day forecasts of environmental conditions in Chesapeake Bay ([www.vims.edu/cbefs])(<http://www.vims.edu/cbefs>)).

Forecasts include salinity, water temperature, waves, pH, aragonite saturation state, harmful algal blooms, *Vibrio vulnificus*, stinging sea nettles, dissolved oxygen, hypoxic volume, marine heat waves, and water clarity.

CBEFS includes simplistic data assimilation, real-time model-to-data comparisons, AI-based forecasting of riverine biogeochemistry, and automated alerts to end users.

Outreach to end users has disseminated the availability of the daily forecasts and guided development of forecast graphics. These user-driven forecast graphics are available on the CBEFS dashboard, while daily model output is publicly available through a data server. Use cases have included scientists planning field studies and evaluating hard clam and oyster mortality events, managers evaluating water temperature for Striped Bass spawning, water temperature alerts for fish stuns, anglers planning fishing activities, power plant operators understanding the probability of jellyfish, and seasonal reporting of the overall health of the Bay.

Use of the CBEFS dashboard is tracked using Google Analytics. Similar tools applied to the Bay-Delta could provide short-term daily forecasts of actionable information to regulators, water project operators, farmers, anglers, and boaters.

Speaker: Aaron Bever, FlowWest

Co-authors: Marjorie Friedrichs, Virginia Institute of Marine Science; Pierre St-Laurent, Virginia Institute of Marine Science; Susanna Musick, Virginia Institute of Marine Science; Michael MacWilliams, FlowWest

Track: Managing Competing Demands for Water

Continuous monitoring of juvenile salmon migration from managed rice fields using video and computer vision technology



During California's 2023–2025 commercial salmon fishery closure, farmers, commercial and recreational fishing groups, and scientists formed a coalition (The Bridge Group) to advance new strategies for increasing production from Coleman National Fish Hatchery.

One such strategy leveraged studies showing that winter-flooded rice fields can produce abundant zooplankton and support rapid growth of juvenile Chinook Salmon. In January 2026, approximately one million hatchery fall-run Chinook Salmon fry, per field, were released onto rice fields in the Yolo Bypass at Knaggs Ranch and Conaway Ranch, which used different draining practices. At Knaggs, fish could leave volitionally through holes in drain boards, whereas Conaway retained fish until rapid drainage at the study end.

We installed remote stations to monitor dissolved oxygen and water temperature, game cameras to assess avian predation pressure, and video monitoring stations at field exits to continuously record fish movement during outmigration. Two deployment designs were tested to inform future work. Videos were analyzed with a fish detection model to automatically identify and count individual fish.

The method was effective at Knaggs, where lower turbidity allowed reliable detection; however, high turbidity at Conaway limited visibility (average turbidity: 18.6 NTU at Knaggs; 245.6 NTU at Conaway). Preliminary results from Knaggs detected 12,393 salmon exiting the field, primarily at night, over 14.66 days of recorded video. Volitional movement was pulse-like and appeared to increase during storms despite a lack of flow change within the field. Review of Conaway videos is still underway.

This pilot year highlighted both the value of cross-sector collaboration and the potential of continuous video monitoring to detect and efficiently quantify outmigrating juvenile Chinook Salmon, while also providing lessons on selecting field conditions suitable for video monitoring stations.

Speaker: [Jasmine Williamshen](#), Cramer Fish Sciences

Co-authors: [Andrew Veary](#), Cramer Fish Sciences; [Matthew Ziemer](#), Cramer Fish Sciences; [Steve Zeug](#), Cramer Fish Sciences

Tracks: Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Integrating Computer Vision, eDNA, and Aquatic Imaging to Evaluate Ecological Function in Restored and Managed Delta Habitats



The Sacramento–San Joaquin Delta is a novel aquatic ecosystem in which habitat loss, altered hydrology, and species invasions have reshaped ecological structure and function. In such systems, restoration and management often work within persistent change rather than restoring historical conditions.

We synthesized results from two field studies that used a Before–After–Reference–Impact (BA:RI) design to evaluate how restoration and managed hydrologic interventions influence food webs and fish communities using integrated low-disturbance tools, including underwater video with computer vision, environmental DNA (eDNA), in situ zooplankton imaging, and water-quality sensors.

At Dutch Slough, restored tidal habitats shifted toward reference conditions within two years of levee breaching, with improved dissolved oxygen dynamics, reduced chlorophyll-a, greater water-quality heterogeneity, stronger food-webs, and increased fish use.

Longer, more complex channels supported higher zooplankton density, more juvenile fish, and greater species richness, especially near vegetated margins. eDNA and video revealed rapid increases in taxa, including seasonal expansion of native species amid persistent non-native dominance.

At Meins Landing on Montezuma Slough, managed return of floodwater from agricultural land seasonally inundated to control invasive Russian thistle produced gradients in turbidity, chlorophyll-a, zooplankton density, and fish concentration, with fish aggregating near plume margins. Responses indicated short-term trophic enhancement, though assemblages remained dominated by non-native fish.

Together, these studies show that low-disturbance, multi-tool monitoring can detect rapid ecological responses to restoration and managed flow actions in the Delta. Results highlight the importance of habitat complexity, connectivity, and hydrologic subsidies in shaping food webs and fish habitat and provide guidance for adaptive management in highly altered landscapes.

Speaker: Joseph Merz, Cramer Fish Sciences

Co-authors: Kai Ross, Cramer Fish Sciences; Bobbie Flores, Cramer Fish Sciences; Andrew Veary, Cramer Fish Sciences; Katie Karpenko, Cramer Fish Sciences; Cheryl Dean, Cramer Fish Sciences; Katherine Bandy, California Department of Water Resources; Molly Ferrell, California Department of Water Resources

Tracks: Invasive Species & Novel Ecosystems · Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 50 · 5 PRESENTATIONS

Climate change and resiliency planning



Speakers: Annika Ragsdale, Delta Stewardship Council; Alison Whipple, San Francisco Estuary Institute; Yuchuan Lai, Tetra Tech Inc.

The Delta in a Changing Climate: Findings from California's Fifth Climate Change Assessment



The Sacramento-San Joaquin Delta (Delta) is essential to California's water, agricultural, ecological, and cultural systems. It supplies a portion of the water used by more than 27 million Californians, supports a \$4.6 billion agricultural economy, and sustains habitat for more than 750 plant and animal species. Yet it is also one of the most climate-vulnerable regions in the state, facing higher relative sea level rise than the San Francisco Bay Area due to land subsidence and its position at the confluence of California's two largest rivers.

Recognizing that California's Climate Change Assessments do not usually produce a synthesis focused solely on the Delta, the Delta Stewardship Council led the development of a report for California's Fifth Climate Change Assessment (Fifth Assessment) to illuminate the complex climate change vulnerabilities of the region and support adaptation decision-making.

The report compiles the best available data on climate change in the Delta, highlights impacts to Delta communities, ecosystems, agriculture, and infrastructure, uplifts regional adaptation and investment needs, and identifies adaptation governance challenges.

Key findings of the report are that:

- 1) the Delta's vulnerability to climate change has statewide implications,
- 2) the Delta is one of the most flood-prone regions of the state, and
- 3) the Delta faces chronic underinvestment relative to the need.

This presentation would summarize content from the report, highlight new projections developed for the Delta in the Fifth Assessment, and propose adaptation priorities and governance strategies to make the Delta more resilient to a changing climate.

Speaker: Annika Ragsdale, Delta Stewardship Council

Co-authors: Morgan Chow, Delta Stewardship Council; Annie Merritt, Delta Stewardship Council; Ashok Bathulla, Delta Stewardship Council; Edmund Yu, Delta Stewardship Council; Nicholas Rowlands, Delta Stewardship Council; Denise Colombano, Delta Stewardship Council; Kim Luke, Delta Stewardship Council

Tracks: Nature-Based Solutions & Landscape Resilience · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Historical Patterns of the Sacramento Valley River-Wetland Corridor to Advance Landscape Resilience Thinking



Sound decisions toward recovery of resilient functioning landscapes for both people and wildlife require an understanding of patterns and processes of the past—the conditions to which species are adapted. Motivated by this need, an initial reconstruction of the early 1800s Sacramento Valley river-wetland corridor was undertaken in the first phase of the Sacramento Valley Historical Ecology Study, conducted by the San Francisco Estuary Institute in collaboration with CalTrout and supported by the Floodplain Forward Coalition.

We used archival datasets, including maps, texts, and photographs, to develop a preliminary map of historical channel configuration and habitat types in the core river-wetland corridor of the Sacramento Valley prior to major Euro-American modification. Draining the largest watershed in California, the Sacramento River's regular flooding cycles historically transformed the Sacramento Valley into a vast inland sea extending for miles from the river, often sustained for months.

Diverse and extensive wetland and riparian habitats followed distinct landscape positions, with broad and complex riparian forest lining the river's natural levees, vast tule-dominated perennial wetlands extending across the flood basins, and a variety of seasonal wetlands along transition zones.

This diverse and dynamic landscape supported immense numbers of salmon, migratory waterbirds, and other fish and wildlife species. Nearly two centuries of levee construction, upstream hydraulic mining and dams, and agricultural development have transformed the Valley and severed many river-landscape connections, resulting in dramatic loss of historical floodplain and wetland habitats. In future phases of work, we hope to further refine mapping, evaluate change over time, and develop in-depth descriptions of processes and functions.

Knowing the past is foundational to reintroduce elements for landscape resilience and ecological recovery in our contemporary highly managed systems.

Speaker: Alison Whipple, San Francisco Estuary Institute

Co-authors: Sean Baumgarten, San Francisco Estuary Institute; Ben Satzman, San Francisco Estuary Institute formerly; Jennifer Symonds, San Francisco Estuary Institute; Sacha Heath, San Francisco Estuary Institute; Evan Melendez, San Francisco Estuary Institute

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

Sequential Runoff Projection for San Francisco Estuary Upstream Watersheds Using Bayesian State-Space Modeling



Interannual variability and long-term change in runoff to San Francisco Estuary has critical implications for California. Projections of upstream watershed runoff are typically developed using global climate models (GCMs) coupled with downscaling and hydrologic modeling and used in multiple state and regional planning efforts.

However, these projections are subject to multiple sources of uncertainty, may not align well with historical observations, and can be difficult to update as new data become available. This work presents a statistical time-series modeling approach with parameters informed by GCM-based projections and further calibrated using historical observations.

This approach provides an efficient framework to: a) bridge process-based modeling results with historical data, b) integrate Bayesian inference to update prior beliefs using existing and new observations, and c) support adaptive decision-making by providing a quantitative tool for investigating future learning about climate variability and change. Building on a state-space modeling (SSM) framework, the model includes parameters that represent global and regional climate and hydrologic changes.

Through Bayesian inference, the SSM uses observations to update parameter estimates and their associated uncertainties, thereby providing insights into historical variability and expected future changes. By using synthetic observations (i.e., model simulations used as hypothetical realizations of future climate and hydrology), the SSM can also be used to evaluate expected improvements in future runoff projections, supporting dynamic, adaptive decision-making and associated cost-benefit analyses.

This methodology is seen as a meaningful advancement for regularly updated water resource planning required under several mandates in California, such as the biennial Delivery Capacity Report.

Speaker: Yuchuan Lai, Tetra Tech Inc.

Co-authors: Sujoy Roy, Tetra Tech Inc.

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Leveraging social ecological network analysis to advance climate adaptation among small surface water dependent water systems including systems reliant on imported water



Climate change necessitates adaptation among drinking water systems to sustain reliable potable water service. Adaptation among small systems is particularly critical given small systems' outsized climate vulnerabilities and the potential for climate change to exacerbate existing inequities.

However, gaps in adaptive capacity are particularly prevalent among these systems, often halting progress and at times spurring negative feedback loops and maladaptation. Here we propose Social Ecological Network (SEN) analysis as an analytical approach uniquely capable of bridging scales and resources to further climate adaptation in the face of these challenges. We analyze 859 water systems and their surface water sources.

Unlike groundwater sources, which are usually located within, or near, system service boundaries, surface water sources are often derived from outside service boundaries, sometimes far outside (e.g. reliance on imported supplies from Northern California in Southern California).

