2012-2015 Phytoplankton Community Composition

The Department of Water Resources (DWR) and the US Bureau of Reclamation (USBR) are required by Water Right Decision 1641 (D-1641) to collect phytoplankton samples to monitor algal community composition at 13 selected sites in the upper San Francisco Estuary (Estuary) as part of the Environmental Monitoring Program (EMP). These sites represent a variety of aquatic habitats, from narrow, freshwater channels in the Delta to broad, estuarine bays. Sites were grouped into six regions based on location for analysis (Figure 1).

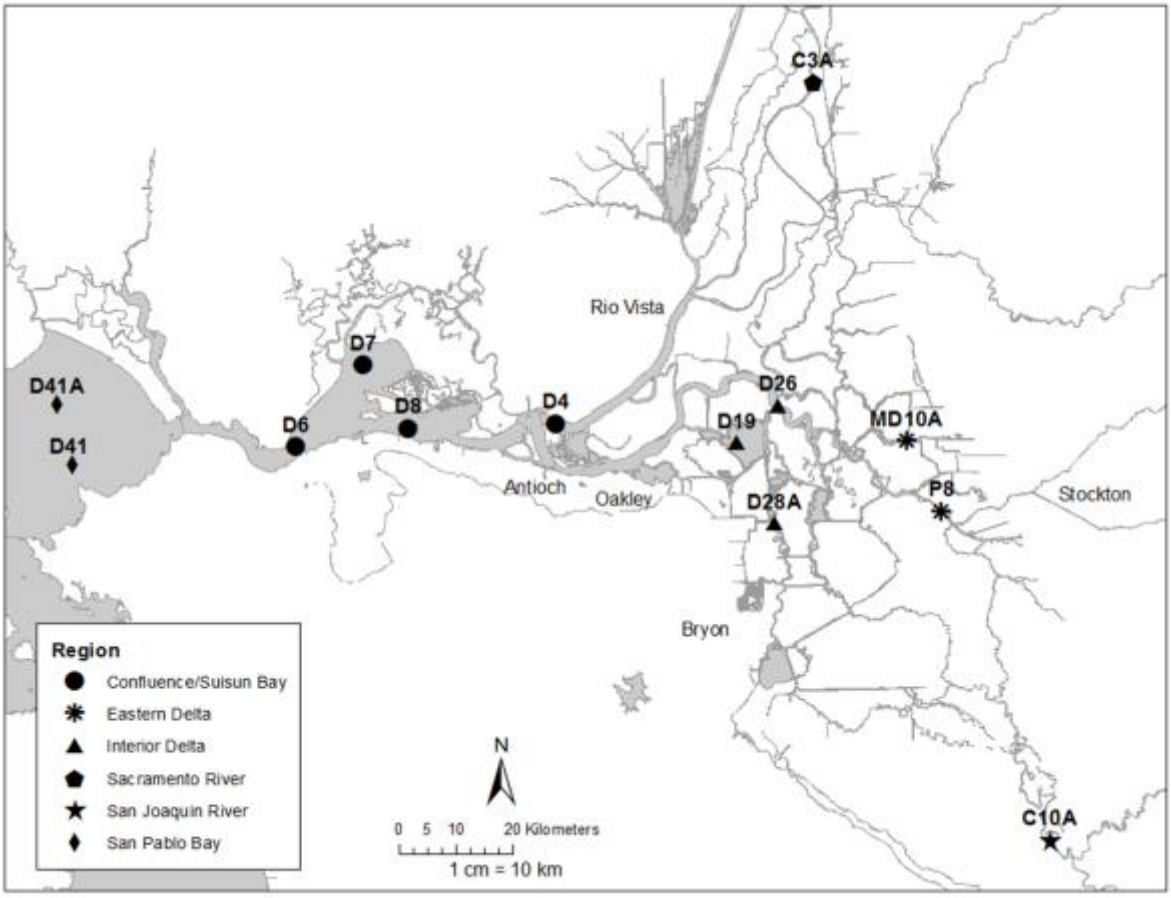

Figure 1. Map of Environmental Monitoring Program discrete phytoplankton stations.

Samples were collected using a submersible pump from 1 meter below the water's surface and stored in 50-milliliter glass bottles with Lugol's solution added as a stain and preservative. Phytoplankton were identified and enumerated, and organism counts for each sample were converted to organisms per mL. Any phytoplankton group that did not have significantly high yearly total was grouped together as "Other." Most of the December 2014 phytoplankton samples were frozen in transit; therefore, any analyses for December 2014 were removed since most of the samples were lost.

Note that even though the quantity of cyanobacteria is high, their sizes are considerably smaller than other phytoplankton such as centric and pennate diatoms, often by an order of magnitude or more. The biovolume of a large single-celled diatom such as *Coscinodiscus* sp. can be equal to or greater than a few hundred small cyanobacterial cells. While biovolume is important for assessing the potential food quality of phytoplankton available to higher trophic levels, count data, which is reported below, is necessary to determining the structure of the phytoplankton community.

Sacramento River (C3A)

Site C3A at the Sacramento River region was dominated by pennate diatoms in 2012-2013. Centric diatoms also made moderate contributions in 2012-2013. While 2012-2013 cyanobacteria totals were low, cyanobacteria dominated the site in 2014 and 2015 (Figure 2).

