Operation Baseline: Modernizing Water Quality Monitoring to Capture Changes over Time and Space

Information Sheet

Delta Science Program
DELTA STEWARDSHIP COUNCIL

"Operation Baseline has transformed water quality monitoring in the Sacramento-San Joaquin Delta – we've gone from taking 'polaroid snapshots' of nutrient dynamics to 'streaming movies', which is much more helpful in managing the Delta ecosystem."

– Dr. Lisamarie Windham-Myers, Delta Lead Scientist

What is Operation Baseline?

It is a targeted multiyear research effort that was initiated in 2016 by the Delta Stewardship Council's (Council) Delta Science Program. The Council invested nearly $4.5 million to get the work off the ground, which later drew in additional funders. The effort was forged through collaboration across agencies, universities, and organizations to:

- Establish a baseline of water quality, focusing on nutrients and phytoplankton, in the Delta.
- Assess the effects of a $1.7 billion upgrade to a major wastewater treatment plant in the Delta (EchoWater).

Figure 1. Photograph of monitoring equipment. Credit: Tamara Kraus, U.S. Geological Survey

Modernize and expand water quality monitoring to better capture changes over space and time.

What motivated the project?

Operation Baseline was motivated in large part by the need to understand how nutrients influence the Delta food web (Figure 2). Phytoplankton feed zooplankton and other small organisms that many Delta fish rely on, yet scientists lacked the tools to measure exactly how nutrients regulate growth of those organisms.

Broadly, scientists understand that what drives the production of phytoplankton is the combination of water quality conditions (i.e., light availability, temperature, salinity, predation, etc.) and nutrients. Key nutrients like nitrate, ammonium, and phosphate must fall within a balanced range to support phytoplankton; too little limits productivity, while too much can fuel 'blooms', some of which produce toxins harmful to humans and pets and encourage growth of unwanted aquatic plants.

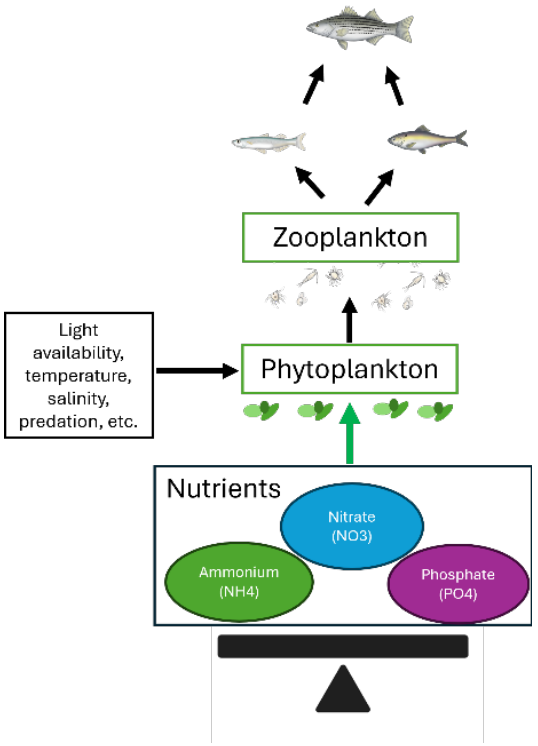

Figure 2. Simplified Delta food web. Nutrients affect phytoplankton growth, in addition to other factors. Fish depend on the lower food web to survive.

Figure 3. Sacramento Sewer District's EchoWater Resource Recovery Facility (EchoWater). This facility treats on average 135 million gallons of wastewater per day.

Why was the EchoWater Resource Recovery Facility Upgraded?

For years, several scientists suspected that high nitrogen inputs in the form of ammonium from wastewater treatment effluent were contributing to declines in beneficial phytoplankton and therefore causing fundamental changes to the ecosystem. In response to these concerns,

Sacramento Sewer District's EchoWater, the second largest facility of its kind in the United States (Figure 3), underwent a $1.7 billion upgrade to dramatically reduce nutrient discharges into the Delta by 2021. However, at the time the Delta's monitoring system wasn't designed to confirm whether the upgrade improved conditions. For example, ammonium was not consistently measured, and water quality data relied on spaced-out fixed stations and individual grab samples, making it impossible to fully evaluate the ecological effects of EchoWater or understand nutrient-phytoplankton dynamics across the Delta. Understanding the impact of the upgrade is further complicated by the Delta's dynamic and interconnected nature, where multiple factors such as estuarine hydrodynamics, drought and flood cycles, aquatic vegetation, invasive species, reservoir operations, wetland restoration, and engineered barriers all interact to influence water quality and ecosystem conditions.

How did Operation Baseline modernize water quality monitoring?

Operation Baseline studies began with a set of pilot studies designed to test new monitoring tools and methods, supported by an in-depth review of existing scientific literature to build a strong conceptual foundation. In the second phase, the research program continued advancing an innovative mapping survey technique developed by the USGS California Water Science Center Biogeochemistry Group (Figure 5).