Historically this has obscured our understanding of risks associated with these sources, including the potential for climate impacts. By explicitly representing water sources and the relationships between sources and systems and among systems themselves, our results provide new insights into the patterns of vulnerability among small water providers. Importantly, SEN also informs new opportunities for planning and intervention.

For example, measures of centrality and embeddedness identify critical components of the state's overall drinking water landscape for investment and stabilization. SEN can also provide a consistent framework for tracking progress on adaptation through time and help to identify cascading impacts caused by water purchasing, including among the 414 community water systems served by the State Water Project and/or Central Valley Project.

Authors: Kristin Dobbin, University of California, Berkeley; Benji Reade-Malagueño, University of California Berkeley; Margot Cohen, University of California Berkeley; Alondra Zamora-Olivares, University of California Berkeley; Jenny Rempel, University of California Berkeley; Aneesa Gomez-Cervantes, University of California Los Angeles

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Bay Adapt Navigator: A Living Dashboard Tool to Empower the Bay Area Region



The Bay Area faces an estimated \$96 billion cost to adapt to sea level rise and flooding by 2050. But only \$6.5 billion in funding is forecast. The San Francisco Bay Conservation and Development Commission (BCDC) and the Metropolitan Transportation Commission (MTC) are developing the Investment Strategy – an interactive user-friendly dashboard that empowers the San Francisco Bay region to connect and explore sea level rise adaptation projects and funding opportunities to help address the funding shortfall.

The objective of the presentation is to share a data-driven effort to coordinate 101 cities and 9 counties in the Bay Area region to address a significant funding shortfall in sea-level rise adaptation. BCDC will provide an overview of the funding landscape in the Bay Area and present a demo of the Bay Adapt Navigator tool.

BCDC developed the Bay Adapt Navigator dashboard to empower local decision-makers to easily quantify the cost and benefits of sea level rise adaptation projects. As part of the tool's release this fall, BCDC is excited to present new analysis where we quantify the benefits of sea level rise adaptation to the region, specifically to people, critical infrastructure, transportation, recreation, and contamination. Measuring the benefits of sea level rise adaptation promotes long-term ecosystem sustainability as the region can better understand the true value of sea level rise adaptation to local communities.

In the demo, the presenter will walk through various use cases and share examples of how stakeholders could leverage the tool to advance their goals. Takeaways will include 1) new insights on the costs and benefits of sea level rise adaptation in the Bay Area region 2) planning strategies to coordinate a multi-jurisdictional region to address sea level rise and 3) data lessons on how to build a tool that supports regional stakeholders, such as project leads, funders, agencies, and advocates.

Authors: Ujay Siddharth, San Francisco Bay Conservation and Development Commission; Cory Copeland, San Francisco Bay Conservation and Development Commission; Aidan Williams, San Francisco Bay Conservation and Development Commission

Tracks: Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 51 · 5 PRESENTATIONS

Elevate Bay Delta



Together, these presentations will highlight the scientific opportunities enabled by comprehensive elevation data and the value of cross-regional collaboration in advancing ecosystem resilience and long-term stewardship of the Bay-Delta Estuary.

The session will consist of five different powerpoint presentations; an introductory talk followed by 4 related talks; each 15 minutes in length followed by 5 minutes for Q&A.

Session Chair: Alex Braud, San Francisco Estuary Institute

Co-authors: Mino Han, San Francisco Estuary Institute; Ashok Bathulla, Delta Stewardship Council; Michelle D'Agullio, UC Davis

Tracks: Systems Thinking for the Whole Ecosystem · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Replacing the Patchwork: Collaboratively Building a Cohesive High-Resolution Dataset for the Bay-Delta Estuary



The Bay-Delta Estuary supports a unique ecosystem that provides millions of Californians with water, but it is becoming increasingly vulnerable to environmental changes. To fully understand environmental changes, assessing risk, and supporting resilient communities, it is essential to have a cohesive, region-wide elevation dataset. However, elevation data across the Estuary has historically been collected through individual acquisitions, resulting in an incomplete picture of the region. This patchwork approach has limited the ability of researchers, planners, and decision-makers to conduct collaborative, region-wide analyses. As a result, communities across the Estuary are making consequential decisions based on outdated representations of a rapidly changing landscape.

To address this challenge, the San Francisco Estuary Wetlands Regional Monitoring Program (WRMP), the California Department of Water Resources (DWR), and the Delta Stewardship Council partnered to acquire and publish the first comprehensive lidar (Light Detection and Ranging) dataset spanning the entire Bay-Delta Estuary. The scale and scope of this effort would not have been possible without this cross-agency collaboration. Data was acquired during the summer of 2025, when lower water levels allowed for improved detail. The resulting survey provides a consistent, high-quality elevation baseline of the Bay-Delta that captures fine-scale features at an unprecedented level of detail. Compared to previous regional elevation products, this dataset offers substantial improvements in spatial resolution and accuracy. This presentation highlights the importance of inter-agency collaboration, and provides an overview of the lidar and how it offers new opportunities for flood risk mitigation, improved habitat restoration, and subsidence monitoring. Replacing this fragmented collection of datasets with a standardized elevation map establishes a shared foundation for collective problem-solving.

Authors: Addie Gleekel, Delta Stewardship Council; Alex Braud, San Francisco Estuary Institute; Arina Ushakova, DWR; Ashok Bathulla, Delta Stewardship Council; Megan Thomson, Delta Stewardship Council; Lisamarie Windham-Myers, Delta Stewardship Council; Michelle Stern, Delta Stewardship Council; Erin Mullin, Delta Stewardship Council

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

A Shared Framework for Flood Risk Assessment in the Sacramento-San Joaquin Delta



The Sacramento-San Joaquin Delta is central to California's flood safety, water supply, and climate resilience. Despite its importance, there is currently no public, Delta-wide hydraulic model that provides a shared foundation for flood risk assessment. As a result, agencies operating within the Delta rely on different tools and assumptions, creating inconsistencies in flood risk analysis and planning efforts. To address this gap, the Delta Stewardship Council is developing a publicly accessible Delta-wide 2D hydraulic model in partnership with the California Department of Water Resources (DWR).

This project incorporates the new 2025 lidar dataset to improve topographic accuracy and provide a more reliable understanding of present and future flood risk. Bathymetric data for Delta channels is also being compiled with guidance from DWR's Bay-Delta Modeling Support Group to ensure accurate representation of channel conditions and hydrologic processes. Model development is ongoing and remains on schedule for completion by the end of the year. Once completed, the model will serve as a shared resource for agencies, researchers, and stakeholders across the Delta. It will support flood mapping, levee investment decisions, climate planning, and emergency preparedness. By providing a common framework, this project aims to improve coordination among Delta partners and strengthen the region's resilience to flooding and climate change.

Speaker: **Ashok Bathulla**, Delta Stewardship Council

Co-authors: **Michelle Stern**, Delta Stewardship Council; **Erin Mullin**, Delta Stewardship Council; **James Edwards**, Delta Stewardship Council

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System

Correcting Vegetation Bias in the 2025 Estuary-Wide Lidar DEM for San Francisco Bay Tidal Marsh Applications



Lidar-derived digital elevation models (DEMs) often struggle to reflect true bare ground when dense wetland vegetation prevents lidar pulses from penetrating the canopy. Resulting DEMs often reflect this vegetation bias, sometimes overestimating the surface elevation by up to one meter. These errors are particularly consequential in estuarine tidal wetlands where the entire range of ecological function is compressed into a narrow intertidal window of roughly one to two meters. Within that range, even modest elevation bias can obscure sea level rise vulnerability assessments, misclassify wetland condition, and introduce meaningful uncertainty into elevation-based habitat and hydrodynamic models.

Through an iterative process of selecting and testing input data and training parameters, we are generating a vegetation-corrected DEM for the San Francisco Baylands, congruent with the 2025 estuary-wide lidar acquired through a multi-partner coalition. RTK-GPS survey data collected across the study extent from 2022-present, lidar point cloud metrics, tidal datums, vegetation indices derived from 2024 aerial imagery, and Synthetic Aperture Radar (SAR) data are being used to train a Random Forest regression model of predicted elevation bias across the Bay tidal marsh extent. As part of the Beneficial Baylands project, the resulting DEM will be used to improve suitability and benefits models for nature-based shoreline adaptation solutions. We will present model performance results, and discuss how this resulting data product is being applied by the Beneficial Baylands project, the San Francisco Estuary Wetlands Regional Monitoring Program, and other estuarine science initiatives around San Francisco Bay.

Speaker: Mino Han, San Francisco Estuary Institute

Co-authors: Alex Braud, San Francisco Estuary Institute; Lydia Vaughn, San Francisco Estuary Institute; Matthew Ferner, San Francisco Bay National Estuarine Research Reserve

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Interdisciplinary Science & Cross-Knowledge Integration

Spatial variation in sedimentation and revegetation rates among five restored tidal salt marshes in the San Francisco Bay Estuary



Tidal marsh restoration in coastal California has been a growing priority, as tidal wetlands face historic losses in the last two centuries and contemporary threats to remaining ecosystems. While there are currently hundreds of completed, ongoing, and planned restorations in the San Francisco Bay Estuary (SFBE), there is still uncertainty regarding the amount of sediment entering restored marshes, and whether there is enough sediment in the estuary to support all current and planned restorations. To explore factors influencing variation in sedimentation and revegetation rates for SFBE restorations, we measured the biological and physical attributes of five marshes restored between the late 1990's and early 2010's. In 2024 and 2025, we measured site elevation, plant species presence, abundance, and average height, and sediment properties including bulk density, percent organic matter, particle grain size distributions, and percent organic and inorganic carbon.

Further, we extracted elevation derived from lidar collected in 2010 and 2025, and estimated sediment accretion rates at each of the restorations during this interval. We found that sites varied greatly in accretion and revegetation rates, with higher rates of sedimentation occurring in South Bay and lower rates occurring in San Pablo. There was a linear relationship between time since restoration and percent occupation of *Spartina foliosa* (declining) and *Salicornia pacific* (increasing), providing evidence that quantitative metrics of these species could be useful indicators of recovery trajectory at wetland restoration sites. Accretion rates declined as restoration age and starting elevation increased. This pattern is aligned with the accommodation space framework, which explains how sediment and organic matter accumulate. These results contribute to our understanding of the multitude of factors influencing variation in sedimentation and revegetation in SFBE restorations.

Speaker: Michelle D'Aguillo, US Geological Survey, Western Ecological Research Center

Co-authors: Daniel Nowacki, US Geological Survey, Pacific Coastal and Marine Science Center; Samantha McGill, US Geological Survey; Jessica Lacy, US Geological Survey, Pacific Coastal and Marine Science Center, retired; Karen Thorne, U.S. Geological Survey

Track: Nature-Based Solutions & Landscape Resilience

Filling the Mudflat Monitoring Gap: Satellite-Derived Intertidal Elevation for Sediment Dynamics and Restoration Assessment in San Francisco Bay



Unvegetated intertidal mudflats play an important role in sediment storage, redistribution, and contaminant fate in San Francisco Bay, yet continuous, spatially explicit elevation data in these dynamically active zones is difficult and expensive to obtain over wide areas. Direct measurement of intertidal elevation change using field surveys is spatially limited and lidar is infrequent, making it difficult to characterize broad patterns or long-term change of this often overlooked habitat covering greater than 26,000 acres across the Bay.

The 2025 estuary-wide lidar acquisition was tide-controlled for collection below Mean Sea Level in San Francisco Bay, but for most of the Bay that still left a data gap across the broad mudflats extending between the marsh edge and the subtidal, where tidal sampling constraints and collection costs limit repeat coverage. This study demonstrates the application of satellite-derived intertidal elevation methods to the unvegetated intertidal zone of San Francisco Bay, using multispectral satellite imagery combined with modeled and observed tidal water levels to estimate intertidal surface elevations continuously across the estuary and characterize geomorphic change over time. We evaluate tradeoffs among available satellite platforms and tidal water levels sources, leveraging the 2025 lidar as validation for direct assessment of method performance, and demonstrate management applications spanning restoration monitoring, sediment dynamics assessment, and shoreline resilience planning.

