NOVEMBER 2023

Delta Breeze

A newsletter by the Delta Science Program

Delta Lead Scientist "Dear Colleagues"

I am excited to share with you this edition of the Delta Breeze, which is all about **open science** in California's Delta. The theme is timely, as the federal government has recognized 2023 as a Year of Open Science, designed to "spark change and… advance adoption of open, equitable, and secure science." Open science is foundational to the imperative for the Delta community to align decision-making with best available science. "Best" implies science with integrity, that is reproducible and transparent. "Available" implies science that is accessible to all. **These components – reproducibility, transparency, accessibility, and equity – are core elements of open science and are explored in this newsletter.**

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Delta Science Program

DELTA STEWARDSHIP COUNCIL

I am of an age at which I resent the term "mid-career" (hey, don't I still have many more years in front of me than behind?!), but when I think of the change I have witnessed through the open science movement, I feel like a dinosaur. Gone are the days of traveling through the snow to a university library to access research journals, several pounds of coins jingling in my pockets for photocopies. Gone are the days when data and code linger in secrecy, imprisoned on a disk sitting on my shelf. As the years flashed by, I learned to navigate open data repositories, community interfaces for sharing code, journal open-access fees, metadata and documentation standards, and version control software. These **recent developments have come a long way in breaking down barriers to participation in science** and making the most of the modern era's big datasets. **Yet the science community is truly building the plane while it is flying.** Needs and nuances are continually emerging, such as the recognition that open science can also contribute to new inequities and participation barriers.

I gained new appreciation for just how hard open science is when I piloted a graduate course on Reproducible Data Science at Berkeley in 2018. My co-instructor, environmental economist Max Auffhammer, and I curated a set of papers that we believed embodied open science best practices and, after extensive discussion, asked the students to reproduce key analyses in the papers. The success rate? Near zero, often due to software versioning issues or missing steps in the documentation of the data processing pipeline. Scientists are on the right track toward making information open and accessible, but there is still much to teach, learn, and improve upon.

As I continue to partake in the open science movement, my appreciation of the nuanced challenges – both technical and social – deepens. Fortunately, the Bay-Delta science community has some of the best minds working on these challenges and promoting understanding, from the State Water Resources Control Board's Office of Information Management and Analysis, to Interagency Ecological Program Project Work Teams, to the work of tribal liaisons and the Global Indigenous Data Alliance. I recently learned from some of these colleagues about the complementary FAIR (findable, accessible, interoperable, reusable) principles of data management and CARE (collective benefit, authority to

control, responsibility, ethics) principles of stewardship of indigenous data, emphasizing both the technical and equity-centered governance aspects of the open science movement. While we have a long way to go, I am confident we are moving in the right direction—toward even better and more equitable "best available science."

In this edition of the Delta Breeze, you will learn more about FAIR and CARE and open science resources available to the Delta science community. You will also learn about how the Delta Science Program is promoting open science in its forthcoming research proposal solicitation, as well as how previous investigators have promoted open science in their work.

Enjoy the newsletter! Unfortunately, this letter will be my swan song, as my term as the Delta Lead Scientist ends on November 30. I will miss leading this science community and thank all of you for your contributions. I have learned so much and enjoyed becoming part of the Delta science family. I am confident that you will be in good hands with the next Delta Lead Scientist.

Dr. Laurel Larsen
Delta Lead Scientist

Investing in Meaningful Access to Research through Open Science

By Jill Harris, Senior Environmental Scientist Specialist

Open science is a global movement to make scientific research processes and products accessible to all. The key principle is transparency, and by making science more transparent, scientists promote equity, inclusivity, and collaboration. Open science practices also make the research process more effective. With the availability of increasingly large and open datasets, scientists can engage with a global pool of researchers who bring a diversity of perspectives to make meaningful scientific progress.

