Phytoplankton Monitoring Report for Water Year 2023

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ENVIRONMENTAL MONITORING PROGRAM

Introduction

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 and chlorophyll *a* samples to monitor algal community composition and biomass at select sites in the upper San Francisco Estuary (Estuary). This report describes the results of these monitoring efforts for water year 2023 (October 1st 2022 through September 30th 2023) which was classified as a wet year in the Sacramento and San Joaquin Valleys (source).

Methods

Phytoplankton samples were collected monthly at 24 monitoring sites throughout the Upper Estuary and were grouped into regions based on their geographic location (Figure 1; Table 1). These sites represent a variety of aquatic habitats, from narrow, freshwater channels to broad, estuarine bays.

Phytoplankton

The 10 most common genera were determined by summing the normalized organism counts across all stations and months for each genus. For the bar graphs, average organism counts were calculated per month, per region, and normalized to the number of stations. Average summary statistics are reported as the mean (μ) $\pm$ the standard deviation.

For more in-depth methodology, see here.

Chlorophyll *a* and Pheophytin *a*

Samples of chlorophyll *a* and pheophytin *a* were collected monthly at 24 monitoring sites throughout the upper Estuary using a submersible pump positioned 1 meter below the water's surface. Average analyte concentrations were then calculated per month, per region, and were normalized to the number of stations. Average summary statistics are reported as the median (M) $\pm$ the median absolute deviation.

For more in-depth methodology, see here.

Overall Results

Phytoplankton Identification

All organisms collected in water year 2023 fell into these 12 algal groups:

- Centric Diatoms
- Chrysophytes
- Ciliates

- Cryptophytes
- Cyanobacteria
- Dinoflagellates
- Euglenoids
- Green Algae
- Haptophytes
- Pennate Diatoms
- Raphidophytes
- Synurophytes

The 10 most common genera collected in water year 2023 were, in order:

- Eucapsis (cyanobacteria)
- Chlorella (green algae)
- Cyclotella (centric diatoms)
- Plagioselmis (cryptophytes)
- Nitzschia (pennate diatoms)
- Skeletonema (centric diatoms)
- Monoraphidium (green algae)
- Teleaulax (cryptophytes)
- Cryptomonas (cryptophytes)
- Planktolyngbya (cyanobacteria)

Of the groups identified, centric diatoms, cyanobacteria, and green algae constituted 98.99% of the organisms collected (Figure 2).

Pigment Concentrations

97.92% of samples had chlorophyll *a* levels below 10 g/L, which is considered limiting for zooplankton growth (Müller-Solger et al., 2002). The average chlorophyll a value was 2.20 ± 0.99 µg/L; values ranged from < 0.50 µg/L to 23.70 µg/L. 0.69% of samples were below the reporting limit. The average pheophytin a value was 0.88 ± 0.37 µg/L; values ranged from < 0.50 µg/L to 6.39 µg/L. 18.75% of samples were below the reporting limit.

Regional Results

Carquinez

Water Quality

The average chlorophyll a value was 2.54 ± 0.91 µg/L; values ranged from 0.56 µg/L to 4.87 µg/L. The average pheophytin a value was 0.64 ± 0.38 µg/L; values ranged from < 0.50 µg/L to 1.84 µg/L. 37.5% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 3.

Phytoplankton

The most abundant algal groups were cyanobacteria (96% of organisms, μ = 58746 ± 72498 organisms/mL), green algae (2.2% of organisms, μ = 1434 ± 1814 organisms/mL), and centric diatoms (1.1% of organisms, μ = 459 ± 574 organisms/mL). The remaining 0.7% of organisms were comprised of chrysophytes, ciliates, cryptophytes, dinoflagellates, euglenoids, and pennate diatoms (Other, Figure 4).

Central Delta

Water Quality

The average chlorophyll a value was 1.58 ± 0.68 µg/L; values ranged from < 0.50 µg/L to 7.95 µg/L. 2.08% of samples were below the reporting limit. The average pheophytin a value was 0.70 ± 0.27 µg/L; values ranged from < 0.50 µg/L to 2.62 µg/L. 16.67% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 5.

Phytoplankton

The most abundant algal groups were cyanobacteria (94.9% of organisms, μ = 21804 ± 48437 organisms/mL), green algae (2.6% of organisms, μ = 666 ± 1203 organisms/mL), and centric diatoms (0.9% of organisms, μ = 282 ± 388 organisms/mL). The remaining 1.6% of organisms were comprised of chrysophytes, cryptophytes, dinoflagellates, euglenoids, haptophytes, and pennate diatoms (Other, Figure 6).

Confluence

Water Quality

The average chlorophyll a value was 2.05 ± 0.90 µg/L; values ranged from 0.61 µg/L to 5.42 µg/L. The average pheophytin a value was 0.80 ± 0.30 µg/L; values ranged from < 0.50 µg/L to 2.20 µg/L. 18.75% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 7.

Phytoplankton

The most abundant algal groups were cyanobacteria (95.7% of organisms, μ = 51544 ± 84041 organisms/mL), green algae (2.5% of organisms, μ = 1166 ± 1833 organisms/mL), and centric diatoms (0.9% of organisms, μ = 483 ± 763 organisms/mL). The remaining 0.8% of organisms were comprised of chrysophytes, ciliates, cryptophytes, dinoflagellates, euglenoids, pennate diatoms, and raphidophytes (Other, Figure 8).

North Delta

Water Quality

The average chlorophyll a value was 1.98 ± 0.87 µg/L; values ranged from 0.53 µg/L to 5.45 µg/L. The average pheophytin a value was 0.70 ± 0.38 µg/L; values ranged from < 0.50 µg/L to 3.57 µg/L. 37.5% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 9.