Speaker: Alex Braud, San Francisco Estuary Institute

Tracks: Nature-Based Solutions & Landscape Resilience · Decision Science & Adaptive Mindsets in a Dynamic System · Interdisciplinary Science & Cross-Knowledge Integration



Competing and complementary visions for salmon recovery: An interactive fishbowl on salmon recovery and water management

While science is critical in resource management, competing values, priorities, and governance structures often shape how scientific information is interpreted and translated into policy and management decisions. This session explores how different communities define the problem of salmon recovery, where perspectives converge and diverge, and what those differences reveal about opportunities and constraints for future action.

Rather than a traditional panel, this session uses a facilitated fishbowl and revolving conversation to create direct dialogue among representatives from diverse communities and groups with an interest in salmon and water management. Participants will provide concise, unrehearsed perspectives on the challenges facing Central Valley salmon and respond to one another in real time. Audience members will actively participate through polling and facilitated discussion designed to surface assumptions, priorities, and areas of disagreement.

The session serves as an experiment in collaborative inquiry. By bringing together participants with different experiences and knowledge systems, the format makes visible the values, tradeoffs, and underlying assumptions that often influence management decisions but remain implicit in technical discussions. Audience polling and reflection will allow participants to compare how the problem is defined, evidence is evaluated, and solutions are prioritized.

This session is not striving for consensus, the goal is to deepen understanding of the diverse perspectives shaping salmon recovery efforts. The session will use a variety of visual facilitation tools to identify areas of alignment, explore sources of disagreement, and highlight opportunities for collaboration, learning, and innovation. In doing so, it offers a new approach for examining complex natural resource challenges where scientific, social, cultural, and institutional factors are deeply interconnected.

Session Chairs: Kimberly Horndeski; Brett Harvey, California Department of Water Resources

Tracks: Systems Thinking for the Whole Ecosystem · Managing Competing Demands for Water · Finding Collaborative Solutions

Longfin Smelt Science Program: Improving our understanding of species ecology for improved management (Part 3)



These three oral sessions cover a diverse range of research efforts that collectively comprise the Longfin Smelt Science Program. Co-chaired by DWR and CDFW, the Longfin Smelt Science Program, tasked with developing and implementing the Longfin Smelt Science Plan, serves as a venue for collaborating on new Longfin Smelt science, identifying science priorities to guide Longfin Smelt management, and guiding science investments in compliance with DWR's ITP for operating the State Water Project.

These activities are conducted in partnership with USFWS, USBR, and the State Water Contractors. The presentations in these three sessions provide updates to ongoing studies and new findings in Longfin Smelt ecology since the 2024 Bay Delta Science Conference.

Session Chair: Brian Schreier, California Department of Water Resources

Co-authors: Brian Schreier, California Department of Water Resources; Adam Chorazyczewski, California Department of Fish and Wildlife

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems

Zooper Small, Zooper Important: Temporal Shift in the Zooplankton Community in the Napa River



The California Department of Fish and Wildlife's 20-mm Survey has been monitoring juvenile fishes and their prey availability in the San Francisco Estuary since 1995. In 2025, the survey data showed notably higher Longfin Smelt (*Spirinchus thaleichthys*) catch relative to historical observations in the Napa River. This exceptionally high abundance has not been recorded since 2000.

This oral presentation will explore how the zooplankton community has changed over time in the Napa River and address how recent consecutive years of favorable hydrological conditions and optimal food availability have created an environment conducive to Longfin Smelt success.

Speaker: Jessica Jimenez

Track: Ecology, Food Webs, & Changing Ecosystems

Effects of acoustic tagging surgery on survival and swimming performance in longfin smelt



Longfin smelt are a pelagic, small-bodied forage fish distributed along the Pacific coast of North America. The San Francisco Estuary of California supports the Bay-Delta Distinct Population Segment of longfin smelt, a genetically distinct source population and the southernmost reproductive population of the species.

Once among the most abundant fishes in the estuary, long-term monitoring programs have documented a precipitous decline in Bay-Delta longfin smelt abundance since the 1960s, with current estimates at less than one percent of pre-1980 levels. Recent advances in transmitter miniaturization, including the development of the 0.05 g Shad Tag, have created new opportunities to apply acoustic telemetry to the study and conservation of wild longfin smelt populations.

Prior to implementing acoustic telemetry as a conservation tool, however, the effects of acoustic tagging surgery and tag-carrying burden must be evaluated under controlled conditions.

These evaluations are necessary to verify that survival, behavior, and physiology of tagged longfin smelt are not inhibited and that telemetry-derived data are representative of the broader population. Early results indicate that successful acoustic tagging of wild-caught longfin smelt is feasible using methods developed for the sympatric Delta smelt, with post-surgical survival exceeding 90% relative to untagged controls through 30 days post-surgery. These findings inform ongoing assessments of acoustic telemetry as a research and conservation tool for longfin smelt.

Speaker: Sebastian Gonzales, UC Davis

Co-authors: Brian Schreier, California Department of Water Resources; Anna Steel, University of California, Davis; Dennis Cocherell, UC Davis; Daniel Deng, Pacific Northwest National laboratory PNNL; Levi Lewis, Otolith Geochemistry & Fish Ecology Laboratory, University of California, Davis, CA; Rick Wilder, ICF; Nann Fangue, UC Davis

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health



An interactive online tool for in-season tracking of Longfin Smelt salvage and forecasting season-scale entrainment risk

Longfin smelt (LFS) are at risk of entrainment into the South Delta and pumping facilities at multiple life stages. While adults are sporadically observed in the fish salvage facilities, post-larval LFS are more commonly counted in salvage, and qualitative larval monitoring indicates that the smallest life-stages are also at risk of entrainment.

Most salvage of post-larvae occurs in the late winter and spring, during which efforts to minimize entrainment are undertaken by the Smelt Monitoring Team (SMT). While this real-time assessment of risk is an important tool for minimizing entrainment of a threatened species, historical patterns of LFS salvage suggest that entrainment is influenced not only by geographically and temporally proximate conditions, but also by hydrologic and life-history dynamics that operate at seasonal timescales.

Based on a working theoretical model, we hypothesized that LFS entrainment risk increases when spawners are abundant and distributed further inland, and that hydrological conditions during winter and early spring could therefore be useful for predicting season-scale risk of larval and post-larval LFS entrainment.

We found that annual salvage of post-larval LFS was negatively correlated with multiple metrics of flow through the Bay-Delta, and that the strength of these correlations increased through the winter, with many becoming statistically significant by mid-January. Based on these relationships, we developed an online dashboard that tracks in-season LFS salvage and fish monitoring survey catches and reports predicted annual LFS salvage while incorporating uncertainty from multiple sources.

This tool is not intended to replace real-time assessments; instead, it represents a complementary approach to understanding LFS entrainment risk that can provide early warning when hydrologic conditions and spawner abundance indicate the potential for increasing LFS salvage.

Speaker: Michael Tillotson, ICF

Co-authors: Brian Schreier, California Department of Water Resources

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

A 5-year Narrative to Understand Detection Probability and the Risks of Entrainment



The 5-year Larval Entrainment Survey (LES) provides a unique insight into detection of larval Longfin Smelt (*Spirinchus thaleichthys*) in the southern region of the San Francisco Delta, to help inform future Long Term Monitoring (LTM) survey design for imperiled species in the Delta.

Agencies track population level changes for Longfin Smelt and other species through repeated measure of abundance indices. Accuracy and utility of indices are affected by gear efficiency, spatial and temporal sampling scope, and distribution of the target species. Declines in Longfin Smelt indices identified a need to evaluate current detection and monitoring methods, particularly in relation to Federal and State Water Projects where Longfin are at risk for entrainment.

LES results provide the opportunity to evaluate Longfin Smelt sampling methods and refine abundance indices. The survey targeted larval longfin below 20mm, the threshold for Fish Facility salvage, using 3-8 pelagic ichthyoplankton tows.

Initial LES years 2022-2023 sampled outside of Clifton Court Forebay and confirmed the presence of larval Longfin Smelt several weeks before larval were qualitatively observed in the Fish Facilities.

When the survey moved downstream to the lower San Joaquin River in 2024-2026, larval Longfin were observed within this region for a longer period than LTM programs currently sample. The study then focused on calculating detection probabilities and compared the effects of spatial (station transects) and environmental (turbidity, salinity, temperature) variability across seasons and years. While detection probability did increase further downstream, differences between sample location occasionally contributed less to variation than differences between tows.

This suggested a variable and patchy larval population, underscoring the value of replicated sampling efforts for enhancing detection probability and improving information needed to reduce entrainment risk.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/activities/larval-smelt-entrainment-monitoring>

Speaker: Timothy Malinich

Co-authors: Tim Malinich, California Department of Fish and Wildlife; Morgan Gilbert, California Department of Fish and Wildlife

Track: Ecology, Food Webs, & Changing Ecosystems

The Value of Replication in Long Term Ecological Monitoring for Rare and Imperiled Species



The Sacramento-San Joaquin Delta benefits from several long-term fish monitoring programs like the Smelt Larval Survey (SLS, 2009-present), which provide a robust picture of landscape-scale patterns for species like Longfin Smelt (*Spirinchus thaleichthys*). But as this species has become rarer, its representation in catch has declined and become more variable. Because spatially-replicated studies like SLS are not designed to estimate station-level catch variance, they provide limited ability to detect and estimate abundance of this increasingly rare species.

The Larval Entrainment Survey (LES, 2022-2026) was initiated to inform State Water Project (SWP) long-term operations. It provided quantitative estimates of larval Longfin Smelt abundance where entrainment was likely. Early LES sampling (2022–2023) occurred adjacent to the SWP, where entrainment risk was highest and SLS did not normally sample.

In 2024, LES shifted downstream to established SLS stations in the Old River, Middle River and lower San Joaquin River. LES sampled during the SLS season, using similar oblique tows and matched SLS net dimensions and meshes (500 μ m), but conducted multiple replicate tows at each station and weekly (vs SLS biweekly) temporal replicates. This overlap allowed direct evaluation of whether LES-style replication could be incorporated into long-term monitoring programs.

By quantifying variance components through mixed-effects models, evaluating tow-order and drift effects, and using bootstrap simulations to quantify divergence of single-tow from replicate-based estimates, we will isolate key drivers of catch variability. This will demonstrate how replication improves sensitivity over single-tow designs, reduces sampling bias, and enhances abundance estimates for rare species like Longfin Smelt. We will conclude by highlighting how replication-focused approaches can calibrate long-term monitoring and support adaptive management through more reliable population trend assessments.

Speaker: Morgan Gilbert, California Department of Fish and Wildlife

Co-authors: Tim Malinich, California Department of Fish and Wildlife

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water



Realizing the opportunity for hypothesis-centered science: The Healthy Rivers and Landscapes Science Program (Part 1)

The Healthy Rivers and Landscapes (HRL) Program commits 155 – 825 thousand acre-feet (TAF) of spring-season flows and over 30,000 acres of restored habitat across the Sacramento-San Joaquin Delta watershed and is under consideration for inclusion in the updated Bay-Delta Water Quality Control Plan.

HRL includes a comprehensive science program, guided by a Science Committee, that ensures strategic research and monitoring across the watershed to evaluate outcomes to native fish from flow and habitat actions. The Science Committee developed the HRL Science Plan, which provides a suite of hypotheses structured in tiers to progressively address local-scale (i.e. project-level) outcomes, tributary and Delta-scale hypotheses on flow provisions, and system-scale hypotheses on population-level trends.

The Science Plan was independently peer reviewed in 2025, prompting substantive improvements in the monitoring design framework for understanding biological effectiveness of restoration projects, power analyses to guide sampling design and intensity, and in how to address difficult questions such as estimating program impact on natural production of Central Valley Chinook salmon within a mixed population of hatchery-origin (marked and unmarked) fish.

This 2-block session will describe the framework for conducting hypothesis-centered science at a watershed scale. Presentations will provide examples of HRL science activities from each hypothesis tier for habitat restoration, environmental flows, and approaches for capturing population-scale impacts. Across agencies, academia, and non-governmental organizations, a long-held vision has been that science activities with similar purpose align their approaches to scale individual research and monitoring projects to system-scale information that is relevant to system-scale decisions.

The HRL Science Program is one approach to achieving this vision in a way that is responsive to decision-maker needs.