Common practices of open science include:

- using reproducible workflows and publishing model code
- practicing data management in accordance with the FAIR principles (Findable, Accessible, Interoperable, Reusable)[1]
- contributing data to existing public databases *(see sidebar)*
- publishing in open-access journals that the public can read without paying for a subscription (e.g., the *San Francisco Estuary and Watershed Science* journal)

For many years, the Delta Science Program (DSP) has promoted open science principles. The DSP is guided by its vision of *One Delta, One Science*, which is based on an open Delta science community. In 2014, the DSP hosted an environmental data summit, along with California's Department of Water Resources, Department of Fish and Wildlife, the Delta Conservancy, the San Francisco Estuary Institute, the State Water Board, the State Water Contractors, and other experts, to discuss solutions for sharing and integrating environmental data. Since then, the DSP and partners have continued their commitment to making scientific ideas, research, and results accessible. Currently, DSP requires that all data generated from DSP-funded research be made publicly accessible, except for sensitive data such as human subject data and tribal knowledge *(see box next page)*. Scientists funded by the DSP must add their research to the Delta Science Tracker, a public online database

Open Data Platforms for the Delta

- CEDEN (California Environmental Data Exchange Network)
- EDI Repository (Environmental Data Initiative)
- IEP Monitoring Data
- CNRA Open Data Platform
- CDFW California Natural Diversity Database
- PAD (CDFW Fish Passage Assessment Database)
- DataOne
- EcoAtlas
- SWAMP (Surface Water Ambient Monitoring Program) and other Water Board monitoring data
- USGS National Water Information System
- Bay-Delta Live
- SFEI HAB satellite data

[1]Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3:160018 (2016). https://doi.org/10.1038/sdata.2016.18

that promotes collaboration and information sharing across the scientific community. The 2019 Delta Science Plan has open science principles woven throughout, including specific goals of developing a shared framework for data management and promoting access to scientific literature and tools. DSP has also been investing in resources to promote broad access to data and computing, including an R Shiny dashboard for synthesis products and cloud computing resources for the community.

The DSP is in good company in its emphasis on open science. The 2014 data summit laid the foundation for California Assembly Bill 1755, The Open and Transparent Water Data Act, mandates a statewide open science platform for water and ecological data. The IEP's data utilization working group is leading the way for open science in California by developing best practices for data management and storage and promoting openness and interoperability. The State Water Board's College of Water Informatics offers an excellent set of resources such as training, templates, and how to get engaged with the open science community. The federal government has declared 2023 the Year of Open Science, with participation from federal agencies, including the US EPA, the National Science Foundation, and the USGS. Across the board, agencies and scientific institutions are working to ensure that the public has meaningful access to publicly funded research and that data are easy to find and use. Together, these open science efforts are expanding the reach of scientific ideas and advancing scientific progress, making open science good for society and good for scientists.

Special Considerations for Open Science

One of the key tenets of open science is sharing data. And while openly sharing research and data certainly has many benefits, what can we do when sharing data could be harmful?

The DSP and other agencies with data-sharing requirements make special exceptions for sensitive data, such as Tribal and traditional knowledge. For example, in recognition of the inherent sovereign right for Tribes to govern and control their own data, there may be specific ways that proprietary Tribal knowledge can be used and specific people with whom it can be shared. This draws a sharp contrast with, for example, the Western science practice of making a dataset available for anyone to download and use as they wish.

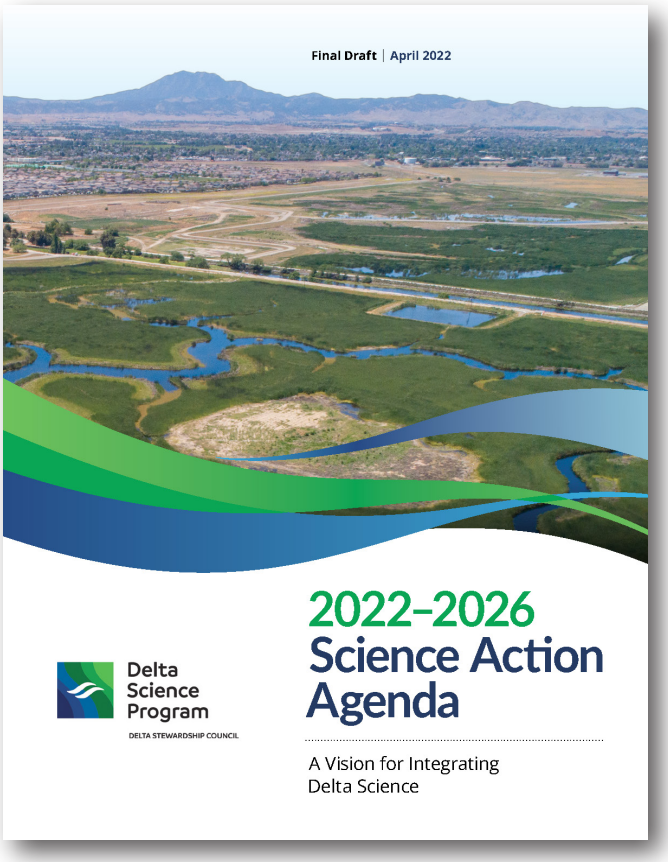
Consider a hypothetical example of a study on vegetation range shifts due to climate change. Such a study could benefit from understanding traditional knowledge about where specific plants are located and how those locations have shifted over time. However, publicizing such data could lead to over-harvesting or interfere with sacred locations. In such a situation, traditional knowledge can be interwoven with research without being disclosed beyond the research team.

