INTERAGENCY ECOLOGICAL PROGRAM

2020 ANNUAL WORKSHOP

POSTER ABSTRACTS

AUGUST 17- OCTOBER 13, 2020

Interagency
Ecological Program

COOPERATIVE ECOLOGICAL
INVESTIGATIONS SINCE 1970

Listed alphabetically by presenting author.

How do *Pseudodiaptomus forbesi* growth rates correlate with abundance and types of available food within different habitats?

Allison Adams*[1], Anne Slaughter[2], Toni Ignoffo[3], Wim Kimmerer[4]

Estuary & Ocean Science Center
San Francisco State Romberg Tiburon Campus
3150 Paradise Drive, Tiburon, CA 94920
[1](415) 316-4853
aadams5@mail.sfsu.edu
[2](415) 338-3548
aslaught@sfsu.edu
[3](415) 338-3510
tignoffo@sfsu.edu
[4](415) 338-3515
kimmerer@sfsu.edu

Copepods are a critical foodweb link in the upper San Francisco Estuary (SFE), where food limitation constrains foodweb support for native pelagic fishes. Copepods are highly selective feeders that can consume a wide variety of prey, and the prey differs among habitats in composition, biomass, and probably nutritional value. We aim to clarify copepod diets to better understand how *P. forbesi* is using this food, and how different foods contribute to copepod growth rate. During July-September 2019, we collected environmental samples and conducted feeding experiments at 4 sites that differ in key characteristics, e.g., channel size, riverine vs. off-channel, slough vs. open water, and a range of turbidity: Yolo Bypass Toe Drain (YBP), Wildlands restored wetland (WLD) in the Cache Slough Complex, Low-Salinity Zone (LSZ, salinity 0.1 to 0.5), and lower San Joaquin River (SJR). We measured growth rates of *P. forbesi* from each site by the artificial cohort method. Copepods collected in the field were size-fractionated to include only 200-224 µm juveniles (copepodite stages C1-C3), and these artificial cohorts were incubated at field temperatures for 0, 24, and 48 h. Copepods were later imaged using *ImageJ* software to determine the volume of each copepod, which was used to estimate carbon through a previous calibration. Growth rates (d^{-1}) were calculated as the time rate of change of log carbon per copepod. Growth rates were interpreted in the context of the types and amounts of food copepods were eating; we employed a variety of analytical techniques to describe prey composition and quantity, and feeding experiments to gain insight into what affects copepod abundance and ability to grow. These results may help elucidate the picture of food availability to imperiled pelagic fishes in the SFE.

Clam populations in the North Delta dominate below the Yolo Bypass Toe Drain

Jesse Adams*[1]
jesse.adams@water.ca.gov
916-376-9661
Elizabeth Wells[1]
elizabeth.wells@water.ca.gov
916-376-9821
Janet Thompson-McHendrie[2]
jthompso@usgs.gov
650-329-4364
Brian Schreier[1]
brian.schreier@water.ca.gov
916-376-9759
Brittany Davis[1]
brittany.e.davis@water.ca.gov
916-376-9756

1. California Department of Water Resources, 3500 Industrial Blvd., Sacramento, CA 95691
2. United States Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025

Benthic communities play a large role in lower trophic food webs. Invasive clams in the San Francisco Estuary, CA consume plankton and organic particulates, reducing food availability for zooplankton, a key prey for critical fish species including Delta Smelt. With adaptive management actions, such as the North Delta Flow Action that use augmented flows to improve primary productivity and food availability in the Cache Slough Complex and Lower Sacramento River, it is important to understand the impact of these clams. This study investigated clam assemblage, biomass, population density, and age-class structure to assess the impacts on productivity and food availability in the North Delta. Prior to the 2019 North Delta flow pulse, clams were sampled across six locations throughout the North Delta from Lisbon Weir in the Yolo Bypass Toe Drain to the Sacramento River at Rio Vista. The dominant clam species in the North Delta was the non-native *Corbicula fluminea*, exceeding native clam density and biomass. Clam biomass, population density, age-class structure and assemblages varied across the North Delta. Overall, clam biomass was the greatest in Cache Slough Complex and in the Lower Sacramento River, with the exception of Liberty Island. Clam density in the Toe Drain was low, with very few clams found in the scoured hardpan clay of the channel. Furthermore, there were differences in water quality and substrate conditions across North Delta regions. Data from 2019 will be compared to a previous North Delta clam study in 2014 to better understand clam community structure and population dynamics in the North Delta over time.

What a Decade of Monitoring can Tell Us About Fish Trends in the Sacramento Deep Water Ship Channel

James Cole Anderson* and Christina E. Burdi

Interagency Ecological Program
California Department of Fish and Wildlife
2109 Arch Airport Road, Suite 100, Stockton, CA 95206
(209) 234-3426
Corresponding Author: Christina.Burdi@Wildlife.CA.Gov

The Sacramento Deep Water Ship Channel (SDWSC) is an artificial waterway completed in 1963 connecting the port of Sacramento to the greater San Francisco bay-delta estuary, allowing the direct flow of ships and goods between the agricultural regions of northern California and the San Francisco Bay. The channel has become an important habitat for several species of the estuary, including Threadfin and American Shad, Striped Bass, and the endangered Delta Smelt. The California Department of Fish and Wildlife's (CDFW) long-term monitoring surveys Summer Townet and Fall Midwater Trawl began sampling the SDWSC in 2009 and 2011, respectively. These surveys provide valuable data on the fish community in this region from June to December annually, however neither of these surveys use data from the SDWSC in their species index calculations. Fish trends in the SDWSC were examined from June to December in 2011-2019 to detect any changes in the fish community during this time period. American and Threadfin Shad were the most common species in the SDWSC, with American Shad being more common in September, and Threadfin being more common in December. However, Threadfin Shad have seen serious fluctuations in abundance during the time period studied. Delta Smelt have seen a precipitous decline in abundance, despite the SDWSC once being considered a refuge for the species. Many different species utilize the SDWSC and the wide array of fishes found there warrant further study moving forward as part of overall ecosystem management and preservation.

2019 Longfin Smelt Symposium: A Synthesis of Management-relevant Science

Darcy Austin*, Science Manager
State Water Contractors
1121 L Street, Suite 1050
Sacramento, CA 95814
(916) 447-7357
daustin@swc.org

Jennifer Pierre, General Manager
State Water Contractors
1121 L Street, Suite 1050
Sacramento, CA 95814
(916) 447-7357
jpierre@swc.org

Ian Anderson,
Fiona Hutton and Associates
Los Angeles and Sacramento
ianderson@fionahuttonassoc.com

On November 7, 2019 the State Water Contractors (SWC) Science Program hosted a science symposium highlighting recent research on Longfin Smelt. The invited speakers were Trishelle Tempel, CDFW; Michelle Jungbluth, SFSU; Tien-Chieh Hung, UC Davis; Jim Hobbs, CDFW; Mandi Finger, UC Davis; Fred Feyrer, USGS; Levi Lewis, UC Davis; Corey Phillis, MWD; Ed Gross, RMA; Wim Kimmerer, SFSU; Shawn Acuna MWD; and Lenny Grimaldo, ICF. This poster will provide a synthesis that highlights the key symposium findings of management relevance. These findings include that Longfin Smelt have diverse diets; they are found seaward in the lower Estuary, especially during high flow years, where they appear to be occupying marsh habitats; they don't appear to spawn only in freshwater; the population in the Estuary is the southernmost range of the species and genetic flow appears to be northward towards Canada and Alaska; Longfin Smelt tend to stay low in the water column during the day and distribute more evenly throughout the water column at night; entrainment doesn't seem to be a big stressor for the species at this point; ocean conditions may be important to their life history. We anticipate that the information highlighted in the symposium will inform management actions intended to benefit Longfin Smelt. Some next steps for research include to understand spawning better, understand how ocean conditions affect the species, to look at ocean occupancy, and to understand the effects of contaminants. We will publish a synthesis summary of findings and areas for potential research. The video recordings for the symposium can be found on the SWC website at: SWC Longfin Smelt Symposium Video. This poster will also briefly describe the SWC Science Program and will point to future funding opportunities for researchers.

Larval and Juvenile Longfin Smelt Feeding in Restored Tidal Habitats

Arthur Barros*: aebarros@ucdavis.edu
Levi Lewis: lewis.sci@gmail.com
James Hobbs: jahobbs@ucdavis.edu
Malte Willmes: mwillmes@ucdavis.edu
Christina Parker: chrparker@ucdavis.edu
Micah Bisson: mgbisson@ucdavis.edu

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

San Francisco's distinct population of Longfin Smelt (*Spirinchus thaleichthys*) has collapsed over the last 50 years and is now threatened with extinction. While population dynamics appear to be driven by variation in recruitment success of juveniles, mechanistic interactions remain unknown. Juvenile Longfin Smelt utilize shallow open bays, tidal sloughs, and tidal marsh ponds throughout the San Francisco Estuary (SFE) as rearing habitats from winter through spring. Understanding the factors that affect growth and survival during this critical development stage is integral to understanding population dynamics and making informed management decisions for this imperiled species. Feeding success of larval and juvenile Longfin Smelt in two potential nursery regions of the San Francisco Estuary (SFE) was examined in relation to zooplankton prey concentration and composition. Relationships among fish size, feeding incidence, prey mass in diet, and available prey concentrations were investigated and compared among the northern and southern marshes and bay areas of the SFE. Results showed that feeding success was strongly correlated with fish length, and that all fish fed selectively on the abundant copepod *Eurytemora affinis*. Furthermore, the Alviso marsh in the southern SFE contained much higher concentrations of important zooplankton prey for early life stage Longfin Smelt then other potential nursery habitats in the estuary. These higher concentrations of available food items correlated with higher feeding success in larval Longfin Smelt found in that region. Taken together these findings suggest that the Alviso marsh, habitat previously unaccounted for in Longfin Smelt population models, may act as important nursery grounds for the threatened Longfin Smelt in the SFE.

Building an Integrated Dataset of Zooplankton Monitoring in the San Francisco Estuary

Sam Bashevkin*: Delta Science Program, Delta Stewardship Council, 980 9th St. Suite 1500, Sacramento, CA 95814, sam.bashevkin@deltacouncil.ca.gov, 916-322-6607
Karen Kayfetz: Delta Science Program, Delta Stewardship Council, 980 9th St. Suite 1500, Sacramento, CA 95814, Karen.Kayfetz@deltacouncil.ca.gov, 916-445-5694
Madison Thomas: Delta Science Program, Delta Stewardship Council, 980 9th St. Suite 1500, Sacramento, CA 95814, Madison.Thomas@deltacouncil.ca.gov
Rosemary Hartman: Department of Water Resources, 3500 Industrial Blvd #131, West Sacramento, CA 95691, Rosemary.Hartman@water.ca.gov, 916-375-2070
Christina Burdi: California Department of Fish and Wildlife, 2109 Arch Airport Rd, Suite 100, Stockton, CA 95206, Christina.Burdi@wildlife.ca.gov, 209-234-3664
Trishelle Tempel: California Department of Fish and Wildlife, 2109 Arch Airport Rd, Suite 100, Stockton, CA 95206, Trishelle.Tempel@wildlife.ca.gov, 209-234-3663
April Hennessy: California Department of Fish and Wildlife, 1010 Riverside Parkway, West Sacramento CA 95605, April.Hennessy@wildlife.ca.gov, 916-376-5328
Arthur Barros: California Department of Fish and Wildlife, 2109 Arch Airport Rd, Suite 100, Stockton, CA 95206, Arthur.Barros@Wildlife.ca.gov

Several programs in the San Francisco Estuary have collected zooplankton over the past five decades. Although most datasets are available online, they can be difficult to access and lack standardized formatting. Consequently, they are challenging to combine and analyze. Combined datasets offer improved spatial and temporal resolution for analysis, allowing researchers to more accurately analyze zooplankton across space, time, and environmental conditions. We created tools to easily integrate these datasets according to user specifications. Our R package or interactive point-and-click R shiny app can be used to combine, filter, and download the data based on a variety of parameters, while simultaneously resolving differences in taxonomic resolution. The R shiny app also allows users to visualize and explore the datasets. To inform this data integration effort, we have compiled methods and metadata from our source datasets. Studies used different gear types, trawling methods, lab sampling methods, and data formats. Our work on dataset integration has led us to develop several recommendations for zooplankton monitoring programs:

1. Publish data online, preferably in flat files (e.g. csv) rather than database formats (e.g. Access);
2. Document taxonomic classifications (i.e. the list of taxa and their life stages searched for in every sample) and any changes to identification methods over time;
3. Identify each species to life stage when possible;
4. Distinguish between zero-catch (0) and non-counted (NA);
5. Provide GPS coordinates of sampling locations.

We hope that these recommendations will streamline data collection and comparability among zooplankton monitoring programs in the Delta. In addition, the integrated dataset and corresponding tools allow users to easily access and integrate zooplankton datasets in a repeatable manner that resolves differences among studies, increasing the usability of zooplankton datasets in the future.

The Shiny App can be found at Zooplankton Data Synthesizer main page and the R package is available atcode and files related to zooplankton synthesis.

Post-rescue survival and migration patterns for southern Distinct Population Segment (sDPS) green sturgeon (*Acipenser medirostris*) and white sturgeon (*Acipenser transmontanus*)

Marc Beccio*, Morgan Kilgour, and Colin Purdy

California Department of Fish and Wildlife, North Central Region Anadromous Fisheries, 1701 Nimbus Road, Rancho Cordova, CA 95670 (916) 358-2900

Sacramento Valley flood control weirs can act as fish passage barriers once flood waters recede resulting in stranding of anadromous fish such as sturgeon migrating to their spawning grounds. From 2011 through 2019, California Department of Fish and Wildlife staff rescued 52 adult green sturgeon and 24 white sturgeon from the Yolo and Sutter bypasses following high flow events. Of these, 44 green sturgeon and 24 white sturgeon were tagged with 69 kHz acoustic transmitters with a 10-year battery life and released in the Sacramento River near the point of capture. In addition to preventing the loss of a portion of the spawning population, fish rescues represent a unique opportunity to handle and tag adult sturgeon. Tag detection data from rescued adult sturgeon provided valuable information on post-rescue survival, behavior, and movement patterns, as well as unparalleled data specific to California's Central Valley on large-scale migration patterns, habitat utilization, and spawning periodicity over a long time period and across water year types. Overall, post-rescue survival of green sturgeon was 91% based on tag detection data; 63% reached their spawning grounds post-rescue and 75% were detected at their spawning grounds in subsequent years. Post-rescue survival and successful spawning are likely linked to the duration of the stranding event prior to rescue and abiotic conditions. These data underscore the need for maintaining acoustic receiver arrays in Central Valley rivers, the San Francisco Bay-Delta Estuary, and the Pacific Ocean to continue to provide spawning periodicity, and spawning pre and post migration pattern data.

In-field measures of thermal physiology on critically sensitive Delta Smelt

Heather N. Bell*
(619) 817-5135
hnbell@ucdavis.edu
†One Shields Avenue, Davis, CA 95616
Department of Wildlife, Fish, and Conservation Biology
University of California, Davis

†Dennis Cocherell
decocherell@ucdavis.edu; (925) 963-1621

Brittany Davis
(916) 376-9756
brittany.e.davis@water.ca.gov
3500 Industrial Blvd. West Sacramento, CA 95691
Office of Water Quality and Estuarine Studies
California Department of Water Resources

†Nann Fangue
nafangue@ucdavis.edu; (530) 752-4997

Delta Smelt (*Hypomesus transpacificus*), a small pelagic fish endemic to the San Francisco Estuary, is critically endangered due to their rapid population decline. Hatchery propagation of Delta Smelt at the UC Davis Fish Conservation and Culture Laboratory (FCCL) provides a refuge population that may support future supplementation efforts; however, prior to supplementation, it is important to understand how hatchery fish may respond to variable habitat conditions such as extreme warm temperatures and if they have different tolerances than previous laboratory findings. This study, in collaboration with the California Department of Water Resources (DWR) cage experiments, tested upper temperature tolerance and acclimation capacity of hatchery Delta Smelt after acclimatizing to natural field conditions. Critical thermal maxima (CTM) tests, a measure for temperature tolerance, were conducted at cage sites including Yolo Bypass, Rio Vista, and Suisun Marsh at Belden's Landing for two experimental seasons (Summer and Fall of 2019). Field CTM data were then compared to previous laboratory CTM results. During the CTM trials, fish were placed into individual chambers contained in a water bath which gradually heated chambers at 0.3°C/min. Trials ended when fish experienced a loss of equilibrium (LOE) and were unable to right themselves; the temperature at LOE was recorded as the CTM. CTM of summer (27.6 ± 3^{o}C, mean ± sd) and fall (25.6 ± 1.3^{o}C) hatchery Delta Smelt at Rio Vista were lower than previous laboratory studies at similar acclimation temperatures, although fish did encompass similar abilities to acquire thermal tolerance demonstrated by the acclimation rates. Using generated acclimation rates, hatchery fish should be acclimated to warmer temperatures to increase field survival. This is the first study to successfully conduct measures of thermal physiology of Delta Smelt in the field. This data will aid biologists in predicting the thermal limits and survival of smelt in supplementation efforts.

Go West (and South) Young Smelt: Evaluating Model Predictions of Habitats Associated with Juvenile Longfin Smelt

Corey Phillis[1], Dave Fullerton[1], Aaron Bever[2], Michael MacWilliams[2], John Brandon*[3], Lenny Grimaldo[3]

Management and conservation of listed species requires an understanding of the environmental characteristics associated with species distribution. Previous research in the San Francisco Estuary has emphasized the importance of spring freshwater outflow to support the state-listed Longfin Smelt (LFS) population. However, in wet years the index of juvenile LFS declines because the population distributes downstream of the California Department of Fish Wildlife (CDFW) 20-mm survey stations. To improve our understanding of factors associated with juvenile LFS distribution, we examined two decades of LFS catch data using Boosted Regression Tree analysis. Turbidity, conductivity, and temperature dominated the relative importance of predictor variables, consistent with other studies of LFS catch. In order to evaluate the predictive ability of the model, we gathered independent catch data by sampling habitats in locations within, as well as outside the CDFW 20-mm survey area during March–April, 2019 (a wet year). The distribution of independent catches was consistent with CDFW catches within the 20-mm survey area during overlapping time periods. The results also indicate that, at least during a wet year, the model is able to accurately predict the spatial distribution of juvenile LFS outside the CDFW 20-mm survey area. The CDFW 20-mm surveys typically start in March; however, the temporal catch frequency patterns from that survey suggest juvenile LFS are present earlier in the year. Therefore, in order to investigate the model's ability to predict juvenile LFS distribution temporally, we conducted an independent survey again in 2020 prior to the onset of the CDFW survey. A preliminary analysis of the 2020 independent catch data and temporal model evaluation results will also be presented. Our results provide managers of this state-listed species with an improved understanding of how suitable habitat for juvenile Longfin Smelt is temporally and spatially distributed in the San Francisco Estuary.