Session Chairs: Louise Conrad, California Department of Water Resources; Pascale Goertler, Department of Water Resources; Brian Crawford, Compass Resource Management

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System

Introducing the Healthy Rivers and Landscapes Science Plan: Providing the hypothesis-centered framework for scalable science to serve adaptive management and decision-makers



The Agreements to support Healthy Rivers and Landscapes provide commitments for science, environmental flows and habitat restoration across the Sacramento-San Joaquin Bay-Delta and seven of its rivers. These agreements are currently under consideration for the update of the State Water Resources Control Board's Bay-Delta Water Quality Control Plan.

A major component of the agreements is a comprehensive science program, guided by a Science Committee, that plans and implements science and monitoring to inform the adaptive management of the flow and habitat commitments during the term of the proposed 8-year program. The Science Committee has completed a draft Science Plan that adopts a scaled approach to hypotheses, metrics, and baselines for evaluation of environmental flows and habitat restoration, as well as a framework for tracking the impacts to native fish populations.

This presentation will introduce this session and provide an overview of the Science Plan and its 55 hypotheses, identified gaps in current monitoring networks, and how data and information are expected to be used to produce recommendations. The Science Plan has been revised by input from the Water Resources Control Board's public process and recent independent peer-review to provide a comprehensive and collaboratively developed evaluation of the Healthy Rivers and Landscapes Program. This presentation will include an overview of recent Science Plan updates, such as the sampling design recommendations for biological effectiveness assessments of restoration projects and associated power analyses as well as considerations of consistency in population estimates across tributaries.

The framework of hypotheses and sampling designs in this presentation will provide context and foundation for the ensuing talks in the rest of the 2-block session that will exemplify hypothesis evaluation and science planning for the Healthy Rivers and Landscapes Science Program.

Speaker: [Pascale Goertler](#), Department of Water Resources

Co-authors: [Louise Conrad](#), California Department of Water Resources; [Brian Crawford](#), Compass Resource Management

Tracks: Nature-Based Solutions & Landscape Resilience · Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System



Refining the HR&L Science Plan: Using Historical Data to Standardize Spawning Habitat Restoration Effectiveness Monitoring

Session Title: Realizing the Opportunity for Hypothesis-Centered Science: The Healthy Rivers and Landscapes Science Program

Abstract:

The Healthy Rivers and Landscapes (HR&L) Science Plan describes a tiered approach of hypotheses for evaluating flow and non-flow restoration actions implemented within the program. Hypothesis S3 is a local-tier hypothesis designed to test whether spawning habitat restorations are effective at increasing Chinook Salmon spawning (redd) density at restored reaches compared to suitable benchmark locations in close proximity. This hypothesis has been addressed using different approaches on multiple tributaries in recent decades.

An important step in refining the HR&L Program Science Plan is leveraging existing data to develop standards and study designs for analysis of the data collected to address this hypothesis.

We worked collaboratively across multiple tributary teams to discuss external factors that could influence restoration response (time since restoration, location along river continuum, survey method, and escapement/flow and other factors that vary inter-annually). We then used spawning datasets from early implementation Feather and American river habitat restoration projects to explore how the hypothesis could be tested with different study designs and analytical frameworks (BACI, CI). Finally, we conducted a power analysis on available datasets to explore how these factors might influence effect size and provide recommendations related to study design, response predictions, methodology, and sampling effort for future HR&L HS3 projects.

Speaker: Ryon Kurth, Department of Water Resources

Co-authors: Kirsten Sellheim, Cramer Fish Sciences; Kiera McNeely, Cramer Fish Sciences; Kai Ross, Cramer Fish Sciences; Jamie Sweeney, Cramer Fish Sciences; Pascale Goertler, Department of Water Resources; Gretchen Murphey, Department of Fish and Wildlife; Chris Cook, Department of Water Resources

Track: Decision Science & Adaptive Mindsets in a Dynamic System

Integrating Existing Monitoring Programs into the Healthy Rivers and Landscapes Program Local Tier Hypotheses: An Example from a Yuba River Juvenile Salmonid Habitat Restoration Project



The Healthy Rivers and Landscapes Program (HRL) Science Plan is built upon a robust set of hypotheses designed to determine the effectiveness of habitat restoration actions in meeting biological and physical habitat goals. Here, we leveraged the existing monitoring program currently being implemented by Yuba Water Agency for the 155-acre Hallwood Side Channel and Floodplain Restoration Project (Project), which was completed in fall 2023, to inform expectations about biological response to tributary restoration actions.

The Project increased inundation frequency and duration during the juvenile salmonid rearing period in a network of perennially and seasonally inundated side channels, removed unnatural constraints between main channel and floodplain areas, and reduced predator habitat. Several hypotheses included in the Project monitoring program related to water quality, salmonid growth, predation, secondary (prey) productivity, and stranding risk overlapped directly with local-tier hypotheses from the HRL Science Plan.

This presentation will describe how the results of the Hallwood monitoring program are being integrated with the HRL Science Plan hypotheses including how we are leveraging analytical results to inform expectations, adjusting study approaches as needed to address all metrics and covariates described in the HRL Science Plan, and ensuring that the Project data conforms to HRL data availability standards.

Authors: Kirsten Sellheim, Cramer Fish Sciences; Mollie Ogaz, Cramer Fish Sciences; Avery Scherer, Cramer Fish Sciences; April Sawyer, Verdantas; Chris Hammersmark, Verdantas

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions



Earth observation data for assessing acreage and suitability on wetted lands in the Yolo and Sutter Bypass

Floodplain restoration across California's Central Valley is central to recovering juvenile Chinook Salmon, yet a key management question remains unresolved: can expanded salmon access to bypass floodplains be achieved in a way that maximizes connectivity of suitable habitat and minimizes juvenile stranding to levels that are negligible to the population? Answering this requires spatially continuous, frequently updated information on inundation extent, connectivity, drainage patterns, pool persistence, and water quality; information no single sensor or in situ measurement delivers at the cadence adaptive management requires.

Here, we are developing an operational Earth observation (EO) framework that extends an existing multi-sensor platform, AquaWatch, led by Australia's National Science Agency (CSIRO), to California water resource applications.

The framework integrates NASA EO data products and CSIRO data cubes (Sentinel, Landsat, MODIS, and complementary observations) through a unified set of software, data-ingestion pipelines, and a decision-support interface. We are applying and validating this framework in the Yolo and Sutter Bypass systems to track wetted-area dynamics, floodplain connectivity, and the formation and persistence of isolated pools during recession. We will present the framework architecture, initial multi-sensor inundation and connectivity products for the bypasses, and the workflow that translates EO observations into decision-ready indicators of floodplain habitat condition.

Alongside the technical products, we aim to deliver hands-on training so agency scientists can apply the framework directly, establishing durable in-house EO capacity. By linking continuous satellite observation to the specific hydrologic signals that govern salmon habitat benefit and stranding risk, this work provides a scalable, repeatable basis for monitoring floodplain performance and informing where and when restored habitats deliver the greatest ecological benefit.

Speaker: Fernando Romero Galvan, Department of Water Resources

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Evaluation of potential benefits for juvenile Chinook Salmon diet and growth in restored off-channel tidal habitat and comparisons with adjacent riverine channels in the North Delta.

McCormack-Williamson Tract (MWT) is a historically leveed agricultural island in California's North Delta that reverted to tidal aquatic habitat following unintentional levee breaches. As part of a broader assessment of restored habitat function, we hypothesized that juvenile Chinook Salmon reared within MWT would exhibit higher growth rates and diets reflecting greater densities of beneficial prey taxa than fish reared in adjacent habitats of the Mokelumne River, Snodgrass Slough, and Deadhorse Cut. We conducted a 3-week net-pen study across MWT and adjacent channels using PIT-tagged hatchery juvenile Chinook Salmon.

Fish growth and environmental conditions were monitored weekly. The study concluded early due to seasonally high water temperatures. Upon conclusion, fish were preserved for otolith extraction and stomach content analyses using visual and genetic methods. Zooplankton tows characterized prey availability and will be compared to observed diets.

Volitionally migrating juvenile Chinook Salmon were also collected for comparative analyses to assess potential pen effects.

Preliminary observations show spatial variability in environmental conditions and juvenile Chinook Salmon growth. Growth rates appeared higher in southern MWT habitats near a large breach than in more isolated northern habitats, suggesting flow connectivity may influence rearing conditions. Growth rates in channel habitats were like those in Southern MWT.

Increasing water temperatures and declining dissolved oxygen likely contributed to differences among sites. Ongoing analyses of otolith daily annuli, stomach contents, zooplankton, and volitionally migrating salmon will further elucidate these relationships. In this presentation we will discuss how study results can help evaluate the return of tidal habitat processes and inform adaptive management of MWT and other Delta off-channel habitats.

Authors: Maeghen Wedgeworth, Cramer Fish Sciences; Steve Zeug, Cramer Fish Sciences; Chase Ehlo, Cramer Fish Sciences; James Pearson, East Bay Municipal Utility District; Joseph Merz, Cramer Fish Sciences

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 55 · 5 PRESENTATIONS

Advancing salmon resilience: Integrating life-cycle models, climate stressor insights, and innovative monitoring



Spring-run Chinook salmon monitoring in the lower Tuolumne River in 2025

The lower Tuolumne River, a major tributary of the San Joaquin River, provides important spawning and rearing habitat for fall-run Chinook salmon (*Oncorhynchus tshawytscha*) in the southernmost reaches of the native range. In spring 2025, ~1,000 adult spring-run Chinook salmon unexpectedly arrived on the lower Tuolumne River.

This presented unique and unexpected management challenges that necessitated novel monitoring approaches. We expanded redd surveys and instituted drone surveys to count adults and document the extent, timing, and locations of holding and spawning. We installed an additional upstream rotary screw trap near La Grange to capture information about juvenile outmigration in the upper reaches.

Drone surveys were able to confirm comparable estimates to escapement surveys based on carcass surveys and provided important information about oversummer survival rates and habitat use on a weekly basis.

Redd surveys documented a narrow temporal separation of spring- and fall-run spawning, and use of restored riffles by both run types. Coded wire tags recovered from carcasses confirmed that recovered fish were from releases by the San Joaquin River Restoration Program in winter 2023. Initial genetic information collected from juveniles at the La Grange rotary screw trap documented some juvenile fish with homozygous early return genotypes.

As of late May 2026, approximately 100 adult spring-run fish returned to the Tuolumne River, suggesting the need to further develop and refine a long-term monitoring plan for spring-run Chinook salmon in the system.

Speaker: Sara Hugentobler, FISHBIO

Co-authors: Jason Guignard, FISHBIO; Matt Peterson, FISHBIO

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Finding Collaborative Solutions

Juvenile Salmonid Survival in the Delta



Reclamation continues to update lines of evidence and evaluate previously applied performance metrics for salmonid survival in the Delta. To address this, they requested 6 studies from literature and data reviews to model sensitivities.

Two literature reviews were conducted to:

- (1) identify the connections between juvenile survival in the Delta and adult returns, and
- (2) assess if the 1:1 Vernalis inflow-to-export (I:E) ratio increased the survival of outmigrating San Joaquin juvenile salmonids.

Two studies evaluated how acoustic tag data may be used to assess how entrainment and environmental variables may influence juvenile salmonid survival. A modeling study evaluated the use of CWT data to assess the impact of environmental and operational variables and the proportion observed at salvage on the probability of survival to adult size (smolt/adult ratio or SAR).

The final study applied sensitivity analyses on three life cycle models (IOS, OBAN, and WRLCM) to assess the role of hypothetical additional Delta mortality on the overall survival of winter-run Chinook salmon.

Findings of these activities showed that

- 1) most of the literature focuses on individual mortality factors, however, these stressors are not independent and the number of adult returns is hard to connect to a single stressor;
- 2) literature on the I:E ratio suggests this ratio should be viewed as one element of sequential, reach-specific management framework if increased survival is the objective ;
- 3) there is no indication that fish entrained in the CVP were differentially affected by exports;
- 4) exports show the greatest effect on routing towards the ocean at HOR, the single junction that is not tidally dominated; and 5) life cycle models can be refined to address small incremental changes in Delta mortality to show resulting effects on productivity, abundance, and cohort replacement rates.

Many of these lines of evidence are being peer reviewed by the Delta Science Program in 2026.

