# Columbia Lake Phytoplankton Summary Report 2021-2022

## Overview

Samples were collected from one site on Columbia Lake during 2021 and 2022 ( Figure 1; Table 1). Algae were identified to the taxonomic level of species and grouped into broad alga types for analysis.

*Table 1: Sample sites and dates sampled in 2021 and 2022*

| Sample Site (EMS#) | Dates |
|---|---|
| COLUMBIA LAKE; MIDLAKE NORTH (0200434) | 2021-04-27<br>2021-08-18<br>2022-04-20<br>2022-08-11 |
| | **Total= 4 samples** |


*Figure 1: Aerial view of Columbia Lake*

Samples contained low concentrations of diatoms; *Fragilaria crotonensis* was the dominant diatom species identified. Moderate concentrations of Dinoflagellates, Chrysophyta, Cryptophyta, green algae, and cyanobacteria were observed in all samples.

Elevated concentrations of debris was observed in spring samples (Figure 2). Excessive suspended debris can affect the health and aesthetics of a water system. Particulates in the water column can cause turbidity and provide adhesive for pollutants including metals and bacteria (Water Science School et al., 2018). Turbidity spikes, from debris, during the spring are common due to elevated wind, rain, erosion, and runoff events (Card et al., 2014). Suspended materials include clay, silt, organic and inorganic matter, algae, dissolved color compounds, and bacteria (Card et al., 2014; Figure 2).

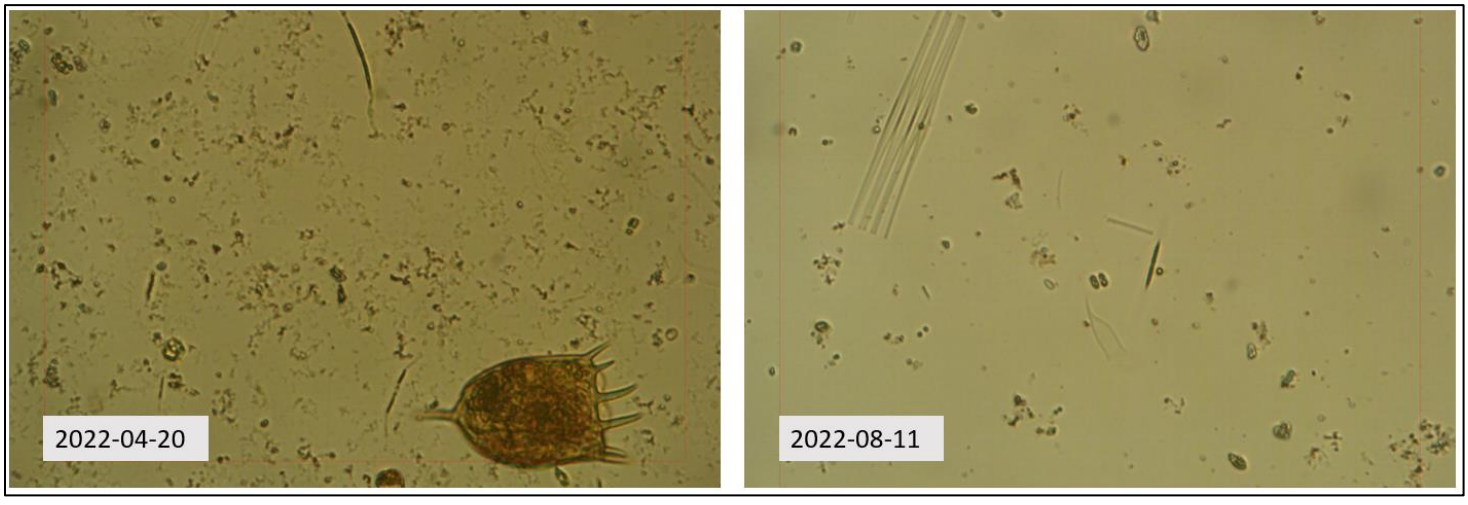


*Figure 2: Debris concentration in a spring sample (left) vs a summer sample (right)*

## Overview (continued)

The dinoflagellate *Gymnodinium cf. aeruginosa* (20%) and Chrysophyta genus *Dinobryon* (14%) dominated total biovolumes (Figure 3; Figure 4). *Monoraphidium indicum* were also observed frequently (13%; Figure 3).

