INFORMATION ITEM

Lead Scientist Report

Summary

Although many studies focus on understanding how individual stressors (e.g., flow, salinity, temperature, predator abundance) impact native fish species, few yield understanding of how different combinations of stressors impact fish. Consequently, managers have little insight into which stressors should be key focal points for the management of threatened and endangered species. This study, funded by the Delta Stewardship Council, State Water Contractors, and Department of Water Resources, addressed this knowledge gap for delta smelt. Leveraging decades of monitoring data, the researchers tested competing hypotheses about how combinations of stressors impact the presence or absence of delta smelt in locations throughout the Delta. Results highlight the overriding importance of temperature and salinity and suggest a more minor role for predation and potentially water clarity. Notably, X2, an integrative measure of Delta outflow used in targets for the management of delta smelt, did not emerge as a control on smelt presence or absence.

Relations between abiotic and biotic environmental variables and occupancy of Delta Smelt (*Hypomesus transpacificus*) in autumn

A. Noble Hendrix, Erica Fleishman, Martha Wohlfeil Zillig, and Eva Dusek Jennings. Estuaries and Coasts (2023). https://doi.org/10.1007/s12237-022-01100-x.

Management of the critically endangered delta smelt is based on establishing regulatory targets for X2, a measure of distance from the Golden Gate at which the salinity of the near-bottom water is two parts-per-thousand. As such, X2 is an integrative measure that reflects Delta outflow and, to some extent, salinity within the estuary. During dry conditions, it increases as river flows compete less effectively with tidal flows, and during wet conditions, it shrinks. As a management

standard, X2 is appealing because it is easy to measure and because salinity is a known factor important for delta smelt abundance. Namely, juvenile smelt migrate to low-salinity waters in the fall (specifically, a region called the Low-Salinity Zone) as part of their life cycle before moving back upstream to spawn. Thus, the success of spawning depends on the survival of delta smelt populations through the fall. In the fall, the Low-Salinity Zone shifts depending on the balance between tidal flows and Delta outflows. When the Low-Salinity Zone coincides with the marshlands of Suisun and the Cache Slough complex, populations are more abundant than when it is pushed into the agricultural north Delta.

Meeting the X2 target often restricts water exports, particularly during dry periods. Recently, the efficacy of the X2 regulatory standard has been called into question. Several studies have found only a weak relationship between X2 and delta smelt survival and recruitment. Other studies have also highlighted the importance of non-salinity stressors on delta smelt populations, including predation, competition with the non-native threadfin shad, and temperatures, which may impose a lethal limit at levels observed in the Delta. These studies raise the question of which factor(s) are driving the critically low abundances of delta smelt in specific regions of the Delta. The question is challenging for scientists to address, as these factors vary simultaneously in space and time. However, it is highly relevant to management questions of how to more effectively manage the delta smelt, potentially through altered regulatory standards.

The research team that wrote the spotlighted article adopted an innovative, participatory approach to address the question of how different stressors interact to control the abundance of delta smelt system-wide. The research initiative developed out of the Collaborative Adaptive Management Team, a technical team under the umbrella of the multi-agency Collaborative Science and Adaptive Management Program. The research leveraged 35 years of monitoring from the Fall Midwater Trawl dataset. To address the impracticality of testing how well every possible equation relating stressors to delta smelt presence or absence matched observations, the research team consulted with a wide range of delta smelt experts to develop a finite set of testable hypotheses. They then translated these hypotheses into equations and statistically tested how well those equations predicted the observed patterns of smelt presence or absence. They also tested

whether combinations of the hypothesized equations could produce better predictions of the observations.

Findings highlighted the overriding importance of temperature and salinity in predicting the presence or absence of delta smelt, with smelt presence associated with lower temperatures and salinity. Temperature and salinity alone produced predictions of delta smelt presence or absence that matched observations far better than models with other combinations of stressors. Nevertheless, among the other best-performing models, one enhanced predictive power when combined with the temperature and salinity model. That model included water clarity, threadfin shad abundance, and a metric representative of predation intensity. Smelt presence was weakly associated with turbid water and more strongly associated with low abundance of threadfin shad abundance and high predation intensity. The association of delta smelt presence with high predation may seem surprising but may reflect that conditions that favor delta smelt also tend to favor their predators.

