INTERAGENCY ECOLOGICAL PROGRAM
2019 ANNUAL WORKSHOP

POSTER ABSTRACTS

MARCH 5-7, 2019
LAKE NATOMA INN
FOLSOM, CA

Interagency Ecological Program
COOPERATIVE ECOLOGICAL INVESTIGATIONS SINCE 1970

Listed alphabetically by presenting author.

USGS Step UP! Employee Empowerment Strategies: A Bystander Intervention Program for Scientific Workplaces

Chany Huddleston Adrianza[1], Alexandra Etheridge[1], Moses Milazzo[2]
[1]USGS California Water Science Center, Sacramento, CA, USA.
[2]USGS Astrogeology Science Center, Flagstaff, AZ, USA.

Recent studies and news reports have shown that workplace harassment is occurring in almost all fields including the geosciences [e.g., 1-4]. United States Geological Survey (USGS) leadership recognize that harassment in and around our scientific community seriously and persistently undermines our ability to complete our mission. USGS has engaged in practical steps to reduce harassment in our community. One such effort is the development of a peer-led anti-harassment workshop by coauthors Etheridge and Milazzo, designed specifically for our scientific workplaces, including offices, scientific conferences, and fieldwork. Etheridge and Milazzo were recently jointly awarded the Association for Women Geoscientists President's Award for their efforts in creating this anti- harassment workshop, which illustrates the impact that this program has already had.

The Equal Employment Opportunity Commission and the National Institutes of Health have determined that one of the most successful ways to reduce harassment is a system of anti-harassment programs broadly described as "bystander intervention" [e.g., 5-10]. Bystander intervention is an evidence-based framework intended to reduce the burden of protecting oneself from harassment and shift the burden to the community. Harassment extends well beyond the target into the community, and ultimately harms science itself. The University of Arizona developed the StepUp! bystander intervention program for implementation on college campuses [11]. With their support, and withthe support of National Aeronautics and Space Administration (NASA) and USGS funding, Milazzo and Etheridge modified the workshop to be applicable to scientific workplaces.

Since the initial rollout of USGS SEES (Step UP! Employee Empowerment Strategies) in late 2017, more than 1,000 individuals have attended the workshop. Additional peer facilitators have been trained so this program can extend its reach further within our community. For example, Chany Huddleston Adrianza will lead the rollout of USGS SEES across the USGS Pacific Region during FY2019.

References: [1] Gilpin, L. (2016) High Country News [2] Ghorayshi, A. (2015) Buzzfeed News [3] Ghorayshi, A. (2016) Buzzfeed News [4] Clancy, K.B.H et al. (2017) DOI: 10.1002/2017JE005256 [5] Darley, J.M., Latane, B. (1970) ISBN-13:978-0139386138
[6] Feldblum, C.R. and Lipnic, V.A., (2016) EEOC [7] Basile, K.C. (2016) doi:10.1056/NEJMe1503952 [8] Nickerson, A.B. et al. (2014) doi:10.1016/j.adolescence.2014.03.003 [9] Swan, S.L. (2015) WI Law Rev. [10] DeGue, S. (2014) White House Task Force: Evidence-Based Strategies for the Primary Prevention of Sexual Violence Perpetration. [11] Bell, B. (2008), StepUp: A prosocial behavior/bystander intervention program for students.

Incorporating Human Perspectives into the Role of Diversity and Inclusion in Wildlife Science

Bayan Ahmed, Jaclyn Aliperti, Chris Collier, Korinna Domingo, Ximena Gil

Studies have found that diverse workplaces are positively correlated with enhanced innovation, productivity, communication, and problem-solving. Inclusivity among individuals from underrepresented backgrounds allows for creative and effective approaches to conducting scientific research. Wildlife biology is a multidisciplinary science that would likely benefit from the inclusion of diverse people and perspectives; however, it has been suggested that the field of wildlife biology fails to adequately reflect the diverse communities it represents. The Wildlife Society Western Section (TWS-WS) Diversity Committee paired a short film with a digital questionnaire to bring attention to the various perspectives regarding diversity among biologists in the field and to examine whether these perspectives are adequately reflected in wildlife team composition and project goals. We filmed 7 projects and interviewed 19 students, professors, and project leads. The film will debut during the TWS-WS 2019 conference. The online questionnaire examines people's different social dimensions (demographics, economic status, barriers) and their perspective on diversity. We hypothesized that most wildlife biologists recognize the importance of increasing diversity but these ideals are not adequately represented in practice. We recommend researchers and employers change this by proactively incorporating diversity into team composition and management strategies. Follow the conversation using the hashtag **#DiversifyWildlife**.

What's bugging you? A key to common Delta invertebrates at wetland restoration sites

Michelle Avila[1] (Michelle.Avila@wildlife.ca.gov), Rosemary Hartman[1], and Tricia Bippus[2]

[1]CDFW Fish Restoration Program Monitoring Team [2]CDFW Diet Study Program
2109 Arch Airport Road Stockton, CA 95206
209-234-3428

The Fish Restoration Program (FRP) Monitoring Team conducts frequent aquatic invertebrate sampling at wetland restoration and reference sites throughout the San Francisco-San Joaquin region. This allows us to collect pre- and post-restoration food web data for endangered and threatened fish in the target areas. The large number of taxa present in wetlands and their wide range of morphological characteristics creates a challenge for the laboratory staff tasked with identifying invertebrates in samples. This is compounded by the fact that detailed taxonomic resources on many invertebrate groups are either lacking or difficult to find. To address this issue, we photographed dozens of organisms under a dissecting microscope and created a simple taxonomic key encompassing the most commonly encountered invertebrate groups in FRP samples. Our goal is simple: provide a clear reference for staff allowing them to take a specimen, narrow it down to a group (usually order or family) using the poster, and easily choose the appropriate key afterwards when protocol requires a lower level of identification. This should reduce training time by putting relevant taxonomic information in one location for new staff with limited prior knowledge of invertebrate identification. We encourage other taxonomists to give us feedback on our key and hope the key will be a resource for other monitoring groups working in the estuary.

Signatures of Disease Prevalence and Host Genomic Responses in Central Valley Salmonids

*__Bryan T. Barney__[1], Matthias Hasenbein[1], Ken M. Jeffries[2], Nann A. Fangue[3], Richard E. Connon[1]

[1]Anatomy, Physiology & Cell Biology, School of Veterinary Medicine, University of California, Davis, California;
[2]Department of Biological Sciences, University of Manitoba;
[7]Department of Wildlife Fish & Conservation Biology, University of California, Davis, California.

Understanding the patterns of prevalence of pathogens, as well as the host genomic response to infection from those pathogens, is critical for proper management practices of the Chinook salmon. In this study, we collected outmigrating juveniles (n=84) from multiple locations within the Sacramento-San Joaquin River Delta. By employing a method developed in other salmonids and optimized for Chinook salmon, we tested for the presence of 47 different pathogen species, including bacteria, parasitic invertebrates, and viruses. In addition, a suite of 30 genes relevant to immune or generalized stress responses were analyzed for changes in gene expression associated with infection status. We found a significant number of *Ceratonova shasta* and *Parvicapsula minibicornis* co-infections in fish from the Sacramento River and Confluence, but nearly no infections in the San Joaquin River. *Candidatus Branchiomonas cysticola* and *Ichthyophthirius multifiliis* infecitons were detected throughout the region in moderate numbers. Here, we show our ability to detect both pathogen presence or absence as well as differences in individual physiological response to pathogen infections.

Decrease in Delta Smelt Prey Availability During a Low Flow Year

Colin Brennan (ICF Fish and Aquatic Sciences, Colin.Brennan@icf.com (925)330-7723)
Calvin Lee (ICF Fish and Aquatic Sciences, Calvin.Lee@icf.com (510)381-0222)
Angelina Ravani (ICF Fish and Aquatic Sciences, Angelina.Ravani@icf.com (415)246-5088)
201 Mission St 15th floor, San Francisco, CA 94105

Freshwater outflow into the lower Sacramento River and Suisun Bay was dramatically higher during 2017 than 2018. This can affect habitat availability and use by delta smelt as well as the lower trophic level organisms and communities these endangered fish feed on. Using data collected from the Direct Outflow Project in the fall of 2017 and 2018, the abundance of amphipod and mysid in the Suisun and Sacramento River region are compared during these two different flow regimes. The 2018 sampling period showed a marked decline of prey items, particularly mysids. The data presented only represents approximately 80% of the samples taken in 2018, and further ongoing work is being done to characterize the zooplankton community. Understanding what organisms are present and the relative abundance of these organisms can provide information on habitat suitability for delta smelt.

HAB Scoring in the Central and South Delta

Matthew Breuer (Matthew.Breuer@water.ca.gov) and Jared Frantzich (Jared.Frantzich@water.ca.gov)
Department of Water Resources
North Central Region Office, Water Quality Evaluation Section
3500 Industrial Blvd. Floor 1, West Sacramento, CA 95691

Harmful algal blooms or "HABs" are large overgrowths of algae in marine ecosystems that have the potential to produce toxins that harm other living organisms. HABs have been on the rise nation-wide and reports of these blooms are more and more common, especially in U.S. coastal states. The Sacramento-San Joaquin Delta has experienced numerous HABs in the past few years throughout the central and south Delta composed primarily of the freshwater algae called cyanobacteria, or blue-green algae (BGA). Specifically, one of the most prevalent cyanobacteria in recent years is *Microcystis aeruginosa*; a known producer of toxins called microcystins that negatively affect the health of aquatic organisms and can impact human health. In late 2017, DWR as required by South Delta Temporary Barriers Projects CVRWB Section 401 Water Quality Certification, began implementing and recording a surface *Microcystis* bloom visual index value during standard water quality station visits every 3-4 weeks. This visual qualitative index was adopted from the IEP Environmental Monitoring Program to provide comparability with other IEP long-term Delta surveys. The index values range from 1 to 5 with 1 indicating no visible *Microcystis* and 5 indicating a very high concentration of contiguous colonies of *Microcystis*. To determine potential hotspots for HABs in the south and central Delta, we summarized results from 2017- 2018 to identified stations with frequently high index values. We further investigated corresponding physical and organic variables at those stations to determine potential environmental mechanisms that may lead to the higher prevalence of HABs in this region of the Delta. It is our hope that this additional spatial and temporal HAB monitoring data will improve future state and federal Delta water management strategies to protect aquatic and human health.

Zooplankton Community Response to the Suisun Marsh Salinity Control Gate Project

Christina E. Burdi*, April Hennessy, and Ugochi Ikeme
California Department of Fish and Wildlife, Stockton, CA 95206
Christina.Burdi@wildlife.ca.gov

The Suisun Marsh Salinity Control Gate (SMSCG) Project was conducted in August 2018 to improve habitat conditions in Suisun Marsh. The gates are typically operated in fall to decrease salinity in the Marsh for waterfowl. In 2018 this project was implemented earlier to potentially benefit delta smelt by increasing accessible habitat. The gates were opened during ebb tides and closed during flood tides to maintain fresh water in Montezuma Slough. During this time, additional sampling was conducted by the California Department of Fish and Wildlife to detect any changes in the zooplankton community. Calanoid copepods were hypothesized to increase in the low salinity zone overall but to remain the same within Suisun Marsh. Calanoid copepod densities were examined before, during, and after the gate operation. Copepod densities in Suisun Marsh during this time were also compared to the immediate surrounding areas outside the Marsh such as the lower Sacramento River and Suisun Bay. *Acartiella sinensis* and *Pseudodiaptomus* spp. were the most abundant species during these time periods. Calanoid copepods are important components of the food web and are prey for many fish species in the San Francisco Estuary. Understanding the impact adaptive management actions such as the SMSCG project has on the zooplankton community increases the knowledge of the food web within the San Francisco Estuary.

Parsing the DOM sources using calibrated biomarkers in the San Francisco Bay Estuaries

Chia Ying Chuang1*, Peter Hernes2, Francois Guillemette3, Jennifer Harfmann2, Karl Kaiser4, Robert Spencer5, Brian Bergamaschi6

1Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan;
anderinchuang@gate.sinica.edu.tw; 88627875861
2Department of Land, Air, and Water Resources, University of California Davis, CA, USA
3Département des Sciences de l'environnement, Université du Québec à Trois-Rivières, QC, Canada
4Department of Marine Sciences, Texas A&M University at Galveston, TX, USA
5Earth, Ocean & Atmospheric Science Department, Florida State University, FL, USA
6United States Geological Survey, Sacramento, CA, USA

Dissolved organic matter (DOM) fuels the microbial loop, and estuarine environments contain some of the most diverse sources, concentrations, and reactivities of DOM in the world. We conducted three transects in the San Francisco Bay Estuary (SFBE) across a salinity gradient in order to investigate the roles of sources, hydrologic and seasonal changes on the DOM composition. Sampling started with a riverine endmember, through a vast area of marshes, wetlands, to the Golden Gate, the largest estuary in western North America. The winter transect (Dec 2014) at maximum winter discharge allowed the study of DOM dynamics largely in the absence of photodegradation processes and low levels of algal production; the summer transect (June 2015) captured significant photodegradation and algal production; the spring transect revealed the signal of stored DOM from the snowmelt cold water flows. Multiple studies indicate that algal primary production alone cannot support the SFBE foodweb, hence other sources of organic matter must be considered, including autochthonous and allochthonous DOM. Terrestrial DOM export in SFBE were revealed by dissolved lignin dynamics. Optical proxies (UV-vis and fluorescence) were also used to study the photochemical and biological transformations of DOM.

Turbidity in the Sacramento-San Joaquin Delta during Water Years 2017 – 2018

Anna L. Conlen (916) 591-0784, aconlen@usgs.gov
Tara L. Morgan-King (916) 502-3348, tamorgan@usgs.gov

United States Geological Survey, California Water Science Center
1280 Terminal St. West Sacramento, Ca

The spatial and temporal distribution of sediment throughout the Sacramento-San Joaquin River Delta (Delta) is an important determinant of ecosystem health, habitat availability, fish distribution, and restoration feasibility. Sediment supply in the Delta has declined from historic levels, causing concern for future landscape and ecosystem function. U.S. Geological Survey (USGS) and CA Department of Water Resources (DWR) turbidity sensor data are used to estimate suspended sediment concentrations throughout the Delta. We assessed Delta turbidity at 24 USGS and DWR stations in water years (WY) 2017 and 2018 to inform our understanding of turbidity and seasonal sediment supply. We focused on regional results, comparing WY 2018 average and peak turbidities in the north, central and south Delta and North Delta Habitat Arc. The Habitat Arc region of the Delta connects the Yolo Bypass, Cache Slough Complex and Suisun Bay, and has been identified as a habitat corridor for the endangered delta smelt. We also compared turbidities in WY 2018 to turbidity values observed during WY 2017. Water year 2017 was an exceptionally wet year, with extreme flow events that caused significant export of sediment out of the Delta. In WY 2018, a moderate precipitation year, we observed lower average turbidities at most stations throughout the Delta compared to WY 2017, possibly due to minimal sediment deposition in WY 2017. Similarly, average fall turbidities at stations along the Habitat Arc were lower in 2018 than the previous 3 years. Average annual turbidities in WY 2018 were higher in the north and central Delta than in the south Delta, consistent with previously observed spatial variations. Delta turbidity monitoring efforts in 2018 continue a long-term record of sediment availability and flux – data that can be utilized in habitat restoration, modeling efforts, and management decisions.

