

## USEPA Big Cypress REMAP Report EPA-904-R25-002 2025

### Appendix 6: Plants and Periphyton

Periphyton and plants play an integral role in the productivity of marsh ecosystems such as those in the Big Cypress National Preserve. Periphyton is a community of various types of organisms, including microbial organisms, algae, cyanobacteria, fungi, detritus and animals. These periphyton communities form the foundation of ecosystems like Big Cypress, serving as primary producers via photosynthesis and altering the chemical composition of the system, leading to the production of marl soils that other plants depend on (National Park Service, 2020). Plants, particularly sawgrass, are also critical to the functioning of the marsh ecosystem due to their role as primary producers in conducting photosynthesis. Additionally, plants and periphyton often provide physical refugia for other organisms in the community.

Biochemical data can be collected for plants and periphyton to draw inferences about the status of the ecosystem. Analytes such as bulk density, organic matter, chlorophyll *a*, total carbon, total nitrogen, total phosphorus, total mercury and methyl mercury can be important indicators of larger conditions within the community. During the REMAP 2023 cycle, these data were collected from water column periphyton, benthic periphyton and sawgrass plants, as available. Data were compared to historic datasets where applicable and analyzed for latitudinal gradients and percent of sampled marsh area impacted by the analytes.

#### Water Column Periphyton

##### Bulk Density

REMAP 2023 water column periphyton bulk density concentrations ranged from 0.01 to 0.14 g/cc, with a median concentration of 0.05 g/cc (Figure CP-1). REMAP did not determine periphyton bulk density in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.77$ ,  $\rho = 0.06$ ). About 50% of the marsh area sampled had a water column periphyton bulk density concentration at or below 0.05 g/cc, with a 95% confidence interval of 41.76% to 56.42% (Figure CP-2).

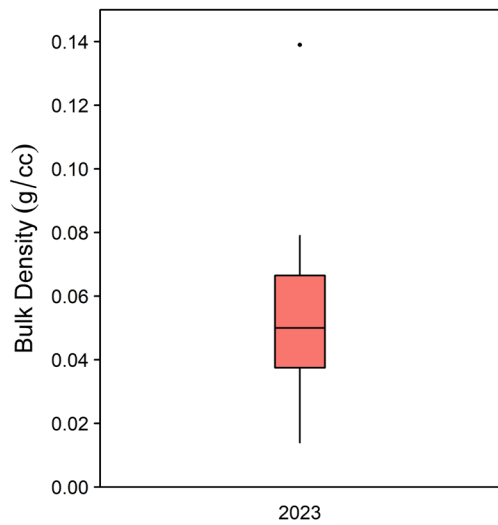


Figure CP-1: Water column periphyton bulk density (g/cc), from 2023 REMAP data

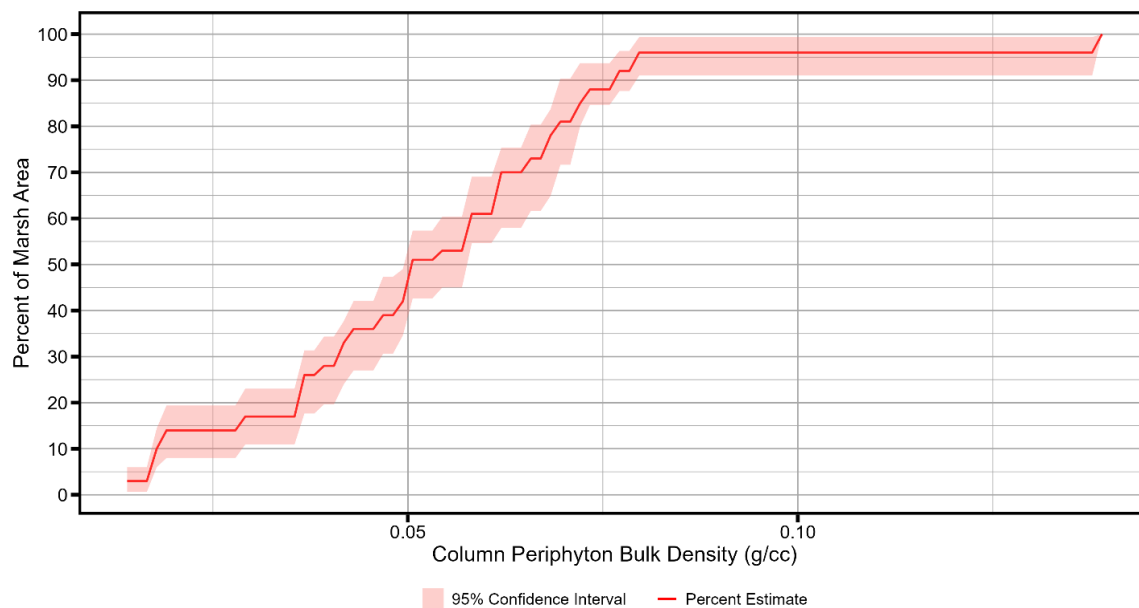


Figure CP-2: Water column periphyton bulk density (g/cc) estimates of sampled area

## Total Carbon

REMAP 2023 water column periphyton total carbon concentrations ranged from 214.10 to 438.00 g/kg, with a median concentration of 244.30 g/kg (Figure CP-3). Water column periphyton total carbon data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.38$ ,  $\rho = 0.18$ ). About 50% of the marsh area sampled had a water column

periphyton total carbon concentration at or below 241.20 g/kg, with a 95% confidence interval of 40.53% to 56.99% (Figure CP-4).

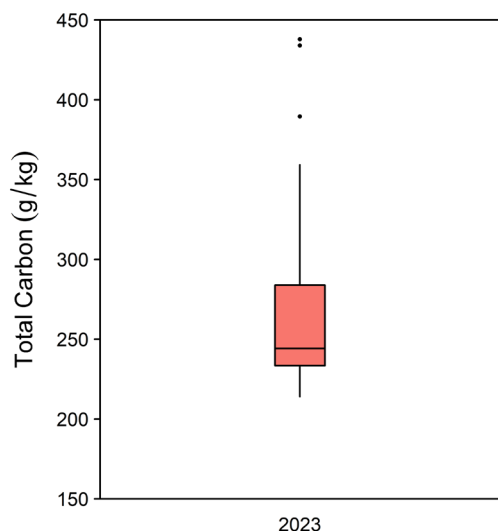


Figure CP-3: Water column periphyton total carbon (g/kg), 2023 REMAP data

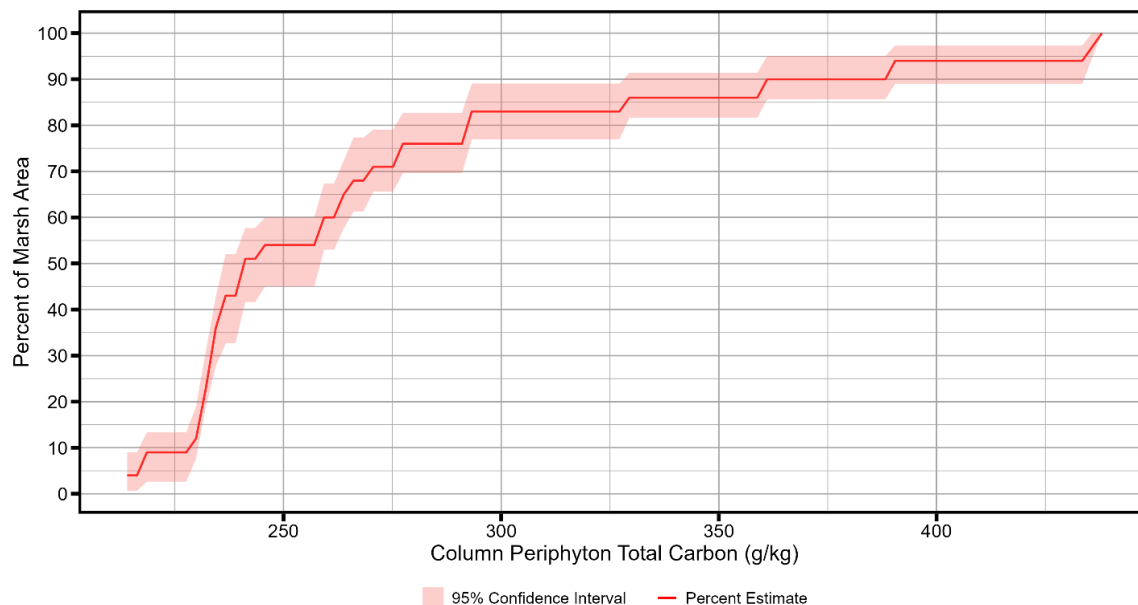


Figure CP-4: Water column periphyton total carbon (g/kg) estimates of sampled area

Expressed in terms of concentration by volume, REMAP 2023 water column periphyton total carbon concentrations ranged from 5.50 to 29.80 mg/cc, with a median concentration of 13.40 mg/cc (Figure CP-5). Water column periphyton total carbon data were not calculated by volume in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.69$ ,  $\rho = 0.08$ ).

About 50% of the marsh area sampled had a water column periphyton total carbon concentration at or below 13.40 mg/cc, with a 95% confidence interval of 43.48% to 57.38% (Figure CP-6).

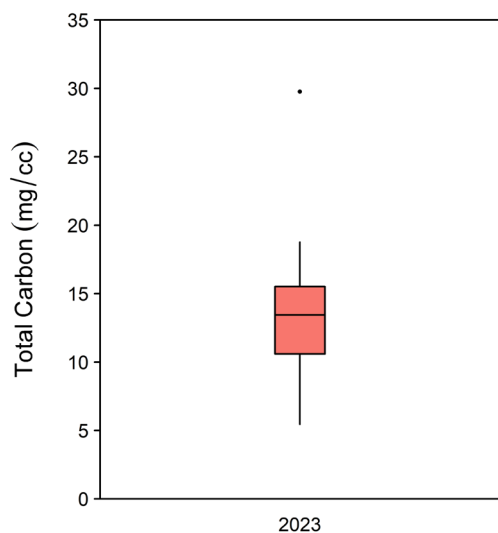


Figure CP-5: Water column periphyton total carbon (mg/cc), 2023 REMAP data

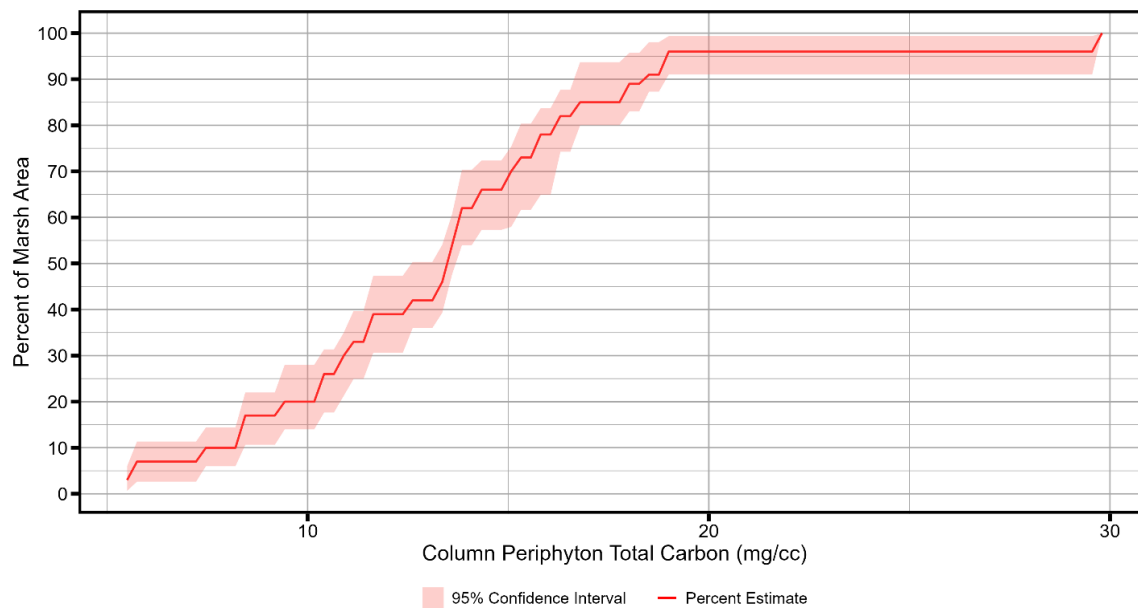


Figure CP-6: Water column periphyton total carbon (mg/cc) estimates of sampled area

## Total Nitrogen

REMAP 2023 water column periphyton total nitrogen concentrations ranged from 8.88 to 37.30 g/kg, with a median concentration of 12.84 g/kg (Figure CP-7). Water column periphyton total nitrogen data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.16$ ,  $\rho = 0.28$ ). About 50% of the marsh area sampled had a water column periphyton total nitrogen concentration at or below 12.68 g/kg, with a 95% confidence interval of 42.40% to 57.84% (Figure CP-8).

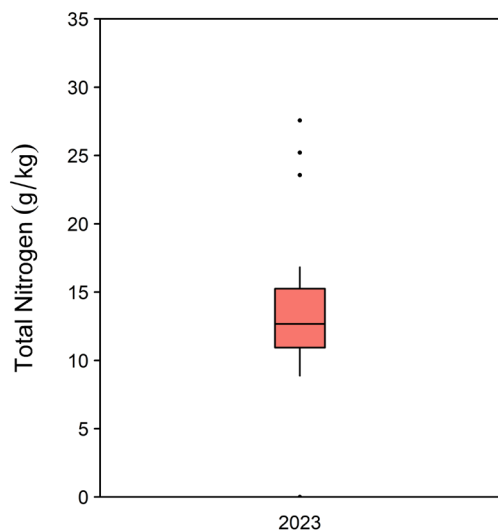


Figure CP-7: Water column periphyton total nitrogen (g/kg), 2023 REMAP data

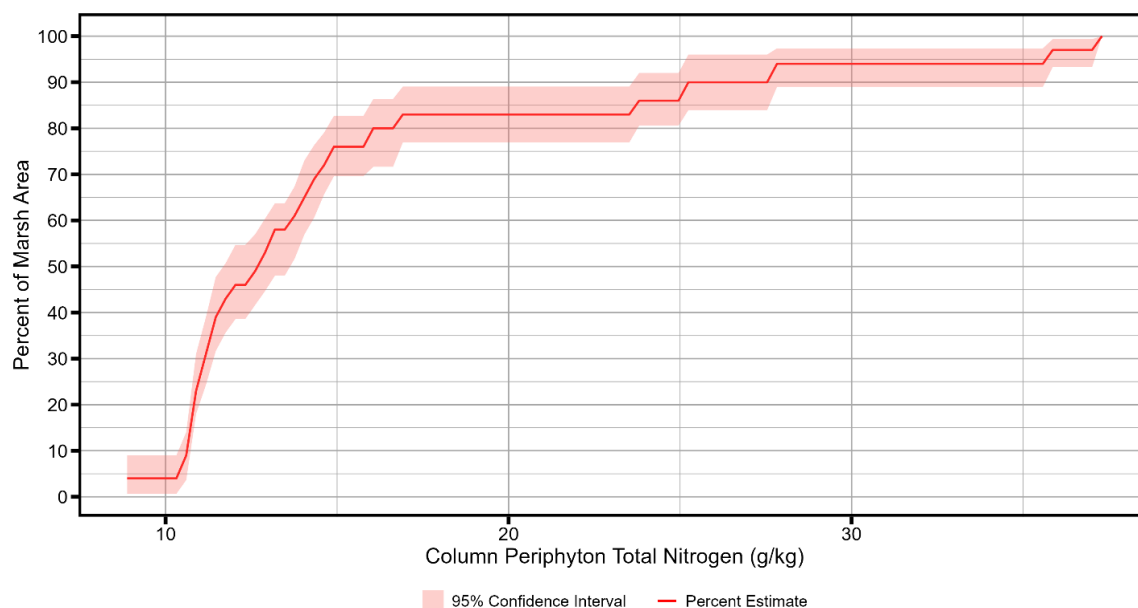


Figure CP-8: Water column periphyton total nitrogen (g/kg) estimates of sampled area

Expressed in terms of concentration by volume, REMAP 2023 water column periphyton total nitrogen concentrations ranged from 0.35 to 1.23 mg/cc, with a median concentration of 0.68 mg/cc (Figure CP-9). Water column periphyton total nitrogen data were not calculated by volume in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.23$ ,  $\rho = 0.24$ ). About 50% of the marsh area sampled had a water column periphyton total nitrogen concentration of 0.69 mg/cc, with a 95% confidence interval of 42.04% to 59.15% (Figure CP-10).

