Poster Abstracts

2024 Bay-Delta Science Conference

Abstracts for poster sessions presented at the 2024 Bay-Delta Science Conference are compiled in this document. Abstracts are listed in the order that they appear in the program. Asterisks (*) indicate the presenter is competing in the student presentation awards competition.

Contents

Poster Presentations

Applied Sciences & Adaptive Management

1-Delta Integrated Modeling Framework and Collaboratory

Ben Geske, DSC

In large social-ecological systems such as the Sacramento-San Joaquin Delta (Delta), the need for advanced modeling capabilities spans disciplines and agencies, and models underpin complex legal frameworks for resource management. The Delta Science Program aims to catalyze the implementation of a collaborative and integrated modeling framework for the Bay-Delta region that supports initiatives with public agency, academic, private sector, and community participants, harnessing the resources we currently have on hand and strategizing for future, ambitious goals. Central to this goal is the establishment of a "Delta Modeling Collaboratory" formed around a common set of tools, best practices, and human resources. Focused working groups will be organized within the structure of the Collaboratory to advance modeling initiatives focused on specific topics. The Collaboratory and its overarching framework will be guided by an inclusive governance structure that reflects necessary participation and support from agency, research, and community partners. Ultimately, the goal of this integrated modeling framework is to establish and implement transparent, trustable, efficient, and effective decision support processes in the Delta.

2-Delta Science Tracker: Fostering Collaboration and Transparency in the Sacramento-San Joaquin Delta Science Community

George Isaac, DSC

The Sacramento-San Joaquin Delta, a critical and complex ecosystem, hosts a multitude of scientific endeavors conducted by a diverse number of entities, including government agencies, academic institutions, non-governmental organizations, and private research groups. Despite concerted efforts, a standardized inventory for tracking science activities has been notably absent, which has limited accountability and impeded opportunities for collaboration and coordination. To address this gap, the Delta Science Program developed the Delta Science Tracker, a publicly accessible website intended to centralize comprehensive information about science activities across the Delta landscape, providing an important resource for researchers, managers, decision-makers, and the public alike. Users are able to explore and visualize recent research and monitoring efforts through the lenses of science activities, organizations leading or funding the activities, and the people involved in them. The Delta Science Tracker's primary objective is to improve communication and connectivity within the Delta science community, but it also provides open access to a wide range of information about the research and monitoring activities being undertaken in the system. For example, users can explore funding streams, access products and outputs of activities, and view visualizations summarizing implementation of activities aligned with the Science Action Agenda. In line with the Delta Science Plan's visionary concept of 'One Delta, One Science,' the Delta Science Tracker embodies a shared commitment to building a collective body of scientific knowledge.

3-The State of Bay-Delta Science: Extreme climatic and weather events affecting the San Francisco Estuary and its watershed

Denise Colombano, DSC

The State of Bay-Delta Science (*SBDS*) is a synthesis and communication effort intended to inform science and policy audiences about the state of science in the Bay-Delta system. As a key element in the overall Delta Science Strategy, which also includes the Delta Science Plan and Science Action Agenda, the specific goals of *SBDS* are to synthesize the state of science conducted on topics of high management concern, communicate information appropriately and effectively to various Delta stakeholders, and foster a deeper connection between science conducted in the Delta and policy or management decisions. Currently underway is an issue focusing on extreme climatic and weather events affecting the San Francisco Estuary and its watershed, with individual chapters exploring our current understanding of heatwaves, droughts, atmospheric rivers, wildfires, and governance. This poster will provide an opportunity for interaction and feedback on the edition currently underway as well as for potential future topics, themes, and communication venues to explore through *SBDS.*

4-Monitoring in the Estuary: Bay-Delta Connections for Wetland Management

Hannah Kempf, SF Estuary Partnership, hannah.kempf@sfestuary.org

The San Francisco Estuary provides innumerable benefits to people and wildlife alike. The Estuary is often managed as two geographically separate regions: the “lower estuary” (the Bay) and “upper estuary” (the Delta). Wetlands throughout the San Francisco Estuary support and protect a wide variety of plant, animal and human communities. However, since European colonization the San Francisco Estuary has lost over 90% of its historical tidal wetlands. The remaining marshes continue to face numerous, compounding threats including drought, decreased sediment loads, invasive species, excessive nutrients, harmful algal blooms, urban development, climate change, and sea level rise. Monitoring the indicators that relate to these threats is critical for effective adaptive management. Currently, many different entities conduct a patchwork of environmental monitoring activities throughout the Estuary. These monitoring activities collect data at different spatial and temporal scales, and often lack standardized methodologies, making it difficult for scientists and managers interested in whole-estuary studies to synthesize all relevant data and adapt to climate change with a regional perspective. Greater coordination between the monitoring enterprises in the lower and upper estuary may yield more effective long-term management outcomes. Here, we 1) summarize monitoring activities and interests of wetlands and wetland-dependent species in the lower and upper estuary, and 2) identify where monitoring in the Bay could be used for adaptive management in the Delta, and vice versa.

5-Designing Habitat Projects to Benefit Birds and Salmon

Cliff Feldmein, Ducks Unlimited, cfeldheim@ducks.org

In San Joaquin Valley, at the China Island Unit of the North Grasslands Wildlife Area, Ducks Unlimited is working with its partners, CDFW, California Trout, MBK, and Valley Eco to design a 1,300-acre managed floodplain habitat project. Building on the floodplain food production research by California Trout and UC Davis in the Sacramento Valley and Delta, we are designing elevations that allow for the San Joaquin River to flood overland, capturing water to allow for increased residence times, and using adjacent managed wetlands to allow wetland managers to grow aquatic invertebrates and have them delivered into the floodplain and into the River during periods when out-migrating juvenile salmon are present. Providing out-migrating juvenile salmon food upstream of the Delta should result in bigger stronger juvenile salmon reaching the Delta, increasing their survival through the Delta and increasing their return rate. The goal of this project is to design habitat improvements that can increase the survival of out-migrating juvenile salmon and improve wintering, breeding, and migratory bird habitat while recognizing that different water years will produce different species management actions but ensuring that "the table is set" such that when conditions are right for a target species (the target species may vary based on water year type), the target species can take full advantage of the conditions. In addition to improving the survival of out-migrating salmon, this work will result in helping meet the habitat goals identified in the Central Valley Joint Venture Implementation Plan for 10 riparian landbird species, wintering and migratory shorebirds and waterfowl, as well as breeding ducks, while also reducing the risk of flooding downstream of the project.

6-Brood Year Assessments of Sacramento River Winter-Run Chinook Salmon (Oncorhynchus tshawytscha) to Inform Water Management in a Changing Environment.

Emma Nordlund, Anchor QEA, enordlund@anchorqea.com

Brood year (BY) assessments of the endangered Sacramento River winter-run Chinook Salmon (WRCS) are needed to inform how management actions support the productivity of WRCS under changing environmental conditions. The assessments are conducted by compiling publicly available environmental, habitat, and biological data with a focus on freshwater life stages. The Salmon Assessment of Indicators by Life Stage conceptual models provide a framework to assess the relative success of each BY by providing life-stage-specific hypotheses on how fish responses are influenced by environmental and habitat conditions that are controlled in part by water management operations. The performance of each BY is summarized using a semi-quantitative rubric that rates the status of fish responses and environmental conditions compared with historical data (i.e., the 10-year or 20-year average), or when data are limited, with available scientific literature. To improve communication, the rubric-based performance of each BY is summarized visually using a color-coded "stoplight" table that rates the status of fish responses, habitat attributes, and environmental drivers over multiple BYs. Assessments for BYs 2019, 2020, and 2021 (in progress) reflect performance of WRCS following and during severe drought conditions that occurred from 2013 to 2015 and from 2020 to 2022 and the emergency management actions taken in response. Notable trends over these three BYs include strong adult returns (from BYs 2016, 2017, and 2018) and declining freshwater conditions for juveniles due to drought, including increased incidence of parasite infection, reduced survival of eggs and fry from thiamine deficiency and other factors, and low survival for migrating juveniles in the middle Sacramento

River. By compiling data from myriad sources and highlighting trends over multiple BYs, these assessments help inform water management decisions for supporting the continued existence of WRCS in the Sacramento River and Delta.

7-Ecosystem Flux Partitioning in Tidal Wetlands: Analyzing Net Ecosystem Exchange and Evapotranspiration Through Artificial Neural Networks*

Eduardo Gamez Jr, CSU-Easy Bay, egamezjr@horizon.csueastbay.edu

Tidal wetlands are vital ecosystems providing wildlife habitat, mitigation of sea level, and carbon sequestration. Despite their importance, there are significant knowledge gaps regarding water and carbon budgets in these wetlands. Understanding transpiration and evaporation processes is crucial for effective tidal wetland management, as these processes contribute to environmental cooling and water use patterns. Additionally, studying carbon dynamics, including carbon sequestration and emissions through ecosystem respiration and gross primary productivity, is essential for assessing the role of tidal wetlands in global carbon cycles and climate change mitigation. This study utilizes a high-frequency continuous eddy covariance dataset (2018-2024) to explore fluxes in restored tidal wetlands at Eden Landing Ecological Reserve in South San Francisco Bay. By investigating both water and carbon fluxes, this research aims to enhance the understanding of tidal wetlands' ecological functions and support informed decision-making by wetland managers and policymakers. Improved management strategies based on these insights can enhance the effectiveness of wetland restoration projects, ensuring these ecosystems continue to provide critical services such as flood protection, water quality improvement, shoreline erosion control, and climate regulation. Our preliminary findings indicate that carbon dioxide and water exchange are dominated by transpiration and photosynthesis, respectively, during the growing season. Evaporation and respiration both represent smaller fractions of the water and carbon budgets. Our ongoing analyses investigate drivers of these fluxes as the wetland land cover changes over the years, specifically evolving from a mud-flat-dominated ecosystem to a vegetation-dominated one. Our findings highlight the potential of advanced technologies, such as artificial neural networks, to analyze ecosystem fluxes in greater detail. Integrating these technologies can provide deeper insights into the mechanisms driving ecosystem fluxes, ultimately contributing to more effective climate change mitigation and habitat restoration efforts.

8-Earth observations to combat invasive aquatic vegetation

Bailey Morrison, UC Merced, bmorrison3@ucmerced.edu

Over the past 15 years, submerged and floating invasive aquatic vegetation (IAV) have more than doubled in extent, threatening water supply, ecosystem health, and the co-equal goals in the Sacramento-San Joaquin Delta. There is mounting evidence that herbicide treatments are not effective, and that water management action and wetland restoration may be having huge impacts on IAV. A lack of consistent, long-term IAV monitoring has been identified as a major data gap by the Delta Stewardship Council (DSC) and the Delta Independent Science Board. The DSC previously invested in an explorative study to improve satellite-based remote sensing for IAV monitoring using Sentinel-2 (S2) data, which resulted in a nearly operational IAV mapping prototype. In conjunction with the DSC, CA Department of Fish and Wildlife, CA Department of Water Resources, and NASA's Applied Sciences Program, our team will build on the DSC's previous study to completely operationalize the production of S2 derived IAV maps. These maps will be used to improve existing IAV occupancy models and co-design IAV-based performance metrics and mapping tools with stakeholders to assess the impacts of past and future actions on IAV distributions. Monthly and seasonal estimates of submerged and floating aquatic vegetation coverage are expected to help state and federal agencies improve their performance metrics for better evaluation of the Delta Plan, better assess whether management is meeting the co-equal goals of the Delta, evaluate how management actions affect the spread and persistence of IAV in the Delta, and incorporate these findings into structured decision-making frameworks that account for the negative consequences of IAV. By using open science and a stakeholder-centered co-design process, this project will meet the information needs from multiple agencies and inform decision making that meets the co-equal goals, ultimately promoting a secure water future for California and ensuring conservation and restoration success.

9-Lamprey Passage Improvements to New and Existing Facilities in the Yolo Bypass

Zoltan Matica, DWR, zoltan.matica@water.ca.gov

Human development along waterways throughout California during the last 160 years have adversely affected fish populations in many watersheds. Most fish passage improvement efforts in California have focused largely on salmonids. For multispecies fish passage to be effective, conditions in fishways need to meet the specific hydraulic requirements, as well as the abilities, behavior, and size for all fish species being considered. The Pacific North American lamprey (*Entosphenus tridentatus*) is a State Species of Special Concern. Its populations are in decline, both in abundance and distribution [TG1] [ZM2] , and have been negatively affected by stream habitat degradation, water pollution, water diversions, water temperature increases, and migration impediments (Beamish 1980; Moyle et al. 2009). The California Department of Water Resources, as a signatory to the multiagency/multistate Pacific Lamprey Conservation Initiative, has recently incorporated lamprey passage elements into the development and design of the Yolo Bypass Salmonid Habitat Restoration and Fish Passage ("Big Notch") Project at Fremont Weir. These design criteria will help to inform design for future Department fish passage projects.

10-Promoting Independent Scientific Peer Review and Advice

Rachel Klopfenstein, DSC, rachael.klopfenstein@deltacouncil.ca.gov

The Delta Stewardship Council's Delta Science Program (DSP) is a leading coordinator of independent scientific peer review in the Sacramento-San Joaquin Delta (Delta). This function is provided as part of the DSP's mission to provide the best possible unbiased scientific information to inform water and environmental decision-making in the Delta. The DSP promotes and facilitates independent scientific reviews to evaluate complete or near complete processes, programs, plans, and products for a variety of topics. Since 2010, the DSP has coordinated 34 independent review and advice efforts. The DSP's peer review process uses independent scientific experts and established guidelines to ensure credible and legitimate science can be used by water and environmental decision-makers within the Delta. Reviewers respond to a set of questions (a "Charge") and produce a report posted on the DSP's peer review webpage. Most recent reviews focused on the Summer-Fall Habitat Action (SFHA) Monitoring and Science Plans and Structured Decision Making Approach for the Department of Water Resources and on the Fish and Aquatic Effects Analysis for Long-Term Operations for the Central Valley Project and State Water Project for the U.S. Bureau of Reclamation. This poster will highlight the DSP's robust and transparent process for administering peer reviews for complex science and management topics in the Delta and highlight key takeaways from recent peer reviews.

11-Development of Quantitative Tools to Forecast Larval and Post-Larval Longfin Smelt Entrainment Risk at Seasonal and Biweekly Scales

Kim Brewitt, ICF, kim.brewitt@icf.com

The abundance of longfin smelt (LFS) in the Bay-Delta remains severely depressed relative to historic records; the population is currently listed as threatened by the State of California, and it is a candidate for federal listing. Minimizing the impact of entrainment of all LFS life stages into the South Delta water export facilities is a key management action for the protection of the population. Quantitative models can help identify conditions associated with entrainment risk, and in the future these models may help to predict and minimize high-risk periods. However, development of such tools for larval LFS is challenged by a lack of reliable entrainment data. Water-diversion facilities are equipped with behavioral louvers intended to divert fish out of the flow and return them to the estuary (i.e. salvage), but salvage is not efficient for fish under 20mm and any that are incidentally captured are not enumerated. To overcome this challenge, we first compared post-larval LFS salvage (20mm) and larval trawl catches (20mm) in the South Delta and lower San Joaquin River at various time lags, and then developed separate models relating environmental and operational conditions with these two potential metrics of entrainment risk at survey (i.e. biweekly) and annual scales. At the annual level, entrainment risk is strongly predicted by spawner abundance and water year type. At the survey level, turbidity and water temperature were the strongest predictors of risk, while hydrologic conditions played a secondary but significant role. Although further validation and testing are needed, these results nevertheless

highlight the potential for quantitative risk forecasts to directly inform adaptive management of threatened and endangered species in the Bay-Delta.

12-Health and mortality effects of using a propeller fish pump to transport Delta Smelt

Yi-Jiun Tsai, UC Davis, yjtsai@ucdavis.edu

Recent conservation efforts to supplement endangered Delta Smelt into the wild have required a dramatic increase in the scale of production at the Fish Conservation and Culture Laboratory, thereby necessitating changes to regular rearing practices. For example, Delta Smelt are normally hand netted for transport, but this method is inefficient when moving thousands of fish. At other hatcheries, pumps are widely accepted and commonly-used for transporting large numbers of fish. However, the health and mortality effects of pumping on Delta Smelt, a relatively small, particularly sensitive, and imperiled species, are unknown and require examination before this practice can be implemented. We conducted a pilot study in which we evaluated the use of a propeller fish pump as an alternative to hand netting for transporting Delta Smelt. We found that mortality (assessed across 3 d) did not differ between pumping and netting and that the mortality rate for pumping appeared to decrease with increased operator experience. However, pumping resulted in more injuries (sampled after 24 h), a higher probability of being injured, and a higher severity of injury compared to netting and baseline (pre-experiment) conditions. Thus, Delta Smelt suffered negative health effects when subject to pumping, and this cost should be considered when determining whether to use propeller fish pumps for culture and supplementation purposes.

13-Living Pilings: Evaluating a novel approach to subtidal habitat restoration

Samantha Richman, USGS, srichman@usgs.gov

We are evaluating a novel approach to subtidal habitat restoration by repurposing creosote-treated timber pilings (CTPs) using a commercially available piling repair system. While removal of derelict CTP is preferred, there are some areas where removal is not feasible or practical. Where CTPs are ineligible for removal, encapsulating CTP may reduce or eliminate chemical leaching from creosote (polycyclic aromatic hydrocarbons, PAH) known to affect the growth and survival of marine organisms, provide a non-toxic surface for vital fish and invertebrate communities, and enhance prey resources for waterfowl. In November 2020, we installed two types of piling repair jackets on 24 CTP made of fiberglass (n = 12, Denso SeaShield™) and PVC rated for potable water (n = 12, SnapJacket™), and each piling was capped with a hardwood roosting platform. To encourage rapid recruitment of invertebrates, we tested two surface treatments of aluminum or fiberglass mesh. For each CPT encapsulation treatment and unencapsulated controls, samples across tidal zones (subtidal, intertidal) were collected quarterly to compare algae and invertebrate colonization rates, and PAH concentrations in invertebrates. Within 6 months of deployment, both types of jackets had 60-80% live cover consisting of algae and early succession invertebrate species, and by 12 months they were 100% covered. We observed high densities of barnacles, mussels, and oysters within 9 months of deployment. We are currently evaluating biodiversity and composition of native and exotic species, biomass, and/or density. future applications could include using a conservation aquaculture approach, wrapping encapsulated

pilings with hatchery-reared native blue mussels (*Mytilus californianus*) to accelerate the creation of subtidal mussel reefs. This work is informing the use of existing infrastructure and commercially available materials to provide a cost-effective and low maintenance restoration alternative, broadly applicable to urban estuaries and remediation of derelict pilings to advance subtidal habitat goals.