To ensure that valuable Tribal knowledge is not exploited, DSP and many other agencies follow guidelines such as the CARE principles put forth by the Global Indigenous Data Alliance: indigenous data should be used for the **C**ollective benefit; Indigenous people have the **A**uthority to control their own data; there is a **R**esponsibility to ensure that Tribal knowledge is used to benefit tribes; and **E**thical processes are followed to protect Indigenous peoples' rights and well being.

By following these principles and working with Tribal experts, we can protect sensitive data from unintended use. "CAREful" management of sensitive data also builds trust, encouraging more collaboration among Tribal experts, agencies, and scientists.

Pushing the Open Science Frontier Further through Science Funding

By Dylan Stern, Environmental Program Manager



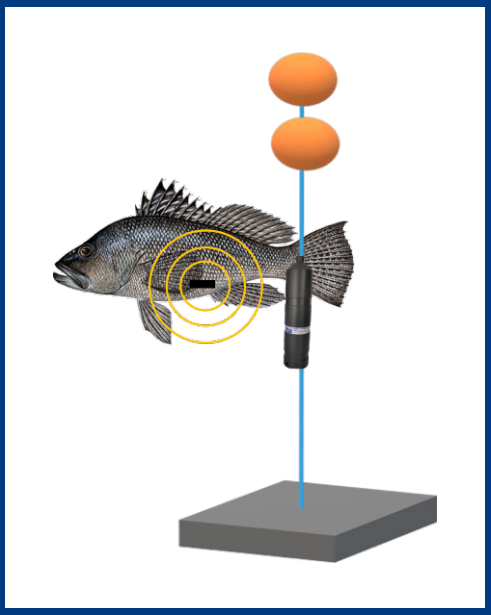
Research funded by the 2023/2024 Delta Research Proposal Solicitation will reduce uncertainty in decision-making by filling knowledge gaps identified in the 2022-2026 Science Action Agenda to support natural resource management in the Delta. We believe this will be achieved best by encouraging open science. Understanding interacting effects across a dynamic, complicated system like the Delta requires long-term data across multiple components of the Delta (for example water, fisheries, and habitat) that **are available quickly enough** to inform operations and other decisions. Synthesis, data integration, and analysis will be the most efficient and useful by adopting open-source technologies and by fostering data that is open, interoperable, discoverable, and usable by all.

Recognizing the importance of open science principles, researchers applying to the 2023/2024 Solicitation are required to make all data generated from Delta Science Program-funded research publicly accessible with the exception of sensitive data. Researchers are strongly encouraged to follow the FAIR (findable, accessible, interoperable, reusable) data principles, to publish reproducible modeling workflows including quality assurance documentation, and to publish their work in open-access journals. Check out the "Special Considerations for Open Science" article on page 5 in this newsletter for more details!

Open science is the way of the future. Join us and others on a data journey to enhance data reproducibility, transparency, accessibility, and equity for the Delta and beyond.

Research Highlights: Studies Funded by the Delta Science Program that Exemplify Open Science

By Eva Sideris, Delta Science Communication Fellow



Standard Operating Procedure for Diagnosing and Addressing Predator Detections in Salmon Telemetry Data

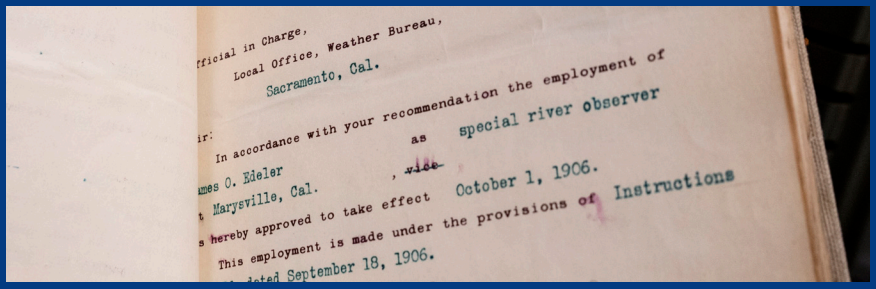
Principal Investigators Rebecca Buchanan from the University of Washington and Russell Perry from the U.S. Geological Survey