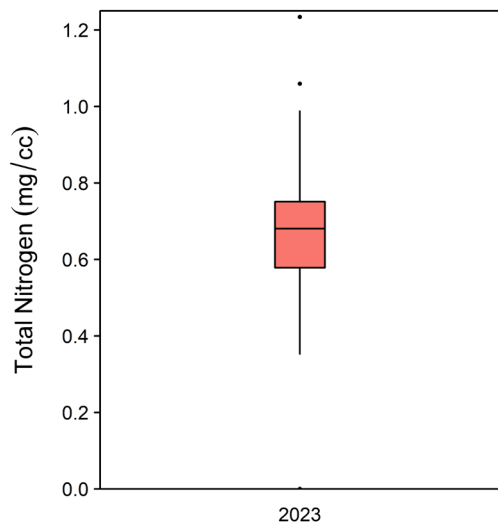


Figure CP-9: Water column periphyton total nitrogen (mg/cc), 2023 REMAP data

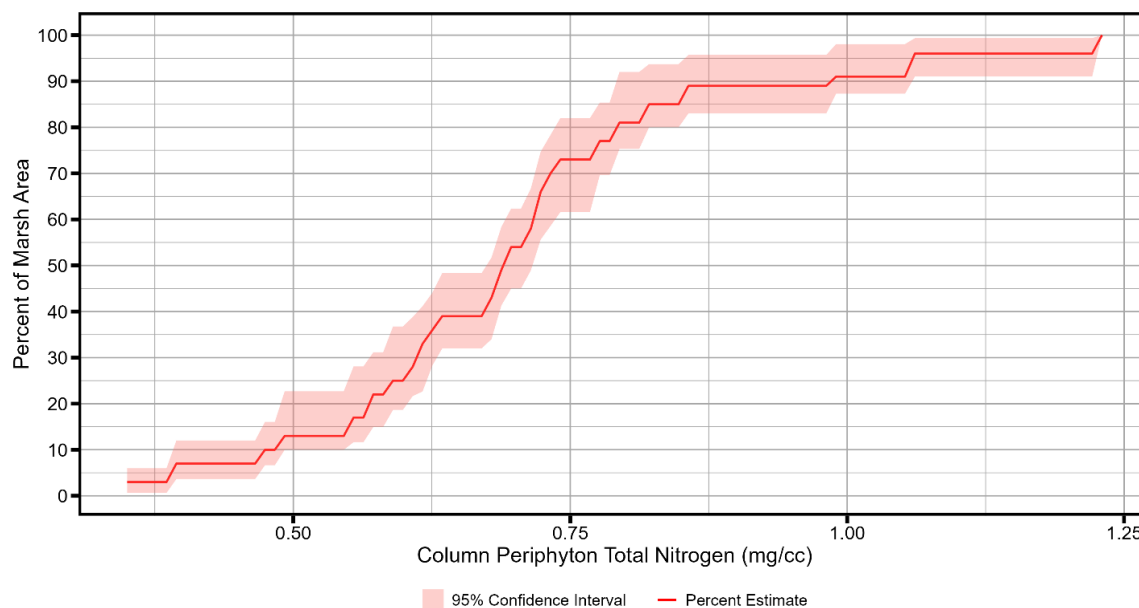


Figure CP-10: Water column total nitrogen (mg/cc) estimates of sampled area

## Total Phosphorus

REMAP 2023 water column periphyton total phosphorus concentrations ranged from 31.71 to 679.35 mg/kg, with a median concentration of 96.83 mg/kg (Figure CP-11). Water column periphyton total phosphorus data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.21$ ,  $\rho = 0.25$ ). About 50% of the marsh area sampled had a water column periphyton total phosphorus concentration at or below 93.60 mg/kg, with a 95% confidence interval of 42.96% to 58.33% (Figure CP-12).

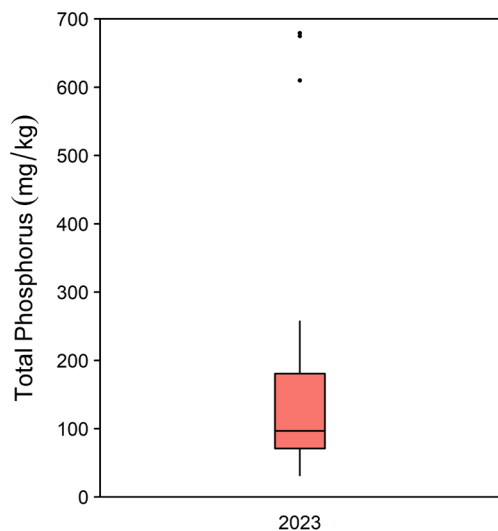


Figure CP-11: Water column periphyton total phosphorus (mg/kg), 2023 REMAP data

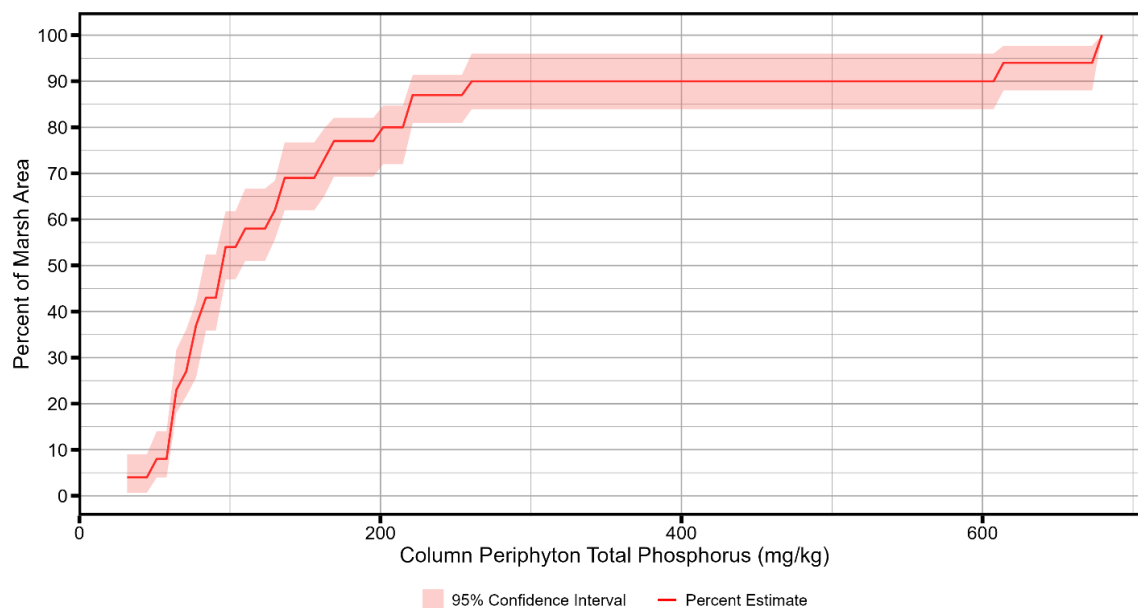


Figure CP-12: Water column periphyton total phosphorus (mg/kg) estimates of sampled area

Expressed in terms of concentration by volume, REMAP 2023 water column periphyton total phosphorus concentrations ranged from 1.85 to 12.91  $\mu\text{g/cc}$ , with a median concentration of 4.81  $\mu\text{g/cc}$  (Figure CP-13). Water column periphyton total phosphorus data were not calculated by volume in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.14$ ,  $\rho = 0.29$ ). About 50% of the marsh area sampled had a water column periphyton total phosphorus concentration at or below 4.81  $\mu\text{g/cc}$ , with a 95% confidence interval of 43.73% to 59.76% (Figure CP-14).

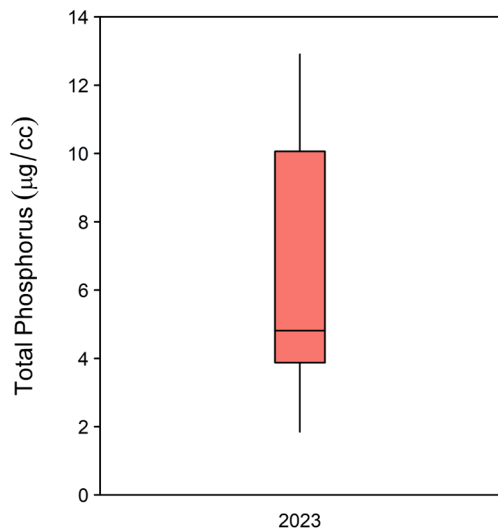


Figure CP-13: Water column periphyton total phosphorus ( $\mu\text{g/cc}$ ), 2023 REMAP data

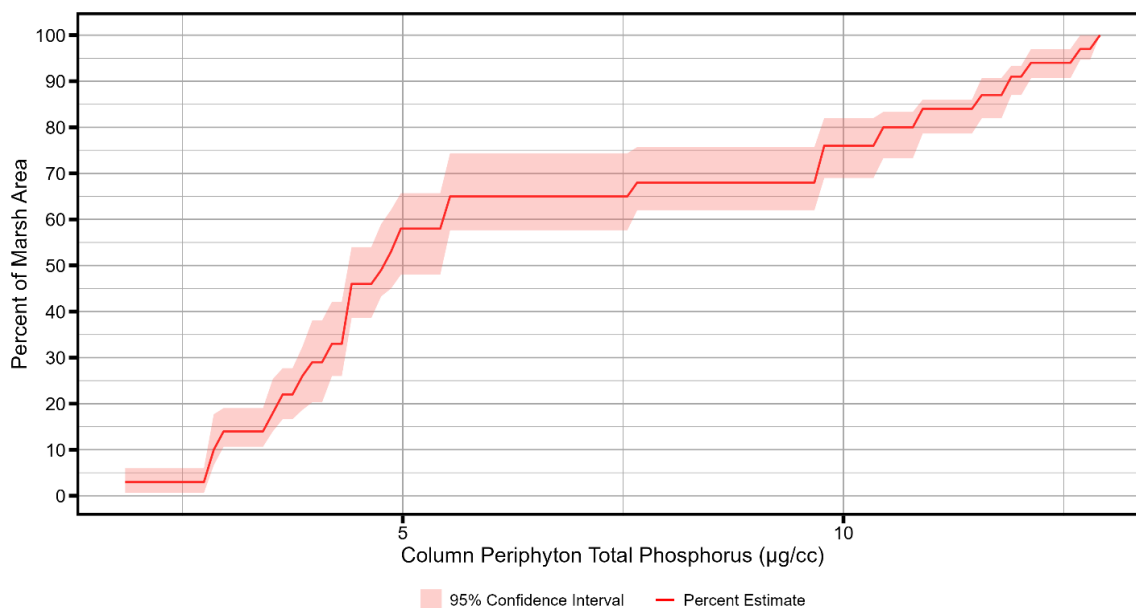


Figure CP-14: Water column periphyton total phosphorus ( $\mu\text{g/cc}$ ) estimates of sampled area

## Total Mercury

REMAP 2023 water column periphyton total mercury concentrations ranged from 10.20 to 128.30 ng/g, with a median concentration of 27.60 ng/g (Figure CP-15). 1995-1996 REMAP marsh data ranged from 4.70 to 329.78 ng/g with a median of 63.46 ng/g. REMAP 2023 concentrations were not significantly different ( $p = 0.09$ ; Dunn's test) from the 1995-1996 data (Figure CP-15). REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.44$ ,  $\rho = 0.15$ ). About 50% of the marsh area sampled had a water column periphyton total mercury concentration at or below 27.2 ng/g, with a 95% confidence interval of 41.06% to 56.72% (Figure CP-16).

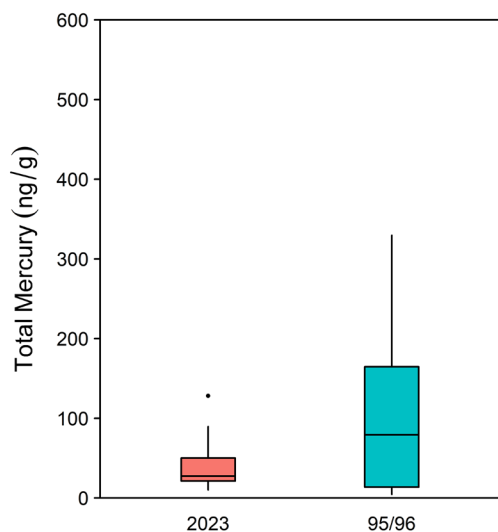


Figure CP-15: Comparison of water column total mercury (ng/g) between 2023 REMAP data and 1995-1996 REMAP data

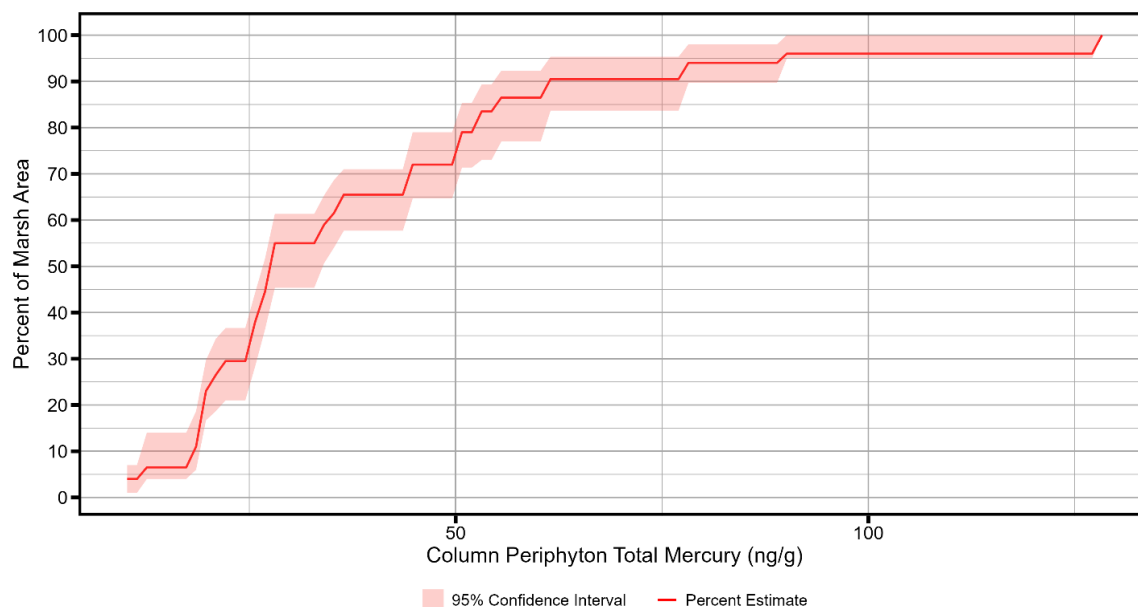


Figure CP-16: Water column periphyton total mercury (ng/g) estimates of sampled area

Expressed in terms of concentration by volume, REMAP 2023 water column periphyton total mercury concentrations ranged from 0.48 to 3.89 ng/cc, with a median concentration of 1.77 ng/cc (Figure CP-17). Water column periphyton total mercury data were not calculated by volume in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.50$ ,  $\rho = 0.13$ ). About 50% of the marsh area sampled had a water column periphyton total mercury concentration at or below 1.77 ng/cc, with a 95% confidence interval of 40.13% to 56.50% (Figure CP-18).

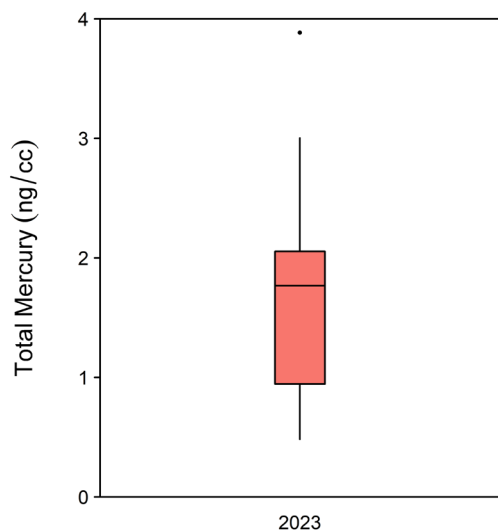


Figure CP-17: Water column periphyton total mercury (ng/cc), 2023 REMAP data

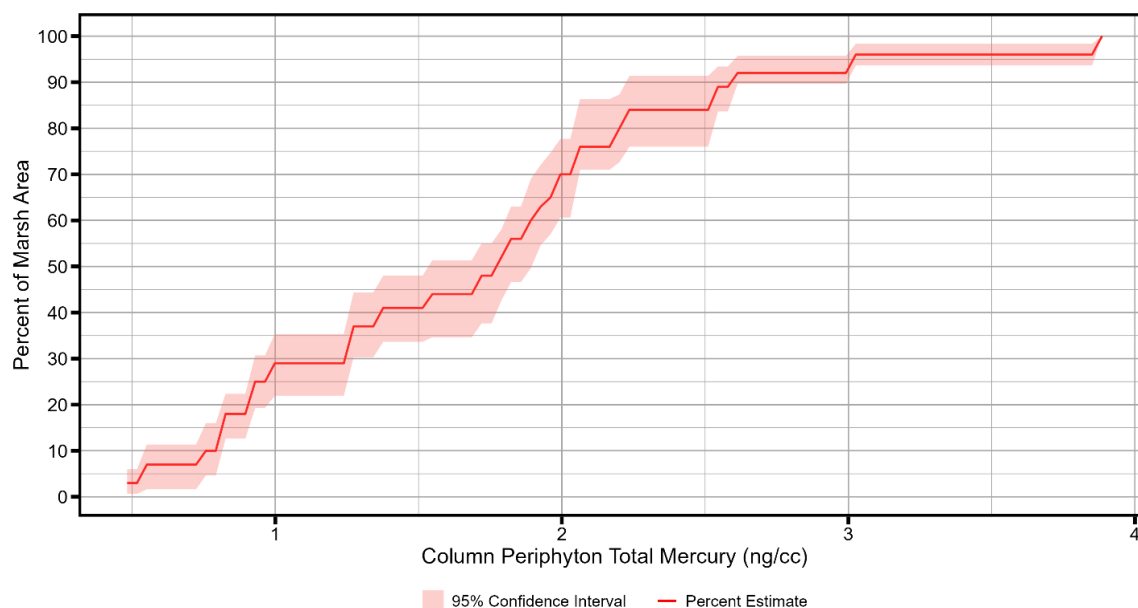


Figure CP-18: Water column periphyton total mercury (ng/cc) estimates of sampled area

## Methylmercury

REMAP 2023 water column periphyton methylmercury concentrations ranged from 0.30 to 8.0 ng/g, with a median concentration of 1.35 ng/g (Figure CP-19). 1995-1996 REMAP marsh data ranged from 0.06 to 1.78 ng/g with a median of 0.67 ng/g. REMAP 2023 concentrations were higher ( $p < 0.05$ ; Dunn's test) than the 1995-1996 data (Figure CP-19). REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.37$ ,  $\rho = 0.18$ ). About 50% of the marsh area sampled had a water column periphyton methylmercury concentration at or below 1.30 ng/g, with a 95% confidence interval of 41.10% to 56.19% (Figure CP-20).