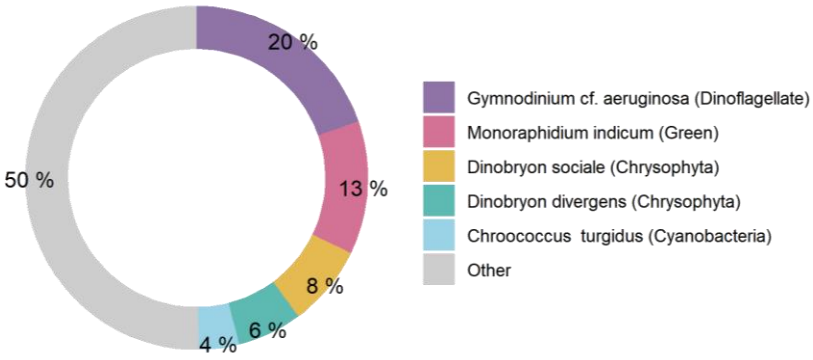


*Figure 3: Dominant organisms from Columbia Lake (0200434) as percent of total biovolume*

Marine species of *Gymnodinium* are commonly associated with the production of several toxins. Saxitoxin is a by-product of several *Gymnodinium* species (Osterbauer & Dobbs, 2009). Few studies evaluate threats posed by freshwater *Gymnodinium* species.

Chrysophyta, including genus *Dinobryon,* are advantageous and detrimental in freshwater systems, depending on their context. Some Chrysophyta are known to produce odor metabolites described as fishy, while others eat bacteria and reduce negative odor metabolites (Wehr et al., 2015).

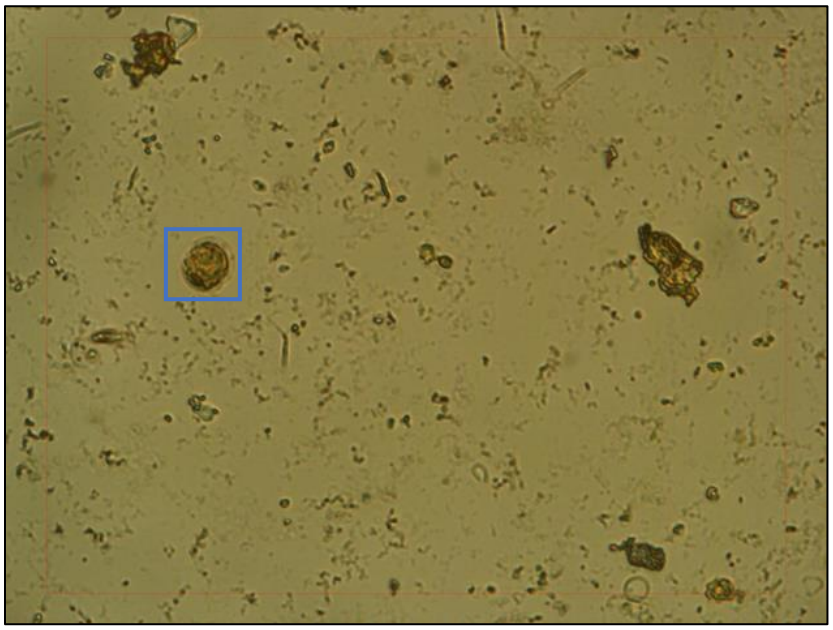

*Figure 4: 400x magnification of EMS #0200434 collected on 2022-04-20 demonstrating morphology of Dinoflagellate Gymnodinium cf. aeruginosa (blue box)*

### Algae – why should we care?

Algae blooms are becoming more frequent and severe worldwide due to excessive nutrient loading and warming summer lake temperatures. Diatom blooms can cause filter clogging, and odor issues.

Intense cyanobacteria blooms can threaten human safety and aquatic health through their toxicity. Illness related to cyanotoxins can include: liver, kidney, and nerve cell damage, cancer, skin and gut irritation, and neurological issues. Cyanotoxins, including microcystins, are now known to accumulate in the food chain (Lance et al. 2014). Fish from lakes with heavy cyanobacteria blooms can have higher toxin concentrations than the lake water (Greer et al. 2021) and consuming them can increase the risk of liver disease (Zhao et al., 2020).

## Cyanobacterial Presence

Summer samples contained elevated concentrations of cyanobacteria. Dominant genera included *Anacystis*, *Aphanocapsa,* and *Lyngbya* (Figure 5).