14-The Delta Monitoring Enterprise: A Comprehensive Review by the Delta Independent Science Board

Margot Mattson, DSC, margot.mattson@deltacouncil.ca.gov

The 2009 Delta Reform Act directs the Delta Independent Science Board (ISB) to review scientific research and monitoring that support adaptive management of the Delta. Recognizing the need for a comprehensive review of monitoring activities, the ISB reviewed the suite of monitoring occurring in the Delta, referred to as the monitoring enterprise. The purpose of this review was to assess if information collected from monitoring is meeting the needs of the management agencies; if coordination, efficiencies, data quality, and data accessibility could be improved; and how monitoring data can better support the implementation of adaptive management. This review includes a comprehensive inventory of all monitoring activities and was informed by a literature review, public comments, seminars and panels, a workshop, a survey, and subsequent interviews with experienced scientists and managers involved in Delta monitoring. The Delta ISB developed an adaptive management framework for monitoring that would better meet the needs of management and stakeholders and apply the five best practices identified in the review: (1) formally tie monitoring to goals, objectives, and questions; (2) be informed by stakeholder needs and capabilities and include alternative forms of data and knowledge; (3) adapt as new information, science, and technology become available; (4) include data management, analysis, storage and synthesis; and (5) ensure that data are accessible. In addition, the Delta ISB recommends the following three transformative changes for the monitoring enterprise to better link monitoring to management: (1) develop priority management-informed science needs and questions for the monitoring enterprise and synthesize information around these questions in biennial reports or at a summit, (2) reimagine monitoring designs that are guided by priority management-informed science needs and a system-wide conceptual model; and (3) strengthen the integration, organizational and funding structure to support monitoring, analysis, and adaptive management.

15-Evaluating the early detection, rapid response framework for aquatic species in the Delta

Christine Whitcraft, CSULB, ariel.m.capella@gmail.com

Aquatic invasive species and their impacts have been ecological and management challenges in the Sacramento-San Joaquin Delta (Delta) since the 1970s. Despite these impacts, the Delta still provides a suite of ecosystem services. To continue to protect this watershed, an efficient early detection and rapid response (EDRR) framework must be implemented with the goal to find, report, and eradicate invasive species before they spread and cause harm. Effective EDRR frameworks require coordination as well as early action, but frequently the implementation of effective EDRR is limited by lack of information or coordination. To address this need, we conducted an evaluation of the existing draft EDRR framework developed by the Delta Interagency Invasive Species Coordination (DIISC) Team by conducting a series of

stakeholder interviews. Through qualitative review of these interviews, we identified potential barriers and areas for increased coordination at each stage in the EDRR process. Actionable opportunities include improved coordination around potential vectors, regular funding for baseline monitoring, and use of existing structures for collaborative reporting and science review. In addition, we researched the invasive submerged aquatic species, ribbon weed (*Vallisneria australis*), as a case study to understand challenges with the EDRR process. Literature review indicates ribbon weed often forms dense mats and impacts native aquatic ecosystems by outcompeting native aquatic vegetation, reducing habitat diversity and altering the availability of resources such as light, nutrients, and oxygen. Finally, we collected data on ribbon weed plant traits to directly inform the response and treatment step of the EDRR process. Our findings can inform our understanding of how invasive species management response for aquatic plants and hopefully increase our abilities to get ahead of the invasion curve.

16-Big Plans for Big Notch: Adaptive Management in Action

Brandy Smith, DWR, brandy.smith@water.ca.gov

The Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Big Notch Project) is a nearly complete environmental infrastructure facility located in the Fremont Weir that aims to help restore California's native salmonid and sturgeon populations. This project is jointly funded by the California Department of Water Resources and the US Bureau of Reclamation to mitigate for the State Water Project and Central Valley Project. The Big Notch Project is planned to be operational by November 2024. The objectives of the Big Notch Project are to: 1. Create floodplain rearing habitat and entrain juvenile salmonids; 2. Reduce migratory delays and loss of adult anadromous fishes; and 3. Limit unforeseen impacts to existing land uses. The DWR Restoration Ecology Unit along with the multi-agency and multi-disciplinary Fisheries and Engineering Technical Team (FETT) have jointly drafted a protocol for responding with adaptive management if the project is not meeting one or more objectives. The team will use a variety of monitoring categories, including telemetry, sonar imagery, fish rescue data, rotary screw trap and beach seine data, hydraulics, and land use impacts to inform the adaptive management process. This poster presents a case study of adaptive management by highlighting a planned study of juvenile salmonid entrainment using tagged Chinook salmon.

Advancing Ecosystem Restoration Towards a Resilient Delta

17-Advancing Ecosystem Restoration Towards a Resilient Delta

Elizabeth Brusati, Delta Stewardship Council, elizabeth.brusati@deltacouncil.ca.gov

Adopted in June 2022 by the Delta Stewardship Council, the Ecosystem Amendment to Chapter 4 of the Delta Plan provides guidance and a vision for a resilient Delta ecosystem. The Ecosystem Amendment promotes restoration that provides direct social benefits to Delta communities, minimizes conflicts to surrounding communities and land uses, and highlights proactive consultation and coordination with

Native American tribes. It also synthesizes restoration goals from existing strategies, plans, and biological opinions to identify a restoration target of 60,000 to 80,000 acres by 2050 (above a 2007 baseline). This acreage goal is divided among ecosystem-specific categories.

While considerable restoration progress has been made in recent years, the pace and scale of restoration will need to accelerate to meet these Delta Plan targets. Many groups are implementing restoration projects, especially for tidal wetlands, and local organizations are engaging their communities to provide educational opportunities about restoration and habitat enhancement.

The posters in this cluster showcase the benefits of ecosystem restoration and the range of organizations and habitat projects that are completed or in progress in the Delta and Suisun Marsh. Projects featured in this cluster will provide a range of benefits to the Delta and its communities, including reducing flood risk, improving climate resilience, sequestering carbon, and adding habitat for rare and common species.

18-An Overview of the Delta Conservancy's Ecosystem Restoration and Climate Adaptation Grant Program

Anjali Shakya, Delta Conservancy, anjali.shakya@deltaconservancy.ca.gov

The Sacramento-San Joaquin Delta Conservancy is a lead state agency in the implementation of ecosystem restoration in the Delta and supports efforts that advance environmental protection and the economic well-being of Delta residents. The Delta Conservancy works collaboratively and in coordination with local communities, leading efforts to protect, enhance, and restore the Delta's economy, agriculture and working landscapes, and environment, for the benefit of the Delta region, its local communities, and the citizens of California. The Delta Conservancy's Ecosystem Restoration and Climate Adaptation Grant Program refers to a collection of projects that support multi-benefit ecosystem restoration, watershed protection, and climate adaptation projects in the Sacramento-San Joaquin Delta and Suisun Marsh. Projects in this program are supported through various funding sources: the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1), and two general fund allocations supporting both climate resilience, community access, and natural resource protection, as well as wetland restoration through Nature Based Solutions. To date, the program has provided $77 million to support 39 projects.

The poster provides an overview of the Delta Conservancy's Ecosystem Restoration and Climate Adaptation Grant Program and highlights several habitat restoration projects that have been awarded funding by the Delta Conservancy. The multi-benefit ecosystem restoration projects featured on this poster are at various stages of completion. When implemented, these projects will improve water quality, restore and protect wildlife habitat, provide flood protection for communities in the Delta, and increase climate resilience.

19-The Landscape Scenario Planning Tool: A single mapping toolbox that brings together ten years of science-based research and peer-reviewed methods for California's Suisun-Delta region.

Helen Casendino, SFEI, helenc@sfei.org

As climate change exacerbates vulnerabilities in the Delta and Suisun Marsh, resource managers, planners, local governments, and other decision makers are increasingly challenged to promote a healthy ecosystem that sustains community uses and a diverse assemblage of wildlife and plant species. Landscape-scale planning must consider multiple management goals such as wildlife support, subsidence and greenhouse gas mitigation, reliable water provision, and a vibrant agricultural economy. In partnership with the Delta Stewardship Council, California Department of Fish and Wildlife, HydroFocus, the UC Merced Water Systems Management Lab, USGS, and Greeninfo Network, the San Francisco Estuary Institute developed the Landscape Scenario Planning Tool (LSPT) to inform such planning efforts. The LSPT, a GIS-based scenario analysis tool, assesses how scenario land-use changes in the Suisun-Delta region will affect a suite of landscape metrics relating to desired ecosystem functions and services. The tool integrates ecological, economic, and land use information to evaluate changes in wildlife support, marsh resilience, greenhouse gas mitigation, and agricultural revenue, among other desired functions. In addition to facilitating comparisons between alternative scenarios relative to both modern and historical conditions, the tool can measure ongoing progress towards regional restoration goals as projects are implemented and modify landscape conditions. The LSPT is free and available to the public, with target end users including agency staff, planners, and researchers. LSPT analyses and guiding datasets bring together a decade of research, peer-reviewed methods, and engagement with a broad set of interested parties to support evidence-based landscape planning for a healthy and resilient Suisun-Delta region.

20-Advancing Climate Resilience in the Department of Water Resources (DWR)'s Multibenefit Habitat Restoration Projects

Michelle Jesperson, Department of Water Resources, michelle.jesperson@water.ca.gov

The Department of Water Resources (DWR) is a leading the implementation of many habitat restoration projects in and around the San Francisco Bay Delta. DWR is focused on implementing a comprehensive suite of habitat restoration actions to support the long-term health of the Delta and its native fish and wildlife species. This poster will highlight the successes of DWRs efforts since 2015 to accelerate habitat restoration projects in the Delta. To date, DWR has completed or has projects underway to restore approximately 30,000 acres including 10,000 acres of tidal and freshwater wetlands, with an additional 8,500 acres in planning stages to complete by 2030, including another 4,000 wetland acres. The Department is looking closely at how these restoration efforts can also build resilience to climate change by factoring in sea level rise and considering opportunities to maximize carbon sequestration in project design and in the long-term management of project sites. The poster will provide an overview of the completed projects and projects in planning and design stages. The poster will also highlight recent efforts to estimate carbon sequestration benefits of its wetland restoration projects and provide project examples where carbon sequestration at the wetland project site is being assessed and measured.

Contaminants

21-Current-use Pesticides in Zooplankton and Water Collected from the Yolo Bypass and Cache Slough Complex, 2022-2023

James Orlando, USGS, jorlando@usgs.gov

Zooplankton are a key food source for juvenile fishes in the Sacramento-San Joaquin Delta, (Delta) including the endangered Delta Smelt (Hypomesus transpacificus). Studies have shown that zooplankton and water in the Yolo Bypass and Cache Slough complex (a key habitat for Delta Smelt) contain complex mixtures of current-use pesticides. To better understand the quality of zooplankton available as food for native Delta Smelt as well as the quality of the water Delta Smelt are exposed to, zooplankton and water samples were concurrently collected from multiple sites in the Yolo Bypass and Cache Slough complex as well as at a comparison site on the Sacramento River below Sacramento. Samples were collected biweekly in the summer/fall of 2022 (a critically dry year) and 2023 (an extremely wet year) and analyzed for a suite of up to 179 current-use pesticides and degradates. During these periods a total of 25 pesticides were detected in zooplankton samples, and 66 of the 73 samples contained multiple pesticides (up to 16 per sample). Pesticides detected most frequently in zooplankton included azoxystrobin, bifenthrin, fluridone, and dichlorodiphenyldichloroethylene (p,p'-DDE). During the same sampling periods a total of 59 pesticides were detected in water samples and each of the 83 samples contained multiple pesticides (up to 32 per sample). The most frequently detected compounds in water were 3,4-dichloroanline, azoxystrobin, chlorantraniliprole, hexazinone, and methoxyfenozide. Several pesticides were also detected in water at concentrations that exceeded U.S. Environmental Protection Agency benchmarks for acute and chronic aquatic invertebrate toxicity. In general, more pesticides were detected in both zooplankton and water samples from 2023 versus 2022. The types of pesticides detected, and their timing of detection often differed between zooplankton and water which suggests that understanding pesticide concentrations in zooplankton is key to assessing the potential effects of these contaminants on the Delta ecosystem.

22-Systematic Review of Dissolved Pesticide Concentrations in the Sacramento-San Joaquin Delta from 2015 to 2024

Matthew De Parsia, USGS, mdeparsia@usgs.gov

Complex mixtures of pesticides are known to occur in Sacramento-San Joaquin Delta (Delta) waters and their presence is of concern for Delta ecosystem health. Over the past ten years the U.S. Geological Survey (USGS) has participated in several studies in the Delta in cooperation with local, state, and federal partners. In total, we have analyzed over 1000 water samples collected in the Delta and generated more than 200,000 publicly available pesticide results. There are many reports concerning pesticides in the Delta, but most are short-term or focused on a limited number of locations. A systematic review of pesticide sampling results in the Delta can be used to inform researchers of problematic seasonal trends or pesticide detection patterns.

To build a dataset suitable for trend analysis we retrieved all USGS pesticide results analyzed by the USGS Organic Chemistry Research Laboratory from the USGS National Water Information System for samples collected between 2015 and 2024. We then applied a series of preprocessing steps to reduce the dataset to a consistent subset of pesticides that were measured in all samples using comparable methods. After processing the data, we reduced the dataset from approximately 200,000 to 90,000 pesticide results. Overall, 80 pesticides out of 136 selected for analysis were detected in the Delta in this review. Azoxystrobin (fungicide), hexazinone (herbicide), and methoxyfenozide (insecticide) were the most frequently detected pesticides with detection frequencies over 80 percent for each. Average pesticide concentrations increased from 2015 to 2019 then declined from 2020 to 2024. We observed a seasonal trend of lower pesticide concentrations in spring to early summer and higher concentrations in late summer to winter. A greater understanding of the magnitude and trends of pesticides in the Delta will provide critical information for resource managers working to improve ecosystem health in the region.

23-Sublethal Toxicity Testing of Commonly Used Pesticides at Varying Salinities in Menidia beryllina*

Katherine Berreman, OSU, katherine.berreman@oregonstate.edu

Various stressors due to climate change including sea-level rise and drought impact estuarine ecosystems and contribute to fluctuations in salinity levels. When there is a high salt concentration in an ecosystem, the salting out effect may occur and decrease solubility of compounds present. This is due to an increase in competition between salt ions and other compounds for interactions with water molecules, which reduces the amount of a compound dissolved in water and causes the chemicals to have a higher octanol-water partition coefficient, K, or the likelihood for a compound to dissolve in fats and lipids. As a compound becomes more lipophilic, coastal organisms may be more sensitive to chemical exposure as bioaccumulation may occur. Pesticides are chemical compounds commonly used for agricultural and household purposes, and they can enter estuarine ecosystems through runoff and spray drift. To determine if there is a difference of pesticide toxicity at varying salinities, *Menidia beryllina* embryos at five days post fertilization (dpf) were exposed to sublethal levels of six pesticides (bifenthrin, chlorpyrifos, dicloran, myclobutanil, penconazole, triadimefon) at two salinities (5 PSU and 25 PSU) for 96 hours. *Menidia beryllina* (Inland silverside) are a euryhaline model species, which allows for the ability to observe stressor effects over a broad range of salinities. Behavior, growth, and gene expression are endpoints that will be analyzed for effects at sublethal exposure levels as impacts observed at early life stages of fish could have potential population effects due to organism fitness contributing to overall survival. Main findings include significant differences in the behavior assay where a general trend of increased response or hyperactivity was evident in 25 PSU exposures. There was no significant difference found between control and treatment groups for growth.

Emerging Technologies

24-Metabolomic & metagenomics of the IAV in the California Bay-Delta

Skylar Carlson, Univ. of the Pacific, scarlson1@pacific.edu

The Carlson Lab at the University of the Pacific was established in 2019. As chemical ecologists, we specialize in small molecule characterization and look forward to meeting and establishing collaborations with bay-delta ecosystem experts. We are actively seeking collaborators and a better understanding of the ecosystem in our back yard. Our analytical chemistry group specializes in mass spectrometry, nuclear magnetic resonance, and high-performance liquid chromatography in addition to metagenomic experience. Previous work in the group has established key small molecules at work in the marine ecosystem that drive the settlement of *Vibrio* spp. bacteria to the surface of the invasive algae *Caulerpa* spp.. We are seeking input on our study design to understand the chemical communication in invasive aquatic vegetation. Through the lenses of chemical ecology and metagenomics, we seek to understand the chemical cues driving the various life stages of Brazilian waterweed (*Egeria densa*), water hyacinth (*Eichhornia crassipes*), and water primrose (*Luwigia* spp).

25-Delta Drought Response Pilot Program: A Novel Approach to Building Resiliency to Drought

Rachel Lane, Delta Conservancy, rachel.lane@deltaconservancy.ca.gov

The Delta Drought Response Pilot Program (DDRPP) launched in January 2022 as a response to the continued risk of drought in the Delta Watershed. The Program was developed in partnership with the Delta Conservancy, the Office of the Delta Watermaster, the California Department of Water Resources, the California Department of Food and Agriculture, The Nature Conservancy, University of California researchers and extension experts, and in coordination with Delta water users. The DDRPP objectives were to conserve water on a net basis, protect Delta water quality, promote soil health, and mitigate potential drought impacts on fish and migratory birds. To address these objectives, the Delta Conservancy provided incentive payments to farmers to carry out water conservation and bird benefits practices in the legal Delta, resulting in 94 projects over two years. Consumptive water use savings for DDRPP was calculated using OpenET, an open-source satellite-based tool for measuring evapotranspiration (ET). Analysis of the 2023 Program showed that reducing applied irrigation amounts through deficit irrigation of crops, changing crop type, and even fallowing or idling cropland did not substantially reduce consumptive water use on participating fields. Our results suggest agricultural areas at higher elevations show more potential for water savings. However, elevation only partially explained the patterns of water savings/use among DDRPP fields, and several fields below sea level showed some water savings. Variation in water saved/used on fields may also have been driven by vegetation management, crop type, soil type, and local flooding. Using open-source, remote sensing satellite estimates of evapotranspiration, like those from OpenET, makes it possible to cost-effectively measure water use, and can be used to identify the specific regions, field characteristics, crops, and field management practices likely to produce the most cost-effective and efficient agricultural water savings during future droughts, both in the Bay-Delta and further upstream.