Phytoplankton

The most abundant algal groups were cyanobacteria (92.1% of organisms, μ = 25302 ± 47095 organisms/mL), green algae (4.5% of organisms, μ = 832 ± 1730 organisms/mL), and centric diatoms (1.1% of organisms, μ = 309 ± 383 organisms/mL). The remaining 2.1% of organisms were comprised of chrysophytes, ciliates, cryptophytes, dinoflagellates, euglenoids, and pennate diatoms (Other, Figure 10).

San Pablo Bay

Water Quality

The average chlorophyll a value was 3.38 ± 1.48 µg/L; values ranged from < 0.50 µg/L to 16.50 µg/L. 2.78% of samples were below the reporting limit. The average pheophytin a value was 0.79 ± 0.32 µg/L; values ranged from < 0.50 µg/L to 5.90 µg/L. 25% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 11.

Phytoplankton

The most abundant algal groups were cyanobacteria (94.5% of organisms, μ = 48328 ± 43726 organisms/mL), green algae (3% of organisms, μ = 1292 ± 1578 organisms/mL), and centric diatoms (1.8% of organisms, μ = 471 ± 666 organisms/mL). The remaining 0.7% of organisms were comprised of chrysophytes, ciliates, cryptophytes, dinoflagellates, euglenoids, pennate diatoms, and synurophytes (Other, Figure 12).

South Delta

Water Quality

The average chlorophyll a value was 2.52 ± 1.18 µg/L; values ranged from 0.57 µg/L to 23.70 µg/L. The average pheophytin a value was 1.39 ± 0.51 µg/L; values ranged from < 0.50 µg/L to 6.39 µg/L. 4.17% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 13.

Phytoplankton

The most abundant algal groups were cyanobacteria (95.4% of organisms, μ = 34945 ± 172287 organisms/mL), green algae (2.2% of organisms, μ = 694 ± 1354 organisms/mL), and centric diatoms (1.2% of organisms, μ = 523 ± 910 organisms/mL). The remaining 1.1% of organisms were comprised of chrysophytes, ciliates, cryptophytes, dinoflagellates, euglenoids, and pennate diatoms (Other, Figure 14).

Suisun and Grizzly Bays

Water Quality

The average chlorophyll a value was 2.58 ± 0.87 µg/L; values ranged from 0.83 µg/L to 6.79 µg/L. The average pheophytin a value was 0.93 ± 0.38 µg/L; values ranged from < 0.50 µg/L to 2.40 µg/L. 19.44% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 15.

Phytoplankton

The most abundant algal groups were cyanobacteria (95.8% of organisms, μ = 56948 ± 83181 organisms/mL), green algae (2.4% of organisms, μ = 1381 ± 2127 organisms/mL), and centric diatoms (1.1% of organisms, μ = 543 ± 959 organisms/mL). The remaining 0.8% of organisms were comprised of chrysophytes, ciliates, cryptophytes, dinoflagellates, euglenoids, haptophytes, and pennate diatoms (Other, Figure 16).

Suisun Marsh

Water Quality

The average chlorophyll a value was 2.21 ± 1.12 µg/L; values ranged from 0.99 µg/L to 9.46 µg/L. . The average pheophytin a value was 1.44 ± 0.56 µg/L; values ranged from < 0.50 µg/L to 3.56 µg/L. 4.17% of samples were below the reporting limit. Time series plots averaged over region are shown in Figure 17.

Phytoplankton

The most abundant algal groups were cyanobacteria (96.4% of organisms, μ = 82361 ± 78772 organisms/mL), green algae (2% of organisms, μ = 1693 ± 2008 organisms/mL), and centric diatoms (1.1% of organisms, μ = 790 ± 1435 organisms/mL). The remaining 0.4% of organisms were comprised of chrysophytes,

cryptophytes, dinoflagellates, euglenoids, pennate diatoms, and raphidophytes (Other, Figure 18).

Interpretations

Overall, chlorophyll-*a*, pheophytin-*a*, and phytoplankton abundance followed a seasonal pattern with the highest values of pigments and abundances in the spring and summer months and lower values and abundances in winter months. One exception was a large cyanobacterial bloom in January 2023 which occurred across all regions. However, this bloom was not associated with larger chlorophyll-*a* values, suggesting that, while the cyanobacteria were abundant, they were not producing large amounts of biomass as chlorophyll-*a*. Though cyanobacteria were dominant in the abundance counts, all phytoplankton fell into 12 distinct taxonomic groups distributed across all the regions of the San Francisco Estuary. Chlorophyll-*a* values were low throughout the year across all regions, with the majority of values below 10 µg/L, which is considered food limiting for zooplankton.

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Archived Reports

Previous EMP phytoplankton reports can be found here.