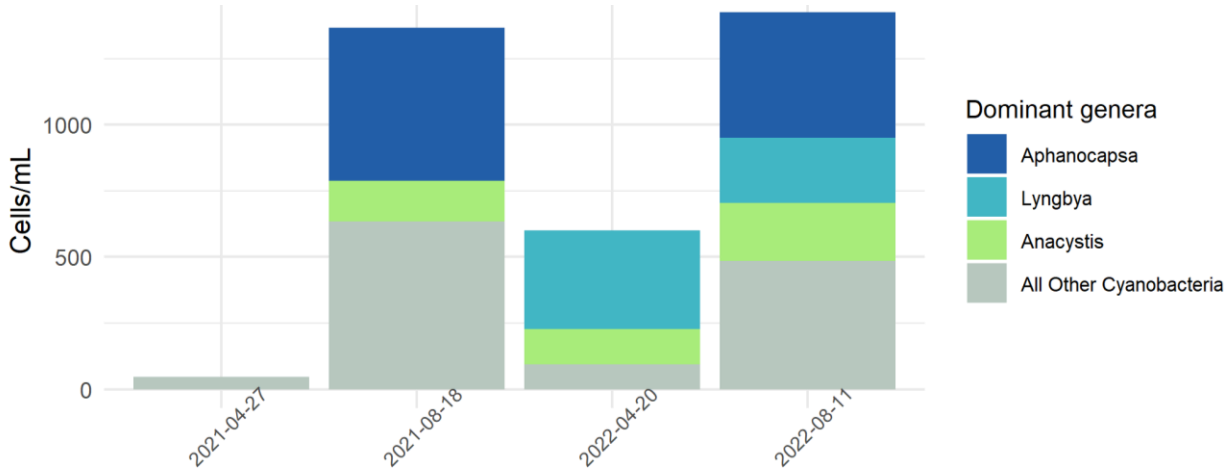


*Figure 5: cell abundance for dominant cyanobacteria genera on Columbia Lake*

Dominant cyanobacteria in Columbia Lake are associated with several cyanotoxins (Table 2). Illnesses related to cyanotoxins can include: liver, kidney, and nerve cell damage, cancer, skin and gut irritation, and neurological issues (Lance et al., 2014). Concentration of cyanobacteria observed in Columbia Lake were too low to represent risks to human health (Lance et al., 2014).

*Table 2: Dominant genera of cyanobacteria on Columbia Lake and their associated toxins*

| Genus | Maximum Abundance* (cells/mL) | Toxins Produced |
|---|---|---|
| ***Aphanocapsa*** | 581 | Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA |
| ***Lyngbya*** | 372 | Lyngbyatoxin LYN, Aplysiatoxins APL, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor |
| ***Anacystis*** | 220 | Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT |

Note: * = counted in samples

## Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria identified in Columbia Lake can produce cyanotoxins (Table 2).

Columbia Lake displayed a range of cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 860 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Columbia Lake compared to alert levels defined by several authorities including the WHO and the EPA.

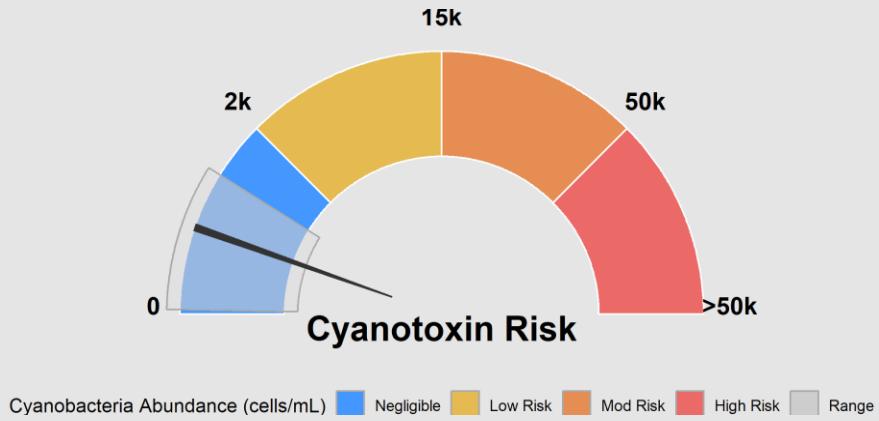


*Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Columbia Lake*

Cyanobacteria frequently dominate algal communities in total cell count, but because of their small cell size their biovolume is usually low relative to the other types of algae present. This is highlighted in Figure 7 where a single green algae cell dwarfs the adjacent cyanobacteria cell.