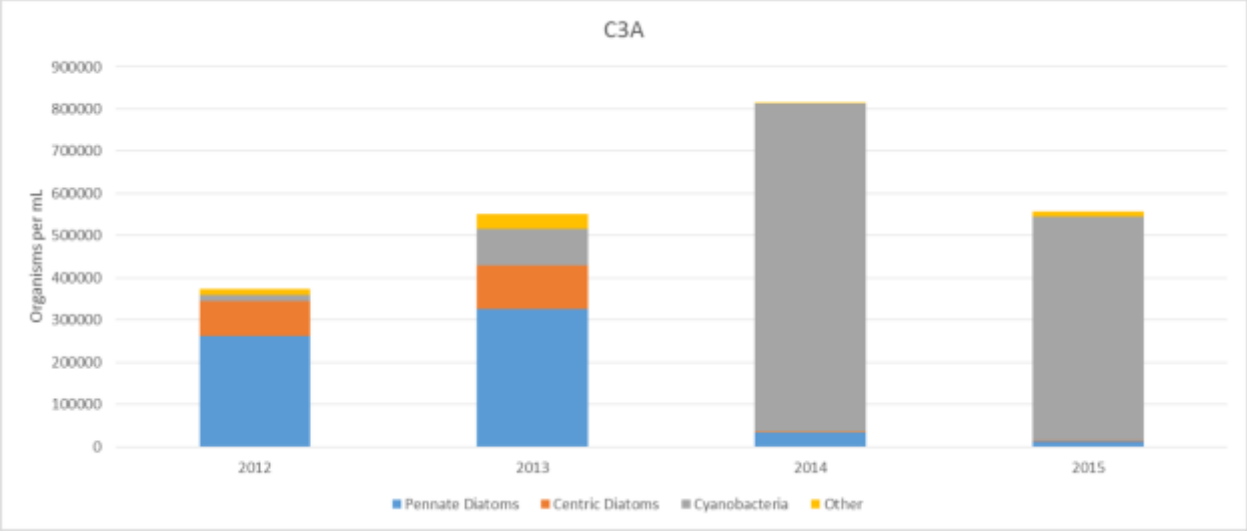

Figure 2. Phytoplankton yearly total organisms per mL at Sacramento River region: site C3A, 2012-2015. Other = cryptomonads, dinoflagellates, euglenoids, green algae, and chrysophytes. For all graphs and each year, "Other" represented the sum of the yearly organisms per mL from any phytoplankton groups that were present but low in numbers.

San Joaquin River (C10A)

In the San Joaquin River region, site C10A was dominated by centric diatoms followed by cyanobacteria in 2012-2013. Cyanobacteria comprised about 80% of all phytoplankton in 2014 and 2015, although the total organisms per mL for both years were drastically lower than the two previous years (Figure 3).

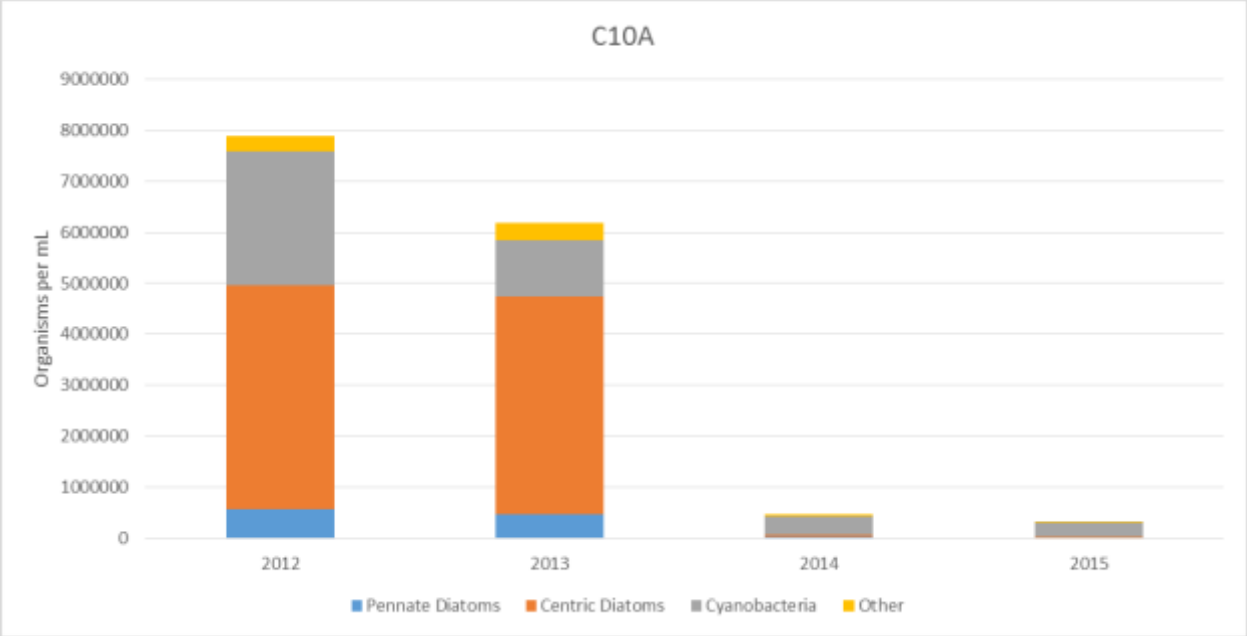

Figure 3. Phytoplankton yearly total organisms per mL at San Joaquin River region: site C10A, 2012-2015. Other = cryptomonads, dinoflagellates, euglenoids, green algae, raphidophytes, xanthophytes, and chrysophytes.

Interior Delta (D19, D26, D28A)

In the interior Delta, site D19 was dominated by cyanobacteria between 2012 and 2015, comprising over 70% of all phytoplankton in 2012-2013 and over 94% in 2014 and 2015. Cyanobacteria totals were also much higher in 2014 and 2015 (Figure 4). In 2013, site D26 was dominated by cryptomonads (66%) and cyanobacteria (25%) (Figure 5). With the exception of 2013, D26 was heavily dominated by cyanobacteria, which comprised 90% of the organisms in 2012 and over 96% in 2014-2015. Site D28A was heavily dominated by cyanobacteria between 2012 and 2015. Pennate and centric diatoms counts were at this station were much lower in 2014-1015 compared to 2012-13. (Figure 6).