Figures

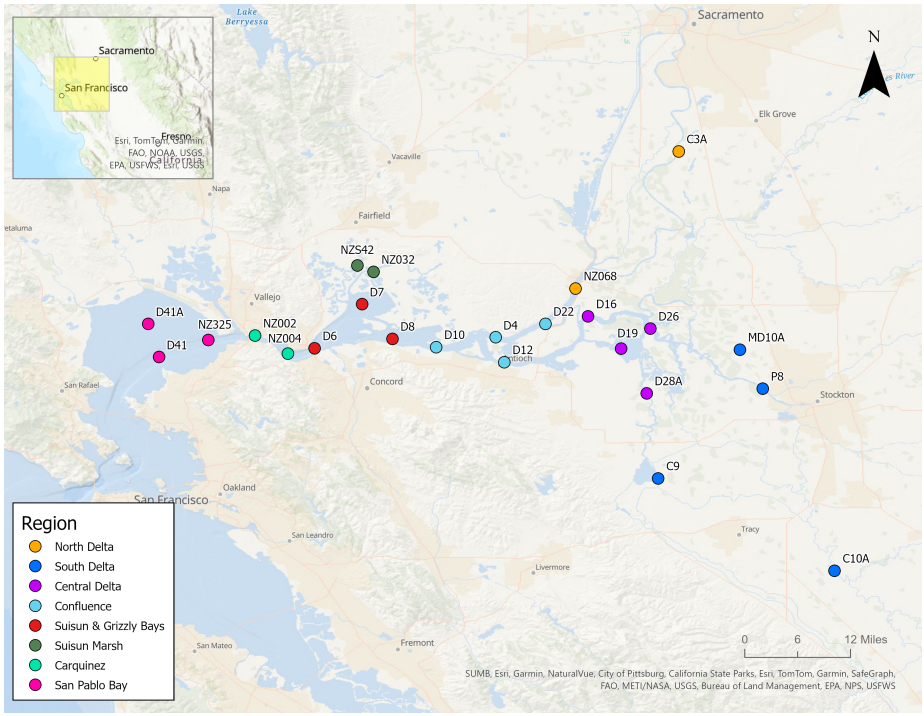

Figure 1: Map of EMP's phytoplankton field sites.

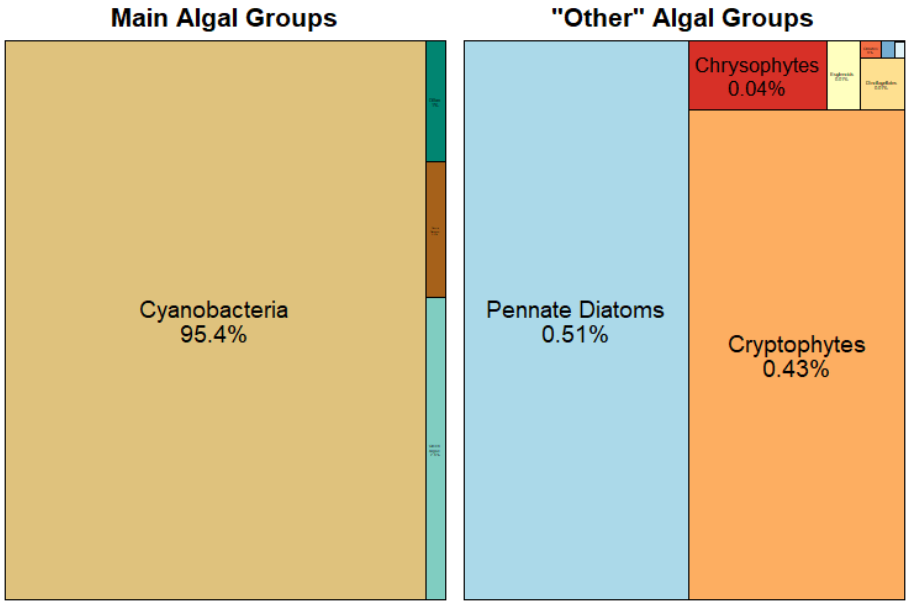

Figure 2: Phytoplankton composition by algal group.

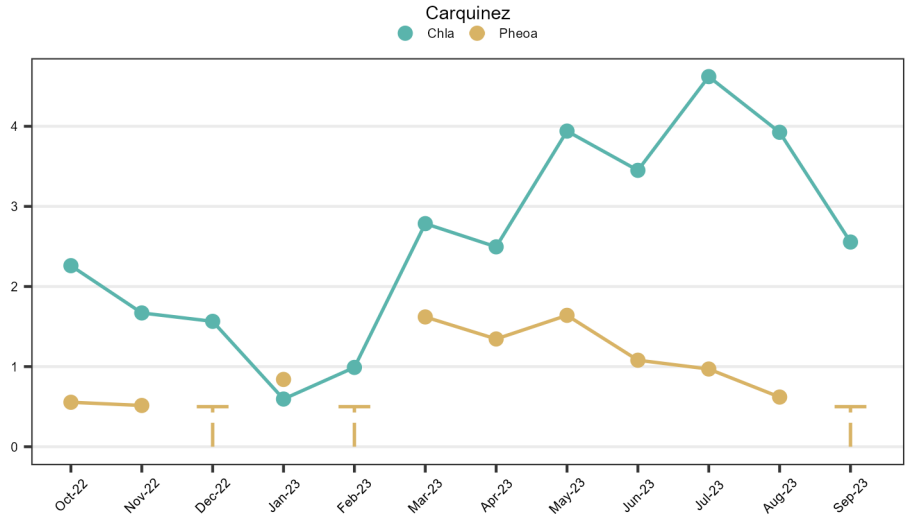

Figure 3: Chlorophyll a and pheophytin a average concentrations in Carquinez.