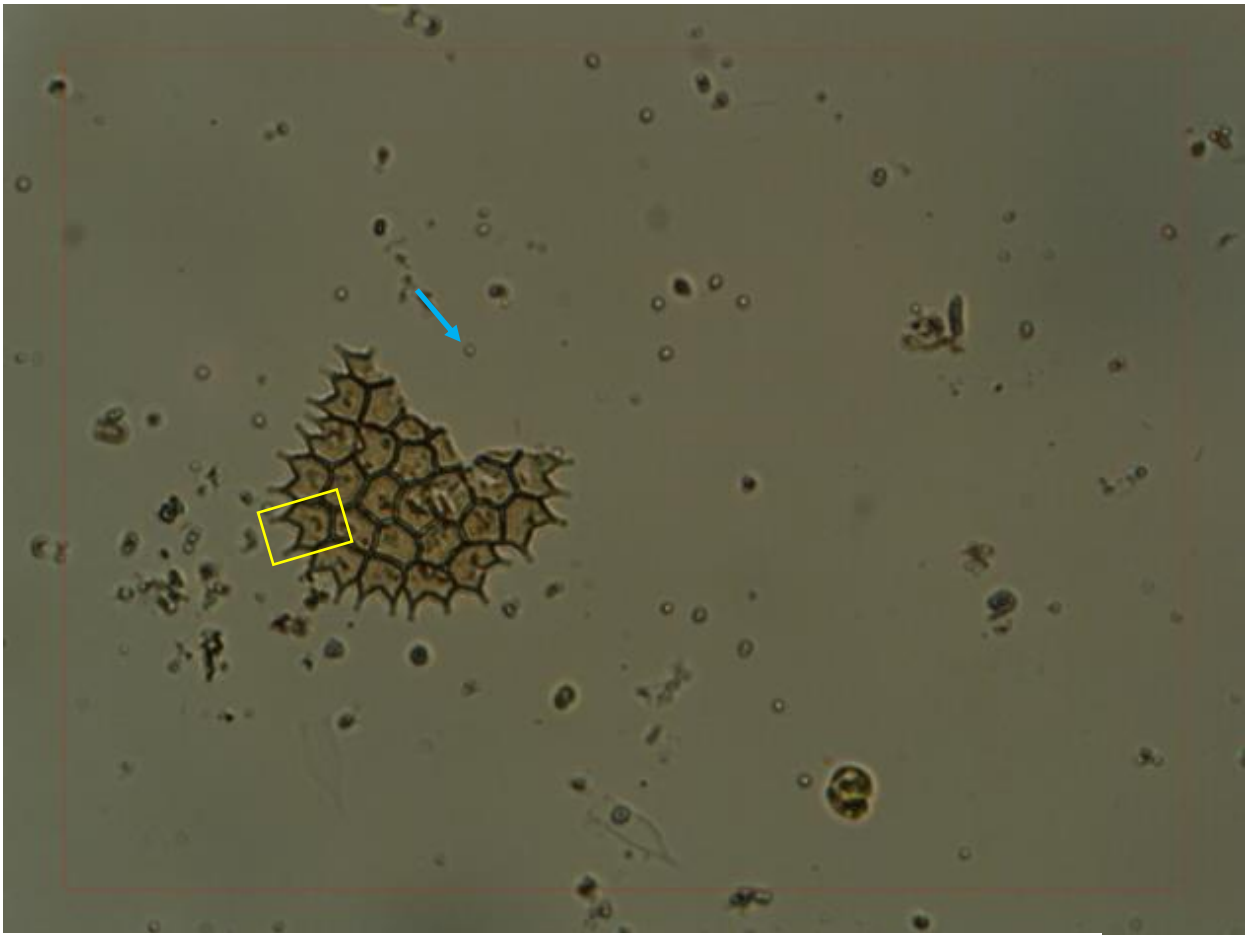

*Figure 7: Size comparison of a Pediastrum boryanum cell (yellow box) to an Anacystis cell (blue arrow)*

## Species Composition

Algae samples were identified to the species level and grouped into broad alga types for analysis. The figures below display total cell counts for each broad algae group alongside their biovolume. The difference between Figure 8 (cell abundance) and Figure 9 (biovolume) illuminates the difference between cell abundance and biovolume.