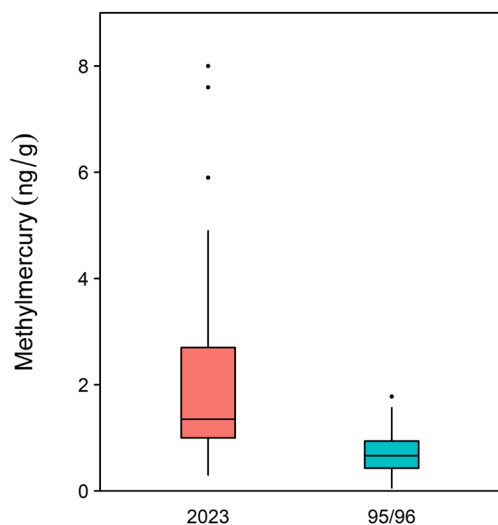


Figure CP-19: Comparison of water column periphyton methylmercury (ng/g) between 2023 REMAP data and 1995-1996 REMAP data

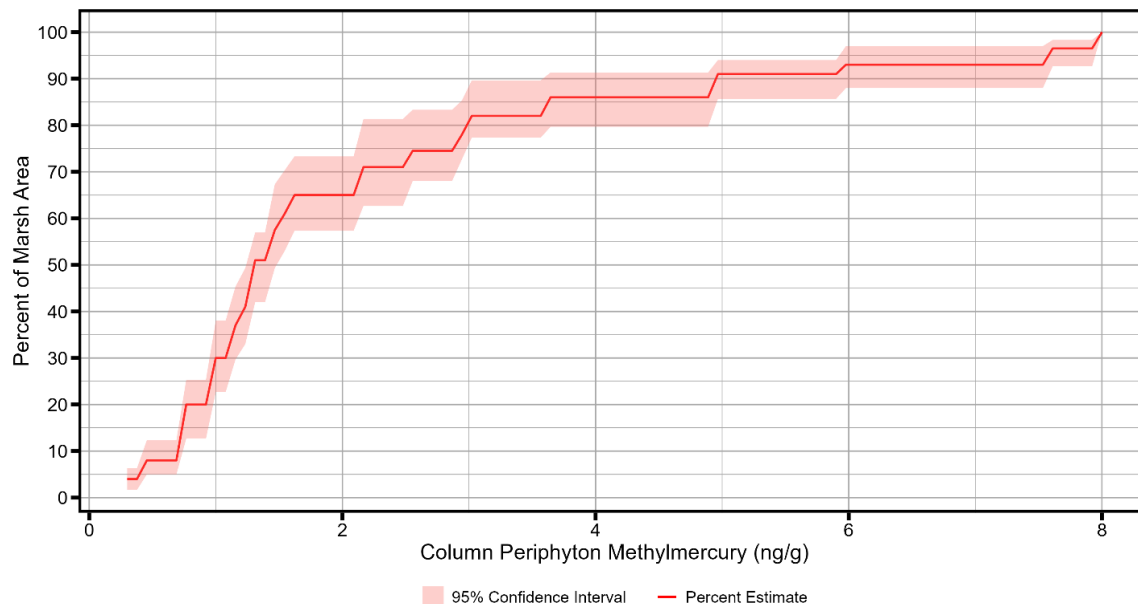


Figure CP-20: Water column periphyton methylmercury (ng/g) estimates of sampled area

Expressed in terms of concentration by volume, REMAP 2023 water column periphyton methylmercury concentrations ranged from 0.02 to 0.23 ng/cc, with a median concentration of 0.07 ng/cc (Figure CP-21). Water column periphyton methylmercury data were not calculated by volume in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.33$ ,  $\rho = 0.19$ ). About 50% of the marsh area sampled had a water column periphyton methylmercury concentration at or below 0.07 ng/cc, with a 95% confidence interval of 42.95% to 57.00% (Figure CP-22).

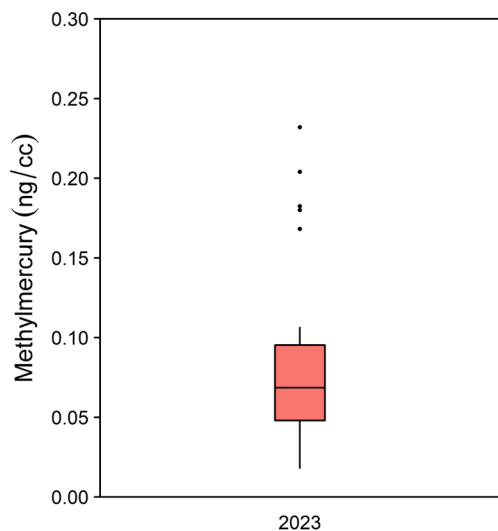


Figure CP-21: Water column methylmercury (ng/cc), 2023 REMAP data

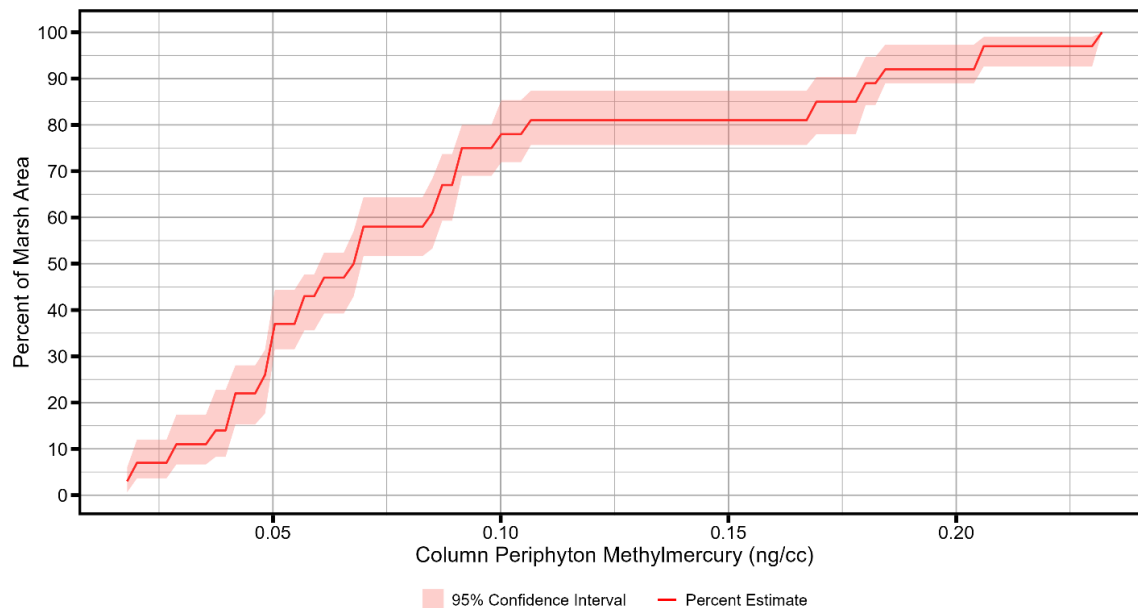


Figure CP-22: Water column periphyton methylmercury (ng/cc) estimates of sampled area

### Chlorophyll *a*

REMAP 2023 water column periphyton chlorophyll *a* concentrations ranged from 18.60 to 2333.90 mg/kg, with a median concentration of 249.30 mg/kg (Figure CP-23). Water column periphyton chlorophyll *a* data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.60$ ,  $\rho = -0.11$ ). About 50% of the marsh area sampled had a water column periphyton chlorophyll *a* concentration at or below 239.40 mg/kg, with a 95% confidence interval of 44.37% to 57.38% (Figure CP-24).

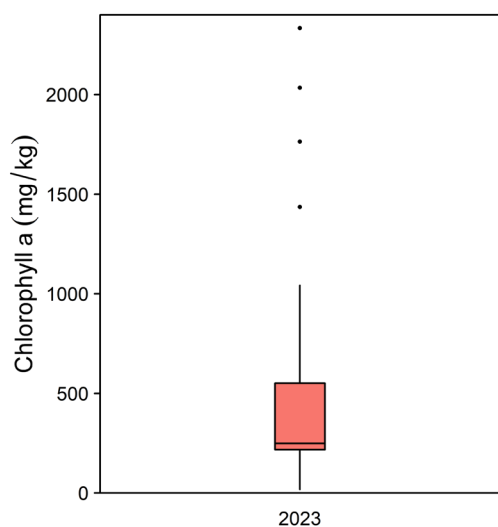


Figure CP-23: Water column periphyton chlorophyll *a* (mg/kg), 2023 REMAP Data

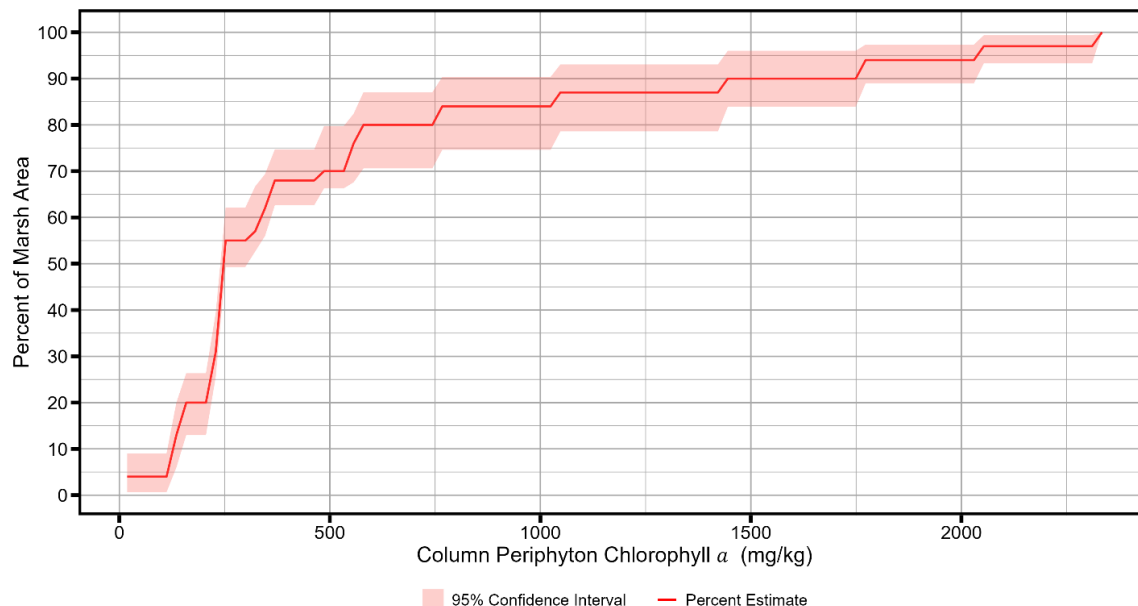


Figure CP-24: Water column periphyton chlorophyll *a* (mg/kg) estimates of sampled area

### Organic Matter

REMAP 2023 water column periphyton organic matter concentrations ranged from 30.65 to 909.35 g/kg, with a median concentration of 403.87 g/kg (Figure CP-25). Water column periphyton organic matter data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.29$ ,  $\rho = 0.21$ ). About 50% of the marsh area sampled had a water column periphyton organic matter concentration at or below 384.04 g/kg, with a 95% confidence interval of 42.32% to 57.60% (Figure CP-26).

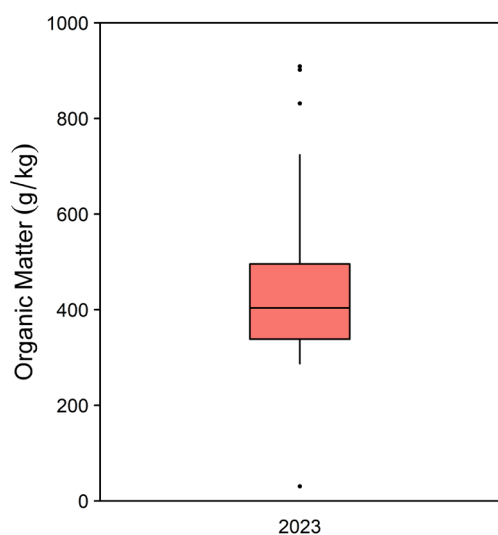


Figure CP-25: Water column periphyton organic matter (g/kg), from 2023 REMAP data

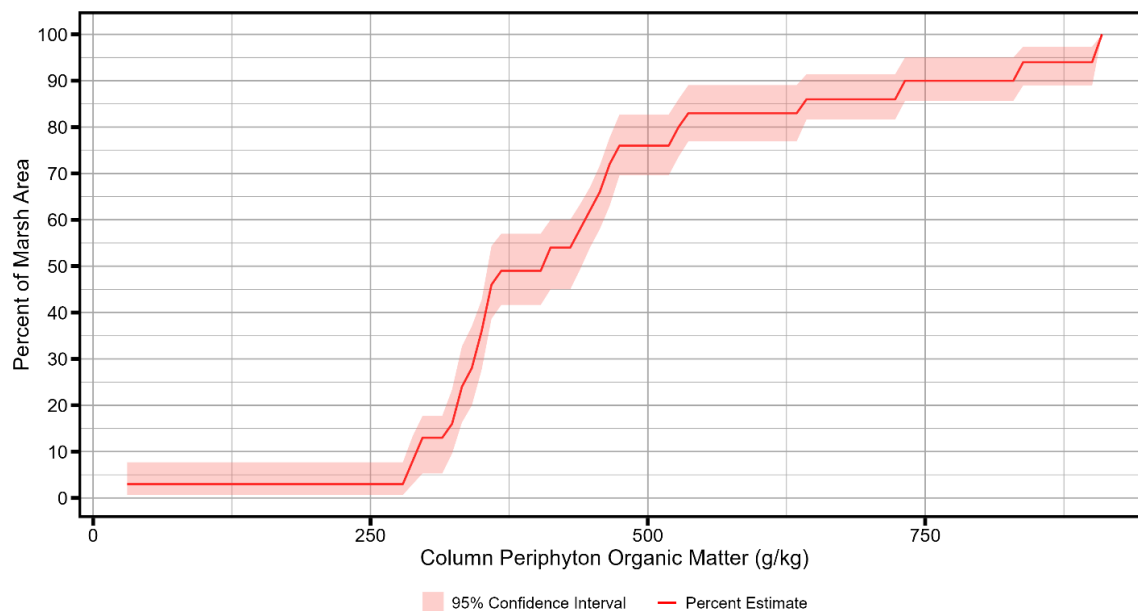


Figure CP-26: Water column periphyton organic matter (g/kg) estimates of sampled area

## Benthic Periphyton

### Total Carbon

REMAP 2023 benthic periphyton total carbon concentrations ranged from 168.00 to 416.90 g/kg, with a median concentration of 223.10 g/kg (Figure BP-1). Benthic periphyton total carbon data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.45$ ,  $\rho = 0.17$ ). About 50% of the marsh area sampled had a benthic periphyton total carbon concentration at or below 223.10 g/kg, with a 95% confidence interval of 40.00% to 57.50% (Figure BP-2).