Elevation is Destiny – Where Surface Water Level with Sea Level Rise Could Overtop Levees

Dan Constable[1], Ron Melcer Jr.[1], Cory Copeland[2], Kate Anderson[1]

Ronald.Melcer@deltacouncil.ca.gov, Kate.Anderson@deltacouncil.ca.gov,
Dan.Constable@deltacouncil.ca.gov, Cory.Copeland@deltacouncil.ca.gov
Delta Stewardship Council – – [1]Ecosystem Restoration, Land Use, and Scientific Integration Unit,
[2]Performance Management Unit, Sacramento, CA 95814, U.S.A.

Projected future surface water levels plus sea-level rise of 12 inches (0.3048 m), 36 inches (0.9144 m), and 83 inches (2.1082 meters) were added to observed water levels, which were detrended to January 1, 2009 and generated by the UnTRIM San Francisco Bay-Delta model (UnTRIM Bay-Delta model) (MacWilliams et al 2015) for the Delta and Suisun Marsh. Historic inflows, wind, evaporation, and precipitation were applied for model boundary conditions. Historic operations were assumed for the Suisun Marsh Salinity Control Gates, Delta Cross Channel, water export facilities, temporary agricultural barriers, and Delta Island Consumptive Use. For each of the three sea level rise amounts, a maximum and average water level was generated, resulting in six water level scenarios. To identify areas where water levels overtopped levee heights, levee elevations were used from an analysis of Delta levee compliance with HMP and PL84-99 design geometry (DWR 2012). The poster shows where overtopping by levee segment could occur given different amounts of sea level rise under projected maximum or average conditions.

One person's trash is another one's data

Emma Davidson[1] and Justin Dummitt[2]

[1]U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave, Suite 105, Lodi CA 95240; 209-334-2968; emma_davidson@fws.gov
[2]U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave, Suite 105, Lodi CA 95240; 209-334-2968; justin_dummitt@fws.gov

The Lodi U.S. Fish and Wildlife Service's several IEP monitoring elements conduct year-round sampling efforts throughout the San Francisco Bay-Delta (Delta). Each week's sampling covers between 51 and 56 nearshore sites and between 38 and 43 trawl sites. These sites range from the western edge of the San Francisco Bay, to Colusa on the Sacramento River, to the confluence of the Tuolumne and San Joaquin rivers, covering a total area of approximately 3800 square kilometers. Through this sampling, the monitoring crews frequently collect trash as bycatch and dispose of it appropriately. A pilot project was initiated in May 2018 aimed at quantifying the amount of trash collected during normal sampling efforts so that we could estimate the impact of the program on cleaning up the Delta. During pilot efforts, each crew used a collection bucket with a ruler affixed to the inside to estimate the volume of trash collected. Approximately 595 gallons of trash were collected during the pilot study. While this method allowed us to gather valuable information on the amount of trash we collected each day, it also highlighted ways in which the project could be improved in the future. To better streamline data collection, we began using the citizen-science based trash collection phone application Litterati in December of 2018. Using this application has allowed us to increase participation in trash reporting by crews; to get photos of individual pieces of trash; and to identify trash type, method of collection, and GPS location. Since December 2018, 359 pieces of trash have been collected, with over 50% being plastic. Approximately 58% of the trash recorded to date was purposely collected during monitoring activities and 39% was collected as bycatch.

Using a novel optical instrument to characterize algal blooms in the SFE

Ayelet Delascagigas

USGS Hydrologic Technician, 6000 St Placer Hall Sacramento, CA 95819
916-823-1793, adelascagigas@usgs.gov

In the San Francisco Estuary (SFE), abundance of phytoplankton species, nutrient concentrations and forms, vary over short temporal and spatial scales. This makes it difficult to make conclusive statements about ecosystem responses to changes in nutrients. Here we discuss results from using a commercially available instrument designed to continuously quantify major algal taxa in situ, based on fluorometric quantification of primary and accessory pigments. We also show how data from high-frequency (15-min) monitoring of algal pigments, nutrients (nitrate, ammonium and orthophosphate), and ancillary water quality at a fixed station can provide insights into drivers of phytoplankton abundance and community structure. Finally, we demonstrate how high-speed (5 to >10 m s−1) boat mapping at high sampling frequencies (1 Hz) can provide additional insights into drivers of phytoplankton, help us resolve differences attributable to mixing of different water sources, and explore the complex linkages among time-dependent hydrologic and biogeochemical processes in the SFE.

Trajectories of flow and ammonium that lead to phytoplankton blooms in the lower San Francisco Delta.

Richard Dugdale
Estuary and Ocean Science Center, Romberg Tiburon Campus, San Francisco State University, 3150 Paradise Drive, Tiburon, CA 94920; 415 338 3518; rdugdale@sfsu.edu

Ball and Arthur (1979) in a landmark study made by the Bureau of Land Management concluded that phytoplankton blooms in the lower Delta occurred only within a limited flow range and other studies later described relationships between flow and blooms. However, reliance on a single factor to predict bloom formation does not suffice and a more holistic approach to include other drivers is proposed. For example, analysis of time series data show that high chlorophyll concentrations are not observed at elevated ammonium concentrations, regardless of flow conditions. Studies of nitrogen uptake by phytoplankton in the San Francisco Bay/Delta ecosystem indicate that ambient ammonium concentrations suppress the uptake of nitrate by the phytoplankton and hold primary productivity to low levels (the ammonium paradox). Subsequently, a sequence for bloom formation has been described, based on the requirement for improved light conditions, then low ammonium concentrations in order for phytoplankton to access nitrate for growth. Using the SCHISM/CoSINE model for the San Francisco Bay/Delta ecosystem, and data, this poster shows how flow is added to this sequence to predict favorable or unfavorable environments for phytoplankton bloom formation. Only with both low flow and low ammonium concentrations are blooms predicted by the model and confirmed by data.

Enhanced Delta Smelt Monitoring Experimental Larval Survey: Trials and errors in postlarval and juvenile Delta Smelt capture

Kate Erly[1], Brynn Perales[2], and Denise Barnard[3]

[1]U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave, Suite 105, Lodi CA 95240; 209-334-2968; kate_erly@fws.gov

[2]U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave, Suite 105, Lodi CA 95240; 209-334-2968; brynn_perales@fws.gov

[3]U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave, Suite 105, Lodi CA 95240; 209-334-2968; denise_barnard@fws.gov

In April 2017, the Enhanced Delta Smelt Monitoring Program (EDSM) began sampling for postlarval-juvenile Delta Smelt *Hypomesus transpacificus* within the Sacramento-San Joaquin Delta and San Francisco Estuary. Using identical gear as the California Department of Fish and Wildlife's historical 20-mm survey, our objective was to obtain distribution and abundance estimates of postlarval-juvenile Delta Smelt with increased resolution and precision. During the 2017 postlarval-juvenile sampling season, EDSM struggled to achieve its objectives due to low catch numbers. In 2018, EDSM spent the months of April and May preparing for and conducting an Experimental Larval Survey (ELS) to test potential alternative postlarval sampling gear types. In order to sample various parts of the water column, we conducted four different methods of sampling. ELS completed three experimental sampling days, each consisting of concurrent sampling by (1) a larval beach seine net, (2) paired manta nets, (3) a 20-mm net sampling on the surface of the water, and (4) a 20-mm net sampling at mid-depth. Shallow water habitat (<1.2 m) was sampled with a larval beach seine. Intermediate depths (1.2 m–4 m) were sampled using manta nets, which were two modified Neuston nets towed simultaneously from either side of a boat. The deep water habitat (>4 m) was sampled by two 20-mm nets towed side-by-side from separate boats. All four sampling methods appeared feasible from a monitoring operations perspective, although sampling of shallow water habitat was limited to areas suitable for pulling a beach seine (e.g., unobstructed beach). Captures of Delta Smelt in all sampling methods were scarce. The larval beach seine collected two Delta Smelt during testing while none were captured using the other methods. This poster will present pros and cons of the different gear types tested during 2018 ELS sampling and our plans for more experimental sampling in the future.

The Suisun Marsh Waterfowl and Managed Wetland Research Program

Cliff Feldheim
Branch Chief, Suisun Marsh Branch, Division of Environmental Services
CA Department of Water Resources
3500 Industrial Blvd., West Sacramento, CA 95691
916-376-9693, Cliff.Feldheim@water.ca.gov

The Suisun Marsh (Marsh) has long been recognized for its importance to waterfowl throughout the Pacific Flyway. In 1974, the Legislature passed the Suisun Marsh Preservation Act which declared the need to preserve waterfowl carrying capacity in the Marsh. Since 1974,7 species of wintering waterfowl have shown significant population declines (24 to 83%) in the Marsh, and the total number of dabbling ducks are down 60%. Since 2014, we have deployed solar powered cell-tower GPS transmitters on a total of 13 species of waterfowl (more than 500 individuals). Tagged waterfowl wintering in the Suisun Marsh and the Delta selected breeding sites as far west as arctic Siberia and east through the Central Canadian Arctic. Some Northern Pintail traveled more than 2,000 miles from the Marsh until selecting a nest site in Alaska, averaging speeds of over 50 mph during 10+ hours flights. Greater White-fronted Geese nesting is southern Alaska migrated extensively over the Pacific Ocean and along the West Coast. For all ducks trapped in Suisun, either before the breeding season or during the winter, 50% of the winter was spent in the Sacramento Valley. With the importance of the area to waterfowl clearly demonstrated, we have been working with project partners deploy audio-detection devices for rail detection, evaluate Salt Marsh Harvest Mouse use of managed wetlands, conduct telemetry studies on Western Pond Turtles and Northern Harriers, and understand how managed wetland operations could benefit native fish with the overarching goal of providing habitat for a variety of species while still maximizing habitat for waterfowl, particularly on the 52,000 acres of managed wetlands and 158 duck hunting clubs, located in the Marsh.

Changes to the north Delta ecosystem from 2010-2018

Lyndsay Floyd, Chris Jasper, Avery Kruger, Brian Williamson, and John Durand*

UC Davis Center for Watershed Sciences
*Primary contact:
One Shields Avenue; University of California Davis, CA 95616
530-601-3001 jrdurand@ucdavis.edu

Parts of the north Delta offer promising habitat for restoration purposes. Benefits include access to relatively high freshwater inflows from the Sacramento River, high turbidity, large areas of shallow water habitat; a gradual slope to upland habitat, and a relatively high number of native species compared to other parts of the Delta. Because of this, the UC Davis Arc Project began studying fish and invertebrate community composition and abundance, food web production and water quality in the upper Cache and Lindsey Slough complex in 2012.

Since then, we have found that the north Delta ecosystem appears to be changing. These changes are reflected in the spread of alien species, particularly aquatic weeds such as *Egeria densa* and *Eichhornia crassipes*. These species spread extensively during the 2012-16 drought, and show few signs of retreating with the advent of high flows in 2017 and 2018. Associated with these weeds are conditions that include increased water clarity, higher temperatures, and increased numbers of invasive sunfish, including largemouth bass.

We examine these trends, and reflect on the future of the ecosystem in the region, including recommendations for management actions.

Food Quantity and Composition, or Female Mortality: What Controls Copepod Egg Production Rates?

Austin Gearty

Estuary & Ocean Science Center, San Francisco State University
agearty@mail.sfsu.edu (714) 717 – 4642
3150 Paradise Drive, Bldg 36. Tiburon, CA 94920
Toni Ignoffo, Estuary & Ocean Science Center, San Francisco State University tignoffo@sfsu.edu
Anne Slaughter, Estuary & Ocean Science Center, San Francisco State University aslaught@sfsu.edu
Wim Kimmerer, Estuary & Ocean Science Center, San Francisco State University kimmerer@sfsu.edu

Egg production, growth, and mortality rates are key parameters that must be quantified for understanding copepod population dynamics and their availability as food for fish. The calanoid copepod *Pseudodiaptomus forbesi* is an important food source for native larval fish in the northern San Francisco Estuary (SFE). We measured Egg Production Rate (EPR) of the copepod *P. forbesi* in the northern SFE between 2006 and 2017. Egg production is low in large estuarine channels, consistent with year-round low chlorophyll *a* concentration, a proxy for phytoplankton biomass. In tidal freshwater sloughs and wetlands chlorophyll is generally higher, but egg production rates for *P. forbesi* respond unpredictably to chlorophyll. Three factors likely contribute to this apparent disparity. First, chlorophyll *a* is a proxy for phytoplankton biomass fluctuating between different species and growth conditions. Second, copepods are selective feeders and many of their prey lack pigment, requiring more specific measures of food availability and quality. Last, high mortality of females (i.e., predation) elevates the proportion of pre-reproductive females, resulting in low EPR even with plentiful food. Mortality is especially difficult to measure in an estuarine environment where tidal exchange is strong and requires corrections for gains and losses via transport. We are exploring the relationship between mortality and female age structure that can affect overall EPR regardless of food availability. Additionally, improving measurements of food, combined with estimates of female mortality rates, will refine our understanding of the relationship between copepod diets and reproduction.

IMPROVING BENTHIC NUTRIENT FLUX RATE DETERMINATIONS USING REAL-TIME, FIELD-BASED HIGH FREQUENCY MEASUREMENTS

Alan Gelber, Jeffrey Hansen, Tamara Kraus, Bryan Downing, Nicholas Graham, Katy O'Donnell, Brian Bergamaschi

Understanding sources, sinks, and transformation rates of nutrients (e.g. nitrate, ammonium, dissolved organic nitrogen, phosphate) in California's Sacramento-San Joaquin Bay-Delta is key to understanding their effects on habitat and identifying effective management strategies for many regional and statewide stakeholders. Prior studies using the mass balance approach suggest that processes occurring within the Delta significantly alter nutrient concentrations and forms. While nutrient exchange between the water column and the benthos is assumed to be important, available information on sediment fluxes is limited, indicating there are large uncertainties in our understanding of uptake, release, and transformation in sediments.