Speaker: Stephanie Theis, Stantec

Co-authors: Joshua Israel, United States Bureau of Reclamation; Matt Espe, Cramer Fish Sciences; Noble Hendrix, QEDA Consulting LLC; Jason Hassrick, ICF Environmental, Inc.; Suzanne Manugian, Manugian Environmental Services; Steve Zeug, Cramer Fish Sciences; Kelly Mistry, ICF

Tracks: Nature-Based Solutions & Landscape Resilience · Managing Competing Demands for Water

Applying temperature-dependent oxygen limitation to resolve habitat viability for Chinook salmon across the freshwater to marine life history transition

Climate change is causing increased temperature and oxygen loss in aquatic ecosystems globally. This is especially problematic for cold-water fishes like Chinook salmon due to temperature-dependent oxygen limitation (TDOL): they require more oxygen at warmer temperatures, but warmer water holds less oxygen.

We developed a methodology for assessing how temperature and oxygen synergistically impact habitat viability for California Central Valley (CCV) fall-run Chinook salmon under current and future conditions. As an initial step, we parameterized a mechanistic model of TDOL for this population across the freshwater to saltwater life history transition, using laboratory respirometry experiments. We then used this model to translate environmental temperature and oxygen into a metric of physiological viability for CCV fall-run Chinook salmon (ϕ), which enabled us to identify a ϕ threshold of habitat viability for CCV fall-run Chinook salmon, below which fish were 19x less likely to recover from exhaustive chase.

Furthermore, our results suggest that, when juveniles first enter the ocean, aerobic activity (e.g., during predator evasion) is severely limited by oxygen availability, likely due to the additional metabolic demand associated with physiological transition to saltwater.

However, we found that larger body size can somewhat offset relevant impacts of TDOL. The next study step will convert projections of future ocean conditions into ϕ to identify potential non-viable marine regions under possible climate change scenarios. Our results are useful to managers and policymakers for two reasons. First, given that ϕ is sensitive to body size and lifestage, it captures the uneven risk that Chinook salmon face from TDOL across their ontogeny; it could therefore guide specific management actions (e.g., hatchery practices, harvest regulations, etc.).

Second, identifying future viable marine regions can help prioritize coastwide restoration efforts to adjacent watersheds.

Speaker: Lance Takata, University of California, Santa Cruz

Co-authors: Brendan Lehman, University of California, Santa Cruz; Cyril Michel, University of California, Santa Cruz; Benjamin Burford, University of California, Santa Cruz

Track: Ecology, Food Webs, & Changing Ecosystems

Reducing decision-support uncertainty for Sacramento River Chinook Salmon through acoustic tracking of the previously untaggable

Recovery of Sacramento River Chinook Salmon relies on restoration and flow-management decisions in a historically altered system undergoing hydrologic and ecological change. Yet the CVPIA Science Integration Team's decision-support models (DSMs) for Chinook Salmon and ITP conditions of approval have used smolt survival and movement rates as proxies for wild parr, because tags were too large for smaller fish. This untested assumption potentially propagates uncertainty and error into life-cycle models and restricts targeted adaptive-management interventions. We hope to address this challenge using the newly developed Shad Tag, which enables telemetry of previously untaggable parr-sized fish.

Acoustic tagging would be conducted across three component areas: wild parr in the upper river, hatchery parr in the estuary, and hatchery smolts.

JSATS receivers would enable tag detections, with the Central Valley array forming the core network with additional receivers deployed to assess the influence of levee features on the middle and lower Sacramento River. We would also examine the incidence of emigrant stopovers in tidal wetlands and associated residence times and habitat-use patterns. Concurrent smolt releases would enable comparisons with parr of cross-channel distribution, travel time, and reach-specific survival. This expands on previous work by incorporating a wider range of habitats and life stages, enabling direct comparison of habitat use and survival across the diverse life-history types of the Central Valley Chinook Salmon population.

We expect parr to migrate earlier and more slowly than smolts, with extended residence in off-channel habitats, tributaries, and tidal wetlands, revealing estuarine rearing opportunities not represented in current models. These findings will provide life-stage-specific estimates of parr behavior and survival for incorporation into CVPIA DSMs, improving evaluation of habitat restoration and flow-management actions.

Speaker: Jason Hassrick, ICF Environmental, Inc.

Co-authors: Keith Marine, Aquatic Resources Consulting Scientists; Cyril Michel, University of California, Santa Cruz; Rebecca Buchanan, Columbia Basin Research, University of Washington; David Ayers, UC Davis Center for Watershed Sciences; Jeremy Notch, University of California Santa Cruz / NOAA Fisheries; Daniel Deng, Pacific Northwest National laboratory PNNL; Eric D. Chapman, ICF

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System

Model emulation as a tool for amplifying the utility of computational models in the Delta

The complexity and large spatial extent of the Delta ecosystem have led to the development of ever more complicated and sophisticated computational models. These include hydrologic, hydrodynamic, fish migration, and lifecycle models used to inform policy and management decisions in support of endangered Sacramento River winter-run Chinook salmon. Such models often entail daunting computational expense, which can severely limit their utility for scenario evaluation.

Model emulation, in which a more computationally efficient surrogate is used in lieu of a full model, can be an effective strategy for generating approximate outputs for a small fraction of the computational expense. Here, we present the development and application of submodel emulators for the Winter-run Chinook salmon Lifecycle Model (WRLCM), used to evaluate long-term, population-level effects of environmental conditions and management actions.

We created a Gaussian process regression surrogate of three submodels: a hydrodynamic model (DSM2 HYDRO), a habitat capacity model, and an agent-based model of Chinook smolt outmigration in the Delta (ePTM).

Training of the emulator using a small number of model evaluations relative to the full parameter space was sufficient to achieve satisfactory performance, both in terms of the accuracy of the emulated submodel outputs and the fidelity of the emulator-based WRLCM predictions. Submodel runtimes were reduced from multiple days/scenario to a few seconds/scenario, enabling the evaluation of hundreds of management and hydroclimate scenarios—orders of magnitude more than would be feasible otherwise. However, this efficiency comes at the cost of increased uncertainty, both due to strategic simplification of the model inputs and inherent limitations of the emulation. As our results demonstrate, model emulation can be a powerful tool for amplifying the utility of more complex computational models, provided it is used judiciously and with full awareness of trade-offs.

Speaker: Doug Jackson, QEDA Consulting

Co-authors: Noble Hendrix, QEDA Consulting LLC

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 56 · 5 PRESENTATIONS

Data from the sky: Remote sensing and monitoring technologies



Improving Continuous Monitoring of the Delta: A Suite of Software Tools Supporting Continuous Water Quality, Hydrodynamic, Sediment, and Phytoplankton Data Collection and Sharing



The Bureau of Reclamation's Bay-Delta Flow and Water Quality Monitoring Network maintains continuous hydrodynamic, water quality, sediment, and phytoplankton monitoring at 40+ stations across the Sacramento-San Joaquin Delta and Suisun Bay. Scientists and management personnel require an expansive view of high-quality data for real-time operation of water export facilities, understanding Delta ecosystem responses to hydrological conditions, and evaluating restoration actions. To facilitate these needs, our team has developed a suite of software tools that streamline the monitoring effort from data collection through to public dissemination.

The automated, cloud-based Delta Monitoring Network continuously retrieves telemetry data from field data loggers deployed across the Delta and sends the data to an Aquarius database functioning as a centralized repository. Data are automatically published to CDEC, providing real-time Delta monitoring data to the community.

Data and metadata are acquired directly from the repository using an R package based on the API and are then summarized and visualized on the Delta Data Checker, a web app developed by our team for real-time system monitoring and QA/QC of data streams.

We developed automated daily reports and emails that are sent to field leads to quickly identify and address data gaps and issues across stations. Our team has also developed the Delta Site Visit Tool (DSVT), a full stack desktop application for field crews to record field visit data while at the monitoring stations. The app enhances data quality and streamlines data entry by standardizing data fields and uploading information directly to the Aquarius database.

For more information, see -

<https://sciencetracker.deltacouncil.ca.gov/activities/continuous-flow-and-water-quality-monitoring-network-sacramento-san-joaquin-delta-and>

We will present this suite of software tools to show how they improve data integrity, quality, and accessibility; enhance and accelerate workflows; and enable faster identification and response to data gaps across the monitoring network, providing reliable information to agency managers and data users.

Authors: Cat Pien, FlowWest; Emanuel Rodriguez, FlowWest; Jordan Hoang, FlowWest; Willie Whitfield, FlowWest; Mark Inc, DR Reed and Associates; Nicole Kwan, FlowWest; Joseph Hatfield, DR Reed & Associates, Inc.; Lillian McCormick, USBR

Tracks: Water Quality, Contaminants, & Aquatic Health · Interdisciplinary Science & Cross-Knowledge Integration

Does grain size matter? Scale-sensitivity in measuring wetland properties from remote sensing footprints

Advances in remote sensing have revolutionized our capacity to monitor wetlands and up-scale their ecosystem functions from local measurements to management-relevant extents even in most access-limited landscapes.

However, substantial uncertainty remains due to a limited understanding of how remotely sensed wetland properties respond to changing spatial resolution of the input data.

This issue is further amplified by inherent spatial heterogeneity of wetland environments. As modeling methods grow increasingly sophisticated, these foundational scaling relationships must be addressed.

This study investigates this gap by assessing the scale-sensitivity of spectral vegetation indicators across a suite of restored wetlands in the Sacramento-San Joaquin Delta.

By comparing sites with similar vegetation composition but different spatial configuration and age since restoration, it examines how statistical inference on vegetation indicator characteristics varies across data sources, landscape configurations, and seasonal phenological conditions.

These findings provide critical insights for navigating uncertainty and signal-to-noise tradeoffs in wetland monitoring, offering a framework applicable to the emerging monitoring needs in the Bay-Delta region and beyond.

Speaker: Iryna Dronova

Tracks: Systems Thinking for the Whole Ecosystem · Invasive Species & Novel Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

Quantifying Restoration-Related Habitat Change Using Airborne and Orbital Hyperspectral Remote Sensing



Wetland and freshwater restoration have become major management priorities across California. The Sacramento-San Joaquin Delta, as an example, has lost more than 97% of its historical freshwater wetlands. Although restoration projects continue to expand, there is still limited understanding of how much habitat has changed and how restored ecosystems evolve through time. The objective of this work is to quantify restoration-related habitat change using long-term hyperspectral remote sensing observations. We also want to evaluate whether orbital hyperspectral imagery can support future large-scale wetland monitoring across California.

To address these questions, EcoAtlas restoration records are being linked with airborne AVIRIS-Classic and AVIRIS-NG wetland classification maps collected annually between 2004 and 2024.

The maps are compared year by year within restoration areas to measure whether habitats have changed over time and in what way. Transition matrices are then used to summarize the dominant habitat changes occurring and identify long-term restoration pathways.

Preliminary analysis shows measurable vegetation and habitat transitions within restored regions. We have also observed differences among restoration pathways and vegetation communities. In addition, EMIT orbital hyperspectral imagery is being evaluated against the airborne products to determine whether similar classification approaches can be extended beyond regions with existing airborne coverage. EMIT assessments show that orbital imagery is available during periods overlapping airborne acquisition campaigns, allowing validation between the two platforms. Early classification results also demonstrate promising agreement between EMIT-derived products and existing airborne maps despite the coarser spatial resolution. These findings show that long-term hyperspectral monitoring can track restoration-driven habitat change and support statewide wetland mapping for adaptive management.

Speaker: **Fabjola Kasaj**, Department of Civil & Environmental Engineering, University of California, Merced

Co-authors: **Erin Hestir**, Department of Civil & Environmental Engineering, University of California, Merced; **Shruti Khanna**, California Department of Fish and Wildlife; **Bailey Morrison**, Department of Civil & Environmental Engineering, University of California, Merced

Tracks: Decision Science & Adaptive Mindsets in a Dynamic System · Ecology, Food Webs, & Changing Ecosystems · Systems Thinking for the Whole Ecosystem · Policy & Management Showcase

Advancing Earth Observations into Decision Making: Operational Monitoring of Invasive Aquatic Vegetation in the Delta with Satellite Remote Sensing



Invasive aquatic vegetation (IAV) continues to threaten habitat quality, water conveyance, recreation, and restoration outcomes throughout the Sacramento-San Joaquin Delta. Effective management requires consistent, spatially comprehensive monitoring, yet existing monitoring programs remain limited in their ability to track IAV dynamics across the full Delta on management-relevant time scales. To address this need, we are developing the first multi-agency remote sensing-based monitoring program for submerged and floating IAV using Sentinel-2 (S2) satellite imagery.