[1] Metropolitan Water District of Southern California, 1121 L St #900, Sacramento, CA 95814

Contact: CPhillis@mwdh2o.com 916-650-2630

[2] Anchor QEA, 130 Battery St, San Francisco, CA 94111

[3] ICF International, Inc., 201 Mission St 15th floor, San Francisco, CA 94105

Mysid and Amphipod Trends from 2011 to 2017 using Fall Midwater Trawl Data

Spencer Breining-Aday* and Christina E. Burdi

Interagency Ecological Program
California Department of Fish and Wildlife
2109 Arch Airport Road, Stockton CA 95206. 209-234-3426
Spencer.Breining-Aday@wildlife.ca.gov

The planktonic macroinvertebrate community of the San Francisco Estuary serves as an important food source for threatened and declining pelagic fish. The distribution and abundance of mysid shrimp and amphipod species are changing in response to environmental conditions as well as invasive species introductions. Tracking these changes is crucial to understanding the dynamics and health of the food upon which estuarian fish species rely. Since 2011, the California Department of Fish and Wildlife's Fall Midwater Trawl survey (FMWT) has been collecting mysid and amphipod samples along with historically conducted fish tows at 32 stations throughout the estuary. Mysid and amphipod Catch Per Unit Effort (CPUE) was calculated for each station from September through December from 2011 to 2017. Biomass Per Unit Effort (BPUE) for mysid and amphipod species was also calculated using length measurements and established length weight relationships. Most recent attempts to quantify the abundance and distribution of these species have focused on CPUE. It is the goal of this poster to examine the trends in mysid and amphipod biomass as measured by BPUE and to compare those with the more commonly utilized CPUE. Using both metrics in concert may allow for a deeper understanding of the dynamics of this subsection of the food web.

Calanoids, Cyclopoids, and Cladocerans, Oh My! Zooplankton Trends in the San Francisco Estuary from 2011-2019

Christina E. Burdi* and Maria Velazquez

Interagency Ecological Program
California Department of Fish and Wildlife
Stockton, CA
Christina.Burdi@Wildlife.CA.Gov

Zooplankton are an important component of the food web and prey for many fish species in the San Francisco Estuary (SFE), including Delta Smelt, *Hypomesus transpacificus,* and Longfin Smelt, *Spirinchus thaleichthys*. The zooplankton community in the SFE has experienced several shifts in composition due to introduced species often outcompeting natives. The California Department of Fish and Wildlife's (CDFW) Summer Townet and Fall Midwater Trawl are two long-term monitoring projects that have been conducting fish surveys since 1959 and 1967, respectively. Both surveys added zooplankton monitoring in 2011 to detect trends in food availability for fish. Summer Townet collects samples twice a month from June to August and Fall Midwater Trawl collects samples monthly from September to December. Regional trends in zooplankton abundance June to December from 2011 to 2019 were examined. Calanoid copepods dominate the zooplankton community in most regions during this period, with a spike during the summer months due to *Pseudodiaptomus forbesi*. Cyclopoids had higher abundances during winter months. Overall, there were increases in zooplankton in 2019 compared to 2018. The South Delta had the highest average abundances, and Suisun Bay had the highest species diversity. Regular monitoring of zooplankton in the SFE allows for yearly status and trends to detect any changes in this community due to environmental factors or species introductions. Detecting changes in the zooplankton community can help assist with the management of endangered fish species in this region.

You Only Leave Once: Use of the Yolo Bypass by Out-Migrating Juvenile Chinook Salmon

Amanda Casby*, Nicole Kwan, Brian Schreier

Amanda Casby
Department of Water Resources
3500 Industrial Blvd.
West Sacramento, CA 95691
(916)376-9834
Amanda.Casby@water.ca.gov

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

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

Since 1998, the Yolo Bypass Fish Monitoring Program has monitored water quality, lower trophic organisms, and fish presence in the Yolo Bypass, the largest remnant floodplain of the Sacramento River. This program provides critical information regarding the significance of seasonal floodplain habitat to native fishes, including its capacity to provide productive rearing habitat for juvenile Chinook salmon. To better understand the use of the Yolo Bypass by threatened and endangered runs of Chinook salmon, the program began collecting and analyzing caudal fin clips in 2015 for the purpose of genetically identifying the run type of each salmon sampled. Juvenile salmon genetic results, coupled with catch-per-unit-effort estimates for beach seining and rotary screw trap operations, highlight the variability of floodplain use across water year types by the different runs of Chinook salmon. Factors such as the timing and duration of floodplain inundation play a key role in determining how many juvenile salmon can access the habitat, with spring and winter run juveniles rarely detected in dry years. A better understanding of how different salmon runs utilize the Yolo Bypass across a range of hydrologic regimes is of increasing importance as California's climate becomes more variable due to climate change and could help promote management for maximizing abundance and life history diversity.

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

Jeffrey Caudill[1*], Ajay R. Jones[2], Lars Anderson[3], John D. Madsen[4], Patricia Gilbert[1], Scott Shuler[2], Mark A. Heilman[2]

[1] California Department of Parks and Recreation, Division of Boating and Waterways, 1 Capitol Mall, Sacramento, CA
[2] SePRO Corporation, 11550 North Meridian Street, Suite 600, Carmel, IN 46032
[3] Waterweed Solution, P.O. Box 73883, Davis, CA 95617
[4] USDA Agricultural Research Service, UC Davis Plant Sciences Department MS 4, 1 Shields Avenue, Davis, CA 95616

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

Effects of Domestication Selection in Captive Delta Smelt

Samantha Chase*, Luke Ellison, Evan W. Carson, and Tien-Chieh Hung

Samantha Chase
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803
snchase@ucdavis.edu

Luke Ellison
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803
ellison@ucdavis.edu

Evan W. Carson
San Francisco Bay-Delta Fish and Wildlife Office, US Fish & Wildlife Service
916-930-5624
evan_carson@fws.gov

Tien-Chieh Hung
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803
thung@ucdavis.edu

Delta Smelt (*Hypomesus transpacificus*) is a native fish in the San Francisco Bay-Delta whose population has undergone a dramatic decline, which led to the fish being listed as endangered in the state of California. The decreased availability of wild *H. transpacificus* has also led to culturing efforts by the UC Davis Fish Conservation and Culture Lab to act as a safeguard against extinction. Additionally, the imperiled status of this fish in the wild has generated interest in potentially re-stocking *H. transpacificus* back into the Delta using captive fish. However, artificial selection and domestication can unintentionally occur in cultured populations leading to fish that are better suited to cultured environments over wild conditions, but these potential domestication effects in *H. transpacificus* have not yet been investigated. The objective of this study is to assess if cultured *H. transpacificus* have a difference in growth and survival when compared to fish with wild ancestry. We compared the weight, length, and survival of fish with wild ancestry (Low Domestication Index) to fish with intensely cultured ancestry (High Domestication Index) as well as fish with combined ancestry (Mixed Domestication Index). We found both growth and survival was higher in the High DI groups.

Flowmeters; Variability and Suggested Best Practices

Adam Chorazyczewski*, Timothy D. Malinich, Daniel Ellis

California Department of Fish and Wildlife, 2109 Arch Airport Rd, Suite 100,
Stockton, CA 95206

Flowmeters are used to calculate the speed and volume of water sampled for multiple fisheries and are commonly used by many agencies sampling within the Bay-Delta region. These devices estimate water volume using an impeller which rotates with water flow, turning an interior counter (flowmeter counts) at a constant value (rotor constant). The precision and accuracy of flowmeter counts has significant implications on catch per unit effort (CPUE) abundance estimates for fish and invertebrates reported by Bay-Delta region agencies. Concerns have been made on the reliability and utility of flowmeters in the field, and some discrepancies exist among agencies in their use and care for flowmeters. Understanding the variability of flowmeter values, within and among different flowmeters and among different flowmeter brands will be valuable toward ensuring we are producing accurate CPUE estimates. Further, we propose that there is a need to define best practices for flowmeter use and encourage consistent protocols among agencies. We examined the variability in flowmeter counts for a single flowmeter brand using datasets produced by the Department of California Fish and Wildlife and the Interagency Ecological Program. Using variance partitioning we examined contributors to flowmeter variance such as weather condition and boats used. We also examined the precision of flowmeters using field reported counts as well as a company flowmeter tester, and further compared two brands of flowmeters. We report on estimates for flowmeter longevity and provide a suggestion for how often flowmeters should be replaced entirely. Finally, based on our work and a discussion of flowmeter use with multiple CDFW surveys, we provide guidelines toward standardizing flowmeter use across agencies within the Bay-Delta region. We propose several practices for regularly testing and maintaining flowmeters particularly in relation to maintaining the rotor constants.

Evidence for Multiple Broods and Early Gametic Production in the Threatened Longfin Smelt

Alyssa A. Cooper*[1]: aabaldo@ucdavis.edu
Levi S. Lewis[1]: lslewis@ucdavis.edu
Malte Willmes[2]: mwillmes@ucsc.edu
James A. Hobbs[1]: jahobbs@ucdavis.edu

[1]Wildlife, Fish, and Conservation Biology, University of California, Davis
1088 Academic Surge, Davis, CA 95616
[2]Institute of Marine Sciences, University of California, Santa Cruz
1156 High Street, Santa Cruz, CA 95064

Longfin Smelt were once an abundant native species of commercial and ecological significance in the San Francisco Estuary (SFE). Over the last 50 years, this distinct population has collapsed to less than 1% of its historic abundance, and a gap in our understanding of their population biology is likely limiting our ability to identify the cause of this decline. Longfin Smelt are thought to have a 2-year semelparous (single spawning) life history strategy; however, detailed studies of Longfin reproductive biology are limited. Determining maturation timing, batch fecundity, and lifetime fecundity is likely critical to understanding population dynamics and informing conservation. Here, we collected adult Longfin Smelt from South San Francisco Bay during the 2018-2019 winter spawning season and assessed gonad development (gonadosomatic index, GSI) and egg development (stage) as functions of standard body length (SL). Longfin are considered mature adults around 80mm SL, but dissections revealed gonads in 25% of 50-59mm SL fish, 65% of 60-69mm SL fish, and 92% of 70-79mm SL fish, while microscopy of eggs revealed instances of two distinct developmental stages of eggs within individual gonads. Earlier reproductive maturity and greater lifetime fecundity have implications for the population's ability to rebound and are thus critical important considerations for future studies to inform and enhance conservation efforts for this threatened species.

From Trash to Data: Using Bycatch to Gain Insight into Trash Trends

Emma Davidson*, US Fish and Wildlife Service, 707-529-8768, emma_davidson@fws.gov ;
Justin Dummitt, US Fish and Wildlife Service, 305-215-0156, justin_dummitt@fws.gov

The Lodi U.S. Fish and Wildlife Service conducts year-round fish sampling efforts throughout California's 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. We began using the citizen-science based trash collection phone application Litterati in December of 2018. Using this application we get photos of individual pieces of trash, identify type, method of collection, and GPS location. The majority of the trash recorded to date was collected as bycatch during normal sampling. A percentage of the trash bycatch is able to be paired with sampling effort, allowing for CPUE estimates that can inform and show relative trash abundance trends over space and time.

Development of a low-cost active water sampler for in-situ solid phase extraction

Matthew De Parsia*[1], Michelle Hladik[1], James Orlando[1], Corey Sanders[1], Matthew Uychutin[1]

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

The Sacramento-San Joaquin Delta is a highly dynamic system in which tides, diversions, agricultural operations, and storms combine to make the study of contaminant fate challenging. Capturing the temporal component of contaminant transport and fate would typically require labor-intensive, high-frequency sampling programs or the use of passive samplers. Passive samplers are potentially more cost effective, but often require substantial method development to deliver analytical results that are usable by policymakers. Active samplers offer a combination of the two approaches; the samplers are deployed autonomously like passive samplers, but known volumes of water are pumped through the sampling devices allowing for a more straight-forward calculation of analyte concentrations. Commercially available active samplers cost upwards of $7000 and may not be affordable to many projects; the current goal was to create a low-cost active sampler using readily available parts. The prototype device, SPEbot (solid-phase extraction robot), pumps in water from the environment at user defined intervals, through solid-phase extraction (SPE) media, and then through a flow meter to measure a sample volume. SPEbot costs roughly $400 to build; parts include an Arduino microcontroller board, batteries, pumps, SPE media holders, and flow meters. The sampler fits in a 12” x 9” x 5” case and is capable of being deployed autonomously for weeks at a time. We conducted a successful test deployment in the Delta using SPE disks targeting pesticides and pesticide degradates. Alternatively, the sampler could be configured with SPE disks that target other contaminants such as algal toxins, PAHs, PCBs, or pharmaceuticals.

Matthew De Parsia (mdeparsia@usgs.gov, 916-278-3080)
Michelle Hladik (mhladik@usgs.gov, 916-278-3183)
James Orlando (jorlando@usgs.gov, 916-278-3271)
Corey Sanders (csanders@usgs.gov, 916-278-3289)
Matthew Uychutin (muychutin@usgs.gov, 916-278-3127)

The Interagency Ecological Program's Ability to Provide Science Supporting Adaptive Management of the Delta: A Report of the Delta Independent Science Board

Delta Independent Science Board
(disb@deltacouncil.ca.gov)

The Delta Independent Science Board recently reviewed the Interagency Ecological Program (IEP). Our review was finished in November 2019 and is available at Delta Independent Sciance Board's review of IEP Functions. The review process involved consideration of prior reviews, examination of how science is organized across other large ecosystems, insights reached through 111 responses to a questionnaire and more than 400 written comments received, and interviews with IEP participants and stakeholders. Recommendations include:

1. Core monitoring and reporting functions of IEP must be continued.
2. The value of long-term data in coping with rapid environmental changes should be better emphasized.
3. Data management requires a more accessible IEP website and improved data portals.
4. A standing committee should continually assess new monitoring methods, phasing out those that are no longer appropriate, and cross-calibrating new and old methods.
5. An improved mechanistic understanding of problems is needed to address the Delta's environmental problems, and additional resources are needed to augment monitoring with experimentation and synthesis.
6. IEP should undertake a formal, transparent assessment to develop a consistent set of goals defining its mission and activities.
7. IEP Directors, staff, and stakeholders should hold in-depth discussions of IEP's organization and operations, to include consideration of alternative structures.
8. IEP should prioritize its activities to justify additional funding and partnerships and/or to reallocate resources among existing activities.

We conclude that: IEP remains the most important interagency science program in the Delta but is not living up to its full potential--funding constraints, structural issues, and lack of permanent positions are hindrances to IEP's effectiveness; IEP must continue to evolve, adapt, and prepare for future issues--increasing the involvement of outside expertise is needed. Any changes to structure or operations should concentrate on protecting what IEP does well.

The effects of environmental variability on phenological traits of endangered Delta Smelt

Christian Denney*[1]
Email: ctdenney@ucdavis.edu Phone: (209) 614-5224

Malte Willmes[2]
email: mwillmes@ucsc.edu

Levi S. Lewis[1]
Email: lslewis@ucdavis.edu

Wilson Xieu[1]
Email: wtxieu@ucdavis.edu

Rachel Fichman[1]
Email: rafichman@ucdavis.edu

Feng Zhao[1]
Email: mayzhao@ucdavis.edu:

Andrew Schultz[3]
Email: aschultz@usbr.gov

James A. Hobbs[1]
Email: jahobbs@ucdavis.edu

[1] Wildlife, Fish and Conservation Biology, University of California Davis. 1088 Academic Surge, Davis, CA 95616
[2] Institute of Marine Sciences, University of California Santa Cruz. 1156 High St, Santa Cruz, CA 95064
[3] United States Bureau of Reclamation, Federal Office Building, 2800 Cottage Way, Sacramento, CA95825

Climate change is causing ever greater variability in the frequency of floods, droughts, and heat waves to which estuaries and freshwaters are considered to be highly sensitive. Delta Smelt (*Hypomesus transpacificus*) is a small endemic estuarine species nearing extinction in

the wild due to a variety of factors such as loss of habitat, reduction in freshwater flows, changing food webs, and entrainment into water diversions. Climate change is likely to exacerbate these problems and lead to new challenges for the management of this imperiled species. In this study we documented changes to the estuarine thermal regime over the last 20-years, including a period of extreme heat wave in 2014 and 2015, causing Delta Smelt to reproduce earlier and contributing to a miss-match with prey and decreased recruitment. Furthermore, using a 20-year otolith dataset, we've documented an effect of early warming on the dispersal history causing fish to shift habitat use towards areas of the estuary with cooler temperatures but less food. Combined, these changes appear to be pushing the species ever closer to extinction and emphasize the need to consider thermal management strategies in future conservation efforts.

Salinity Tolerance of Delta Smelt Sperm

Fish biology and reproduction, captive breeding, environmental stress

Angela Eads (postdoctoral scholar*)
Fish Conservation and Culture Lab
Biological and Agricultural Engineering, UC Davis
5280 Bruns Rd, Byron, CA, 94514
areads@ucdavis.edu
Ph: 925-329-8878
* Qualifies for early career poster awards

Tien-Chieh Hung
Fish Conservation and Culture Lab
Biological and Agricultural Engineering, UC Davis
5280 Bruns Rd, Byron, CA, 94514
thung@ucdavis.edu
Ph: 209-830-9803

Delta smelt (*Hypomesus transpacificus*) are an anadromous small fish found in the Sacramento-San Joaquin Delta. Recent population declines have occurred in this system, likely due to environmental disruptions, and management strategies are being introduced to prevent extinction, including captive breeding colonies. This species inhabits the estuary region for most of the year, but most individuals migrate upstream to spawn in freshwater following the initial winter flow events. There are multiple hypotheses to explain these movement patterns, including microhabitat requirements for reproduction. One aspect of this may include the water chemistry necessary for sperm activation and mobility, but this is as yet unstudied in this species. We will evaluate the sperm motility of delta smelt under a range of naturally occurring salinities. We anticipated that sperm performance would be superior in freshwater, reflecting their spawning behaviour patterns, and that high salinity would have detrimental outcomes for sperm motility overall. Our findings will contribute to a better understanding of their migratory behaviours, as well as inform best practices for captive breeding programs.

Quality-Assurance Procedures & Open Data: Time-series Water-Quality Data Examples

Alexandra Etheridge*[1], Rachel Pisor[2]

[1]Water-Quality Specialist, U.S. Geological Survey, California Water Science Center, 6000 J Street Placer Hall, Sacramento, CA 95819, 916-995-0784, aetherid@usgs.gov
[2]Senior Environmental Scientist, Department of Water Resources, 3500 Industrial Blvd, West Sacramento, CA 95691, 916-376-9711, Rachel.pisor@water.ca.gov

In 2006, the U.S. Geological Survey (USGS) published a techniques and methods paper to establish procedures and guidance for quality assuring time-series water-quality data (Wagner and others, 2006). USGS continues to serve open data to the public via the National Water Information System (NWIS), but changes to protocols are needed to evolve along with sensor technology, to better meet open-data and open-science practices, and to ensure reproducibility of quality assurance processes within modernized database infrastructure. In addition, when research partners from different agencies work together in a common study area, comparable methods of data collection and quality assurance are often desired. Identical quality-assurance processes among different agencies are not necessarily feasible given differences in workflows and database infrastructure, but collaboration can ensure cross-agency data comparability and reproducibility. Considerations for ensuring comparable, high-quality, reproducible data within the IEP program will be discussed along with considerations ongoing in USGS to modernize procedures for quality assuring time-series water-quality data. Lastly, plans for collaboration on quality-assurance practices and procedures among research partners in the Interagency Ecological Program will be described.