An approach has been developed for rapidly quantifying sediment/water interactions using an isolation chamber sealed into the benthic surface. Isolated water captured within the chamber is pumped through a closed loop system that continuously measures nitrate, ammonium, and dissolved organic matter (as DOM fluorescence), along with ancillary measurements (e.g., temperature, turbidity, chlorophyll, dissolved oxygen). Establishing the rate of change in constituent concentration over time permits us to calculate fluxes into or out of the sediment. Further, the chamber is outfitted with LED lights, permitting us to simulate and assess the extent to which photosynthetic processes affect rates.
Sampling at four different wetland sites in the Delta revealed a measurable efflux and influx of nitrate and ammonium over a 30-minute interval. Hourly nitrate flux ranged from 0-501 µmol/m^2-h and Ammonium flux ranged from 60-315 µmol/m^2-h. The varying rates measured at the four different sites are influenced by sediment and site characteristics while the variability between site measurements likely highlights biological, physical, and environmental processes that influence nutrient cycling. However, long-term nutrient cycling in the benthos of the Delta is still poorly understood and requires more in situ measurements.

Alan Gelber, agelber@usgs.gov, 916-200-8462, 6000 J St. Placer Hall Sacramento CA 95819
Jeffrey Hansen, jahansen@usgs.gov, 916-278-3070, 6000 J St. Placer Hall Sacramento CA 95819
Tamara Kraus, tkraus@usgs.gov, 916-278-3070, 6000 J St. Placer Hall Sacramento CA 95819
Bryan Downing, bdowning@usgs.gov, 916-278-3070, 6000 J St. Placer Hall Sacramento CA 95819
Nicholas Graham, ngraham@usgs.gov, 6000 J St. Placer Hall Sacramento CA 95819
Katy O'Donnell, kodonnell@usgs.gov, 916-278-3070, 6000 J St. Placer Hall Sacramento CA 95819
Brian Bergamaschi, bbergama@usgs.gov, 916-278-3070, 6000 J St. Placer Hall Sacramento CA 95819

Water Quality Conditions in the Central Delta during the Delta Smelt Spawning Season

Jasmine Hamilton (Jasmine.Hamilton@water.ca.gov), Amanda Maguire (Amanda.Maguire@water.ca.gov), Jared Frantzich (Jared.Frantzich@water.ca.gov)

Water Quality Evaluation Section
North Central Region Office; 3500 Industrial Blvd. Floor 1
West Sacramento, CA 95691

Water quality and hydrology are important factors to consider when managing endangered Delta Smelt habitat. In the 2011 high outflow year there was an increase in abundance of all life stages of Delta Smelt in the San Francisco Estuary, suggesting that the population still has the potential for growth given the right combination of favorable habitat conditions. In the 2017 high outflow year we did not see this type of growth, in fact, smelt abundances decreased to record lows. The 2016 Delta Smelt Resiliency Strategy recommended a focus on improving resolution and understanding of success factors across Delta Smelt life stages (i.e., reproduction, recruitment, survival, and growth). Habitat compression related to climate change and extreme drought has exacerbated already existing stressors to Delta Smelt in recent years. The magnitude and timing of flow, water temperature, salinity (positioning of LSZ), and turbidity have been identified as important for spawning, growth and survival of smelt. Using data from a network of real-time water quality stations, we examine variability in flow and water quality in the Delta across high flow years and drought years during the Delta Smelt spawning migration period (winter and spring months). We focus on the central region of the Delta specifically, since it is the corridor through which water is exchanged between the Sacramento-San Joaquin Delta and San Francisco Bay, and is part of the historical Delta Smelt spawning habitat. Although research is primarily focused is on the Cache Slough and Sacramento corridor, we evaluate key water quality and flow conditions in years that had higher Delta Smelt catch in the San Joaquin River corridor during smelt spawning season, a fairly neglected area of research.

Mapping nitrogen concentrations in the Delta: Results from a newly developed continuous flow-through ammonium analyzer

Angela Hansen*[1], Tamara Kraus[1], Bryan Downing[1], Alan Gelber[1], Brian Bergamaschi[1]

[1]USGS California Water Science Center, 6000 J Street, Sacramento, CA 95819

The concentration and form of dissolved inorganic nitrogen (DIN; sum of nitrate/nitrite and ammonium) in Delta waters is believed to directly impact phytoplankton productivity, the occurrence of harmful algal blooms and associated toxins, and the growth of aquatic vegetation, all of which have repercussions on beneficial uses (e.g., food web, drinking water quality, recreation, etc.). To date, information about nitrate and ammonium concentrations in the Delta predominantly relies on approximately monthly collection of discrete samples, and much of these data are limited to well-mixed main channels. This approach misses spatial and temporal variability and thus may not provide adequate information to identify specific sources, understand drivers, and develop effective responses. Over the last few years, the deployment of high frequency, in situ nitrate sensors has greatly increased the information we have about nitrate in the Delta. However, comparable information about ammonium – and thus calculation of DIN – has not been available. To address this need, the USGS Biogeochemistry group has worked in collaboration with Timberline Instruments of Boulder, Colorado, to modify their benchtop TL- 2800 to meet the specific needs of our boat-based water quality mapping operations. This has enabled us to collect ammonium concentration data in situ continuously (1 measurement recorded per second) in conjunction with nitrate and other measurements (temperature, dissolved oxygen, conductance, etc.). Here we present data collected from the past year across the Delta and into Suisun Bay. Measurements completed at Cache Slough Complex in the North Delta yielded ammonium concentrations ranging from as low as <0.5 µM in the Stair Step to 20 µM in the Sacramento River. Additional cruise tracks covering the central and southern Delta, as well as data collected from tidal wetlands and areas dominated by aquatic vegetation, are providing us with a more complete understanding of nitrogen cycling in the Delta.

Terrestrial organic matter as a subsidy to the lower aquatic food web in the San Francisco Bay-Delta

Jennifer Harfmann (Department of Land, Air, and Water Resources, University of California Davis, CA 95616; jharfman@ucdavis.edu), Tomofumi Kurobe (Aquatic Health Program, University of California Davis, CA 95616; tkurobe@ucdavis.edu), Brian Bergamaschi (United States Geological Survey, Sacramento, CA 95819; bbergama@usgs.gov), Swee Teh (Aquatic Health Program, University of California Davis, CA 95616; sjteh@ucdavis.edu), and Peter Hernes (Department of Land, Air, and Water Resources, University of California Davis, CA 95616; pjhernes@ucdavis.edu)

In the San Francisco Bay-Delta (SFBD), phytoplankton primary production is understood as a major food source for the lower aquatic food web, and other sources of organic matter (OM) such as plant-derived detritus are perceived to contribute only minimally. Yet algal resources are by no means abundant in this estuary due to turbidity – limiting the photic zone – and the introduction of *Potamocorbula amurensis* – causing grazing competition. In fact, the SFBD is classified among the lowest 15% of estuaries worldwide in terms of phytoplankton primary production, raising the question: what other food resources are supporting the lower aquatic food web in the SFBD? Terrestrial organic matter (tOM) is a non-trivial component of particulate organic carbon (POC) in this estuary, and despite its relatively low nutritional content, tOM has been identified as a significant food resource for copepods in other estuaries. In order to clarify the role of tOM in the SFBD lower aquatic food web, we designed a zooplankton feeding experiment that used a combination of chemical biomarkers (lignin, chlorophyll a) and a novel DNA amplicon metagenomics technique to track Suisun Marsh POC water chemistry and *Eurytemora affinis* gut content after feeding. We also investigated the impact of tOM on zooplankton survivability using observational laboratory feeding experiments with *E. affinis* across a spectrum of algal and tOM food treatments. Our results suggest that tOM alone is insufficient to support zooplankton, but in the presence of phytoplankton tOM enhances survival more than phytoplankton alone. This synergy between tOM and phytoplankton emphasizes the value of landscape diversity for food web management, particularly in light of current and future restoration efforts in the SFBD.

A web application for predicting and visualizing the risk of salmonid incidental take at the CVP and SWP

Jason Hassrick[1], Michael Tillotson[1], Alison Collins[2], Corey Phillis[2]

1: ICF, 201 Mission Street, Suite 1500, San Francisco, CA 94105. Jason.hassrick@icf.com (530) 312-3275, mike.tillotson@icf.com (206) 605-8416
2: The Metropolitan Water District of Southern California, 1121 L St., #900, Sacramento, CA 95814. acollins@mwdh2o.com (916) 650-2628, CPhillis@mwdh2o.com (707) 616-3431.

Incidental take of listed steelhead and Winter Chinook occurs at the CVP and SWP pumping facilities as a result of water export operations. Although salmonids migrate through the delta at roughly the same time each year, substantial variation in numbers taken occurs within and between years. Understanding the causes of this variation could help to forecast risk of incidental take, and in turn inform more flexible and effective management actions for avoiding entrainment of these species. To this end, we have developed a predictive model that utilizes quantile regression forests (QRF) to estimate the risk of incidental take based on environmental conditions, water operations and recent salvage history. To facilitate sharing of this model with management and research personnel we also developed a web application for interacting with the QRF models. Here we describe some important attributes of the underlying predictive model and demonstrate the functionality of the web-based tool which can be accessed at: https://tillotson.shinyapps.io/Incidental_Take/. We also present results from ongoing testing of model performance being conducted during water year 2019.

Delta Smelt's Response to Drought, Flood and Climate

Jim Hobbs, Levi Lewis, Malte Willmes, Christian Denney, Wilson Xieu, Rachel Fichman
Andrew Schultz, Towns Burgess.

Wildlife, Fish and Conservation Biology, University of California Davis. 1088 Academic Surge, Davis, Ca. 95616
US. Bureau of Reclamation. Bay-Delta Office, 801 I Street, Suite 140, Sacramento Ca. 95814

The Delta Smelt (Hypomesus transpacificus) was historically an abundant pelagic, euryhaline species endemic to the tidal freshwaters and brackish habitats of the upper San Francisco Estuary, but is nearing extinction in the wild. The decline of the species has been attributed to a variety of anthropogenic habitat alterations and food web changes due to non-native species. Managing freshwater outflow to maintain the Low-Salinity Zone (LSZ) within Suisun Bay has been one of the primary management strategies for supporting Delta Smelt and their habitat. However, this is extremely challenging during drought conditions and there is uncertainty regarding the benefits of such efforts to Delta Smelt. In this study we used conceptual life cycle models to develop testable hypotheses of Delta Smelt's response to environmental variability over a time series spanning two periods of drought and flood conditions. We predicted growth rates of Delta Smelt would increase in high flow years due to greater access to high quality nursery habitat when the LSZ is located in Suisun Bay. We also predicted greater diversity in several key life history attributes, including hatch-date, natal origin and migration history during high flow years. We tested these predictions using otolith microstructure to reconstruct age, growth and hatch-date distributions as well as otolith strontium isotope geochemistry to infer natal origins and migration history for Delta Smelt. We found Delta Smelt mean growth rates were not strongly driven by the number of days the LSZ was in Suisun Bay, but was negatively correlated with temperature. Individual growth rates were also not influenced by salinity, but were significantly reduced by warm waters and tended to be lower for fish caught in the confluence region. Hatch-date and natal origins were not associated with variability in outflow but hatch-dates were driven by temperature. Migration history appeared to also be associated with warming temperature in freshwater during the summer, and overall life history diversity was reduced during drought.

Limits of detection and quantification for Delta Smelt environmental DNA

Ann E. Holmes[1], Grace Auringer[1], Melinda R. Baerwald[2], Jeff A. Rodzen[3], Brian M. Schreier[2], Ted R. Sommer[2], and Amanda J. Finger[1]

[1]Genomic Variation Laboratory, UC Davis, 1 Shields Avenue, Davis, CA 95616
[2]California Department of Water Resources, 3500 Industrial Blvd, West Sacramento, CA 95691
[3] California Department of Fish and Wildlife, 830 S Street, Sacramento, CA 95811

Holmes (530) 752-6351, aholmes@ucdavis.edu
Auringer (530) 752-6351, gmauringer@ucdavis.edu
Baerwald (916) 376-9742, Melinda.Baerwald@water.ca.gov
Rodzen (916) 327-8175, Jeff.Rodzen@wildlife.ca.gov
Schreier (916) 376-9759, Brian.Schreier@water.ca.gov
Sommer (916) 376-9772, Ted.Sommer@water.ca.gov
Finger (530) 752-6351, ajfinger@ucdavis.edu

Environmental DNA (eDNA) sampling is a sensitive and non-invasive method for detecting fish using trace amounts of DNA shed in the water. The method has the potential to provide valuable data for monitoring rare and endangered species. However, the ability of eDNA sampling to give quantitative estimates of fish populations or biomass is poorly understood. One aspect of determining the quantitative capabilities of eDNA lies with the capability of quantitative PCR (qPCR) detection assays to reliably detect DNA at low concentrations. While single-species qPCR detection is often assumed to be quantitative for eDNA in the field, this may not be the case at very low DNA concentrations. Here we describe the limits of detection and quantification for qPCR detection of Delta Smelt in eDNA samples collected in the San Francisco Estuary. Our results show that field samples of Delta Smelt eDNA typically have concentrations below the limit of quantification. Therefore, current eDNA technology is better suited for determining presence/absence rather than quantitative estimates. Other technologies are available (e.g. digital PCR) that may allow for quantitative estimates using eDNA. This work helps to establish the capabilities and limitations for eDNA sampling of Delta Smelt in the San Francisco Estuary and increases the value of eDNA for management.

The Delta Science Tracker

George Isaac
Delta Science Program, Delta Stewardship Council
980 Ninth Street, Sacramento, CA 95814
gisaac@deltacouncil.ca.gov; 916-445-0533

The goal of the Delta Science Tracker (Tracker) is to develop a comprehensive internet-based science project tracking tool that provides a mechanism to efficiently display information on science activities in the Delta to stakeholders, the public and agency entities. The Tracker will capture and display a broad spectrum of science activities related to the Delta's ecosystem.

Independent approaches by different organizations (Government agencies, academic institutions, private and quasi-governmental research groups) lack the capacity or mandate to address grand challenges that require a long-term interdisciplinary effort that focuses on a shared approach for organizing and integrating ongoing scientific research and related activities.

The Delta Science Plan calls for a standardized and transparent method for collecting and sharing information about science activities. The Tracker is envisioned to improve communication among the Delta science community, promote opportunities for leveraging and integrating science efforts, as well as track progress and performance of shared implementation of the Delta Science Plan. The Tracker will gather, organize, and categorize critical information about science activities in a manner that is valuable to decision makers and managers of science projects in the Delta. Shared development and use of the Tracker will make progress on the Delta Science Plan's vision of 'One Delta, One Science' – an open Delta science community that works collaboratively to build a shared body of scientific knowledge with the capacity to adapt and inform future water and environmental decisions.

