Central Valley Regional Water Quality Control Board Delta Nutrient Research Plan 2026 Status Report

The Central Valley Regional Water Quality Control Board's Delta Nutrient Research Plan identifies information gaps for determining need and potential scope of water quality objectives for nutrients in the Delta. The Central Valley Water Board approved the Delta Nutrient Research Plan (NRP) under Resolution R5-2018-0059 (August 2018). Completion of the NRP was a priority action in the Central Valley Water Board's 2014 Delta Strategic Work Plan. The Plan's intent is to identify and collect information to determine the need and potential thresholds for numeric nutrient water quality objectives in the Delta. The Delta NRP was developed in collaboration with a public stakeholder group and technical expert working groups. The technical expert groups provided state of the science and remaining information gaps for the most important nutrient-related topics in the Delta: cyanobacteria harmful algal blooms (CHABs), excess aquatic plant growth, drinking water protection, modeling tools and nutrient forms and ratios. The Delta NRP includes summaries of nutrient-related concerns and prioritized tables of research, management and modeling needs.

Following approval of the Delta NRP, Central Valley Regional Water Quality Control Board staff (R5 staff) worked to fill data gaps through the Delta Regional Monitoring Program's (DRMP) projects, novel research, monitoring, creative use of sparse funds and collaborations. Cyanobacteria blooms and associated cyanotoxins were identified in the stakeholder advisory process as the nutrient-associated issue of greatest concern. Unfortunately, the Delta lacks regular monitoring of cyanobacteria and factors that affect bloom formation. Because of water quality concerns and extent of missing information, R5 staff focused on improving the understanding of cyanobacteria-nutrient relationships in the Delta.

Delta Nutrient Research Plan Implementation Actions

Implementation actions for the Delta NRP occurring in the period 2018-2025 are summarized below. Implementation actions include those directly involving R5 staff (Table 1) and activities led by other entities that fill information gaps (Table 2).

TABLE 1. IMPLEMENTATION PROJECTS INVOLVING R5 STAFF

Work Area	**Actions**
Nutrient Load Estimates	Estimation of Nitrogen (N) & Phosphorus (P) mass balances for 2008-2019 (R5 staff). Missing from existing mass balances and modeling are estimates of N & P flux from shallows and wetlands, N & P balances in dead-end channels and contributions of internal N & P cycling.
Modeling	Application of San Francisco Estuary Institute (SFEI's 3-dimensional hydrodynamic-biogeochemical model for the Delta to nutrient reduction scenarios. SFEI's model includes loss of phytoplankton by clam grazing and removal of nutrients by aquatic vegetation. The model predicts N fate & transport and total chlorophyll. Biogeochemical models of the Delta, including from this group, are not yet adept at predicting growth of cyanobacteria versus desirable phytoplankton (SFEI, DRMP and others)
Monitoring	Cyanotoxins monitoring at six sites in north, west and central Delta, 2020-2022 (USGS with funding from DRMP and others).
Cyanobacteria special studies	• Special study in 2020-2023 of cyanotoxin distribution and persistence in clams (R5 and DWR) • Special study in 2022 of nutrients and hydrodynamics in the Stockton Channel (R5 and DWR) • Special studies in 2020-2025 tracking strains of the cyanobacteria genus *Microcystis* between overwintering in sediment and summer growth in water column in various habitat types (R5 and DWR) • MERHAB 2024-2027 project monitoring cyanotoxins in the Delta and Bay and developing an Estuary-wide data platform (San Francisco Bay Regional Water Board, R5, SFEI, USGS and DWR with federal funding)
Mitigation and Management	• Pilot test of hydrogen peroxide treatment applied within floating containers in Discovery Bay. The treatment effectively removed Microcystis cells and associated toxins. • Open water test of hydrogen peroxide treatment in a lake near Discovery Bay that was initiated, then halted due to costs and logistics issues. • Project in the Stockton Channel in 2025-2029 assessing the effectiveness of dredging to limit HABs by removing nutrients and overwintering cells in sediment. (US Army Corps of Engineers, Port of Stockton, Robertson-Bryan Inc, DWR and R5)
Integration and Coordination	Development and ongoing implementation of the 2024 Delta CHAB Monitoring Strategy, a multi-agency effort led by Delta Science Program Implementation is led by State Water Board's Division of Water Rights and includes annual workshops, refinement of management questions and project tracking.