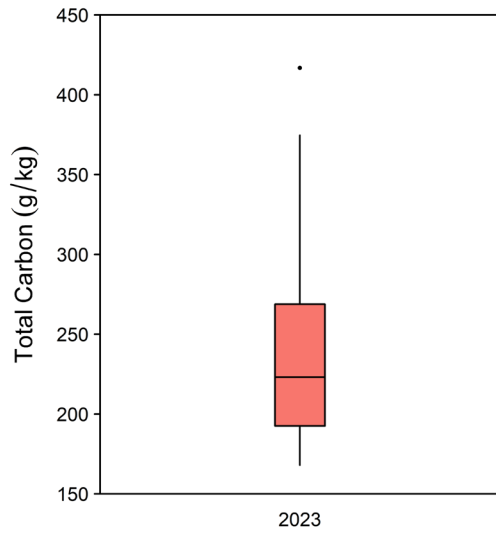


Figure BP-1: Benthic periphyton total carbon (g/kg), 2023 REMAP data

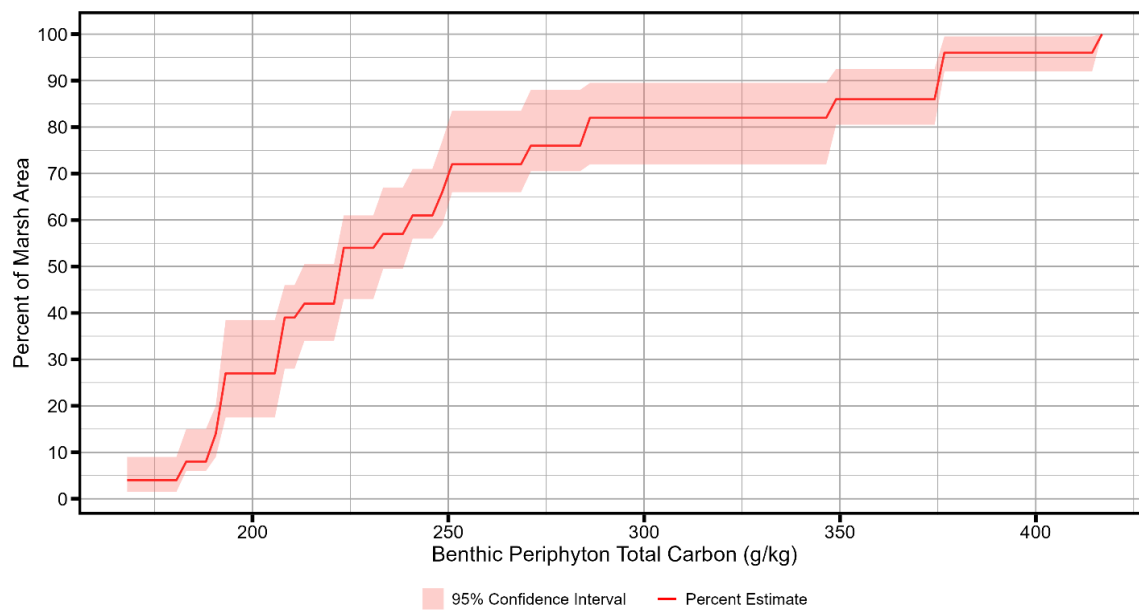


Figure BP-2: Benthic periphyton total carbon(g/kg) estimates of sampled area

## Total Nitrogen

REMAP 2023 benthic periphyton total nitrogen concentrations ranged from 9.57 to 35.13 g/kg, with a median concentration of 13.54 g/kg (Figure BP-3). Benthic periphyton total nitrogen data were not collected in 1995-96. REMAP 2023 data had a significant latitudinal gradient ( $p = 0.02$ ,  $\rho = 0.50$ , Figure BP-4). About 50% of the marsh area sampled had a benthic periphyton total nitrogen concentration at or below 13.54 g/kg, with a 95% confidence interval of 38.00% to 58.55% (Figure BP-5).

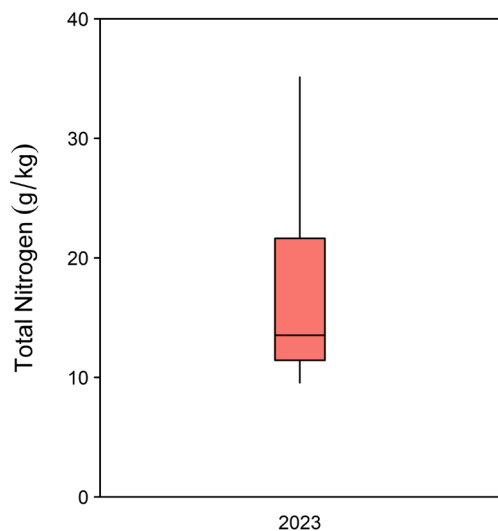


Figure BP-3: Benthic periphyton total nitrogen (g/kg), 2023 REMAP data

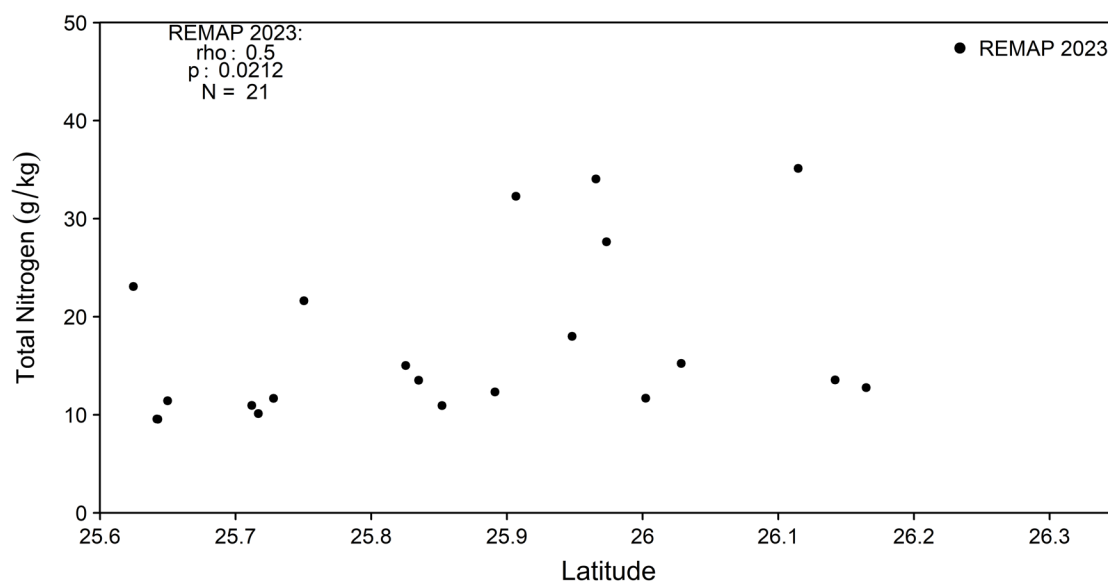


Figure BP-4: Benthic periphyton total nitrogen (g/kg) latitudinal gradient plot

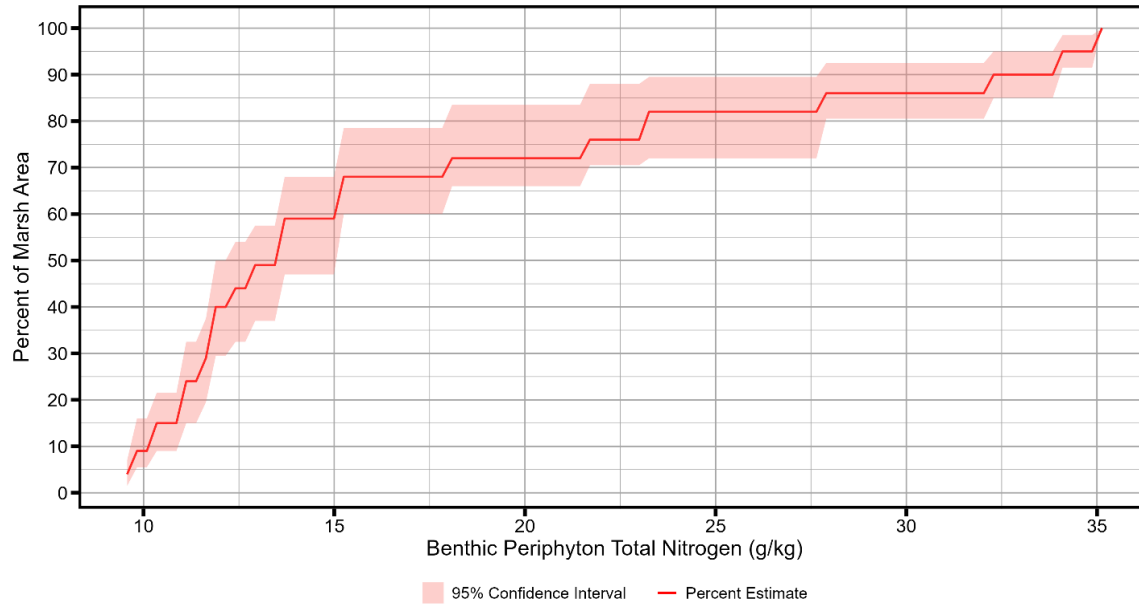


Figure BP-5: Benthic periphyton total nitrogen (g/kg) estimates of sampled area

### Total Phosphorus

REMAP 2023 benthic periphyton total phosphorus concentrations ranged from 43.19 to 352.98 mg/kg, with a median concentration of 174.27 mg/kg (Figure BP-6). Benthic periphyton total phosphorus data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.22$ ,  $\rho = 0.28$ ). About 50% of the marsh area sampled had a benthic periphyton total phosphorus concentration at or below 174.27 mg/kg, with a 95% confidence interval of 41.00% to 57.00% (Figure BP-7).

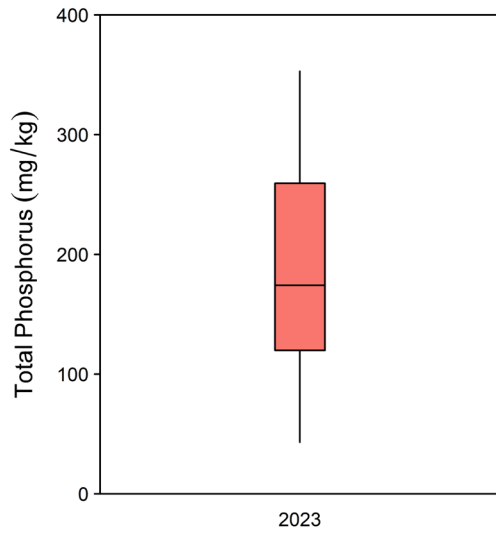


Figure BP-6: Benthic periphyton total phosphorus (mg/kg), 2023 REMAP data

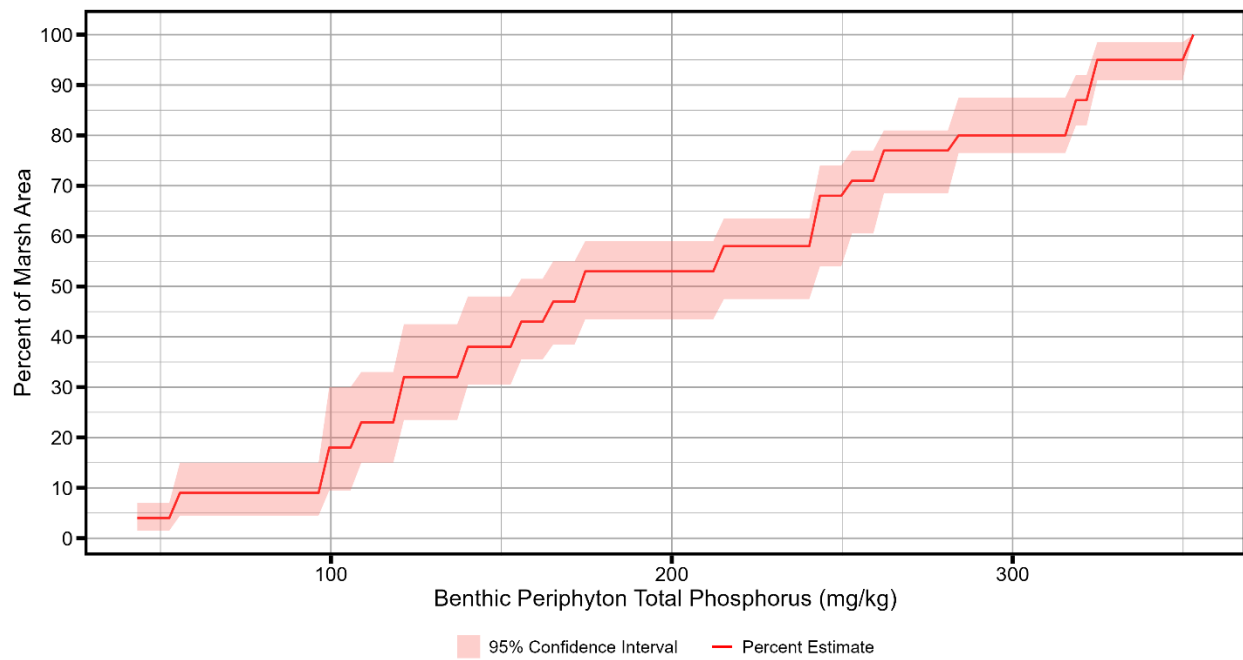


Figure BP-7: Benthic periphyton total phosphorus (mg/kg) estimates of sampled area

## Total Mercury

REMAP 2023 benthic periphyton total mercury concentrations ranged from 8.00 to 267.90 ng/g, with a median concentration of 43.55 ng/g (Figure BP-8). 1995-1996 REMAP marsh data ranged from 35.71 to 417.40 ng/g with a median of 145.47 ng/g. REMAP 2023 concentrations were lower ( $p < 0.05$ ; Dunn's test) than the 1995-1996 data (Figure BP-8). REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.46$ ,  $\rho = 0.16$ ). About 50% of the marsh area sampled had a benthic periphyton total mercury concentration at or below 43.40 ng/g, with a 95% confidence interval of 39.01% to 57.85% (Figure BP-9).

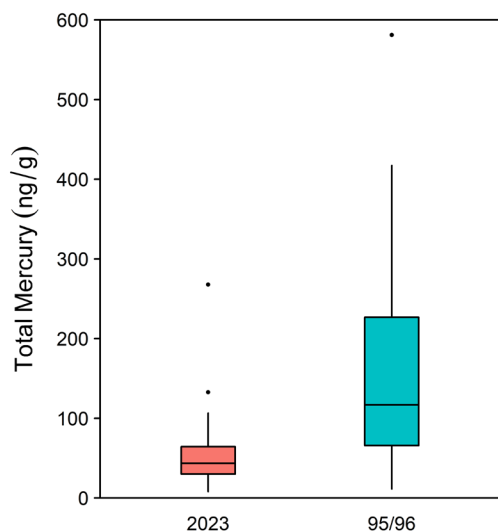


Figure BP-8: Comparison of benthic periphyton total mercury (ng/g) between 2023 REMAP data and 1995-1996 REMAP data

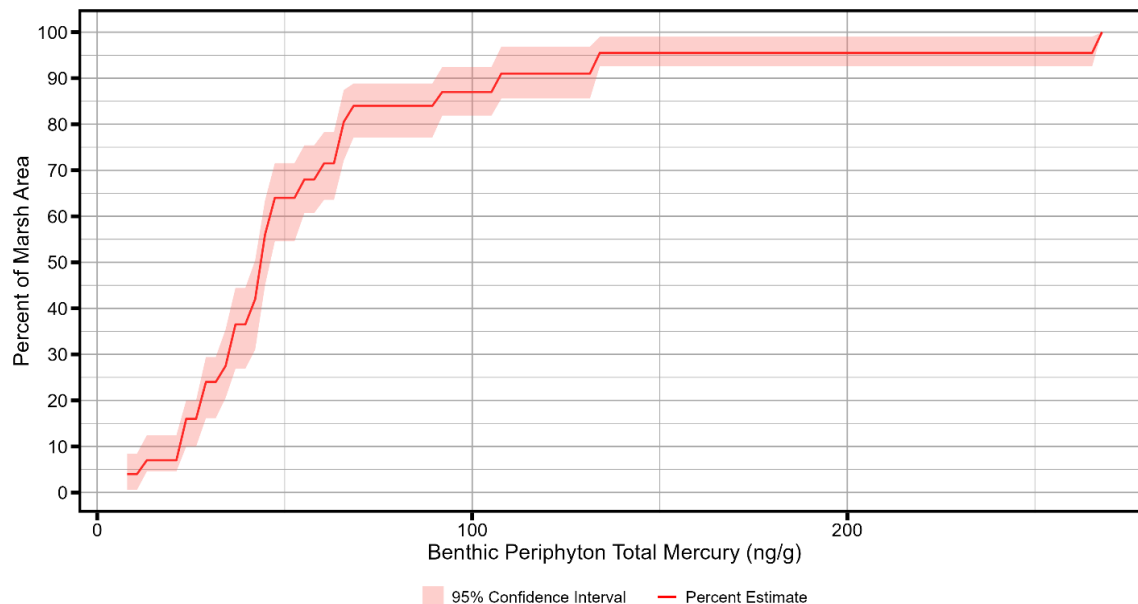


Figure BP-9: Benthic periphyton total mercury (ng/g) estimates of sampled area

### Methylmercury

REMAP 2023 benthic periphyton methylmercury concentrations ranged from 0.3 to 14.1 ng/g, with a median concentration of 1.25 ng/g (Figure BP-10). 1995-1996 REMAP marsh data ranged from 0.05 to 4.28 ng/g with a median of 0.44 ng/g. REMAP 2023 concentrations were higher ( $p < 0.05$ ; Dunn's test) than the 1995-1996 data (Figure BP-10). REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.32$ ,  $\rho = -0.21$ ). About 50% of the marsh area sampled had a benthic periphyton methylmercury concentration at or below 1.10 ng/g, with a 95% confidence interval of 43.48% to 60.41% (Figure BP-11).