26-Developing a Multiplexed SHERLOCK Genetic Assay for Rapid Detection of Central Valley Chinook Early and Late Migration Phenotypes

Hannah Miller, UC Davis, hwmiller@ucdavis.edu

Central Valley Chinook salmon are comprised of four genetically distinct runs (fall, late fall, winter and spring) that are named for the time they return to freshwater to spawn. Damming of river systems in the Central Valley has led to a significant decline in abundance of the spring and winter-run populations. Central Valley spring-run is listed as Threatened and Sacramento River winter-run is listed as Endangered under the Endangered Species Act. We previously utilized Specific High-Sensitivity Enzymatic Reporter UnLOCKing (SHERLOCK) technology to develop a rapid genetic tool that can differentiate between early and late adult migration phenotypes by taking advantage of an indel present in the *greb1l*/*rock1* region located on chromosome 28. SHERLOCK assays rely on CRISPR/Cas technology and are ideal for rapid Chinook salmon run identification because they are simple to use, don't require expensive equipment, can be completed in approximately one hour, and can be deployed in the field with minimal training. The early adult migration SHERLOCK assay detects listed winter/spring-run, while the late migration assay detects non-listed fall/late fall-run. Currently, each Chinook individual is assayed for early and late adult migration alleles in separate reactions to obtain a *greb1l/rock1* genotype. The ability to detect multiple alleles at once using a single SHERLOCK assay would greatly improve our efficiency and reduce costs for rapid Chinook salmon genetic run assignment. Presently, we are in the process of developing a multiplexed SHERLOCK assay for detection of both early and late migration alleles in a single reaction. We aim to combine multiple Cas enzymes with different cleavage preferences and multiple reporter molecules to facilitate the detection of two or more alleles simultaneously. If successful, this work will enhance our ability to rapidly differentiate between listed and non-listed Chinook salmon and expedite related management decisions.

27-Evaluating Image-Based Deep Learning Methods for Zooplankton Sample Processing

Katie Hostetler, CDFW, katherine.hostetler@wildlife.ca.gov

Zooplankton are a crucial part of food web dynamics that support Bay-Delta fish, including threatened or endangered species. Zooplankton monitoring collections are carried out by five CDFW surveys using three different gear types for IEP, in which 1,500 total samples are collected annually. Processing these samples is time-consuming and requires expertise. This project evaluates the use of image-based classification ("Deep Learning") modeling to identify and count the zooplankton species in IEP survey samples. These auto-detection methods have the potential to reduce processing and reporting time, and to improve data quality.

The application of image-based deep learning is optimized with large reference image libraries (a high number of images per class). We used culturing methods to propagate zooplankton species that were collected with pump sampling (micro-zooplankton) by the Environmental Monitoring Program survey (Department of Water Resources). We imaged the zooplankton cultures using a FlowCam 8001 (Yokogawa Inc).

We used the web-based deep learning model, Ecotaxa, to test the strength of our reference library. We pre-processed images using the Zooprocess software package to segment objects from raw FlowCam images, standardize backgrounds, and generate image filter data. We uploaded images and associated data to Ecotaxa and validated species identification to establish a primary "project" (a collection of images that have been sorted against validated images by the deep learning tool) having three taxa classifications.

For testing, we exported the primary project library and set a randomized subsample to the 'unknown' status. These, together with the remainder as the test library, were uploaded to a test project in Ecotaxa. The resulting Ecotaxa class predictions for the unknowns were 98.7% accurate.

With this early deep-learning classification success, image library development and testing efforts will be continued in order to support accurate identification of all 23 micro-zooplankton classes documented in IEP surveys.

28-Using parentage-based tagging to identify origins of Chinook salmon (Oncorhynchus tshawytscha) returning to a restored creek*

Alana Luzzio, UC Davis, aluzzio@ucdavis.edu

Ecosystem rehabilitation is integral to recovering and supporting native species biodiversity. Putah Creek, a tributary to the Sacramento River, has now undergone 24 years of restoration activities, focused mainly on reestablishing perennial flows to support native fishes. Recently, Chinook salmon have been observed spawning in Putah Creek. While most salmon have been identified as hatchery strays, there is preliminary evidence using otolith chemistry that some of these individuals originated from Putah Creek. Problem statement: However, the exact contributions of Putah Creek origin fish to the subsequent generations remain largely unknown. I will use the genetic method of parentage-based tagging (PBT) via a validated SNP panel to 1) elucidate how many Chinook salmon spawning in Putah Creek are the progeny of those spawned in previous years; and 2) explore factors influencing individual reproductive success. Bioinformatic analysis to discover and validate candidate SNPs from carcass tissues of returning spawners and out-migrating offspring is underway. Once complete, I will analyze seven consecutive years of carcass tissue samples using a validated SNP panel, and assign parentage using COLONY. To investigate reproductive success, I will analyze total lifetime fitness (TLF) of each spawner, assessing the number of adult offspring produced by each parent in subsequent spawning years. Preliminary analyses using a subset of 2017 carcasses and 2018 down migrating progeny suggest that a small number of SNPs (~120) are powerful enough for parentage assignment in this population. Salmon are declining throughout California and the Bay Delta. However, confirmation of a new spawning run, initiated by hatchery strays, is interesting and 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.

29-AquaWatch California-Australia: Updates on International Cooperation to Pilot a "Weather Service" for Water Quality in the Sacramento-San Joaquin Delta

Erin Hestir, UC Merced, ehestir@ucmerced.edu

Water quality is a critical component of water security. As climate change continues to challenge sustainable water resource management, there is an increasing need for near real-time water quality monitoring and early warning forecasts to inform water resource managers, ecosystem managers, and the public. AquaWatch is a collaboration between California and Australia that is seeking to develop a 'weather service' for water quality for California, Australia, and eventually, globally. AquaWatch is integrating ground-to-space based water quality monitoring with advanced, cloud-based data analytics forecasts within an Internet of Things (IoT) framework. The project seeks to use existing networks of in situ water quality sensors and contribute additional in situ sensors for high-accuracy ground-based measurements. These will be combined with satellite observations made from a constellation of existing and future custom-built earth observing satellites to scale highly precise water quality across large regions. The first pilot site in the United States is being deployed in the Sacramento-San Joaquin Delta, with a first focus on turbidity, followed by development for other optically active water quality constituents such as dissolved organic matter and algal blooms. The work is part of the Action Plan under the recently signed Memorandum of Understanding (MOU) between the Commonwealth of Australia and the Government of the State of California to address climate change and a transition to green energy. A critical facet of the MOU and the project is the exchange of scientific knowledge and technical expertise, and co-design of the system with local indigenous, public, and private water resource managers. The purpose of the presentation is to raise awareness of the project, update the community on progress, seek ongoing input for the co-design process, and explore future opportunities for collaboration and exchange of knowledge and expertise.

30-Introducing a hydraulic injection method for instream egg incubation above a rim dam in California's Central Valley

Jason Hassrick, ICF, jason.hassrick@icf.com

In the face of climate change, actions taken below rim dams alone will not likely result in long-term salmon conservation. The effect of warming temperatures is expected to intensify with increased water demands, necessitating the evaluation of putting salmon above known barriers into thermally suitable habitats. Accordingly, a study is being conducted on the feasibility of returning spring-run Chinook Salmon to historically available, high-quality habitat in the North Fork Feather River watershed above Lake Almanor (NFFAA). This study component evaluated two instream incubation methods, Whitlock-Vibert (WV) egg boxes and hydraulic egg injections, to determine the hatching success of eggs in the NFFAA. Both methods were employed to ensure successful emergence from multiple locations in the watershed. In 2023, triploid Chinook salmon eggs (150k) were reared to the eyed stage and transported to historic Chinook spawning habitat in the NFFAA. The novel use of hydraulic egg injection in California was conducted side-by-side with WV boxes. The primary difference between the two methods is that

rocks and gravel are manually excavated by hand for WV egg boxes, whereas water injected through a funnel flushes away fine substrate and creates a pocket for planting eggs directly in the gravel. Parentage-based tagging will be used to confirm if either method produced more fish downstream from juvenile monitoring traps. If this method proves successful, it can be applied to restoration and reintroduction projects for other salmonids in California.

31-Utilizing In Situ Monitoring and ESA Earth Observations within the BayDeltaLive Constituent Tracker Decision Support Tool to Monitor Environmental Conditions

Amye Osti, 34 North, amye@34north.com

Water quality variability in the Delta is, at its core, governed by the movement of water quality fields that move at timescales that vary from the rapid twice daily movements of the tides. These tidal movements (which can be on the order of 8 miles in the western Delta) also respond to changes in river flows, the spring/neap (14 day) cycle and pumping. All of these factors can quickly change the water quality constituent field. These changes often happen much faster than the response of water project operations, with response times that can take days or weeks. In collaboration with USGS (concept and algorithm development) and DWR (transect data), this project summary describes a water quality constituent tracking tool that assimilates real-time time-series data collected at fixed stations in the Delta. The development of this project aims to advance the Bay-Delta Live (BDL) data management platform and leverage the Delta's sensor network, remote sensing data and also provides data and decision support tools for viewing and analyzing continuous water quality conditions at finer spatial scales. This data assimilation tool may be incorporated into existing monitoring programs to evaluate current conditions, assess turbidity, salinity and nutrient conditions, supplement or replace DWR early warning turbidity transect operations, as well as help to evaluate changes due to wetland restoration, flow alteration, gate installations and other management actions.

In collaboration with 34 North, USGS, NASA/JPL and DWR, this research and development project advances the Bay-Delta Live (BDL) technology platform to provide data and decision support tools that implement novel methods needed to view and analyze continuous water quality conditions at a finer spatial scale within the Sacramento-San Joaquin Bay Delta.

32-Assessing A Changing World: Analyzing Sea Level Rise Inundation on Coastal Wetlands in San Pablo Bay, CA*

Steve Brewer, John Hopkins Univ., sbrewer012@gmail.com

Sea levels continue to rise, fueled by our changing climate. This has left land planners and environmentalists looking for methods to examine the impacts of rising seas on coastal wetlands. San Pablo Bay has one of California's most extensive coastal wetlands and currently faces these exponentially rising sea levels. This research employs a comprehensive methodology. It utilizes Esri ArcGIS Pro, a powerful geographic information system software, along with NOAA's current and future

sea level spatial layers, USGS Bathymetry data, and USGS Land use raster layers. These tools and data are used to conduct a detailed analysis of the potential inundation of coastal wetlands due to sea level rise, without any human intervention. The findings of this research are alarming. They indicate that, in the absence of current efforts or a catastrophic levee break, San Pablo Bay could witness a staggering loss of more than 50% of its coastal wetlands by the year 2100. Looking further ahead, a potential 9-foot sea level rise could lead to a devastating 100% loss of these vital ecosystems in San Pablo Bay. What are the scientific and management implications of your findings, including the relevance of your findings to Bay-Delta management? What insights do your findings provide towards ecosystem sustainability in the near and long-term futures? The findings of a loss of as much as 50% of coastal wetlands loss in San Pablo Bay by 5 feet of sea level rise would be catastrophic to Californian ecology. Current efforts to curb climate change impacts on coastal wetlands need to be further invested and implemented. Further modeling improvements also need to include pH level, salinity, and temperature to examine less obvious impact drivers on coastal wetlands and gauge the impact that levees and dike systems have on slowing down this crisis.

Fish Biology, Ecology, & Protection

33-Assessing the Life History of Central Valley Steelhead Using Otoliths

Feng Zhao, UC Davis, mayzhao@ucdavis.edu

The California Central Valley Steelhead (CVS) is a distinct population of anadromous Rainbow Trout (Oncorhynchus mykiss) that is listed as ‘threatened’ under the Endangered Species Act. Critical information gaps regarding our knowledge of Steelhead demographics and life histories in the Sacramento and San Joaquin River watersheds hinder their effective management and conservation. Here we report on the initial findings of a new 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. In this project we are utilizing increment and geochemical analyses of archived otoliths (ear stones) to reconstruct the age structure, growth, and migratory life history of Steelhead from the Upper Sacramento, Feather, American, Tuolumne, Merced, and Stanislaus Rivers. These data allow us to explore the region-wide variation in the life history of Central Valley Steelhead

34-Needle in the Haystack: Quantifying Otolith Banding Patterns to Identify Wild Age-2 Delta Smelt

Claire Chung, UC Davis, cychung@ucdavis.edu

Delta Smelt (Hypomesus transpacificus) is a critically endangered migratory fish that is endemic to the San Francisco Estuary. Most Delta Smelt are believed to reproduce at 1 year of age; however, length data from field surveys suggest the historic presence of big, old, fat, fecund females (BOFFFs in the

fisheries literature) that deviate from this pattern and may spawn at age 2. These older females likely exhibit higher fecundity than age-1 spawners, thus possibly contributing disproportionately to population dynamics. Yet, it remains unclear whether these large females are truly age-2 or fast-growing age-1 fish. Here, opaque and translucent ("annual") banding patterns in otoliths (calcified ear stones) were used to reconstruct the annual ages of Delta Smelt from the California Department of Fish and Wildlife's (CDFW) Spring Kodiak Trawl Survey (2003 to 2023). Although rare, otolith-based analyses identified several large individuals that indeed survived a full second summer and were possibly preparing to spawn in their second year of life. Our results confirm the presence of this longer-lived life-history phenotype and suggest that variation in the abundance of age-2 spawners could be an important parameter for an improved understanding of the biology and conservation of this imperiled species.

35-Geochemical and thermal tagging techniques for cultured Delta Smelt

Brian Alper, UC Davis, baalper@ucdavis.edu

Delta Smelt (*Hypomesus transpacificus*) conservation efforts have shifted towards supplementation in recent years due to a lack of wild spawning stocks. This being the case, the effectiveness of culture methods and the assessment of post-release survival needs to be determined to optimize the production of fit individuals. This is traditionally done through batch identification, which involves tracing recaptured fish back to a distinct group of fish raised and released under similar conditions. However, current batch differentiation techniques (i.e., alpha numeric tags, VIE tags, genetic analyses) are time consuming and can induce unnecessary stress. Otoliths provide metabolically inert records of growth rates and water chemistry, and may therefore have potential as a viable alternative. By fluctuating conditions in a controlled environment, otolith growth and composition can be changed in predictable ways leaving identifiable marks for batch identification. Here, we have collaborated with the DWR and the FCCL at UC Davis to develop and test otolith-based batch-marking techniques. Delta Smelt were exposed to 3 different treatments: temperature fluctuations (thermal bar-coding), salinity fluctuations (geochemical tagging), and a control treatment. Otoliths were subsequently extracted and sanded in the sagittal plane. Visual and geochemical (LA-ICP-MS) analyses were conducted to assess the presence and timing of thermal check marks (temperature treatment) and geochemical spikes (salinity treatment). Thermal marks displayed a high degree of visibility when imposed later on in life (92%), while early life marks were less evident (57%). Geochemical spikes were prominent and identifiable in almost all chemical profiles (98%). These otolith-based batch-marking techniques provide a new and economical method for tagging large quantities of supplemental Delta Smelt, allowing for the identification and analysis of the success of growth and survival of Delta Smelt to inform supplementation and other population recovery efforts.

36-Can we use vertebral counts to differentiate Chinook Salmon, Oncorhynchus tshawytscha, populations?

Pete Nelson, Department of Water Resources, peter.nelson@water.ca.gov

A persistent and increasingly critical management and conservation challenge in California's Central Valley is distinguishing between juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from the San Joaquin (SJR) and Sacramento (SAC) rivers. According to Jordan's rule, in fishes, the number of vertebral elements is positively correlated with latitude, suggesting a potential rapid and inexpensive means of identifying Chinook natal origin. This project began as a proof of concept to see if Chinook vertebral counts follow Jordan's rule, hypothesized to result from heritable genetic attributes and water temperature during development. We obtained digital radiographic images of juvenile Chinook from the ichthyology collection at the California Academy of Sciences, collected from multiple sites ranging in latitude from 38.1 degrees North on the San Joaquin River, California to 62.5 degrees North on the Copper River, Alaska. We used ImageJ to assist with counting the vertebral elements in each fish (N=61), and linear regression to test the hypothesis that latitude was predictive for vertebral count. Vertebral counts ranged from 61 in a SJR fish to 74 in a fish from Kicking Horse Creek, a comparatively high elevation tributary of the Columbia River in Canada. Our data were consistent with Jordan's rule ($F=233$, $df=1.59$, $p=0.0001$; adjusted $R2=0.79$), although vertebral counts from San Joaquin River fish and those collected near the southern end of the Sacramento River were not significantly different: SJR vs American River, $t=1.0575$, $df=11.275$, $p=0.312$ and SJR vs Deer Creek, $t=1.8336$, $df=25.39$, $p=0.078$. Additional samples are likely to confirm this general rule, but more targeted sampling is needed to determine if vertebral counts can identify the natal origin of salmon among Central Valley stocks. If temperature during development is the primary factor in determining vertebral count, our results suggest the potential for a novel means of "tagging" hatchery salmon.

37-Salmon Need Safer Routes Through the Delta

Douglas Brown, Douglas Environmental, browndoug@att.net

Chinook Salmon and other native fishes moving through the northern portion of the Sacramento-San Joaquin Delta experience hostile conditions in the Sacramento River that substantially diminish species survival. Two Delta reclamation districts are proposing to restore fish passage through a major distributary channel to provide an alternative migration route for salmon traveling through the Delta. Elk Slough was historically maintained by direct flood flows from the Sacramento River that resulted in a well-defined channel bordered by steep natural levees supporting a dense riparian forest. The historic connection of Elk Slough to the Sacramento River was modified in the 1950s with the construction of the Sacramento River west levee and road crossing (South River Road) across the head of Elk Slough. The culvert is a barrier to fish passage and provides only limited exchange of flow between the river and slough. As a result, Elk Slough is currently functioning like a backwater of the Sacramento River. The Elk Slough Fish Passage and Flood Improvement Project proposes to replace the existing levee and culvert

at the head of Elk Slough with a bridge and constructing operable gates at the upstream and downstream ends of the slough to restore fish passage and improve flood protection. To improve species resilience, providing alternative migration routes through the northern Delta is imperative. The proposed reconnection of Elk Slough presents an opportunity to restore access to a historical fish migration route, increase the rearing capacity of the lower Sacramento River, and contribute to the overall diversity of migration pathways and rearing habitats available to salmonids and other native fishes. This project also responds to broader species recovery and ecosystem restoration needs by increasing the diversity, connectivity, and quality of habitats supporting the productivity and persistence of Chinook salmon and other native fish populations.

38-Characterizing movement patterns of native and non-native fishes in the Stanislaus River

Emily Jonagan, FISHBIO, emilyjonagan@fishbio.com

Little information on the movement patterns of native and non-native fishes are available in the San Joaquin River watershed. To fill this knowledge gap, we utilized capture-recapture and resighting data collected from PIT-tagged fishes as part of a suite of predator- and predation-related studies on the Stanislaus River from 2018 to 2023. We used boat electrofishing to capture black bass, striped bass, Sacramento pikeminnow, and hardhead in the lower 64 km of the Stanislaus River, which we subsequently injected with PIT tags. Electrofishing surveys were performed 4 to 6 times from February to June each year to tag additional fish and recaptured tagged individuals. We also characterized the number and timing of resightings of PIT-tagged fish from PIT tag antennas at the Stanislaus River Weir (operated annually from September December) and two stream-width antennas operated year-round beginning in spring 2021. A total of 8,719 fish were tagged with 1,282 individuals being recaptured and/or resighted at the antennas. Black bass were tagged and recaptured at the highest rate and represented over 55% of the data. Black bass exhibited little movement and high apparent site fidelity with 82% recaptured in the same location as tagging. Striped bass were rarely recaptured but were detected frequently by the PIT tag antennas. Both hardhead and Sacramento pikeminnow were observed making seasonal movements within the Stanislaus River near Oakdale suggesting movements associated with spawning. Data from this study can provide important context for mark-recapture based abundance estimates and are a first step to characterize movement patterns of both native and non-native fishes in the Stanislaus River.