Macroinvertebrate Community Differences in a Pre-Restoration Muted Tidal Wetland and a Natural Tidal Wetland Site

Jessica Jimenez, Katherine Russell, and Rosemary Hartman

California Department of Fish and Wildlife, 2109 Arch Airport Road, Stockton, CA 95206.
Rosemary.Hartman@Wildlife.ca.gov, (209) 279-4913

The Fish Restoration Program Monitoring Team monitors the effectiveness of tidal wetland restoration within the Sacramento–San Joaquin Delta and Suisun Marsh. The goal of this study is to provide a preliminary analysis of macroinvertebrate communities at Decker Island and Stacy's Island. Decker was a muted tidal wetland prior to restoration in October 2018, while Stacy's is a natural tidal wetland. Samples were collected in March and April of 2017 and 2018. Different habitats were sampled using sweep nets through aquatic vegetation, and neuston and mysid tows along wetland channels. Macroinvertebrates were sorted into twelve taxonomic groups, and relative abundances were calculated. Environmental parameters were analyzed for differences between the sites to better illuminate driving factors in community composition. Results indicated no significant difference in community composition in 2017, though there was a trend toward different communities in 2018. Several taxa were identified as "indicator species" with the most positive association with Decker in 2018. Most environmental factors were significantly different between sites, which may be due to different hydrological regimes. The Sacramento River contributes cooler water and higher flow to Decker, while Stacy's freshwater inputs stem from the San Joaquin River that has lower flow and warmer temperatures. The region also experienced high precipitation in 2017, potentially driving differences between years. The higher abundance of the indicator species could be supported by the higher density of submersed aquatic vegetation at Decker Island. These results provide insight into food availability prior to restoration at Decker. Though restoration may not impact the macroinvertebrate communities, restoring Decker to full tidal action may change abiotic factors and allow fish access to the site.

Water Quality Monitoring throughout the Sacramento Deepwater Shipping Channel

Leah Kammel, lkammel@usgs.gov, 608-212-7890
U.S. Geological Survey, California Water Science Center
1280 Terminal St., West Sacramento, CA 95691

The Sacramento Deepwater Shipping Channel (SDWSC), a 43-km manmade channel that provides access for large seagoing vessels from San Francisco Bay to the Port of Sacramento, is one of few terminal channels in the Sacramento-San Joaquin Delta and has been identified as an area utilized by the endangered Delta smelt. The SDWSC features a dredged channel ~10 m deep with shallow shoulders on both banks, is tidally forced at the southern end, and connects to the Sacramento River to the north by a set of gates that have been non-operational for many years. While the SDWSC is highly engineered, it's behavior as a terminal channel is thought to resemble the historical channel network before major dredging and leveeing of the region. Recent studies have suggested that terminal channels such as the SDWSC provide conditions supportive of Delta smelt, such as elevated turbidity and concentrations of phytoplankton and zooplankton, making these areas of interest for informing habitat restoration efforts throughout the Delta.

Studies by the USGS, in cooperation with the Bureau of Reclamation, are ongoing to characterize the water quality throughout the SDWSC to better understand the ecological importance of this productive section of the Delta. Continuous monitoring of water temperature, specific conductance, turbidity, dissolved oxygen, pH, and chlorophyll *a* has been ongoing at three stations in the SDWSC since October 2017, with another station added in July 2018. Data are collected at 15-minute intervals, capturing the tidal variability in water quality as well as the longer seasonal fluctuations observed over the length of the study. The distribution of the four stations along the length of the SDWSC provides insight into the variability of water quality conditions present throughout the channel, the impact of tidal excursion on mixing, and consequent development of diverse physical habitat zones throughout this terminal channel.

Zooplankton Family Therapy: Getting the Datasets to Talk

Karen Kayfetz[1], Christina E. Burdi[2], Rosemary Hartman[2], April Hennessy[2], Nicholas Rasmussen[3], Dylan Chapple[1], Madison Thomas[1], Louise Conrad[1], and Larry Brown[4]

[1]Delta Science Program: Karen.Kayfetz@deltacouncil.ca.gov
[2]California Department of Fish and Wildlife
[3]California Department of Water Resources
[4]U.S. Geological Survey

Zooplankton are collected by many programs and studies from a myriad of agencies and organization. These studies result in mountains of data on zooplankton abundance and distribution, however differences in zooplankton sampling, lab processing, and organism identification methodology result in problems integrating these datasets. The IEP Zooplankton Synthesis Team would like to provide recommendations for how to reconcile these differences when comparing zooplankton data across IEP programs. We are developing an integrated zooplankton dataset, complete with metadata that describes assumptions, calculations, and limitations of the synthetic dataset in terms of how it reconciles potential differences between programs. We want to use the integrated dataset to assess variation in zooplankton density and communities across Delta regions and habitat type. This effort is just getting started, so we invite the community to visit our poster and provide input on data sets to include in our synthesis effort and tools to help combine data sets.

Six Year Review of Yolo Bypass Chinook Salmon (*Oncorhynchus tshawytscha*), Steelhead (*Oncorhynchus mykiss*) and Sturgeon (*Acipenser spp.*) Salvage Efforts

Hideaki Shig Kubo & Colin Purdy

CDFW North Central Region; 1701 Nimbus Road; Rancho Cordova, CA 95670
Hideaki.kubo@wildlife.ca.gov (916) 767-4276
Colin.purdy@widlife.ca.gov (916) 358-2943

After six seasons of salmon and sturgeon focused salvage efforts using temporary traps in the Colusa Basin Drain, the Knights Landing Ridge Cut Slough (KLRCS) and the Yolo Bypass toe drain, a total of 1,983 adult Chinook salmon have been trapped along with four steelhead and one white sturgeon. Salmon were trapped across a range of water year types and hydrologic conditions between the different trapping locations and moved back to the Sacramento River. Diversity of Chinook salmon catch includes both natural and hatchery origin of all four Central Valley runs (fall, late fall, winter, spring). Timing of catch in relation to river and bypass conditions suggests cues for attraction are present in both low and high river flow conditions and residence time in the Yolo Bypass is likely highly variable. In 2018, winter-run were captured between February and June in the KLRCS below Wallace Weir, during which time flows in the canal were relatively low and water quality conditions poor. Salvaging winter-run under these conditions highlights the need to better understand attraction cues into the bypass and residence time under different conditions. Additionally, developing an improved understanding on the effects of exposure to poor water quality on anadromous fish in the bypass including temperature, and dissolved oxygen, as well as herbicides, pesticides and fungicides should be prioritized. These observations have implications for project planning in the Yolo Bypass including at Fremont Weir and Sacramento Weir. As employing and operating temporary traps is condition dependent, completion of the permanent fish collection facility at Wallace Weir should improve capture efficiency thereby providing greater insight into attraction cues onto the bypass. The new facility should also help to provide an improved information baseline from which to compare future changes in the bypass.

Copepod culture test for monitoring contaminants and food availability in the Delta

Tomo Kurobe[1], Bruce G. Hammock[1], Ching Teh[1], Peggy Lehman[2], Sarah Lesmeister[2], and Swee J. Teh[1]

[1] Aquatic Health Program, University of California, Davis, 1089 Veterinary Medicine Drive Davis, CA 95616

[2] California Department of Water Resources, 3500 Industrial Blvd, West Sacramento, CA 95691

Pesticides can pose a threat to aquatic ecosystems. In the Sacramento and San Joaquin Delta (the Delta), various types of pesticides, including insecticides and herbicides, have been heavily used for controlling unwanted organisms. These applications can potentially impact non-target organisms, including primary producers (e.g. phytoplankton) and primary consumers (e.g. zooplankton). Zooplankton may be vulnerable to both insecticides and herbicides. Insecticides can directly compromise health of zooplankton since many zooplankton share physiological and biological features with target insects. Herbicides could reduce zooplankton abundance indirectly by suppressing phytoplankton, food for most zooplankton . Therefore, we assessed impacts of contaminants and food availability on primary consumers by running copepod culture tests using *Pseudodiaptomus forbesi* and *Eurytemora affinis* cultured in our laboratory. Copepods were exposed to ambient water samples collected monthly at three sampling stations along the Sacramento River (D22), Old River (D28A), and the downstream from the city of Stockton (P8) from summer through winter in 2017 and 2018. At the end of the four day culture tests, we assessed mortality and growth rates of the copepods. A high mortality rate was observed at D28A (mortality >90%) in June 2019, which was possibly due to contaminants in the ambient water. In addition, seasonal or geographical differences were observed in growth and mortality of copepods that we attribute to food availability. For example, copepod growth rates were higher at P8 than D22 and D28A, and the difference was most prominent in summer months of 2017. Here we present our results to date and discuss possible causes of changes in mortality and growth rates.

Contact Information:
UC Davis (Swee Teh: 530-754-8183): **Tomo Kurobe**: tkurobe@ucdavis.edu; **Bruce G. Hammock**: brucehammock@gmail.com; Ching Teh: foochingteh@gmail.com; **Swee Teh**: sjteh@ucdavis.edu
CDFW: **Peggy Lehman**, Peggy.Lehman@water.ca.gov
CDWR: **Sarah Lesmeister**, Sarah.Lesmeister@water.ca.gov

How do hydrodynamic conditions influence sediment trapping by the invasive submerged aquatic plant *Egeria densa* in the Delta?

J. R. Lacy[1], J.Z. Drexler[2], R. M. Allen[1], D. Schoellhamer[2], M. Downing-Kunz[2], and P.A. Work[2]

Submerged aquatic vegetation (SAV) attenuates currents and traps sediment. The ongoing proliferation of invasive SAV, including Brazilian waterweed (*Egeria densa)*, in the Sacramento-San Joaquin Delta raises concern that sediment trapping is negatively affecting marsh formation and the Delta ecosystem. We are investigating the influence of *E. densa* on currents and suspended-sediment concentration (SSC) at two freshwater, tidal sites: Lindsey Slough, a muddy low-energy backwater in the north Delta, and the lower Mokelumne River, where currents are stronger and bed sediments are predominately sand. At each site we mapped bathymetry and the extent of vegetation; determined vegetation density; measured time series of velocity, depth, and SSC within and outside the vegetation; and analyzed properties of bed sediments.

At both sites, currents were strongly attenuated (more than 90%) within the *E. densa* compared to the unvegetated channel. At low concentrations, SSC was very similar within and outside the vegetation, because the fine particles in suspension at low current speeds remain in suspension even in the quiescent canopy. At higher concentrations SSC within the canopy was reduced (50% at Mokelumne, 30% at Lindsey). At Mokelumne, we attribute the reduction in SSC within the canopy to reduced bed shear stress. Bed shear stress exceeded the threshold for sediment mobilization during strong currents outside the vegetation, but not within, promoting sediment settling in the vegetation. In contrast, in Lindsey Slough tidal currents were too weak to mobilize the muddy bed sediments, yet elevated SSC in the channel was reduced within the canopy by either particle trapping on the plants or limited advection into the vegetation by the extremely low current speeds there (<1 cm/s). These results illustrate the dependence of mechanisms and degree of sediment trapping by submerged vegetation in the Delta on current speed (tidal and riverine), SSC, and sediment characteristics.

1. USGS Pacific Coastal and Marine Science Center, 2885 Mission St, Santa Cruz, CA 95060 jlacy@usgs.gov (831-460-7520), rallen@usgs.gov
2. USGS California Water Science Center, 6000 J St, Placer Hall, Sacramento CA 95819 jdrexler@usgs.gov, dschoell@usgs.gov, mdowning-kunz@usgs.gov, pwork@usgs.gov

Phytoplankton and cyanobacteria growth is inhibited by herbicides (fluridone >> glyphosate > imazamox toxicity)

Chelsea Lam[1], Tomofumi Kurobe[1], Peggy Lehman[2], and Swee J. Teh[1]

[1] Aquatic Health Program, Department of Anatomy, Physiology and Cell Biology, University of California, Davis, 1089 Veterinary Medicine Drive Davis, CA 95616
[2] California Department of Water Resources, Division of Environmental Services, Special Studies Section, 3500 Industrial Blvd West Sacramento, CA 95691
[1]Chelsea Lam, (530) 754-8020, chylam@ucdavis.edu
[2]Peggy Lehman, (530) 400-6885, Peggy.Lehman@water.ca.gov
[1]Tomofumi Kurobe, (530) 754-8183, tkurobe@ucdavis.edu
[1]Swee Teh, (530) 754-8183, sjteh@ucdavis.edu

Herbicides are applied yearly in the Delta to control invasive aquatic plants in the Sacramento-San Joaquin Delta. Phytoplankton and cyanobacteria are non-target species that could be sensitive to these chemicals. In this study, 96-well plate growth tests determined whether the herbicides: glyphosate, imazamox and fluridone would inhibit the growth of some of these non-target species, which naturally occur in the Delta. The three phytoplankton and cyanobacteria used were *Thalassiosira pseudonana* (nutrient rich diatom), *Microcystis aeruginosa* (dominant hazardous cyanobacteria), and *Chlamydomonas debaryana* (model green algae species). *M. aeruginosa* and *C. debaryana* were isolated from Delta waters. We found that glyphosate and imazamox inhibited growth of all species at concentrations higher than what would be found in the environment, inhibiting growth between 7,000 ppb to 70,000 ppb, and between 20,000 ppb to 200,000 ppb respectively. However, IC_{50} for fluridone shows it inhibits algal growth at environmentally relevant concentrations. The IC50 of fluridone was 46.9 ppb (95% CI: 40.5 – 53.4 ppb) for *M. aeruginosa*, 21.0 ppb (95% CI: 14.0 – 27.9 ppb) for *T. pseudonana* and 109 ppb (95% CI: 93.4 – 125 ppb) in *C. debaryana*. Sensitivity to fluridone from most to least was *T. pseudonana*>*M. aeruginosa*>*C. debaryana*. Additional growth inhibition tests with a variety of native algae species can help identify contaminants and contaminant levels that will negatively impact beneficial or harmful species present in the Delta. Of the three herbicides tested, fluridone was the only chemical that inhibited algal growth at concentrations that could potentially be applied in the environment. Fluridone treatments can decrease pelagic primary productivity in the Delta, although further experiments with field water are needed.

Wakasagi egg hatching frames used in Lake Suwa, Japan, and their applications in Delta Smelt

Brandon Lee[1], Will Mulvaney[1], Daphne Gille[2], Tien-Chieh Hung[1]

[1] Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
[2] Animal Science Dept., UC Davis

The Lake Suwa Fishing Collective, a known fishery located in Nagano, Japan, artificially spawns Wakasagi smelt (*Hypomesus nipponensis*) in order to supplement the wild population for recreational purposes. Hatchery staff from the Collective have designed an egg hatching frame and frame box to hold fertilized eggs of Wakasagi in a body of flowing water so that the larvae hatch into the water and are released into the wild. Wakasagi are congeners and are very similar biologically to Delta Smelt (*Hypomesus transpacificus*), a listed fish endemic to the Sacramento-San Joaquin Delta. The two species are also sympatric and have been known to hybridize. It is therefore reasonable to expect the Wakasagi egg hatching frame spawning method will be successful in Delta Smelt. Delta Smelt have been artificially spawned over the last decade at the UC Davis Fish Conservation and Culture Lab in order to sustain a refuge population. The wild Delta Smelt population has diminished to a point where experts believe supplementation using cultured fish needs to be evaluated as a possible management strategy. The Lake Suwa Fishing Collective egg hatching frame system is a good candidate to help reintroduce cultured Delta Smelt back into their natural environment. Releasing cultured Delta Smelt at the fertilized egg stage would minimize the time cultured fish spend in the hatchery and thus limit hatchery adaptation. The aim of this study is to examine and model the efficacy of the Waksagi egg hatching frames, either the one purchased from Japan or a prototype built on site, in spawning Delta Smelt in a culture stream.