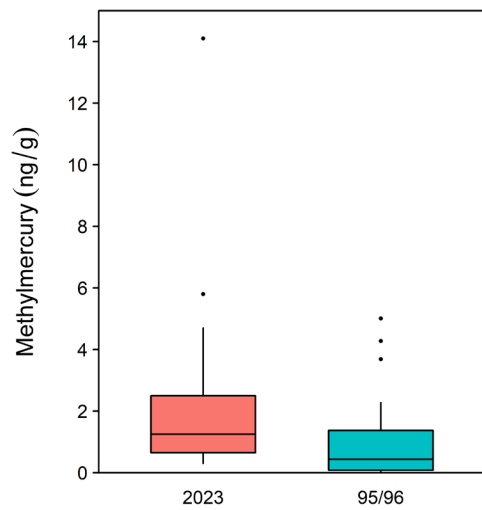


Figure BP-10: Comparison of benthic periphyton methylmercury (ng/g) between 2023 REMAP data and 1995-1996 REMAP Data

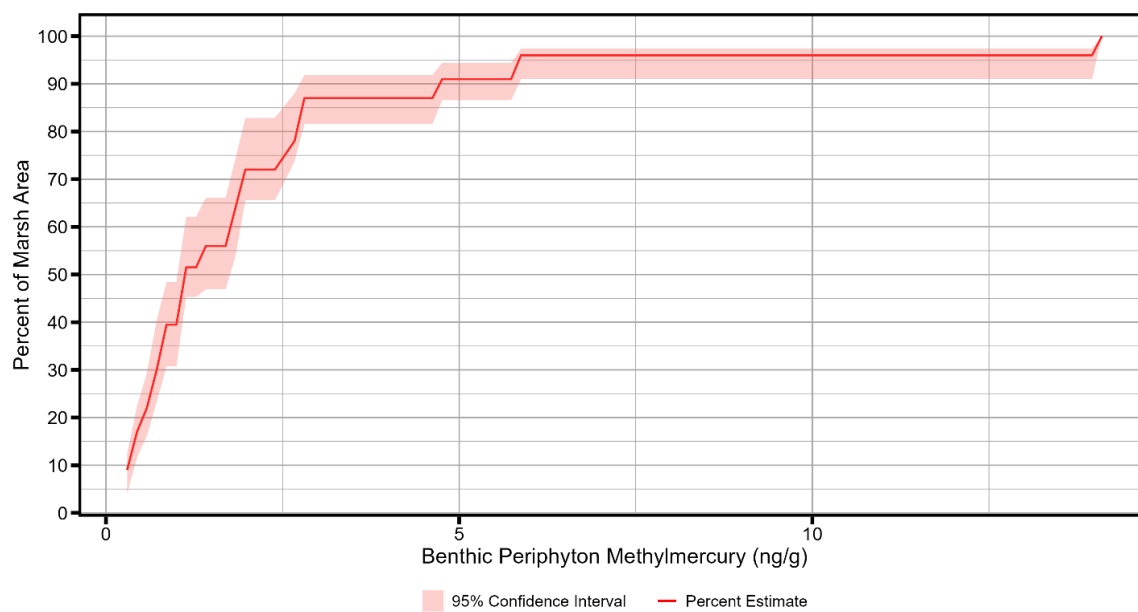


Figure BP-11: Benthic periphyton methylmercury (ng/g) estimates of sampled area

## Chlorophyll *a*

REMAP 2023 benthic periphyton chlorophyll *a* concentrations ranged from 28.50 to 7468.40 mg/kg, with a median concentration of 149.10 mg/kg (Figure BP-12). Benthic periphyton chlorophyll *a* data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.95$ ,  $\rho = -0.01$ ). About 50% of the marsh area sampled had a benthic periphyton chlorophyll *a* concentration at or below 149.10 mg/kg, with a 95% confidence interval of 41.53% to 61.26% (Figure BP-13).

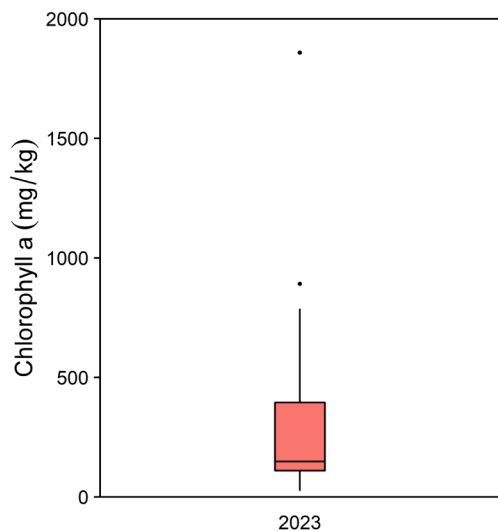


Figure BP-12: Benthic periphyton chlorophyll *a* (mg/kg), 2023 REMAP data. For visibility, the maximum value of 7468.40 mg/kg is removed from the figure.

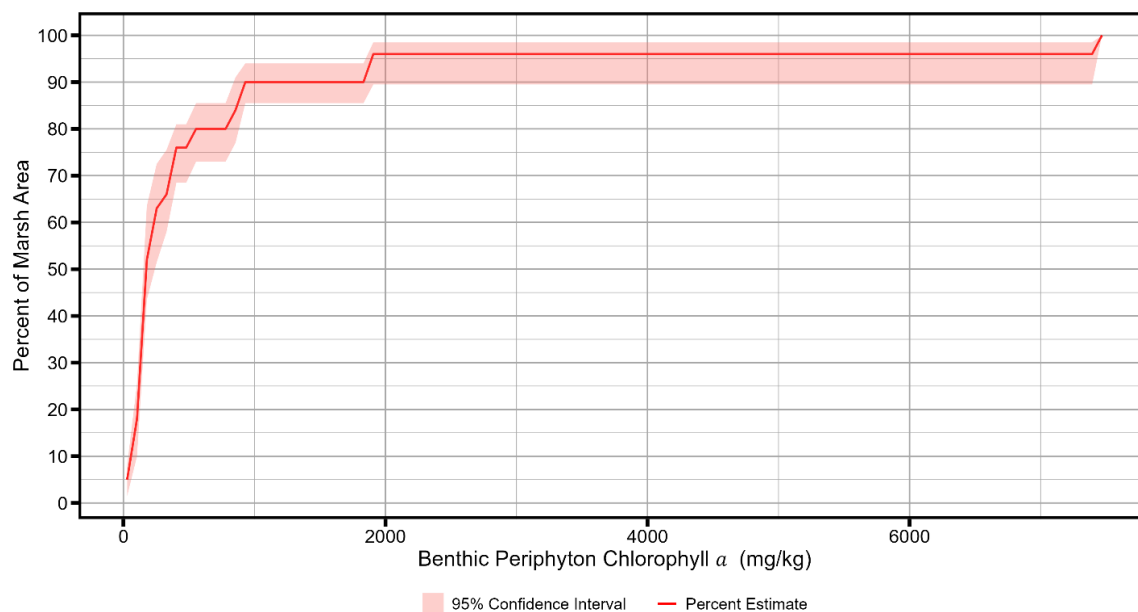


Figure BP-13: Benthic periphyton chlorophyll *a* (mg/kg) estimates of sampled area

## Organic Matter

REMAP 2023 benthic periphyton organic matter concentrations ranged from 197.59 to 896.26 g/kg, with a median concentration of 327.03 g/kg (Figure BP-14). Benthic periphyton organic matter data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.35$ ,  $\rho = 0.21$ ). About 50% of the marsh area sampled had a benthic periphyton organic matter concentration at or below 327.03 g/kg, with a 95% confidence interval of 39.20% to 60.40% (Figure BP-15).

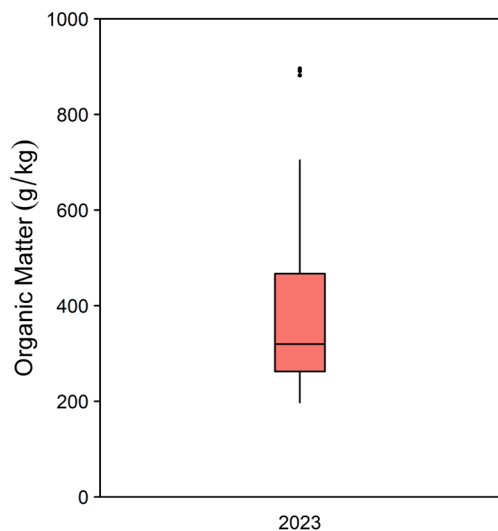


Figure BP-14: Benthic periphyton organic matter (g/kg), 2023 REMAP data

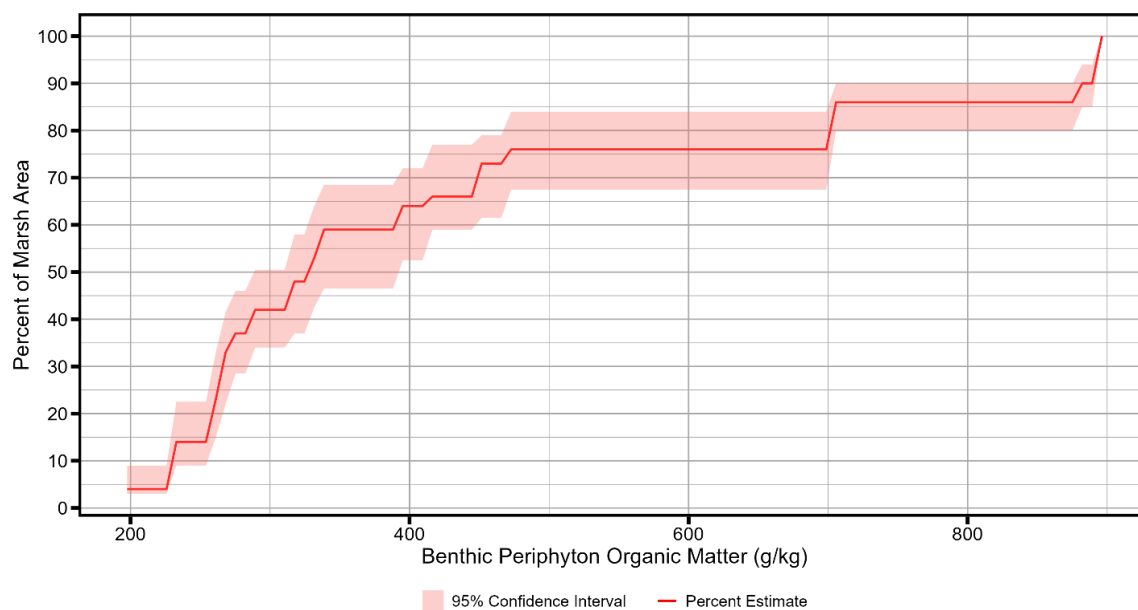


Figure BP-15: Benthic periphyton organic matter (g/kg) estimates of sampled area

## Sawgrass Plants

### Total Carbon

REMAP 2023 sawgrass plant total carbon concentrations ranged from 435.00 to 589.80 g/kg, with a median concentration of 485.10 g/kg (Figure PL-1). Plant total carbon data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.17$ ,  $\rho = 0.29$ ). About 50% of the marsh area sampled had a plant total carbon concentration at or below 485.10 g/kg, with a 95% confidence interval of 40.56% to 56.72% (Figure PL-2).

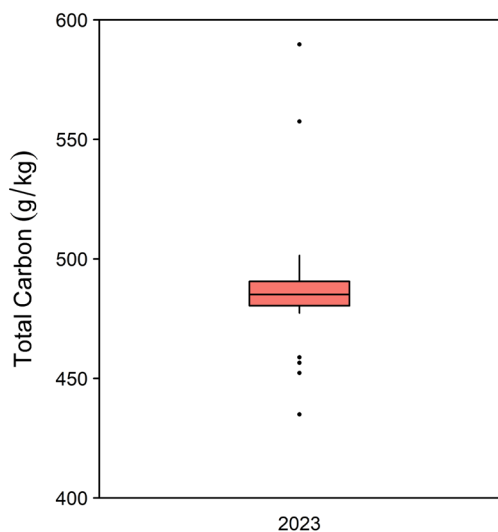


Figure PL-1: Sawgrass plant total carbon (g/kg), 2023 REMAP data

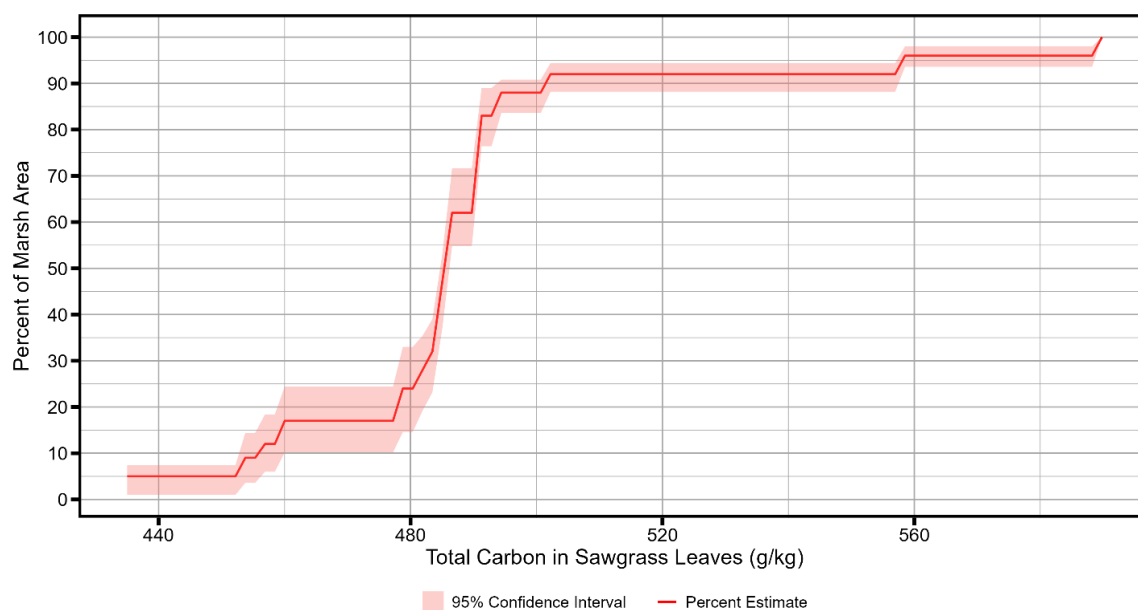


Figure PL-2: Sawgrass plant total carbon (g/kg) estimates of sampled area

## Total Nitrogen

REMAP 2023 sawgrass plant total nitrogen concentrations ranged from 6.42 to 22.92 g/kg, with a median concentration of 8.21 g/kg (Figure PL-3). Plant total nitrogen data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.80$ ,  $\rho = 0.05$ ). About 50% of the marsh area sampled had a plant total nitrogen concentration at or below 8.28 g/kg, with a 95% confidence interval of 42.00% to 57.00% (Figure PL-4).

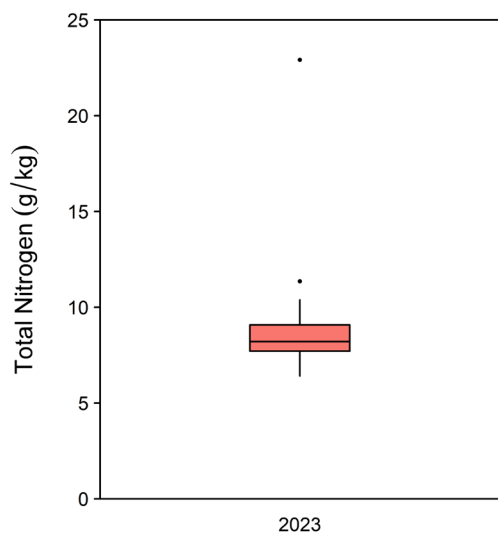


Figure PL-3: Sawgrass plant total carbon (g/kg), 2023 REMAP data

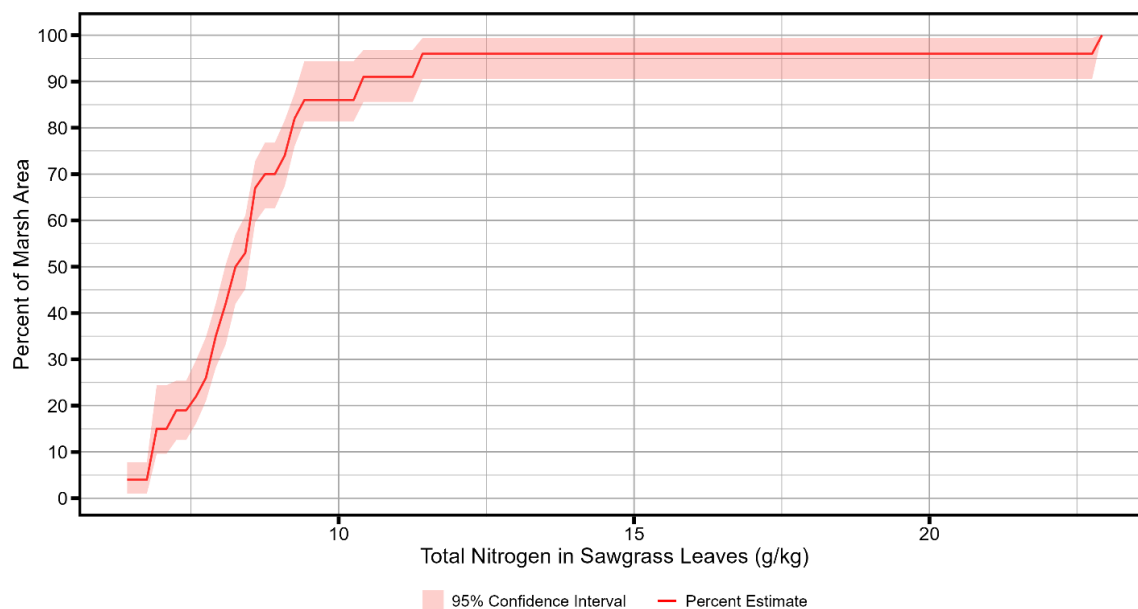


Figure PL-4: Sawgrass plant total carbon (g/kg) estimates of sampled area

## Total Phosphorus

REMAP 2023 sawgrass plant total phosphorus concentrations ranged from 181.31 to 2023.30 mg/kg, with a median concentration of 274.61 mg/kg (Figure PL-5). Plant total phosphorus data were not collected in 1995-96. REMAP 2023 data did not have a significant latitudinal gradient ( $p = 0.89$ ,  $\rho = -0.03$ ). About 50% of the marsh area sampled had a plant total nitrogen concentration at or below 274.61 mg/kg, with a 95% confidence interval of 41.84% to 61.72% (Figure PL-6).