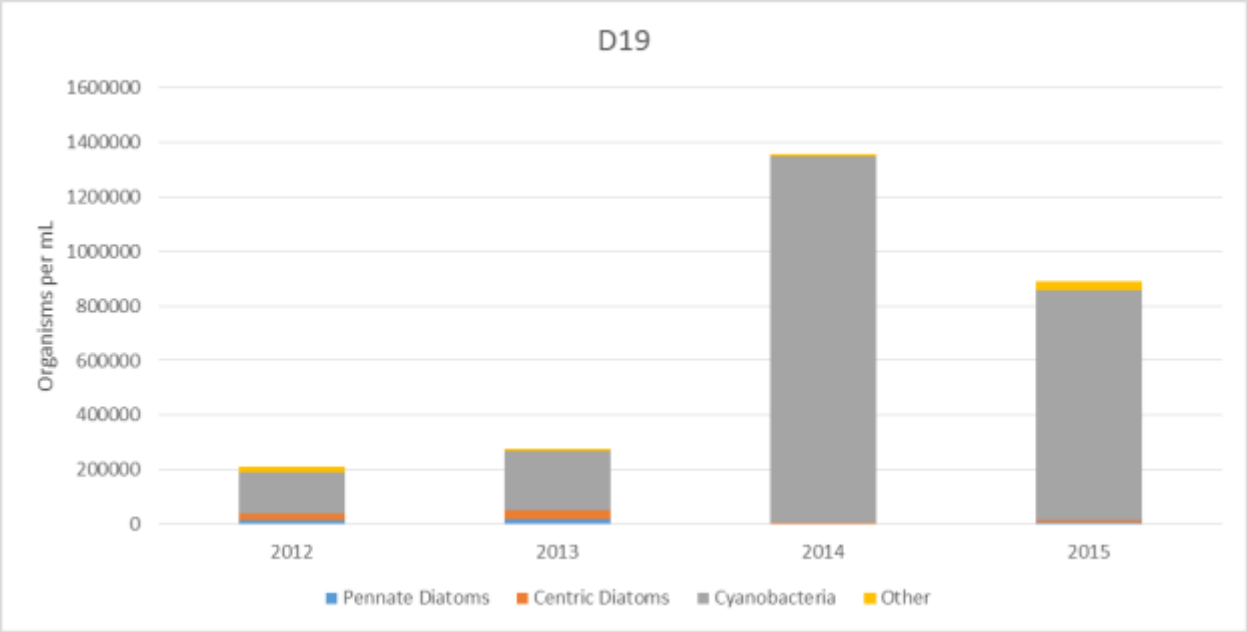

Figure 4. Phytoplankton yearly total organisms per mL at Interior Delta region (D19, D26, D28A): site D19, 2012-2015. Other = cryptomonads, dinoflagellates, euglenoids, green algae, xanthophytes, chrysophytes, and ciliates.

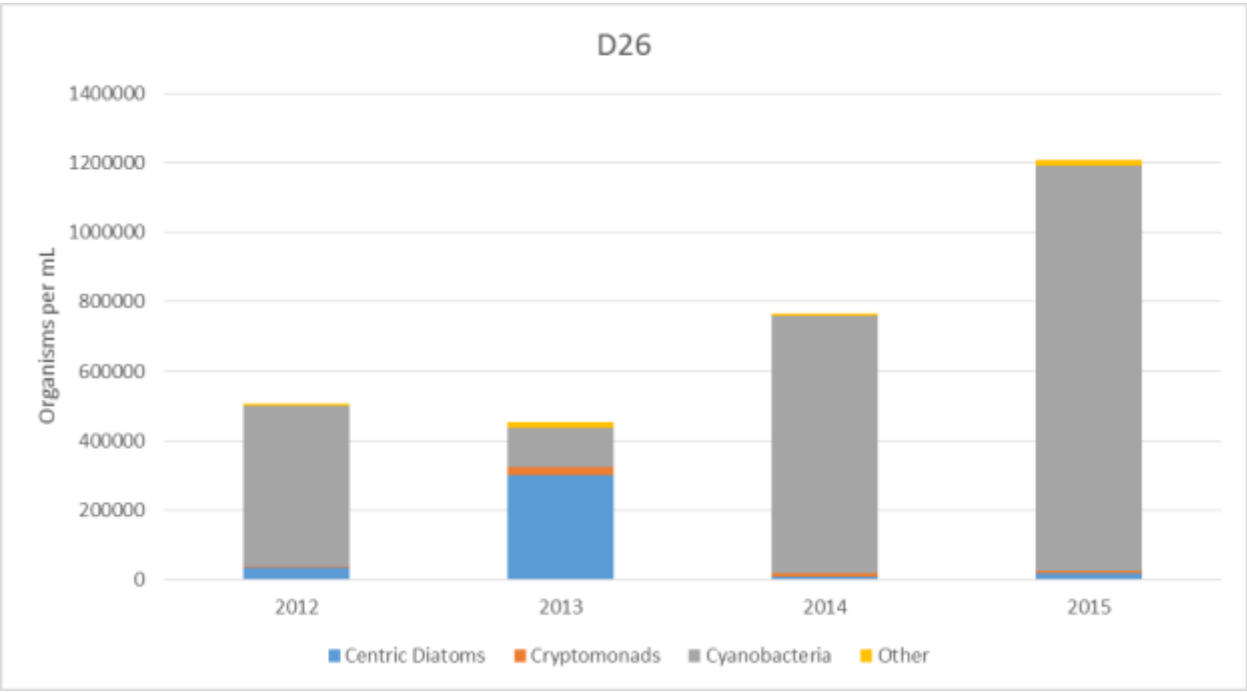

Figure 5. Phytoplankton yearly total organisms per mL at site D26, 2012-2015. Other = dinoflagellates, euglenoids, green algae, pennate diatoms, chrysophytes, and ciliates.