EMP Phytoplankton Dataset Project: Long-term phytoplankton trend analyses

Peggy Lehman, Tiffany Brown, Sarah Lesmeister and Karen Gehrts

California Department of Water Resources, 3500 Industrial Blvd, West Sacramento, CA 95691, Peggy.Lehman@water.ca.gov, (916-376-9767), Tiffany.Brown@water.ca.gov (916-376-9723), Sarah.Lesmeister@water.ca.gov (916-376-9741), Karen.Gehrts@water.ca.gov (916-376-9694)

Phytoplankton community composition has been sampled by the Environmental Monitoring Program (EMP) as part of the compliance monitoring program needed for operation of the State Water Project since the early 1970s. This 40+ year database provides valuable information on the changes in food quality that have occurred at the base of the aquatic food web in the estuary and is particularly important given the decline in fish production in the estuary since 2000. However, effective utilization of the phytoplankton dataset requires attention to changes in methodology associated with precision, magnification and taxonomy. As a part of this project, quality assurance adjustments for precision through aggregation, magnification through size fractionation, and taxonomy through taxa aggregation were used to develop a reliable method for examining long-term change in percent carbon by taxa for phytoplankton data collected between 1975 through 2017. This poster presents data for Suisun Bay, where diatom carbon was relatively low between 1988 and 2010 but remained a dominant source of carbon throughout the years. Cryptophytes, dinoflagellates and cyanobacteria became a large fraction of the total carbon pool in Suisun Bay after 2004, as did the frequency of small volume cells. The data for Suisun Bay demonstrated significant change in primary producer food quality at the base of the aquatic food web in the estuary that would have affected long-term food web production.

How zooplankton go with the Delta flow

Marissa Levinson[1], Nicholas Corline[1], Carson Jeffres[1]
[1] Center for Watershed Sciences, Watershed Sciences Building, University of California, Davis, One Shields Avenue Davis, CA 95616
Marissa Levinson: mrlevinson@ucdavis.edu (916) 690- 4215

The McCormack-Williamson tract (MWT) is a 1500 acre parcel of agricultural land and is one of the few locations within the Delta where a natural gradient of subtidal, intertidal, and seasonal floodplain habitat restoration is possible within a single property. High river flows in 2017 caused an unintentional levee breach, allowing an opportunity to investigate how flood flows impact zooplankton communities and abundance within and around the tract. Monitoring has been ongoing since 2016, allowing us to better understand how zooplankton communities can be bio indicators of ecosystem function during different hydrologic regimes. This analysis is trying to better understand the spatial variation in zooplankton community structure and abundance and its relation to hydrologic conditions. Zooplankton was sampled at multiple locations at varying distances above and below MWT before and after individual storm events, as well as before, during and after levee failure and flooding. Understanding the interaction between hydrology, habitat availability, and zooplankton communities can help guide future restoration actions to benefit higher trophic levels of regulatory importance. Understanding the interaction between hydrology, habitat availability, and zooplankton communities can help guide future restoration actions to benefit higher trophic levels of regulatory importance

Trace Metals to Trace Movements: quantifying variation in the life history of Longfin Smelt

Levi Lewis[1], Malte Willmes[1], James Hobbs[1], Christian Denney[1], Tien-Chieh Hung[1], Randy Baxter[2]

[1]UC Davis
[2]California Department of Fish and Wildlife

The Longfin Smelt is an iconic sea-going forage fish that once thrived in the San Francisco Bay Estuary. In the last 50 years, the population has crashed to less than 1% of historic levels, suggesting the ecosystem has become unsuitable for this native species. However, little is known about the ontogenetic niche (physical habitat characteristics required for successful spawning and rearing) within the Estuary. Building upon our previous work, we are using multiple geochemical tracers in otoliths (ear bones) to quantify variations in life-history strategies of Longfin Smelt across bay regions, years, and climate regimes. Strontium isotopes can be used to reconstruct detailed movements within low salinity environments, oxygen isotopes enable us to reconstruct movements throughout the bay and ocean, and multivariate trace element analyses allow us to identify previous natal rearing habitats. We have validated otolith aging and growth reconstructions and are currently validating the temporal resolution of our geochemical techniques using manipulative experiments at the UC Davis Fish Conservation and Culture Lab. Results of this work could transform our understanding of the habitat requirements and population dynamics of this threatened species, thus enhancing the effectiveness of future water management and conservation efforts.

Delta Smelt egg growth, hatching response, and larval survival at different salinity environments

Will Mulvaney[1], Tien-Chieh Hung[1]
[1]Fish Conservation and Culture Laboratory, Biological and Agricultural Engineering Department, University of California Davis, Byron CA.

Delta smelt (*Hypomesus transpacificus*) is a federally threatened and state listed endangered species endemic to the San Francisco Estuary and Sacramento San Joaquin Delta that acts as an indicator of the ecosystem health. It is important to understand the salinity tolerance of their eggs to determine the critical habitat for delta smelt spawning within this semi-estuarine system. We are currently running trials in several temperature controlled (12°C) flow-through egg incubators with different target salinities (0, 3, 6, 9 or 12 ppt). Eggs are seeded onto glass plates and fertilized, naturally adhering to the surface, and placed into the incubators. The plates will be photographed every 2 h over the first 24 h and then every day for the remainder of the trial. After 10-15 days, the eggs will hatch, and the larvae will be collected and cultured downstream. The photographs of the eggs will be analyzed using image analysis software to determine their growth, development, embryogenesis, and survival. The larvae will be monitored and counted for up to 10 days post hatching to ascertain survival. We will discuss the implications of this study and present preliminary data from this ongoing trial. This study will add to the growing body of knowledge on this important species and provide relevant information for future trials that will explore reseeding the endangered wild population with eggs from cultured delta smelt.

Mossdale Trawl monitoring results 2012-2018

Gretchen Murphey, Adam Russell
California Department of Fish and Wildlife
PO Box 10; La Grange, CA 95329; (209)853-2533 ex 3#

The Mossdale Trawl is operated annually from April-June by the California Department of Fish and Wildlife. The trawl is located on the San Joaquin River about 2 miles downstream of the Mossdale Landing County park and upstream of the Head of Old River. The trawl targets the chinook produced in the San Joaquin basin and produces estimates of abundance and survival of those fish, as well as documenting the timing and size of the out-migrants. For the period of 2012-2018 data from the Mossdale trawl has been used to produce 3 Chinook estimates annually: smolt per acre foot, a vulnerability expansion estimate based on single year data (when study fish are available), and a vulnerability expansion estimate using multiple years of data. Trawl data was also used to produce a steelhead abundance index using the smolt per acre foot calculations. By linking adult escapement egg estimates from carcass surveys with the juvenile estimates we calculated egg to smolt survival. Finally, we calculated the volume of flow at Vernalis from February to June to see how survival was affected by flows.

SFEWS: Open By Design

Lauren D. Muscatine
Muir Institute, University of California-Davis
One Sheilds Avenue, University of California-Davis, Davis, CA 95616
Mailing address: 4417 Tanglewood Way, Napa, CA 94558
(707) 225-7037; ldmuscatine@ucdavis.edu

Once your paper has been accepted by an academic journal, how do you make the data underlying your research available? If you have not already adopted data management practices to support current mandates (e.g., Plan S, AB 1755) and make your data open and available, consider that affiliated universities and journal publishers have services that can support this effort. Through its association with the California Digital Library's eScholarship Publishing group, the academic journal *San Francisco Estuary and Watershed Science* is not only designed to deliver open-access research through its quarterly publication, but also to provide researchers access to a general-purpose, curated data repository that makes the data underlying these scientific publications discoverable, freely reusable, citable, and integrated with that research. *SFEWS*'s open access publishing platform is boosted by underlying open data repository services, now through DASH and soon through Dryad, that serve to increase discoverability, innovation, and open science collaborations. These data services optimize your data deposit for FAIR-ness, making your data Findable, Accessible, Interoperable and Reusable. By usingthese services, your data is associated with your ORCiD ID, and receives a permanent identifier (DOI), a formatted citation, and statistics on views and downloads. Put simply, *SFEWS* is and will always be, an academic journal that is open by design.

Landscape-scale variation in food web isotopes ($\delta^{13}C$ and $\delta^{34}S$) help track fish movements

Dana Myers[1], Miranda Tilcock[1], Carson Jeffres[1], Ted Sommer[2], Louise Conrad[3] and Rachel Johnson[1,4]

[1] Center for Watershed Sciences, Watershed Sciences Building, 1st Floor, University of California, Davis, One Shields Avenue Davis, CA 95616

[2] Department of Water Resources, 3500 Industrial Blvd #131, West Sacramento, CA, 95691

[3] Delta Stewardship Council, 980 9th St, Sacramento, CA 95814

[4] National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA 95060

Isoscapes are an important mapping tool to track the migration and feeding ecology in both terrestrial and aquatic taxa by characterizing the natural isotopic variation that occurs on the landscape. In aquatic systems, biogeochemical processes functioning at different spatial-scales can fractionate light isotopes ($\delta^{13}C$ and $\delta^{34}S$) at the base of fish food webs. Our previous work shows $\delta^{13}C$ and $\delta^{34}S$ isotopes measured in prey and salmon tissues can be used to identify salmon reared on floodplains from river-rearing with high accuracy (88% floodplain; 98% river). Given salmon cannot be effectively sampled in all potential rearing habitats, this study uses a ubiquitous amphipod species (*Gammarus sp.*) to expand the current isoscape to include the Sutter Bypass, Yolo Bypass, and other tidal wetland habitats that juvenile salmonids are likely to rear prior to seaward migration. First, we test how reliable amphipods are as a proxy for $\delta^{13}C$ and $\delta^{34}S$ in salmon diets by comparing amphipods and salmon prey items and muscle tissues from salmon caged on the Sutter Bypass. Lastly, we look at how this isoscape can be used to identify juvenile habitat use in salmonids by using $\delta^{13}C$ and $\delta^{34}S$ signatures permanently recorded within the eye lens.

A View into the Delta Plan Performance Measures

Scott Navarro (Scott.Navarro@deltacouncil.ca.gov), Cory Copeland (Cory.Copeland@deltacouncil.ca.gov), Chris Kwan (Chris.Kwan@deltacouncil.ca.gov), and Martina Koller (Martina.Koller@deltacouncil.ca.gov); (916) 445-5593
Delta Stewardship Council; 980 9th Street, Sacramento California

The Delta Stewardship Council is unveiling the Delta Plan Performance Measures dashboard; a website to view and access performance measures information and data relevant to Delta Plan strategies and recommendations. Delta Plan performance measures track the progress in meeting the coequal goals of a reliable water supply for California and a healthy Delta ecosystem. Additional performance measures track implementation status in the Delta as an Evolving Place, Water Quality, and Protect People and Property areas of the Delta Plan. The performance measures serve multiple purposes: meet requirements of the Delta Reform Act, are a tool for communicating with Delta managers and interested public, and support adaptive management of the Delta. This poster will showcase the dashboard structure and key features that may be of interest to the IEP community.

Use of continuous water isotope ratios and other high frequency measurements to understand water residence time and biogeochemical processes in the Cache Slough Complex

Katy O'Donnell, Bryan Downing, Brian Bergamaschi, Tamara Kraus, Elizabeth Stumpner, and Sharon Gosselink.
USGS California Water Science Center
6000 J Street, Sacramento, CA 95819; 916-278-3000

We employed high-speed boat mapping transects to evaluate the effects of water residence time on biogeochemical processes in the Cache Slough Complex (CSC). Measurements collected over fine spatial scales are needed to adequately resolve sources, quantify concentrations gradients, and understand biogeochemical processes in hydrologically complex tidal environments, such as the CSC.

Using our boat-based flow through system, in addition to collecting high frequency (~1 per second) measurements of nitrate, ammonium, chlorophyll, and ancillary water quality parameters, we simultaneously measured water isotopes ($\delta^{2}H$, $\delta^{18}O$) using a novel, commercially available continuous analyzer. Water isotopes are unique tracers for evaporation (in the absence of precipitation) and thus can be used to calculate water residence time.

High-speed boat transects in the CSC were completed on three separate occasions: October 2017, May 2018, and October 2018. By examining changes in constituent concentrations over time we can calculate rates of ecosystem nitrate and ammonium loss and relate that to chlorophyll concentration and phytoplankton species composition. Differences between sampling campaigns and across the landscape can be related to landscape scale features (e.g., water depth, aquatic vegetation, interaction with wetlands), and environmental drivers (e.g., temperature, chlorophyll-a standing stock).

Floodplain Food Delivered to your Delta Doorstep: From the Fish's Perspective

Mollie Ogaz[1], Kelly Neal[1], Dana Myers[1], Sierra Schleup[1], Carson Jeffres[1], Rachel Johnson[1,2], Ryan Peek[1], Nicholas Corline[1], Anna Sturrock[1]

[1] Center for Watershed Sciences, Watershed Sciences Building, 1st Floor, University of California, Davis, One Shields Avenue Davis, CA 95616
[2] National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA 95060

Mollie Ogaz: mhogaz@ucdavis.edu, (408) 391-5121

Juvenile Chinook salmon that access floodplain habitat may exhibit greater growth and survival than those restricted to river habitats; in part due to the elevated production of zooplankton prey. But to what extent can this production supplement diets of juvenile salmon in the Sacramento-San Joaquin Delta (Delta) through floodplain exports under differing hydrologic conditions? All Central Valley juvenile Chinook salmon must navigate the Delta during their seaward migration, however many of them lack access to highly productive off-channel habitats such as floodplains and wetlands that were historically abundant in this region. Today, the Delta has been transformed into a leveed water conveyance system, densely populated by non-native piscivorous fishes. Survival of juvenile salmon through the Delta is typically low, and the extent to which salmon successfully rear in the Delta is typically assumed negligible. However, otolith reconstructions in returning adults show that Delta rearing can be a viable strategy for winter, spring and fall run outmigrants. Here we examined the importance of different prey items to juvenile Chinook salmon as they migrated through the Delta in dry (2014-2015) and wet (2016-2017) years. We examined spatiotemporal patterns in zooplankton abundance in the guts of the outmigrating juveniles and surrounding water, focusing on taxa typically unique to floodplain habitats (cladocera and ostracoda) to try to decouple the importance of *in situ* production vs. floodplain exports. We hypothesized that if floodplain exports are an important trophic subsidy we would observe focal increases in their abundance in both the water and salmon diet in areas of the Delta draining extensive floodplains (e.g. Yolo and Cosumnes). We also hypothesized that the timing of these "hotspots" would correlate with runoff events, and that their intensity (area and density) would correlate with the volume of runoff and duration of floodplain inundation.