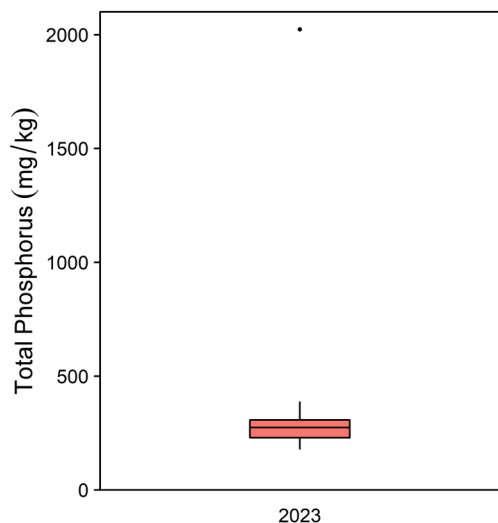


Figure PL-5: Sawgrass plant total carbon (mg/kg), 2023 REMAP data

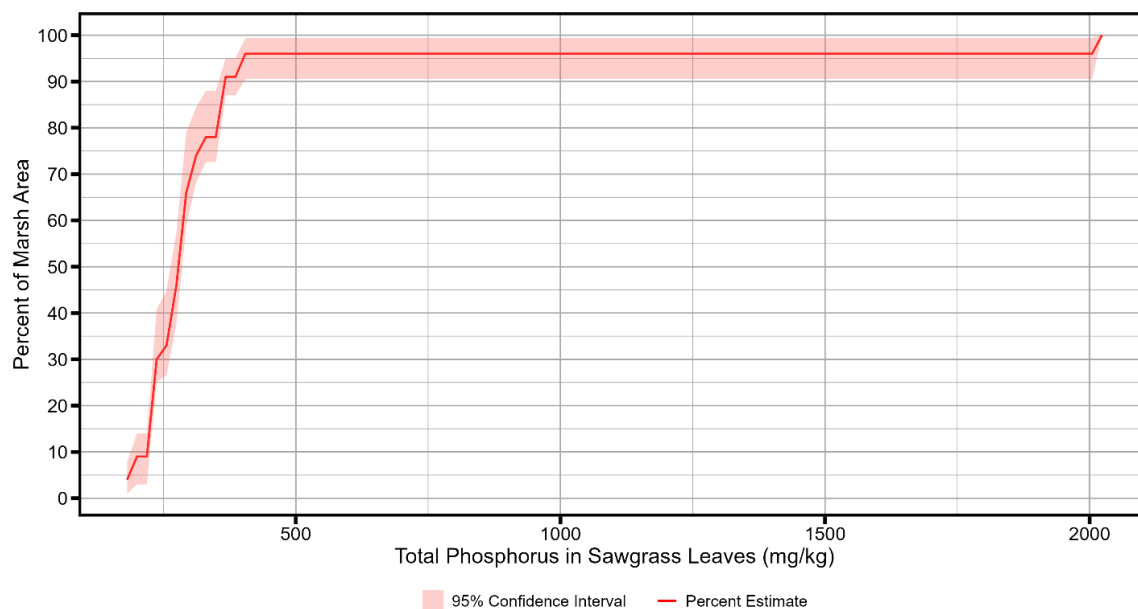


Figure PL-6: Sawgrass plant total carbon (mg/kg) estimates of sampled area

## Non-Significant Latitude Plots for Appendix – Water Column Periphyton

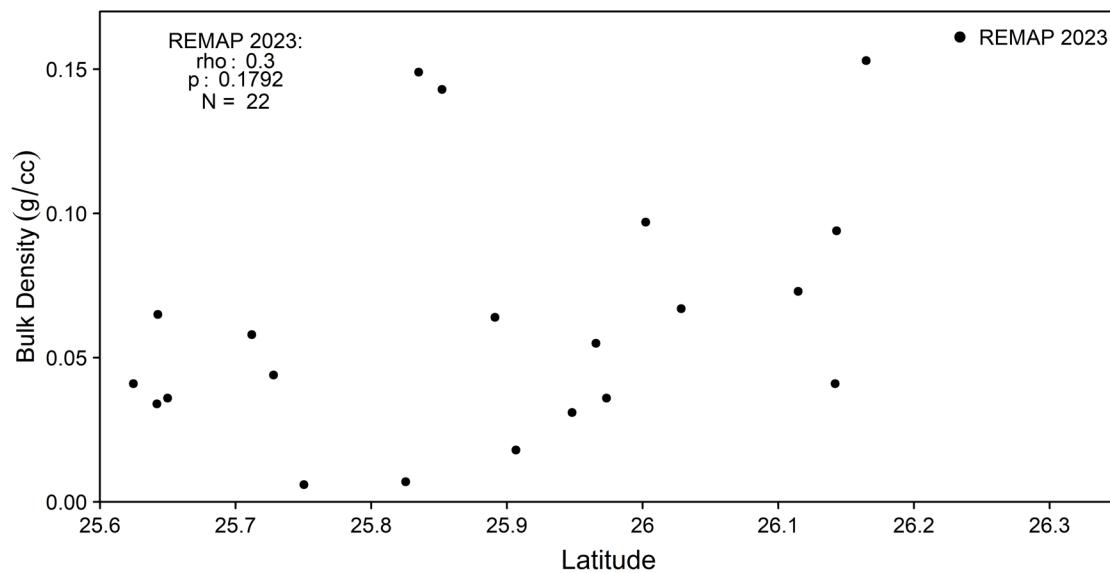


Figure NS-1: Water column periphyton bulk density (g/cc) latitudinal gradient plot

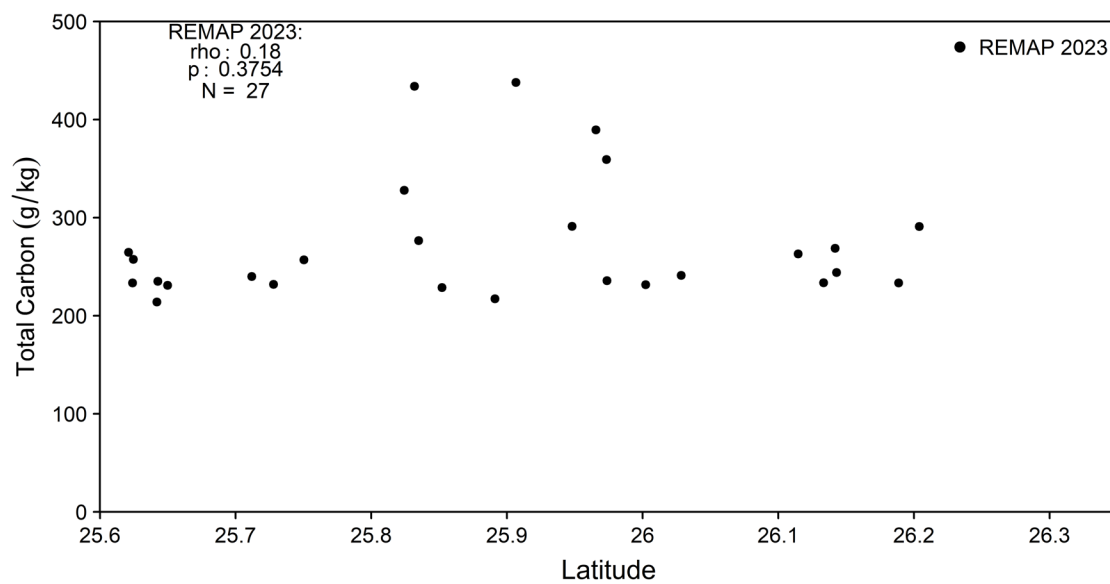


Figure NS-2: Water column periphyton total carbon (g/kg) latitudinal gradient plot

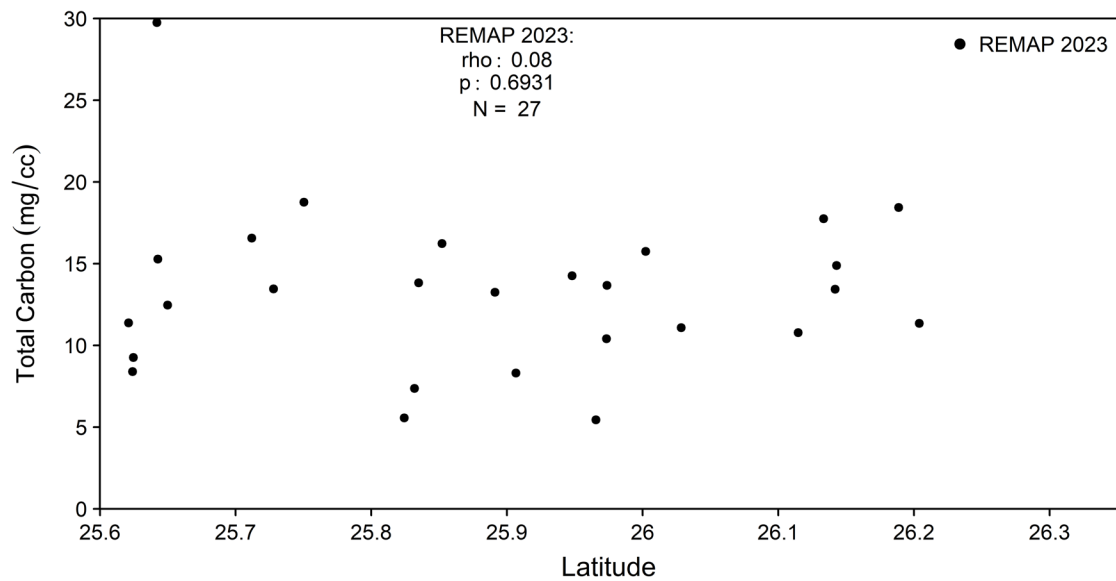


Figure NS-3: Water column periphyton total carbon (mg/cc) latitudinal gradient plot

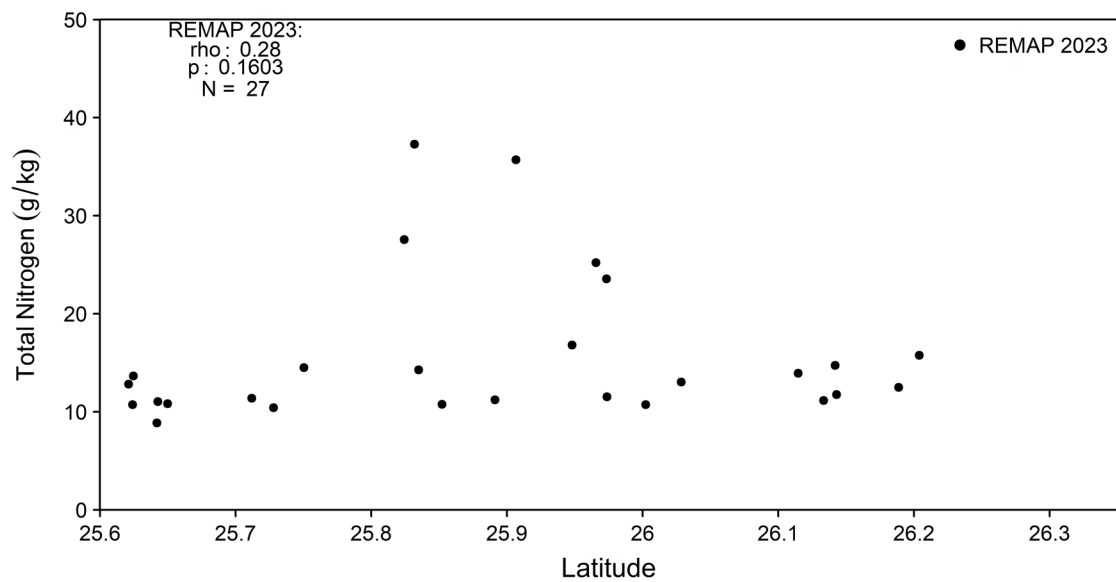


Figure NS-4: Water column periphyton total nitrogen (g/kg) latitudinal gradient plot

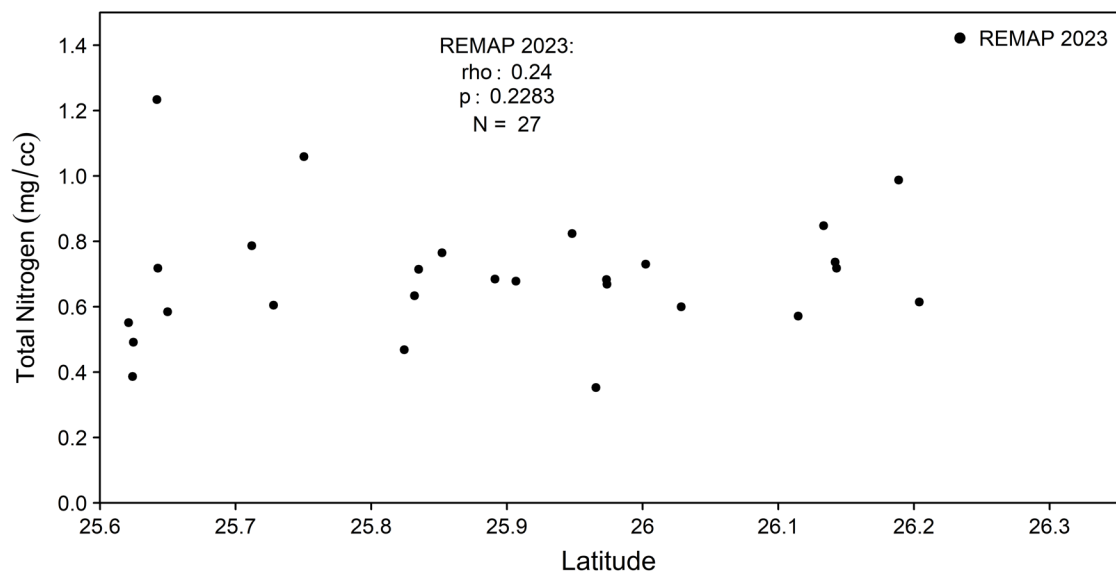


Figure NS-5: Water column periphyton total nitrogen (mg/cc) latitudinal gradient plot

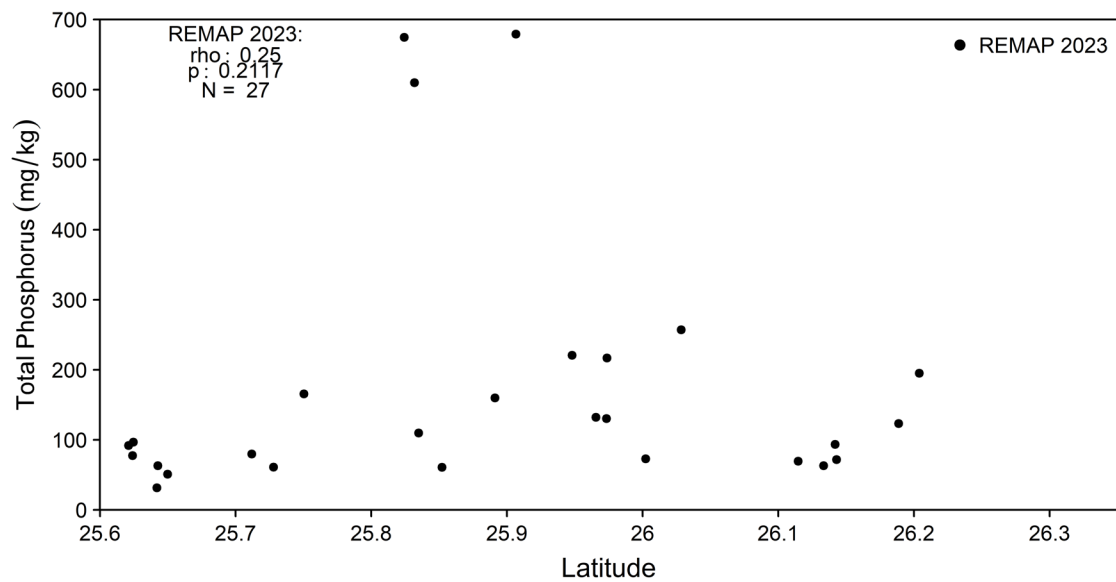


Figure NS-6: Water column periphyton total phosphorus (mg/kg) latitudinal gradient plot