Stable isotopes provide insight into sources and cycling of dissolved nitrogen compounds in the Sacramento-San Joaquin Delta, California, USA

Joseph Fackrell*[1], Carol Kendall[2], Megan Young[2], Tamara Kraus[1], and Sara Peek[2]

[1]USGS California Water Science Center, Sacramento, CA
[2]USGS Water Mission Area, Menlo Park, CA

The Sacramento-San Joaquin Delta (Delta) is a large inverted river delta located in central California, USA, that is fed primarily by the Sacramento River and is comprised of a complex network of distributaries, tributaries, and sloughs. The Delta has been substantially altered by anthropogenic activities including channelization, water diversion, and inputs of agricultural drainage and municipal wastewater. These alterations have a large impact on the concentration, speciation, and biogeochemical cycling of nitrogen (N), an element essential for biological processes. However, due to the Delta's hydrologic complexity and diversity of aquatic ecosystems, assessment of these impacts is challenging. To better understand N compound sources and biogeochemical processes in Delta aquatic environments we utilized a multi-tracer, multi-stable isotope approach that measured N species concentrations and stable isotope values monthly for a period of two years in samples collected from (1) the channelized mainstem of the Sacramento River, (2) two distributaries of the Sacramento River (Miner and Steamboat Sloughs), and (3) Sacramento River tributaries that connect with a large shallow wetland (Cache Slough complex.) We found that N species concentrations and apparent biogeochemical transformations were similar between the mainstem Sacramento River and its Miner and Steamboat Slough distributaries while the Cache Slough complex tributaries are distinct from the Sacramento River and its distributaries in terms of N species concentrations and stable isotope values. Cache Slough complex tributaries may serve as both a source and a sink of N compounds to the Sacramento River depending on flow conditions. These findings highlight both the spatial and temporal variability in N dynamics in river delta environments and the utility of a multi-tracer, multi-stable isotope approach in understanding N dynamics in complex systems.

Changes in Delta Smelt life-history portfolios in relation to regional climate variability

Rachel A. Fichman*[1]
Email: rafichman@ucdavis.edu
707-291-3185

Wilson Xieu[1]
Email: wtxieu@ucdavis.edu
415-533-9506

Feng Zhao[1]
Email: mayzhao@ucdavis.edu
530-219-8226

Wendy Chen[1]
Email: wegchen@ucdavis.edu
303-257-4380

Malte Willmes[2]
Email: mwillmes@ucsc.edu
530-574-7914

Christian Denney[1]
Email: ctdenney@ucdavis.edu
530-754-7770

Levi S. Lewis[1]
Email: lslewis@ucdavis.edu
707-338-4145

Andrew Schultz[3]
Email: aschultz@usbr.gov
916-414-2415

James A. Hobbs[1]
Email: jahobbs@ucdavis.edu
707-480-0188

[1]UC Davis Department of Wildlife, Fish &Conservation Biology
1 Shields Ave, Davis, CA 956163
[2]Institute of Marine Sciences/NOAA Fisheries Collaborative Program, UC Santa Cruz,
1156 High Street, Santa Cruz, CA 95064
[3]U.S. Bureau of Reclamation
2800 Cottage Way, Sacramento, CA 95825

Delta Smelt (*Hypomesus transpacificus*) are an endangered fish endemic to the upper San Francisco Estuary. Water management policies aimed at recovering the species have been controversial as they, at times, can restrict the export of freshwater for agricultural and urban use. A detailed understanding of the habitat-use and life history of Delta Smelt is critical for effective management and conservation plans. Delta Smelt are managed under a semi-anadromous lifecycle model with spawning migration leaving brackish water for freshwater in winter then early life stages returning to brackish water after rearing in spring. Recent studies have challenged this model by suggesting that this species is an estuarine resident with residing in localized "hot spots" of abundance. To further investigate these models, we analyzed the microstructure and chemistry of otoliths - continuously growing ear bones that accrete daily rings - providing a time series of growth, movement, and ambient environmental conditions. In our dataset spanning the last decade we found three distinct life history strategies: freshwater residents, brackish water residents, and semi-anadromous individuals that exhibit a wide range of movement timings. Life-history portfolios were diverse across years in relation to water temperature and freshwater outflow. Understanding how Delta Smelt persist in this dynamic environment over time is imperative for the conservation of this endangered species on the brink of extinction.

New bathymetric data and DEM of the Cache Slough Complex, Sacramento-San Joaquin Delta, California

Theresa A Fregoso*[1], Andrew W. Stevens[1], Rueen-Fang Wang[2], Thomas Handley[2], Evan T Dailey[1], Peter Dartnell[1], Jessica R. Lacy[1], Eli Alteljevich[2]

1) United States Geological Survey (USGS) - Pacific Coastal and Marine Science Center, Santa Cruz, CA

2) California Department of Water Resources Bay-Delta Office, Sacramento, CA

This poster presents a Digital Elevation Model (DEM) of bathymetric and topographic data collected between 2017 and 2019 in the Cache Slough Complex (CSC), northern Sacramento - San Joaquin Delta, California. CSC is ecologically important because of the diversity of its habitats and the continued presence of native fishes, and is the site of multiple habitat restoration actions. The shallow, highly vegetated aquatic habitats of CSC necessitated a variety of survey platforms and techniques to capture the best hydrographic survey data. In the deeper channels, USGS collected swath bathymetry data using a 234.5 kHz interferometric sidescan sonar system mounted to the 26-ft R/V *San Lorenzo*. In smaller channels and shallow areas not accessible with the *San Lorenzo*, we acquired swath bathymetry data with *Kelpfly*, a personal watercraft (PWC) equipped with a 468 kHz interferometric sidescan sonar. Two PWCs equipped with 200 kHz single-beam sonars were primarily used to survey the large, gently sloping flooded agricultural tracts and areas with dense submerged vegetation. The combination of these techniques resulted in good coverage of both the main channels and shallow embayments. Topographic data were collected by hiking over the land surface, with global satellite navigation system receivers (GNSS) mounted on backpacks. We merged the new bathymetric and topographic data with existing datasets acquired from 2004 – 2019, to produce a seamless digital elevation model of the Cache Slough Complex with a grid resolution of 1 m. The DEM will support modeling and field studies in the region. This work is part of a larger project funded by the U.S. Bureau of Reclamation to improve understanding of habitat quality in the CSC and the effects of restoration actions in the Sacramento – San Joaquin Delta.

Movements of Reintroduced Juvenile Central Valley Chinook Spring-run Salmon from the San Joaquin River Restoration Program

Hilary Glenn* & Katherine Schmidt

National Marine Fisheries Service, 650 Capital Mall Suite 5-100
Sacramento, CA 95814

The National Marine Fisheries Service writes an annual Technical Memorandum for the Accounting of San Joaquin Spring-run Chinook Salmon at the Central Valley Project and State Water Project Sacramento-San Joaquin Delta Fish Collection Facilities (Tech Memo). The Tech Memo is a reporting requirement from the Designation of a Nonessential Experimental Population of Central Valley Spring-run Chinook Salmon Below Friant Dam in the San Joaquin River, California (70 FR 79622, December 31, 2013). Part of the 2020 Tech Memo included graphs and figures tracking the presence of juvenile Central Valley spring-run Chinook salmon released by the San Joaquin River Restoration Program. Those figures and figures/tables from the 2020 Tech Memo will be presented on this poster.

Keywords: Spring-run, juvenile salmonid monitoring, reintroductions

Rapid Smelt Species Identification in the San Francisco Estuary using CRISPR-based SHERLOCK

Alisha M. Goodbla*[1], Melinda R. Baerwald[2], Raman P. Nagarajan[3], and Andrea M. Schreier[6]

[1] Department of Animal Science, University of California Davis, One Shields Ave, Davis, CA, USA
amgoodbla@ucdavis.edu, 530-752-6351
[2] California Department of Water Resources, 3500 Industrial Blvd, Sacramento, CA 95691, USA
Melinda.Baerwald@water.ca.gov, 916-376-9742
[3] Department of Animal Science, University of California Davis, One Shields Ave, Davis, CA, USA
rpnagarajan@ucdavis.edu, 530-752-6351
[6] Department of Animal Science, University of California Davis, One Shields Ave, Davis, CA, USA
amdrauch@ucdavis.edu, 530-752-0664

We have developed a novel ecological monitoring approach using CRISPR technology, which is widely utilized in the biomedical field, but is only starting to expand into other disciplines such as conservation biology. This CRISPR-Cas13a-based SHERLOCK (Specific High-sensitivity Enzymatic Reporter unlocking) platform is a highly sensitive, specific, and rapid method to discriminate between species in the field. Traditional genetic species identification requires sampling tissue from the organism and several days of processing in a molecular biology lab. SHERLOCK, however, can be completed in an hour or less without DNA extraction. Being able to make real-time management decisions based on accurate identifications in the field is critical when protecting threatened species, particularly in California's watersheds. In this study we focused on three morphologically similar smelt species co-occurring in the San Francisco Estuary, the U.S. threatened and California endangered Delta Smelt, the California threatened Longfin Smelt, and the non-native Wakasagi. These three species can be challenging to identify in the field, particularly as juveniles, which can lead to incorrect abundance estimates. Using a simple mucus swab for DNA input, we were able to accurately distinguish these three smelts using the SHERLOCK platform. This technique can be utilized by non-molecular biologists with minimal training and can be applied to an expansive range of species found in the Bay-Delta system. SHERLOCK is a powerful molecular tool that can aid in efficient species identification for both monitoring and management.

Common Delta Base Map: Delta Aquatic Resources Inventory (DARI)

Cristina Grosso*

San Francisco Estuary Institute
4911 Central Avenue, Richmond, CA 94804 Phone: (510) 746-7371
Email: cristina@sfei.org

Thomas Jabusch

Sacramento-San Joaquin Delta Conservancy
1450 Halyard Dr #6, West Sacramento, CA 95691
Phone: (916) 375-2084
Thomas.Jabusch@deltaconservancy.ca.gov

DARI is the Delta Aquatic Resources Inventory of surface waters, wetlands, and other aquatic resources in the Sacramento-San Joaquin Delta (Delta). The goal of the DARI project is to develop a geospatial inventory of aquatic resources that will be used as a common base map for the Delta. A similar mapping approach used to create the California Aquatic Resource Inventory (CARI) will be applied to provide a map of the aquatic resources and their associated attributes. The final map will be incorporated into CARI and made publicly available through EcoAtlas (ecoatlas.org) and similar platforms.

The inventory of aquatic resources created for the Delta will provide a standardized regional approach to wetland classification and mapping to support multiple current efforts in the Delta, including regional watershed restoration planning, tracking, and reporting. Since a goal of this project is to encourage ongoing stewardship, protocols will be established for submitting new or revised data using the CARI Editor Tool and incorporating updates into the DARI base map in the future.

Project funding and oversight are provided by USEPA and the California Wetland Monitoring Workgroup. Once completed in 2020, the common Delta base map will provide several benefits, including to establish a baseline of existing aquatic resources in the Delta; inform prioritization of management actions and evaluate the effectiveness of projects; increase the ability to assess and track the amount and quality of wetlands in the Delta to support compliance monitoring and assessment of wetlands projects; increase the capacity for assessing regional and statewide net change in the abundance, diversity, and condition of wetlands as affected by land use; facilitate wetland monitoring and assessment coordination in the Delta region to assess the status and trends in its wetland ecosystems; and encourage ongoing stewardship and updating of DARI with protocols and online tool

Velocity Rating Solved: An Application of New Software for Developing Index Velocity Ratings

Joseph E. Hatfield*

U.S. Geological Survey, West Sacramento Hydrodynamics Group

Discharge can be measured and computed using a variety of methods. One such method is index velocity. Which is the product of the cross-sectional area and mean-channel velocity of a river cross-section (Q=V*A). The index-velocity rating establishes a relationship between the measured velocity from an Acoustic Doppler Current Profiler (ADCP) located at each station to the mean-channel velocity calibration measurements that are collected during site visits using a boat-mounted system.

The station-mounted ADCP measures velocity into the stream cross-section. The instrument can measure not only an average value across the sampling volume, it can also report velocities measured in individual sub-sections, or bins, within the sampling volume. It's not uncommon for only a portion of the measured velocity to be used in the regression due to interference with the channel bed, water surface, or other factors. Therefore, bin selection plays an integral part in developing an effective index velocity rating.

Traditionally, bin selection was based on a visual inspection of bin velocity data and beam time series analysis of the return signal strength indicator (RSSI). From this analysis a hydrographer can determine which subset of velocity bins within the ADCP beams are most suitable to represent the mean velocity of the river. Calculating an index for all possible bin combinations is a lengthy process and often not done. Rating Solver, a program created to analyze all possible bin combinations, aids hydrographers in creating an index velocity rating by determining which bin subset yields the best regressions. Rating Solver expedites the bin selection process, increases workflow efficiency, and improves rating accuracy.

Updating and Expanding the Delta Smelt Individual-Based Life Cycle Model

Li-Ming (Lee) He* U.S. Fish and Wildlife Service, San Francisco Bay Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. 916-930-2653. li-ming_he@fws.gov

Kenneth Rose, University of Maryland Center for Environmental Science, Horn Point Laboratory, PO Box 775, Cambridge, MD 21613. (225) 773-5625. krose@umces.edu

Derek Hilts, U.S. Fish and Wildlife Service, San Francisco Bay Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. 916-930-5633. derek_hilts@fws.gov

Wim Kimmerer, Estuary & Ocean Science Center, San Francisco State University, Romberg Tiburon Campus, 3150 Paradise Drive, Tiburon CA 94920. 415 338-3515. kimmerer@sfsu.edu

Matt Nobriga, U.S. Fish and Wildlife Service, San Francisco Bay Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. 916-930-5609. matt_nobriga@fws.gov

Individual-based life cycle models are well suited to incorporating spatial information in a realistic manner and for simulating the complex interactions between the transport and movement of individuals and dynamic environmental conditions. The Delta Smelt individual-based model (DSIBM) follows the daily reproduction, growth, survival, and movement of individuals from eggs through adults within the same spatial grid as that used by the DSM2 hydrodynamic model. An earlier version of the DSIBM was developed by Rose, Kimmerer, and others more than eight years ago. Since then, we have learned a lot about Delta Smelt biology. The Delta Smelt population is near record low abundances during the past few years. As a tool to help understand Delta Smelt population dynamics, we are updating the model by incorporating new knowledge of Delta Smelt biology and ecology, more tightly coupling the model to environmental conditions generated from DSM2, and expanding the historical years simulated. The revised DSIBM will use DSM2 to generate flow, salinity, and water temperature inputs. We will re-calibrate and validate the DSIBM using the 1990 to 2012 time period, and will expand the model to simulate multi-decadal synthetic sequences of scenario conditions. When finished, we anticipate using CalSim II results to inform DSM2, which in turn will be used to generate input to the DSIBM. Such a modeling framework may allow us to evaluate the potential effects (positive or negative) of various long-term water operations scenarios for the Central Valley Project and State Water Project. We also plan to use the improved and expanded model to analyze the interaction of multiple environmental factors and management actions on Delta Smelt reproduction, growth, survival, and movement. The updated DSIBM may also be a useful tool for other ongoing scientific processes including the implementation of the Delta Smelt Science Plan and the Structured Decision Making for Delta Smelt Recovery.

Tell Me What You Want, What You Really, Really Want - The Science Action Agenda and Management Needs Assessment

Yumiko Henneberry*

Delta Science Program
980 9th Street, 15th Floor, Sacramento, CA 95814
Yumiko.Henneberry@deltacouncil.ca.gov|916-445-7690

In this interactive poster, readers will be encouraged to write down what their top management needs and questions are, as well as any related science questions they feel will be critical in supporting pressing natural resource decisions in the Delta. The responses will be used to guide the update of the Science Action Agenda. While the focus will be on the Delta, these management needs and science questions have statewide importance given the significance of this region to the rest of California.

The Science Action Agenda (SAA) is a four-year plan for the Delta that prioritizes actions across agency and multi-group entities to address both regional and state-wide management needs. Priorities are identified based on the objectives of the Delta Science Plan and take into consideration ongoing work, as outlined in the State of the Bay Delta Science. The SAA was developed through an open and collaborative process and reflects input gathered from the Delta science community, the public, major synthesis efforts, and peer-reviewed literature. Science actions identified in the document has been used as topic areas for the 2018 Joint Proposal Solicitation Notice between the Delta Science Program and the CA Department of Fish and Wildlife, with additional support from the US Bureau of Reclamation, as well as for past Sea Grant Science Fellowship call for proposals. The SAA is also intended to guide future workplans of various agencies and collaborative groups (e.g. the IEP) through identifying priorities for science investments. The first Science Action Agenda was released in 2017 and is to be updated every four years. The next will begin in 2020 and will include an investigation of key management needs to determine whether these can help guide identification of additional science actions.

Efforts and progress on the culture of Longfin Smelt (*Spirinchus thaleichthys*)

Tien-Chieh Hung*[1], Galen Tigan[1], Luke Ellison[1], Virginia Afentoulis[2]

Tien-Chieh Hung
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803
thung@ucdavis.edu

Galen Tigan
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803
gttigan@ucdavis.edu

Luke Ellison
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803
ellison@ucdavis.edu

Virginia Afentoulis
Bay Delta Office –SWP Fish Facilities, California Department of Water Resources
209-833-1021
Virginia.Afentoulis@water.ca.gov

The population of Longfin Smelt (*Spirinchus thaleichthys*) in the San Francisco Bay-Delta area has declined dramatically and is currently listed by the state of California as a threatened species. The number of research projects focusing on Longfin Smelt has been increasing but they are limited to the amount of fish available because culture methods for Longfin Smelt have not been fully developed. In this presentation, we report on the past 10 years of research efforts by the UC Davis Fish Conservation and Culture Lab on the culture of wild-caught longfin smelt and lab-breed offspring. Preliminary results of temperature, turbidity, and salinity effects on larval culture are also presented to inform future research directions for rearing method development.

Potential changes in calanoid copepod growth following a low-nutrient pulse in the Sacramento River.