39-Diel changes in abundance and size of larval Longfin Smelt (Spirinchus thaleichthys) across salinity and depth gradients in the San Francisco Estuary

Teague Corning, ICF, teague.corning@icf.com

Longfin smelt (*Spirinchus thaleichthys*) use the San Francisco Estuary for spawning and rearing habitat. Particle-tracking models indicate that if larval and juvenile behaved as passive particles, they would need to adjust their vertical swimming behavior to retain position in the estuary. Preliminary data indicates that smaller larvae are most abundant at the surface while larger larvae are more abundant near the bottom of the water column. Our study is attempting to determine the salinities and water

column position where larval and juvenile longfin are the most abundant, how this changes as fish get larger, and whether the vertical position of fish changes on a diel cycle.
We conducted a sampling program to determine the depth distribution of larvae and juvenile longfin smelt during the day and night at various bottom salinities in the upper and lower water column. Two nets (20 mm and smelt larval net) were used to collect samples from the beginning of March through mid-June every other week for eight surveys (the smelt larval net was only implemented in March). Smaller fish were more vertically dispersed and found in a wider range of salinities, whereas larger fish were often caught lower in the water column at lower salinities. Fish were caught primarily during the day in the lower water column, with lower catch at night and in midwater. Fish may be more widely dispersed at night, coming off the bottom or moving into other habitats we did not sample.
We identified ontogenetic changes in habitat use by longfin smelt in the upper San Francisco Estuary. These sinking behaviors may underpin the strong population response to outflow that has been observed in this species. This provides insight into how changes in gravitational circulation associated with outflow affect the ability of rearing life stages to remain in their nursery habitat.

40-Estimated Striped Bass Biomass From A Predatory Fish Removal Study

Alexander Tasoff, Department of Water Resources, alexander.tasoff@water.ca.gov

The California Department of Water Resources (DWR) recently completed a multi-year study to remove non-native predatory fish from Clifton Court Forebay (CCF). The goal of the study was to decrease predation risks for threatened juvenile fishes prior to reaching the John E. Skinner Delta Fish Protective Facility (i.e., pre-screen loss). One of the target species of this predator removal was Striped Bass (*Morone saxatilis*), which has been identified as a primary predator of threatened juvenile fishes in CCF. We investigated whether specific fishing gear-types were selecting for larger, more piscivorous Striped Bass during removals. We also assessed which gear-types contributed the most catch of Striped Bass during the study. For three years, crews used several gear-types to fish up to 55 cumulative days between January and June. For each gear, crews randomly selected and measured the total length of up to 30 individuals for each species caught each day. The remaining fish were sorted by species and enumerated. We then used established length-weight relationships to calculate the weights of Striped Bass removed during the study. For Striped Bass that without length measurements (i.e., enumerated fish only), the average weight per sampling day and gear type was applied to estimate missing values. We used R to conduct *post hoc* Kruskal-Wallis tests (e.g., e-fishing vs. beach seine gears) to determine whether average weights of Striped Bass differed between gear types. We also used MS Excel to calculate the catch per gear type across field seasons. We found that the different fishing methods selected for different sized Striped Bass, likely due to larger sizes being vulnerable to electrotaxis. Understanding differences in catch between the different gear-types used during this multi-year study can help researchers create a more efficient design for studies targeting specific size classes of Striped Bass in and around CCF.

41-Salmonid conservation through the study of an annelid worm: Manayunkia occidentalis in the Feather River, CA.*

Dana Hartwigsen, Pacific Sate Marine Fisheries Commission, dhartwigsen@csuchico.edu

Spring-run Chinook salmon, *Oncorhynchus tshawytscha*, of the Feather River in California, is a threatened species of economic, cultural, environmental, and recreational importance whose wild population has been rapidly declining. A major source of juvenile mortality is disease caused by the parasite *Ceratonova shasta*, a myxosporean with a complex life cycle and two mandatory hosts: salmonids, and the definitive freshwater annelid worm *Manayunkia occidentalis*. Salmonids and *C. shasta* have been extensively studied on the Feather River, yet annelids populations have not yet been found. Locating the annelids is crucial for developing informed hatchery spring-run Chinook release strategies, as well as water release management to support out-migrating juvenile Chinook. Therefore, this study, a collaboration by the California Department of Water Resources, CSU Chico, and OSU Corvallis, focusses on completing the puzzle through studying the annelid host. Previous studies have identified an 'infectious zone' - downstream of an influx of water from a warm and shallow source, the Thermalito Afterbay Outlet (TAO) where parasite spores/L are significantly higher than elsewhere in the river. We hypothesize that the highest population density of *M. occidentalis* can be found in the previously identified infectious zone due to a relatively high nutritional content originating from the TAO. To investigate this claim, we will conduct a field collection study, water nutrient analysis using spectrophotometry, and estimate prevalence of *C. shasta* infection in the annelids through qPCR. Data will be processed and analyzed using PCA to identify which environmental factors are most likely to explain the density of *M. occidentalis* populations and prevalence of infections with *C. shasta* in the Feather River, CA. The results of this study will add to the knowledge base related to Delta Science Management need 5B.

42-Combining multiple gears to evaluate impacts of the San Francisco Bay Living Shorelines Project on fish community abundance and diversity

Dana Lee, FISHBIO, danalee@fishbio.com

The San Francisco Bay Living Shorelines Project at Giant Marsh is a restoration effort to provide forage and habitat resources for a variety of native species, with a focus on the enhancement of key native species such as Olympia oysters (*Ostrea lurida*) and eelgrass (*Zostera marina*). The project, completed in 2019, consists of 368 acres of existing tidal marsh, oyster reefs, mudflats, and eelgrass beds located within the Point Pinole Regional Shoreline in Richmond, California. Post-project monitoring in July 2022 utilized multiple sampling techniques including environmental DNA (eDNA), an ARIS sonar camera, and two physical sampling gears (seine and hoop nets) to compare the fish assemblages, relative abundance, and habitat use of fishes among two unrestored control sites (unvegetated mudflats and natural eelgrass beds) and two restored treatment sites (eelgrass beds and restored oyster reefs). Overall, we observed 19 fish species, 63% of which were only detected by a single sampling gear, suggesting that the mixed gear approach captures a more complete picture of the fish community. The sonar camera detected greater numbers of fish and larger fish (>1m in length) compared to traditional sampling gear. Six species were detected in eDNA samples that were not captured in seine or hoop nets,

suggesting that eDNA may be useful for detecting species that evade traditional sampling methods. Species composition, size composition, and relative abundance of the fish community were generally similar across both the restored and unrestored sites. This outcome is likely due to the relatively short time since project completion and because fish assemblages readily mix in the dynamic, open intertidal zone. Continued monitoring at longer time scales post-restoration are likely needed to assess the effectiveness of these kinds of restoration efforts for the overall fish community.

43-Energy use in the Bay and Delta and Central Valley Chinook salmon spawning migration survival

Alyssa Fitzgerald, NOAA, alyssa.fitzgerald@noaa.gov

Using bioenergetic modeling based on water temperature and velocity, we can estimate fish swim speed, metabolic and swimming costs, and the likelihood of survival based on energy budget principles. This method has been employed successfully for adults migrating and spawning on the mainstem Sacramento River. However, fish must travel 100 river km (rkm) through the Bay and Delta. Estimating fish swim speed in the Bay/Delta – and subsequently, energetic swimming costs and survival – is difficult due to a lack of widespread temperature and velocity data and tidal influence. To approximate fish swim speed through the Bay/Delta, we compared theoretical estimates of ground speed from two swim types (tidal surfing or cruising at a constant speed of 1 body length/s) to empirical data from 69 tagged adult fall-run Chinook salmon (*Onchorhynchus tshawytscha*) that successfully migrated the Bay/Delta in 2022 and 2023. To estimate thermal exposure, we linked fish location to temperature estimated from tag sensors and water gages. We then used bioenergetic modeling based on approximated fish swim speeds and thermal exposure to quantify energy expenditure. In the Bay/Delta, the average thermal exposure of fish that made it to Rio Vista was 20.5°C (hourly: 11.5-24.3°C). Tidal surfing in temperatures 20°C better reflected observed migration times. An average sized fish tidal surfing at 20.5°C would expend 8% of its energy budget whereas at 16°C, it would expend 2% of its energy budget. Bay/Delta energy use was added to calculate total energy costs and migration survival. Fall-run Chinook salmon migrating in the Bay/Delta are more likely tidal surfing to minimize energy expenditure. Bay/Delta energy use in warm waters was non-negligible. Cooler water temperatures during adult migration would lower energy costs and increase migration survival.

44-Forensic geochemistry identifies the natal origins of record high numbers of steelhead (Oncorhynchus mykiss) salvaged at the state and federal water project pumps

George Whitman, UC Davis, gewhitman@ucdavis.edu

The Federal and State Endangered Species Act dictates limits on take of threatened and endangered fish species when extracting water for urban and agricultural use. The annual allowed take limit for wild steelhead (Oncorhynchus mykiss) was possibly exceeded when a record number of juveniles (n=2919) were entrained by the Central Valley Project and State Water Project export facilities between December 2023 to March 2024. A large fraction of these juveniles had their adipose fin intact, indicating

natural origin, which could exceed the take limit depending on how many were unmarked hatchery fish. Water exports were temporarily reduced, potentially lowering the entrainment of fish but also reducing water deliveries. To investigate the natal origins of the adipose-intact steelhead juveniles, 4 adipose fin clipped, and 12 unclipped juveniles collected in February and March 2024 were sacrificed, and their otoliths removed for geochemical analysis. The otoliths were thin sectioned to expose their cores and juvenile rearing phase and analyzed for strontium isotopes (87Sr/86Sr) via laser-ablation at UC Davis. A set of natal origin assignment models were developed based on the strontium isoscape of the Central Valley, with random forest performing best with a classification accuracy of ~90%.

Analyses of the adipose-intact juveniles revealed a range of different natal origins, including natural origin fish as well as unmarked hatchery fish. 8 of the juveniles were of natural origin, mainly from the Tuolumne (n=3) and Feather Rivers (n=3), while 4 of the adipose-intact fish were of hatchery origin from the Mokelumne Hatchery (n=2) and Nimbus Hatchery (n=2). Of the clipped juveniles, 3 were assigned to the Nimbus Hatchery and 1 could not be accurately assigned. This study suggests that while there are unmarked hatchery steelhead included in the juveniles collected at the pumps, the majority of the adipose-intact individuals originated from different rivers.

45-The Spring Kodiak Trawl: A Survey in Summary

Jennifer Oceguera Zavala, CDFW, jennifer.ocegueraZavala@wildlife.ca.gov

The Spring Kodiak Trawl (SKT) was designed to improve the detection rate of adult Delta Smelt (Hypomesus transpacificus) during their spawning season in the San Francisco Estuary. This survey was initiated in 2002 following the conclusion of the Spring Midwater Trawl Survey in 2001 because of its improved efficiency in catching adult Delta Smelt. The primary goal of the SKT was to provide valuable information about the population dynamics, reproductive success, and habitat use of Delta Smelt. The SKT employed surface trawls to sample the top 1.8 meters of the water column. It covered a total of 40 sampling stations distributed throughout the San Francisco Estuary and extended up the Sacramento and San Joaquin Rivers. These stations were sampled once per month during the Delta Smelt spawning season, from January to May, making SKT the only long-term monitoring program to follow the Delta Smelt population during this key reproductive time. The study performed dissections in the field to determine the proportions of males and females at different reproductive stages: pre-spawning, spawning, and spent Delta Smelt. Field dissections provided near-real time gonadal maturity data to water managers used to assess reproductive timing, reduce adult entertainment, and infer whether the next generation might have hatched near water export pumps. Most recently, due to the release of cultured Delta Smelt that started in 2021, SKT data was used to track the movement and the spawning development of cultured Delta Smelt. The Spring Kodiak Trawl survey concluded in 2023. This poster provides a project overview and summary of the contributions that the Spring Kodiak Trawl made to the conservation efforts and to help close the knowledge gap on Delta Smelt's life history over the 22-year study.

46-History of and results from a Yolo Bypass adult salmon and sturgeon acoustic telemetry study

Dennis Finger, Department of Water Resources, dennis.finger@water.ca.gov

The Yolo Bypass has been identified as a high restoration priority, and several restoration projects have been or will be implemented to improve upstream fish passage, reduce stranding risks, and provide rearing habitat for native fishes. However, there are substantial data gaps that must be filled to design and operate restoration plans, develop performance metrics for evaluation of restoration actions, and assess fisheries risks. To address these data gaps, the California Department of Water Resources (DWR) leads a long-term acoustic telemetry tagging and tracking study in the Yolo Bypass, annually tagging adult White Sturgeon and adult Central Valley fall-run Chinook Salmon as surrogates for Green Sturgeon and Central Valley salmonids, respectively. The goal is to develop a conceptual model of fish movement in the Yolo Bypass that can be used to inform fish passage operations and adaptive management strategies for the Yolo Bypass.

Here, we present a history of the multi-decade tagging study, illustrating changes in tag technologies and methodologies through time. We also present results from the past two years of the DWR acoustic telemetry study. We found that certain passage barriers impact salmon residence time during migration, that salmon display a wide range in movement patterns within the Yolo Bypass, and that salmon and sturgeon display high variability in migratory fates after leaving the Yolo Bypass.

47-Correlating ambient water velocities to the catch of small pelagic fish species of the San Francisco Bay Estuary and Delta.

Timothy Carrara, ICF, timothy.carrara@icf.com

Many small pelagic fishes are declining in the San Francisco Bay Estuary and Delta (SFE). In 2016, U.S. Fish and Wildlife Service implemented the Enhanced Delta Smelt Monitoring (EDSM) program to study delta smelt in the SFE. The program provides an opportunity to evaluate populations of other small pelagic fish species and the ability to correlate catch to ambient variables. For example, localized habitat variables, like water velocity, may affect the catchability of fish. We hypothesize that fish catch is inversely related to water velocity. High water velocities may make it more energetically difficult for fish to maintain horizontal position in.

From 2019 to 2022, we sampled with EDSM throughout the upper SFE from June through November. We deployed an Acoustic Doppler Current Profiler (ADCP) with the EDSM Kodiak trawl transect. Water velocity from the ADCP transects was compared to EDSM's catch data, focusing on small pelagic fish (e.g. longfin smelt, northern anchovy, threadfin shad, Wakasagi smelt and Mississippi silverside) within the first two meters of the surface water. We used generalized linear models to predict fish catch from water velocity and other water quality parameters.

Delta smelt catch was not correlated with water velocity. However, we observed a positive relationship between velocity and catch of longfin smelt and northern anchovy. We observed a negative relationship between water speed and catch for threadfin shad, wakasagi, and Mississippi silverside. We also found a small but significant positive correlation between specific conductivity and water speed.

Our results suggest some small pelagic fishes may respond to water velocities that affect catch. This may cause differences and limitations in sampling gear efficiency. The trend varied between fish species,

suggesting different responses to local water flow. These findings are important for understanding small pelagic fish species' population dynamics and catchability in estuarine environments.

Flow & Physical Processes

48-Is particle size a good predictor of bulk density?

Samantha McGill, USGS, scmcgill@usgs.gov

Sediment bulk density and particle size are two of the most relied upon parameters for predicting seabed erosion; bulk density, however, can be tedious to accurately measure. In addition, the units of bulk density have not been consistently reported in the literature, leading to confusion, particularly in the calculation of sediment budgets that typically require integrating mass-based and volumetric components. Relationships between dry density and sediment composition have been developed for other water bodies and differ between systems. Developing a system-specific predictive method for sediment bulk density can help fill data gaps, improving sediment budgets, model accuracy, and estimates of quantities of sediment needed for restoration. In this study, we investigate whether bulk density in San Francisco Estuary can be predicted from particle size, which is more easily and frequently measured. Sediment properties from the top 1 cm of cores collected over the past decade throughout the inter- and sub-tidal regions of San Francisco Bay and the Sacramento-San Joaquin Delta were compiled to examine the relationship between grain size and bulk density. Sample composition ranged from 2.18 to 99.97% fines (particles = 0.062 mm), dry bulk densities ranged from 0.217 to 1.54 g/cm3, and % organic carbon were 0.076 to 2.43%. Regression analysis indicates that the percent of fines explains 92% of the variation of dry bulk density (p-value = 0.05). The coefficient of determination decreased by 2% when % organic carbon was incorporated in the regression analysis (p-value = 0.05). The influence of additional variables that may impact sediment erodibility, such as hydrographic and oceanographic conditions, will be examined in the context of the regression results. Results are compared with published predictors for bulk density from other systems.

Food Webs

49-Finding the Zooplankton Buffet – Does high chlorophyll mean more Cladocera, Copepods, Rotifers, or Mysids?

Rosemary Hartman, Department of Water Resources, rosemary.hartman@water.ca.gov

Zooplankton are usually thought of as ‘primary consumers’, eating chiefly phytoplankton. Therefore, measurements of chlorophyll-a in the water column are often thought of as measurements of food supply for zooplankton. However, many zooplankton also consume microzooplankton, ciliates, bacteria,

and detritus as well as phytoplankton. In the Sacramento San Joaquin Delta and Suisun Marsh, many management actions are targeting increased primary productivity to bolster food-web support for pelagic fishes, but links between primary production and zooplankton have remained elusive. In this project, we used a series of generalized linear models to identify the most important predictors of abundance for eleven of the most common zooplankters in the upper estuary. We also conducted a literature review and data inventory to identify gaps in our understanding of zooplankton diets that might help future modeling efforts. We found that most of the herbivorous zooplankters were positively correlated with chlorophyll-a (with the copepod *Pseudodiaptomus forbes*i being a notable exception), whereas most omnivorous and predatory zooplankters were better predicted by biomass of microzooplankton. Recent research on zooplankton diets has shown selectivity in types of phytoplankton consumed, as well as consumption of detritus and microzooplankton even among "herbivorous" taxa. A full understanding of zooplankton abundance will need additional effort to quantify detrital resources, microplankton, and picoplankton.