This presentation provides an update on the development of the IAV monitoring system from a research prototype toward operational deployment. We will summarize recent advances in S2 mapping of IAV and other related cover classes, including the development of monthly, Delta-wide vegetation maps spanning 2017 to the present. These products provide consistent, 10m resolution observations of aquatic vegetation dynamics across seasons and years and are designed to support management applications.

Funded by NASA, with co-investment from CA Department of Water Resources, the Delta Stewardship Council, and the CA Department of Fish and Wildlife, a central focus of this effort is the co-development process with end-users and decision makers from the respective state agencies. We will share outcomes from recent workshops, surveys designed to identify management priorities, evaluate product usability, establish performance metrics, and guide future mapping developments. Feedback from participants has informed improvements to map products, uncertainty reporting, and pathways for integrating Earth observation products into existing monitoring and management workflows.

This project demonstrates how sustained collaboration between scientists and resource managers can accelerate the operational adoption of Earth observations and support adaptive management of California's most important estuarine ecosystem.

For more information, see <https://sciencetracker.deltacouncil.ca.gov/node/54477>

Speaker: Bailey Morrison, Department of Civil & Environmental Engineering, University of California, Merced

Co-authors: Shruti Khanna, California Department of Fish and Wildlife; Erin Hestir, Department of Civil & Environmental Engineering, University of California, Merced

Tracks: Invasive Species & Novel Ecosystems · Interdisciplinary Science & Cross-Knowledge Integration

Satellite Remote Sensing to Map Mercury in South San Francisco Bay



The San Francisco Bay Area has a long history of mercury pollution. During the California Gold Rush (1840s–1900s), mercury was mined extensively at the New Almaden Quicksilver mine in a watershed draining into south San Francisco Bay (SFB), burying mercury in bay sediments. Today, that mercury can be resuspended by wind or tidal water movement, and additional mercury enters the bay through surface runoff. This project aims to understand the drivers and spatial distributions of mercury in south SFB.

We used 10-meter Sentinel-2 satellite imagery and a map-building workflow we term the Mercury Mapping Assembly Process (HgMAP) to estimate total mercury (THg) and methylmercury (MeHg) concentrations in surface waters from 2022–2024, a period characterized by multiple extreme atmospheric rivers.

HgMAP models were developed using in situ surface water samples of THg, MeHg, total suspended sediments (TSS), colored dissolved organic matter (CDOM), and radiometry to tune remote sensing algorithms and constrain biogeochemical relationships as a function of salinity, temperature, TSS, and CDOM. Final HgMAP models combine Sentinel-2 imagery with real-time data from continuous monitoring sites.

The model outputs are maps of estimated THg ($R^2 = 0.49$, $nRMSE = 20\%$) and MeHg ($R^2 = 0.74$, $nRMSE = 12\%$) surface water concentrations. The resulting time series showed concentration increases following some atmospheric rivers, with drivers varying between runoff and wind-driven resuspension, potentially modulated by tidal influence. These results highlight the lasting environmental consequences of mercury and can inform managers in south SFB and other mercury-impacted systems on when and how elevated concentrations may arise.

Speaker: Niky Taylor, USGS Western Geographic Science Center

Co-authors: Kristin Byrd, USGS; Mark Marvin-DiPasquale, U.S. Geological Survey; Jacob Fleck, U.S. Geological Survey; Brian Bergamaschi, U.S. Geological Survey; Jennifer Agee, USGS; Emily T. Richardson, CA Department of Water Resources; Patrick Dellwo, USGS

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Water Quality, Contaminants, & Aquatic Health

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 57 · 5 PRESENTATIONS

Modeling and managing stressors: Contaminant exposure, invasive mussels, and herbicide persistence in the Delta



Speakers: Marisa Escobar, PhD; Lu Han, Contra Costa Water District; Matthew Taylor, University of California, Davis; Lily Tomkovic, California Department of Water Resources

System-Scale Evaluation of Invasive Mussel Infestation Risk Across Critical Water Infrastructure



The recent detection of golden mussels (*Limnoperna fortunei*) in California has heightened concerns regarding the vulnerability of interconnected water infrastructure to invasive aquatic species. While research exists on zebra and quagga mussels, relatively few studies have developed approaches for evaluating vulnerability to golden mussel invasion across water systems that integrate reservoirs, rivers, canals, tunnels, pipelines, pumping facilities, hydropower infrastructure, and operational interconnections.

This work develops a screening-level vulnerability assessment framework for evaluating invasive mussel risk across complex water infrastructure. It integrates three components: (1) habitat suitability assessments based on environmental conditions; (2) infrastructure susceptibility focused on facilities vulnerable to biofouling, operational disruptions, and maintenance impacts; and (3) introduction pathway analyses evaluating connectivity, water transfers, equipment movement, recreation, and other vectors.

Results from these assessments can be incorporated into an integrated vulnerability model ranking facilities, operational conditions, and pathways according to their relative susceptibility. The approach supports identification of high-risk assets, monitoring priorities, operational pinch points, and key data gaps. We will include preliminary findings from case study applications to illustrate how system connectivity, environmental conditions, and infrastructure characteristics interact to influence vulnerability across a water conveyance network.

The framework provides a useful decision-support tool for prioritizing monitoring, prevention, and future mitigation options. The methodology is applicable to water infrastructure throughout California, including systems connected to the Bay-Delta watershed. As invasive species threats continue, this work can help agencies allocate resources and improve infrastructure resilience while supporting adaptive management.

Speaker: Marisa Escobar, PhD

Co-authors: Marisa Escobar, Geosyntec Consultants; Christopher Adkison, Geosyntec Consultants; David Martin, Geosyntec Consultants; Mark Hanna, Geosyntec Consultants

Tracks: Systems Thinking for the Whole Ecosystem · Invasive Species & Novel Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System

When do Golden Mussels spawn in the Delta?

First detected in the Sacramento-San Joaquin Delta in October 2024, the invasive golden mussel (*Limnoperna fortunei*) is a high-priority biofouling threat to California's water infrastructure. While international literature identifies a spawning threshold of 16–17°C and our analysis of six decades of historical Delta temperature data (1959–2022) indicates that the region is thermally suitable for reproduction for approximately half of the year, actual phenology in this new habitat remains poorly understood.

Preliminary field observations from 2025 highlight this uncertainty: despite Delta temperatures reaching the 16°C threshold in early spring, no veligers were detected until late June, a 2-month gap.

This discrepancy suggests that temperature alone may be an insufficient predictor for spawning success in the Delta environment.

To address these gaps in Delta-specific knowledge, a collaborative research project was launched to track golden mussel reproductive cycles and the environmental triggers in the Delta near water diversion facilities. Field sampling began in late May 2026 to collect adult mussels and water quality data.

The initial phase of research focuses on assessing gonad ripeness through histology while monitoring water quality. We will present preliminary field and laboratory findings from this first sampling season and discuss how this information can be used to strengthen efforts to monitor, predict, and respond to this emerging threat.

Speaker: Lu Han, Contra Costa Water District

Co-authors: Grace Westphal, University of California, Berkeley; Daniel Okamoto, University of California, Berkeley; Lucinda Shih, Contra Costa Water District

Tracks: Invasive Species & Novel Ecosystems · Policy & Management Showcase

Evaluating Delta Smelt Early Developmental Exposure to Hydrophobic Organic Contaminant (HOC) Mixtures Detected in the Sacramento Deep Water Ship Channel



The California native Delta Smelt (*Hypomesus transpacificus*) is an endangered species endemic to the San Francisco Bay-Delta. The Bay-Delta is one of the most human-transformed estuaries in the world, with most of its modifications being in the service of the ever-increasing agricultural industry in California.

Not only has this resulted in loss of habitat for the Delta Smelt, but increasing agriculture also increases the use of pesticides in the region. The Sacramento Deep Water Ship Channel is a region of the Bay-Delta that has been listed as crucial habitat for the Delta Smelt life cycle due to being potential spawning grounds.

A recent study assessing this ecosystem detected harmful contaminants known as hydrophobic organic compounds (HOCs). This class of contaminants includes organochlorine pesticides and polycyclic aromatic hydrocarbons, which often enter ecosystems through runoff and direct deposition.

This study evaluated how environmentally-relevant aqueous HOC mixtures affect early life stage Delta Smelt. Three HOC mixtures were formulated based on concentrations previously reported from distinct exposure pathways: suspended solids, total extractable sediment, and bioaccessible sediment.

Delta Smelt embryos at 8 days post-fertilization were exposed for 96 hours, during which hatching occurred. Effects were assessed based on hatching success, survival, and sublethal neurobehavioral endpoints using automated locomotor activity assays to quantify contaminant-induced changes in swimming behavior under alternating light-dark cycles.

Data analysis is still ongoing; however, preliminary results based on 100x below environmentally relevant concentrations showed no impact on hatching or survival percentage, but did show significant sublethal effects on behavior across all mixtures, with the bioaccessible mixture having the most consistent effects.

Speaker: Matthew Taylor, University of California, Davis

Co-authors: Maxime Debources, University of California, Davis; Zoha Siddiqua, University of California, Davis; Kara Huff Hartz, Southern Illinois University; Michael Lydy, Southern Illinois University; Amelie Segarra, University of California, Davis

Track: Water Quality, Contaminants, & Aquatic Health

Models are Indeed Useful: Simulating Herbicide Persistence for Treatment of Invasive Submerged Aquatic Vegetation

Lookout Slough, a restored tidal wetland near the Yolo Bypass, was restored in September 2024 through the construction of tidal channels connecting to floodplain habitat. Following hydraulic reconnection, invasive submersed aquatic vegetation (SAV) rapidly colonized the channels, posing a potential threat to restoration objectives by displacing native vegetation, trapping sediment, and altering aquatic food web dynamics.

Herbicides are the primary tool used for SAV management in the San Francisco Estuary, but it is unknown if they will be effective in this tidally influenced site. The objective of this study was to evaluate how the hydrodynamics of the Lookout Slough restoration site influence herbicide concentrations, and to develop a modeling framework to inform treatment timing and locations to improve herbicide efficacy.

This study focused on a simulated use pattern for the contact herbicide diquat, which is applied directly to the water column and is most effective when target concentrations are maintained for 6 to 12 hours. To investigate herbicide transport and retention, the three-dimensional hydrodynamic model Bay-Delta SCHISM was refined within Lookout Slough to better represent site-specific hydraulic conditions. In October 2025, a pilot rhodamine dye study was conducted within a side channel of one of the restoration site's main sloughs to characterize constituent transport with observed field data.

Comparison of observed dye concentrations with simulated tracer results demonstrated that the model successfully reproduced the transport and retention patterns observed during the field study. This agreement supports the use of the model as a tool for evaluating how alternative herbicide application strategies influence treatment efficacy and for estimating herbicide dispersion beyond targeted treatment areas.

The results demonstrate the value of hydrodynamic modeling as a decision-support tool for aquatic vegetation management in tidal restoration systems.

Speaker: Lily Tomkovic, California Department of Water Resources

Co-authors: Nick Rasmussen, CA DWR DISE; David Colvin, CA DWR SWPAO; Jens Beets, USDA REE-ARS; Brian Armstrong, CA DWR DISE; Jeff Caudil, CA DBW; Gina Darin, California Department of Water Resources; Louise Conrad, California Department of Water Resources

Tracks: Invasive Species & Novel Ecosystems · Finding Collaborative Solutions · Interdisciplinary Science & Cross-Knowledge Integration

Evaluating Organic Carbon and Alkalinity Behavior in the Sacramento-San Joaquin Delta (1990-2025)



Concentrations of total/dissolved organic carbon (TOC/DOC) and alkalinity impact the treatability of water diverted from the Sacramento-San Joaquin Delta. The co-occurrence of high TOC and low alkalinity challenges water treatment operations due to reduced buffering capacity for organic coagulation. Furthermore, drinking water regulations require greater fractional removal of TOC from raw water with increasing TOC and decreasing alkalinity. Understanding trends in these constituents is essential to managing this critical drinking water source. In this work, we analyze long-term and seasonal trends for these important Delta constituents during a 36-year period that experienced several interesting hydrologic events, including extreme multi-year droughts and intervals of intense rainfall and river flows.