Toni Ignoffo*[1], Anne Slaughter[2], Lisa Thompson[3], and Wim Kimmerer[4]

[1, 2, & 4]Estuary & Ocean Science Center
San Francisco State University, Romberg Tiburon Campus
3150 Paradise Dr.
Tiburon, CA 94920
[1](415) 338-3510
tignoffo@sfsu.edu
[2](415) 338-3548
aslaught@sfsu.edu
[4](415) 338-3515
kimmerer@sfsu.edu
[3]Sacramento Area Sewer District & Sacramento Regional County Sanitation District
10060 Goethe Road
Sacramento, CA 95827
w (916) 876-6364
thompsonlis@sacsewer.com

Nutrients, especially nitrogen, play an important role in phytoplankton growth, and changes in phytoplankton growth affects the pelagic foodweb. The Sacramento River will receive decreased nutrient loading from the Sacramento Regional Wastewater Treatment Plant (SRWTP) with planned infrastructure upgrades in 2021. In the summer of 2019, a collaboration of researchers took advantage of a temporary hold of SRWTP effluent, creating an opportunity to study the ecosystem response to a large reduction in nutrient loading. The scheduled system maintenance of the SRWTP provided parcels of nutrient-rich and nutrient-poor water, identifiable by water-quality measurements, which we sampled as they moved through the Delta. This allowed us to concurrently sample present-day conditions and a proxy for future conditions as the parcels moved through the system. We sampled in the North and South Forks of the lower Mokelumne River which have relatively long residence times, allowing several days for the phytoplankton to respond to the nutrient changes with changes in biomass and species and size composition. We measured the responses of zooplankton consumers on these phytoplankton by conducting growth-rate experiments with *Pseudodiaptomus forbesi.* We conducted 12 experiments over a 3-day sampling period in September using the modified artificial cohort method. Water was collected from each channel and each nutrient condition daily and *P. forbesi* was collected from the San Joaquin River and maintained in the laboratory for the experiments. Copepods are consumed by nearly all estuarine fishes during early life and their growth is food-limited in much of the estuary; thus our results should be helpful in forecasting and later understanding the changes to the food web that occur after the SRWTP upgrade, and thereby changes in the fish assemblage.

Use of Autonomous Unmanned Surface Vessels for Collection of Tidal Discharge Measurements in the Sacramento-San Joaquin Delta

Mark R Inc*

US Geological Survey, West Sacramento Hydrodynamics Group
1280 Terminal St, West Sacramento, CA 95691
916.204.0026
Minc@usgs.gov

The USGS has begun using autonomous unmanned surface vessels (USVs) to collect tidal discharge measurements in the Sacramento-San Joaquin Delta. We have stations throughout the Delta collecting continuous velocity and stage data to compute real-time water discharge. Our current workflow for creating and verifying regression models relating the index-velocity measured at a station and the mean-channel velocity measured using a moving boat system relies on manned vessels. By transitioning to USVs, we expect to be able to collect discharge measurements with constant boat speed, straight travel paths, and consistent start and end points. We believe this increased level of reproducibility and the removal of human error will improve our regression models and the quality of the data we publish.

(Bio) Foul! Does biofouling change caged smelt diets?

Terence Jarrell*[1], Melinda Baerwald[1], Catarina Pien[1], Nicole Kwan[1], Brian Schreier[1]

[1]Department of Water Resources; 3500 Industrial Blvd. West Sacramento, CA 95691
Presenting Author Phone: (916) 376-9794; Email: Terence.Jarrell@water.ca.gov

Due to a rapid decline in wild Delta Smelt abundance, the population is unlikely to recover without support from captive-bred Delta Smelt. Field enclosure studies were conducted in 2019 to examine whether captive-bred Delta Smelt could survive in the wild. In October 2019, Delta Smelt from the UC Davis Fish Conservation & Culture Laboratory were held in cages at Rio Vista, Suisun Marsh, and the Yolo Bypass for approximately one month. During these deployments, algal biofouling and associated invertebrate communities developed on the cages. In the wild, Delta Smelt are opportunistic and visual feeders that rely on tidal currents and diel vertical migration to follow concentrations of zooplankton in the water column. An enclosed, biofouled system creates an invertebrate community that is different from the normal habitat of Delta Smelt, potentially altering their feeding behavior. This biofouling prompted a pilot study to analyze the community composition associated with the mesh of the enclosures. Biofouling samples were collected during the cage retrieval process in November 2019. These samples were compared to the stomach contents of Delta Smelt held in these cages and to zooplankton tow data. Initial observations of the biofouling community suggest a potential food source containing more prey options than their normal diet of planktonic copepods, cladocerans, and amphipods. Further analysis is needed to obtain a comprehensive list of species from the biofouling community of these enclosures. This information will be useful for determining whether this artificial environment is providing supplementary food sources for the enclosed Delta Smelt, thereby limiting the ability to utilize diet data from these enclosures for answering ecological questions.

Fish Guts: Open for a View of Cyclopoids in the San Francisco Estuary

Jessica A. Jimenez*, Tricia L. Bippus, Christina E. Burdi

Interagency Ecological Program
California Department of Fish and Wildlife
2109 Arch Airport Road, Stockton, CA 95206.
(Jessica.Jimenez@wildlife.ca.gov)

There are several monitoring projects within the Interagency Ecological Program that collect and identify zooplankton in the San Francisco Estuary (SFE). Zooplankton are prey for many fishes in the SFE, including the endangered Delta Smelt. Cyclopoid copepods are an important group within zooplankton. Despite this, cyclopoid copepods are less studied in this region than other groups such as Calanoid copepods. To examine cyclopoids further, fish diet analysis was conducted by the California Department of Fish and Wildlife's (CDFW) Diet Study. Delta Smelt were collected by several long-term monitoring projects conducted by the CDFW and the U.S. Fish and Wildlife Service (USFWS). The CDFW Diet Study then identified gut contents to the lowest possible taxonomic level. Currently, the CDFW Diet Study identifies the cyclopoid copepods *Acanthocyclops* and *Limnoithona* to genus, *Oithona* to species and categorizes nine other cyclopoid genera as "Other Cyclopoids". *Acanthocyclops*, *Limnoithona*, and *Oithona* can look very similar to these "other cyclopoids", especially in a digested state. Therefore, the ability to identify "other cyclopoids" further, is necessary to ensure correct identification of *Acanthocyclops*, *Limnoithona*, and *Oithona*.

Feeding habits and novel prey of larval fishes in the San Francisco Estuary

Michelle J. Jungbluth*[1], Lenny Grimaldo[2], Aspen Katla[3], Wim Kimmerer[1]

[1]Estuary and Ocean Science Center, San Francisco State University
3150 Paradise Dr., Tiburon, CA 94920

[2]ICF Inc.
2600 Hilltop Dr., Richmond CA 94806

[3]North Seattle College, Seattle, WA
9600 College Way N., Seattle, WA 98103

Food limitation is a likely constraint on the abundance of several species of fish in the San Francisco Estuary, especially for larval survival. We used DNA metabarcoding analysis on the guts of larval longfin smelt (*Spirinchus thaleichthys*) and Pacific herring (*Clupea pallasii*) to describe the prey important to these species and we DNA barcoded specific zooplankton species to fill gaps in the genetic database of known organisms. Larval fishes and zooplankton were collected in shoals, tidal marshes, and channels of San Pablo Bay and Suisun Bay during spring 2017. There were 12 metazoan species that overlapped between the two fish species. The prey with the greatest frequency of occurrence across guts for both species includes *Eurytemora affinis* (>38% frequency of occurrence, FO), *Acanthocyclops americanus* (>24% FO) and *A. robustus* (>7% FO). Some prey were more common in one species than the other. Herring consumed *Limnoithona tetraspina* more frequently (26% FO) than did the smelt (2% FO). Longfin smelt consumed four other fish species (presumably eggs) while herring consumed longfin smelt, and herring consumed more cladocerans (up to 7% FO) than the smelt (up to 2% FO). We found unexpected prey items in the fishes' diets that would not be identifiable using morphological diet analysis, including a cnidarian *Hydra oligactis*, a polychaete *Dasybranchus* sp., a rotifer *Synchaeta kitina*, worms, and the cyclopoid copepods *Acanthocyclops americanus, Acanthocyclops robustus,* and *Mesocyclops pehpeiensis*. Our genetic identifications of *M. pehpeiensis* and *L. tetraspina* are the result of individually barcoding cyclopoid copepods: this is the first report of *M. pehpeiensis* in the Estuary. Many genetic groups in the diets could not be classified to a reliable level based on existing databases, which highlights the need for more work generating DNA barcodes for local species as eDNA and community metabarcoding sees wider use for biomonitoring and management.

Phytoplankton Responses During the Delta Smelt Fall Outflow Action: How did the Base of the Food Web Respond to a Change in X_2?

Andrew Kalmbach*[1] (Andrew.Kalmbach@icf.com), Caitlin Hall[1] (caitlinelisehall@gmail.com), Jason Hassrick[1](Jason.Hassrick@icf.com), Lenny Grimaldo[1] (Lenny.Grimaldo@icf.com) Andrew Schultz[2] (aschultz@usbr.gov), Towns Burgess[3] (oburgess@usbr.gov)

1. ICF 980 9th St Suite 1200, Sacramento, CA 95814 (916) 737-3000
2. U.S. Bureau of Reclamation Bay-Delta Office 801 I St., Suite 140,
3. Sacramento, CA 95814 (916) 414-2415
4. U.S. Bureau of Reclamation Bay-Delta Office 801 I St., Suite 140,
5. Sacramento, CA 95814 (916) 414-2416

How does management of water flow and salinity affect the phytoplankton assemblages in the Sacramento River Delta? At the base of the aquatic food web, responses to changing environmental conditions by microalgae can impact fish populations through bottom-up processes. Changing salinities, turbidities, and nutrients can drive shifts in the assemblage structure, promote or inhibit blooms, and affect herbivore populations. The Fall Outflow Action is a regulatory requirement requiring modification of flows to move the 2 ppt isohaline (aka X2) downstream in the autumn during above normal and wet water years. In the fall of 2017 and 2018 we collected phytoplankton throughout the northern Delta and Suisun Bay following a generalized random tessellation stratified (GRTS) spatially balanced survey design.

The 2017 the Fall Outflow Action moved X2 to 81 km upstream of the Golden Gate, and there was no outflow action in 2018. Nutrient concentrations and the phytoplankton assemblage were analyzed following the GRTS approach, in conjunction with the Enhanced Delta Smelt Monitoring. Phytoplankton biomass was similar between the two years, although nitrate concentrations were higher in 2017. In both years, the phytoplankton species assemblages shifted with X2 location in the Delta and nutrient concentration.

Estimation of longfin smelt hatching distribution, abundance, and entrainment using three-dimensional hydrodynamic and particle-tracking models

Edward Gross, Resource Management Associates Inc., 1840 San Miguel Dr. Suite 102, Walnut Creek, CA 94596, USA, ed@rmanet.com

Wim Kimmerer*, Estuary & Ocean Science Center, San Francisco State University, 3150 Paradise Drive, Tiburon, CA 94920, USA, 415-338-3515, kimmerer@sfsu.edu

Josh Korman, Ecometric Research, Vancouver, BC V6S 1J3, Canada, jkorman@shaw.ca

Lenny Grimaldo, ICF, 650 Folsom St., Suite 200, San Francisco, CA 94107, USA, lenny.grimaldo@icf.com

Scott Burdick, Resource Management Associates Inc., 1756 Picasso Avenue, Suite G, Davis, CA 95618, USA, scott@rmanet.com

Longfin smelt (*Spirinchus thaleichthys*) spawn in shallow, fresh to brackish water, and the larvae disperse seaward toward deep higher-salinity water. Actual locations of spawning have not been determined, and recent studies have found abundant larvae further seaward than the extent of the fish surveys during wet years. We modeled the movements of larvae after hatching to infer the geographic distribution and timing of hatching, and to estimate natural mortality and losses of larvae to entrainment in south Delta diversion facilities. The UnTRIM hydrodynamic model was used with boundary conditions for 2013 (dry) and 2017 (wet) to provide input to the FISH particle-tracking model. The model domain was divided into 13 regions, of which nine east of San Pablo Bay were used as source regions. Each day particles representing hatching larvae were distributed in each source region, and positions were tracked through time. Particles released over two-week periods were combined into "cohorts" representing larvae that grew at the same constant rate from an assumed length at hatch. For each cohort on each day we determined the proportion of particles in each region that were from each source region. Then we determined the likelihood of hatching in each of the source regions for each cohort by comparing modeled distributions with observed abundance and length distributions from the Smelt Larval Survey; we also estimated natural mortality and entrainment losses. Hatching occurred primarily in and around Suisun Bay and Marsh during 2013, and further seaward in shallow regions of San Pablo Bay in 2017. Longfin smelt were inferred to hatch mostly west of the Delta in both years, and model results show that entrainment losses at the export facilities were small compared to natural mortality, and therefore not a major risk to the population.

Delta Social Science Task Force

Rachael Klopfenstein*

Delta Stewardship Council's Delta Science Program)
980 Ninth St, Sacramento, CA 95814
(916) 445-5088
Rachael.Klopfenstein@deltacouncil.ca.gov

In collaboration with the UC Davis Coastal and Marine Sciences Institute, the Delta Stewardship Council's Delta Science Program convened a panel of six social scientists, the Delta Social Science Task Force (Task Force), in late 2018. The Task Force was charged with developing a strategic plan to strengthen and integrate social sciences into the science, management, and policy landscape of the Delta. Key interest group meetings convened in Summer 2018 influenced the areas of expertise represented on the Task Force. Two workshops hosted in 2019 provided the Task Force with opportunities to engage with Delta agency representatives and highlight the value and relevance of social science research to Delta management challenges. In their draft report submitted in December 2019, the Task Force identified three key findings: 1) research activities are ongoing, but there is no long-term vision for social science integration; 2) there is a lack of social science capacity and investment; and 3) social science does not explicitly inform adaptive management structures and processes. Nine recommendations were provided to help address these findings. Agency staff and stakeholders provided comments on the draft report for the Task Force to consider in their final report (available in March 2020). The Delta Science Program and other agencies can utilize the recommendations in the report to better support the use of social sciences, therefore strengthening the Delta science enterprise and the use of best available science to inform water and environmental decision-making.

A Comparison of Methods Used in Mossdale Trawl Efficiency Tests

Ryan Kok* (ryan.kok@wildlife.ca.gov, 209-853-2533 x5#)
Gretchen Murphey (Gretchen.murphey@wildlife.ca.gov, 209-853-2533 x3#)

California Department of Fish and Wildlife, PO Box 10, La Grange CA 95329

The California Department of Fish and Wildlife has been conducting the Mossdale trawl annually on the San Joaquin River since 1988. The data collected from the trawl is used to estimate the number of juvenile Fall-run Chinook salmon out-migrating from the San Joaquin River and its tributaries. Efficiency tests have been conducted since 1989 in order to generate a more accurate estimate of the population exiting the system. For each test, a known number of dye-marked individuals are released upstream of the trawl, to be recaptured approximately two miles downstream. Efficiency releases have generally been conducted at the Mossdale park boat ramp, but release strategies have varied greatly over time. The methods have ranged anywhere from a single release group lasting five minutes to a stepped release over the course of two hours. We compared these two methods during years of similar streamflow in order to evaluate the differences in recapture rates between the release types. These results will then be used to help determine the methods to be used in future surveys.

Using otolith geochemistry to quantify life-history diversity in Longfin Smelt

Jonathon Kuntz[1*], Malte Willmes[2], James Hobbs[1], Christian Denney[1], Tien-Chieh Hung[3], Randy Baxter[4], Levi Lewis[1]

[1]Otolith Geochemistry and Fish Ecology Laboratory, Department of Wildlife, Fish and Conservation Biology, University of California Davis. 1088 Academic Surge, Davis, CA. 95616; jpkuntz@ucdavis.edu; jahobbs@ucdavis.edu; lewis.sci@gmail.com (530)754-7770

[2]Institute of Marine Sciences/NOAA Fisheries Collaborative Program, UC Santa Cruz. 1156 High St, Santa Cruz, CA. 95064; mwillmes@ucdavis.edu

[3]Fish Conservation and Culture Laboratory, Department of Biological and Agricultural Engineering, University of California Davis. 17501 Byron Hwy, Byron, CA. 94514; thung@ucdavis.edu

[4]California Department of Fish and Wildlife, 1416 9th Street, Sacramento, CA. 95814; randy.baxter@wildlife.ca.gov

Little is known about the ontogenetic niche of threatened Longfin Smelt within the San Francisco Estuary, limiting our ability to make informed conservation and water management decisions. We are using increment and geochemical analyses of otoliths (ear bones) to quantify variation in life-history strategies of Longfin Smelt across bay regions, years, and climate regimes. Strontium isotopes have identified at least four larval life history phenotypes, with some individuals rearing in more saline brackish waters, whereas all individuals surviving to adulthood migrate bay-ward by ~150 days post hatch. While Sr isotopes are informative for tracking larvae at low salinities, oxygen isotopes provide salinity reconstructions of entire adult life histories at higher salinities. Oxygen isotopes have revealed very rapid movements of juvenile Longfin Smelt to higher salinity habitats, as well as a variety of adult patterns, including bay and ocean residency. Though larvae are found throughout the SFE in wet years, preliminary multivariate trace element analyses suggest natal habitats are primarily confined to the northern San Francisco Estuary, with limited individuals being categorized to Lower South San Francisco Bay. 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.

Viewing Delta Ecosystem Performance on Functional Flows and Native Fishes

Chris Kwan[1*], Cory Copeland[1], Scott Navarro[1], Martina Koller[1]

[1]Delta Stewardship Council
980 9th St, 15th Suite
Sacramento, CA 95618
*Corresponding author: chris.kwan@deltacouncil.ca.gov, 916-445-5562

The Delta Stewardship Council unveiled the Delta Plan performance measures dashboard in spring 2019. The dashboard is a website that reports performance measure information related to the health of the Delta. In the fall of 2019, the dashboard was updated to include 122 administrative measures tracking management actions led by implementing State and Federal agencies. Delta Plan performance measures integrate scientific findings into decision-making and adaptive management processes, assessing progress toward achieving the coequal goals of a reliable California water supply and a healthy Delta ecosystem. Performance measures for restoring the Delta ecosystem include improving native species populations and using more natural functional flows to support increased floodplain inundation, higher spring peak flows, more gradual recession flows, and greater freshwater outflow from the Delta into the San Francisco Bay. Performance measures also cover other Delta Plan topics: Delta as an Evolving Place, Water Quality, and Protect People and Property. The performance measures serve multiple purposes: define measures of success relative to the coequal goals, assess how well Delta Plan strategies, policies, and recommendations are working, providing a tool for communicating with Delta managers and interested public, and supporting decision-making in the Delta. The dashboard helps convey the purpose of the performance measures, contributing to government accountability and transparency, and facilitating coordination and collaboration across local, state, and federal agencies in the Delta.

Testing of Wakasagi hatching frames for potential applications on Delta Smelt (*Hypomesus transpacificus*)

Brandon Lee*, Will Mulvaney, Evan W. Carson, Tien-Chieh Hung

Brandon Lee
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803 bthlee@ucdavis.edu

Will Mulvaney
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803 wjmulvaney@ucdavis.edu

Evan W. Carson
San Francisco Bay-Delta Fish and Wildlife Office, US Fish & Wildlife Service
916-930-5624 **evan_carson@fws.gov**

Tien-Chieh Hung
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis
209-830-9803 thung@ucdavis.edu

Delta Smelt (*Hypomesus transpacificus*) are an endangered fish endemic to the Sacramento-San Joaquin delta. The Fish Conservation and Culturing Laboratory in Byron, CA, is working on a number of projects studying the Wakasagi frame hatching method in an effort to help increase the wild Delta Smelt population while minimizing the time cultured fish spend in the hatchery and thus limit hatchery adaptation. The objectives of the project are to assess the feasibility in the hatching success and survival of fertilized Delta Smelt eggs on different hatching frames under laboratory conditions as well as testing the performance of the hatching frames in seeding Delta Smelt eggs under different environmental conditions. Preliminary trials testing different fabric types for egg seeding onto the hatching frames has been completed, and a new material has been selected that can be easily found and used without effecting hatching rates. Flow speed and patterns inside the hatching frames have been simulated using a computational fluid dynamic software, COMSOL (version 5.5), to better understand the flow velocity that the eggs would be exposed to and make recommendation to future field applications.