Notably, none of the highly performing models included X2. The authors attributed this finding to complexity in how X2 is related to suitability in the Low-Salinity Zone for delta smelt. Instead of X2, salinity measured at specific locations of interest is far more predictive of delta smelt abundance, and temperature is also highly important. The authors suggest that regulatory measures for delta smelt that consider more than one variable may be more appropriate than regulation based on X2. Last, by examining patterns of presence and abundance in the monitoring data, they point out that delta smelt are consistently found in the Cache Slough and lower Sacramento River to Suisun Bay in the fall, and thus, these may be the best regions on which to focus habitat improvement measures.

This study is responsive to Action 5D of the 2022-2026 Delta Science Action Agenda: *Integrate and expand on existing models of hydrodynamics, nutrients, and other food web drivers to allow for the forecasting of the effects of interacting stressors on primary production and listed species*. It was also the subject of a recent (March 2023) presentation to the Collaborative Science and Adaptive Management Program.

Delta Science Program Activities

Release of the Harmful Algal Blooms Workshop Report

The Delta Science Program released a detailed workshop report summarizing the discussions and findings of the November 2022 Delta Harmful Algal Blooms (HABs) workshop. The workshop laid the groundwork for the establishment of a coordinated harmful algal blooms monitoring framework for the Delta. The workshop report, distributed via the Council's listserv, can be found at https://www.researchgate.net/publication/368841409_Delta_Harmful_Algal_Blooms_Monitoring_Workshop_Summary_-_November_2022.

The report contains a complete list of presentations, sessions, links to talks, and summaries from the breakout sessions. Key takeaways include widespread recognition that HABs monitoring should be a critical component of the Estuary-wide monitoring enterprise and is unique in the immediate and long-term needs that the data must serve. Common themes across the meeting included a desire for long-term funding to support a standardized approach for monitoring and incident response, recognition of a need to better understand the human communities affected by HABs and an understanding that data should be integrated and publicly available in a format that meets the needs of the intended audience. As a next step, information from the workshop will be incorporated into a Delta HABs monitoring strategy that will provide specific recommendations, with an expected release later in 2023.

Delta Breeze

The April 2023 edition of the Delta Breeze newsletter was released last week to coincide with Earth Day. The Delta Breeze, the Delta Science Program's science funding newsletter, targets scientists, funders, and managers and is published two times per year. The April edition highlights social science research and events. This issue includes articles about the science governance research that Mark Lubell and Tara Pozzi of UC Davis are conducting, the Delta Residents Survey, the Council's environmental justice work, and recent events, including Science for Communities and Advancing Interdisciplinary Research. The Delta Breeze is distributed on our listserv and available on our website.

Decision-making Under Deep Uncertainty Seminar Series Kickoff

On April 26, the Delta Independent Science Board and Delta Science Program kicked off a seminar series on decision-making under deep uncertainty. "Deep uncertainty" refers to "black swan" events that cannot be easily quantified or anticipated using models and may arise from coinciding or prolonged extreme conditions spanning multiple entities or phenomena. The inaugural speaker was Alice Hill, who currently serves as the David M. Rubenstein senior fellow for energy and the environment at the Council on Foreign Relations. Previously, she served as a special assistant to President Barack Obama and senior director for resilience policy on the National Security Council, where she led national policy development to build resilience to catastrophic risks, including climate change and biological threats. The seminar series, which will occur monthly, will lay the foundation for an Independent Science Board Review on the same topic.

Delta Residents Survey

The Delta Residents Survey was launched to ~80,000 households in the Delta in early 2023 to learn more about Delta residents' livelihoods, well-being, priorities, and concerns for the region. The Delta Residents Survey, data collection phase, was completed in early April, with over 2,400 responses received from residents across the Primary and Secondary zones of the Delta, as well as from residents in Delta-adjacent communities in Stockton and Sacramento. The research team saw just under a 3% total response rate to the survey, which was higher than expected; similar survey research designs tend to average between 1 and 1.5% response rates. The research team is excited to dig into the data in the coming months and will share more updates to survey respondents, the Council, and the public as they become available.