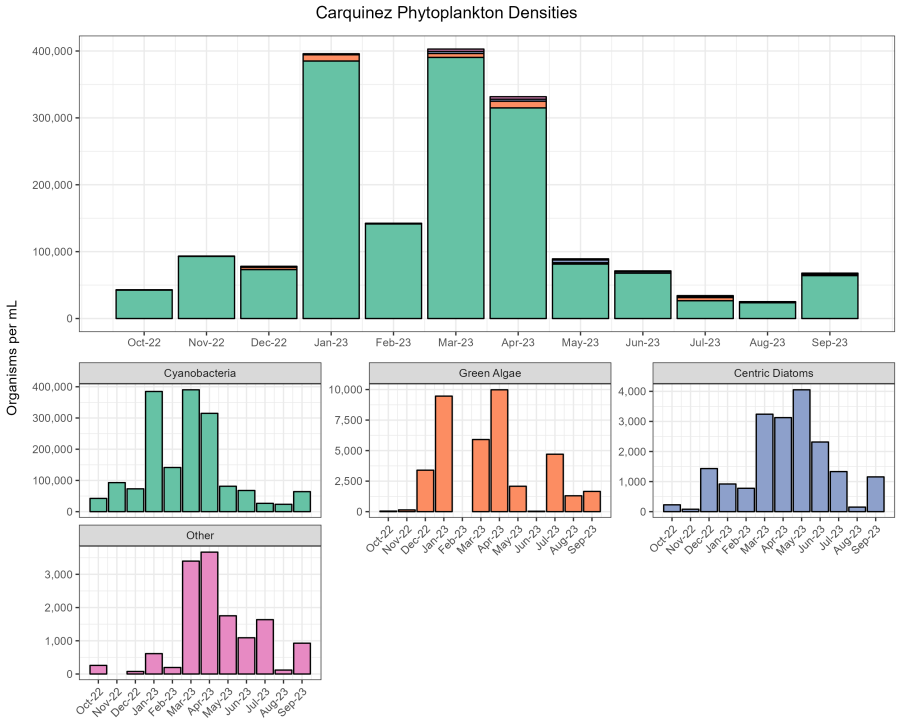

Figure 4: Density of phytoplankton organisms in Carquinez.

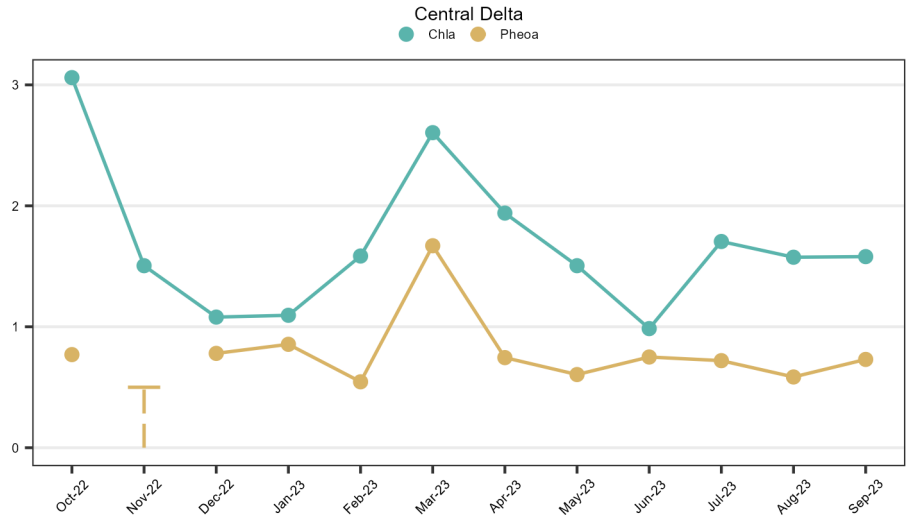

Figure 5: Chlorophyll a and pheophytin a average concentrations in the Central Delta.

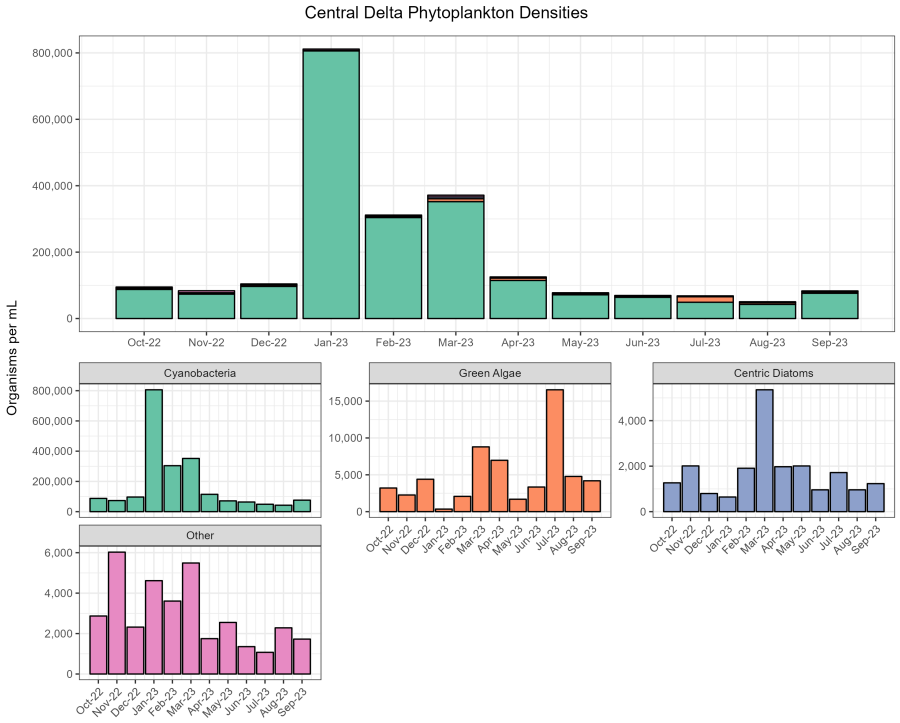

Figure 6: Density of phytoplankton organisms in the Central Delta.

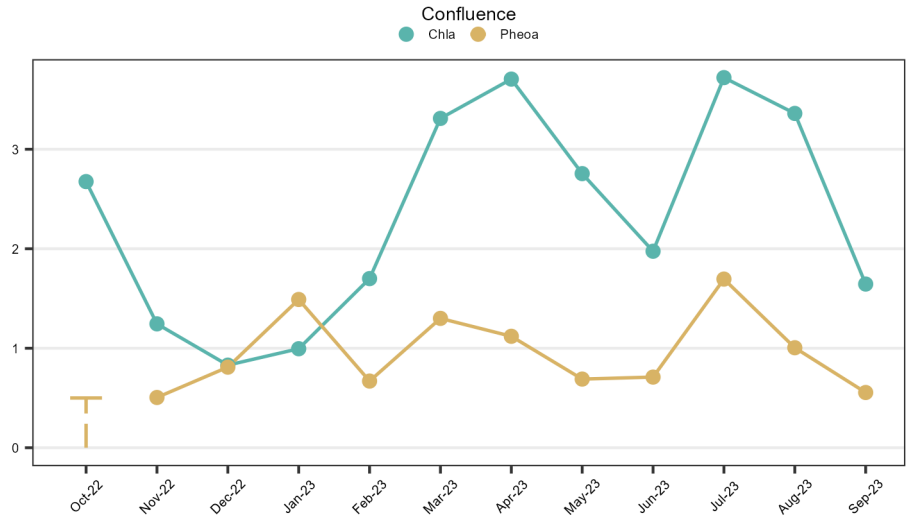

Figure 7: Chlorophyll a and pheophytin a average concentrations in the Confluence.

