Delta Stewardship Council
A CALIFORNIA STATE AGENCY

INFORMATION ITEM

Lead Scientist Report

Summary

Avouris et al. (2025) undertook a study to show how in-the-water measurements and continuous sensors can be integrated with less frequent satellite data to give an independent and regional view of water quality in the Delta at any point in time. They took data on dissolved organic matter (DOM) from extensive US Geological Survey datasets in 2018–2020 and combined that data with Sentinel-2 satellite imagery. They then used the combined data to create a machine learning model that can estimate DOM concentrations across the entire Delta whenever a new satellite image is collected. The resulting "ground-to-space" network can be used to create and continually update data-driven remote sensing models that facilitate near real-time monitoring of environmental conditions at regional scales.

Using a ground-to-space sensor network to monitor dissolved organic matter in the Delta

Avouris, D. M., Hestir, E. L., Fleck, J., Hansen, J. A., & Bergamaschi, B. A. (2025). An Integrated Sensor Network and Data Driven Approach to Satellite Remote Sensing of Dissolved Organic Matter. Earth and Space Science, 12(9), e2024EA004048. https://doi.org/10.1029/2024EA004048

Using satellite data to monitor environmental conditions in the Delta (and beyond) is becoming increasingly important and sophisticated. One of the main advantages of using satellite data (often referred to as "remote sensing") is that data can easily be collected over large areas relatively quickly and cheaply, especially when compared to using individual on-the-ground instrumentation. Previous Lead Scientist Reports have described how scientists can use satellites to directly measure things like water surface elevation and subsidence (e.g., see the February and July 2025 reports). However, remotely sensed data can also be used to build and operate models which estimate environmental conditions across broad areas. The general idea is to take actual on-the-ground measurements and match them to what the satellite can see in the same place at the same time. Because every “real” ground measurement is now associated with satellite data, you can train a computer model to use the satellite data to estimate what is present in areas where you don’t have sensors on the ground. This data-driven approach to modeling is a type of machine learning—and the more on-the-ground data points you have, the better the model learns.

Avouris et al. (2025) used this approach to build a model that estimates water concentrations of dissolved organic matter (DOM) in Delta waterways. This is important because DOM plays a large role in aquatic ecosystems, helping to power microbial respiration and affecting how nutrients and contaminants behave in the system. DOM can also be used to track other constituents, like mercury or salinity. From a regulatory perspective, high DOM can be a problem for wastewater treatment plants, where the DOM can lead to toxic chlorinated byproducts.

The researchers used a dataset of DOM concentrations measured between 2018 and 2020 at nine continuous water quality monitoring stations in the Delta operated by the U.S. Geological Survey (USGS). They matched nearly 1,000 of these DOM measurements with concurrent satellite imagery from the European Space Agency’s Sentinel-2 mission, and used those matches to train a machine learning model to estimate DOM concentration based solely on satellite imagery. This is doable because most DOM is colored brown, like tea or coffee. However, measuring water quality remotely is hard because water absorbs so much of the light hitting it, rather than reflecting the light back as a signal. Avouris et al. 2025 is one of the first successful attempts to build a repeatable remote-sensing model for water quality in our complicated Delta, focusing on a water component that is actually in the visible spectrum. The model worked well: It could estimate DOM with reasonable accuracy across the Delta, during different seasons, and at varying tidal stages. This success was in large part due to the extensive USGS dataset, which provided sufficient data to train the model. (Similar modeling efforts in the past have had to rely on far fewer data.)

However, the implications of the study extend beyond DOM monitoring. Zooming out, the study acts as proof of concept for how on-the-ground sensors can be integrated with satellite data. The resulting “ground-to-space” network can be used to create and continually update data-driven remote sensing models that facilitate near real-time monitoring of environmental conditions at regional scales. Thinking about the Delta, key takeaways from the study include:

- Remote sensing models built by combining on-the-ground data with satellite data can be used to monitor water quality across large areas in close to real-time.
- Such models can help to inform proactive and quick-response decision-making, perhaps by feeding their results into live data dashboards.
- Maintaining and further developing robust on-the-ground monitoring networks—such as those operated by USGS—is vital for developing effective remote sensing models.
- As technology advances there will be an increasing need for collaboration and coordination across the Delta on things like data storage, quality assurance and control, cloud computing, and model compatibility.
- This is a key motivation for the Delta Collaboratory, a Council Delta Science Program project to help develop a collaborative virtual hub that promotes open science and resource sharing to support synthesis and modeling.

Delta Science Program Activities

Peer review updates

The peer review for the “Water Year 2024 and 2025 Winter-Run Chinook Salmon Annual Loss,” requested by the US Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR), kicked off on November 13. The intent of the review is to provide Reclamation and DWR with recommendations to stay within the annual loss thresholds for natural and hatchery winter-run Chinook salmon as part of State Water Project and Central Valley Project operations. These thresholds are outlined in the Incidental Take Permit (one of the regulatory requirements governing the water projects' operations), which calls for this review if an exceedance occurs. The three-member panel will write a joint panel letter by late January. The review also provided an opportunity for public input on the review through December 15. You can learn more about the peer review here: https://deltacouncil.ca.gov/delta-science-program/water-year-2024-and-2025-winter-run-chinook-salmon-annual-loss-independent-peer-review.

The peer review for the "Spring-Run Juvenile Production Estimate" (SRJPE) requested by DWR is in the planning stages and will start early 2026. The SRJPE will support the development of future measures to minimize the impacts of water operations on spring-run Chinook salmon and development of a spring-run life cycle model. Reviewers will be asked to provide recommendations for improving the SRJPE. A public meeting will be held for the review in February, and the review will wrap up in spring 2026.

Initial efforts are underway to organize the peer review for the "Stanislaus River Steelhead Juvenile Production Estimate" requested by Reclamation. The juvenile production estimate (JPE) represents the estimated number of juvenile steelhead that migrate out of the streams where they were born each year and may help inform actions to increase steelhead abundance and survival through the Delta. Reviewers will be asked to evaluate the steelhead JPE framework and make recommendations on approaches to establish a steelhead JPE.

Draft 2026 Delta Science Plan released

The draft 2026 Delta Science Plan is now available for public comment. The Delta Science Plan provides the vision, principles, and approaches for conducting, coordinating, and communicating science in the Delta. Drafting each iteration of the Delta Science Plan provides an opportunity for us to work together as a community to identify tools and strategies that are relevant to current science and management needs. Public comments may be submitted through a survey, email, or mail. For more information on how to provide public comment, please see the Delta Science Plan webpage: https://deltascienceplan.deltacouncil.ca.gov/. By providing feedback on the draft 2026 Delta Science Plan, you will help ensure the plan accurately reflects the needs of the Delta science community.

On Your Radar

Save the date! Bay-Delta Blue Carbon Symposium – March 5, 2026

The Council's Delta Science Program is collaborating with UC Davis's Coastal and Marine Sciences Institute to host a symposium on March 5, 2026. The symposium will convene leading researchers, policymakers, natural resource managers, practitioners, and other interested parties to explore the science and policy of blue carbon (carbon captured and stored in coastal and aquatic ecosystems) in the Bay-Delta. The event will highlight the current state of the science on topics like greenhouse gas atmospheric flux, subsidence, and carbon crediting. It will also provide a platform for diverse perspectives on carbon management in the Delta and an opportunity to discuss the socio-political factors that influence this complex system. The symposium will be a hybrid event located on the UC Davis campus. More details on the agenda and registration are coming soon.

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

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