Utilizing NASA and ESA Earth Observations to Monitor Water Quality Conditions in the San Francisco-Bay Delta

Amye Osti
34 North; 40169 Truckee Airport Road Suite 202; Truckee, Ca 96161
(310) 305 8289; amye@34north.com
Collaborators: NASA/JPL, 34 North, Oregon State University, U.C. Merced, USGS, MWD and DWR

The decline of the Delta Smelt reinforces our need for effective Operational Management in the Bay-Delta. Turbidity conditions in the winter months are a signal of Delta Smelt Movement for spawning and often lead to operational changes in the system. This project aims to add additional data sources to the decision-making tool box to ensure that fish are protected and exports can available to water users. In this project we are adding 2 additional resources to for Managers:

- High Resolution Remote Sensing Imagery Post-Processed for Turbidity
- Constituent Tracker Output Values for Turbidity Without Tidal Influence

The Bay Delta Live water quality and operations data portal is a collaborative effort to integrate NASA Earth Science Data with water quality, environmental data and decision support tools for water operations. This project's major objective is to make NASA Earth science data available to water resource managers and decision makers in an easy to use web-based application. The data and tools are added to current workflows and can be easily synthesized with other key operations, monitoring data and models. This project will be used for improved monitoring and management strategies for pumping facilities, such as pumping restrictions, periodic closure, or Delta smelt salvage at pumping facilities in the southern Bay-Delta. The project includes:

Data Collection: Data is collected from various sources; remote sensing imagery and boat cruises as well as web services from CDEC and USGS.

Data Analysis and Comparison: Remote sensing data is post processed and aggregated with boat transects and in situ data.

Web Display of Data and Information: Post-processed satellite imagery for key parameters (Turbidity, Temperature, and Chlorophyll-a) is made available. This data can be combined with boat transect results, in-situ data, and much more.

Calibration and Validation of Data and Results: This process validates the remote sensing algorithm results and values through use of the extensive in situ sensor network throughout the Bay-Delta.

Slack Water Model for Salt and Sediment Transport in the Sacramento-San Joaquin River Delta

David Osti and Jon Burau

34 North; 40169 Truckee Airport Road Suite 202; Truckee, Ca 96161
(310) 305 8289; amye@34north.com
Collaborators: USGS, 34 North, California Department of Water Resources and Metropolitan Water District Southern California

Endangered species protections for Delta smelt, a functionally extinct endemic-to-the-Sacramento/San Joaquin Delta fish, can significantly constrain water supplies south of the Delta in the winter, when, tragically, there is the greatest amount of water available for export.

There are a number of different regulatory triggers aimed at protecting delta smelt that can curtail pumping: the main triggers being salvage at the pumps and elevated turbidities in the central and south Delta. For example, reductions in pumping are required when the 14-day average turbidity exceeds 12 NTU at stations PRI, HOL, and VIC.

Within existing regulatory frameworks, a better understanding of the turbidity field in the central and south Delta will have the collateral benefit of increasing water supply reliability south of the Delta. Exports of water to regions south of the Delta. The Delta plays a critical role in California's economy, the largest state economy in US (~20% of US GDP) and the 6th largest economy in the world.

Field measurements of salt and sediment concentrations (or turbidity) made from boats (e.g. along-channel transects) often involve campaigns that are long in duration compared to a tidal cycle. As a result, they can provide a spurious picture of the spatial distribution of concentrations and how they vary over time. This project makes use of existing concentration and flow data collected at fixed stations to provide a web based model and maps of the spatial patterns in the concentration data.

The model and web -based decision support tool (www.baydeltalive.com) aims to measure observations of water quality constituents or proxies (specific conductivity and turbidity) and measured velocities to demonstrate the constituent field at a constant point in *tide.* This work is being conducted in order to reduce the need for in situ measurements of turbidity and other constituents.

Longfin Smelt in the Lesser Watersheds of the San Francisco Estuary

Christina Parker: chrparker@ucdavis.edu, 530-341-2383
Levi Lewis: lewis.sci@gmail.com
Malte Willmes: mwillmes@ucdavis.edu
James Hobbs: jahobbs@ucdavis.edu

Wildlife, Fish and Conservation Biology, University of California Davis.
1088 Academic Surge, Davis, Ca. 95616

The threatened Longfin Smelt (*Spirinchus thaleichthys*) utilizes estuaries and freshwater rivers for spawning and rearing along the west coast of North America, from the San Francisco Estuary (SFE) to Alaska. Though spawning and rearing in the SFE is believed to occur primarily in the Sacramento-San Joaquin River Delta, recent evidence suggests that Longfin Smelt may also utilize smaller watersheds throughout the SFE for rearing and reproduction. The importance of these smaller bay tributaries to Longfin population dynamics, however, remains unknown. From 2015 to present, the Hobbs Lab (UC Davis Biogeochemistry and Fish Ecology Lab) has conducted larval, juvenile, and adult surveys to examine variation in habitat use by Longfin Smelt among several tributaries of San Pablo Bay and Lower South San Francisco Bay. To facilitate comparisons with long-term monitoring efforts, we used gear similar to that of California Department of Fish and Wildlife's sampling gears (e.g., smelt larval sled, 20mm sled, and otter trawl). Over the study period, relative abundances of adult Longfin in these lesser watersheds were often comparable to or even greater than abundances measured in the Delta. In 2017, a wet year with high freshwater outflow, these bay tributaries provided additional suitable low-salinity habitats in sloughs and marshes that supported high densities of larval and juvenile Longfin Smelt. Thus the lesser watersheds of the SFE appear to be important habitat for Longfin Smelt, especially when salinities are favorable for larval recruitment and rearing.

Investigating Copepod Diet Using qPCR: The Details are in the DNA

Cheryl Patel, Graduate student researcher
San Francisco State University at the Estuary & Ocean Science Center
Estuary & Ocean Science Center
San Francisco State University
3150 Paradise Drive, Delta Hall/Bldg 36
Tiburon, CA. 94920
510-760-3348 cpatel2@mail.sfsu.edu

Michelle Jungbluth, Adjunct Assistant Professor
San Francisco State University at the Estuary & Ocean Science Center
Estuary & Ocean Science Center
San Francisco State University
3150 Paradise Drive, Delta Hall/Bldg 36
Tiburon, CA. 94920
415-338-3510 mjungbluth@sfsu.edu

Calvin Lee
San Francisco State University at the Estuary & Ocean Science Center and ICF International
Estuary & Ocean Science Center
San Francisco State University
3150 Paradise Drive, Delta Hall/Bldg 36
Tiburon, CA. 94920
415-338-3510 Cal10lee@gmail.com

Toni Ignoffo, Research Technician
San Francisco State University at the Estuary & Ocean Science Center
Estuary & Ocean Science Center
San Francisco State University
3150 Paradise Drive, Delta Hall/Bldg 36
Tiburon, CA. 94920
415-338-3510 tignoffo@sfsu.edu

Wim Kimmerer, Adjunct Professor
San Francisco State University at the Estuary & Ocean Science Center
Estuary & Ocean Science Center
San Francisco State University
3150 Paradise Drive, Delta Hall/Bldg 36
Tiburon, CA. 94920
415-338-3515 kimmerer@sfsu.edu

In 2017 our laboratory used Next Generation Sequencing (NGS) to investigate copepod diets in a region of the San Francisco Estuary where copepod growth rates are generally high. Results showed a surprisingly high proportion of cyanobacteria in copepod guts despite their potentially low nutritive value, and low proportions of those cyanobacteria in the corresponding water column, while the opposite pattern was seen for cryptophytes. In this study, we aim to quantify copepod feeding rates on cyanobacteria and cryptophytes using quantitative polymerase chain reaction (qPCR) and explore diel variation in feeding rates. Our lab used qPCR previously to investigate the feeding and reproductive response to a large bloom of the diatom *Aulacoseira* in the upper San Francisco Estuary. We determined the number of copies of the selected gene of *Aulacoseira* in the guts of female adult copepods, and converted copy number to

approximate consumption rates using literature estimates and residence times of DNA in copepod guts. The same methods will be used in determining feeding rates on cyanobacteria and cryptophytes. This

presentation shows the initial results from primer development and optimization for cyanobacteria and cryptophyte in *Pseudodiaptomus forbesi* diet as well as qPCR results of *Aulacoseira* consumed by *P. forbesi* during a bloom. Copepods contained roughly 300–7000 pg C copepod^{-1} day^{-1} from *Aulacoseira* cells. When compared to the amount of food needed to support growth of *P. forbesi*, the consumption rates would only make up no more than 2% of the *P. forbesi* diet. It appears that *Aulacoseira* is not an important food item for this copepod, perhaps because the diatom chains are too large for the copepods to ingest easily. Further investigation of *P. forbesi* diet will reveal how important cyanobacteria and cryptophytes are as a food source.

Drivers of short-term growth in juvenile Delta Smelt in the Sacramento-San Joaquin Delta and San Francisco Estuary

Wilson F. Ramírez-Duarte[1*], Bruce G. Hammock[1], Andrew Schultz[2], Swee J. Teh[1]
[1] Department of Anatomy, Physiology, and Cell Biology, School of Veterinary Medicine, University of California, Davis, CA 95616, USA
[2] Mid-Pacific Region, Bay–Delta Office, U.S. Bureau of Reclamation, Sacramento, CA 95825, USA
*Corresponding author. E-mail: wframirezduarte@ucdavis.edu; Tel.: +1 (530) 754-8020

The purpose of this study is to determine drivers of short-term growth of juvenile Delta Smelt, using RNA to DNA ratio in skeletal muscle as proxy. Data for this study were gathered from juveniles collected from June through September from 2011 through 2016 in the Sacramento San Joaquin Delta and San Francisco Estuary (n=414). Several Gaussian linear models were fit and compared with Akaike's Information Criterion corrected for small sample size (AIC_c), using RNA-DNA as the response. As shown for other juvenile fish, RNA to DNA ratio in Delta Smelt decreases as fish mature, indicating that younger fish have higher growth rates than older fish. After accounting for fish size differences, the influence of other variables on RNA to DNA ratio was analyzed. Smaller RNA to DNA ratios were observed at higher temperatures suggesting that Delta Smelt cannot fully compensate for increased metabolic demand at higher temperature by eating more, causing growth to decline. Additionally, significant differences in Delta Smelt growth were observed among regions and years. Delta Smelt collected at Suisun Marsh had the highest recent growth rate (relatively high RNA to DNA ratio) while those collected at Confluence and Suisun Bay had the lowest recent growth rate (relatively low RNA to DNA ratio). Juvenile Delta Smelt collected in 2012 and 2013 grew the fastest and fish from 2016 grew the slowest. This study suggests that low temperatures in combination with high percent gut fullness (as an indicator of foraging success) positively affect short-term growth in Delta Smelt. A laboratory experiment to establish RNA to DNA ratio levels indicative of good and poor growth in Delta Smelt is needed.

An overview of the process of Coded Wire Tag hatchery-released juvenile Chinook salmon salvaged at SWP facilities.

James Robinson – Department of Water Resources: Division of Environmental Services – P.O. Box 942836 Sacramento, CA 94236 – (916) 376 - 9793 – James.Robinson@water.ca.gov
Harry Spanglet – Department of Water Resources: Division of Environmental Services – P.O. Box 942836 Sacramento, CA 94236 – (916) 376-9844 – Harry.Spanglet@water.ca.gov
Kevin Reece – Department of Water Resources: Division of Environmental Services – P.O. Box 942836 Sacramento, CA 94236 – (916) 376-9709 – Kevin.Reece@water.ca.gov

The 2009 National Marine Fisheries Service Biological Opinion for the Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP) includes operational triggers related to loss of hatchery-released juvenile Chinook salmon. These fish are marked by a clipped adipose fin and implanted with coded wire tags (CWT) with a laser etched code indicating when and where the fish was released. CWT fish that travel into the Clifton Court Forebay and through the fish diversion process are salvaged at the SWP John E. Skinner Delta Fish Protective Facility. Salvage rates of tagged late-fall-run juveniles are used to monitor and calculate loss of ESA-listed juvenile yearling spring-run Chinook salmon due to pumping operations at the export facilities and predation within Clifton Court Forebay. An overview is presented of the CWT salvage process and regulatory environment, as well as potential further uses of the data between release and salvage of CWT juvenile Chinook salmon at CVP and SWP facilities whose goal is to understand and analyze trends of the surrogate spring run Chinook salmon in the Sacramento River.

Velocity and Discharge Measurements in Montezuma Slough During Suisun Marsh Salinity Control Gate Reoperations

Catherine Ruhl
cruhl@usgs.gov, 916 216 7267
U.S. Geological Survey, California Water Science Center
1280 Terminal St., West Sacramento, CA 95691

Suisun Bay and Suisun Marsh are critical habitat regions for the endangered Delta Smelt; however, during lower flow conditions common in the summer and fall months, the Delta Smelt may not be able to utilize these regions due to elevated salinity. The Suisun Marsh Salinity Control Gates (SMSCG) located in the eastern reach of Montezuma Slough were designed to move fresh water into Suisun Marsh, but are typically operated in the fall and winter to improve habitat conditions for waterfowl. A diverse group of modelers, engineers, and scientists developed a plan to operate SMSCG earlier in the season to direct more fresh water into the Suisun Marsh area and to collect the data necessary to quantify the habitat benefits for Delta Smelt.

The US Geological Survey (USGS) played a small role in this large effort. The SMSCG were tidally operated from August 2 – September 7, 2018. To characterize the hydrodynamic conditions prior to, during, and following this action, the USGS deployed two acoustic Doppler current profilers to measure the velocities in Montezuma Slough from July through October 2018. In addition, the CA Department of Water Resources and the USGS collaborated to collect a series of discharge measurements to develop ratings. The results from this effort will be used to verify modeling results. The model can then be used to develop and refine management strategies in the future.