Acoustic telemetry is a widely used tag technology that tracks and transmits data about fish movements. It helps scientists understand the movements of juvenile salmon in the Delta and aids in decision-making on salmon management. But predators like striped bass, largemouth bass, and channel catfish feed on juvenile salmon, often ingesting telemetry tags along with the fish. Even after the tagged fish is digested, the telemetry tag continues to transmit location data – only now it is tracking the movement of a predator instead of a juvenile salmon. Thus, tags can produce misleading data unless scientists can accurately determine if a juvenile salmon was eaten. To address the problem, scientists from the University of Washington and the U.S. Geological Survey (USGS) are creating a standard operating procedure (SOP) for interpreting telemetry data and diagnosing and handling detections of predator-impacted tags. The research team is developing the SOP using spring-, fall-, and late-fall run Chinook salmon and Steelhead data from the Sacramento River in the North Delta and the San Joaquin River in the South Delta. Researchers are also developing a software program and training opportunities that will be freely available on www.cbr.washington.edu. There is also a resource guide and literature review for addressing the problem of tag predation in salmonid studies in the Central Valley of California.

Assessing Sea-Level Rise and Flooding Changes in the Sacramento-San Joaquin Delta Using Historical Water-Level Records

Principal Investigators Stefan Talke from California Polytechnic State University and David Jay from Portland State University

Record keeping may feel like a simple scientific activity, but stretched over a century, long-term water level records transform into a treasure trove for researchers evaluating the incremental effects of important climate and landscape changes in the Delta. Scientists from California Polytechnic State University and Portland State University have been busy digitizing and analyzing decades of 'lost-and-forgotten' water level changes from the region, stretching as far back as the 1800s. The newly recovered tidal records, obtained from California state archives and other old records, contain valuable information about water level changes including historical tidal, flood, and sea level trends. This information can help researchers identify specific current flood risk hotspots within the Delta due to factors like climate change and physical alterations by humans, providing researchers with a better understanding of how changing water levels are affecting current tidal levels. The project will also include 'time scale' maps that can show the time remaining until flooding becomes chronic in Delta communities.

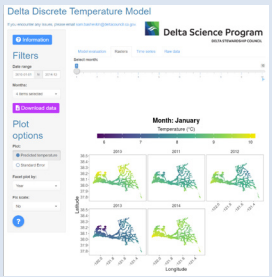
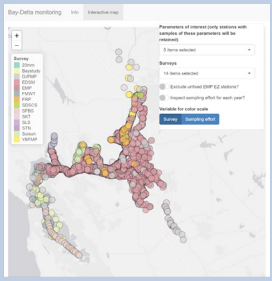


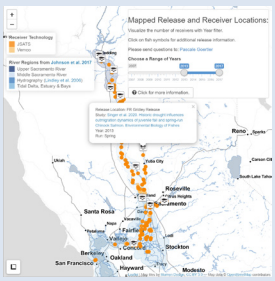
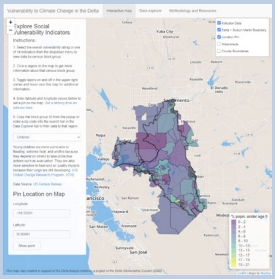
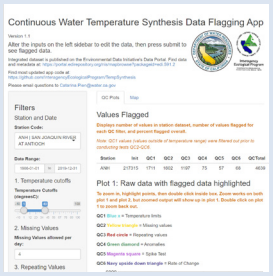
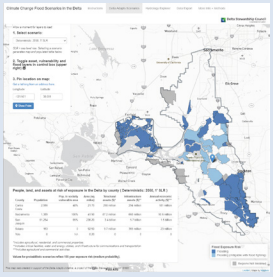
Shiny Apps: An Open Door to Open Data for Synthesis

By Lynn Takata, Senior Environmental Scientist Specialist

As the effects of climate change layer on top of the challenges we already face in our complicated Delta system, the need to answer broader, more complicated environmental questions continues to grow. Integrating data, ideas, and experts from diverse disciplines is a powerful approach for such problems. Also known as "scientific synthesis," this integration can help us begin to answer more holistic questions not addressable by examining any single element on its own.