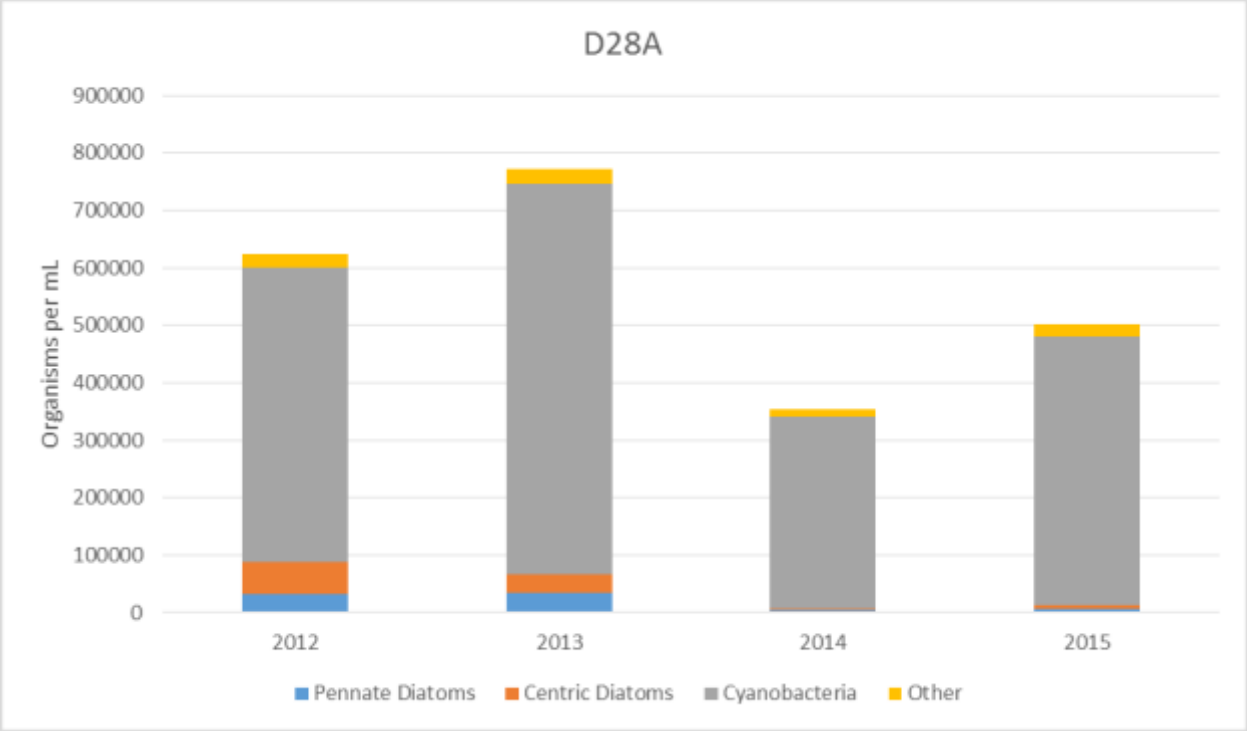

Figure 6. Phytoplankton yearly total organisms per mL at site D28A, 2012-2015. Other = cryptomonads, chrysphytes, euglenoids, and green algae.

Eastern Delta (MD10A and P8)

Site MD10A in the eastern Delta was dominated by cyanobacteria (73%) and centric diatoms (17%) in 2012. Total phytoplankton decreased after 2012, although cyanobacteria remained the dominant phytoplankton in 2014 and 2015. In 2013, MD10A was dominated by centric diatoms (58%) and cyanobacteria (32%) (Figure 7). Site P8 was heavily dominated by cyanobacteria through the 2012-2015 period. Centric diatoms made up 8% of all phytoplankton in 2012 and dropped below 1% in 2014 and 2015 (Figure 8).