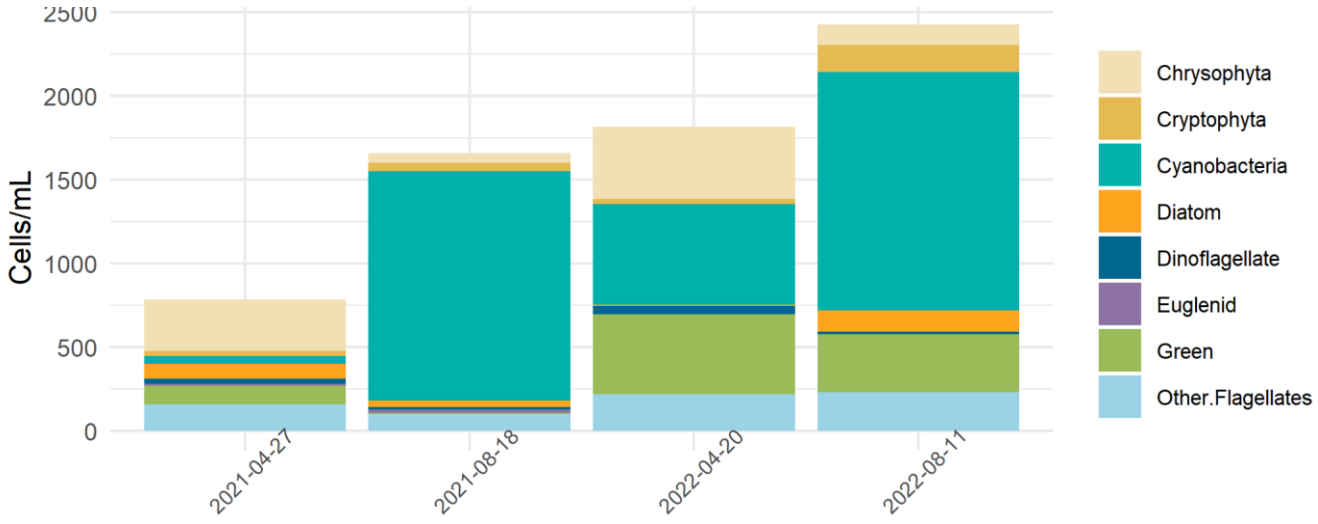


*Figure 8: Cell abundance of high-level taxa groups on Columbia Lake*

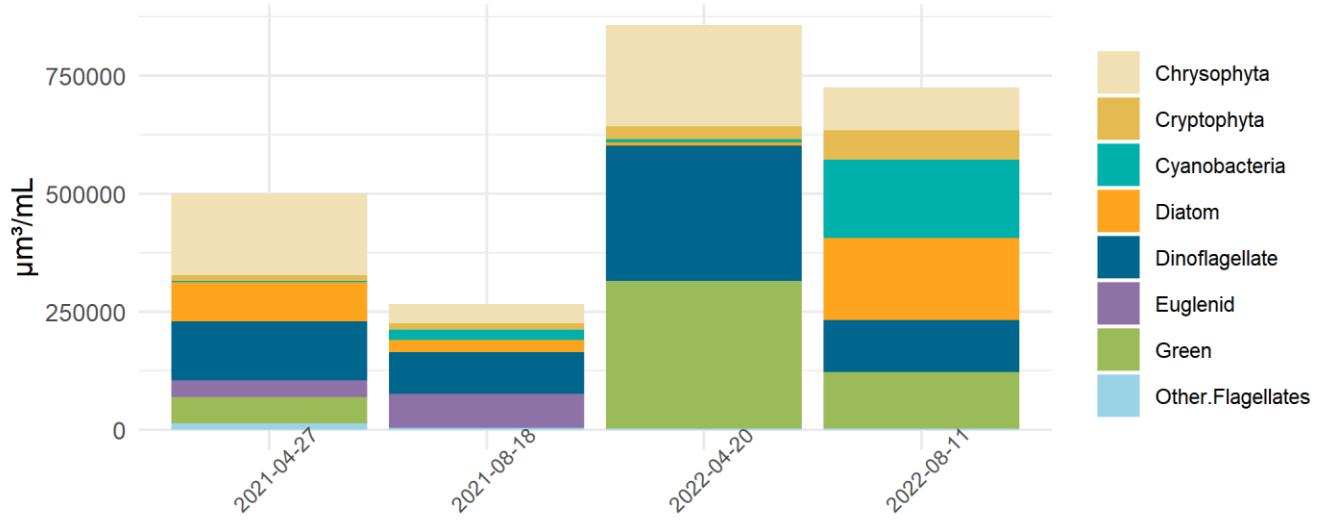


*Figure 9: Biovolume of high-level taxa groups on Columbia Lake*

## References


Card, A., Fitch, K., Kelly, D., Kemker, C., & Rose, K. (2014, June 13). *Turbidity, Total Suspended Solids & Water Clarity*. FONDRIEST.