An essential element for synthesis is the open availability of data. To that end, the DSP leverages Shiny, a digital interface for creating point-and-click applications in the programming language R. The DSP hosts several Shiny applications developed by members of the Delta science and management community, allowing anyone who is interested to browse, visualize, and download a wealth of data from across the Bay-Delta system. The Shiny applications are described below and are openly available on our Shiny application web page.

Application	Description
 **Zooplankton Synthesis App**	Integrates zooplankton data from five different long-term monitoring programs run by the Interagency Ecological Program. Data may be searched, mapped, graphed, and downloaded by criteria such as taxa, community, size class, survey, or time period.
 **Delta Discrete Temperature Model**	Presents modeled surface water temperatures across the Delta and Suisun Bay. Temperature model estimates are based on point measurements taken by 11 different studies conducted by the Interagency Ecological Program, the U.S. Geological Survey, and the U.S. Bureau of Reclamation.
 **Bay-Delta Monitoring Map**	Displays sampling coverage across space and time for 13 Bay-Delta long-term monitoring programs, allowing users to explore when and where data is available from each program. Maps may be generated by organism group of interest, survey, station, and sampling effort.

 **Salmon Release and Telemetry Receiver Map**	Map of telemetry receivers in the Delta and upstream Sacramento River, with locations where tagged salmon have been released. Telemetry receivers detect and record when fish with implanted telemetry tags pass nearby. See the earlier article in this issue, "*Standard Operating Procedure for Diagnosing and Addressing Predator Detections in Salmon Telemetry Data*," on page 7.
 **Climate Change Social Vulnerability Map**	Illustrates the overlap of vulnerable human populations with climate hazards, including flood risk, extreme heat, and wildfires, through the Delta Social Vulnerability Index. The app integrates fourteen indicators that contribute to increased sensitivity and decreased adaptive capacity to these hazards. These indicators were developed by Delta Stewardship Council staff through a literature review and interviews with Delta community leaders.
 **Continuous Water Temperature Synthesis and Data Flagging**	Brings together continuous water temperature data from multiple sources in the San Francisco Estuary into an integrated, standardized, and quality control checked dataset. Users can graph and map the data by criteria such as station, date, temperature cutoffs, and quality control thresholds.
 **Delta Fish Database**	Integrates fish data from nine different long-term surveys run by the Interagency Ecological Program across the San Francisco estuary. Over 50 years of data and 224 fish taxa are included, and users can search, graph, and download data by survey, years, and species.
 **Climate Change Flood Scenarios in the Delta**	Allows users to visualize and download flood scenarios developed by the Delta Stewardship Council's Delta Adapts program. Users can map flooding risk along a number of criteria, including different future scenarios and the people, land, and assets at risk.

Recent Publications from the Delta Science Program

This roundup of new scientific journal articles features publications funded by the Delta Science Program (DSP) and authored by our staff. Funding scientific research is one of the ways that we carry out our mission to provide the best possible scientific information for decision-making in the Delta. Since our inception, the Delta Science Program has funded hundreds of research projects that advance our fundamental understanding of the Bay-Delta social-ecological system.

Publications Authored or Co-Authored by DSP Staff

**Highlighted author names below indicate current or former DSP staff.*

- Cox M, Harrison HL, Partelow S, Curtis S, **Elser SR,** Wagner CH, Hobbins R, Barnes C, Campbell L, Cappelatti L, De Sousa E, Fowler J, Larson E, Libertson F, Lobo R, Loring PA, Matsler AM, Merrie A, Moody E, Quiñones R, J. Sauer R, Shabb K, Simonsen SH, Washko S & Whitaker B. (2023) **How Academic podcasting can change academia and its relationship with society: A conversation and guide.** *Frontiers in Communication.*

- Grimm NB, Kim Y, Sauer JR, & **Elser SR** (2023) **Nature-based Solutions and Climate Change Resilience.** *In Nature-based Solutions for Cities* (pp. 13-28). Edward Elgar Publishing.

- Pak N, **Colombano DD,** Greiner T, Hobbs JA, Carlson S, & Ruhi A (2023) **Disentangling abiotic and biotic controls of age-0 Pacific herring population stability across the San Francisco Estuary.** *Ecosphere,* 14(5).

- **Rudnick J,** Khalsa SDS, Lubell M, Leinfelder-Miles M, Gould K, & Brown PH (2023) **Understanding barriers to adoption of sustainable nitrogen management practices in California.** *Journal of Soil and Water Conservation,* 78(4): 347-363.