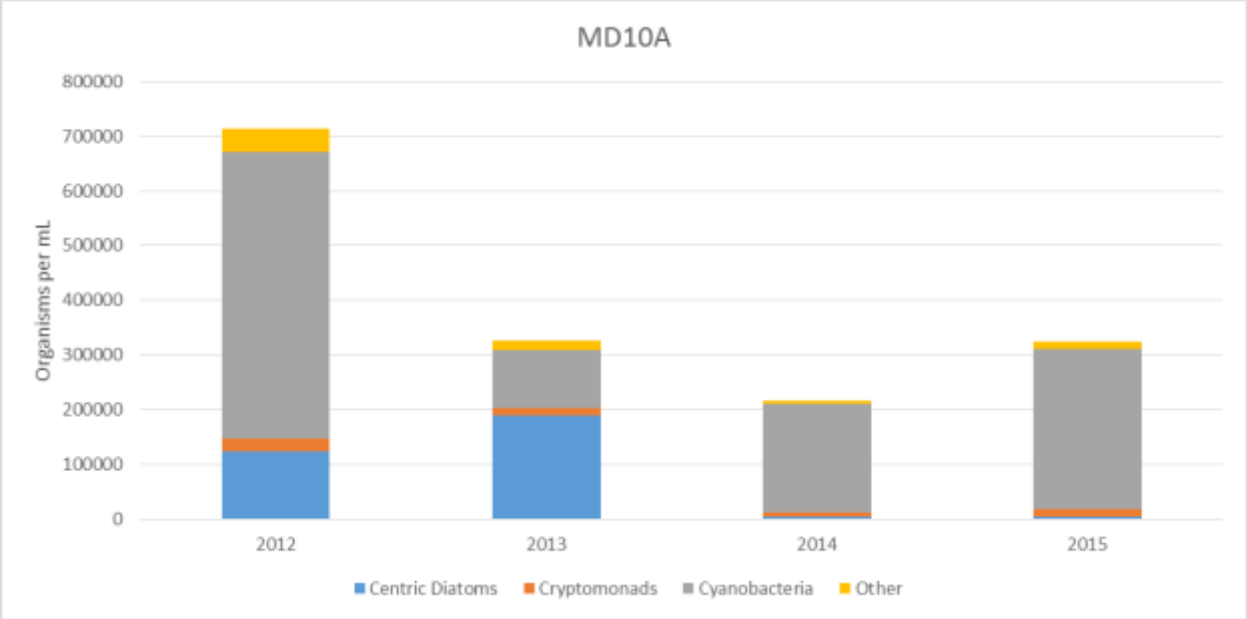

Figure 7. Phytoplankton yearly total organisms per mL at Eastern Delta region (MD10A, P8): site MD10A, 2012-2015. Other = dinoflagellates, euglenoids, green algae, synurophytes, xanthophytes, pennate diatoms, and chrysophytes.

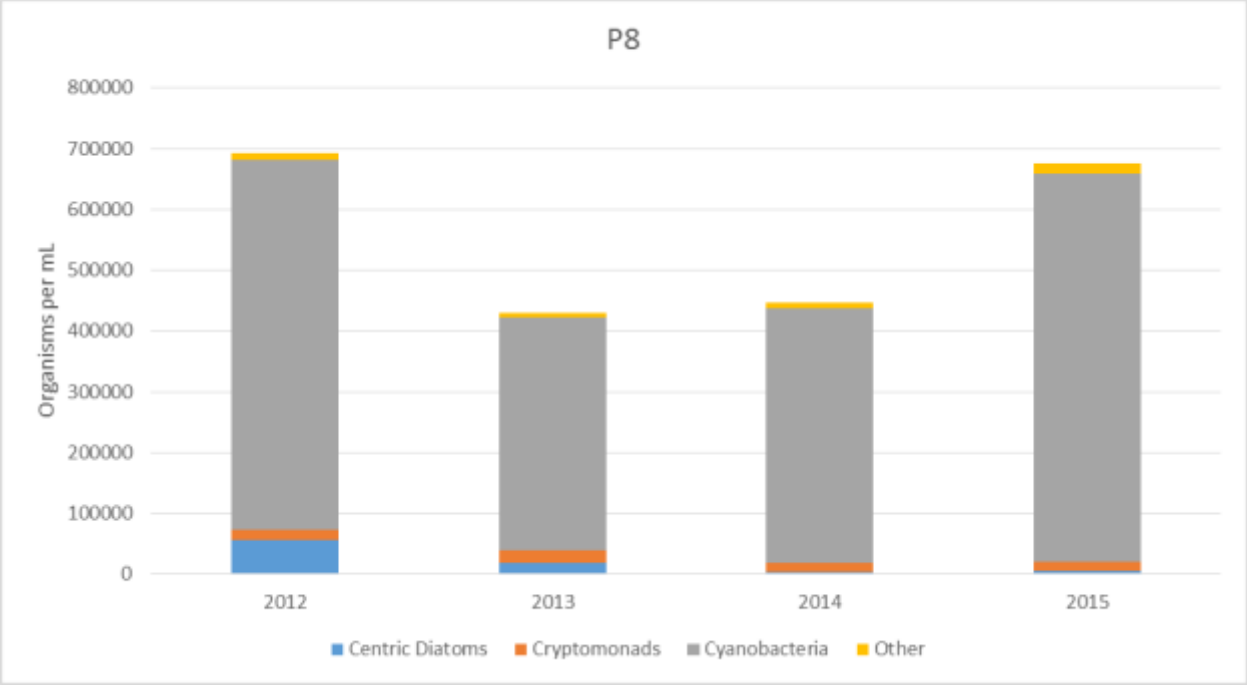

Figure 8. Phytoplankton yearly total organisms per mL at site P8, 2012-2015. Other = dinoflagellates, euglenoids, green algae, xanthophytes, pennate diatoms, chrysophytes, and ciliates.

Confluence/Suisun Bay (D4, D6, D7, and D8)

Site D4 in the confluence and sites D6, D7, and D8 in the Suisun Bay were heavily dominated by cyanobacteria in 2014 and 2015, and total phytoplankton counts at all sites, except D4, were extremely low in 2012 and 2013 (Figures 9–12). Centric diatoms made up 97.3% of all phytoplankton at site D4 in 2012, and pennate diatoms comprised over 75% of all phytoplankton (Figure 9). Phytoplankton at sites D6, D7, and D8 were significantly lower in 2012 and 2013 compared to 2014-15, with centric diatoms and pennate diatoms as the primary phytoplankton observed in 2012 and cyanobacteria dominating in 2013-2015 (Figures 10 – 12).