Where Predators and Prey Meet: Anthropogenic Contact Points Between Fishes in a Freshwater Estuary

Brendan M. Lehman*[1], Thomas Reid Nelson[1], Cyril J. Michel[1]

[1]University of California, Santa Cruz
Affiliated with Southwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
110 McAllister Way, Santa Cruz, CA 95060

*brendan.lehman@noaa.gov – 925-788-1919
thomas.nelson@noaa.gov – 831-420-3986
cyril.michel@noaa.gov – 336-817-8846

The Sacramento–San Joaquin Delta has been invaded by several species of non-native predatory fish that are presumed to be impeding native fish population recovery efforts. Since eradication of predators is unlikely, there is substantial interest in removing or altering manmade structures in the Delta that may exacerbate predation on native fish (contact points). It is presumed that these physical structures influence predator-prey dynamics, but how habitat features influence species interactions is poorly understood, and physical structures in the Delta that could be remediated to benefit native fish have not been inventoried completely. To inform future research efforts, we reviewed literature that focused on determining the effects of predator-prey interactions between fish, based on contact points that are commonly found in the Delta. We also performed a geospatial analysis to determine the extent of potential contact points in the Delta. We found that the effects of submerged aquatic vegetation (SAV) and artificial illumination are well studied and documented to influence predation in other freshwater systems worldwide. Conversely, other common structures in the Delta—such as docks, pilings, woody debris, revetment, and water diversions—did not have the same breadth of research. In the Delta, the spatial extent of the different types of contact points differed considerably. For example, 22% of the Delta water surface area is occupied by SAV, whereas docks only cover 0.44%. Lastly, we present results from the first year of an experimental field study focused on studying predation around artificial lights and SAV. Results suggest that nighttime illumination aggregates predatory fish which may increase predation on juvenile salmon.

Share your work with future scientists!

Peggy Lehman[1*], Pedro Morais[2], Frances Wilkerson[3], Ted Flynn[1]

[1]California Department of Water Resources
[2]University of Algarve
[3]San Francisco State University

The IEP is working with the publisher Frontiers In to develop a collection of scientific papers on San Francisco Estuary entitled "Where the River Meets the Ocean: Stories from San Francisco Estuary" for the journal Frontiers In Science for Young Minds. The journal targets young minds 8 to 15 years old. A description of the collection is online at Where The River Meets the Ocean, Stories from San Francisco Estuary. We currently have over 30 proposed papers that cover stories on many research topics in the estuary, with chapters on habitats, water quality, plants and animals and conservation. There is room for your story too! Papers are short at 1500 words and can summarize an area of research or one of your already published papers. The main requirement is that the papers are written in a simple and interesting enough way for young people to understand and enjoy. Abstracts are still being accepted and final draft papers are due October 1, 2020. The final e-book and collection should be complete by early 2021. The poster will provide details on the collection and the publication process for this young person IEP outreach project.

Drivers of Dispersion and Mixing in the Sacramento Deepwater Shipping Channel

[1]Leah Lenoch*, llenoch@usgs.gov, 608-212-7890
[1]Paul Stumpner, pstumpner@usgs.gov
[1]Jon Burau, jburau@usgs.gov
[2]Luke Locken, lclocken@ucdavis.edu
[2]Steve Sadro, ssadro@ucdavis.edu

[1]U.S. Geological Survey, California Water Science Center, 1280 Terminal St., West Sacramento, CA 95691
[2]UC Davis, 1 Shields Ave, Davis, CA 95616

The Sacramento Deepwater Shipping Channel (SDWSC) is a terminal channel in northern Sacramento-San Joaquin Delta that provides large seagoing vessels access to the Port of Sacramento. The SDWSC is strongly tidally forced (tidal discharge of +/- 30,000 cfs) at the south end where it connects to Cache Slough. The SDWSC receives no freshwater inflow at its north end, the location of a set of inoperable gates. Even though it is a completely man-made, engineered channel of consistent depth (~10m) and cross-sectional area (~1200 m^2) that is likely larger and deeper than a naturally occurring low-order tidal slough, the SDWSC exhibits physical and biological characteristics like the dead-end sloughs that were common in the historic Delta prior to agricultural reclamation of the region (Whipple et al., 2012). These characteristics include a flood-dominant tidal current asymmetry that leads to both a turbidity maximum (Morgan-King and Schoellhamer, 2013) and increased abundance of pelagic organisms within the SDWSC (Feyrer et al., 2017).

In the summer of 2019, the U.S. Geological Survey and University of California, Davis, with financial support from the Bureau of Reclamation, conducted a nitrate addition study, aimed at increasing primary production in the upper SDWSC. In this poster, we discuss the drivers of tidal dispersive mixing that controlled the dispersal of nitrate in this experiment and control primary production in the SDWSC in general. A series of continuous water temperature, specific conductance, and other water quality sensors were deployed for 11 weeks at several locations along the channel which, along with vertical velocity profiles along the channel cross-section collected throughout several tidal cycles, were used to investigate the vertical, lateral, and longitudinal mixing in the SDWSC. A subset of these data was also used to monitor and understand the mechanisms responsible for the formation and breakdown of thermal stratification.

An Estuary-Wide Synthesis of the Distribution of Larval and Adult Longfin Smelt

Levi S. Lewis*[1]	lslewis@ucdavis.edu	(530)754-7770
Arthur Barros[1]	aebarros@ucdavis.edu	(530)754-7770
Christina Parker[1]	chrparker@ucdavis.edu	(530)754-7770
Micah Bisson[1]	mbisson@ucdavis.edu	(530)754-7770
Patrick Crain[1]	fishguy122@gmail.com	(530)754-7770
James Hobbs[1]	jahobbs@ucdavis.edu	(530)754-7770

[1]Otolith Geochemistry and Fish Ecology Laboratory, Department of Wildlife, Fish and Conservation Biology, University of California Davis. 1088 Academic Surge, Davis, CA. 95616

Malte Willmes[2]	mwillmes@ucdavis.edu	(530)754-7770

[2] Institute of Marine Sciences, University of California Santa Cruz. 1156 High St, Santa Cruz, CA 95064

The tributaries and marshes of San Pablo Bay and Lower South San Francisco Bay may serve as additional spawning and larval rearing habitats for San Francisco's genetically unique and severely threatened Longfin Smelt. However, long-term surveys have often omitted these "bay tributaries" and associated brackish wetlands, thus their use by Longfin Smelt has remained unknown, until now. The Otolith Geochemistry & Fish Ecology Lab @ UC Davis recently completed additional surveys in wetland habitats of the northern and southern Estuary. Results were combined with on-going long-term surveys to provide a comprehensive assessment of the geographic distribution of Longfin Smelt across life stages, seasons, and years (2015-2019). In all years of the study period, which included both severe drought and extreme rainfall/outflow, Longfin Smelt were regularly observed in northern and southern SFE wetlands, with the highest catches consistently in Alviso Marsh. Furthermore, many fish captured in these wetland habitats exhibited signs of recent or active reproduction. In drought years, larvae were mostly confined to upstream habitats in Suisun Bay and the Delta. In wet years, however, relatively high densities of larval and post-larval Longfin Smelt were observed in wetland and bay habitats of the northern and southern estuary. These results suggest that Longfin Smelt can use brackish wetlands of the Northern and Southern SFE for spawning and rearing; the relative importance of these habitats, however, remains a key question for future research and management.

North Delta Flow Action 2019: Continuous Water Quality Monitoring in the Yolo Bypass

Amanda Maguire*
Department of Water Resources
3500 Industrial Blvd.
West Sacramento, CA 95691
(916) 372-7311
Amanda.Maguire@water.ca.gov

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

Mallory Bedwell
Department of Water Resources
3500 Industrial Blvd.
West Sacramento, CA 95691
(916) 376-9740
Mallory.Bedwell@water.ca.gov

Brittany Davis
Department of Water Resources
3500 Industrial Blvd.
West Sacramento, CA 95691
(916) 376-9756
Brittany.E.Davis@water.ca.gov

Jared Frantzich
Department of Water Resources
3500 Industrial Blvd.
West Sacramento, CA 95691
(916) 376-9823
Jared.Frantzich@water.ca.gov

In a collaborative effort during the summer and fall of 2019, the DWR North Central Region Office and Aquatic Ecology Section installed and maintained six continuous water quality stations to monitor changes in conditions in response to the North Delta Flow Action (NDFA) and Food Web Study, a California Natural Resource Agency Delta Smelt Resiliency Strategy. Stations were located at fixed points along a north to south transect, starting at the Colusa Basin Drain

and continuing southward along the Yolo Bypass Toe Drain. We measured water quality variability using YSI EXO2 multiparameter sondes equipped with a full-suite of parameters: temperature, specific conductivity, dissolved oxygen, pH, turbidity, chlorophyll, and fDOM. This collection of continuous data creates a high resolution and multi-faceted picture of the variability in ambient water quality conditions throughout the managed flow action; from baseline conditions, to increased flows into the Colusa Basin and Toe Drain of Yolo Bypass, and the resulting chlorophyll florescence response (a signal for productivity). Preliminary results from relationships of dissolved oxygen, pH, and chlorophyll identify periods of higher primary productivity in the upper Yolo Bypass Toe Drain before the managed action. In addition, specific conductivity and chlorophyll measurements provided evidence of the movement and transport of this phytoplankton biomass into the lower Yolo Bypass Toe Drain. This continuous water quality data will help to assess the habitat impacts of the 2019 NDFA and inform future adaptive management strategies for optimal spatial and temporal food web transport into the Cache Slough Complex and lower Sacramento River for Delta Smelt and other pelagic fishes.

Diving into Summer Townet: Depth Logger and Flowmeter Variability in Townet Sampling

Timothy D. Malinich*

California Department of Fish and Wildlife, 2109 Arch Airport Rd, Suite 100, Stockton, CA 95206

The California Department of Fish and Wildlife Summer Townet Survey (STN), part of the Interagency Ecological Program (IEP) has been monitoring the pelagic zooplankton and fish community throughout the Bay-Delta region for 60 years. The STN conducts 2-3 oblique tows, moving from a variable depth toward the surface at 30-40 stations, bi-weekly over 2-6 surveys conducted June-August. Townet crews have attempted to maintain consistent towing practices to sample depths evenly, as well as sampling similar volumes of water. This consistency helps maintain the integrity of the STN dataset by allowing STN samples to remain comparable across its 60-year history. Historically, the volume of water sampled by STN, briefly tested in 1971, was considered consistent and did not require regular measurement by flowmeter. In 2003, flowmeters were regularly added to the STN to report water volume sampled at each tow. Contrary to water volume, examination of STN's oblique towing has occurred more recently. Depth of the STN is controlled by letting out a specific amount of cable, from a known height and angle, and retrieving it at scheduled intervals to tow at different depths. Depth loggers, used as early as 2011, found that the cable-out estimates for depth were an accurate method of sampling specific depths (within 1.1 ft, S. Slater personal communication). Depth loggers were used intermittently since 2011, but were regularly attached to the STN starting around 2017. This allowed an expanded analysis of the sampling behavior of the STN, looking at the flowmeter and depth logger data. Specifically, the goal was to assess variation in depth and volume sampled, testing for significant differences and primary drivers of variation, such as boats, wave strength etc. Identifying the greatest contributors to variation will help inform best practices for STN sampling in the future.

Spatial Distribution and Migration Timing of Central Valley Steelhead Hatchery Stocks.

Leslie Alber (California Department of Fish and Wildlife), 916-375-5489, Leslie.Alber@wildlife.ca.gov, 980 Riverside Parkway Suite 110 West Sacramento CA 95605.

Daniel Martinez* (Pacific States Marine Fisheries Commission), 916-375-6086, Daniel.Martinez@wildlife.ca.gov, 980 Riverside Parkway Suite 110 West Sacramento CA 95605.

Written in 2010, The Central Valley Steelhead Monitoring Program (CVSMP) is intended to provide data necessary to assess the restoration and recovery of Central Valley (CV) steelhead by determining the distribution, abundance, and population trends of these fish (Eilers et al. 2010). One of the main objectives of the plan is to identify the spatial distribution of steelhead in the CV to assess their current range and observe changes in their range. The Mainstem Sacramento River Mark-Recapture Project uses large wire fyke traps to capture and mark adult steelhead migrating into the main stem Sacramento River near Clarksburg/Freeport and near Knights Landing. Adult steelhead are sampled for origin, sex, fork length, scales, genetics, and assessed for marks and tags. If tags are not present steelhead are implanted with PIT tags that are detected in CV tributary and hatchery ladder PIT tag arrays that act as a secondary mark and recapture project. Detection data from these arrays provides tributary distribution and timing data for adult CV steelhead tagged at the mainstem fyke traps. Additional detections can be made with hand-held PIT tag readers by scanning fish captured during other studies and hatchery operations. Parentage assignments from genetic samples show that most steelhead captured in the fyke traps originated from Coleman Nation Fish Hatchery stock. A significant presence of American River Hatchery stock and a small number of Feather River Hatchery and Mokelumne River Hatchery stock were also captured. Migration timing between hatchery stocks was variable with peak migration of American River Hatchery stock occurring between January and March and peak migration of Coleman Hatchery stock occurring between August and October.

Does Size Matter? An investigation of suspended sediment particle size distribution in the San Francisco Estuary

Morgan Martinez* and Sarah Perry
DWR
IEP EMP Program Element Number: 072
3500 Industrial Blvd, West Sacramento, CA 95691

Morgan Martinez
916-376-9765
Morgan.Martinez@water.ca.gov
Sarah Perry
916-376-9649
Sarah.Perry@water.ca.gov

Various monitoring programs and research studies in the San Francisco Estuary (SFE) have examined the discrete water quality measurement of turbidity and its effects on the aquatic ecosystem. Examining turbidity provides information about the abundance of suspended solids in a water body, but there is little understanding of the composition of those particles and how they behave over time. Particle size distribution (PSD) is defined as the amount (by mass) of particles within a given size class. These particles are typically made up of sediment, inorganic/organic matter, and plankton. While particle size analysis does not determine the composition of suspended particles in the water, it does reveal their size class distributions, which is important to aquatic food webs for several reasons. First, PSD can influence settling rates of suspended sediment and, ultimately, light attenuation in the water column. PSD can also affect the bio-availability and toxicity of contaminants (e.g. metals, hydrophobic compounds, pesticides); as particle size decreases, surface area ratio increases, therefore smaller particles bind better to contaminants than larger particles. Furthermore, PSD can impact feeding habits of fish (e.g. Delta Smelt) and zooplankton. Many beneficial zooplankton in the SFE are suspension feeders. High counts of inedible particles in their optimum feeding size range will likely decrease feeding efficiency and adversely impact zooplankton populations, and, ultimately, fish populations as well. The purpose of this study is to better understand suspended sediments in the SFE and their relation to other measures of water quality by investigating the PSDs at 12 established monitoring stations in the SFE. The data collected showcases how the particles behave spatially and temporally, which will provide a foundation for future turbidity and suspended sediment research in the SFE.

Plants Favored in Waterfowl Management Promote Zooplankton Production in Suisun Marsh

Rachel M. McConnel*, UC Davis, 675 #40 Alvarado Ave, Davis, CA 95616, (310) 924-4265, rmmcconnell@ucdavis.edu

Kyle A Phillips, UC Davis, 1311 Drake Drive, Davis, CA 95616, (760) 707-6701, kapphillips@ucdavis.edu

John R Durand, UC Davis, 425 La Rue Road Davis CA 95616, (530) 601-3001, jrdurand@ucdavis.edu

Production is an essential ecological function that must be considered when restoring habitat. Collapse of pelagic fish species in the San Francisco Estuary has been attributed to declining plankton production. In response, California EcoRestore calls for 8,000 acres of tidal restoration in the Suisun Marsh region of the estuary. Effects of tidal restoration on aquatic food web processes remain poorly understood and are further complicated by the establishment of non-native species. Mounting evidence suggests that managed wetlands (or 'ponds') in the Suisun Marsh produce high concentrations of plankton food resources, providing a unique opportunity to study drivers of productivity.

Vegetation management in ponds may play a key role in plankton production. Ponds consist of diked habitats that are seasonally flooded from early fall to spring for waterfowl management. Pond vegetation is typically dominated by leafy-green terrestrial halophytes (e.g. sea-purslane) that propagate in summer and decompose when flooded in the fall. Tidal marsh vegetation is dominated by stands of emergent plants (e.g. tule) which are known to resorb nutrients prior to shedding their leaves in fall. We hypothesize that decomposing terrestrial plants will promote higher zooplankton production rates than decomposing emergent plants.

We will present results from a recent experiment, testing the effect of vegetation type on zooplankton production rates. In November 2019, We filled replicate buckets with environmental water from Montezuma slough and assigned one of three substrate treatments: 3g dried sea purslane, 3g dried tule, or a control. Water was incubated for 14 days in a temperature regulated greenhouse and was then subsampled to grow Juvenile *Daphnia magna* for 96 hours at 100%, 50%, and 25% dilutions.

Somatic growth and egg production will be measured to assess productivity. This experiment aims to illuminate processes that drive wetland productivity to ultimately inform management and restoration practices.

Boat electrofishing in the California Delta: species detection efficiency and role in long-term monitoring of the Delta fish community

Ryan McKenzie*, Brian Mahardja

USFWS- Lodi FWO,
850 S. Guild Ave
Suite 105
Lodi, CA 95240

The California Delta is an incredibly diverse ecosystem with a mosaic of aquatic habitats inhabited by a number of economically, culturally, and ecologically important fish species. To monitor the temporal and spatial trends of this rich fish community, long-term fish monitoring programs within the Delta use a number of different gear types to capture fish species across life stages and habitats. However, concerns have been raised that current sampling gears may fail to detect certain species, or life stages, that inhabit areas that are not accessible by current gear types (e.g. rip-rap banks, shallow vegetated areas). Boat electrofishing is one sampling method that has been proposed to supplement the Delta's current long-term fish monitoring. In this study, we used fish catch data from boat electrofishing surveys and long-term fish monitoring programs within the Delta to compare the detection efficiency of gear types across the suite of Delta fish species. Based on our preliminary findings, we found that detection efficiency differed across gear types and that long-term monitoring programs within the Delta may benefit from boat electrofishing due to its higher detection efficiency for certain species.