Delta Science Spot

The Delta Science Spot is a weekly social media science communication series written by the Delta Science Program. It highlights science in the Sacramento San Joaquin Delta, so it's digestible for both technical and non-technical audiences. Specific topics and themes vary, ranging from the distillation of recent journal

articles to science events and their significance, to the science behind happenings such as the recent series of atmospheric rivers.

Sea Grant State Fellows at the Science Program interested in learning about science communication participate on the Delta Science Spot writing team. With guidance and coordination from Senior Environmental Scientist Lynn Takata, they choose specific topics and learn how to boil down the information into brief Twitter-style statements that are connected in a "thread" that tells a coherent science story.

In 2022 and early 2023, Sea Grant fellows Elishebah Tate-Pulliam from the Science Communication, Synthesis, and Decision Support unit and Tabitha Birdwell from the Collaborative Science and Peer Review Unit wrote for the Spot. Their posts covered models evaluating the integrity of Delta levees, equity in water management, how microbe communities on the skin of local salamanders are indicators of organism health and much more.

With the fellowship year ending for Elishebah and Tabitha, members of the incoming 2023 class of Sea Grant State Fellows are joining the writing team at the end of April. We will welcome fresh science perspectives written by Eduardo Martinez with the Collaborative Science and Peer Review Unit, Pooja Balaji with the Science Communication and Decision Support Unit, and Sam Pyros with the Interagency Ecological Program.

Social Science Community of Practice

In March 2023, the Social Science Community of Practice steering committee held its first meeting of 2023. This group will meet quarterly throughout 2023 to continue to build more relationships across social science disciplines and share updates on social science research happening across the estuary. More information on the Social Science CoP, including contact information for anyone interested in joining the listserv or steering committee meetings, is available on the Council's website (https://deltacouncil.ca.gov/bay-delta-social-science-community-of-practice).

On Your Radar

2023 NCEAS Working Group

Staff continue to plan for a 2023 National Center for Ecological Analysis and Synthesis (NCEAS) working group to focus on interdisciplinary social-ecological data synthesis. NCEAS working groups receive specialized training on methods for performing synthesis (i.e., telling a big-picture story by looking across multiple studies and datasets) while advancing novel research on a compelling science problem. The 2023 NCEAS working group will identify available data related to the social dimensions of the Delta and integrate it with available ecological and biophysical data to develop a more sophisticated understanding of the interactions between the social and ecological components of the estuary. Participants from agencies and academic research institutions in the region have been recruited throughout early 2023, and the working group will get underway this summer.

UC Davis Coastal and Marine Sciences Institute/DSP Joint Symposium: Implications of Rising Temperatures for Coastal, Marine, and Estuarine Ecosystems

On Friday, May 19, 2023, the UC Davis Coastal and Marine Science Institute, in partnership with the Delta Science Program, will host a symposium to discuss the state of research on the influence of extreme heat on organisms, communities, and socio-ecological systems.

The symposium will meet in person on the UC Davis campus and will be livestreamed and recorded. Registration can be accessed at https://www.eventbrite.com/e/implications-of-rising-temperatures-coastal-marine-estuarine-ecosystems-tickets-608702153527.

2023 Adaptive Management Forum

The 2023 Adaptive Management Forum (Forum) will take place on May 4, 2023. The Delta Science Program hosts the Forum biennially to bring together scientists and adaptive management practitioners to promote shared learning and discussion. Adaptive management provides a structured approach for adaptation in a context of rapid, often unprecedented, and unpredictable environmental change. Its success depends on support from the larger social, regulatory, and institutional

context, or governance system. The 2023 Forum will have a thematic focus on governance for adaptive management, with the aim of fostering learning and discussion around governance needs to support effective, equitable, and inclusive processes in the Delta. The Forum will be hybrid, with the in-person event taking place in the CNRA building. Registration can be accessed at https://www.eventbrite.com/e/2023-adaptive-management-forum-tickets-607854417927.

By the Numbers

Science Program staff will summarize current numbers related to Delta water and environmental management. The summary (Attachment 1) will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues.

List of Attachments

Attachment 1: By the Numbers

Attachment 2: Visual Summary of Hendrix et al. (2023)

Contact

Dr. Laurel Larsen

Delta Lead Scientist

Phone: (916) 445-0463