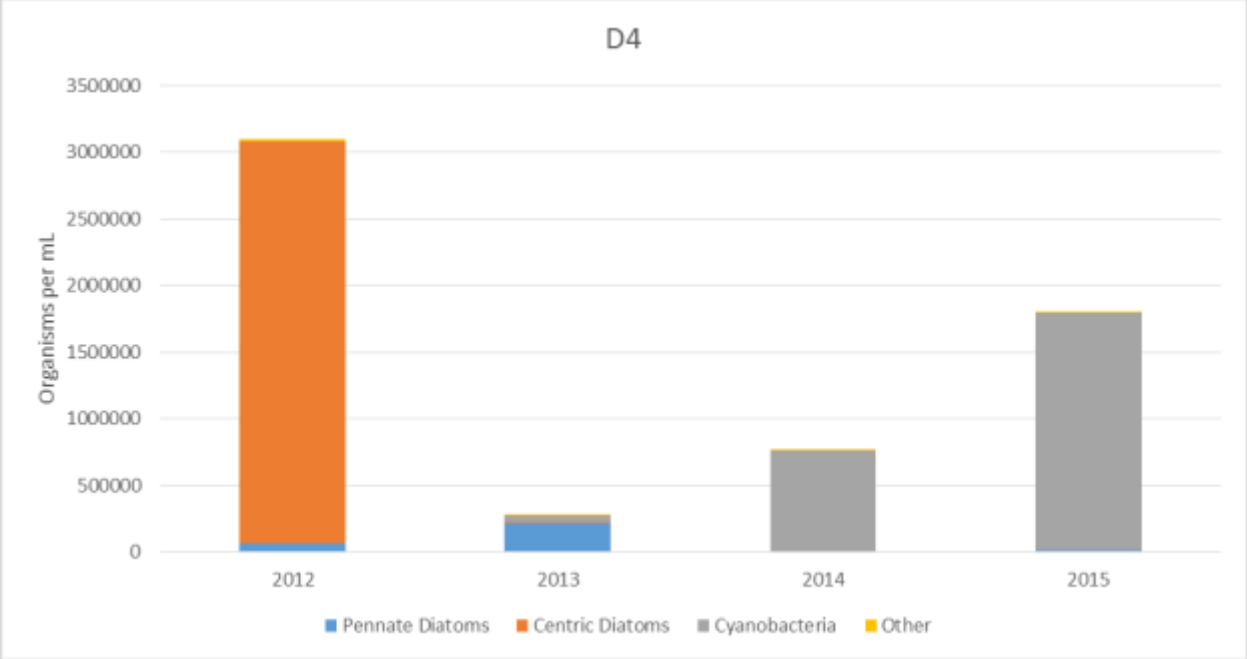

Figure 9. Phytoplankton yearly total organisms per mL at Confluence/Suisun Bay region (D4, D6, D7, D8): site D4, 2012-2015. Other = ciliates, cryptomonads, dinoflagellates, euglenoids, green algae, raphidophytes, and chrysophytes.

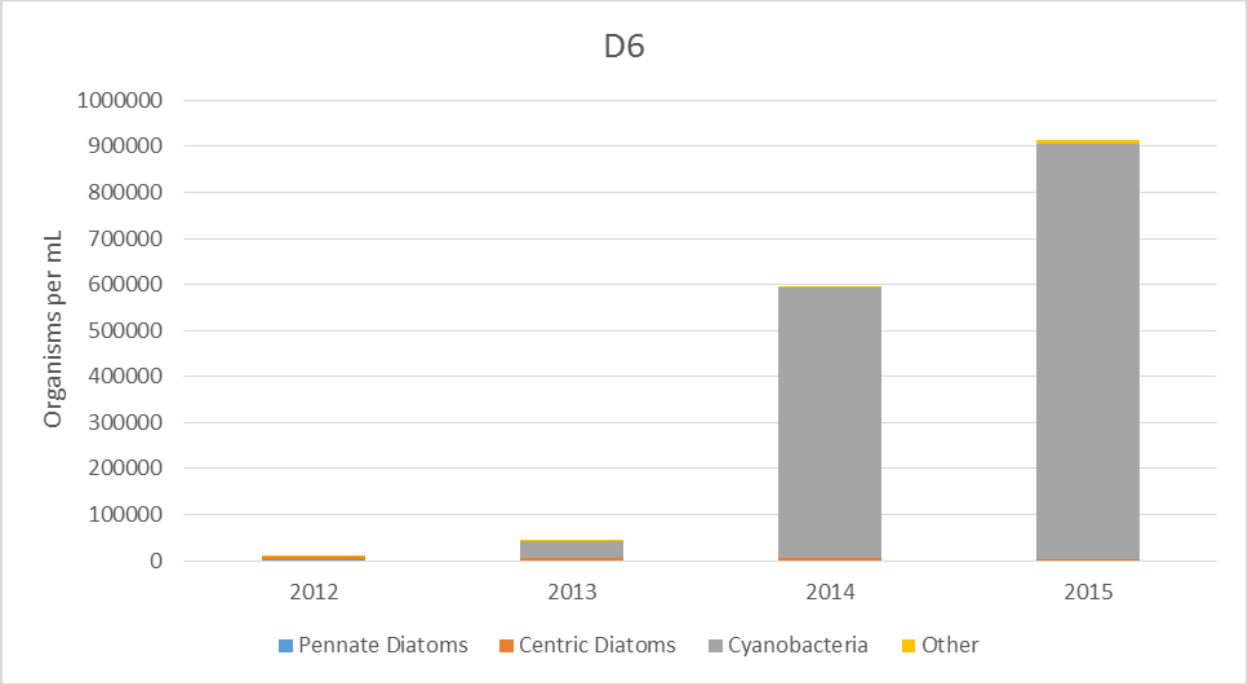

Figure 10. Phytoplankton yearly total organisms per mL at site D6, 2012-2015. Other = cryptomonads, dinoflagellates, euglenoids, green algae, silico-flagellates, chrysophytes, and ciliates.