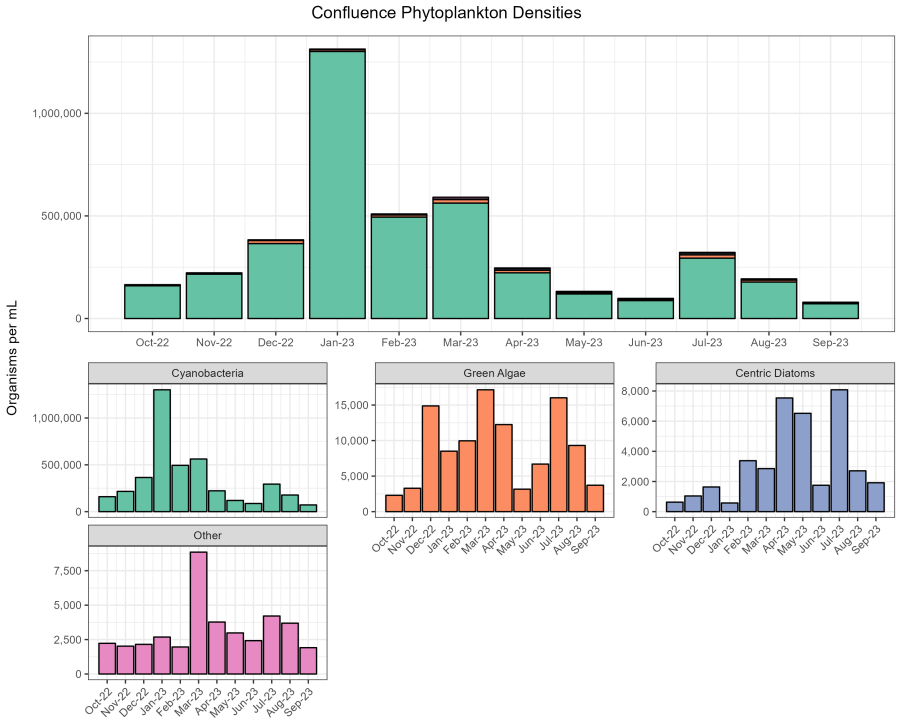

Figure 8: Density of phytoplankton organisms in the Confluence.

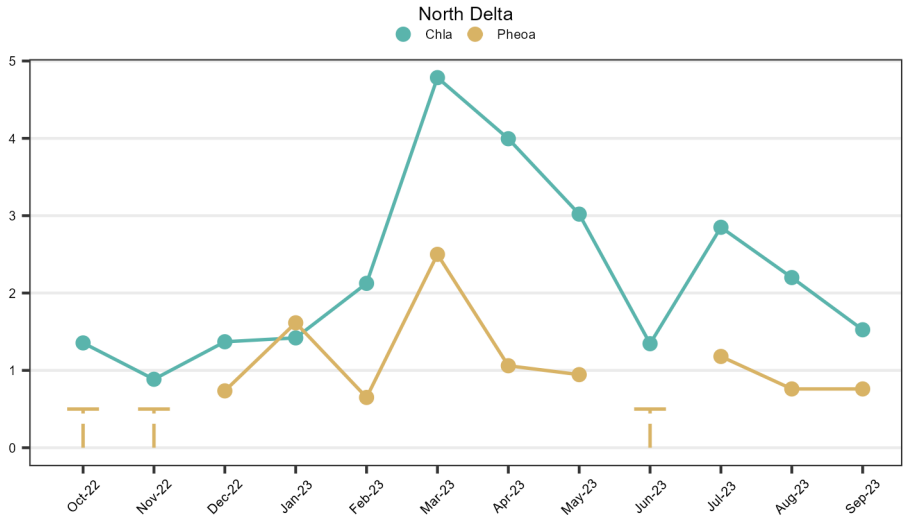

Figure 9: Chlorophyll a and pheophytin a average concentrations in the North Delta.