- Johnson D, Almaraz M, **Rudnick J,** Parker LE, Ostoja SM, & Khalsa SDS (2023) **Farmer Adoption of Climate-Smart Practices Is Driven by Farm Characteristics, Information Sources, and Practice Benefits and Challenges.** *Sustainability,* 15 (10): 8083.

- Sommer T, Conrad LC, & **Culberson S** (2023) **Data to Decisions: How to Make Science More Relevant for Management of the San Francisco Estuary.** *San Francisco Estuary & Watershed Science,* 21(1).

- Yando ES, Jones SF, James WR, **Colombano DD,** Montemayor DI, Nolte S, Raw JL, Ziegler SL, Chen L, Daffonchio D, Fusi M, Rogers K, & Sergienko L. (2023) **An integrative salt marsh conceptual framework for global comparisons.** *Limnology and Oceanography Letters.*

Publications Supported with DSP Funding

- Anthony TL, Szutu DJ, Verfaillie JG, Baldocchi DB, & Silver WL (2023) **Carbon-sink potential of continuous alfalfa agriculture lowered by short-term nitrous oxide emission events.** *Nature Communications,* 14: 1926.

- Gross E, Holleman R, Kimmerer W, Munger S, Burdick S, & Durand J (2023) **Using Age Tracers to Estimate Ecological Rates in a Phytoplankton Model.** *Water,* 15(11), 2097.

- Hagani JS, Takekawa JY, Chappell SC, Tanner RL, Ernst AR, & Kettenring KM (2023) **A remote sensing approach to assess the historical invasion of Phragmites australis in a brackish coastal marsh.** *Frontiers in Ecology and Evolution,* 11.

- Hendrix NA, Fleishman E, Zillig MW, & Jennings ED (2023) **Relations Between Abiotic and Biotic Environmental Variables and Occupancy of Delta Smelt (Hypomesus transpacificus) in Autumn.** *Estuaries and Coasts,* 46: 149-165.

- Klotsko S, Maloney J, & Watt J (2023) **Shallow deformation on the Kirby Hills fault, Sacramento–San Joaquin Delta, California (USA), revealed from high-resolution seismic reflection data and coring in a fluvial system.** *Geosphere,* 19 (3): 748–769.

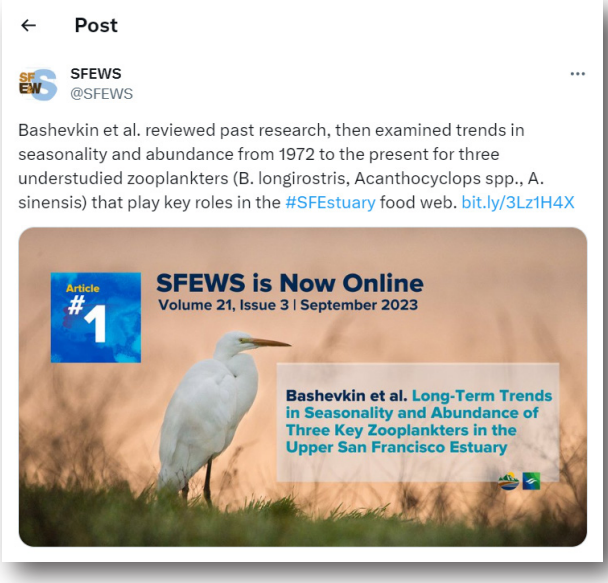
- Richardson CM, Young M, & Paytan A (2023) **Paired Synoptic and Long-Term Monitoring Datasets Reveal Decadal Shifts in Suspended Sediment Supply and Particulate Organic Matter Sources in a River-Estuarine System.** *Estuaries and Coasts,* 46: 660–677.

- Tran V, Helmrich S, NWT Quinn, & O'Day PA (2023) **Operationalizing Real-Time Monitoring Data in Simulation Models Using the Public Domain HEC-DSSVue Software Platform.** *Journal of Water Resources Planning and Management,* 149(9).