Effects of salinity, flow, and substrate on fertilization, hatching success, and larval survival of a cultured endangered fish species

Will Mulvaney*, Evan W. Carson, Leanna Zweig, Tien-Chieh Hung

Will Mulvaney
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis, 5280 Bruns Rd, Byron, CA 94514
wjmulvaney@ucdavis.edu Cell: (530) 204-8909

Evan W. Carson
San Francisco Bay-Delta Fish and Wildlife Office, US Fish & Wildlife Service, Bay-Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814
evan_carson@fws.gov Office: (916) 930-5624

Leanna Zweig
San Francisco Bay-Delta Fish and Wildlife Office, US Fish & Wildlife Service, Bay-Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814
leanna_zweig@fws.gov Office: (916) 930-5631

Tien-Chieh Hung
Fish Conservation and Culture Lab, Biological and Agricultural Engineering Dept., UC Davis, 5280 Bruns Rd, Byron, CA 94514
thung@ucdavis.edu Office: (209) 830-9803

Reducing extinction risk for listed species is often hampered by insufficient understanding of their basic biology. This problem is exemplified by delta smelt (*Hypomesus transpacificus*), an imperiled endemic fish of the Sacramento-San Joaquin River Delta estuary. The species carries a high risk of extinction in the wild due to extensive ecological alteration and degradation, and this risk is exacerbated by knowledge-gaps that hinder management. One of these is longstanding uncertainty about spawning microhabitat and associated conditions that support development and survival of eggs and larvae. We conducted two experiments at the UC Davis Fish Conservation and Culture Laboratory to test the effects of salinity, flow rate, and substrate type on fertilization, hatching success, and larval survival of delta smelt. Experiments were conducted in temperature-controlled (12˚C) flow-through egg incubators. Experiment 1 tested response across a range of salinities (0, 3, 6, 9, and 12 ppt) thought to be typical of those encountered in the wild. Experiment 2 tested effects of different rates of flow (2.92 cm/s and 5.89 cm/s) over hypothesized 'preferred' delta smelt spawning substrates (sand and pebble). Our study narrows critical knowledge-gaps and sets a foundation for experiments to evaluate performance of cultured eggs and early life-stage delta smelt in the wild.

Building a Comprehensive and Accessible DNA Barcode Database for Fish and Invertebrates in the San Francisco Estuary

Ravi Nagarajan*, Ann Holmes, Julia Mouat, Alisha Goodbla, Mallory Bedwell, Melinda Baerwald, Brian Schreier, Andrew Rypel, Larry Brown, & Andrea Schreier

Environmental DNA (eDNA) methods complement traditional monitoring and can be configured to detect multiple species simultaneously. One such approach, eDNA metabarcoding, uses high-throughput DNA sequencing to indirectly detect many different organisms, spanning broad taxonomic boundaries, from water samples. We are optimizing a non-invasive, low cost eDNA metabarcoding protocol to be used in conjunction with existing IEP monitoring programs. One resource that is currently lacking for metabarcoding studies in general, including those in the San Francisco Estuary (SFE), is a comprehensive database of DNA barcode reference sequences. Without this foundational data, many species go undetected or misidentified in metabarcoding studies. To meet this need, we are building a custom barcode sequence database for the SFE by DNA sequencing estuarine and freshwater species of interest to monitoring programs and ecological studies. We are currently targeting 40 fish and 33 invertebrates, including rare and potentially invasive species, at multiple barcoding loci including Cytochrome C Oxidase I (*COI*), Cytochrome B (*Cytb*), and the *12S* and *16S* rRNA genes. In our presentation we will list these organisms, summarize currently available public barcode data, and provide an update on our sequencing efforts. We will also evaluate these four barcoding loci and PCR primers *in silico,* including analyses of probability of successful PCR amplification and ability to discriminate between closely related species. When completed, our custom reference sequence database for the SFE will be made publicly available to all researchers following the principles of Open Science, and will be used in later stages of this project to benchmark eDNA metabarcoding against several existing IEP monitoring programs.

Author information

Ravi Nagarajan
Assistant Project Scientist
University of California, Davis
One Shields Ave
Davis, CA 95616
rpnagarajan@ucdavis.edu
(530) 752-6351

Ann Holmes
Graduate Student
University of California, Davis
One Shields Ave
Davis, CA 95616
aholmes@ucdavis.edu
(530) 752-6351

Julia Mouat
Graduate Student
Integrative Genetics and Genomics Graduate Group
University of California, Davis
One Shields Ave
Davis, CA 95616
jmouat@ucdavis.edu
(530) 752-6351

Alisha Goodbla
Lab Manager
University of California, Davis
One Shields Ave
Davis, CA 95616
amgoodbla@ucdavis.edu
(530) 752-6351

Mallory Bedwell
Environmental Scientist
California Department of Water Resources
3500 Industrial Blvd
West Sacramento, CA 95691
California Department of Water Resources
mallory.bedwell@water.ca.gov
(916) 376-9740

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

Brian Schreier
Senior Environmental Scientist
California Department of Water Resources
3500 Industrial Blvd
West Sacramento, CA 95691
Brian.Schreier@water.ca.gov
(916) 376-9759
Andrew Rypel
Associate Professor

University of California, Davis
One Shields Ave
Davis, CA 95616
rypel@ucdavis.edu
(530) 752-9567

Larry Brown
Research Biologist
US Geological Survey, California Water Science Center
Placer Hall
6000 J St.
Sacramento, CA 95819
lrbrown@usgs.gov
(916) 278-3098

Andrea Schreier
Adjunct Assistant Professor
University of California, Davis
One Shields Ave
Davis, CA 95616
amdrauch@ucdavis.edu
(530) 752-6351

Sensor calibration protocols to improve collection of long-term field data using YSI EXO2 FDOM sensors

Kyle Nakatsuka*[1], Angela Hansen[1], Tamara Kraus[1], Brian Bergamaschi[1]

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

Dissolved Organic Matter (DOM) includes a broad range of organic molecules of various sizes and composition that are released by all living and dead plants and animals. Measuring the fraction of light absorbed at specific UV wavelengths and subsequently released at longer wavelengths (that is, fluorescence) is diagnostic of DOM type and amount. Studies have often used the excitation and emission at 370 and 460 nanometers (nm), respectively, to quantify the fluorescent fraction of DOM (hereafter referred to as fDOM). Optical sensors measuring fDOM have gained popularity in recent years for use as a proxy for measuring the concentration of dissolved organic carbon (DOC) and for other dissolved constituents that are commonly associated with DOC such as mercury species. We sought to develop sensor calibration protocols to improve our collection of long-term field data using YSI EXO2 FDOM sensors.

Typically, raw fDOM sensor output is calibrated to quinine sulfate dihydrate (QS), a colorless solution that has a peak fluorescence at excitation 350 nm and emission 450 nm, within the spectral window where fDOM sensors are measuring fluorescence. We calibrated the fDOM sensors using two solutions: a degassed zero solution (organic-free laboratory reagent grade water) and 300 ppb quinine sulfate solution. Prior to sensor calibration, quinine sulfate solution concentration was verified using a benchtop spectrofluorometer (Aqualog; Horiba Scientific, Inc, New Jersey, USA). After calibration following the manufacturer recommended protocol for two-point calibration, probes were deployed in the San Francisco Estuary and checked approximately monthly to verify calibration and perform general maintenance. Accuracy and precision of deployed probes were compared against a “reference probe” (i.e. one that had been calibrated to 300 ppb QS, but never deployed). Measured differences between the reference and deployed sensors averaged from 1-5 QSE units for sensors calibrated to 300 ppb QS prior to deployment as opposed to 5-33 QSE units for sensors that had remained factory calibrated. Our conclusion is that the factory calibration is insufficient, and that pre-deployment sensor calibration and field validation are critical steps in evaluating instrument performance, identifying necessary corrections to be applied to field data, and ensuring that data are comparable across sites and sensors.

Abstract for the IEP Workshop 2020
IP-114683
CONFERENCE: 2020 IEP Workshop
LOCATION: Folsom, CA
DATES: March 18-20, 2020

Sacramento San Joaquin Bay-Delta Water Quality Constituent Tracker and Decision Support

Jon Burau, USGS, Sarah Lesmeister, DWR, Nathan Hemenway 34 North, Dave Osti , 34 North, Darcy Austin, State Water Contractors, Amye Osti*, 34 North
Contact:
Amye Osti, 34 North
amye@34north.com (310) 305-8289

The constituent tracker provides a web-based tool for generating constituent fields as a data visualization from time series data at 50 fixed sites throughout the Delta. The basic concept behind the constituent tracker will work for any constituent including: temperature, conductivity, turbidity, Chl-a, DO. At some limited number of sites, FDOM and a suite of nutrients are also measured (nutrients are mostly measured in the north Delta up to the confluence).

Using the advection algorithm developed by USGS, the Constituent Tracker linearly interpolates constituent values to a constant point in tide using the velocity at each site to estimate the constituent fields between stations. The constituent tracker will allow us to: identify and track in space the source of any measured constituent; to track turbidity throughout the system including the evolution of the turbidity bridge between confluence and the facilities, the turbidity field near the regulatory stations (Prisoner's Point, Holland Cut and Victoria Canal) and near the facilities themselves. The tools proposes to replace DWR's weekly turbidity transects that likely provide spurious tidally aliased data; help to identify localized events: such as wind-wave generated turbidity in Franks Tract and its influence on the turbidity triggers and exports; leverage existing nutrient and water velocity time series to estimate their spatial distributions (where data are available) and assess biological rates important in phytoplankton blooms and monitor the spatial distribution of the salt field which is especially important during droughts when DCIU can govern south delta distributions and when barriers are installed.

Vegetation mapping and monitoring at wetland restoration sites in the Delta and Suisun Marsh

Aicha Ougzin*

California Department of Fish and Wildlife
2109 Arch Airport Way, Suite 100
Stockton CA 95206
(209) 234-3434
Aicha.Ougzin@Wildlife.ca.gov

The Fish Restoration Program (FRP) is a cooperative effort by the Department of Fish and Wildlife (CDFW) and the Department of Water Resources (DWR) to address specific habitat restoration requirements of the CDFW Longfin Smelt Incidental Take Permit (ITP) and the US Fish and Wildlife Service (USFWS) Biological Opinion and National Marine Fisheries Service (NMFS) Biological Opinion for the State Water Project (SWP) and Central Valley Project (CVP) operations. An objective of FRPA is to restore 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh to benefit Longfin Smelt and to enhance food production and availability for native Delta fishes. CDFW's Fish Restoration Program is tracking habitat development over time and establish measurable restoration outcomes through spatial extent and species composition of vegetation at restoration sites. Using methodology developed by CDFW's Vegetation Classification and Mapping Program, FRP will use aerial imagery and GIS to map vegetation composition and cover. Vegetation at each restoration site will be mapped pre-construction, immediately after construction (as-built) and every 3 years post construction, for a minimum of 10yrs. To date, pre-construction true color 1-foot resolution aerial photography was collected and ground verification surveys were completed for all restoration sites. Pre-construction vegetation maps have been completed for all sites and as-built vegetation maps have been completed for 4 restoration projects finished in 2018 and 2019.

Seeing redds: Evaluating and Communicating Salmonid Habitat Restoration Success with Aerial Photo Spawning Surveys

Katherine Perkins*, Sacramento Water Forum, 1330 21st St., Sacramento, CA, 916-808-1988, kperkins@waterforum.org
Lilly Allen, Sacramento Water Forum
John Hannon, Bureau of Reclamation Bay-Delta Office, jhannon@usbr.gov
Ian Smith, Bureau of Reclamation Bay-Delta Office, ismith@usbr.gov

Our research uses aerial photography to demonstrate the success of a fall 2019 restoration project at Sailor Bar by quantifying the number of redds constructed at the restoration site by returning salmon. Restoration is needed because Folsom and Nimbus dams block Chinook salmon from accessing their historic spawning grounds in the Sierra Nevada foothills while also blocking sediment (e.g. gravel used by salmon to build redds) from moving past the dams. As a result, spawning habitat is limited in the remaining accessible waters of the urbanized lower American River. Restoration projects led by the Sacramento Water Forum and the Bureau of Reclamation have sought to increase the quantity and quality of spawning habitat through augmentation of suitably-sized gravels at the appropriate water depths and velocities during flows typical of the spawning season. The Water Forum and Reclamation have teamed up to monitor the effectiveness of these projects using aerial photography from 2008 to 2019. Our research also examined how site-specific restoration may have positive effects throughout the river, by reducing density dependent impacts (redd superimposition) at other spawning locations. Additionally, our work demonstrated how aerial photo spawning surveys can be used to educate the public about restoration project value for native fish that depend on the urban lower American River to complete their life cycle.

Synthesized Dataset of Length-Weight Regression Coefficients for Delta Fish

Sarah Perry* and Pascale Goertler

DWR
IEP Program Element Number: 318
3500 Industrial Blvd, West Sacramento, CA 95691
Sarah Perry
916-376-9649
Sarah.Perry@water.ca.gov
Pascale Goertler
916-445-5243
Pascale.Goertler@deltacouncil.ca.gov

Multiple studies conducted within the Delta use biomass as a metric to describe fish communities. To calculate biomass, weight data for each fish specimen is required. However, it can be difficult to ascertain accurate fish weights in the field. Therefore, it is common to instead measure fish length in-situ and use the mathematical relationship between length and weight to calculate the variable. Weight is estimated from length using the exponential function $\mathrm{W} = a\,\mathrm{L}^{b}$, which requires two species-specific parameters. These can be calculated using the linear regression of the log-transformed equation ($\log(\mathrm{W}) = \log(a) + b\log(\mathrm{L})$), with a corresponding to the intercept and b to the slope. For Delta fish populations, these species-specific parameters are not easily accessible. Here, we have created a synthesized dataset consisting of the length-weight equation coefficients for all fish species commonly found in the freshwater tidal habitats of the Delta, with associated publication(s) and relevant metadata information included. This dataset will soon be made available via a public database hosted by the Environmental Data Initiative (EDI), which will allow scientists to quickly and easily access the relevant length-weight regressions for their studies.

Long-Term Continuous Monitoring in the Sacramento-San Joaquin River Delta

Catherine Ruhl*

US Geological Survey
1280 Terminal Street
West Sacramento, CA 95691
(916) 617-2799 x 7720
cruhl@usgs.gov

The US Geological Survey has been collecting continuous data in the Sacramento-San Joaquin River Delta (Delta) for decades. The network has expanded from several experimental stations in the 1970's and 1980's to a robust and integrated monitoring network. Today over 40 stations are collecting a range of water-level, discharge, and water-quality data that support critical real-time water management decisions as well as in-depth analyses. Our group collaborates with stakeholders to increase the power of the data being collected across the monitoring network. The data are transformed into information in a variety of ways, including: constituent mapping; salmon out-migration survival studies; interdisciplinary tidal-marsh function studies; hydrodynamic model calibration and validation.

Long-term data sets in conjunction with modelling efforts and process-based studies provide insight into the impacts that various habitat restoration and water management actions have had on the circulation and mixing in the Delta. More changes are proposed in the future that will directly impact the basic hydrodynamic processes at work in the Delta. These long-term monitoring data provide a framework for assessing the impacts of proposed actions. Moreover, as they are integrated with additional data streams such as biological monitoring, scientists can gain insight into the impacts that physical and chemical processes have on the distribution of native and non-native species in the Delta.

This program has been strongly supported by the Interagency Ecological Program (IEP), California Department of Water Resources (CADWR), United States Bureau of Reclamation (BOR), State Water Resources Control Board, Sacramento County, the City of Stockton, and Contra Costa Water District over a period of decades. Without the ongoing support of our collaborators and cooperators this monitoring network would not be possible, and their support is gratefully acknowledged.

Water Quality Comparison within Decker Island, a newly restored Tidal Marsh, and the Surrounding Channels

Mandy Salminen*

California Department of Fish and Wildlife
2109 Arch Airport Road, Suite 100
Stockton, California 95206
209-234-3445
Mandy.Salminen@wildlife.ca.gov

Decker Island is a 140-acre tidal marsh, restored in September 2018. This restoration's main objective is to provide long term benefits for juvenile Chinook Salmon, Delta Smelt, and Longfin Smelt populations. The Fish Restoration Program (FRP) is assigned to evaluate the effectiveness of restoration sites by monitoring the water quality, fish use, and food production over time.

I compared conductivity, temperature, and turbidity data collected in 15 minutes intervals for 6 months from two YSI Exo2 sondes located within the restoration site, called Breach and interior pool, to the three closest DWR California Data Exchange Center (CDEC) stations: Sacramento River channel outside of Decker (SDI), off Emmaton (EMM), and at the entrance of Three Mile Slough (TMS). When available, the stations' data were compared from May and June through November of 2019.

Decker Island sondes recorded similar trends for temperature as the long-term monitoring stations. However, the temperature reached higher maximums within the island than in the Sacramento River. The Decker Island sondes recorded similar trends in conductivity compared to the long-term monitoring stations but the Decker conductivity was less variable. Furthermore, the SDI monitoring station recorded lower turbidity measurements overall and less fluctuation than found within the island. I investigated the range of the conditions found within Decker and compared these ranges to the preferences and tolerances by the three species. By comparing the water characteristics of the surrounding area to the water within Decker, I can assess potential benefits that the newly restored tidal marsh has for Delta Smelt and Longfin Smelt in the local area.

Estimating Chinook Salmon Fecundity Using Image Analysis

Shelly Schubert*

California Department of Fish and Wildlife PO Box 10
La Grange, CA 95329 (209) 853-2533 ext 9#
Shelly.Schubert@wildlife.ca.gov

Fecundity estimates of Chinook salmon (*Oncorhynchus tshawytscha*) in the lower San Joaquin river basin are used in escapement survey analyses to provide estimates of the river production on each tributary. Current fecundity estimates are based on a 1988 gravimetric study of 48 salmon.

This study was conducted to develop a protocol for counting salmon eggs to provide more research on the fecundity of *O. tshawytscha.* The protocol needed to provide an accurate, efficient, and safe process for handling live eggs during the spawning process at the Merced River Fish Facility. For this project, I started by using eggs from unripe females that died in the hatchery trap. The eggs needed to be manually removed from the ovarian skeins and laid flat on a tray. The eggs were then photographed with an identifying label and a five mm grid on the tray. I was able to analyze egg photos from five Chinook females that died in the trap before spawning and the egg photos from two Stanislaus River rainbow trout (*Oncorhynchus mykiss*) that were found during an escapement survey. The process took approximately one hour per fish to count the eggs from the placement on the tray to a finished imaged egg count after partially automating the egg counts using free ImageJ (FIJI) software.

Our goal is to apply this process at the hatchery on live eggs from every female spawned and to become more proficient with ImageJ in order to fully automate the counting process. This project has the potential to provide an alternative and inexpensive procedure for providing a much broader knowledge base of the fecundity of the salmon in the San Joaquin basin using fish that are being spawned at a hatchery.