We use both discrete laboratory-analyzed samples and continuous monitoring data from the Municipal Water Quality Investigations (MWQI) program and other sources to construct an observed time series spanning 1990 to present for organic carbon and alkalinity. We developed a historical DOC scenario and established an alkalinity scenario (using surrogate relationships with specific conductance) to define model boundary conditions for California Department of Water Resources' Delta Simulation Model II (DSM2). We validated the model's ability to match observations at key locations and supplemented our analysis of trends of organic carbon and alkalinity, in particular the occurrence of challenging high-DOC, low-alkalinity conditions, with model results. We found evidence of subtle but significant trends in both organic carbon and alkalinity that vary by season, hydrological conditions, and location. Fingerprinting simulation results suggest that the co-occurrence of high DOC and low alkalinity often results during periods of high San Joaquin River flow when water quality in the interior Delta is dominated by loads entering the Delta at Vernalis.

Speaker: John Rath, Tetra Tech

Co-authors: Sujoy Roy, Tetra Tech Inc.; Paul Hutton, DWR; Leslie Palencia, Consultant to State Water Contractors

Track: Water Quality, Contaminants, & Aquatic Health

WEDNESDAY, SEPTEMBER 30, 2026 - SESSION 58 · 3 PRESENTATIONS

Ecosystem health across scales: From watershed transformation to nutritional stress in fish



Advancing River Dechannelization in Urban Watersheds: Lessons from the Sepulveda Basin Vision Plan

In 2024, the City of Los Angeles Bureau of Engineering (BOE), in partnership with the City of Los Angeles Department of Recreation and Parks (RAP) and the Mountains Recreation Conservation Authority (MRCA), completed the Sepulveda Basin Vision Plan. The Vision Plan process included community engagement to determine goals for the future of the basin. A primary goal is to naturalize the LA River and the tributaries within the basin, returning the system to a more naturally functioning condition rather than the incised channels that exist today. These efforts are expected to increase flood storage capacity, reduce erosion, enhance habitat, and increase environmental, cultural, and recreational opportunities for communities.

Following the Vision Plan, the City and its partners moved forward with technical studies that provide the information required to advance design, permitting, and construction for several projects focused on river naturalization.

The technical studies include hydrology and hydraulics, geomorphology, ecology, circulation and access, recreation modernization, permitting, and operations and maintenance evaluations.

Hydrology was advanced by leveraging the USACE HEC-HMS model and using smaller watershed delineations for the main stem and tributaries. The refined hydrology was applied to a two-dimensional hydraulic model to evaluate channel landforms through aspects such as inundation, velocity, shear stress, and geomorphic response under existing and proposed conditions. The project also evaluated existing constraints common to the urban ecological interface.

The technical studies demonstrate that significant opportunities exist to advance river and tributary dechannelization while enhancing flood management and considering infrastructure constraints. The analyses identified opportunities to increase flood storage capacity, reduce channel erosion, improve habitat connectivity and biodiversity, and expand environmental and recreational benefits.

Speaker: Mark Hanna, Geosyntec Consultants

Co-authors: Marisa Escobar, Geosyntec Consultants; Al Preston, Geosyntec Consultants; Jessica Henson, Olin Studio

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System

Restoring for Recovery – Early Implementation Progress towards Achieving Healthy Rivers and Landscapes Program Habitat Commitments on the Lower American River



Proposed Session: HR&L session organized by Louise Conrad, pending space

In order to improve the ecological health of the Sacramento-San Joaquin Delta, the Healthy Rivers and Landscapes Program (HRLP) has proposed, among other elements, a combination of flow and non-flow actions within tributaries to the Delta. For the American River, HRLP participants pledged to restore 25 acres of spawning habitat and 75 acres of instream rearing habitat for salmonids. Since 2019, the Sacramento Water Forum in collaboration with local, state and federal partners has successfully designed, permitted, implemented and monitored six Early Implementation Projects in the lower American River that contribute to the HRLP commitments.

Project features include the enhancement and/or creation of spawning riffles, side channels, seasonally inundated benches, planting of riparian vegetation, and the placement of large woody material. The ecohydraulic design process used includes comprehensive bathymetric and topographic surveys, hydraulic surveys/measurements, vegetation and substrate mapping and development of two-dimensional hydraulic and habitat suitability models. Extensive post-project physical and biological monitoring has occurred at these sites, which has documented the utilization of the restored sites by salmonids at various life stages in a variety of hydrologic conditions (i.e., critically dry through wet years), as well as the rate of degradation or evolution of the restored habitats. These post-project monitoring data have been used to enhance the design process and project complexity in subsequent projects. The projects have substantially contributed to the limited amount of suitable salmonid habitat in the lower American River. This presentation will provide an overview of the completed Early Implementation Projects highlighting aspects of the design process and both physical and biological monitoring results.

Speaker: [Chris Hammersmark](#), Verdantas

Co-authors: [Kirsten Sellheim](#), Cramer Fish Sciences; [Erica Bishop](#), Sacramento Water Forum

Tracks: Nature-Based Solutions & Landscape Resilience · Managing Competing Demands for Water

Archival Tissues Identify Trophic Narrowing of Marine Foodwebs Preceding Nutrient Deficiencies in California Chinook Salmon



In 2020, California Central Valley Chinook salmon were found to be affected by thiamine deficiency complex (TDC), a nutritional disorder associated with insufficient vitamin B₁. The emergence of TDC coincided with marine food-web restructuring following the 2014–2016 northeast Pacific marine heatwave. Although marine diet shifts have been proposed as a cause of TDC, it is unknown whether measurable changes in marine feeding ecology preceded its detection in 2020. To reconstruct historical marine feeding patterns, we used carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) stable isotope analysis of 996 archived scales from fall, winter, and spring run Chinook salmon from 2013–2023. Because scales retain a chemical record of marine feeding history, they provide a retrospective view of dietary diversity through time. Dietary diversity was quantified using Bayesian standard ellipse area (SEAB) and within-cohort $\delta^{15}\text{N}$ standard deviation.

Dietary niches contracted prior to and during the documented TDC period across all three runs, indicating a narrowing of the marine prey base. Winter run, the run most affected by thiamine deficiency, showed the earliest and most severe contraction, with isotopic niche size declining by 87% between 2016 and 2021. Comparisons between pre-TDC and TDC years showed average niche reductions of 49% in winter run, 37% in fall run, and 26% in spring run. Trophic variability (SD of $\delta^{15}\text{N}$), a measure of how broadly fish fed across different levels of the food web, was more strongly associated with egg thiamine concentration than overall niche size (SEAB) and explained approximately twice as much variation in egg thiamine. Importantly, isotopic niche contraction preceded the first documented occurrence of TDC, indicating that archived scales could have provided advance warning of population-level vulnerability. The simultaneous contraction of dietary niches across three genetically and ecologically distinct Chinook salmon runs suggests ecosystem-scale restructuring of the California Current prey community.

Speakers: [Alexandra Chu](#), University of California, Davis; [Miranda Lowe-Webb](#); [Bruce Finney](#); [Rachel Johnson](#), NOAA Fisheries, Southwest Fisheries Science Center and UC Davis, Center for Watershed Sciences; [Carson Jeffres](#), University of California, Davis

Track: Ecology, Food Webs, & Changing Ecosystems



Realizing the opportunity for hypothesis-centered science: The Healthy Rivers and Landscapes Science Program (Part 2)

The Healthy Rivers and Landscapes (HRL) Program commits 155 – 825 thousand acre-feet (TAF) of spring-season flows and over 30,000 acres of restored habitat across the Sacramento-San Joaquin Delta watershed and is under consideration for inclusion in the updated Bay-Delta Water Quality Control Plan.

HRL includes a comprehensive science program, guided by a Science Committee, that ensures strategic research and monitoring across the watershed to evaluate outcomes to native fish from flow and habitat actions. The Science Committee developed the HRL Science Plan, which provides a suite of hypotheses structured in tiers to progressively address local-scale (i.e. project-level) outcomes, tributary and Delta-scale hypotheses on flow provisions, and system-scale hypotheses on population-level trends.

The Science Plan was independently peer reviewed in 2025, prompting substantive improvements in the monitoring design framework for understanding biological effectiveness of restoration projects, power analyses to guide sampling design and intensity, and in how to address difficult questions such as estimating program impact on natural production of Central Valley Chinook salmon within a mixed population of hatchery-origin (marked and unmarked) fish.

This 2-block session will describe the framework for conducting hypothesis-centered science at a watershed scale. Presentations will provide examples of HRL science activities from each hypothesis tier for habitat restoration, environmental flows, and approaches for capturing population-scale impacts. Across agencies, academia, and non-governmental organizations, a long-held vision has been that science activities with similar purpose align their approaches to scale individual research and monitoring projects to system-scale information that is relevant to system-scale decisions.

The HRL Science Program is one approach to achieving this vision in a way that is responsive to decision-maker needs.

Session Chairs: Louise Conrad, California Department of Water Resources; Pascale Goertler, Department of Water Resources; Brian Crawford, Compass Resource Management

Tracks: Nature-Based Solutions & Landscape Resilience · Systems Thinking for the Whole Ecosystem · Decision Science & Adaptive Mindsets in a Dynamic System

From Flow Accounting to Adaptive Pulse Flow Science: Integrating Operations, Planning, and Evaluation to Maximize Ecological Benefit

Healthy Rivers and Landscapes (HRL) is designed to deliver environmental flows through a coordinated, multi-agency framework that must be both operationally feasible and scientifically rigorous. In 2025 and 2026, state and local agencies completed dry-run exercises that simulated the planning, coordination, and accounting processes required to deploy and protect environmental water under real-time conditions.

These exercises simulated the deployment of more than 600 thousand acre-feet of environmental water from over 10 sources and tested procedures for defining reference flows, quantifying incremental HRL flows, and tracking upstream releases through the Delta as additional outflow.

This presentation will describe how HRL conducted and is now building on those dry runs to develop an integrated model for flow planning, deployment, and evaluation.

This next phase is linking operational decisions with best-available science so that pulse flows are not only accounted for transparently, but also designed and evaluated as hypothesis-driven adaptive management actions.

This includes developing coordination pathways for flow operators and scientists to work together; identifying decision points where scientific information can inform pulse timing, magnitude, duration, and rates of change within regulatory and operational constraints; and designing monitoring approaches that can detect ecological responses.

To provide a concrete example, we will discuss study-design considerations for evaluating tributary pulse-flow hypotheses, including the use of a power analysis to determine tagging release group sizes; before, during, and after pulse comparisons; and criteria for distinguishing managed pulse flows from natural events.

Together, these efforts illustrate how HRL can evolve from demonstrating that environmental flows can be planned, accounted for, and protected, to demonstrating how those flows can be adaptively deployed to maximize ecological benefit.

Speaker: Lucy Andrews, California Department of Water Resources

Co-authors: Aaron Miller, California Department of Water Resources

Tracks: Systems Thinking for the Whole Ecosystem · Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System

Using Pulse Flows to Reduce *C. shasta* Spore Concentration and Infection Rates in Juvenile Chinook Salmon.

Session Title:

Realizing the Opportunity for Hypothesis-Centered Science: The Healthy Rivers and Landscapes Science Program

Abstract:

Ceratomyxa shasta is a devastating myxozoan parasite found in California watersheds that causes severe enteritis and high mortality in juvenile Chinook salmon.

On regulated river systems, pulse flows are an important management tool that can be strategically deployed to dilute spore concentration and reduce infection rates among juvenile salmon, thus improving their survival as they migrate downstream.

The Healthy Rivers and Landscapes (HR&L) Science Plan provides a set of hypotheses to evaluate the effectiveness of pulse flows in tributaries to improve migration and survival of Chinook salmon. Hypothesis TribFlow specifically addresses the potential of pulse flows to reduce the impact of pathogens on juvenile Chinook salmon.

Using existing data from monitoring on the Klamath River and Feather River, we will discuss the effectiveness of pulse flows at reducing the impact of *C. shasta* and how that informed the proposed methodology provided in the HR&L plan.