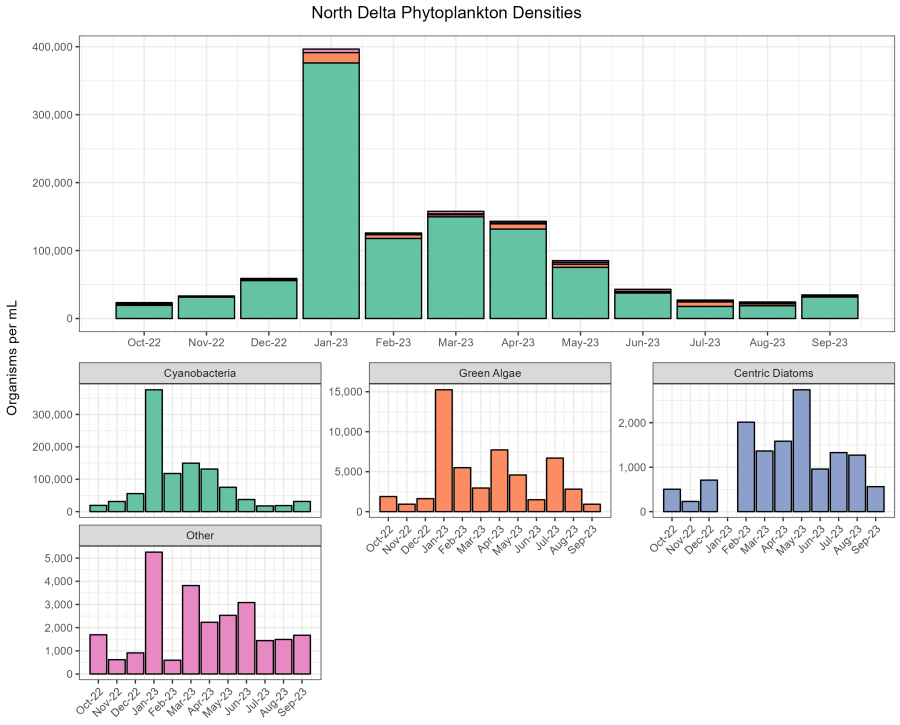

Figure 10: Density of phytoplankton organisms in the North Delta.

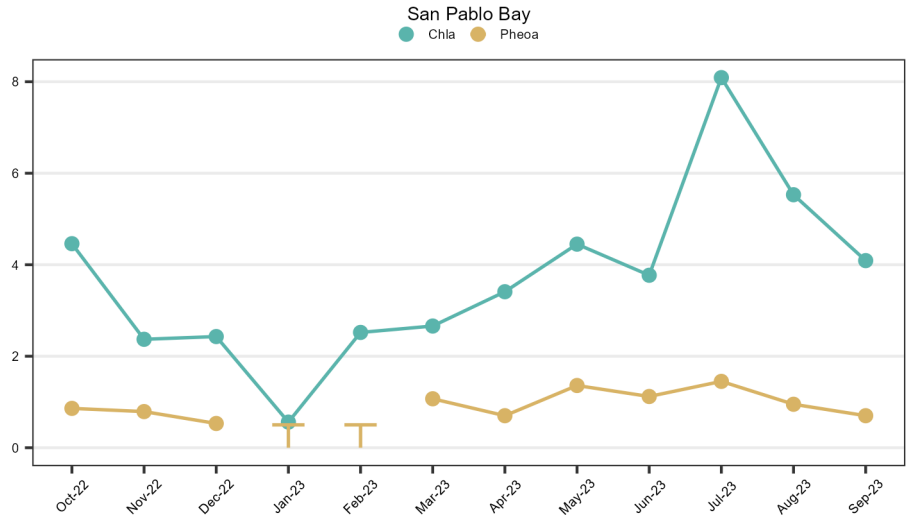

Figure 11: Chlorophyll a and pheophytin a average concentrations in the San Pablo Bay.

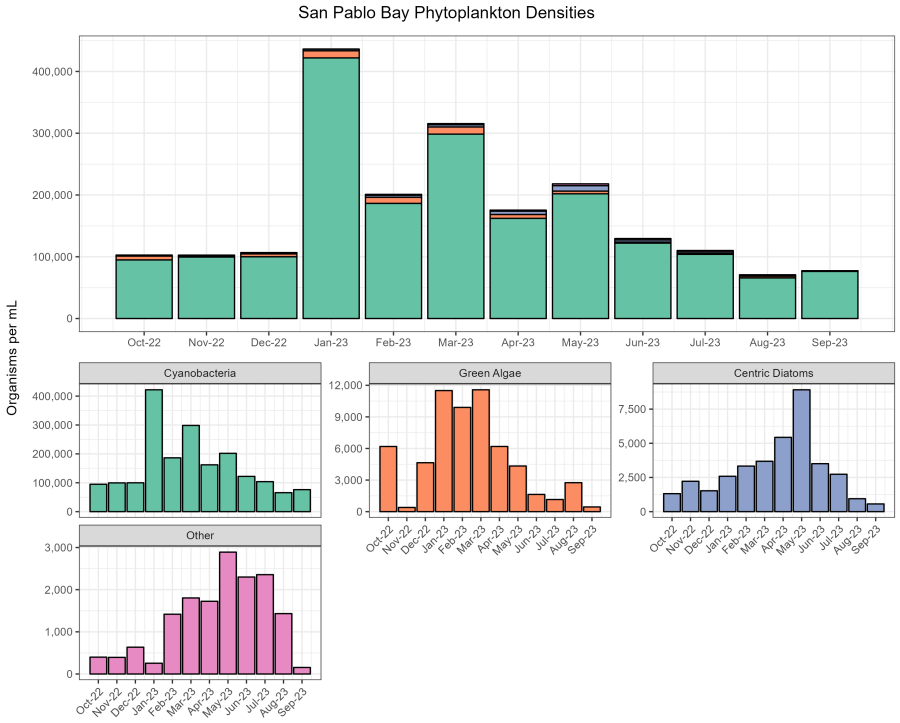

Figure 12: Density of phytoplankton organisms in the San Pablo Bay.