Lance, E., Petit, A., Sanchez, W., Paty, C., Gérard, C., & Bormans, M. (2014). Evidence of trophic transfer of microcystins from the gastropod Lymnaea stagnalis to the fish Gasterosteus aculeatus. *Harmful Algae*, *31*, 9–17. https://doi.org/10.1016/J.HAL.2013.09.006

Osterbauer, P. J., & Dobbs, M. R. (2009). Neurobiological Weapons. In M. R. Dobbs (Ed.), *Clinical Neurotoxicology: Syndromes, Substances, Environments* (pp. 631–645). Elsevier. https://doi.org/10.1016/B978-032305260-3.50061-7

Water Science School, Swanson, H. A., & Baldwin, H. L. (2018, June 18). *Turbidity and Water*. USGS.

Wehr, J. D., Sheath, R. G., & Kociolek, P. (2015). *Freshwater Algae of North America* (Second). Elsevier Inc.

Zhao, Y., Yan, Y., Xie, L., Wang, L., He, Y., Wan, X., & Xue, Q. (2020). Long-term environmental exposure to microcystins increases the risk of nonalcoholic fatty liver disease in humans: A combined fisher-based investigation and murine model study. *Environment International*, *138*, 105648. https://doi.org/10.1016/J.ENVINT.2020.105648



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## Appendix

Additional figures and raw data are listed below:

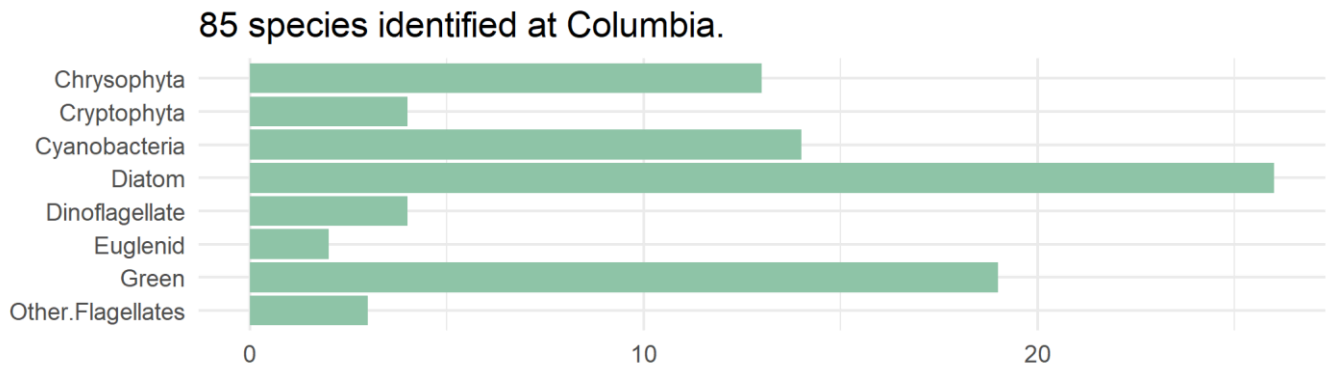


*Figure 10: Identified species sorted into categories of higher-level taxa*

| EMS ID: 0200434 | **Total Abundance (cells/mL):** | **783** | |
|---|---|---|---|
| Collection Date: 2021-04-27 | Total Biovolume (µm³/mL): | 499529 | |
| | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** |
| Chroomonas acuta | 15 | 8103 | Chrysophyta |
| Dinobryon divergens | 106 | 91367 | Chrysophyta |
| Dinobryon sociale | 27 | 32945 | Chrysophyta |
| Kephyrion sp. | 110 | 23040 | Chrysophyta |
| Ochromonas sp. | 4 | 856 | Chrysophyta |
| Chrysococcus sp. | 38 | 12617 | Chrysophyta |
| Ochromonas sp lrg pointed | 8 | 4072 | Chrysophyta |
| Cryptomonas ovata | 4 | 8704 | Cryptophyta |
| Rhodomonas lacustris | 27 | 2932 | Cryptophyta |
| Planktothrix sp. | 46 | 2561 | Cyanobacteria |
| Achnanthidium minutissima | 23 | 2439 | Diatom |
| Amphora ovalis | 4 | 5833 | Diatom |
| Fragilaria crotonensis | 8 | 3884 | Diatom |
| Frustulia sp. | 11 | 17417 | Diatom |
| Mastogloia albertii | 4 | 21768 | Diatom |
| Navicula ingenua | 4 | 903 | Diatom |
| Navicula radiosa | 4 | 8207 | Diatom |
| Navicula cf. caterva | 4 | 204 | Diatom |
| Nitzschia sp. small | 4 | 2827 | Diatom |
| Nitzschia acicularis | 11 | 8685 | Diatom |
| Ulnaria acus | 11 | 11460 | Diatom |
| Gymnodinium cf. aeruginosa | 4 | 36949 | Dinoflagellate |
| Gymnodinium cf. lantzschii | 8 | 12064 | Dinoflagellate |
| Peridinium inconspicuum | 4 | 7326 | Dinoflagellate |
| Peridinium sp. | 15 | 67663 | Dinoflagellate |
| Trachelomonas volvocinopsis | 11 | 35278 | Euglenid |
| Closteriopsis sp. | 8 | 1433 | Green |
| Closteriopsis longissima | 19 | 6029 | Green |
| Closterium kuetzingii | 8 | 3063 | Green |
| Crucigenia quadrata | 4 | 245 | Green |
| Elakatothrix gelatinosa | 8 | 1413 | Green |
| Pediastrum boryanum | 23 | 39371 | Green |
| Scenedesmus bijuga | 30 | 3271 | Green |
| Schroederia setigera | 4 | 1018 | Green |
| Tetraedron minimum | 8 | 984 | Green |
| UID flagellate | 30 | 10436 | Other.Flagellates |
| nanoflagellates | 65 | 1957 | Other.Flagellates |
| picoflagellates | 61 | 205 | Other.Flagellates |

*Figure 11: Raw data from 2021-04-27 EMS site 0200434*

| EMS ID: 0200434 | Total Abundance (cells/mL): | 1657 | |
|---|---|---|---|
| Collection Date: 2021-08-18 | Total Biovolume (µm³/mL): | 266384 | |
| | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** |
| Chroomonas acuta | 8 | 4322 | Chrysophyta |
| Dinobryon divergens | 27 | 23273 | Chrysophyta |
| Dinobryon sociale | 4 | 4881 | Chrysophyta |
| Dinobryon sertularia | 4 | 4918 | Chrysophyta |
| Chrysococcus sp. | 11 | 3652 | Chrysophyta |
| Ochromonas sp. Small | 4 | 109 | Chrysophyta |
| Cryptomonas ovata | 4 | 8704 | Cryptophyta |
| Rhodomonas lacustris | 46 | 4995 | Cryptophyta |
| Anathece sp. | 133 | 557 | Cyanobacteria |
| Anacystis cyanea | 152 | 229 | Cyanobacteria |
| Anabaena aequalis | 57 | 1910 | Cyanobacteria |
| Aphanocapsa elachista | 581 | 1622 | Cyanobacteria |
| Chroococcus limneticus | 46 | 5874 | Cyanobacteria |
| Chroococcus turgidus | 8 | 7238 | Cyanobacteria |
| Gloeocapsa sp. | 15 | 652 | Cyanobacteria |
| Planktolyngbya limnetica | 304 | 1555 | Cyanobacteria |
| Rhabdogloea sp. | 72 | 1696 | Cyanobacteria |
| Achnanthidium minutissima | 11 | 1166 | Diatom |
| Asterionella formosa | 4 | 2785 | Diatom |
| Epithemia sorex | 4 | 13195 | Diatom |
| Fragilariformis sp. | 4 | 1280 | Diatom |
| Fragilaria crotonensis | 8 | 3884 | Diatom |
| Nitzschia sp. | 4 | 367 | Diatom |
| Ulnaria acus | 4 | 4167 | Diatom |
| Gymnodinium cf. aeruginosa | 8 | 73898 | Dinoflagellate |
| Gymnodinium cf. lantzschii | 4 | 6032 | Dinoflagellate |
| Peridinium inconspicuum | 4 | 7326 | Dinoflagellate |
| Trachelomonas volvocinopsis | 15 | 48107 | Euglenid |
| Trachelomonas cf. hispida var. papillata | 4 | 24176 | Euglenid |
| Chodatella quadriseta | 4 | 302 | Green |
| Tetraedron minimum | 4 | 492 | Green |
| UID flagellate | 4 | 1391 | Other.Flagellates |
| nanoflagellates | 49 | 1475 | Other.Flagellates |
| picoflagellates | 46 | 154 | Other.Flagellates |