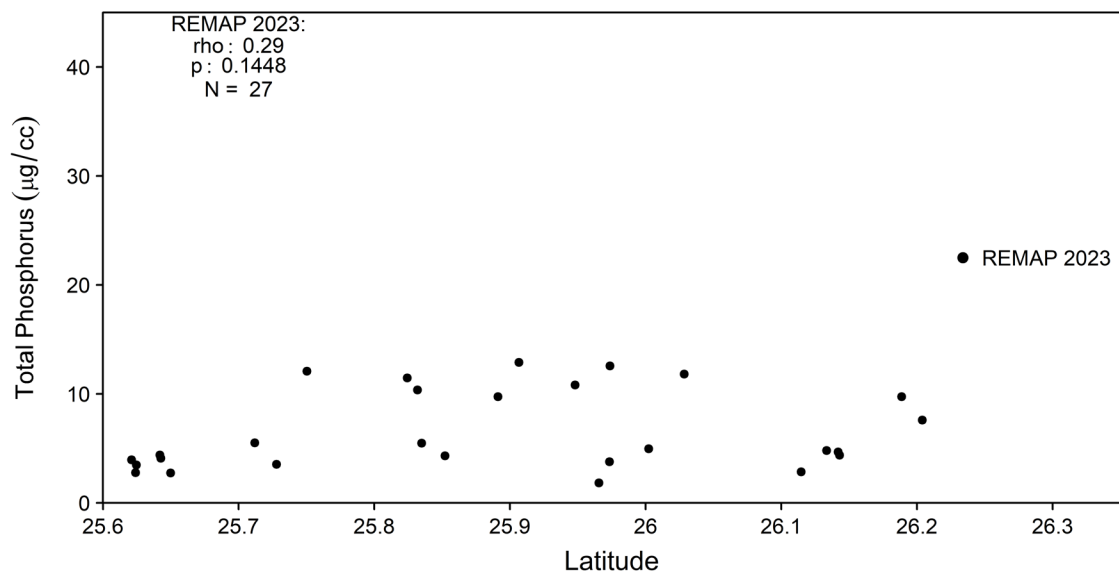


Figure NS-7: Water column periphyton total phosphorus ( $\mu\text{g/cc}$ ) latitudinal gradient plot

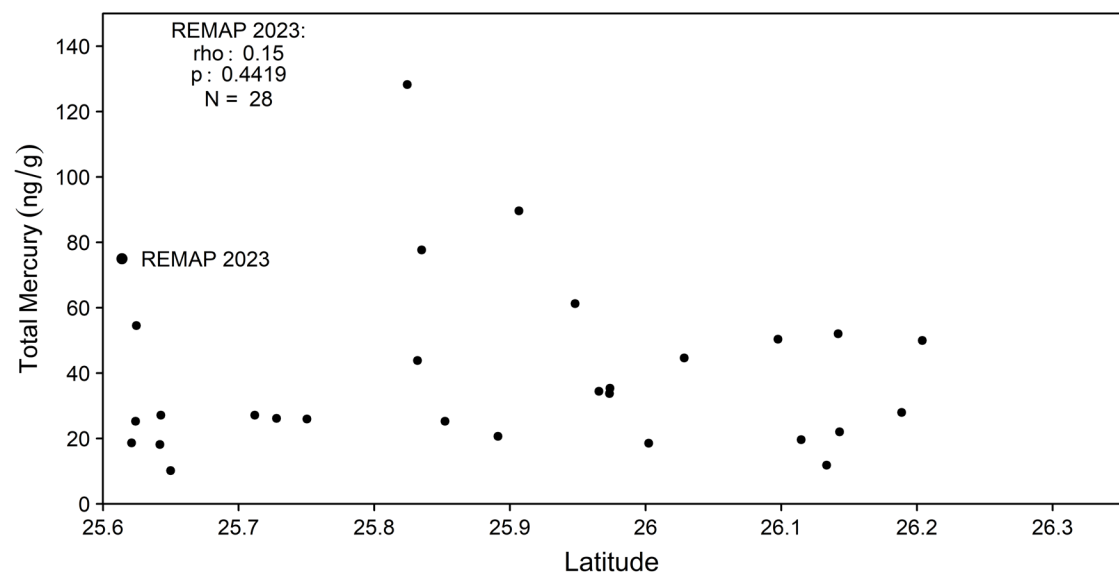


Figure NS-8: Water column periphyton total mercury (ng/g) latitudinal gradient plot

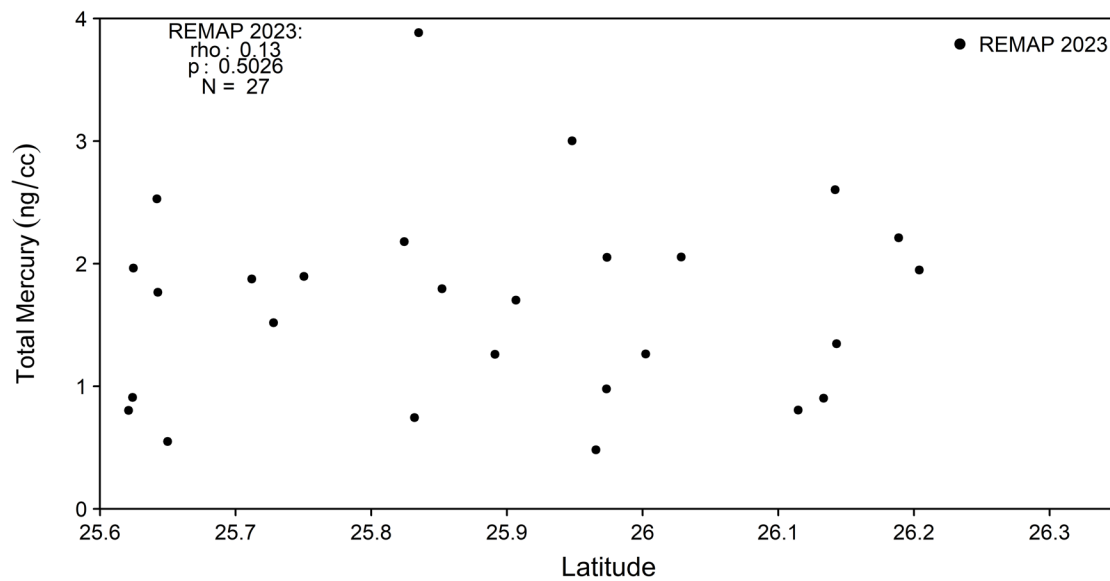


Figure NS-9: Water column periphyton total mercury (ng/cc) latitudinal gradient plot

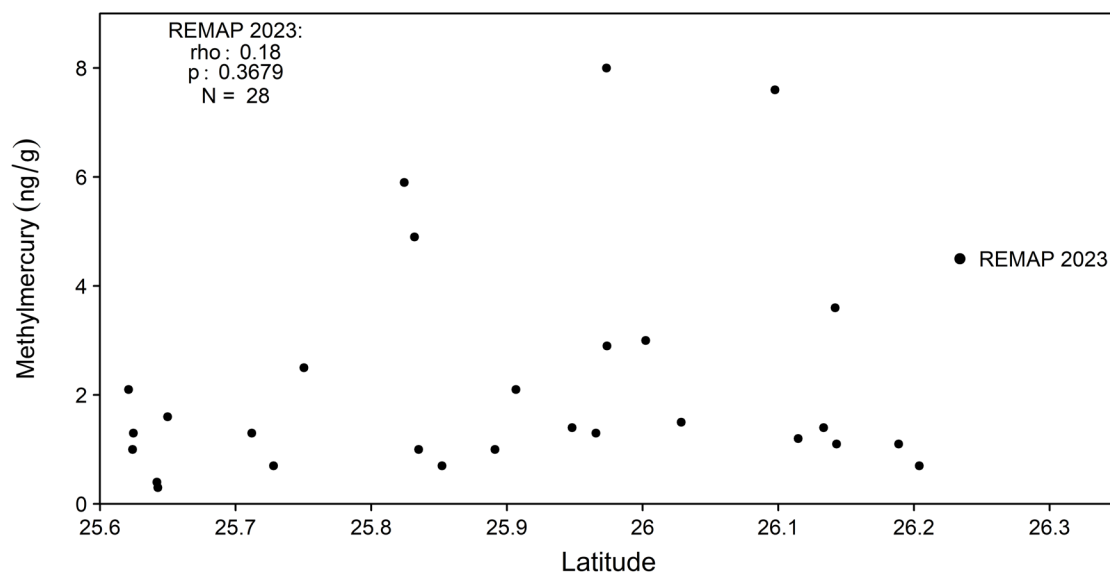


Figure NS-10: Water column periphyton methylmercury (ng/g) latitudinal gradient plot

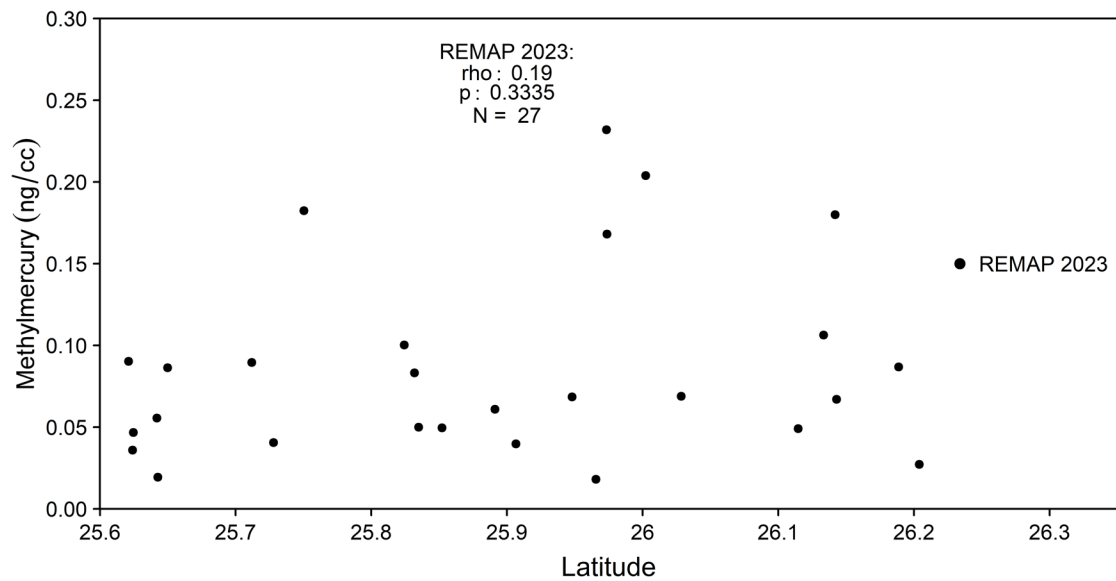


Figure NS-11: Water column periphyton methylmercury (ng/cc) latitudinal gradient plot

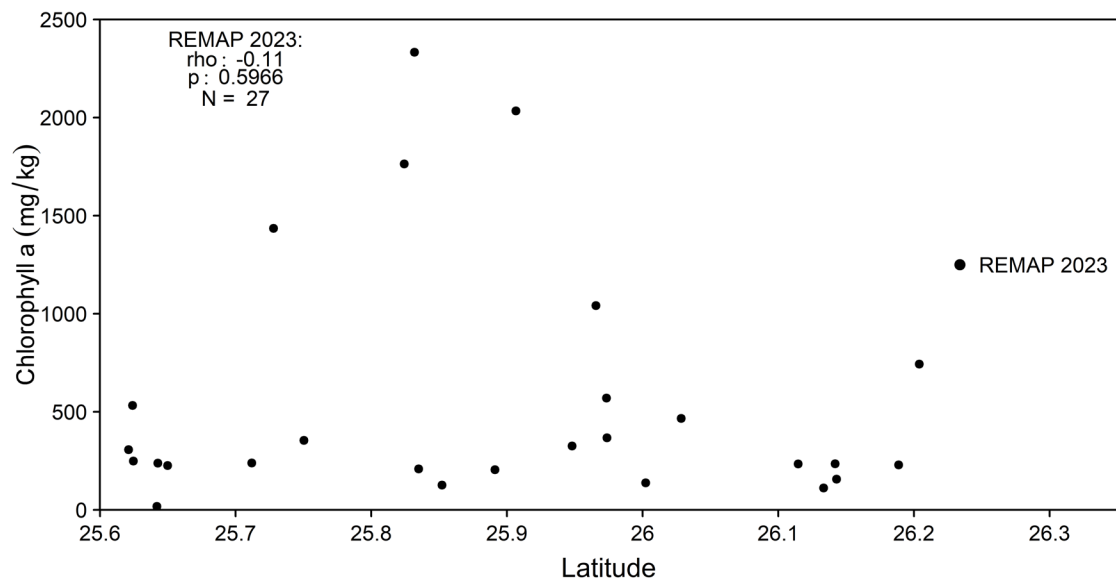


Figure NS-12: Water column periphyton chlorophyll *a* (mg/kg) latitudinal gradient plot

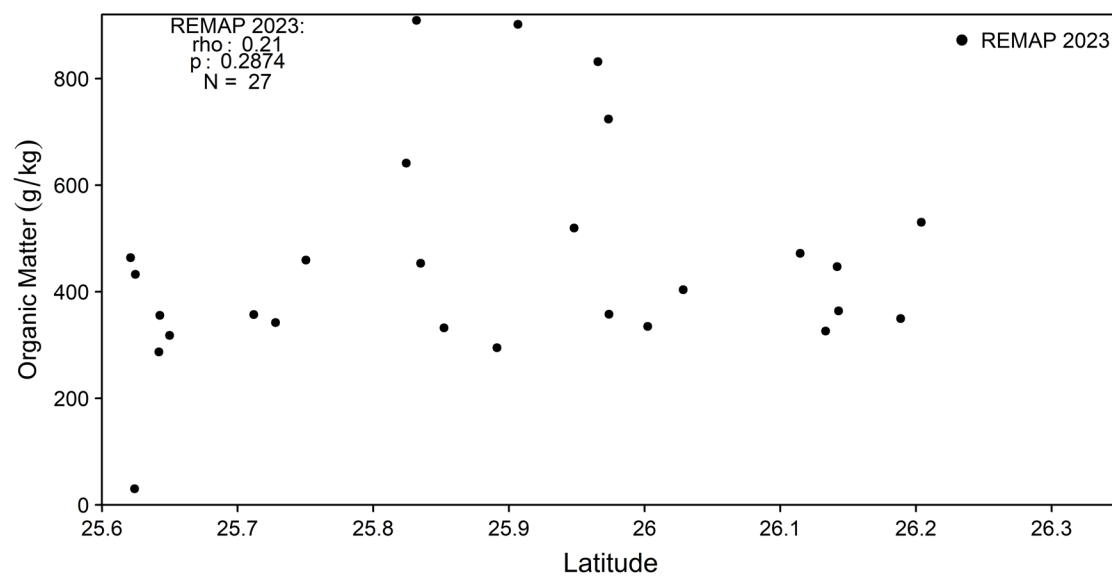


Figure NS-13: Water column periphyton organic matter (g/kg) latitudinal gradient plot

## Non-Significant Latitude Plots for Appendix – Benthic Periphyton

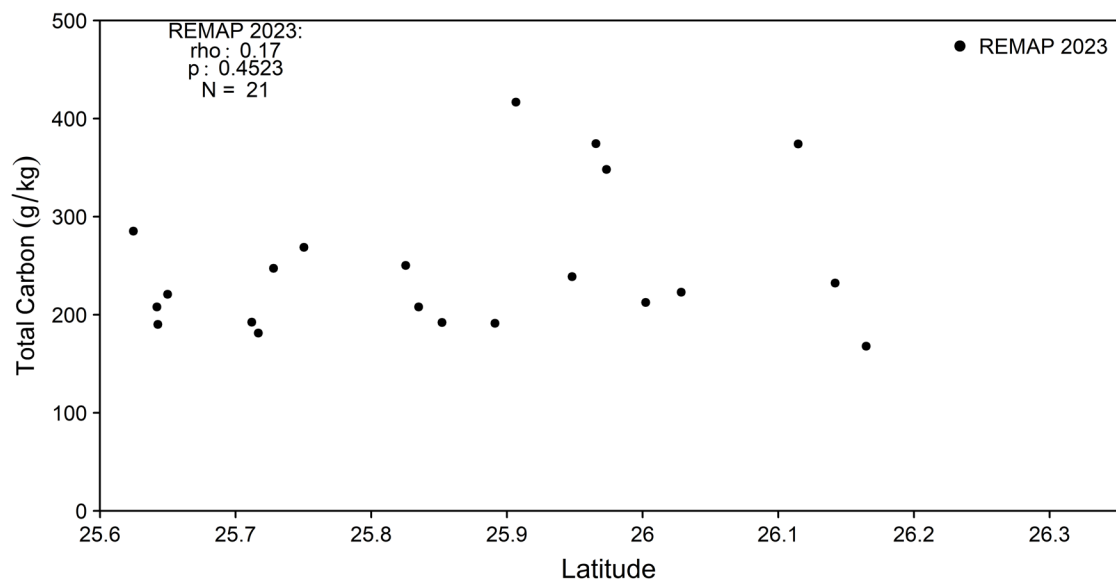


Figure NS-14: Benthic periphyton total carbon (g/kg) latitudinal gradient plot

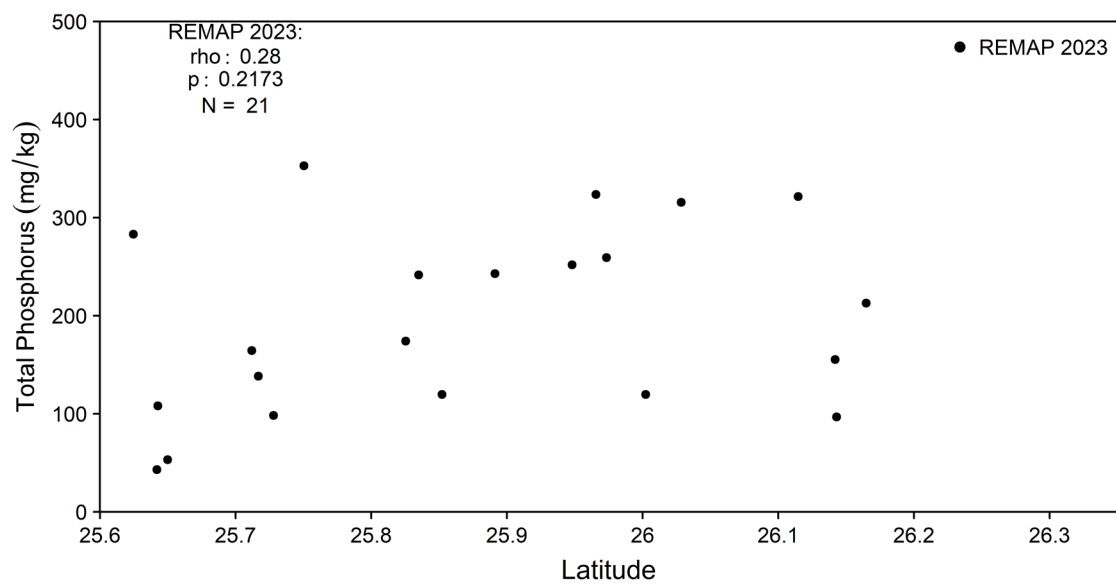


Figure NS-15: Benthic periphyton total phosphorus (mg/kg) latitudinal gradient plot