Speaker: Ryon Kurth, Department of Water Resources

Co-authors: Nicholas Som, California Polytechnical Institute, Humboldt

Track: Decision Science & Adaptive Mindsets in a Dynamic System

How Much Trap-Efficiency Monitoring Is Enough? Evaluating Monitoring Standards for Juvenile Salmonid Production Estimates in California Central Valley Tributaries.

Reliable estimates of juvenile salmonid production are essential for evaluating the effectiveness of flow and habitat restoration actions implemented through the Healthy Rivers and Landscapes Program. Rotary screw traps (RSTs) are widely used throughout California's Central Valley tributaries to estimate juvenile abundance during outmigration, but variation in efficiency monitoring protocols among watersheds can limit the comparability and precision of production estimates.

As coordinated monitoring expands across tributaries, understanding the factors that influence trap efficiency and the sampling effort required to characterize those factors is critical for developing consistent monitoring standards. We analyzed more than 15 years of RST efficiency-trial data collected on the Mokelumne River to evaluate environmental conditions and trap dynamics influencing capture efficiency.

Candidate models incorporating hydrologic conditions, seasonal timing, fish characteristics, and trap performance metrics were evaluated using an information-theoretic framework (i.e., AICc).

We then systematically reduced the frequency and richness of efficiency-trial data to evaluate how alternative monitoring strategies affect efficiency estimates, uncertainty, model selection, and identification of key drivers of trap performance. By quantifying the tradeoffs between monitoring effort and efficiency estimation performance, this study provides an empirical basis for defining minimum and gold-standard monitoring requirements for RST programs.

Further, results from this study will support the development of consistent monitoring protocols across tributaries and improve the ability of the Healthy Rivers and Landscapes Program to evaluate biological responses to flow and habitat actions throughout the California Central Valley.

Speaker: Michael Beakes, Environmental Protection Agency

Co-authors: Joshua Meko, East Bay Municipal Utility District; James Pearson, East Bay Municipal Utility District; Casey Del Real, East Bay Municipal Utility District

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Managing Competing Demands for Water



From Sacramento River to the Central Valley: How fish archival tissues guide HRL tributary sampling design

Understanding population scale response to changes in management and restoration requires linking early life habitat use to returning adult populations. Under the Healthy Rivers and Landscapes (HRL) Science Plan, hypothesis HTribPop1 aims to evaluate whether increased juvenile use of off-channel habitat and associated food resources are reflected in returning natural origin Chinook salmon populations across Central Valley tributaries.

Quantification at the tributary level can be challenging because adult carcass collections in one tributary may yield limited numbers of true natal-origin individuals due to hatchery influence and strays. In addition, some major off-channel systems, such as the Yolo Bypass, operate at a broader basin scale. These challenges call for a systemwide framework that can account for these factors, while still informing tributary level sampling targets for implementation.

The mainstem Sacramento River is a useful case study for evaluating the relationship between juvenile habitat use and adult return success, as archival tissues collected during adult carcass surveys preserve information on early-life habitat use. The mainstem Sacramento River also produces the greatest abundance of natural-origin fish that support the fishery. To trace juvenile life histories, we combined otolith geochemical analysis to identify adults originating from the Sacramento River with stable isotope analyses of eye lens to assess whether individuals used off-channel habitats during their juvenile rearing and outmigration.

Using these records from adult Sacramento River fall-run Chinook salmon from the 2016, 2017 and 2021 outmigration cohorts, we performed power analysis to estimate the sampling effort needed to detect similar off-channel signals from returning adults.

This work provides guidance for other HRL tributaries to develop science plans for tracking habitat restoration outcomes through archival tissue collections, building on existing monitoring programs.

Speaker: Carson Jeffres, University of California, Davis

Co-authors: Danhong Ally Li, University of California Davis; Kohma Arai, Center for Watershed Sciences, UC Davis / Japan Fisheries Research and Education Agency; Miranda Bell Tilcock, UC Davis Center for Watershed Sciences; George Whitman, Center for Watershed Sciences, UC Davis; Rachael Ryan, University of California Davis; Alexandra Chu, University of California, Davis; Rachel C. Johnson, Center for Watershed Sciences, UC Davis / Southwest Fisheries Science Center, NOAA

Tracks: Ecology, Food Webs, & Changing Ecosystems · Decision Science & Adaptive Mindsets in a Dynamic System · Interdisciplinary Science & Cross-Knowledge Integration



Parentage-based tagging to estimate abundance of adult, natural origin fall-run Chinook salmon

The number of adults produced by in-river spawning salmon (natural origin) is critical data for assessing system-wide benefits of the HRL program. In many Central Valley (CV) rivers, the population of NO salmon is small relative to hatchery origin (HO) adults. In these circumstances, marking and coded-wire-tagging 25% of hatchery produced juveniles provides insufficient precision to detect changes in NO abundance.

The use of parentage-based-tagging (PBT) in CV hatcheries was initiated to help evaluate the effectiveness of early season fry releases. However, a fully implemented PBT program-- where all hatchery broodstock are genotyped and where tissue samples are routinely collected from adult salmon— greatly improves the accuracy and cost-effectiveness of estimating the abundance of NO salmon.

In a tributary, a precise NO abundance estimate (e.g. $\pm 15\%$) can be achieved by analyzing as few as 500 tissue samples collected from unmarked salmon. Genotyping in-river spawning salmon provides additional benefits. Juveniles encountered in outmigrant monitoring can be linked to their parents, allowing for reproductive success comparison based on spawning habitat utilized, spawn timing, and parental attributes (size, origin).

Genotyping will also allow ocean harvest impacts on CV NO salmon to be estimated directly—critical for HRL performance metrics like pre-fishing Cohort Replacement Rate. A PBT Technical Working Group was convened to help develop marking, tagging and sampling designs necessary to support HRL evaluation along with broader California Chinook salmon conservation and management information needs.

Speaker: Brad Cavallo

Track: Managing Competing Demands for Water

Cleaner waters and broader benefits: Lessons from the convergence of physical, biological, and chemical restoration



Is our current approach to protecting listed fish in the Bay-Delta leaving ecosystem benefits on the table?

We know from research in the Bay-Delta and watersheds that contaminants are part of fish habitat and are present at levels that are harmful to aquatic life. However, much of that research has been done in silos, often with researchers studying one contaminant at a time. While this can be effective in reducing the presence of specific contaminants, new chemicals are developed faster than the corresponding research, and we are playing a losing game.

To achieve more holistic contaminant management with ecosystem-wide benefits, we need an integration of water quality and ecosystem protection. This session will highlight research and conversations that we hope will be the essential building blocks of that new framework.

With the goal of advancing a more integrated approach toward co-managing contaminants for broader ecosystem benefits, this session will highlight insights and lessons from both traditional and integrated contaminant management practices, such as those used by practitioners of green infrastructure, urban planning, and organic farming.

Session Chair: Darcy Austin, State Water Contractors (SWC)

Track: Water Quality, Contaminants, & Aquatic Health

Ecosystem management in a polluted world

The Bay-Delta has been managed for centuries for a variety of ecosystem services such as fishing, agriculture, and recreation. These and other services have been under threat by a rapidly changing environment of contaminants but despite recognizing the importance of contaminant effects in the Bay-Delta, the management of contaminants has many limits. A recent symposium Cleaner Waters and Broader Benefits held June 23, 2026, showcased how various ecosystem and contaminant researchers and managers have tried to reduce those limits and developed methods to prevent and/or reduce contaminant effects and improve the ecosystem. Efforts to be better stewards of the Bay-Delta have led to investments in green infrastructure, organic farming, the use of advanced risk assessments tools, and advanced laboratory and modeling methods.

Speaker: Shawn Acuna, Metropolitan Water District of Southern California

Co-authors: Shawn Acuña, Metropolitan Water District of Southern California; Darcy Austin, State Water Contractors (SWC); Tracy Collier, NOAA Fisheries (retired); Stephanie Fong, CA Department of Fish and Wildlife; Nat Scholz, NOAA Fisheries (retired)

Restoring urban water quality through integrated monitoring and mitigation of urban runoff



Urban runoff continues to serve as a major transport pathway for insecticides into California's surface waters, underscoring the need for long-term monitoring and adaptive mitigation. More than a decade of data from the California Department of Pesticide Regulation's (DPR) Surface Water Protection Program (SWPP), are presented, showing observed patterns in pyrethroid and fipronil contamination across urban monitoring sites statewide. Both classes of insecticides were detected frequently in storm drains and receiving waters, with seasonal and regional trends indicating elevated detections during storm events and in highly urbanized areas.

To address aquatic risks, DPR implemented statewide pyrethroid regulations, enacted in 2012, restricting applications on impervious surfaces by professional applicators. Additional product-specific actions, such as the bifenthrin Memorandum of Agreement, further limit high-risk uses on horizontal and vertical impervious surfaces.

For fipronil, collaborative studies conducted with USEPA, University of California researchers, registrants, and pest control professionals demonstrated that restricted application practices substantially reduced runoff while maintaining effective pest management. These results informed fipronil label changes for outdoor structural uses that reached the market in 2018.

Complementing regulatory efforts, DPR engages both professional applicators and residents through outreach on Integrated Pest Management (IPM) and proper pesticide stewardship. Residential survey data show broad variation in pesticide use practices, reinforcing the need for continued public education and accurate pesticide use reporting. Overall, this work highlights the importance of sustained monitoring, targeted mitigation, and community outreach in reducing pesticide loading in urban waterways and safeguarding aquatic ecosystems.

Speaker: Marie Garcia

The challenge of toxic runoff for river restoration projects emphasizing fish passage: the tire chemical 6PPD-quinone as a case example

Non-point source pollution has long been a foremost challenge to aquatic habitat conservation throughout the United States. For example, development transforms natural landscapes into pavement and other impervious surfaces, increasing stormwater runoff and driving biological decline in urban watersheds. While the physical and biological aspects of this urban stream syndrome have been studied for decades, the role of chemical contaminants remains highly uncertain. This presentation will consider the influence of the transportation grid, and specifically motor vehicles, on chemical habitat quality in urban river networks.

Ongoing habitat restoration efforts to recover threatened Pacific salmon and steelhead (*Oncorhynchus* spp.) in the western U.S. have historically prioritized the removal of migration barriers to allow access to upstream spawning and rearing sites. However, in the Pacific Northwest, coho salmon returning to restored urban watersheds have experienced unsustainable rates of adult spawner mortality, attributable to a novel and highly toxic contaminant (6PPD-quinone) derived from vehicle tires. Recent advances in analytical chemistry are revealing the full chemical dimension of freshwater and estuarine habitats, which scale in complexity across gradients of urban/suburban/exurban land use. Going forward, clean water strategies will be essential for effective restoration. Such strategies include, for example, landscape-scale vulnerability mapping, chemical source control, green stormwater infrastructure, and expanded chemical and biological monitoring for project effectiveness.

Speaker: Nathaniel Scholz



Multi-benefit contaminant solutions for the Bay-Delta

Contaminants, in combination with other stressors, challenge Bay-Delta ecosystem health, and addressing them is essential to restoration. Multi-benefit contaminant solutions exist at both local and region-wide scales. For example, integrating contaminant considerations into urban runoff and agricultural drainage designs leads to installation of multi-benefit systems capable of addressing a broad range of stressors, including contaminants like pesticides and the tire-derived chemical 6PPD-quinone.

Looking upstream to contaminant true sources, California has unique, powerful new chemicals management programs within Cal-EPA that provide tremendous capacity for development of multi-benefit sustainable solutions for contaminants in the Bay-Delta. California's pesticide regulators now have the mission to work with state and external partners to foster Sustainable Pest Management in both urban and agricultural contexts, thus stepping away from the multi-decade pesticide treadmill that has challenged ecosystems since the days of DDT. For non-pesticide contaminants, California's Safer Consumer Products regulatory program has broad authorities to require shifts to safer, feasible alternative chemicals. It has already initiated efforts toward shifting to safer substitutes for multiple water contaminants, including tire additives and PFAS. Obtaining current contaminant monitoring data and providing coordinated input to these existing state programs would create major benefits for Bay-Delta ecosystem.

Speaker: Kelly Moran