50-Estimating historical and current primary production and fishery yield from regressions of nitrate uptake, carbon uptake and chlorophyll on ammonium with reference to the origin of the POD

Richard Dugdale, SFSU, rdugdale@sfsu.edu

Almost twenty years ago, using the stable isotope 15N as a tracer to measure phytoplankton nutrient uptake in the Bay/Delta ecosystem, ammonium concentrations at low levels were shown to repress nitrate uptake and therefore the completion of uptake of all the available inorganic nitrogen for phytoplankton growth. The phenomenon, well known to plant physiologists and oceanographers was no surprise in view of large inputs of ammonium from local sewage plants in the Bay Area and especially Regional San after the Clean Water Act. High chlorophyll concentrations were only observed at low ammonium levels. Enclosure experiments and field observations showed a consistent sequence of events with first ammonium uptake that dropped ammonium to low levels for nitrate uptake to begin followed by rapid chlorophyll concentrations accompanying high carbon uptake, until all nutrients were consumed. The relations between these events has been statistically quantified so that primary productivity (carbon uptake) can be predicted from ammonium concentrations. This provides a powerful tool to explore historical changes in primary productivity from long term ammonium data sets, including changes in primary productivity during the onset of the POD. This approach is also relevant to nutrient management decisions in the ecosystem. Plots of primary productivity calculated from historical ammonium concentrations and connected to fishery yield will be provided, to illustrate this novel application.

51-Modeling phytoplankton productivity: insights from a light utilization approach*

Reed Hoshovsky, SFSU, rhoshovsky@sfsu.edu

Phytoplankton compose the base of the food web in the San Francisco Bay-Delta (SFBD) and exert a bottom-up control on pelagic organisms. Phytoplankton productivity (productivity) is largely considered to be light-limited in the SFBD and thus can be linearly estimated from a factor that combines phytoplankton biomass and light availability. As a result, relatively few studies over the last 40 years have directly measured productivity with isotopic tracers in the SFBD. Most reported SFBD productivity are based on a single linear model calibrated in 1997 (e.g., Jassby et al 2002). A review of studies having implemented the linear model since 1997 shows that it is variable interannually and that the slope of the model (ψ) has decreased. Applying the value of ψ (0.73 ±0.02) from 1997 to contemporary data may be overestimating productivity by up to 50%. This study directly measured productivity with 13C-labeled bicarbonate between March and November of 2023 in the northern and western Delta. We determined ψ using these direct productivity values (ψ was 0.43 ±0.02), confirming the reduction in ψ since 1997. Productivity in 2023 is overestimated by 56% when applying the value of ψ from 1997 to data in this study. These results are reminders for management that the SFBD is highly dynamic and emphasizes the challenges associated with utilizing models based invariable conversion factors as opposed to working with direct measurements. Additionally, the observed decrease in ψ could suggest that phytoplankton are using light less efficiently or that increases in available light do not improve productivity. This speaks to recently observed taxonomic level changes in the phytoplankton community and can help guide restoration actions seeking to bolster phytoplankton productivity in the SFBD.

Harmful Algal Blooms

52-Exploring the potential for managing large scale hydrodynamic conditions to address cyanobacteria harmful algal blooms in the Sacramento-San Joaquin Delta

Ellen Preece, Department of Water Resources, ellen.preece@water.ca.gov

Cyanobacteria harmful algal blooms (CHABs) are increasing in frequency, intensity and duration in estuaries worldwide. In the Sacramento San Joaquin Delta (Delta), CHABs have been a topic of concern over the past two decades. In response, managers are urgently working to understand the factors that drive CHABs and identify feasible management options to avert ecological and human health consequences. We used a six year data set to explore relationships between flow parameters, temperature, and *Microcystis* biovolume to determine the potential for managing large scale hydrodynamic conditions to address Delta CHABs. We also looked at the relationship between *Microcystis* biovolume and the low salinity zone to see if it could be used as a proxy for residence time, because residence time is positively related to cyanobacteria abundance. We found the low salinity zone is not a useful proxy for residence time in the area of the Delta that experiences the most severe CHABs. Smaller scale tools such as isotopic tracers, particle tracking, or other modeling methods may be useful to predict where and when blooms may form. Our finding suggests that climatic conditions (i.e., temperature and water year type) have the greatest influence on *Microcystis* biovolume in the Delta, with higher biovolume during years with lower flow and higher temperatures. Further, there are interannual differences in *Microcystis* biovolume that cannot be fully explained by flow parameters or

temperature, meaning other factors not included in our model may be involved. We conclude that management actions to increase flow may be ineffective at reducing *Microcystis* to desired levels if water temperatures remain high.

53-Evaluating the ability of chlorophyll fluorescence sensors to detect cyanobacterial colonies common in the California San Francisco Bay Delta

Tim Baxter, USGS, tbaxter@usgs.gov

Understanding how well in situ chlorophyll fluorescence (fCHL) sensors detect cyanobacterial colonies is critical to monitoring harmful algal blooms (HABs) in the San Francisco Bay Delta, California. We conducted laboratory tests to better characterize the ability of commonly used Yellow Springs Instrumentation (YSI) and Sea-Bird Scientific © fCHL sensors to measure cyanobacterial biomass because they are the predominant fCHL sensors used by agencies in the Delta. To better understand how accurately these sensors detect phytoplankton colonies, we constructed an experimental laboratory chamber in which we can manipulate the phytoplankton community measured by the fCHL sensors. We conducted experiments using this chamber to assess how sensors respond to different cyanobacterial colony types, sizes, and densities. Examples of these experiments consist of placing different cyanobacterial colonies in front of the sensor, manually moving the colonies across the sensor face to determine the response time of the sensor, and breaking up the cyanobacteria colonies to evaluate how colony size affects sensor response. From these experiments, we will generate data that can inform how well sensors can estimate chlorophyll concentrations given different colony size distributions and densities in the water column.

54-Identifying spatio-temporal patterns in cyanoHABs using flow-through SPATTs in the California Sacramento-San Joaquin Delta

Katerina Cone, USGS, kcone@usgs.gov

Monitoring for cyanobacterial harmful algal blooms (cyanoHABs) can be challenging due to the ephemeral and episodic nature of blooms. Furthermore, in tidal estuaries, [SEA1] advection and dispersion of blooms over tidal-cycle adds to the spatio-temporal complexity of tracking blooms. To address this challenge, we integrated solid phase adsorption toxin trackers (SPATTs) into a boat-based flow-through-system (FTS) during high-resolution water quality mapping surveys from 2020-2024. SPATTS are a form of passive sampler that accumulate toxins throughout the duration of their deployment. Incorporating SPATT samplers into the FTS enabled us to collect SPATT cyanotoxin data over specific regions of the Sacramento-San Joaquin Delta to evaluate the spatial distribution of cyanotoxins and compare cyanotoxin patterns with other water quality parameters. SPATTs were deployed in a flow-through cooler, oriented perpendicular to flow, and water was pumped through the cooler over the extent of a transect. A flow meter was included to track the volume of water that passed through the cooler. At the same time, high-resolution water quality data was collected using a Yellow Springs Instruments (YSI™) EXO2 multiparameter water quality sonde, Sea-Bird Scientific© SUNA nitrate analyzer, and bbe Moldaenke© Fluoroprobe. Of the cyanotoxin classes, microcystins had the most

detections and the highest concentrations, with the highest concentration reported at 2,500 ng/g. The regions with the highest concentrations of cyanotoxins were in the central and southern Delta: Little Potato Slough, Middle River, the south of the Mokelumne River site, and Sycamore Slough. Of the years of study, the year with the most detections and highest concentrations was 2020, a dry year, while 2023, a wet year, was the only year that had no detections. Incorporating SPATT samplers into the FTS have helped provide more spatially integrated data that combines over bloom heterogeneity and tidal advection to help resolve spatial patterns in cyanotoxins.

55-Insights from years of boat-based water quality mapping surveys in the San Francisco Bay Delta

Jacob Brinkman, USGS, jbrinkman@usgs.gov

The U.S. Geological Survey California Water Science Center Biogeochemistry Group has conducted boat-based mapping surveys in the San Francisco Bay Delta, California in the spring, summer, and fall of 2018 and 2020 - 2023. These surveys produce high resolution and spatially dense water quality data that can be used to compliment traditional discrete sampling methods and continuous monitoring stations. Each survey represents a snapshot in time which can be used for a variety of data analytics pathways and can help inform a wide range of research and management questions. For example, these data document regional changes to water quality gradients, rapidly changing water quality events (such as harmful algal blooms), explore the abundance and distribution of phytoplankton, and much more. By adding or switching out instrumentation, this mapping system can be used to analyze water quality parameters including ammonium, water age, cyanotoxin presence, and algal color classes. This poster presentation will highlight how these data are being used, what some of the findings have been from that research, and possible applications for future use.

56-A new approach to detecting subclinical levels of domoic acid exposure in two nearshore sentinel species

Liz Bowen, USGS, lbowen@ucdavis.edu

There is emerging evidence that in addition to, and as a result of rising temperatures in the nearshore, the frequency and severity of harmful algal blooms (HABs) such as domoic acid (DA) in marine environments is increasing. Changing conditions in coastal ecosystems necessitate methods to assess the health of ecosystems and organismal communities to facilitate management decisions directed at maintaining these resources. The standard approach for evaluating the risk of domoic acid is to quantify the abundance of Pseudo-nitzschia and domoic acid levels in shellfish. In marine mammals, documenting acute domoic acid exposure has included biochemical testing, histopathology, and the observation of neuroexcitation clinical signs. However, these methods are insufficient for assessing chronic sublethal exposures. Levels of marine toxins in bivalves within legal limits for safe human consumption nevertheless may disrupt important cellular processes in bivalves and higher trophic level consumers. Identification of chronic, low-level exposure to domoic acid is critical to our understanding of nearshore ecosystem health for wildlife and human populations. Thus, an alternative approach is needed to measure the influence of domoic acid on the health of the individual and the ecosystem.

Although rapid advances in "-omic" technologies offer unparalleled opportunities to transform the study of HABs, few studies have used this potential. We have developed a new approach to HAB monitoring using transcriptomics in combination with sentinel species, in this case the sea otter (*Enhydra lutris*) and the razor clam (*Siliqua patula*), as examples of monitoring systems targeting subclinical responses to DA. In both cases we were able to detect physiological changes indicative of significant system perturbations due to DA exposure which did not elicit clinical signs and symptoms in the study species. These techniques could be applied to sentinel species in the Bay delta, including mussels, California sea lions, and/or a variety of fish species.

57-Machine Learning-Based Harmful Algal Blooms (HABs) Modeling in the Sacramento-San Joaquin Delta

Gourab Saha, Department of Water Resources, gourab.saha@water.ca.gov

The emergence of Harmful Algal Blooms (HABs) in the Sacramento-San Joaquin Delta (Delta) has become a major concern. Multiple initiatives have been implemented to track the crucial environmental factors influencing HAB formation, with the goal of inferring their occurrence. This study seeks to create a machine learning (ML) modeling framework that utilizes essential environmental variables to predict HABs in the Delta. The study focused on 15 HABs monitoring locations throughout the Delta. Grab samples collected from these sites between 2016 and 2020 included data on water temperature, chlorophyll, dissolved inorganic nitrogen, dissolved phosphate, and cyanobacterial cell count (CCC). This data set was employed to develop various ML models, including random forest, gradient boosting, XGBoost, and Artificial Neural Networks (ANNs). Additionally, a Multiple Linear Regression (MLR) model was created to benchmark the performance of these ML models. During the model development process, 80% of the data was used for training, while the remaining 20% was reserved for testing. The models were assessed using several statistical metrics. The study indicated a significant correlation between the target variable, CCC, and both chlorophyll (0.87) and water temperature (0.33). Furthermore, the study showed that the developed ML models generally outperformed the baseline MLR model. Additionally, the study discovered that water temperatures above 15 degrees Celsius were positively correlated with an increase in CCC, while lower temperatures had a minimal impact on CCC. The developed ML models offer powerful tools for predicting HABs, improving the capacity of Bay-Delta managers to address and mitigate these events. Specifically, by utilizing the advanced modeling techniques proposed in the study, managers can more effectively allocate resources to monitor and control HABs, thereby supporting the ecological health and long-term resilience of the Bay-Delta ecosystem.<

Inclusion, Equity, Diversity in Co-production of Science

58-Ensuring Post-Disaster Liquidity and Affordability: Strategies for Flood Resilience in the California Bay-Delta*

Kathleen Schaefer, CWS-UC Davis, kkschaefer@ucdavis.edu

Levee failures and resultant flooding in the California Bay-Delta pose significant risks to residents, highlighting the critical need for accessible quick liquidity and affordable flood insurance. This presentation addresses two central challenges: providing immediate financial relief to affected individuals and maintaining affordable flood insurance in an increasingly high-risk environment. Our approach, grounded in action research, leveraged the expertise of UC Davis and the private engineering firm of ENGEO in establishing a Geologic Hazard Abatement District (GHAD). By engaging with private insurance vendors and facilitating in-depth discussions with the GHAD Board, we explored sustainable solutions for financial flood risk management. The findings underscore the pivotal role of action research, demonstrating that active researcher involvement is essential for mobilizing external resources and driving practical initiatives. Establishing a GHAD was crucial because it provided a structured forum for communities to have in-depth, informed discussions about flood risk management, a task that they frequently find difficult to complete on their own because of daily obligations. Additionally, our research indicates that affordable flood insurance within the Delta's current risk landscape necessitates supplemental funding from philanthropic sources and general funds. Without such support, insurance costs will continue to rise, leaving many households uninsured and entire communities vulnerable to catastrophic events. This study's relevance is underscored by the growing threat of levee failure exacerbated by climate change. As insurance premiums soar, the proportion of uninsured residents will likely increase, intensifying the vulnerability of not just individual islands but the entire Bay-Delta region. Our research provides actionable insights into enhancing community resilience through strategic partnerships and innovative funding mechanisms, ensuring both immediate liquidity and long-term affordability in the face of flooding risks.

59-Delta Stewardship Council Outreach Posters

Megan Nguyen, Delta Stewardship Council, megan.nguyen@deltacouncil.ca.gov

Dane Whicker, Delta Stewardship Council, dane.whicker@deltacouncil.ca.gov

The Delta Stewardship Council (Council) is working to improve the public's awareness of its identity as an agency. The Council works to bring together representatives of the Sacramento-San Joaquin Delta's (Bay-Delta) diverse interests to collaboratively and inclusively develop science-based equitable solutions to achieve common goals. As part of the Council's Tribal and Environmental Justice initiative, staff have been taking on new engagement strategies, focusing on attending established community meetings – meeting people where they are - rather than asking community members to come out of their way to attend an agency meeting. The Council can strengthen its presence by acting as a liaison between community-based organizations (CBOs) and expert partners to enhance research capacity to address social-environmental issues in the Bay-Delta. To promote collaboration and transparency between the Bay-Delta community and the Council, the Council is sharing findings from and soliciting additional community input on both its climate adaptation (Delta Adapts) and Tribal and Environmental Justice work. Additionally, the Council is developing various outreach materials, including posters, coloring books, and other resources, to improve connections with the public at large events. At the Bay-Delta Science Conference, the Council will advance its objective of enhancing public awareness of the agency by showcasing a series of poster boards. These poster boards will shed light on the council's origins, approach and programmatic activities. Moreover, the outreach materials crafted for this event will serve as conversation starters, enabling the Council to engage with attendees and deepen their comprehension of the agency's role and contributions in the Bay-Delta. These resources offer valuable

opportunities for the public and researchers to learn about the Council's initiatives and participate in discussions about Bay-Delta stewardship.

60-Water Data for the People!

Jill Fantauzza, UC Berkeley

Large-scale scientific datasets are typically not legible to the general public, though the data they provide can inform communities and support their environmental stewardship and self-advocacy. While members of the scientific, policy, and governance communities require online access to these datasets, the conventions and language of scientific data portals are often not supportive of public involvement. This gap limits the ability of non-experts to engage meaningfully with these data and use it to participate in decision-making processes. To address this issue, the COEQWAL (COllaboratory for EQuity in Water ALlocations) project is building a data life cycle around community input. Community-driven questions and concerns determine sophisticated water allocation model runs. The resulting data are tagged with those questions and concerns, along with other community-driven metadata, through the creation and publication process so that they can be searched through the project's online interactive site using keywords familiar to the community. This narrows the gap between the questions that people have about water in the Delta and the conventions of scientific datasets. The COEQWAL website prioritizes data search and interpretation for an audience with a range of data experience. Narrative storylines, comparison tools, and visualizations accompany data. This approach allows us to create a platform that not only provides data access for experts but also supports the general public in engaging with and understanding critical water allocation tradeoffs in the Bay-Delta. Our poster presents these techniques. We will also have a website demo on-hand during the attended poster session and invite feedback to improve usability. By making large-scale scientific datasets accessible and legible to a general audience, the COEQWAL interactive data site aims to support diverse perspectives and public participation in water allocation governance.</p>

More Than Just Fish

61-Restoration Design Update for a Multi-Benefit Mosaic Wetland Project on Webb Tract

Jennifer Burt, GEI Consultants, Inc., jburt@geiconsultants.com

Funded by a grant from the Sacramento-San Joaquin Delta Conservancy, The Metropolitan Water District plans to implement a wetland restoration project on Webb Tract, one of the Metropolitan-owned islands located in Contra Costa County. The project will restore up to 3,500 acres on the deeply subsided island to wetlands, with design, permitting, and construction occurring over the next three years. Key goals of this multi-benefit project include halting and reversing peat oxidation and subsidence, promoting carbon sequestration, generating sustainable revenue to support land management, and restoring high-quality wetland mosaic habitat. This poster summarizes progress-to-

date on the wetland mosaic restoration design, as well as the primary design criteria and ecological considerations integral to the design. For example, restoration of emergent wetlands for subsidence reversal at scale has required accounting for relatively rapid anticipated changes in land elevations (at least 1 foot of accretion per decade) and raising water levels within wetland units to keep pace with accretion. Similarly, project design goals have taken multi-decadal habitat evolution outcomes across a relatively topographically complex landscape into account, as emergent wetland habitats will gradually expand into adjacent transitional uplands with continued subsidence reversal. Ecological restoration design considerations for benefiting migratory birds, GGS, recreation, ecocultural uses, and aquatic food web production to augment the Delta pelagic food web are also described. Successful project implementation on Webb Tract may provide insights for future cost-effective, large-scale wetlands restoration on other subsided Delta islands.