Conceptual Model of Predation and Survival (CMPAS)

Shaara Ainsley,
FISHBIO, 519 Seabright Ave. Suite 208, Santa Cruz, CA 95062; (626)236-0594;
shaaraainsley@fishbio.com

Andrew Schultz*, Ph.D.
Science Division - U.S. Bureau of Reclamation Bay-Delta Office, 801 I Street, Suite 140, Sacramento, CA 95814

Alison Collins
The Metropolitan Water District of Southern California, 1121 L St., # 900, Sacramento, CA 95814

Brett Harvey
DWR, 3500 Industrial Blvd, West Sacramento, CA 95691

Cyril Michel
University of California Santa Cruz/NOAA-NMFS, 110 McAllister Way, Santa Cruz, CA 95060

Tyler Pilger
FISHBIO, 180 East 4th St. Suite 160, Chico, CA 95928

J.D. Wikert
U.S. Fish & Wildlife Service/Anadromous Fish Restoration Program, 850 S. Guild Avenue, Suite 105, Lodi, CA 95240

Predation on native fishes in the Sacramento-San Joaquin Delta, connecting estuary and tributaries is a continuing concern, and there has been extensive debate within the scientific community about the importance of predation as a driver of declining native fish populations. Recent studies have indicated that predation may be a substantial proximate cause of juvenile Chinook salmon mortality in the Delta, but interactions among drivers is not well understood, and further studies are needed. To improve our understanding of predation impacts on listed species, a sub-group of the Predation Project Work Team is developing a conceptual model of predation based on generalized predator-prey theory. The initial model, presented in this poster, is neither species-specific or spatially-specific, and will serve as a base model for more specific future models focused on prey or predator species of interest. This conceptual model is intended to be broad enough to include all predator types, such as fishes, birds, and mammals. The model is presented as a tiered approach following similar prior IEP conceptual models. The tiers move from landscape level attributes at the base (Tier 1), through regional environmental drivers (Tier 2), local environmental drivers (Tier 3), individual attributes (Tier 4), and up to the prey response variable, predation risk (Tier 5). The goal of this effort is a model that allows construction of competing or multiple hypotheses that can be tested to guide research within an adaptive management framework.

Modeling Habitat Suitability for Fishes and Macroinvertebrates in San Francisco Estuary Marshes

Alexander R Scott* [1]
scottalec@gmail.com
(530) 754-7770

Levi S Lewis [1]
lewis.sci@gmail.com

Malte Willmes [2]
mwillmes@ucsc.edu

Christina Parker [1]
chrparker@ucdavis.edu

Micah Bisson [1]
mgbisson@ucdavis.edu

Arthur E Barros [1]
aebarros@ucdavis.edu

Christian Denney [1]
ctdenney@ucdavis.edu

James A Hobbs [1]
jahobbs@ucdavis.edu

[1] Otolith Geochemistry & Fish Ecology Laboratory, University of California Davis
1 Shields Ave, Davis, CA 95616
[2] Institute of Marine Sciences/NOAA Fisheries Collaborative Program, UC Santa Cruz,
1156 HIGH STREET, SANTA CRUZ, CA 95064

The San Francisco Estuary (SFE) historically provided vast tidal salt marsh habitat, but more than 90% of these wetlands have been developed for agricultural, industrial, and urban use. Remaining marshes face multiple anthropogenic perturbations, including modification of freshwater outflow, invasive species, pollution, and climate change. Understanding relationships between water quality and habitat use by fishes and invertebrates is central to effective management of aquatic ecosystems. In order to explore these relationships, bottom trawls were conducted from 2016-2019 in creeks and sloughs adjacent to restored marshes at the southern and northern ends of the SFE, with water quality measurements taken simultaneously. Generalized additive models (GAMs) were used to analyze the relationships between water quality parameters and catch per unit effort (CPUE) of selected native and invasive fishes and invertebrates. The responses of different species to water temperature, salinity, and

dissolved oxygen varied considerably in both direction and magnitude. Thus, water quality preferences for specific taxa should be considered when assessing or predicting habitat suitability for specific fish or invertebrate assemblages in natural and restored wetlands.

What is *Pseudodiaptomus forbesi* eating when foraging within different habitats?

Anne Slaughter*[1], Toni Ignoffo[2], Wim Kimmerer[3]

Estuary & Ocean Science Center
San Francisco State Romberg Tiburon Campus
3150 Paradise Drive, Tiburon, CA 94920

[1] (415) 338-3548
aslaught@sfsu.edu

[2] (415) 338-3510
tignoffo@sfsu.edu

[3] (415) 338-3515
kimmerer@sfsu.edu

Copepods are a critical foodweb link in the upper San Francisco Estuary (SFE), where food limitation constrains foodweb support for native pelagic fishes. Copepods are highly selective feeders that can consume a wide variety of prey, and the prey differs among habitats in composition, biomass, and probably nutritional value. We aim to clarify copepod diets to better understand how *P. forbesi* is using this food, and how different foods contribute to copepod growth rate. During July-September 2019, we collected environmental samples and conducted feeding experiments at 4 sites that differ in key characteristics, e.g., channel size, riverine vs. off-channel, slough vs. open water, and a range of turbidity: Yolo Bypass Toe Drain (YBP), Wildlands restored wetland (WLD) in the Cache Slough Complex, Low-Salinity Zone (LSZ, salinity 0.1 to 0.5), and lower San Joaquin River (SJR). Consumption of phytoplankton by copepods, determined from changes in chlorophyll concentration in feeding experiments, differed widely among sites and times. Clearance rates varied positively with chlorophyll concentration, and the lowest clearance rates were essentially zero. This is in contrast to results of laboratory experiments in which clearance rate generally decreases as food concentration increases. Our results (i.e., increases in chlorophyll concentration over the course of some experiments) instead suggest trophic cascades, by which copepods feed not only on phytoplankton but also on other heterotrophic and mixotrophic consumers of phytoplankton, thereby releasing predation pressure on phytoplankton. This relationship should become clearer with the analyses of micro- and nanoplankton samples collected during these experiments. These results will be placed into the larger context of forthcoming sample analyses (e.g., FlowCam, flow cytometer, copepod gut contents using DNA analysis, nanoflagellates, microzooplankton, bacteria, and copepod growth, egg production, and mortality rates). A second round of experiments and field sampling will occur in summer 2020.

Using survey-grade Global Navigation Satellite Systems (GNSS) to establish stage data referenced to a national vertical datum

Norman W. Soeder*

Hydrologic Technician, United States Geological Survey
Estuarine Hydrodynamics Project Office, West Sacramento
1280 Terminal Street
West Sacramento, CA 95619
916-903-2147
nsoeder@usgs.gov

The USGS Estuarine Hydrodynamics Team is currently testing survey-grade Global Navigation Satellite Systems (GNSS) equipment for the purposes of referencing recorded stage data to a consistent elevation datum across a fixed station monitoring network. This equipment will allow us to relate water elevations measured at gaging stations to the North American Vertical Datum of 1988, the USGS-mandated reference datum. Providing all water-elevation data across the Delta (and throughout the larger, national network) relative to a consistent vertical datum is a high priority for the USGS and our collaborators and cooperators. Moreover, the equipment will allow us to monitor any long-term elevation changes at our gages.

Over forty streamflow monitoring stations will be equipped with survey-grade GNSS receivers and antennae utilizing the Global Positioning System constellation and L1/L2 signals. Elevation data will be collected for twelve hours, once a week, every week. The data will be delivered wirelessly to an File Transfer Protocol server that will serve as a temporary repository before it is processed using the NGS (National Geodetic Survey) Online Position User Service for corrections (for example, ionospheric and tropospheric conditions, clock corrections, changes in satellite flight path, and datum application). The data will be returned from the NGS via email with a unique elevation (maximum uncertainty allowance of 0.16 foot) for each site that will be applied to the stage data.

Improving Bay-Delta, CA data accessibility and usability through an integrated data repository and visualization portal

Jeniffer Soto Perez[1*], Jeffrey A Hansen[2], Brian Bergamaschi[3], and many many others.

U.S. Geological Survey, California Water Science Center, Sacramento, California, 95819
[1] P/ 916-278-3061, E/ jsotoperez@usgs.gov
[2] P/ 916-278-3076, E/ jahansen@usgs.gov
[3] P/ 916-278-3053, E/ bbergama@usgs.gov

Timely access to water quality and habitat condition data – especially recent and real-time data – is vital to support responsive management and to facilitate a greater understanding of dynamics in aquatic habitats of the Sacramento-San Joaquin Delta. Web-based access to real-time and historical data can provide the ability to respond more quickly and in innovative ways to changing conditions in the Bay-Delta ecosystem as well as provide the foundation for interpretation of changing conditions over time. We are attempting to integrate USGS data with other publicly available data into a single repository where they can be analyzed and visualized together using an on-line visualization portal; this will enhance the value and utility of all these data. Scientists, managers, and the public will be able to explore hypotheses and test ideas directly in the portal and download the relevant data with the click of a button. Interactive maps and animated time-series visualizations bring data to life and illustrate how the system interconnects in many complex and exciting ways. Along with partners and local stakeholders, we hope to improve access to a broad range of data types useful for monitoring aquatic habitat conditions and evaluating biogeochemical processes in the Delta. We invite discussions with stakeholders and prospective users about how we can best make this tool useful to the IEP community and what data you think should be accessible through the site.

We are focusing on the Bay-Delta and Suisun ecosystems at this time and will expand the effort to include data from the contributing watershed over the next several years. Talk to us and help us brainstorm on how to best use and synthesize the Interagency Ecological Program's diverse datasets.

Nearshore Fishes of San Pablo and San Francisco Bays

Jacob Stagg[1*], Cory Graham[2], Lara Mitchell[3], Andrew Goodman[4], Brian Mahardja[5]

[1]US Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave #105, Lodi, California, 95240; (209) 334-2968; jacob_stagg@fws.gov

[2]US Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave #105, Lodi, California, 95240; (209) 334-2968; cory_graham@fws.gov

[3]US Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave #105, Lodi, California, 95240; (209) 334-2968; lara_mitchell@fws.gov

[4]US Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave #105, Lodi, California, 95240; (209) 334-2968; andrew_goodman@fws.gov

[5]US Fish and Wildlife Service, Lodi Fish and Wildlife Office, 850 S. Guild Ave #105, Lodi, California, 95240; (209) 334-2968; brian_mahardja@fws.gov

Since 1997, the Delta Juvenile Fish Monitoring Program (DJFMP) has collected beach seine data from San Pablo and northern San Francisco bays as part of its ongoing Chinook Salmon-focused survey. To date, this data set has gone largely unanalyzed and this poster summarizes catch data collected over a 20-year period (1999-2019) from nine fixed beach seine sites strategically placed around the northern half of San Francisco Bay. We used the data to determine the 12 most commonly caught fish species, calculate species-specific annual abundance measures at and across individual seine sites, and compare population trends for different species across time. The analysis indicated that beach seine catches were dominated by three species: Topsmelt (*Atherinops affinis*), Pacific Herring (*Clupea pallasii*), and Northern Anchovy (*Engraulis mordax*), with Topsmelt alone accounting for ~65% of total fishes caught. The species breakdown for each seine site showed that Topsmelt were found at all sites and that there were sporadic large catches of Pacific Herring and Northern Anchovy that did not overlap at any site during a given year. Most seine sites displayed a temporary increase in the number of unique species observed annually between 2010 and 2015. A couple of sites displayed unique patterns: Tiburon showed an overall increase in the numbers of species and Treasure Island had an overall decrease during this time. There was a general decline in the catch of Pacific Herring throughout the sample period. These preliminary analyses provide a foundation for future research that could involve an in-depth analysis of over 60 fish species and several shrimp and jellyfish species that occur in the dataset as well as environmental factors that may help explain the observed population trends for these species.

Effects of Multiple Environmental Stressors on Ecological Performance of Early Life Stage Sturgeon

Anna E Steel*
Department of Fish, Wildlife, and Conservation
University of California, Davis, CA 95616
530-828-2328
aesteel@ucdavis.edu

Richard Connon
School of Veterinary Medicine
Dept. of Anatomy, Physiology and Cell Biology
University of California, Davis, CA 95616
530-752-3141, reconnon@ucdavis.edu

Dennis Cocherell
Department of Fish, Wildlife, and Conservation
University of California, Davis, CA 95616
925-963-1621, decocherell@ucdavis.edu

Nann A Fangue
Department of Fish, Wildlife, and Conservation
University of California, Davis, CA 95616
530-752-4997, nafangue@ucdavis.edu

This poster presents our research plan to develop a better understanding of California sturgeon responses to contaminant exposure at early life-stages. We will focus on the sublethal and ecologically relevant effects of pervasive SFBD contaminants under current and future climate conditions and water operation regimes. Sturgeon larvae will be exposed in a controlled laboratory setting to multiple common stressors: thermal stress combined with various environmentally relevant concentrations of the pesticides fipronil or bifenthrin. We will identify direct effects on embryo and larval survival and development, as well as ecological carryover effects on juvenile metabolic rates, swimming performance, and forging capacity. We anticipate that these contaminants will impair the ability of sturgeon to efficiently and effectively gather resources and utilize energy, thus increasing the probability of mortality due to starvation or predation. Thus, this work will inform understanding of the variable recruitment patterns of sturgeon and the potential role of multiple stressors in recruitment success and population bottlenecks. It will also form a basis for continued exploration of the sensitivity of sturgeon to multiple stressors at early life stages, and the mechanisms underlying ecologically relevant effects. This information is critical to adequately inform management strategies for conservation of sturgeon, as these types of data can be used to improve conceptual and life cycle models by identifying key threats to recruitment.

Evaluation of Tidal Marsh Habitats with Hydrodynamic Metrics in the Sacramento Delta

Paul Stumpner*, 916-207-6762, pstump@usgs.gov
Jon Burau[1], jrburau@usgs.gov

U.S. Geological Survey, California Water Science Center, 1280 Terminal St.
West Sacramento, CA 95691

The most ubiquitous landscape feature in the historic Delta were dendritic marsh systems that inundated the marsh plain at spring-neap (14-day period) timescales. The modification of landscapes for water conveyance and agriculture disconnected marsh and floodplains habitats from pelagic habitats that changed the aquatic food web from what was foundationally a detrital food web to a primarily pelagic food web that is limiting fish biomass in the Delta. Reconnecting the marsh plain to the pelagic habitats will likely increase the detrital food web; however, we also hypothesize that phytoplankton production can also be increased, in the Delta.

Here we demonstrate the facility of three hydrodynamic metrics that can be used as a guide to evaluating existing tidal marsh habitats, as well as inform the design of proposed tidal marshes: (1) the ratio of tidal excursion to channel length (2) the ratio of tidal prism to mean tidal prism and (3) the timescales of variability in both metrics. These metrics are applied to (1) a natural dendritic marsh: First Mallard Branch in Suisun Marsh, (2) a restored dendritic marsh: Liberty Island Conservation Bank, and (3) a proposed restoration site: Lookout Slough; the latter two are located in the Cache Slough Complex. Using these examples, we will show that the height of the channel berm relative to mean-higher-high-water is an important control on the amount and frequency of exchange between dendritic channel systems and their adjacent marshes, which is critical for variability of temporal and spatial scales of marsh inundation that support ecological processes on both the marsh plain and within pelagic habits.

Using isotopes and trace elements as a tool to uncover White Sturgeon life history complexities and habitat use

Jamie Sweeney * [1, 2]
jamie.sweeney@fishsciences.net
(916) 250-1570 ext. 126

Malte Willmes [3]
mwillmes@ucdavis.edu

Kirsten Sellheim [1]
kirstens@fishsciences.net

Levi Lewis [2]
lslewis@ucdavis.edu

James Hobbs [2]
jahobbs@ucdavis.edu

Joseph Merz [1]
jmerz@fishsciences.net

[1]Cramer Fish Sciences
3300 Industrial Blvd Suite 100
West Sacramento, CA 95691
[2]UC Davis Department of Wildlife, Fish & Conservation Biology
1 Shields Ave, Davis, CA 95616
[3]Institute of Marine Sciences/NOAA Fisheries Collaborative Program, UC Santa Cruz, 1156 HIGH STREET, SANTA CRUZ, CA 95064

California White Sturgeon are a long-lived, slow growing, and late-reproducing fish species common to estuaries and coastal habitats along the West Coast of North America. These life history characteristics make their population exceptionally vulnerable to habitat loss, degradation, and over exploitation. In addition, this also makes it challenging to study and manage their population effectively. Various studies involving electronic tagging, video monitoring, trapping and recreational catch efforts have provided insights into migratory patterns and spatial distributions of White Sturgeon in the Sacramento-San Joaquin River system. However, these methods can provide only a brief snapshot in time. In contrast, trace element and isotope analysis of calcified sturgeon fin rays using laser ablation is a non-lethal sampling method capable of reconstructing freshwater/marine residence and migratory patterns throughout an individual's lifespan. To better understand White Sturgeon life history strategies and the inter-annual variability with response to water year, we used laser ablation mass spectrometry to measure strontium isotope ratios in fin rays from wild sturgeon and found that many fish spent their lives primarily in estuarine environments, with very little evidence of freshwater residence within the

first year. We also conducted an experiment focusing on early fin ray calcification to determine how early fin ray microchemistry begins to record migration patterns using trace elements. We found that fin rays begin calcifying and incorporating trace elements from the water as early 30 days post hatch or 30 mm total length and are nearly 95% calcified by 70 mm total length or 72 days post hatch. Results of these studies provide new insights into the movement patterns of White Sturgeon in the Sacramento-San Joaquin River system which can help resource managers refine flow management and habitat restoration strategies to optimize potential impact to sturgeon.

Sunny with a chance of nutria: modeling invasive species habitat with data from an eradication program

Vanessa Tobias*; USFWS; 850 S. Guild Ave, Suite 105, Lodi, CA 95240; 209.334.2968; vanessa_tobias@fws.gov
Pascale Goertler; DSC-DSP; 980 9th Street, Suite 1500, Sacramento, CA 95814; 916.445.5243; pascale.goertler@deltacouncil.ca.gov
Shruti Khanna; CDFW; 2109 Arch Airport Road, Suite 100, Stockton, CA 95206; 209.689.8719; shruti.khanna@Wildlife.ca.gov
Lara Mitchell; USFWS; 850 S. Guild Ave, Suite 105, Lodi, CA 95240; 209.334.2968; lara_mitchell@fws.gov
Louanne McMartin; USFWS; 850 S. Guild Ave, Suite 105, Lodi, CA 95240; 209.334.2968; louanne_mcmartin@fws.gov

Nutria (*Myocastor coypus*) are large (15-20 lbs), semi-aquatic rodents that are native to South America. They have become an invasive species in wetlands across the globe and they were recently discovered in California's Sacramento Delta. Nutria can damage wetland habitats and water control infrastructure through their feeding and burrowing behaviors. This could impact existing wetland habitats and restoration sites through physical damage and impacts to water quality. Early detection and removal of invaders is key to limiting their impact and the cost of control. Forecasting when nutria could arrive at specific locations in the Delta is a question of management concern, especially as it relates to ranges of endangered species and water infrastructure. To address these concerns, we combined spatial data on potential habitat, trapping locations in California, and published information from other regions where nutria are invasive to prioritize search areas for the eradication effort. Here, we present initial results of data preparation, occupancy modeling in the Sacramento Delta, and estimates of dispersal ability from other locations where nutria have invaded. Maps of potential habitat will form the basis for a simulation model that can be used to forecast distributions using various dispersal and control plan scenarios. This proactive approach to invasive species management is intended to give managers early warning of potential impacts and to help agencies prioritize search areas, especially where resources for detection and control are limited.