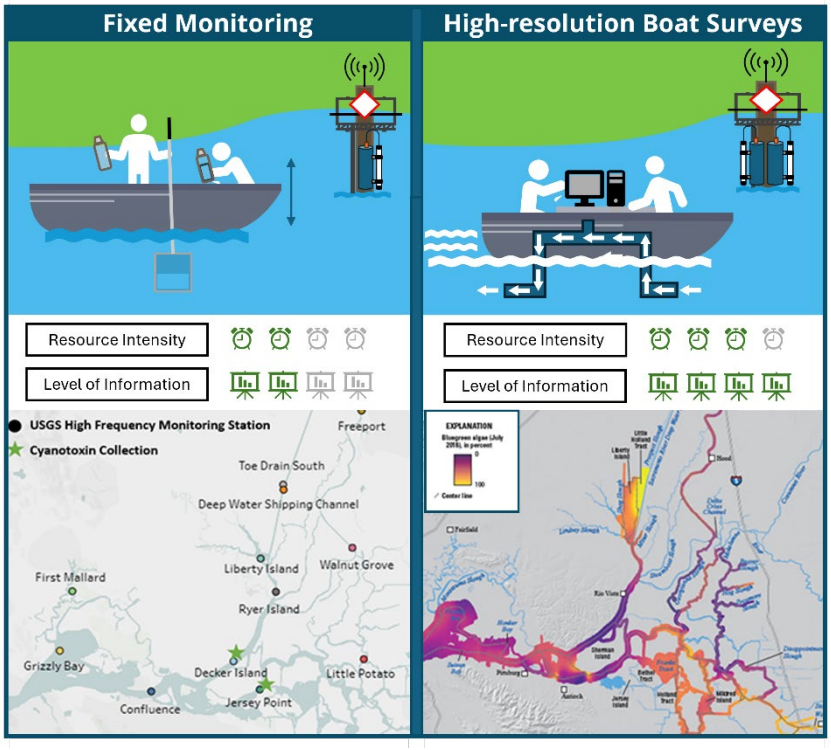

Figure 4. On the left, monitoring before Operation Baseline was limited to fixed stations scattered throughout the Delta and supplemented with occasional single samples. On the right, high-resolution boat surveys generate fuller maps of water quality conditions.

What makes this mapping approach groundbreaking is its ability to cover roughly 100 miles of waterways in a single day. As the survey boat moves, it

continuously pumps water through instruments that measure ammonium, nitrate, different groups of phytoplankton, and other key water quality indicators. With this method, scientists can generate a comprehensive spatial snapshot of conditions across the entire Delta in just three to four days.

Additional Operation Baseline studies set important benchmarks for nutrients in sediment, microbial community composition, stable isotope patterns, and water residence time. Another effort pioneered a new technique for measuring harmful algal bloom toxins at fixed stations and during mapping surveys. Together, these projects provide a stronger, more complete understanding of conditions in the Delta.

Which high priority science needs were addressed?

Importantly, Operation Baseline addressed two priorities in the Council's Science Action Agenda (SAA), a [BRIEF DESCRIPTION HERE]:

- Priority Science Action #4A (SAA 2017-2021): Implement studies to better understand the ecosystem response before, during, and after major changes in the amount and type of effluent from large point sources in the Delta including water treatment facilities.
- Science Action #1C (SAA 2022-2026): "identify and implement large-scale experiments that can address uncertainties in the outcomes of management actions for water supply, ecosystem function, and socioeconomic conditions in the Delta."

Operation Baseline results have informed the Delta Regional Monitoring Program multi-year study plan, nutrient standard development, and the California Department of Water Resources' Environmental Monitoring Program.

Learn more about the Science Actions laid out in the SAA at scienceactionagenda.deltacouncil.ca.gov.

What's Next?

While future funding for this research effort is uncertain, the value is clear. The rich datasets generated during this period serve as a critical baseline to compare with future conditions and improve modeling efforts. If measurements stop now, the full impact of reducing nutrients from treated wastewater will not be clear. These changes in the ecosystem can take many years to show up, in part due to nutrients stockpiled in the sediment and elsewhere. In addition, these data are essential to understand impacts of future management decisions, climate change, invasive species like golden mussels, wetland restoration, and other unknowns like levee breaches. Continued funding for this effort is crucial.

Project Contributors

The Council approved funding for the first pilot studies in 2017. Additional studies were funded by the Council between 2019-2022, and other collaborators and data users contributed funds and in-kind resources including the State Water Contractors, Delta Regional Monitoring Program, CA State Water Resources Control Board, CA Department of Water Resources, US Bureau of Reclamation, US Geological Survey, and others. Research teams included US Geological Survey, San Francisco State University, San Francisco Estuary Institute, Cal Maritime, and Sacramento Area Sewer District.

Where can I learn more?

USGS Comparison of Four Spring High-Resolution Mapping Surveys Report

SFEI Operation Baseline Science and Monitoring Needs Memorandum

SacSewer's EchoWater Resource Recovery Facility Article