PATTERNS OF ZOOPLANKTON USE BY JUVENILE AND SUB-ADULT DELTA SMELT (*HYPOMESUS TRANSPACIFICUS*)

Andrew Schultz
Science Division
U.S. Bureau of Reclamation, Bay-Delta Office
801 I Street, Suite 140, Sacramento, CA 95814
(916) 414-2415 aschultz@usbr.gov

Steven Slater
Interagency Ecological Program
California Department of Fish and Wildlife, Bay-Delta Region
2109 Arch Airport Road, Suite 100, Stockton, CA 95206
(209) 234-3673 steve.slater@wildlife.ca.gov

Bruce Hammock
Aquatic Health Program
School of Veterinary Medicine, Department of Anatomy, Physiology, and Cell Biology
One Shields Avenue, University of California, Davis, CA 95616
(951) 303-7738 brucehammock@gmail.com

April Hennessy
IEP Zooplankton Study
California Department of Fish and Wildlife, Bay-Delta Region
2109 Arch Airport Road, Suite 100, Stockton, CA 95206
(209) 234-3665 april.hennessy@wildlife.ca.gov

Christina Burdi
Fish Diet and Condition Study
California Department of Fish and Wildlife, Bay-Delta Region
2109 Arch Airport Road, Suite 100, Stockton, CA 95206
(209) 234-3664 christina.burdi@wildlife.ca.gov

Jason Hassrick
Fish and Aquatic Science, ICF
201 Mission Street, Suite 1500, San Francisco, CA 94105
(628) 895-6716 jason.hassrick@icf.com

Lenny Grimaldo
Fish and Aquatic Science, ICF
201 Mission Street, Suite 1500, San Francisco, CA 94105
(415) 823-1372 lenny.grimaldo@icf.com

Colin Brennan
ICF, 201 Mission Street, Suite 1500, San Francisco, CA 94105
(925) 330-7723 colin.brennan@icf.com

Swee Teh
Aquatic Health Program
School of Veterinary Medicine, Department of Anatomy, Physiology, and Cell Biology
3203 VM3B, 1089 Veterinary Medicine Dr., University of California-Davis, Davis CA 95616
(530) 754-8183 sjteh@ucdavis.edu

Denise Barnard
U.S. Fish and Wildlife Service,
850 S Guild Ave #105, Lodi, CA 95240
(209) 294-3048 denise_barnard@fws.gov

Oliver (Towns) Burgess
U.S. Bureau of Reclamation Bay-Delta Office
801 I Street, Suite 140, Sacramento, CA 95814
(916) 414-2416 oburgess@usbr.gov

Randall Baxter
California Department of Fish and Wildlife, Bay-Delta Region
2109 Arch Airport Road, Suite 100, Stockton, CA 95206
(209) 234-3483 randy.baxter@wildlife.ca.gov

Management actions to benefit Delta Smelt are currently in place or proposed. How such actions affect food availability and prey use for Delta Smelt is uncertain but the prevailing hypotheses are food production, food quality and feeding success for Delta Smelt increases as the low-salinity zone of the Delta moves seaward. Our study used diet information from 1,869 Delta Smelt collected from 2011-2017 to expand the knowledge base and evaluate hypotheses related to the feeding ecology of Delta Smelt and associated environmental conditions.

Cylcopoid and calanoid copepods were the numerically dominant prey items in guts of Delta Smelt during most years and seasons, and relatively dominant in terms of prey biomass in the guts of young juveniles during summer period. This trend in prey biomass was more variable during fall through spring periods with larger prey items such as mysids, amphipods and larval fishes important during several years. The wet year of 2017 was dominated in terms of prey biomass by amphipods. This largely contrasts prior data from 2011-2016, where as a whole amphipods were not a large biomass component of diet and not when compared to the wet year of 2011.

Gut fullness was significantly higher in 2017 but there was no evidence that gut fullness was greater in Suisun Bay/Marsh or differed across salinity levels. We found a negative linear relationship between gut fullness and condition factor. While gut fullness may be an indicator of short-term food availability or feeding success, it may not have direct relevance to certain health/condition metrics as these measures are impacted more by a suite of prior conditions experienced by each fish. An electivity index was used to measure Delta Smelt selection for prey items.

Fish Surveys of the Delta: Identifying Indicator Species

Dylan K. Stompe, John R. Durand, and Peter B. Moyle
Center for Watershed Sciences, University of California, Davis

Native fish species which inhabit the Delta have generally suffered declines in the past decades, provoking the implementation of a breadth of long-term monitoring programs. The methodology used in each survey has largely remained constant, resulting in rich datasets useful for tracking trends in species abundance, the oldest of which dates back to 1959. The challenge in using these datasets for comparative purposes stems from the sheer magnitude of data available, incompatible data formats, or the general preference for familiar surveys. Problems arise in drawing conclusions based on one or few surveys, as each survey samples a different subset of species and/or reflects different spatial or temporal trends in abundance. In an effort to clarify which survey data is best suited for analysis of trends in specific species abundance, we constructed a rank-based heat map of survey validity for 36 species across 18 Delta surveys. Species in each survey were qualitatively ranked 0-3 based on overall catch and the ability of a given survey to represent trends in abundance, as determined through yearly aggregate catch data. In addition, species catch correlation matrices, trend analysis, and ordination analysis were performed to demonstrate the efficacy of using abundant non-native and native species as indicators of vulnerable species status. High catch correlations, similar trend inflection points, and clustering of ordination indicates that some abundant species, such as Striped Bass, may make for effective indicators of estuarine conditions that also support rare listed species, most notably Delta Smelt and Longfin Smelt.

Caging the beast: Can hatchery Delta Smelt survive in the wild?

Craig Stuart, Nicole Kwan, Melinda Baerwald, Ted Sommer, Daphne Gille, Tien-Chieh Hung, Brian Schreier, Dennis Cocherell, and Nann Fangue

Craig Stuart
California Department of Water Resources
3500 Industrial Blvd
West Sacramento, CA 95691
(916) 376-9766 Craig.stuart@water.ca.gov

Nicole Kwan
California Department of Water Resources
3500 Industrial Blvd
West Sacramento, CA 95691
(916) 376-9818 Nicole.kwan@water.ca.gov

Melinda Baerwald
California Department of Water Resources
3500 Industrial Blvd
West Sacramento, CA 95691
(916) 376-9742 Melinda.baerwald@water.ca.gov

Ted Sommer
California Department of Water Resources
3500 Industrial Blvd
West Sacramento, CA 95691
(916) 376-9772 Ted.sommer@water.ca.gov

Daphne Gille
University of California Davis
One Shields Ave.
Davis, CA 95616
(530) 752-6351 dagille@ucdavis.edu

Tien-Chieh Hung
University of California Davis
One Shields Ave.
Davis, CA 95616
(209) 830-9803 thung@ucdavis.edu

Brian Schreier
California Department of Water Resources
3500 Industrial Blvd
West Sacramento, CA 95691
(916) 376-9759 Brian.schreier@water.ca.gov

Dennis Cocherell
University of California Davis
One Shields Ave.
Davis, CA 95616

(530) 752-4997 decocherell@ucdavis.edu

Nann A. Fangue
University of California Davis
One Shields Ave.
Davis, CA 95616
(530) 752-4997 nafangue@ucdavis.edu

Delta Smelt (*Hypomesus transpacificus*), an endangered fish species native to the San Francisco Estuary, have experienced a dramatic population decline in recent years. Delta Smelt populations have become so depleted that crucial data gaps needed to inform conservation management are becoming more difficult to address. One promising approach to addressing these gaps is the use of hatchery-reared Delta Smelt in wild settings. While a host of policy issues surround this topic, the purpose of our project is to both develop methodology for using hatchery Delta Smelt as sentinel fish for evaluating the effectiveness of targeted management actions, as well as developing procedures that could one day be used during soft releases of hatchery fish to supplement the wild population. The main goals of this study were to 1) develop a Delta Smelt specific enclosure prototype that would securely contain fish while still exposing them to ambient field conditions and 2) test these enclosures to see if hatchery Delta Smelt would be capable of surviving under wild conditions. Enclosure prototypes were designed, constructed, and evaluated at the UC Davis Center for Aquatic Biology and Aquaculture. Initial evaluations confirmed the enclosures allowed for the passage of prey items. Following enclosure testing, 384 hatchery Delta Smelt from the UC Davis Fish Conservation and Culture Laboratory were acclimated to wild conditions (relevant water velocities, temperatures, and live prey) then placed in six cages in the Sacramento River near Rio Vista in the winter of 2019. Delta Smelt survival, growth, and diet were evaluated, as well as prey density, water quality, and biofouling of the enclosures. Preliminary results indicate that hatchery Delta Smelt may be capable of surviving in certain wild conditions.

In Situ Chlorophyll-a Fluorescence Comparison Study

Elizabeth Stumpner[1], John Franco Saraceno[2], Mike Dempsey[2], Thomas Johnston[1], Taylor Winchell[3], and Matthew Heberger[3]

[1] U.S. Geological Survey, CAWSC, 6000 J St. Sacramento, CA 95618, estumpner@usgs.gov, 916-278-3067
[2] California Department of Water Resources, 3500 Industrial Blvd. West Sacramento, CA 95619
[2] San Francisco Estuary Institute – Aquatic Science Center, 4911 Central Ave., Richmond, CA 94804

In situ chlorophyll-a fluorescence is a widely-accepted proxy for phytoplankton biomass and is measured throughout the Sacramento-San Joaquin Delta and San Francisco Bay by multiple federal, state, and non-governmental organizations. While many of these groups employ similar instrumentation, differences in the sensor settings and calibration procedures, deployment and retrieval protocols, quality-assurance, and post-processing methods may impact data comparability and system wide data synthesis efforts. With funding provided by the Bay Regional Monitoring Program (RMP) and Delta RMP, we carried out two side-by-side instrument deployments during Summer 2018 as part of the larger Intercalibration Study for Chlorophyll Fluorescence Sensors in the Bay-Delta. Seven water-quality sondes were deployed over a two-week period in the San Joaquin River at Mossdale (Department of Water Resources station MSD) and Cache Slough at Liberty Island (USGS station 11455315) to study data comparability between these organizations.

Biotic and Abiotic Predictors of Delta Smelt Presence and Abundance

Michael Tillotson[1], Andrew Schultz[2], Michael Beakes[2], Denise Barnard[3], Oliver Burgess[2], Lenny Grimaldo[1], Jason Hassrick[1], April Hennessy[4]

1: ICF, 201 Mission Street, Suite 1500, San Francisco, CA 94105 USA. mike.tillotson@icf.com (206) 605-8416, Jason.hassrick@icf.com (530) 312-3275, Lenny.grimaldo@icf.com (415) 823-1372.
2: U.S. Bureau of Reclamation Bay-Delta Office, 801 I Street, Suite 140, Sacramento, CA 95814. Andrew.schultz@usbr.gov (916) 601-1439, mbeakes@usbr.gov (916) 749-5368, oburgess@usbr.gov (916) 414-2416.
3: U.S. Fish and Wildlife Service, 850 S Guild Ave #105, Lodi, CA 95240. denise_barnard@fws.gov (209) 294-3048
4: California Department of Fish and Wildlife, Bay-Delta Region, 2109 Arch Airport Road, Suite 100, Stockton, CA 95206. april.hennessy@wildlife.ca.gov (209) 234-3665

Augmentation of outflow to allow the low salinity zone to overlap with Suisun Bay and Marsh has been proposed as an approach for increasing the quality and extent of Delta Smelt (*Hypomesus transpacificus*) habitat in the summer and fall. Positive Delta Smelt recruitment events that occurred in 2006 and 2011 coincided with such conditions, but the mechanisms that account for this association remain uncertain. It is hypothesized that low salinity conditions in high quality habitat increase prey availability and will therefore be positively associated Delta Smelt abundance, condition and growth. While prior studies have examined the association between Delta Smelt and a range of environmental variables, we are utilizing only data on Delta Smelt presence and abundance that are directly paired in space and time with biotic (e.g. invertebrate abundance/diversity) and abiotic (e.g. salinity, turbidity) which should maximize the likelihood of identifying significant relationships. In addition, our analysis explicitly accounts for several challenges posed by the Delta Smelt data. We use a hurdle modeling to address a high number of zero counts and account for potential differences in factors that determine presence and abundance, and boosted regression trees (BRT) to explore nonlinearities and complex interactions. Here we present our modeling approach and preliminary results including comparison of variable importance rankings for the occupancy and abundance models based on BRT analysis.

You are here: mapping your journey to open data

Vanessa Tobias, US Fish and Wildlife Service, vanessa_tobias@fws.gov, 209.334.2968
Brittany Davis, CA Department of Water Resources, brittany.davis@water.ca.gov, 916.376.9756
Melinda Baerwald, CA Department of Water Resources, melinda.baerwald@water.ca.gov, 916.376.9742
Rosemary Hartman, CA Department of Fish and Wildlife, rosemary.hartman@wildlife.ca.gov, 209.279.4913
Sarah Lesmeister, CA Department of Water Resources, sarah.lesmeister@water.ca.gov, 916.376.9741
Brian Mahardja, US Fish and Wildlife Service, brian_mahardja@fws.gov, 209.334.2968
Jenna Rinde, CA Department of Water Resources, jenna.rinde@water.ca.gov, 916.376.9644
Brian Schreier, CA Department of Water Resources, brian.schreier@water.ca.gov, 916.376.9759
Rachel Pisor, CA Department of Water Resources, rachel.pisor@water.ca.gov, 916.376.9711
Shruti Khanna, CA Department of Fish and Wildlife, shruti.khanna@wildlife.ca.gov, 209.689.8719
Steve Culberson, Interagency Ecological Program, steve.culberson@deltacouncil.ca.gov, 916-.445.0147

Open Science is a movement that encourages transparency in all aspects of scientific work, including accessible data, reproducible methods, and open access publishing. The Data Utilization Workgroup (DUWG) has made strides towards developing an Open Science Framework for the Interagency Ecological Program (IEP), starting with a focus on Open Data. Open Data increases effectiveness and productivity of the scientific community by making data broadly accessible for use in novel ways. One method to make data more 'open' is to publish datasets in an online data repository that offers a permanent digital object identifier (DOI), allowing datasets to be more easily discovered and their use tracked. After a comprehensive investigation of data repositories, the DUWG found that Environmental Data Initiative (EDI) met IEP's data sharing needs by curating and archiving long-term ecological data with rigorous metadata and quality standards. Publishing datasets on EDI meets requirements of the Open and Transparent Water Data Act (AB 1755) while also providing a DOI, versioning, and the ability for data users to link directly to the data repository. This Open Data effort helps data generators to get the credit they deserve for collecting, managing, and sharing data. The DUWG has conducted a series of test cases and now has published four datasets on EDI. Tracking tools on EDI show that IEP's datasets are being viewed and downloaded on a global scale. In this poster, the DUWG outlines the data life cycle including current steps for data publishing and tools to generate metadata and instructions for publishing. The DUWG also provides resources for scientists who want to get started with publishing their data through EDI.