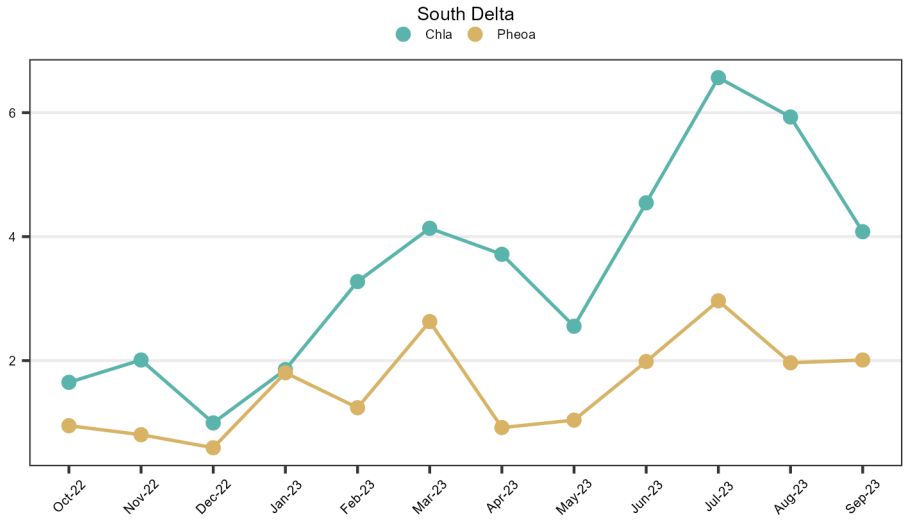

Figure 13: Chlorophyll a and pheophytin a average concentrations in the South Delta.

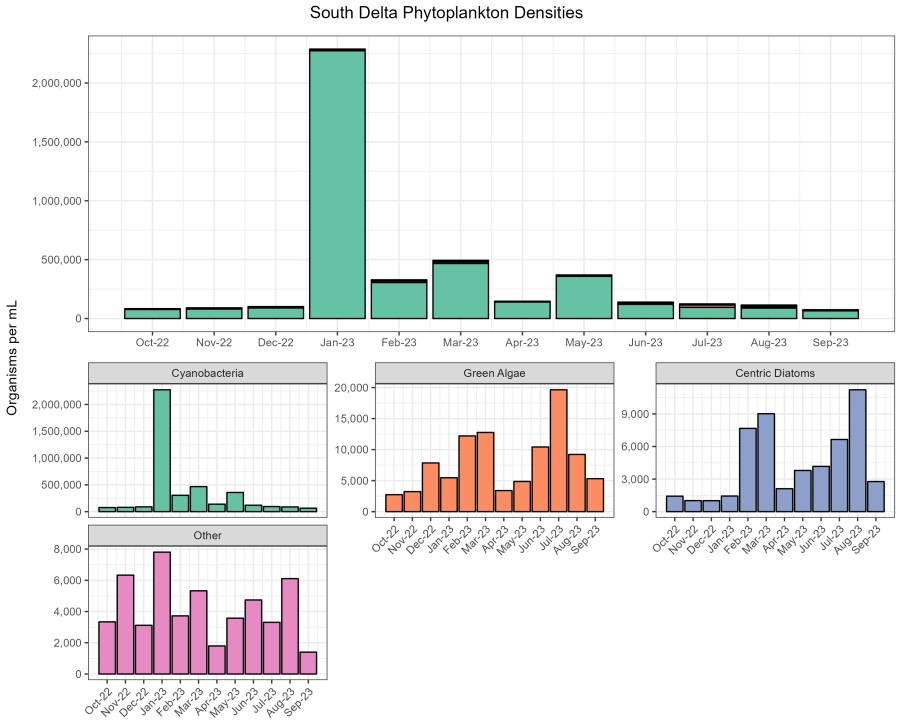

Figure 14: Density of phytoplankton organisms in the South Delta.

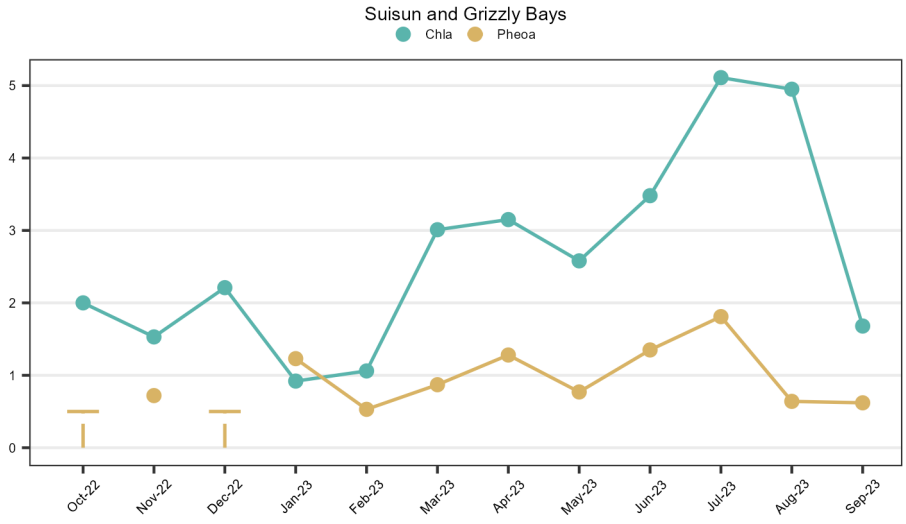

Figure 15: Chlorophyll a and pheophytin a average concentrations in Suisun and Grizzly Bays.