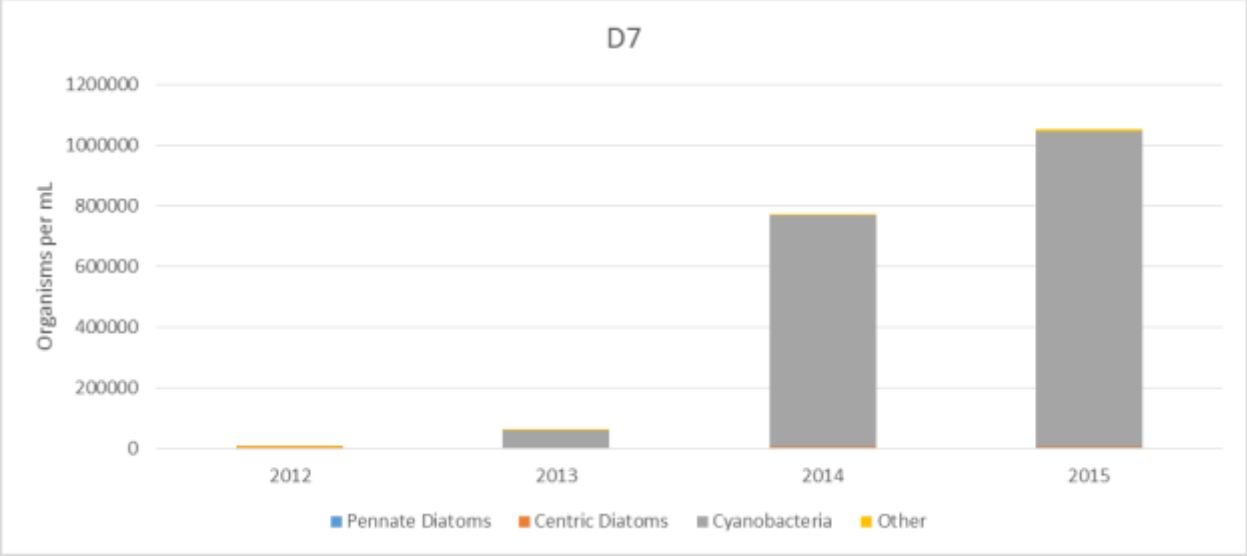

Figure 11. Phytoplankton yearly total organisms per mL at site D7, 2012-2015. Other = cryptomonads, dinoflagellates, euglenoids, haptophytes, green algae, synurophytes, chrysophytes, and ciliates.

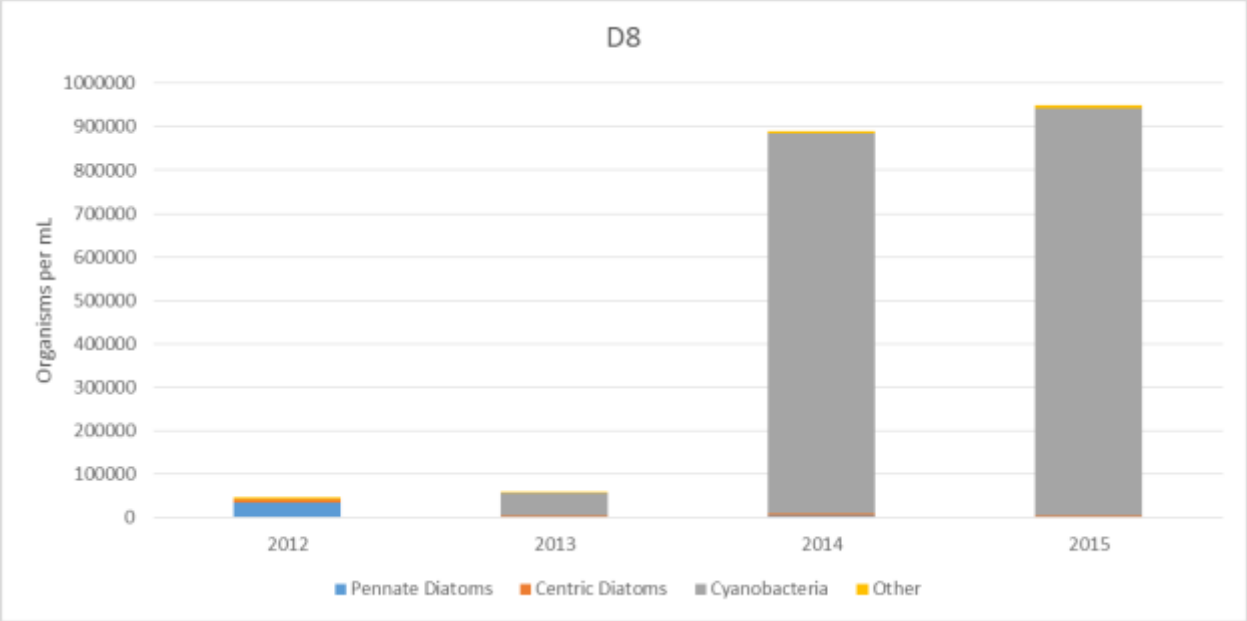

Figure 12. Phytoplankton yearly total organisms per mL at site D8, 2012-2015. Other = cryptomonads, dinoflagellates, euglenoids, green algae, xanthophytes, chrysophytes, and ciliates.

San Pablo Bay (D41 and D41A)

In San Pablo Bay, sites D41 and D41A were heavily dominated by cyanobacteria in 2014-2015. In 2014-2015, cyanobacteria comprised over 95% of all phytoplankton at site D41 and over 98% at site D41A (Figures 13 and 14). Site D41 was dominated by 71% of cryptomonads in 2012, although its number decreased through 2013-2015. Centric diatoms were present in 2012, and like cryptomonads, its number decreased through 2013-2015. Cyanobacteria dominated the site in 2013 with moderate contributions from centric diatoms and cryptomonads (Figure 13). Site D41A was dominated by pennate diatoms (96%) in 2012. There was a noticeable decrease in pennate diatoms from 2012 to 2013-2015, when total cyanobacteria increased and became the dominant phytoplankton during those years (Figure 14).