Effects of Temperature on Refractory Period and Fecundity of Delta Smelt *(Hypomesus transpacificus)*

[1]**Franklin Tran**
1089 Veterinary Medicine Drive, Rm. 1020 University of California, Davis, Davis, CA 95616
(209) 324-6775 fdtran@ucdavis.edu

[1]**KathrynElizabeth Berry**
1089 Veterinary Medicine Drive, Rm. 1020 University of California, Davis, Davis, CA 95616
(503) 707-9523 keberry@ucdavis.edu

[2]**Tien-Chieh Hung**
17501 Byron Hwy, Discovery Bay, CA 94505
209-830-9803 thung@ucdavis.edu

[3]**Evan W. Carson**
650 Capitol Mall, Suite 8-300, Sacramento, CA 95814
(916) 930-5624 evan_carson@fws.gov

[3]**Will Smith**
650 Capitol Mall, Suite 8-300, Sacramento, CA 95814
(916) 930-5666 william_e_smith@fws.gov

[2]**Luke Thomas Ellison**
17501 Byron Hwy, Discovery Bay, CA 94505
209-830-9803 ellison@ucdavis.edu

[1]**Swee Teh**
1089 Veterinary Medicine Drive, Rm. 1020 University of California, Davis, Davis, CA 95616
(530) 754-8183 sjteh@ucdavis.edu

[1]Aquatic Health Program, University of California, Davis
[2]Fish Conservation and Culture Laboratory, University of California, Davis
[3]U.S. Fish and Wildlife Service

The restoration effort for the critically endangered Delta Smelt (ESA threatened, CESA endangered), fish endemic to the San Francisco Estuary, requires accurate and precise egg-production models. The lack of knowledge on Delta Smelt refractory period, total fecundity, and the impacts of temperature change has likely led to an overestimation of recruitment in the Delta Smelt population. To assess the effects of temperature on their reproduction, cultured Delta Smelt were held at temperatures of 12 °C, 16 °C, and 20 °C in triplicate with 22 female and 8 male in each trial tank. Spawning periods for each fish were monitored, and weekly egg collections were counted and measured for density and size. Results indicate that Delta Smelt held at 12 °C were more likely to produce two or three clutches by ten orders of magnitude and spawned 45% and 75% more frequently than 16 °C and 20 °C, respectively. The 12 °C treatment produced significantly more eggs than 16 °C and 20 °C, averaging 2613 ± 142 eggs in its lifetime compared to 1520 ± 168 and 1537 ± 194 eggs ($P<0.0001$). Refractory periods between clutches were also significantly affected by higher temperatures, averaging 58 ± 2 days in 12 °C, 42 ± 5 days in 16 °C, and 40 ± 5 days in 20 °C ($P=0.0012$). Egg density ($P=0.3638$), egg size ($P=0.0733$), and clutch sizes for first ($P=0.2140$) and second clutches ($P=0.1160$) had no significant differences between temperature treatments. Higher temperatures had negative effects on Delta Smelt reproduction by reducing spawning

frequencies and lifetime fecundity. This study provides critical information for development and use of egg-productions models in management of Delta Smelt.

Quality Assurance on the Roadmap to Open Science

Traci Treleaven, JohnFranco Saraceno, Sonia Miller, and Rachel Pisor

CA Department of Water Resources, Division of Environmental Services, Quality Assurance Program
3500 Industrial Blvd., Sacramento, CA, 95691
916-375-4231; Traci.Treleaven@water.ca.gov

Water data tends to be stored across a variety of web portals, in varying formats, of unknown quality, and with inconsistent metadata standards. Not only does this make analyses difficult but it can also hinder effective resource management and decision making. In response to these issues California is embracing the new era of "open science" with the implementation of Assembly Bill 1755, and Quality Assurance (QA) is a critical component on this journey.

QA sets the foundation for scientific activities and enhances data reproducibility, comparability, defensibility, and transparency in open science. By providing standard methods, data collection processes and routine assessment, QA assures standards are being met and that collected data is of known and documented quality. QA should be implemented across a project's life cycle, from planning to publication, and can be applied at any level (from single processes to Agency-wide policies) through education, training, and guidance documentation. This poster demonstrates the importance of QA investment, clarifies the difference between QA and QC (Quality Control), and provides tangible tools to use on your QA journey in the era of open science.

Spawning behavior in cultured Delta Smelt (*Hypomesus transpacificus*)

Yi-Jiun Jean Tsai[1] and Tien-Chieh Hung[1]

[1]Fish Conservation and Culture Laboratory, Byron, California, USA
Biological and Agricultural Engineering Department, University of California Davis
yjtsai@ucdavis.edu, 209-830-9803

Very little is understood about the spawning behavior of Delta Smelt (*Hypomesus transpacificus*), an imperiled fish species endemic to the San Francisco Estuary and Sacramento-San Joaquin Delta. While *H. transpacificus* spawning has been anecdotally observed in culture, it has yet to be observed in the wild or formally characterized. In this study, we will attempt to elicit and characterize the spawning activity of cultured *H. transpacificus*. We will divide an 860 L flow-through tank into two compartments and stock each compartment with four almost-ripe females and four mature males. Fish from each compartment will be exposed to a randomly-selected natural (sand, gravel, small pebble, or large pebble) or control (empty tray) substrate. All behavior will be video recorded for two weeks and analyzed for spawning activity. We will present the preliminary results of this ongoing experiment.

ECO-PTM – An individual-based Juvenile Salmonid Migration Model

Xiaochun Wang, DWR
Russell Perry, USGS
Adam Pope, USGS
Dalton Hance, USGS

Various water resource management actions have been planned to protect and restore salmon populations for a healthy Delta ecosystem. Currently, evaluating the effectiveness of these actions mainly relies on field studies and/or professional opinion. Field studies can be costly and may not provide a complete assessment over a range of applications due to limited study areas, durations, and river conditions. Professional opinion, although valuable, may under or over emphasize the importance of certain project components. To supplement field studies, and provide water resource professionals a quantitative assessment tool, the California Department of Water Resources (DWR) in collaboration with the United States Geological Survey (USGS) has been developing an ecological modeling tool, ecological particle tracking model (ECO-PTM). ECO-PTM is an individual-based juvenile salmonid migration model that is based on a random-walk particle-tracking method, but with fish-like behaviors attached to the particles. The behavioral parameters are estimated from acoustic telemetry tag data of juvenile late-fall Chinook salmon from various field studies, using a stochastic optimization tool, Particle Swarm Optimization. ECO-PTM can simulate juvenile salmonid migration timing, routing, and survival. This poster describes ECO-PTM and its behavioral modules, as well as its performance and a preliminary application to assist water resource management planning, assessment, and decision making related to juvenile salmonid survival outcomes.

Xiaochun Wang
DWR Bay Delta Office
1416 9th St. Rm 215-14,
Sacramento, CA 95814
Phone: (916)-651-9694 Email: Xiaochun.Wang@water.ca.gov

Russell Perry
USGS Western Fisheries Research Center
5501A Cook-Underwood Road
Cook, WA 98605
Phone: (509) 538-2942 Email: rperry@usgs.gov

Adam Pope
USGS Western Fisheries Research Center
5501A Cook-Underwood Road
Cook, WA 98605
Phone: (509) 538-2916 Email: apope@usgs.gov

Dalton Hance
USGS Western Fisheries Research Center
5501A Cook-Underwood Road
Cook, WA 98605
Phone: (509) 538-2986 Email: dhance@usgs.gov

The Delta Remote Imagery Consortium

Amanda Wasserman and Dylan Chapple
Delta Science Program
1405 High St., Auburn, CA 95603
805-729-6164, Amanda.Wasserman@deltacouncil.ca.gov
Dylan.Chapple@deltacouncil.ca.gov

Remote imagery is a valuable, unobtrusive tool for collecting diverse information about large areas of the earth's surface in a short amount of time. It is useful for a range of purposes related to environmental monitoring, agriculture, assessment of natural and anthropogenic disasters, and more. Often, the same image(s) can be used to conduct multiple analyses; for instance, a time series of images could be analyzed to assess changes in vegetation cover as well as land use. In the Sacramento–San Joaquin Delta (Delta), many agencies, institutions, and others have needs for remote imagery to conduct monitoring and research in support of effective management of the Delta's natural resources; however, collection and analysis of data are often conducted on a case by case basis and can be expensive and time-consuming. In order to support more effective and efficient use of remote imagery in the region, we are assessing the feasibility of forming a coordinated, region-wide effort to facilitate the obtainment and analysis of these data. This group, which we are calling the Delta Remote Imagery Consortium (RIC), would be comprised of representatives from agencies, non-profit organizations, institutions, the private sector, and the like, who would pool resources to brainstorm funding sources, obtain costly imagery, share data, and discuss new ideas and technology. We are scheduling a scoping workshop for late March or early April to discuss shared remote imagery needs, determine the possible direction of the group and next steps, and draft a charge. This poster will inform the Delta community about RIC in greater detail and serve as a recruitment tool for others who may wish to join. The results of a survey assessing shared remote imagery needs among potential participants will also be summarized.

Isoscapes in a dynamic system: Advancing tools to reconstruct salinity and temperature life histories of fishes in the San Francisco Estuary

Malte Willmes[1], Christina Parker[1], Alyssa Baldo[1], Levi S. Lewis[1], Randall Baxter[2], Louise Conrad[3], Carol Kendall[4], James A. Hobbs[1]

[1] Wildlife, Fish and Conservation Biology, UC Davis, mwillmes@ucdavis.edu
[2] California Department of Fish and Wildlife, Randy.Baxter@wildlife.ca.gov
[3] Delta Science Program, Louise.Conrad@deltacouncil.ca.gov
[4] United States Geological Survey, ckendall@usgs.gov

Understanding how estuarine and migratory fish, such as Delta and Longfin Smelt, Chinook Salmon, and White Sturgeon utilize the San Francisco Estuary (SFE) is critical for effective management and conservation. Otoliths (fish ear bones) accrete continuously throughout the life of a fish and thus provide a record of age, growth, and environmental conditions. Strontium ($^{87}Sr/^{86}Sr$) and oxygen isotopes ($\delta^{18}O$) measured in otoliths can be used to reconstruct the life history and habitat utilization of fish, if the isotopic compositions can be related to changes in salinity and temperature in the environment.

In the dynamic San Francisco Estuary, the isotopic composition of the water reflects complex processes driven by the mixing of freshwater inputs, mainly from the Sacramento and San Joaquin rivers, and the Pacific Ocean. To understand these processes in more detail, we collected water samples in 2018 across the entire spatial extent of the SFE, capturing a large range of salinity and water temperature combinations. Environmental strontium isotope ratios vary among different geologic regions and provide a robust proxy for salinity from freshwater to low salinity (<6-8 psu). Oxygen isotope ratios vary as a function of water source and evaporation, and show a strong correlation with salinity across a large geographic gradient from 4-32 psu. The combination of both isotope systems can be used to estimate salinity habitats of fish in the entire SFE (0-32 psu). In addition, $\delta^{18}O$ in otoliths can be used to reconstruct ambient water temperature if salinity can be estimated independently. The results of our isotope mixing models will be evaluated over the next year and will be used to predict salinity and temperature habitat for fish utilizing the dynamic estuary.

Source or sink? Tidal flux of a calanoid copepod at a restored marsh in the Cache Slough Complex

Rowan Yelton, ryelton@sfsu.edu, (978) 201-5203
Anne Slaughter, aslaught@sfsu.edu, (415) 338-3548
Wim Kimmerer, kimmerer@sfsu.edu, (415) 338-3515
All authors affiliated with the Estuarine and Ocean Science Center at San Francisco State University, 3152 Paradise Dr, Tiburon, CA 94920

Tidal marshes are productive areas that provide important habitat for fish and may subsidize less-productive open water regions with organic matter. In the urbanized San Francisco Estuary (SFE), marsh area is dwarfed by open-water regions. Since the 1980s, zooplankton biomass in the open waters of the San Francisco Estuary (SFE) has declined, limiting the food supply for endangered pelagic fishes. Several recent restoration projects have taken place in the Cache Slough Complex (CSC) in the Northern Sacramento-San Joaquin Delta, as the area has been used as habitat by a population of Delta smelt *Hypomesus transpacificus*. Marsh restoration in the CSC could provide more habitat area for Delta smelt or serve as source regions of increased zooplankton biomass, and food available to fish in less productive open-water areas. While marshes are typically sources of organic matter, this material may not include zooplankton immediately available to fish; these marshes may be sinks of zooplankton production due to elevated planktivory in shallow waters. Elucidating source-sink dynamics of copepods in tidal systems is made difficult by complex flow patterns and the vertical migration of some zooplankton. Previous studies in SFE wetlands have shown variable net zooplankton fluxes with no trend toward export. We measured the net flux of *Pseudodiaptomus forbesi*, the dominant copepod, between the Liberty Island Conservation Bank constructed by Wildlands Inc., a 186 ac restored tidal marsh, and the adjacent larger channel over four complete tidal cycles. We collected hourly zooplankton samples and used concurrent tidal flow obtained from a bottom-mounted acoustic Doppler current profiler (USGS) to estimate the tidal flux of *P. forbesi*. The results of this study will help us understand the planktonic food-web dynamics of restored marshes and the conditions under which they could act as sources to the open waters.

How light affects phytoplankton productivity and nutrient uptake in the northern San Francisco Estuary

Jamie Yin, Estuary & Ocean Science Center, San Francisco State University, jyin1@mail.sfsu.edu
Frances Wilkerson, Estuary & Ocean Science Center, San Francisco State University, fwilkers@sfsu.edu
Sarah Blaser, Estuary & Ocean Science Center, San Francisco State University, sblaser@sfsu.edu
Jared Frantzich, Department of Water Resources, Jared.Frantzich@water.ca.gov

The availability of photosynthetically active radiation (PAR) is considered a major driver that limits primary production in the turbid northern San Francisco Estuary (nSFE). However, few studies have directly measured how PAR affects the uptake of carbon and dissolved inorganic nitrogen by SFE phytoplankton. Primary productivity in the SFE is typically calculated using an empirical model that combines chlorophyll, PAR, and light attenuation to measure phytoplankton productivity, instead of being directly measured. This research focuses on whether phytoplankton from different locations in the nSFE and Delta exhibit photosynthetic and nutrient uptake rate kinetics that reflect the available light of the waters they were sampled from. Uptake kinetics were calculated from rates obtained using incubations of water containing phytoplankton with added ^{13}C labeled bicarbonate or ^{15}N labeled ammonium or nitrate and incubated at up to eight different light levels. The phytoplankton isotopic enrichment was tracked using mass spectrometry. Samples for incubations were collected at four locations, all within the low salinity zone, with different turbidities along a downstream transect from Cache Slough to Suisun Bay during eight cruises in 2017. At each station, incoming PAR, Secchi depth, beam c (an estimate of turbidity), and concentration of total suspended solids were measured in order to characterize the turbidity. This project provides a useful comparison to the productivity values derived from the empirical productivity model. It describes some of the first nitrogen uptake versus irradiance data for phytoplankton in the nSFE waters. This study is relevant to aquatic scientists by determining how phytoplankton in nature respond to changing irradiances and sediment load. It may also help explain why the SFE does not exhibit the effects of eutrophication, which is typical of other anthropogenically impacted estuaries.

Keywords: phytoplankton, light limitation, primary productivity, nitrogen