The Rise of QA: Implementing a Quality Management System at DWR

Traci Treleaven*, Rachel Pisor, Mike Head, JohnFranco Saraceno, and Sonia Miller

CA Department of Water Resources, QA Program
3500 Industrial Blvd., West Sacramento, CA, 95691
Work: 910-375-4231
Traci.Treleaven@water.ca.gov

Until 2017, the Department of Water Resources (DWR) lacked a robust Quality Assurance Program to ensure the collection of data of known and documented quality. Data collected without quality assurance (QA) hinders the ability to make sound management decisions. This poster illustrates how a QA Program can be started from scratch, implement critical changes in a span of 2 years using a coupled bottom up and top down approach, and make plans for implementing a quality management system across the Department. A few examples include coordinating QA Committees where representatives from each program can find solutions to problems, developing standard operating procedures (SOPs) and standardized forms everyone can implement, establishing consistent processes for calibrating water quality instruments, purchasing QC instruments for verifying sensor accuracy, creating tools to streamline laboratory data review, and working through solutions for various QA issues as they are identified. The DWR QA Program has many ambitious goals for 2020 including establishing a document control system, publishing department-wide SOP's, expanding our QA training program, providing training to staff on QA topics and processes, and supporting DWR's Laboratory transition to the 2016 TNI laboratory standard.

The effect of substrate on spawning in cultured Delta Smelt (*Hypomesus transpacificus*)

Yi-Jiun Jean Tsai[1*], Evan W. Carson[2], Leanna Zweig[2], 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

[2]US Fish & Wildlife Service; San Francisco Bay-Delta Fish and Wildlife Office

We examined the effect of substrate on the *s*pawning of cultured *H. transpacificus* under laboratory conditions. Specifically, we asked whether substrate affects either the spawning behaviors exhibited or resulting egg fertilization success. We addressed these questions by conducting no-choice substrate behavioral trials, in which five ripe females and five mature males were placed into a flow-through tank containing either control (acrylic), sand, or pebble substrate. Fish were allowed to spawn naturally for four days and all behavioral interactions were video recorded. Eggs were then incubated for three additional days and assessed for fertilization success. Videos were analyzed for spawning behavior. We found that the sequence and type of behaviors observed during spawning did not differ by substrate. We also found that substrate did not affect either the percentage of total eggs fertilized or the number of fertilized eggs when controlling for the total number of eggs laid. These preliminary results suggest that cultured *H. transpacificus* can spawn on natural and artificial substrates, regardless of their preferences (Lindberg et al. 2020). They also suggest that, in the absence of choice and under laboratory conditions, substrate may not influence reproductive success (Mulvaney et al. *In Prep*). Instead, other environmental (e.g. water velocity) or social (e.g. sex ratio) conditions may be more influential. Such findings are important to informing ongoing habitat restoration efforts.

To Burst or Not to Burst: Median Filtering High-Frequency Turbidity Data to Eliminate Noise

Trevor Violette*

US Geological Survey, West Sacramento Hydrodynamics Group
1280 Terminal St, West Sacramento, CA 95691
916-709-8671
tviolette@usgs.gov

Optical water-quality sensor data are inherently noisy because it is dependent on how light scatters off particles in the water column. In order to "account" for this, some water-quality sondes use proprietary algorithms to reduce the noise around each single data point. Because the algorithms are proprietary, we cannot be certain as to how each point is being collected and calculated. To guarantee we know exactly how the data are collected, we wrote a program for our dataloggers to get a raw data point. The sonde's processed value is also stored as a comparison. To take this a step further, a new method of producing a data point was developed to help eliminate noise and increase confidence in the point. In order to better understand trends in the turbidity data over tidal cycles, we chose to use a "burst" method of sampling rather than collecting a single data point. Every fifteen minutes, thirty values are collected (approximately one per second), and then a median of the 30 values is calculated. This method helps to eliminate noise and uncertainty around each published value. A minimum, maximum and standard deviation is also calculated on the set of values. When technicians post-process the data and make decisions whether to delete potentially invalid data or not, these statistics are used as additional resources to better inform their decision making. All raw values are also stored so end users of the data have all information available around each published point. Using this technique allows us to have full control over HOW data are collected and processed.

Developing an Integrated Web-Based Delta Data Exploration and Analytics Portal through Community Feedback and Contributions

Brendan F. Wakefield [1*], Jeffrey A Hansen [2*], Jeniffer Soto Perez[3*], Brian Bergamaschi[4*], and many others.

[*]U.S. Geological Survey, California Water Science Center, Sacramento, California, 95819

[2] P/ 916-278-3082, E/ bwakefield@usgs.gov

[2] P/ 916-278-3076, E/ jahansen@usgs.gov

[3] P/ 916-278-3061, E/ jsotoperez@usgs.gov

[4] P/ 916-278-3053, E/ bbergama@usgs.gov

Valuable water-quality and habitat condition data are being collected every day in the Sacramento- San Joaquin Delta by researchers, water managers, federal, state and regional agencies, as well as other stakeholders. We think that integration of these varied data sets into a single access point -- an interactive web-based data exploration portal -- will facilitate a greater understanding of the Delta's complex aquatic habitats by democratizing data access and thus enabling creative exploration of data linkages. The identification of available data relevant to the Delta will play a critical role in the utility of the portal, as will a thorough understanding of the analytics most useful and informative to help researchers and decision makers overcome the many challenges facing the system. The USGS has recently received funding to develop such a portal and we are asking for your input.

The data portal will integrate many data types, including: biogeochemical, hydrologic, geospatial, time-series, discrete/project-based, and others, in order to provide a more thorough analytical platform than is possible through analysis of the data separately. Through this poster, we are interested in meeting with parties with an interest in the health of the Delta ecosystem and hydrology to help identify data sources that should be included, as well as the analytical tools that will contribute to the success of the platform. A short survey will be available to initiate the process of collecting this information and contact information will be shared to form a network of contributing parties. We will also be conducting appointment-based interviews with community members during and after the conference.

We are focusing on the Bay-Delta and Suisun ecosystems at this time and will expand the effort to include data from the contributing watershed over the next several years. Talk to us and help us brainstorm on how to best use and synthesize the Interagency Ecological Program's diverse datasets.

Experimental field study of growth and survival of invasive clams in Montezuma Slough

Jessica Weidenfeld*, Department of Environmental Science and Policy, University of California, Davis, CA 95616; 530-304-6077; jaweidenfeld@ucdavis.edu
Edwin Grosholz, Department of Environmental Science and Policy, University of California, Davis, CA 95616; 530-304-0816; tedgrosholz@ucdavis.edu

Among the most abundant invasive non-native clams in the San Francisco Bay-Delta region are *Potamocorbula amurensis* and *Corbicula fluminea*. They filter and remove phytoplankton from the water column, thus reducing water column primary productivity for higher trophic levels including native fishes. Our research investigated growth and survival of both clam species in the Montezuma Slough region comparing smaller and larger sloughs using two types of field experiments. At four sites, two large and two smaller sloughs, we placed both species of clams together in replicate mesh-lined trays attached to lead lines for later retrieval. To measure predation rates on clams, trays were either covered with wider mesh to exclude predators or left open as controls. All clams were marked with calcein to identify outplanted clams and to measure growth rates. As a second measure of predation rates, we attached clams to monofilament lines that then tied to lead lines, so clams were available to predators. Experimental replicates were retrieved at approximately monthly intervals.

We found significant differences in growth rates among sloughs with a positive trend of greater growth in smaller sloughs for both *P. amurensis* and *C. fluminea*. We also found nearly full survival of both clam species, which strongly suggests little if any predation. So the apparent absence of these invasive clams up into smaller sloughs does not seem to be a function of poor growth rates or high rates of predation. We also examined the influence of August 2019 salinity gate manipulations and found that the changes in water column variables did not appear to have large impact on clam demography. These results will inform water management decisions with regard to invasive clams in the Delta. Our findings suggest that smaller sloughs may help to limit the expansions of *Potamocorbula amurensis* and *Corbicula fluminea.*

Physics versus Biology: Implications for Predation on Juvenile salmon

J.D. Wikert*
U.S. Fish and Wildlife Service
650 South Guild Avenue, Suite 105
Lodi, CA 95205
209 334-2968
John_wikert@fws.gov

Brett Harvey, California Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236
916-376-9739
Brett.Harvey@water.ca.gov

Recent attention in California's Central Valley salmon world has focused on the role of predators, and especially non-native predators, in reducing numbers of juvenile Chinook salmon. Striped bass often receive the most blame for salmon declines in popular media. However, native salmon and striped bass have coexisted in the watershed for over 100 years with reasonably robust populations until recently. Anthropogenic impacts to aquatic and riparian habitats have continued to create physical and biological conditions favoring non-native fish over native fish species. We examine how these physical and biological factors may influence predator-prey dynamics in the Bay-Delta-Tributaries Ecosystem.

The Response of Phytoplankton to Agricultural Flow Releases in the North Delta in 2019

Frances Wilkerson*, Estuary and Ocean Science Center, Romberg Tiburon Campus, San Francisco State University, 3150 Paradise Drive, Tiburon, CA 94920, 415 338 3519, fwilkers@sfsu.edu, Sarah Blaser (sblaser@sfsu.edu), Jessica Wilson(jwilson5@ sfsu.edu), EOS Center,Ted Sommer (Ted.Sommer@water.ca.gov), Brittany Davis (Brittany.E.Davis@water.ca.gov), Mallory Bedwell Mallory.Bedwell@water.ca.gov), Department of Water Resources, 3500 Industrial Blvd. West Sacramento, CA 95691, 916-376-9823,

Managing agricultural return waters to the North Delta has been proposed to promote primary productivity, increase phytoplankton biomass and provide a food subsidy downstream. Phytoplankton blooms were observed in the lower Sacramento River in fall 2011 and summer 2016 after a flow pulse passed through the Yolo Bypass. However, this did not occur following the 2018 North Delta Flow Action when there was a managed augmented flow pulse in late summer, using water from rice-fields near the Colusa Basin, although there was a slight increase in chlorophyll in the lower Bypass. Measured phytoplankton productivity rates were low even though the water was less turbid. It was suggested that the lack of response might be due to insufficient nutrients, low seed stock or something toxic in the source water and use of bio-assay to evaluate the water quality of the managed water was proposed. In 2019, we performed bio-assays before, during and after the 2019 Managed Action using water from upstream source water, downstream at Lisbon Weir and near the confluence at Rio Vista. There was increase in chlorophyll at Rio Vista following the 2019 Action. However 5-day bio-assays showed that the phytoplankton at Rio Vista were able to grow slowly using the ambient ammonium and then nitrate, as were phytoplankton in water from the other sites, although their growth was limited by the available nutrients. Phytoplankton productivity data from the managed flow actions will be compared and the usefulness of the bio-assays for making management assessment of the food subsidy outcomes emphasized.

Reconstructing ancient salmon life history strategies to support modern conservation

Malte Willmes*[1, 2], Lewi S. Levis[3], Rachel Johnson[1,2,4], Anna Sturrock[4], Jeff Rosenthal[5], Jelmer Eerkens[6], James A. Hobbs[3]

[1]UC Santa Cruz, Institute of Marine Sciences, mwillmes@ucsc.edu, 5305747914
[2]National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center
[3]UC Davis Department of Wildlife, Fish, & Conservation Biology
[4]UC Davis Center for Watershed Sciences
[5]Far Western Anthropological Research Group
[6]UC Davis Department of Anthropology

Chinook salmon (*Oncorhynchus tshawytscha*) populations in California are in decline due to the combined effects of habitat degradation, water diversions, and shifting climate regimes. Effective salmon conservation and management relies on understanding their life history diversity and ability to adapt to environmental change. Monitoring efforts and geochemical tools have provided crucial insights into modern salmon population dynamics and behavior in California. However, these data were collected only after significant population declines and extirpation from a large fraction of their historic habitat. Here, we use adult salmon otoliths (fish ear stones) from the lower Feather River to reconstruct juvenile and adult life history metrics, and compare patterns among modern (2002-2010, n=755) and historic (~1840 CE, n=49) populations. Specifically, we investigated the age and size of fall-run salmon when they returned to freshwater and reconstructed their natal origins and juvenile rearing behaviors using strontium isotope ratios ($^{87}Sr/^{86}Sr$). Modern wild salmon on the Feather River generally returned at younger ages and exhibited a more truncated age structure (age-2 and age-3 dominated), while their historic counterparts generally returned as age-3 and age-4 and exhibited a broader age distribution. In modern salmon we identified a significant shift from wild-spawned to hatchery-origin fish on the lower Feather River, particularly after the 2008-09 stock collapse, indicating that the population 'recovery' in 2010-2012 was largely driven by hatchery immigrants. The natal origins and rearing behaviors of the historic population suggests that a diverse range of habitats were used, and that variable life history strategies were successful on the lower Feather River. This study represents the first step towards unlocking the potential for historic fish bones to provide unique insights into California's past salmon populations and to apply this knowledge to guide future salmon conservation, management, and recovery.

Climate change effects on flooding of Yolo Bypass: implications for fishes and ecosystem function

Marissa Wulff*
U.S. Geological Survey
California Water Science Center
6000 J Street, Placer Hall
Sacramento, CA 95819-6129
Phone: (916) 278-3000
Email: mwulff@usgs.gov

Larry Brown
U.S. Geological Survey
California Water Science Center
6000 J Street, Placer Hall
Sacramento, CA 95819-6129
Phone: (916) 278-3098
Email: lrbrown@usgs.gov

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

Yolo Bypass is an important ecological feature of the Bay-Delta ecosystem, providing important spawning and rearing habitat for many species of native fishes. Inundation of floodplains like Yolo Bypass is particularly important for spawning and rearing of Sacramento Splittail (*Pogonichthys macrolepidotus*) and rearing of juvenile Chinook Salmon (*Oncorhynchus tshawytscha*).

Climate change effects on flooding of Yolo Bypass are being assessed by calculating flood metrics including magnitude, duration, frequency, and timing of floods using model outputs from the CASCADE 2 project. The model outputs used in this analysis are Yolo Bypass flows under 20 climate change scenarios from the present to the end of the century. In addition, we are exploring the effects of the planned modifications to Fremont Weir that will result in flooding of Yolo Bypass at lower Sacramento River flows (i.e., “the notch”) These flood metrics will then be interpreted with respect to habitat needs of native fishes and other ecosystem benefits of Yolo Bypass flooding. Given the importance of Yolo Bypass flooding, understanding the influence of climate change on the frequency, magnitude, duration and timing of flooding is critical for understanding future value of the bypass to the Bay-Delta ecosystem.

Copepod tidal flux and demersal behavior at a Cache Slough Complex marsh

Rowan Yelton*, ryelton@sfsu.edu, (978) 201-5203
Anne Slaughter, aslaught@sfsu.edu, (415) 338-3548
Wim Kimmerer, kimmerer@sfsu.edu, (415) 338-3515

Estuary and Ocean Science Center, San Francisco State University.
3150 Paradise Dr, Tiburon, CA 94920

Spatial subsidies and habitat connectivity are critical factors in trophic webs. In the California Delta, the production of zooplankton varies between shallow, nearshore habitats and deeper, open water habitats. Movement of zooplankton across different areas through tidal dispersion and advection could subsidize less-productive regions, providing food for delta smelt and other planktivorous fishes. Transport of zooplankton is complicated by their vertical migratory or demersal behavior, whether it is related to tidal flows or the diel cycle. We sampled over 4 full tidal cycles in summer 2018 for the calanoid copepod *Pseudodiaptomus forbesi* at the mouth of the main channel of the Wildlands restored marsh in the Cache Slough Complex. We estimated net tidal flux as the product of abundance by life stage and tidal volume flow rate, integrated over time. Net copepod flux was small and highly variable. Moreover, *P. forbesi* distributions showed a clear diel vertical migration for all copepodite stages, and late copepodites and adults were nearly absent from the water column during the day, suggesting demersal behavior. Benthic sampling with a small Ponar grab in summer 2019 showed high densities of *P. forbesi* at the bottom during both night and day. Because *P. forbesi* densities in the water column were highest during the night, tidal fluxes were greatest during the night, when tidal flows were predominantly landward. This likely precluded a net flux out of the marsh regardless of any population gradient between the two areas. Comparisons of our three sampling methods (net tow, pumping, and Ponar grab) show that standard methods for collecting pelagic zooplankton may underestimate abundance of demersal species, even if samples are taken at night.

Validation of otolith-based age and size reconstructions for larval, juvenile, and adult Delta Smelt

Feng Zhao[1*], Wilson Xieu [1], Levi Lewis[1], Tien-Chieh Hung[2], Luke Ellison[2], Troy Stevenson[2], Galen Tigan[2], Andrew Schultz[3], James Hobbs[1]

[1] Wildlife, Fish and Conservation Biology, University of California Davis. 1088 Academic Surge, Davis, CA. 95616; mayzhao@ucdavis.edu (530)219-8226; wtxieu@ucdavis.edu (415)533-9506; lewis.sci@gmail.com (707)338-4145; jahobbs@ucdavis.edu (707)480-0188

[2] Fish Conservation and Culture Laboratory, Department of Biological and Agricultural Engineering, University of California Davis. 17501 Byron Hwy, Byron, CA 94514; thung@ucdavis.edu (209)830-9803; ellison@ucdavis.edu; tastevenson@ucdavis.edu; gttigan@ucdavis.edu

[3] United States Bureau of Reclamation. 2800 Cottage Way, Sacramento, CA 95825; aschultz@usbr.gov (916)414-2415

Delta Smelt (*Hypomesus transpacificus*) are an annual fish endemic to the upper San Francisco Estuary (SFE) nearing extinction due to factors such as freshwater flow diversion, habitat loss, and changing environmental conditions. They are an indicator species for the health of the SFE and play an important role in decisions regarding water management. Their otoliths, continuously growing ear bones, provide an estimate for daily age and a time series for growth, movement, and environmental conditions. A previous validation by Hobbs et al. 2007 examined Delta Smelt ranging from 0 to 100 days post hatch. Here, we build upon this study by examining otolith growth relationships for Delta Smelt ranging from 0 to 271 days post hatch using higher resolution imaging and multiple trained transect readers. Validations of otolith techniques were conducted using known-age Delta Smelt in 10 different age classes (0, 5, 10, 30, 61, 90, 180, 215, 243, 271 days post-hatch) reared at the UC Davis Fish Conservation and Culture Laboratory (FCCL). Sagittal otoliths were collected from Delta Smelt and analyzed for age, increment periodicity, and constant proportionality. Otolith-based aging techniques yielded age estimates from 3 independent readers with mean accuracy of ~95%, mean error of ~5%, and inter-operator precision of ~96%. We validated and verified the ages of hatchery-reared Delta Smelt and examined otolith size to fish size relationships. A detailed validation and verification of increment formation in otoliths is critical for any age and growth analyses and provides an important check for any past and future studies analyzing Delta Smelt otoliths.