Retro-Ecological Futures for the 22nd Century

62-Piscivorous birds are utilizing restored tidal habitat aimed towards fish conservation in Suisun Marsh, San Francisco Estuary

Mason Rogers, Center for Watershed Sciences-UC Davis, marrogers@ucdavis.edu

Tidal wetland restoration in the San Francisco Estuary's Suisun Marsh is primarily targeted toward the conservation of endangered fishes. Ongoing monitoring tracks fish abundance and assemblages within many of these restored wetlands, and some research has characterized patterns of predation among birds on fishes (Young et al. 2022). Despite predation as a large focus of native fish decline, little data exist to describe habitat use by fish predators, such as piscivorous birds. We conducted visual bird point count surveys and beach seines in two tidal restoration sites within Suisun Marsh, with one being a more mature restoration and one being a relatively newer restoration, to evaluate habitat usage among both predatory piscivorous birds and prey species of fish. We calculated total abundances of each bird species and quantified their behavior at time of observation (foraging, resting, flying, etc.), to assess what piscivorous birds were present in the restorations and how they were using that habitat. Piscivorous birds such as herons, cormorants, and egrets were observed hunting in these restorations, likely on the novel assemblages of fishes and other aquatic organisms frequenting these habitats. We will analyze the relationship among fish and piscivorous birds in restored tidal wetlands to better understand the complex food webs and intra-taxonomic communities that are developing in these novel systems.

63-Stocked, but not Forgotten: A Comparison of Isolated Bay-Delta Waters Retaining Sacramento Perch

Abigail Deen, Center for Watershed Sciences-UC Davis, adeen@ucdavis.edu

The Sacramento perch *Archoplites interruptus* is California's only native species in Centrarchidae. For the past 200 years, the combined effects of habitat degradation, water diversions, and negative interactions with introduced sunfishes have driven them out of their native waters. This species persists in the state as part of novel ecosystems in ponds and reservoirs where self-sustaining populations have been intentionally introduced for recreation and to serve as genetic source populations. Many of these introductions have failed. The reasons for these failures have not been recorded due to a lack of effective monitoring in these isolated waters. While the physiological tolerances of this species have been tested in the lab, these results have not been compared to the conditions present in natural settings. From June 2024 to August 2026 we will deploy PME miniDOT probes to perform continuous water-quality monitoring at introduction sites in the Bay-Delta region. One site, located within the Dutch Slough Restoration in Oakley, CA, was first stocked in fall of 2023 for mosquito abatement. The status of this new population will be monitored via electrofishing alongside the same water quality parameters as other study sites. We will create an index of the necessary conditions for successful perch introductions and the limits at which certain variables might harm the longevity of existing populations. Current management for the species revolves around finding new sites for robust populations with minimal human intervention required. The information gathered in this study will be a powerful tool to inform the selection of new introduction sites, as well as to determine the resilience of current populations in the face of continued habitat degradation and climate warming.

Species & Communities

64-Comparison of Phytoplankton Community Structure and Nutrient Conditions in the San Francisco Estuary During Flow Augmentation and Non-action Periods

Caitlin Hall, ICF, caitlin.hall@icf.com

Phytoplankton are the principal primary producers in the San Francisco Estuary and Sacramento-San Joaquin Delta system. Phytoplankton dynamics have changed due to anthropogenic alterations to outflow, nutrient supply, and invasive clam introductions. Summer blooms of the cyanobacteria Microcystis spp. create additional environmental stressors, producing toxins and limiting light availability, potentially restricting the growth of more nutritious phytoplankton taxa. Managed flow regimes have been implemented to improve habitat conditions, with the intention of increasing fish

populations throughout the upper San Francisco Estuary. We explore how managed flow and wet-year conditions affected phytoplankton community and biomass. We collected phytoplankton, chlorophyll-a, nutrient samples, and water quality data from randomly-selected sites in the upper San Francisco Estuary in the fall from 2017 to 2022. Microscopy was used to identify and enumerate phytoplankton taxa. The presence of Microcystis spp. was also assessed visually during sample collection. We used ANOVA to contrast nutrient concentrations between years and regions and generalized linear models to correlate phytoplankton biomass with predictor variables. While phytoplankton biomass (as measured by chlorophyll-a) was lower during managed flow action years, the community composition had a larger proportion of diatoms, an important taxa because of their essential fatty acid content and large cell volume. Higher residence times due to lower flows may favor higher biomass, but may also favor cyanobacteria, which have a lower nutritional value and can cause harmful algal blooms; increased flows during the fall decrease the risk of harmful algal blooms. There has been a focus on improving habitat conditions for declining pelagic fish populations in the upper San Francisco Estuary using managed flow actions. These management actions subsequently impact the lower trophic levels of the food web. There have been many hypothesized benefits of flow actions on the phytoplankton community and our analysis examines these impacts.

65-Long-term Patterns in Splittail Abundance: Is a Trend Hidden in Their Inherent Recruitment Variability?

Savannah Valdez, CDFW, savvaldez@gmail.com

Splittail (Pogonichthys macrolepidotus) are endemic cyprinids of the San Francisco Estuary that depend on flooded seasonal wetlands for successful spawning. While populations are equipped to survive drought years with their long-life span and high fecundity, habitat loss, contaminants, and extended drought periods still threaten Splittail survival. Splittail were listed as a threatened species by the United States Fish and Wildlife Service (USFWS) between 1999-2003 and remain a Species of Special Concern in the state of California. Understanding the long-term abundance and recruitment of these native fish is challenging because of their inherent recruitment variability due to the increasingly variable Mediterranean climate and floodplain inundation in California's Central Valley. We analyzed catch of age-0 Splittail from beach seine data collected by the USFWS Delta Juvenile Fish Monitoring Program between 1999-2023 to investigate temporal trends as they relate to variation in precipitation, measured as discharge from the Delta. Twenty-five years of seining (nearly 33,000 individual hauls) across 36 sites yielded over 143,000 Splittail. We hypothesized that catch per unit effort (CPUE) of age-0 Splittail would be significantly higher in wet years than dry years, but that overall CPUE has decreased since 1999 after adjusting for variable Delta outflow. After comparing a set of candidate models, we conclude that Splittail abundance appears to have increased after adjusting for variability in annual precipitation and runoff. Our results also support previous work demonstrating that Splittail abundance and recruitment was higher in wet years than dry years. Our results convey a variable, but increasing Splittail population over 25 years, suggesting that current conservation and restoration efforts may be effective.

66-Salinity-Driven Change in the Suisun Bay Benthos: A Case Study for Identifying Causal Drivers

Phoebe Carpenter, Department of Water Resources, Phoebe.Carpenter@water.ca.gov

While benthic invertebrate communities are often viewed as largely sessile and slow to change, in estuarine environments their composition can shift rapidly in response to the system's complex hydrology. In the San Francisco Estuary (SFE), both natural and engineered hydrological fluctuations can drive salinity in some bays and channels from near-freshwater conditions to mesohaline or higher within weeks or months. Additionally, biological responses to physical drivers can change depending on the ecosystem state, which can make causal relationships difficult to determine. Here we analyzed invertebrate communities in the Delta benthos across a natural salinity gradient using multivariate statistical techniques. We found that benthic communities at the same fixed site differed by water year classification (e.g., dry vs. wet), particularly in Grizzly and Suisun Bay, indicating that related variables such as flow, depth, and salinity might be driving these changes. To better assess causality, we used convergent cross-mapping (CCM) to test for a causal relationship between X2, a measure of bottom salinity intrusion into the Delta, and the abundance of the invasive overbite clam (*Potamocorbula amurensis*) in Suisun Bay. This test case provides evidence for a causal relationship between X2 and *P. amurensis*, in a situation where correlation between the two is present but not straightforward. The application of CCM to long-term monitoring data in the SFE demonstrates its potential as a tool for uncovering mechanistic links between ecosystem drivers and biological communities, with significant implications for resource management.

67-Covariation between zooplankton and phytoplankton communities in the San Francisco Bay-Delta.

Julien Moderan, ICF, julien.moderan@icf.com

Estuaries are highly dynamic ecosystems where different sources of organic matter mix and support complex food webs. Estuarine communities are often characterized by low species diversity, but high functional diversity and high secondary productivity driven by the few taxa more tolerant to highly variable environmental conditions. In the San Francisco Bay-Delta, multiple anthropogenic stressors, including non-native species introductions, and extremely complex and highly managed flows have further altered the structure and function of the system, with several pelagic fish species drastically declining in the early 2000s, including the endangered Delta smelt. Improving our understanding of the structure and dynamics of the lower food-web is critical to inform key management actions. We used extensive datasets collected from 2017 to 2021 as part of the Directed Outflow Project and a range of multivariate approaches including Canonical Correspondence Analysis and Co-correspondence Analysis to gain insight into the relative contribution of environmental drivers and bottom-up effects in structuring the zooplankton community. Despite strong underlying environmental gradients including salinity and turbidity, diversity and abundance patterns in phytoplankton and zooplankton communities are at best only partly explained by the routinely measured environmental variables. Strong covariation at the regional scale between species and observations from both communities suggests that they partly respond to the same environmental drivers but also that variation in the zooplankton community and

key food items for planktivorous fish could be directly controlled by variation in the phytoplankton assemblages. The strength of those relationships is further examined at smaller geographic scales and for different seasons/years.

68-Preservation of salt marsh harvest mouse in San Francisco Bay Estuary*

Alexander Xu, Mountain View Highschool, atrex2015@gmail.com

The salt marsh harvest mouse (SMHS, Reithrodontomys raviventris) is an endangered species enlisted first in 1970. They are endemic to the estuary of the Californian coast and serve as an indicator species for the health of the marsh ecosystems in the Bay-Delta area. Currently, the SMHS is threatened by habitat isolation and loss due to climate change. Various actions have been taken. However, after extensive conservation efforts, this species remains endangered. This presentation will represent a summation of the gaps in our knowledge of SMHS conservation that are important for development of future recovery plans. The research has been conducted through review and analysis of current literature, recovery plans, websites, and interviews of key opinion leaders. These gaps include limited knowledge on how SMHS interacts with other species, its habitat requirements and how the habitat being impacted by the water level, and to a lesser extent what areas will become suitable habitat in the future so that the proper lands can be conserved. Additionally, more analysis of the mouse's populations is needed, and a strategy to increase genetic diversity needs to be developed. Additional work needs to be done to enable a more accurate differentiation of the SMHS from their close relatives. Finally, work has to be done to identify environmental changes associated with restoration challenges. Effective management of the Bay-Delta must balance water supply and quality needs with the requirements of endangered species like the SMHM. Recovery plans of SMHS are due for an update in 2026. The presentation summarizes gaps in our knowledge and recent progress about conservation of the mouse, and makes recommendations for developing future recovery plans. Efforts to preserve SMHS and contribute to broader environmental goals that benefit a wide array of species and help manage the region's critical natural resources effectively.

Water & Sediment Quality

69-Modeling the Impact of Friant Dam Releases on San Joaquin River Temperatures: Implications for Chinook Salmon*

Owen Cancroft, SFSU, ocancroft@sfsu.edu

Hydrologic modeling is an effective tool in managing California's water resources, enabling predictions of streamflow, water temperature, and quality under various scenarios. These models are useful in riverine systems affected by dams, where controlled releases influence downstream river temperatures, a key factor in aquatic ecosystem health. The San Joaquin River downstream of Friant Dam experiences river temperature fluctuations that disrupt aquatic ecosystems. The extent of coldwater habitat for the

native Chinook salmon (*Oncorhynchus tshawytscha*) has been reduced by dams and water regulation practices, leading to river temperature variations that severely impact river life stages. We investigate the effects of controlled water releases from Friant Dam on the San Joaquin River's thermal regime and its implications for Chinook salmon populations by modeling heat fluxes and river temperature. More specifically, we assess how the modeled river temperatures compare to thermal requirements of Chinook salmon during different life stages, under varying temporal and flow scenarios. This study utilizes the Fluvial Energy Balance Model (FLUVIAL-EB), a physically based numerical energy balance model that simulates the spatially distributed energy balance and river temperature continuously over river distance and over time. We predict heat fluxes and river temperature at 100-meter spatial resolution and 30-minute timesteps along a 150-kilometer reach of the San Joaquin River downstream of Friant Dam. The model incorporates hydrological and meteorological data across the watershed to simulate river temperature and energy balance dynamics under different flow release scenarios. Preliminary results indicate that strategic dam releases can moderate river temperatures, reducing thermal stress during critical periods of the Chinook salmon life cycle, although they may be less effective tens of kilometers downstream, providing insights for optimizing water management practices to support the ecological health of the San Joaquin River and the greater Bay-Delta system.

70-Continuous and discrete monitoring of the effects of land use changes on island drainage water quality in the Sacramento-San Joaquin Delta

Christina Richardson, UC Santa Cruz, cmrichar@ucsc.edu

The Sacramento-San Joaquin Delta, California, contains over 57 islands reclaimed from previously existing marshland by the construction of levees and drainage systems. Drainage and agricultural use led to the oxidative loss of the carbon-rich soils; thus, today, many of these islands have subsided several meters below the level of surrounding waterways. Island drainage inputs represent a poorly constrained source of nutrients, carbon (C), and other contaminants to Delta waterways. However, recent work has begun to uncover the significance of island drains in Delta nutrient and C biogeochemistry. For the Delta islands themselves, drainage exports of C, sediment, and nutrients represent mass losses, and these losses are essential to understand as efforts to sequester C and reverse land surface subsidence continue. Restoring wetlands and changing crop types on subsided Delta islands may help counteract subsidence and reduce carbon emissions. However, these changes could have unintended consequences with respect to island drainage. Here, we had the unique opportunity to partner with community groups, The Nature Conservancy and Conservation Farms and Ranches, to collect and compare island drain monitoring data from pre- and post-rice production land use periods on Staten Island. In situ, high-frequency monitoring with water quality sondes was paired with the collection of bimonthly discrete samples to quantify lateral exports of C, nutrients, pesticides, and other water quality constituents. Preliminary results suggest that increasing rice field coverage increases island drainage water and lateral C exports.

71-Assessing Sediments as a Nutrient Source/Sink for the Sacramento-San Joaquin Delta

Nick Framsted, USGS, nframsted@usgs.gov

Sediments represent a large pool of nutrients within aquatic ecosystems, yet rates of nutrient flux from sediments remain largely unconstrained across the Sacramento-San Joaquin Delta (Delta). To investigate benthic nutrient flux across the Delta, we deployed an in situ benthic flux chamber at 18 sites that spanned a range of habitats on two separate dates during the summer of 2021. During deployments, we measured changes in ammonium (NH4), nitrate (NO3), dissolved inorganic nitrogen (DIN, the sum of NH4 and NO3), and dissolved oxygen (DO) in the overlying water using a high frequency, boat-based, flow-through instrument package. We calculated flux rates for each constituent and related them to sediment properties of intact sediment cores collected at each site. We found that DIN flux rates ranged from -292 to 1405 µmol m-2 hr-1 and sediments were a net source of DIN and NH4at 9 of 12 sites with DIN data. Sediment NH4 flux comprised the majority of sediment DIN flux, and the abundance of bivalves was associated with higher DIN fluxes from the sediments, mainly in the form of NH4. Seven of 16 sites with NO3 data were net sinks of NO3, and about one-third of sites showed temporally variable net NO3 flux with sediments switching from sources to sinks (and vice versa) between early and late summer samplings. The benthos was a net sink for DO at all sites, but magnitudes of biological oxygen demand varied from nearly -500 to near 0 mg m-2/ hr-1. We found no relationship between sediment carbon, nitrogen, and Olsen-phosphorus concentrations and DIN fluxes at our sites, suggesting that other factors determined fluxes. These results indicate that the benthos is potentially a source of DIN to the Delta and should be considered in future biogeochemical models and nutrient management plans within the San Francisco Estuary.

72-What Where When: USGS Water Quality, Nutrient, and Phytoplankton Network

Maura Uebner, USGS, muebner@usgs.gov

Multiple stakeholders have an interest in the management of the California San Francisco Bay-Delta to achieve objectives related to water quality, water supply, recreation, and ecosystem health. Reliable, intercomparable, long-term datasets of environmental observations are valuable tools for informing management decisions and keeping the public informed about the state of the ecosystem. The U.S. Geological Survey (USGS), in cooperation with the Bureau of Reclamation, Sacramento Area Sewer District, the San Francisco Estuary Institute, and others, has established a network of over 20 high-frequency in situ monitoring stations throughout the Bay-Delta. These stations collect data at 15-minute intervals, providing real-time measurements of water quality parameters including temperature, specific conductivity, turbidity, dissolved oxygen, pH, dissolved organic matter fluorescence, chlorophyll fluorescence, and nitrate concentrations. At each monitoring station, supplementary discrete water quality samples are collected approximately monthly, and analyzed for nutrient concentrations, phytoplankton enumeration, and cyanotoxin concentrations. USGS data have been used to identify trends, understand environmental drivers, compute fluxes, and to validate coupled hydrodynamic-biogeochemical models. USGS monitoring stations have high temporal resolution with long periods of

record, and we hope to increase awareness of the data and its potential uses in service of improving Delta science and management.

73-Pesticide types and concentrations entering the Sacramento-San Joaquin Delta via island drainage

Christina Richardson, UC Santa Cruz, cmrichar@ucsc.edu

Pesticides are common in surface waters throughout the Sacramento-San Joaquin Delta (the Delta) and can harm aquatic life. Water exported from subsided islands in the Delta, which are commonly farmed, can be sources of pesticides to nearby waterways. However, pesticide inputs from Delta islands remain understudied. To address this knowledge gap, we measured pesticide concentrations in surface water samples collected from the main drains of two Delta islands with distinct land use patterns. Island drainage surface water samples were analyzed on a quarterly basis across multiple years (2022 through 2024) for 178 current-use pesticides (dissolved and suspended phase). Over the first 8 quarterly samplings, we detected 28 different dissolved pesticides (5 fungicides, 12 herbicides, 10 insecticides, and 1 other) across the three sites. Several dissolved pesticides (3,4-Dichloroaniline, Azoxystrobin, Chlorantraniliprole, Clothianidin, Hexazinone, and Methoxyfenozide) were detected in ~70% or more of the samples across all sites. We found 10 different pesticides (4 herbicides and 6 insecticides) associated with suspended sediment across all sites and times. Multiple pesticides (Bifenthrin, Clothianidin, Cyhalothrin, Cypermethrin, Deltamethrin, Dichlorvos, and Imidacloprid) were detected at concentrations that exceeded U.S Environmental Protection Agency acute or chronic invertebrate toxicity benchmarks. Pesticide detections also showed some spatial differences that were site-dependent and likely related to differences in land use. These preliminary results suggest that Delta islands can be sources of diverse groups of pesticides at potentially ecologically consequential concentrations. Moreover, these results could have implications for projects that involve recycling on-island drainage water for multi-benefit land use projects, like flooded rice fields that can support fisheries or for managed non-tidal wetlands.