TABLE 2. OTHER IMPLEMENTATION PROJECTS TRACKED BY R5 STAFF

Work Area	**Actions**
Nutrient Status & Trends	• Syntheses of nutrient spatial distribution and temporal trends 2001-2016 (DRMP and SFEI) • Nonlinear regression models of nitrogen and phosphorus trends in the Delta (SFEI) • High-frequency monitoring cruises to understand spatial and temporal variation in nutrient forms throughout the Delta and in Suisun Bay, three times per year in 2018 and 2020-2024 (USGS with funding from DRMP; Richardson et al 2025 report). • Special study "Operation Baseline" of nutrient transport and transformations before and after the Sac Sewer treatment process upgrade (USGS, SFEI and Delta Science Program)
Nutrient Load Estimates	• Mass balances for nitrogen in the Delta in summer months 2006-2011 (SFEI, 2015) • Estimates of nitrogen and phosphorus loads entering Delta 1970-2019 (USGS, 2015 and 2021)
Cyanobacteria monitoring	New monitoring requirements in the Bay-Delta Plan which include regular cyanotoxin monitoring
Invasive Aquatic Macrophytes	Interagency Ecological Program's Aquatic Vegetation Project Work Team coordination and reviews of current research
Data Comparability	• Chlorophyll sensor intercalibration comparisons of discrete sample collections and fluoroprobe instruments (funded by DRMP and others, published by USGS and Dept. Water Resources) • Interagency Ecological Program's Phytoplankton Enumeration Synthesis Project review of methods and creation of standardized dataset for 20 years of microscopic count data from multiple projects (Dept. Water Resources)
Phytoplankton Abundance & Species	Special studies in the Sacramento River before and after completion of nutrient management upgrades to the Sacramento Regional wastewater treatment facility. (Sac Sewer, USGS, San Francisco Estuary Institute, DRMP)

CONCLUSIONS

Excess growth of cyanobacteria in the Delta is occurring within a global increase in cyanobacteria abundance and nuisance conditions. We know that nutrients are abundant in the Delta. In an average water year, an estimated 70% of nitrogen and 85% of phosphorus entering

the Delta is exported via San Francisco Bay and export pumps. The remainder is retained in the Delta or, in the case of nitrogen, recycled into the atmosphere. Rapid growth of Microcystis, an abundant cyanobacteria genus in the Delta, is triggered by sufficient water temperature and light. Microcystis bloom “hot spots” are also characterized by long water residence time and limited water mixing or turbulence. Ambient concentrations of nitrogen and phosphorus in the Delta are rarely below levels that are considered limiting to initiate phytoplankton and aquatic plant growth. High nutrients favor many types of phytoplankton, while physical conditions and, to some extent, nutrient proportions (stoichiometry), determine the potential for cyanobacteria bloom formation. Adequate nutrients are necessary for persistence of cyanobacteria blooms. Reducing nutrient inputs in the long term is important for reducing the occurrence of cyanobacteria blooms.

To these general understandings, monitoring and studies implemented under the Delta Nutrient Research Plan have added some key findings.

- Microcystis, the most abundant genus of HAB-forming cyanobacteria in the Delta, is genetically highly diverse. Genetic analyses found 36 genotypes of Microcystis in water and sediment samples from the Delta. Individual strains were found in more than one habitat type (flooded island, terminal channel, open water and main channel). Although each sample contained more than one genotype, the dominant strains varied spatially and temporally. The diversity of genotypes overwintering in sediment allows Microcystis to persist across a wide range of environmental conditions.
- Relative to other habitat types, Microcystis bloom “hot spots” have more Microcystis cells that overwinter in sediment. Persistence of cyanobacteria in the sediment through the winter, when it is largely absent from the water column, is a life history strategy that should be considered in management efforts.
- There is no confirmation thus far that water flow manipulation within the highly flow-regulated system of the Delta could limit cyanobacteria blooms. Even after extensive precipitation of Water Year 2023, the hot spot of Discovery Bay had thick cyanobacteria blooms that were typical of previous years. In comparison, the 2023 precipitation and high flows interrupted the pattern of dense cyanobacteria blooms that usually occur June-September in the Stockton Channel. Cyanobacteria blooms were absent in the Stockton channel in 2023 and 2024 while diatoms and chlorophytes were abundant. Two small cyanobacteria blooms appeared there briefly in summer 2025. Likely causes of this switch are dilution of nutrients in the water column and burial or flushing of overwintered cells and organic matter that would otherwise be available for internal recycling.
- Cyanobacteria management is difficult in the tidal system of the Delta. Treatment of bloom cells with peroxide in mesocosms showed good elimination of Microcystis cells and microcystins. The mesocosms also showed rapid recovery of microzooplankton and greater proportions of diatoms and green algae in the phytoplankton community after peroxide treatment. (3) In open water, difficulties in finding the effectual timing for peroxide treatments and high expense caused early termination of a pilot test.

- Nutrient management in the Delta must balance reducing eutrophic conditions with having sufficient nutrients to support primary production that is vital to food webs and healthy ecosystems. Based on nutrient manipulation bioassays with Delta water, attaining at least a 40% reduction in inputs of N and P could be effective for reducing bloom initiation and growth in the Delta (Preece et al, 2025). The DRMP's current nutrients modeling project underway will help our understanding of potential nutrient reductions and distribution throughout the Delta.
- Golden mussels, which were first visually observed in the Delta in 2024, are changing water quality in the Delta. Filder feeding by golden mussels is reducing turbidity and phytoplankton concentrations and increasing water clarity. In the Stockton Channel, for example, changes are substantial. More monitoring and updating of biogeochemical models will be needed to understand golden mussel impacts.