#SciComm Corner

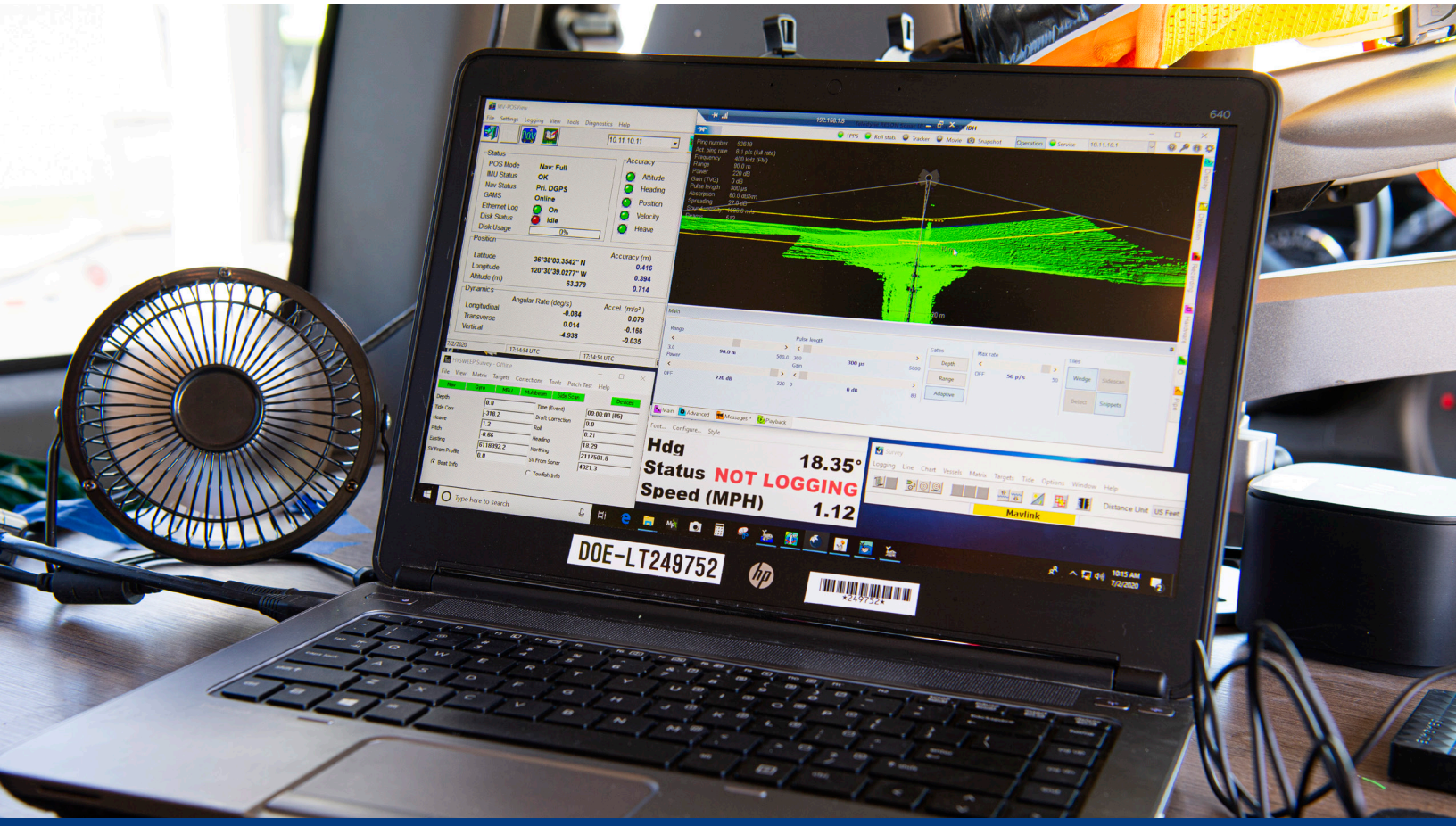
SF Estuary Partnership (@SFEstuary) announces March 12–13, 2024, as the dates of the next State of the San Francisco Estuary Conference.

San Francisco Estuary Watershed Science (@SFEWS) publishes its newest issue, which includes an article about zooplankton.



Delta Science Program (@DeltaCouncil) California State Fellow Sam Pyros writes about the Delta breeze as part of the Delta Science Spot series.

The Delta Stewardship Council (@DeltaCouncil) promotes the Delta Independent Science Board's seminar series recordings on YouTube.



Events on the Horizon

November

- Delta Independent Science Board Meeting & Food-Webs Workshop
  November 8–9
- Delta Invasive Species Symposium
  November 30

December

- Delta Independent Science Board Meeting
  December 6

Visit our event web page for more.