Weaving together Indigenous and Western sciences to restore wild Nur (Chinook Salmon) to the Winnemem Waywaket (McCloud River)

74-Nur Nature-Based System: Winnemem Wintu indigenous science guides the rematuration of winter-run Chinook salmon to the McCloud River

Leanne Pearle, UC Davis, lmpearl@ucdavis.edu

Urgency to reintroduce salmon to natal spawning grounds in California, throughout their historic range, has increased in order to counter the negative effects of climate change, drought, and habitat loss on wild fish populations. Up to this point, reintroduction attempts of salmon (also known as Nur to the Winnemem Wintu Tribe) have followed hatchery-sourced supplementation practices common throughout the western United States. In collaboration with Chief Sisk and the Winnemem Wintu Tribe, and incorporating indigenous science, our team from UC Davis has developed a rearing system for the Nur. The Nur Nature-Based system mimics a natural salmon redd, through inclusion of native river rocks and plants, which allow the Nur an early introduction to their natal environment. The two-part hatching and rearing system, which is passively fed by river water, allows Nur to naturally learn their environment and volitionally move from a hatching incubator to a rearing tank and finally to the McCloud River itself. Between July and October of 2023, the NNB system reared just under 40,000 Nur. We seek to increase those numbers with improvements including the introduction of additional natural elements, such as ripples and pools, allowing us to bring Chief Sisk's vision to life and for the fish to learn to be mountain climbers. This poster presents the detailed system design and outlines improvements intended to bring salmon home to the McCloud River.

75-Pedigree reconstructions of juvenile winter run Chinook salmon (Nur) reveal insights into stream-side incubation approaches for reintroduction

Jaime Ward, Winnemem Wintu Tribe, jamward@ucdavis.edu

In 2023, an innovative system for raising winter run Chinook salmon eyed-eggs along the banks of the Winnemem Waywaket (McCloud River) was designed by Chief Sisk, spiritual leader of the Winnemem Wintu Tribe. The Tribe worked in partnership with UC Davis' Fish Conservation and Physiology Laboratory to bring this salmon rearing vision to reality. The Nur Nature Base (NNB) replicates features that salmon embryos would experience in a natural riverscape- water flowing from below river rocks, native plants that provide medicine, complex hydrodynamics that teach salmon to become strong swimmers, and volitional entry to the river. A total of 80,153 eyed eggs from crosses between 35 females and 59 males from winter run Chinook salmon from Livingston Stone National Fish Hatchery spawned on 6/12/23, 6/28/23, and 7/10/23 created 136 unique family crosses. Eggs from a single cross were either incubated in traditional hatchery heath trays or NNB along the river allowing progeny encountered at later life stages to be traced back to their incubation method through parentage analysis. Downstream collection gear collected and transported McCloud-imprinted juveniles downstream of Keswick Dam to continue their journey to the ocean. Fin clips were not sampled from juveniles for genetic analysis. To reduce fish handling, genetic tissue samples were collected from salmon retrieved from the stomachs of non-native predators also caught in the salmon collection gear. Internal muscle and heart tissues from approximately 200 juveniles were used for genetic analysis to minimize contamination from other salmon in the predator stomachs. USFWS provided the parental genotypes and Cramer Fish Sciences conducted the genetic analysis of progeny. Here, we will present any differences observed in outmigration timing and survival to Shasta Reservoir associated with heath tray and NNB rearing approaches.

Late Breaking

76-California Vernal Pools

Andrew Tate, UC Davis, atate@ucdavis.edu

California vernal pools are complex and assessing the biodiversity of the pools remains challenging due to multiple factors: the pool's ephemeral nature, the expertise needed to differentiate between certain morphologically similar invertebrates inhabiting them, and the fragility of resident species and the pools themselves. To aid federal wildlife managers in assessing the biodiversity of managed pools, I am developing environmental DNA (eDNA) approaches using metabarcoding. Target sequences from common universal barcodes 12S ribosomal RNA, 16S ribosomal RNA, and the plant-specific chloroplast trnL intron are used to investigate the ability of eDNA metabarcoding to detect target taxa, assess biodiversity within and among pools, and identify differences in species composition among sampling methods and between restored and natural vernal pools. I will also develop rapid, sensitive CRISPR-based assays to detect endangered species, such as the vernal pool fairy shrimp and California tiger salamander, in vernal pools in near real-time. This study will aid managers in non-invasively monitoring and assessing biodiversity in vulnerable vernal pool ecosystems over multiple years. By providing managers with more efficient monitoring methods, this study will improve management's capacity to make data-based decisions to close the gap between understanding the ecosystem and implementing conservation actions often found in agency adaptive management cycles.

77-Wallace Weir's Wild Winter: Unprecedented Fish Occurrence in the Yolo Bypass

Hailey Mico, Department of Water Resources, Hailey.Mico@water.ca.gov

The Wallace Weir Fish Rescue Facility is a water control and fish rescue structure in the Knight's Landing Ridge Cut in the western Yolo Bypass designed to address the loss of ESA and CESA-listed anadromous fishes to comply with the 2009 and 2019 NMFS Biological Opinions on the State and Federal Water Projects. The Facility was constructed as a collaborative effort between the California Department of Water Resources and Reclamation District 108. Staff from RD 108 and CDFW operate the Facility to pass excess flows and rescue fish before they enter the Colusa Basin Drain, a dead-end canal with no access to spawning habitat. The Facility is comprised of three bottom-hinged water control gates, six downstream picket weirs which allow water to pass while blocking upstream movement of fish, and a fish rescue facility to corral the target fishes. In this poster, we review Facility operations and fish catch from the 2023-2024 season and highlight special operations and unique considerations. The Facility was operational from November 10, 2023 – June 4, 2024, and CDFW staff successfully rescued a record-breaking 780 Chinook Salmon Oncorhynchus tshawytscha, seven Central Valley steelhead O. mykiss, and three White Sturgeon Acipenser transmontanus which were returned to the Sacramento River to continue their upstream migration. Interestingly, a high proportion of this year's returning Chinook Salmon exhibited the jack/jill life history strategy. In an unprecedented occurrence, six juvenile Southern

distinct population segment of North American Green Sturgeon A. medirostris mortalities washed down the system from an unknown source and onto the Facility's picket weirs. Another novel event took place this operational season when the first ever adult White Sturgeon entered the fish rescue facility. These special circumstances required extensive communication and collaboration with project partners and regulatory agencies to address fish rescue needs and guide future operations.

78-Baylands Habitat Map: Mapping Progress Toward Habitat Restoration Goals

Alex Braud, San Francisco Estuary Institute, alexb@sfei.org

In order to support the San Francisco Estuary Wetland Regional Monitoring Program (WRMP), the San Francisco Estuary Institute (SFEI) employed automated estuarine habitat mapping approaches using Object Based Image Analysis, aerial imagery, and various LiDAR-derived digital elevation model derivatives. The Baylands Habitat Map 2020 updated the existing map of tidal marsh, tidal flats and diked baylands to reflect the many changes in baylands distribution and abundance that have occurred over the last two decades. It also depicts land use and infrastructure information relevant to baylands restoration and management opportunities and constraints. The utilization of advancements in automated Object-Based Image Analysis enables cost-effective regular updates, enabling managers to quantify changes in wetland quantity and quality due to the impacts of climate change, shoreline management, and restoration efforts.

Co-created with the WRMP Geospatial Workgroup, the Baylands Habitat Map is a fundamental component of the WRMP, serving as a common reference map to help coordinate baylands protection and restoration for all interests. It will be used commonly by public agencies to visualize and track baylands projects in EcoAtlas. By combining the Baylands Habitat Map of existing tidal marsh with planned restoration projects, the region is able to better track its progress towards meeting its restoration goals. Furthermore this foundational map will continue to feed into co-developed metrics to assess bayland resilience and change in support of WRMP goals. This new Baylands Habitat Map is necessary for the regional community of planners, regulators, managers, and scientists to track and assess the progress of restoration and protection efforts, relative to each other and over time, in the context of ongoing climate change.

79-Climate-Smart Tools to Protect California’s Freshwater Biodiversity

Ted Sommer, tedsommer3@gmail.com

California’s freshwater ecosystems—and the native plants and animals that rely on them—have been in decline for decades. Roughly half of California’s native freshwater species are highly vulnerable to extinction within this century. But efforts to protect and recover native species now face an additional serious threat: climate change, which is accelerating and compounding the impacts of past and current land and water management issues. Simply working harder, using the same insufficient approaches to conservation, is unlikely to be successful. New approaches, including some that are experimental or

highly controversial, are urgently needed. Based on a review of climate adaptation plans and interviews with a suite of different experts, we identified 22 different management actions that can help California rise to this urgent challenge. The general approaches fall into three general strategies--habitat support, species support and contingency actions. Because of California's geographic variability and climate uncertainties, we recommend a portfolio approach where a suite of actions are vetted and implemented a watershed basis.
Pilot projects and companion research, monitoring, and evaluation are needed to guide decision making, especially given the uncertainties about many of the potential management options.

80-Water-carbon measurements for annual drought management in the Delta

Olmo Guerrero Medina, UC Davis, olguerrero@ucdavis.edu

In collaboration with multiple State Agencies, including the Delta Conservancy and local farmers, we aim to evaluate the efficiency of agricultural water-saving practices in the Sacramento-San Joaquin Delta in adapting to the drier hydrological scenarios expected with climate change. The Delta region used to experience flooding conditions regularly, and drier conditions could increase carbon emissions by oxidation of exposed peat soils. Our approach involves a multi-year measurement effort with data collected at the farm and regional levels to inform water and carbon relations relevant for irrigation water management. In 2023, we installed a network of six micrometeorological stations to continuously measure evapotranspiration (water loss) and CO2 fluxes (capture and emission) using the eddy covariance method, a gold standard in the international scientific community. We carefully considered the location of the experimental equipment in order to represent different Delta Island, crops, management practices and soil conditions. We complement the in-situ measurements with numerical modeling (ACASA), remote sensing products (OpenET) analysis, and AmeriFlux data for the region. This new dataset will provide insights into several key questions: 1) Is water consumption lower on farms using water-restricted practices compared to conventional farming across seasonal and yearly scales? 2) What factors, such as soil, crop, and local climate, influence water use at the farm and regional scales? 3) Are water-saving strategies also carbon-neutral in the region? 3) Can Delta annual crops be managed for both water conservation and subsidence prevention? 4) Is there a specific practice or crop that should be promoted based on its water-saving or carbon-sequestration benefits? Additionally, we will assess the accuracy of OpenET, a new remote sensing tool, in estimating water loss in the region. We look forward to sharing some preliminary results and opening the floor for collaboration and constructive insights.

81-Gaps and opportunities for predicting the effects of water and agricultural managements decisions on community economic and food security through hydro-economic modeling: A meta-analysis

Trevor Partridge, USGS, tpartridge@usgs.gov

Most of the vegetables, fruits, and grains consumed in the United States are grown using supplemental water from surface and groundwater reservoirs for irrigation. However, in many regions of the country, water is a scarce and variable resource and water used for irrigation accounts for the vast majority of total freshwater consumption. Interannual variability as well as extreme weather events such as drought can simultaneously increase agricultural water demand and reduce the total amount of water available for irrigation, potentially leading to challenging water and land management decisions, such as growing a new crop or removing fields from production. Water distribution and management among sectors and users is governed by complex decision making and institutional arrangements at regional, local, and farm scales. This multi-sector and multi-scale governance structure makes it difficult to quantify the cascading impacts of agricultural water availability and use on communities that are heavily dependent on agricultural production for revenue generation and employment. Modeling frameworks that capture aspects of system dynamics across hydrology, socioeconomics, agriculture, and governance provide insight on the tradeoffs involved in water management decisions and could inform how decisions affect irrigation water use and potentially translate to economic impacts within local and state economies, including distributional outcomes across various populations. However, different disciplines (e.g. engineering, economics, or agronomy) often use different methodological approaches when addressing these questions. We are conducting a meta-analysis of existing literature to characterize the methodological differences across disciplines in socio-hydro-agro-economic modeling to identify gaps and opportunities for incorporating human decisions and variable socio-economic outcomes into water use modeling frameworks. Here we present the project overview and preliminary findings. Future work will use the results from this meta-analysis to construct a conceptual modeling framework for simulating water availability and management, and socio-economic outcomes on irrigated agricultural production in the Central Valley of California.

82-Rapid Detection of Chinook Salmon eDNA Using CRISPR-based SHERLOCK Assay

Diana Munoz, UC Davis, damunoz@ucdavis.edu

Detecting DNA in the environment (eDNA) from aquatic species is a non-invasive and cost-effective method of monitoring vulnerable species and is a valuable addition to the resource management toolbox. Quantitative PCR (qPCR) is currently the leading technique for aquatic eDNA detection. However, processing samples via qPCR requires expensive instrumentation, molecular biology experience, and several hours of benchwork to produce results. Outsourcing to laboratories with the necessary equipment can further increase waiting times for results. Recent advances in CRISPR-based diagnostics have enabled the development of alternative methods for eDNA detection. Specific High-sensitivity Enzymatic Reporter unLOCKing (SHERLOCK) assays use the CRISPR-Cas13a enzyme complex to detect target nucleic acids and produce a fluorescent signal. These assays are rapid (< 1 hr), sensitive, and can be performed by non-experts with inexpensive equipment under field conditions. Multiple such assays have been developed for rapid detection of aquatic species in California water bodies. We developed a SHERLOCK assay to monitor Chinook Salmon (Oncorhynchus tshawytscha) re-establishment in upstream locations following dam removal. We designed RPA primers and a crRNA guide sequence to target a species-specific region of the cytochrome b (Cytb) gene in Chinook Salmon mitochondrial DNA. The RPA primers duplicate the target region, if present, in an eDNA sample. The crRNA complements the target site and programs the CRISPR-Cas13a complex to activate when the target region is detected in

an eDNA sample. These two factors contribute to high specificity in SHERLOCK assays. Our final assay detected tissue-derived DNA from 40 Chinook Salmon individuals from multiple populations within 30 minutes of SHERLOCK reaction initiation. We anticipate that our assay will be useful for Chinook Salmon detection across their current range.

83. Pattern, Process, and Precision: understanding data limitations for littoral food webs of the Sacramento-San Joaquin Delta

Matthew Young, USGS, mjyoung@usgs.gov

Ecosystems are inherently complex, and small-scale habitat differences can greatly alter food web structure. This food web variability is further confounded by the presence and abundance of non-native species which can have significant impacts on a variety of ecosystem constituents and processes. In the Sacramento-San Joaquin Delta, non-native species are prevalent, and habitat heterogeneity is an important driver of food web structure. In particular, littoral ecosystems in the Sacramento-San Joaquin Delta support a substantial proportion of primary productivity and are changing rapidly due to proliferating non-native aquatic vegetation and fish species. Largemouth Bass, Micropterus salmoides, and Mississippi Silverside, Menidia audens, are examples of two non-native fish whose impacts have been well studied, but there are many non-native species that are also abundant and have received less study, such as Black Crappie, Pomoxis nigromaculatus. We use an R-based implementation of the EcoPath with EcoSim ecosystem model to quantify the role of Black Crappie and other invasive fish species on food webs in a range of tidal freshwater habitats. Our results indicate that the entire community of non-native species is embedded within local food webs. We also identify which ecosystem constituents lack sufficient data for precise understanding of food web impacts, and quantify the data precision necessary to inform ecosystem modeling of this type. Study results can be used to predict food web structure associated with tidal wetland restorations or other littoral habitat modifications in the Sacramento-San Joaquin Delta.

84. Examining the effects of management practices on plankton productivity in managed wetlands of Suisun Marsh, San Francisco Estuary

Francheska Torres, UC Davis Center for Watershed Sciences, fmtorres@ucdavis.edu.

The pelagic food web has collapsed in the San Francisco Estuary (SFE), with declines in phytoplankton, zooplankton, and pelagic fishes, largely due to invasive clams and water exports. Suisun Marsh, located in the San Francisco Estuary, was historically a vast tidal marsh but is now largely comprised of wetlands managed for waterfowl habitat. Suisun managed wetlands are typically flooded by gravity in fall and winter, drained in spring, and remain dry in summer. The goal of the study is to understand how different management practices affect phytoplankton and zooplankton production to inform management on how to subsidize food for pelagic fish at critical times. We are using a before-after control-impact study design to elucidate how phytoplankton and zooplankton production differ in seasonal and perennial managed wetlands versus tidally restored habitats over two years. We are

monitoring water quality and plankton production in five managed and three tidally restored wetlands in Suisun Marsh once a month. One of the seasonally managed wetlands operates as a perennially flooded wetland for the duration of the study to observe the removal of the flood-pulse effect from seasonal drying in typical Suisun wetland management. We hypothesize that seasonally-flooded wetlands will promote the highest plankton production due to flood-pulse effects and increased water residence time, perennially flooded wetlands will have intermediate production, and tidally restored habitats will have the lowest production. The results of the study will benefit pelagic fishes and future restoration by providing a framework on how to maximize plankton.

85. Future Drought in the Delta Watershed

Dan Cayan, Scripps Institution of Oceanography, University of California San Diego, dcayan@ucsd.edu

Using a large, recent cohort of downscaled global climate models (LOCA downscaled CMIP6) 21st Century projections and associated hydrological model simulations, we canvas an ensemble of droughts that occurred in the Sacramento/San Joaquin Delta watershed. Key findings include: 1) future droughts occur in variable form over the range of model projections; 2) as in the historical observed record, drought duration varies considerably; 3) in some cases, drought intensity exceeds (moderately exceeds) that observed in the historical record; 4) droughts in future will be increasingly warmer. which increasing evapotranspiration losses. For planning purposes, we offer a small set of extreme drought scenarios from the CMIP projections that could be used to evaluate future risk and impacts.

86. Aquatic plant community restoration following the long-term management of invasive Egeria densa with fluridone treatments

Jeffrey Caudill, CA State Parks, jeffrey.caudill@parks.ca.gov

The Sacramento-San Joaquin Delta is one of the largest estuaries in North America, providing water for more than 700,000 acres of agriculture, recreation and fisheries habitat. For decades, the exotic invasive plant Egeria densa has negatively impacted native habitat and navigation of vessels in the Sacramento-San Joaquin Delta. In 2007 the largest waterbody in the Delta, Franks Tract, began to be managed at operational scale utilizing the aquatic herbicide fluridone. A fluridone pellet formulation was applied to achieve in-water concentrations of fluridone between 2.5 and 3.5 ppb for 8 to 16 weeks in areas with dense Egeria densa. Fluridone applications were started as early as March and continued throughout the treatment period to sustain the target concentrations which were verified by an enzyme-linked immunoassay (ELISA) analytical test. Relative frequency of occurrence for native plants significantly increased from 2006 to 2017 ($P < 0.001$). Frequency of occurrence of most native species remained variable across years except for Potamogeton richardsonii where frequency of occurrence increased greatly from 3.6% in 2013 to 80% in 2017 ($P < 0.001$), and significantly increased each year sequentially except between 2015 to 2016 to become the most widespread species. The increase of native plants over the past five years, following management with fluridone, is likely to improve fisheries, native species habitat, and waterway traffic.