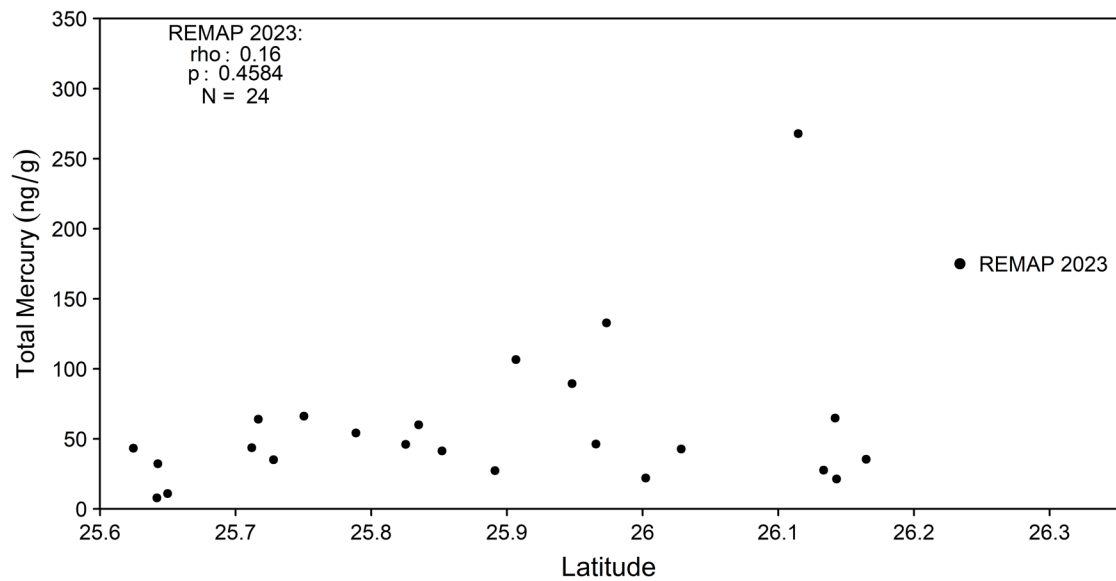


Figure NS-16: Benthic periphyton total mercury (ng/g) latitudinal gradient plot

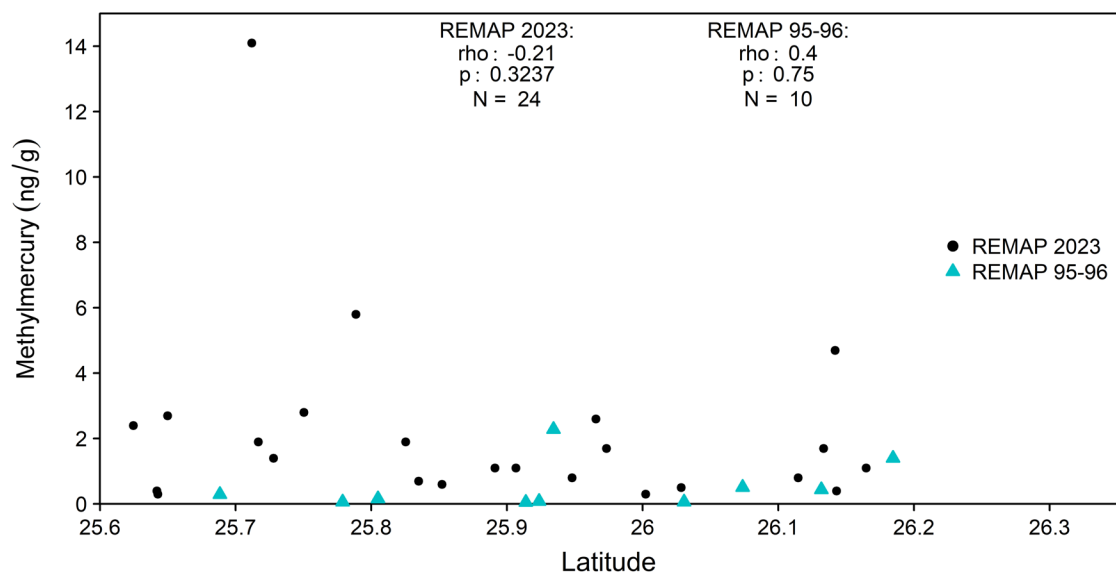


Figure NS-17: Benthic periphyton methylmercury (ng/g) latitudinal gradient plot

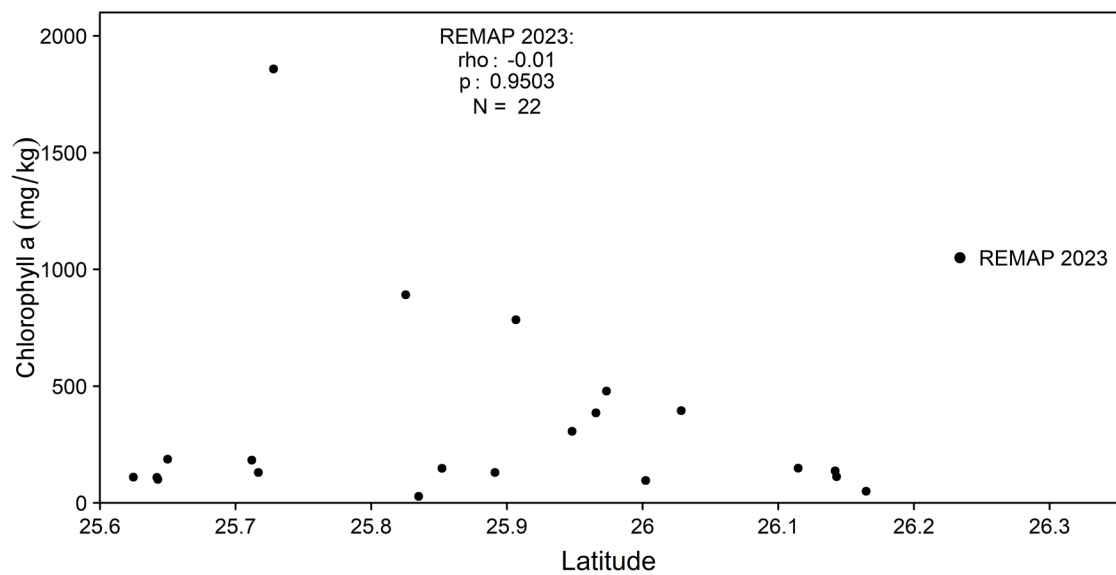


Figure NS-18: Benthic periphyton chlorophyll *a* (mg/kg) latitudinal gradient plot. A high concentration value of 7468.40 mg/kg was removed from the plot in order to better visualize the remainder of the data.

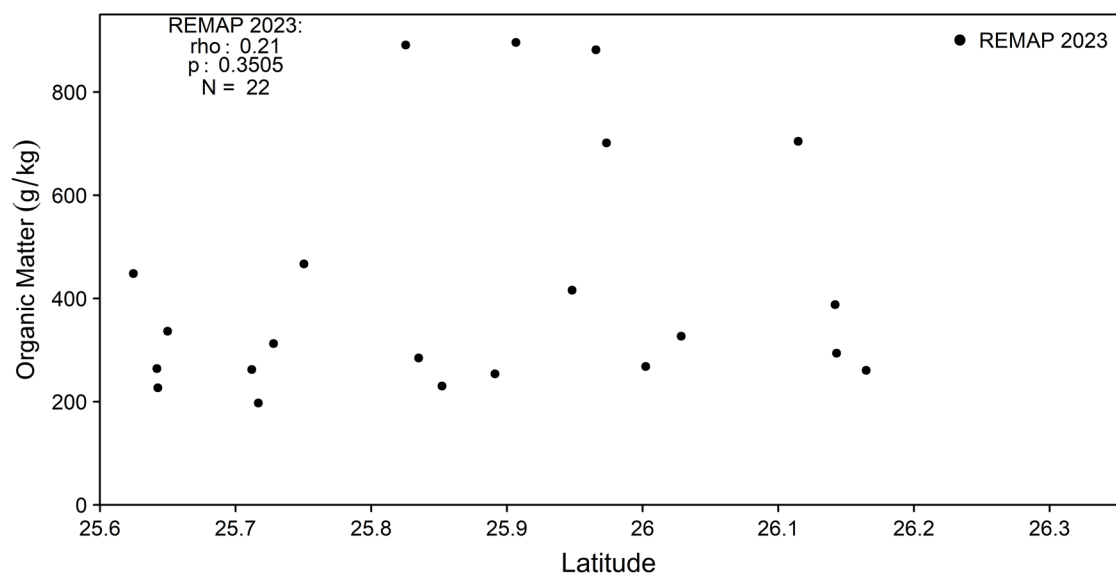


Figure NS-19: Benthic periphyton organic matter (g/kg) latitudinal gradient plot

## Non-Significant Latitude Plots for Appendix – Sawgrass Plants

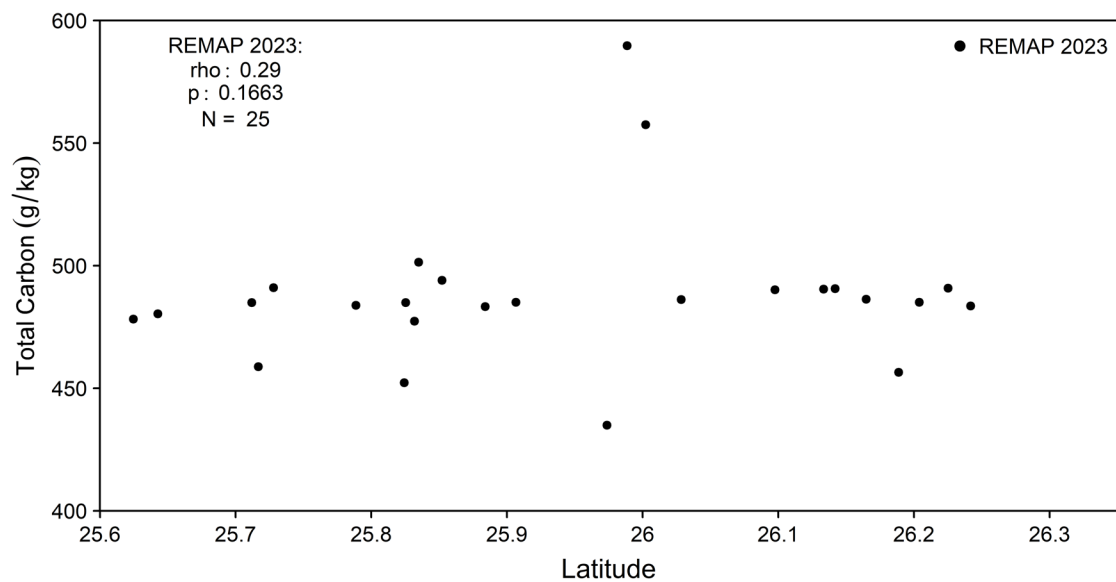


Figure NS-20: Sawgrass plant total carbon (g/kg) latitudinal gradient plot

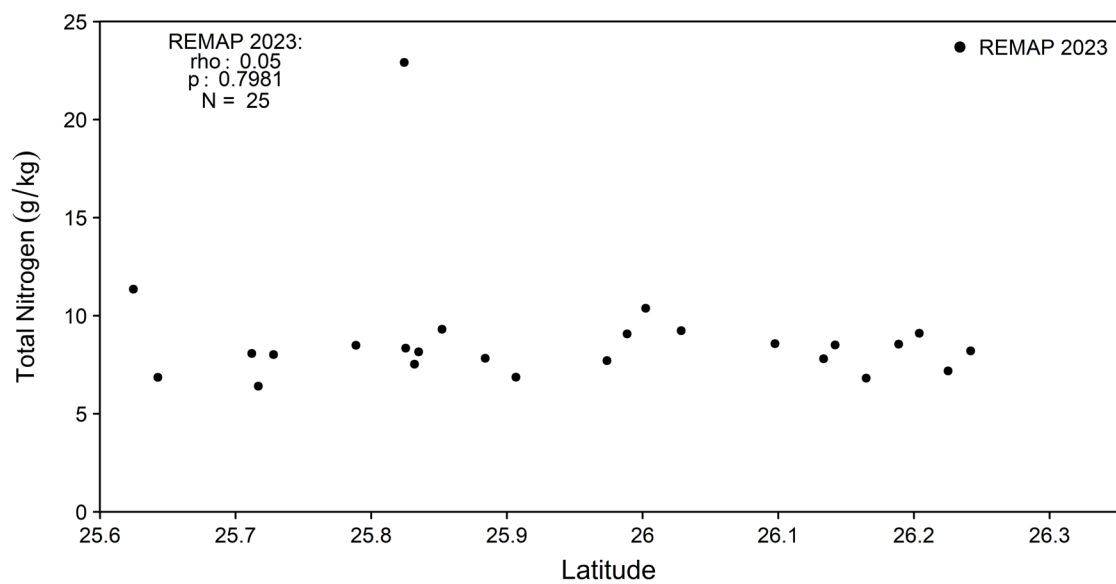


Figure NS-21: Sawgrass plant total nitrogen (g/kg) latitudinal gradient plot

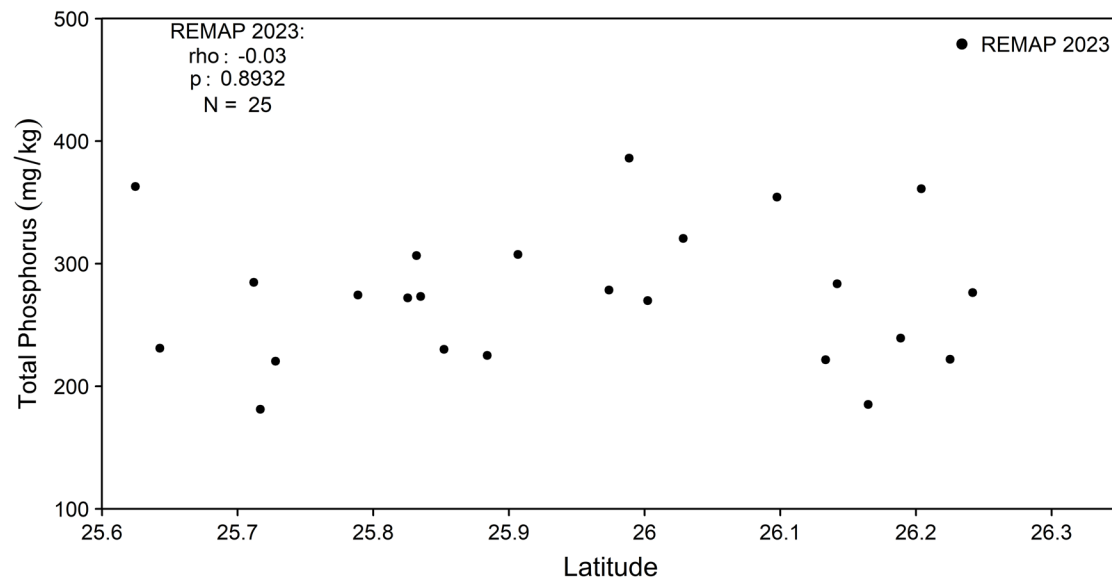


Figure NS-22: Sawgrass plant total phosphorus (mg/kg) latitudinal gradient plot

## References:

National Park Service, Big Cypress National Preserve. (2020). *Periphyton*. Retrieved March 6, 2025 from <https://www.nps.gov/bicy/learn/nature/periphyton.htm#:~:text=Periphyton%20is%20an%20entire%20community,role%20as%20a%20primary%20producer>.