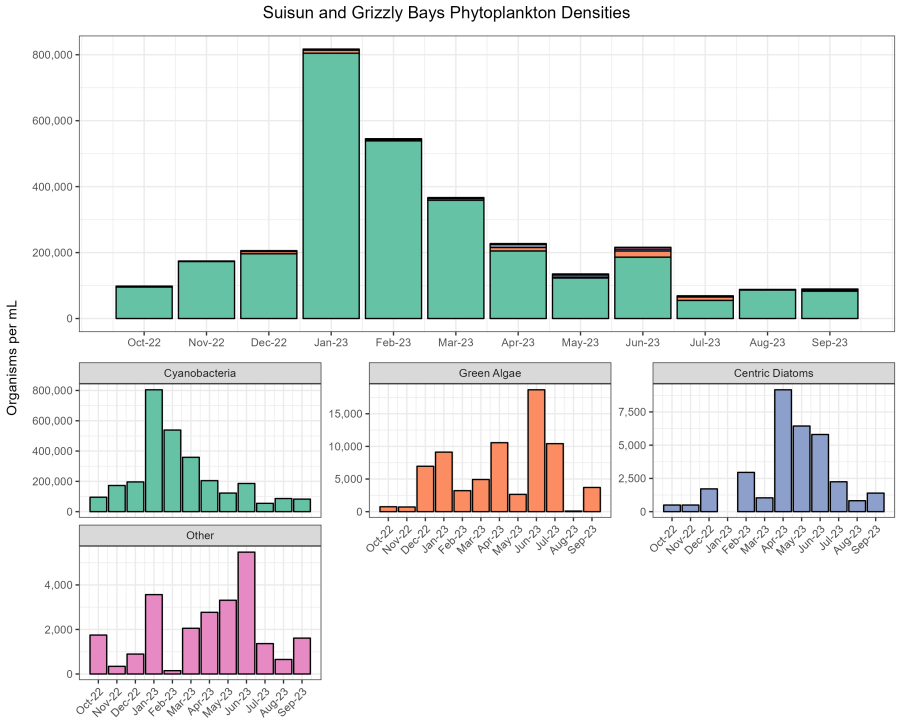

Figure 16: Density of phytoplankton organisms in Suisun and Grizzly Bays.

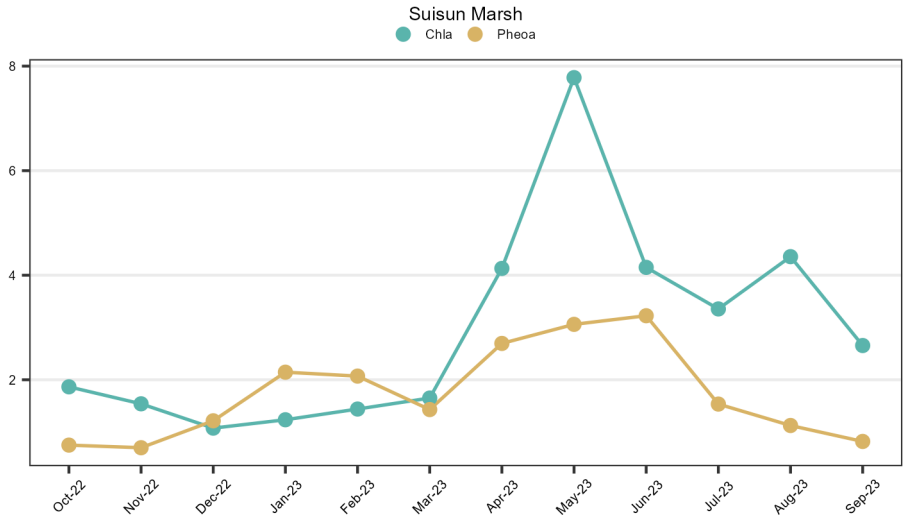

Figure 17: Chlorophyll a and pheophytin a average concentrations in Suisun Marsh.

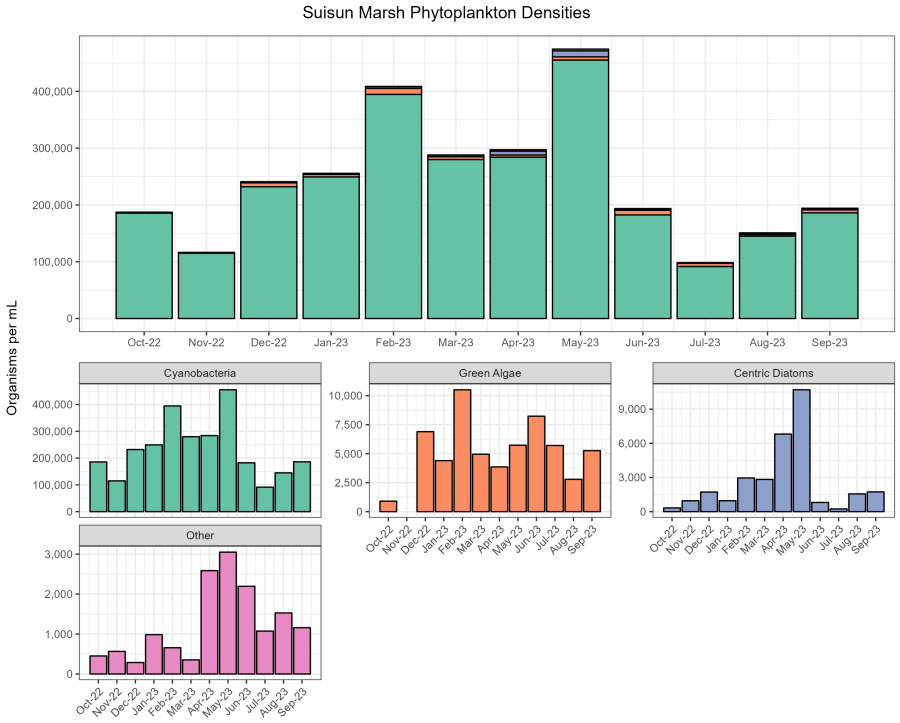

Figure 18: Density of phytoplankton organisms in Suisun Marsh.

Tables

Table 1: Stations included within each region of the Delta

Region	WY Index	Stations
Carquinez	Sacramento	NZ002, NZ004
Central Delta	San Joaquin	D16, D19, D26, D28A
Confluence	Sacramento	D4, D10, D12, D22
North Delta	Sacramento	C3A, NZ068
San Pablo Bay	Sacramento	D41, D41A, NZ325
South Delta	San Joaquin	C9, C10A, MD10A, P8
Suisun and Grizzly Bays	Sacramento	D6, D7, D8
Suisun Marsh	Sacramento	NZ032, NZS42