87. Shaping the Future of Delta Science: Join Us in Collaborative Science Planning!

Tricia Lee, Delta Stewardship Council, tricia.lee@deltacouncil.ca.gov

The Delta Science Plan is a guidance document that provides vision, principles, and approaches for creating best available science in a more collaborative Delta system. The Delta Science Plan is updated every five years, and the next iteration will be released Fall 2025. To meet the needs of the changing Delta, the 2025 Delta Science Plan will be structured to address four Grand Challenges to Delta science:
• Grand Challenge #1 – Scientists and managers must anticipate a world in which environmental conditions and regulations may be fundamentally different from those faced today.
• Grand Challenge #2 – Environmental change is outpacing the traditional pace of science.
• Grand Challenge #3 – Flows of scientific information remain decentralized and poorly connected to communities and decision-makers.
• Grand Challenge #4 – Other ways of knowing, including Traditional Knowledge, remain siloed from decision-making.
How does the Delta Science Plan update affect you and your work? Visit this poster to learn more about what to expect from the updates to the Delta Science Plan and how you can participate.
Need some inspiration? Here's a haiku:
Delta Science Plan
Grand Challenges addressed through
Collaboration

88. Experimental Field Study of Growth and Survival of Invasive Clams in Montezuma Slough

Jessica Weidenfeld, UC Davis & Delta Stewardship Council, jessica.weidenfeld@deltacouncil.ca.gov

Non-native invasive species are a challenge for the ecology and management throughout the San Francisco Bay-Delta region. Among the most abundant and consequential invaders in the North Delta are bivalves. Our study sought to understand what factors influence the distribution of two invasive clam species, Potamocorbula amurensis and Corbicula fluminea, in Suisun Marsh. Previous research documented differences in clam distribution between large and small sized sloughs. Consequently, we placed marked individuals of both clam species in trays in small and large paired sloughs and compared growth and survival over a three-year study. We covered trays to exclude predators and compared these with open controls. We found very low predation at all sites, indicating that predation is not likely limiting abundance. We also found clams in smaller sloughs had greater growth. In another experiment, we attached clams to replicate ropes with half the ropes on the sediment surface and half suspended in the water column. Comparing clams on ropes in small vs. large sloughs, we found that in small sloughs, clams suspended in the water column grew substantially more than those on sediment. To assess food resources, we also sampled phytoplankton and zooplankton comparing larger and smaller sloughs and found that smaller sloughs had greater phytoplankton concentrations. However, small and large sloughs showed little difference in zooplankton composition, despite strong seasonal patterns, suggesting

zooplankton were not driving phytoplankton abundance. These experiments suggest that while small sloughs offer better growth conditions for invasive clams, other factors such as sediment biogeochemistry may influence clam survival and growth. This suggests that shallow dendritic sloughs might provide refuges from clam consumption of phytoplankton, which can inform management and restoration efforts in estuarine marsh ecosystems.

89. Not all floods are created equal: floods and fish in the Yolo Bypass

Matthew Young, USGS, mjyoung@usgs.gov

The Yolo Bypass, located west of Sacramento, California, is part of a flood control system that also represents the largest remnant floodplain of the Sacramento River. Historically, the Yolo Basin (of which the current Yolo Bypass is a part) was a nearly 80,000-acre wetland ecosystem that served as year-round or stopover habitat for a variety of birds, fish, and wildlife. However, in 1924, a system of levees and weirs was constructed to use the Yolo Bypass to divert water away from cities and to protect the cities from rising river height. Since 1998, the Yolo Bypass Fish Monitoring Program (implemented by California Department of Water Resources) has documented the importance of the floodplain for the successful recruitment and growth of native fishes. Here, we quantify the timing, duration, and magnitude of floods and classify Yolo Bypass flood events. We then describe ecosystem responses to these different types of flood events, including fluctuations in both zooplankton and resident fish communities. We also document variability in the distribution and abundance of floodplain affiliated fishes, such as Chinook Salmon (Oncorhynchus tshawytscha), which are favored by intense flood events and less by later flood events and Sacramento Splittail (Pogonichthys macrolepidotus), which are benefitted by later flood events. These findings indicate that not all flood events have the same biological impacts and can be used to inform future management of the Yolo Bypass and other Central Valley floodplains.

90. Land Use Dynamics with Water Availability in the Bay-Delta Area and Central Valley, California

Khandaker Iftekharul Islam, UC Santa Cruz, kiislam@ucsc.edu

Understanding land use variability is essential for effective water management since it directly influences a region's irrigation demands and economic outcomes. This study evaluates land use variations in the Bay Delta and Central Valley of California by analyzing the changes between different water availability conditions. While hydrologic models, like CalSim, often assume static land use distributions, exploring real-world deviations can help improve model accuracy.

The research aims to identify dominant land use trends in response to changing water availability, focusing on how land uses such as rice cultivation and urban development adapt over time. By leveraging sequential land use data, the study investigates adaptations during two distinct periods: 2016 to 2020 (reflecting a shift from normal to dry conditions) and 2020 to 2022 (capturing from dry to critically dry). The study quantifies and maps the spatial distribution of these land use changes across various sub-regions, including the Bay-Delta area and the northern and southern Central Valley.

The findings reveal a significant land use transition with varying water availability across the Central Valley. For example, in 2022, a substantial portion of lands classified under various uses from 2016 to 2020 transitioned to IDLE. Rice—previously covering 28% of the northern Central Valley between 2016 and 2020—declined sharply to 14% by 2022 and was replaced by other land use categories, increasing IDLE land by 4%. Similarly, the Bay Delta Area experienced noticeable transitions from other crop types to IDLE from 2020 to 2022.

The results highlight the impact of changing water availability on land use dynamics and provide valuable information for hydrologic modeling and urban planning, specifically by addressing discrepancies between observed land cover and existing model assumptions.

91. Physics to Fish: Understanding the Factors that Create and Sustain Native Fish Habitat in the San Francisco Estuary

Frederic Feyrer, USGS, ffeyrer@usgs.gov

The U.S. Bureau of Reclamation (BOR) has an ongoing need to improve the scientific basis for adaptive management of the Central Valley Project (CVP) and, by extension, joint operations with California's State Water Project. The U.S. Geological Survey (USGS) works cooperatively with the BOR to generate the information needed to improve the scientific basis for more flexible CVP operations that would achieve water-supply reliability and native fish protection.

Our approach for this cooperative project is based on the "physics to fish" concept, the idea that high-quality habitat is generated and sustained by the interaction between physical processes and the landscape. These interactions create a template for chemical and biological processes that can change across a variety of spatial and temporal scales. Following this concept, this project included monitoring and studies of water flows, sediments, water quality, and invertebrate and fish dynamics across a range of spatial and temporal scales and in regions relevant to resource managers tasked with managing water supplies and ecosystem health in the San Francisco Estuary and Delta. The intent of this approach was to document the habitat conditions, important processes, and interactions among them that create high-quality habitat for native fishes so that the likely effects of future management actions (for example, habitat restoration) can be objectively assessed at the local (site-specific), regional (within subregions of the estuary), and landscape (across the entire estuary and beyond) scales.

The Physics to Fish project has established a foundation and several new concepts for understanding how habitat restoration can benefit native fish populations at the local and regional scales. Many of the ideas regarding habitat restoration and channel modifications outlined in this report could help guide management actions that could improve conditions for native fishes at little or no water cost beyond water already dedicated to other management actions.

92. Developing Guidance for Managing Invasive Aquatic Vegetation in Tidal Wetland Sites

Elizabeth Brusati, Delta Stewardship Council, elizabeth.brusati@deltacouncil.ca.gov

Though wetlands cover a relatively small portion of the global land surface, many of the most harmful weeds are invaders of wetland habitats. This is true of wetlands in the Sacramento-San Joaquin Delta and Suisun Marsh. At least 185 nonnative species are currently present in the Delta, and new species are certain to arrive. Invasive aquatic vegetation (IAV) is a particular concern for Delta managers of tidal wetland habitat, especially on restoration sites. As tidal wetland restoration continues across the landscape, new and existing sites often experience invasion pressure once tidal reconnection occurs.

There is no singular lead entity for managing invasive species in the Delta and Suisun Marsh, so interagency coordination is critical. To serve this need, the Delta Interagency Invasive Species Coordination (DIISC) Team was established in 2013 to provide a forum for agency collaboration. The DIISC Team addresses research and management needs related to invasive species. Through collaborative conversation, land managers and restoration practitioners identified a need for guidance on managing IAV, which may include prioritization approaches, control methods, budgeting recommendations, funding opportunities, and an appendix of resources. In response to their request, DIISC Team members are developing a quick start guide for management of IAV in tidal wetland sites, with a completion target of early 2025. This poster provides an outline of this guidance document and seeks feedback for improving the product.

93. How the SWC Science Program Helps Complete the Salmon Life History Puzzle

Darcy Austin, SWC, daustin@swc.org

California’s Chinook Salmon (Oncorhynchus tshawytscha) populations have experienced significant decline since the mid-1800s. Multiple stressors, including climate change and the construction of dams and levees, have led to significant population declines. Winter-run Chinook are now listed as endangered under both federal and California Endangered Species Acts, spring-run are listed as threatened, and fall-run are supplemented by hatcheries.

Given their ecological, cultural and economic importance, considerable efforts have gone into understanding Chinook salmon life history to manage the species. Several state and federal agencies have conducted research and developed a life history model considering the species' stressors. However, key knowledge gaps remain.

Since 2018, the SWC Science Program has contributed to filling knowledge gaps by funding studies and initiatives aimed at recovering Chinook salmon populations. In February 2023, the SWC issued its first-ever science solicitation, requesting proposals for projects seeking to advance understanding of the San Francisco Bay, Sacramento-San Joaquin Delta and upper watersheds. The six projects awarded funding are investigating the modeling effects of the water projects on salmonid migration/distribution; modeling to better understand salmonid survival, mortality and habitat use; the effects of pesticide mixtures on salmon; and modeling of river temperatures for salmon management.

This poster will synthesize key studies funded by the SWC Science Program, which spends $2 million annually on rigorous, objective, management-relevant science to help inform California State Water Project decision-making. It will highlight findings about management tools, new scientific discoveries like eye lens research, telemetry studies evaluating survival, migration and routing, and modeling designed to identify suites of actions that could lead to salmon recovery.

94. Mapping Factors to Consider in Emergency Management Planning within Sacramento Delta Legacy Communities

Hannah P Chaney, Delta Stewardship Council, hannah.chaney@deltacouncil.ca.gov

In Sacramento County, between 7,000 and 10,000 individuals are unhoused, with 70% of our unhoused neighbors unsheltered due to lack of emergency shelter and affordable and accessible housing. The unaffordability of housing and flood insurance for Delta legacy town residents decreases resilience of community members in the event of a major flood. The intersection of unhoused populations and climate change prompted Sacramento Regional Coalition to End Homelessness (SCREH) to join the Delta Stewardship Council's Environmental Justice Working Group and Science for Communities program. The SCREH Science for Communities project focused on homelessness prevention by asking the question: If a levee were to fail in one of the Delta legacy communities of Clarksburg, Freeport, Courtland, Hood, Locke, Walnut Grove, Ryde, Isleton, Rio Vista, Bethel Island, and Knightsen, who are those at high risk of becoming houseless in this event and how can communities and emergency preparedness organizations better prepare to meet the needs of vulnerable populations? To address this question, the SCREH partnership group created a GIS StoryMap that visualizes the concentration of people that would be considered vulnerable to becoming unhoused including those over the age of 65 and/ or living with disabilities as well as a layer that documents the total occupied and emergency housing units within the Legacy Communities. The map identified moderate to high concentrations of individuals living with a disability and found that most public housing buildings and emergency shelter housing units are concentrated in urban centers outside of the Delta Legacy communities (e.g. Sacramento, Stockton). Evaluating factors like disabilities, age, and amount of emergency housing available is important because it can highlight potential gaps in effective emergency management planning. This Science for Communities project demonstrates the value of collaboration between scientists and community partners, leading to a better understanding of community challenges.

95. What happened after that management action? Quantifying nutrient reductions in the Sacramento River, CA, following the EchoWater Resource Recovery Facility upgrade

Tamara Kraus, USGS, tkraus@usgs.gov

Anthropogenic contributions to elevated nitrogen (N) concentrations in the Sacramento–San Joaquin Delta (Delta), California, can influence the proliferation of harmful algal blooms (HABs), the growth of invasive aquatic vegetation, and the health of the food web. The Sacramento River, the principal freshwater source to the Delta, experiences anthropogenic N contributions from agricultural nonpoint sources and municipal wastewater effluent. Historically, the EchoWater Resource Recovery Facility (formerly known as the Sacramento Regional Wastewater Treatment Plant) discharged approximately

13,000–15,000 kg/d of N to the Delta in the form of ammonium-N. In response to measured declines in ecosystem health within the Delta and San Francisco Bay, revisions to the facility's National Pollutant Discharge Elimination System (NPDES) permit were enacted in 2010, establishing dissolved N limits on treated effluent. Specifically, the current (2021) NPDES permit limits the average monthly ammonium-N concentrations to 2.1 mg/L (2.4 mg/L in winter), with a loading limit of 1,451 kg/d (1,633 kg/d in winter) and limits nitrite+nitrate-N concentrations to 16.1 mg/L, with a loading limit of 6,847 kg/d. To meet these requirements, the facility underwent substantial upgrades, including the installation of an advanced Biological Nutrient Removal (BNR) system, completed in April 2021. To quantify changes in N and other nutrient concentrations and loads entering the Delta from the Sacramento River following the EchoWater Facility upgrade, we combined effluent discharge and nutrient concentration data provided by SacSewer with Sacramento River discharge and concentration data–upstream and downstream of the wastewater outfall–collected by the US Geological Survey (USGS). These combined measurements allow us to determine how the BNR upgrade has altered the Sacramento River's nutrient contributions to the Delta over different time scales (daily, monthly, and seasonally), facilitating the evaluation of responses in nutrient dynamics and ecosystem functioning within the Delta.

96. Evaluating Variability in Future Hydrology for Long-Term Water Resource Planning in California's Central Valley

Abhinav Sharma, UC Santa Cruz, ashar174@ucsc.edu

The water availability to agricultural systems across California's Central Valley heavily depends on the Sierra Nevada snowpack, which faces increasing vulnerability due to the impacts of climate change. Differences in climate and hydrologic model resolution, structure, and biases introduce uncertainties into water resources modeling used to understand the consequences of these changes. Multiple methods have been developed for integrating climate change information into the CalSim3 model of the Central Valley management system, but the difference in outcomes across these methods is not well-quantified. This study seeks to enhance our understanding of climate change modeling methods for CalSim3 by evaluating a method that aligns historical hydroclimate data with future climate conditions. Hydroclimate data derived from selected CMIP6 LOCA2-downscaled meteorological inputs and VIC hydrologic models were utilized, applying a quantile mapping method using both annual totals and monthly averages. This approach effectively perturbs historical time series to reflect projected future climate characteristics, enabling an analysis of potential water resource outcomes in response to seasonal hydrologic shifts. To evaluate the impact of these adjustments, the study tested the data across a selection of CMIP6 projections, spanning three periods: near-term (2020 - 2040), mid-term (2040 - 2060), and long-term (2060 - 2090). The analysis focused on five key water budget areas: four valley watersheds—two in the Sacramento watershed north of the Delta, and two south, in the San Joaquin River Basin and Tulare River Basin—and one Delta region. Critical variables such as Rim Inflow, Precipitation, Maximum and Minimum Air Temperatures, and Evapotranspiration were examined. The results indicate the nature of variability associated with different period selections within climate projections, and aims to provide crucial insights guiding future water planning efforts across California's Central Valley.

97. A Different type of Seasick: Screening of Pathogens in Ocean Caught Chinook Salmon prior to Freshwater Entry.

Andrea Chandler, UC Davis, andchandler@ucdavis.edu

Chinook Salmon are exposed to a multitude of stressors as they migrate to and from the ocean. These hurdles can increase the amount of energy adult salmon need to migrate, and impact spawning success. In addition, California is at the southernmost range for Chinook Salmon, meaning populations are pushed towards their upper thermal limit, leaving them more susceptible to infection. The goal of this project is to develop a better understanding of what pathogens adult salmon are exposed to prior to freshwater entry. This data will add to a larger project to simulate energy use of fall-run Chinook Salmon during migration. To evaluate pathogen presence, gill biopsies were collected from adult fall-run Chinook Salmon in the Pacific Ocean off of San Francisco during the summer of 2022, a dry year, and the summer of 2023, an exceptionally wet year, before they entered freshwater. Using Fluidigm, a real-time qPCR system, we targeted 47 different pathogens (i.e., bacteria, viruses, and parasites) known to be infectious to salmon. We will be presenting preliminary data on the presence and abundance of these pathogens in the collected gill samples. This project will help build a better picture of Chinook Salmon migration and correlation with environmental conditions, with implications for fisheries, conservation, and restoration efforts.

98. Drivers of Spatial Heterogeneity of Greenhouse Gas Fluxes and the Role of Hot Spot Emissions in Delta Agricultural Peat Soil

Charlotte Frances Kwong, UC Berkeley, c.kwong@berkeley.edu

Soil greenhouse gas (GHG) fluxes of methane (CH4) and nitrous oxide (N2O) are characterized by high spatial and temporal variability. In many ecosystems, annual emissions are likely driven by extreme flux events (hot moments). While the spatiotemporal distribution and drivers of hot moments of N2O and CH4 are not well understood, the majority of high emission events are likely concentrated in specific areas (hot spots) on the landscape. Agricultural peatlands are particularly important sources of CH4 and N2O due to high carbon (C) and nitrogen (N) substrate availability and N from fertilizer amendments. Not capturing GHG hot spots and hot moments from peatlands can result in underestimates of annual GHG fluxes and confound our understanding of their environmental controls, limiting our ability to mitigate their effects through management. In this study, terrestrial laser scanning was combined with continuous GHG flux measurements and soil sensing at 21 locations to characterize patterns and drivers of hot spots and hot moments of GHG emissions. Random forest (RF) modeling was able to predict up to 80% of N2O fluxes and 75% of CH4 fluxes. Certain locations on the field were consistent hot spots of N2O and CH4, primarily driven by moisture and oxygen conditions. This field experiment will continue until May 2025. Weekly soil samples of mineral N, labile C, and pH at all 21 locations have been collected for the past year. Including these variables will likely improve RF model ability to explain flux variability. The results of this study will provide a more comprehensive understanding of the spatiotemporal dynamics and associated drivers of GHG fluxes, which can contribute to the development of sustainable land management strategies to lower emissions from drained Delta peatlands.