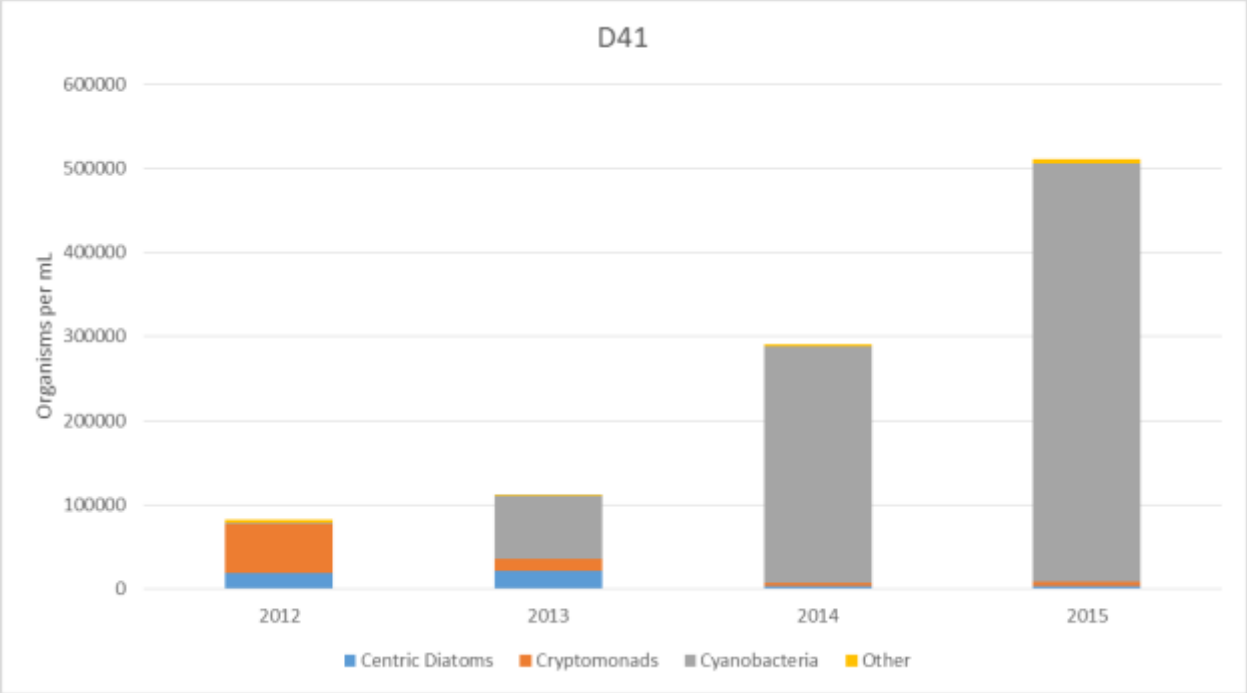

Figure 13. Phytoplankton yearly total organisms per mL at San Pablo Bay region (D41, D41A): site D41, 2012-2015. Other = dinoflagellates, euglenoids, green algae, raphidophytes, silico-flagellates, chrysophytes, pennate diatoms, ciliates, and unknown algae.

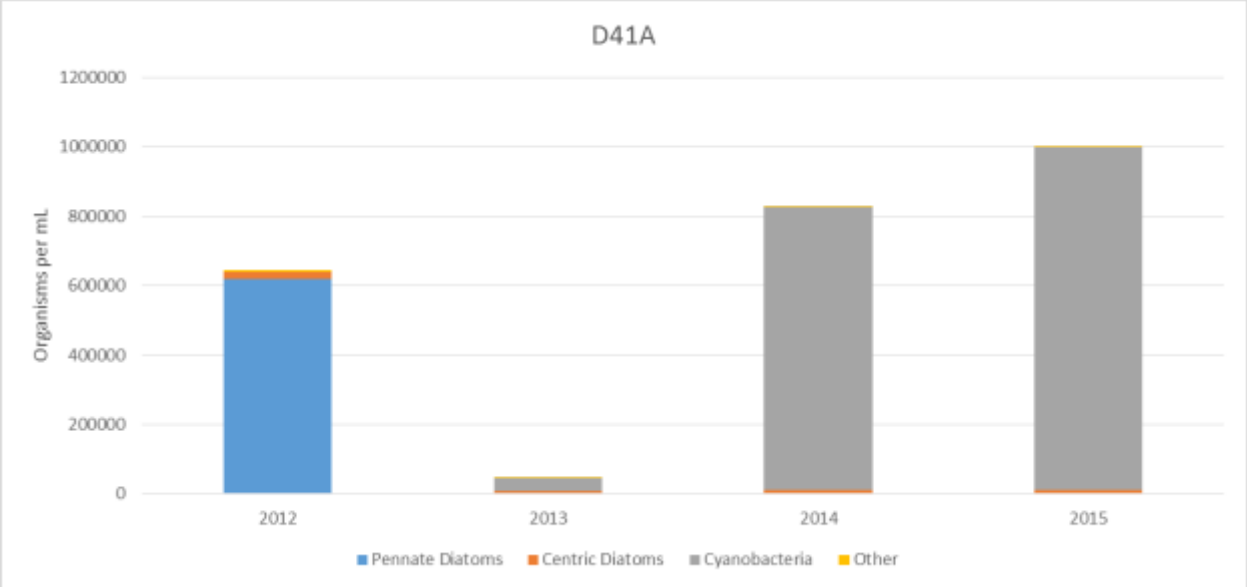

Figure 14. Phytoplankton yearly total organisms per mL at site D41A, 2012-2015. Other = coccolithophores, cryptomonads, dinoflagellates, euglenoids, green algae, silico-flagellates, chrysophytes, and ciliates.