*Figure 12: Raw data from 2021-08-18 EMS site 0200434*

| EMS ID: 0200434 | **Total Abundance (cells/mL):** | **1816** | |
|---|---|---|---|
| Collection Date: 2022-04-20 | **Total Biovolume (µm³/mL):** | **857392** | |
| | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** |
| Chroomonas acuta | 4 | 2161 | Chrysophyta |
| Dinobryon sp. | 53 | 79606 | Chrysophyta |
| Dinobryon divergens | 4 | 3448 | Chrysophyta |
| Dinobryon sociale | 83 | 101276 | Chrysophyta |
| Dinobryon sertularia | 4 | 4918 | Chrysophyta |
| Pseudokephyrion sp. | 231 | 10341 | Chrysophyta |
| Ochromonas sp. | 42 | 8991 | Chrysophyta |
| Chrysococcus sp. | 11 | 3652 | Chrysophyta |
| Cryptomonas curvata | 4 | 25200 | Cryptophyta |
| Rhodomonas lacustris | 27 | 2932 | Cryptophyta |
| Anacystis cyanea | 133 | 200 | Cyanobacteria |
| Lyngbya limnetica | 372 | 376 | Cyanobacteria |
| Planktothrix sp. | 95 | 5288 | Cyanobacteria |
| Fragilaria crotonensis | 4 | 1942 | Diatom |
| Gomphonema intricatum | 4 | 5508 | Diatom |
| Gymnodinium cf. aeruginosa | 27 | 249406 | Dinoflagellate |
| Gymnodinium cf. lantzschii | 15 | 22619 | Dinoflagellate |
| Peridinium inconspicuum | 8 | 14652 | Dinoflagellate |
| Cosmarium sp. | 4 | 2001 | Green |
| Monoraphidium indicum | 444 | 294154 | Green |
| Oocystis parva | 8 | 1798 | Green |
| Pediastrum tetras | 11 | 13590 | Green |
| Scenedesmus dimorphus | 11 | 972 | Green |
| nanoflagellates | 61 | 1837 | Other.Flagellates |
| picoflagellates | 156 | 524 | Other.Flagellates |

*Figure 13: Raw data from 2022-04-20 EMS site 0200434*

| EMS ID: 0200434 | **Total Abundance (cells/mL):** | **2429** | |
|---|---|---|---|
| Collection Date: 2022-08-11 | **Total Biovolume (µm³/mL):** | **725643** | |
| | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** |
| Bitrichia chodatii | 19 | 6342 | Chrysophyta |
| Chroomonas acuta | 8 | 4322 | Chrysophyta |
| Dinobryon bavaricum | 4 | 8706 | Chrysophyta |
| Dinobryon divergens | 30 | 25858 | Chrysophyta |
| Dinobryon sociale | 34 | 41487 | Chrysophyta |
| Pseudokephyrion sp. | 4 | 179 | Chrysophyta |
| Ochromonas sp. | 11 | 2355 | Chrysophyta |
| Chrysococcus sp. | 4 | 1328 | Chrysophyta |
| Ochromonas sp. Small | 11 | 299 | Chrysophyta |
| Cryptomonas curvata | 4 | 25200 | Cryptophyta |
| Cryptomonas marssonii | 11 | 22461 | Cryptophyta |
| Rhodomonas lacustris | 144 | 15635 | Cryptophyta |
| Anabaena circinalis | 224 | 69500 | Cyanobacteria |
| Anacystis cyanea | 220 | 331 | Cyanobacteria |
| Aphanocapsa elachista | 474 | 1324 | Cyanobacteria |
| Chroococcus limneticus | 87 | 11110 | Cyanobacteria |
| Chroococcus turgidus | 91 | 82335 | Cyanobacteria |
| Dactylococcopsis sp. | 15 | 1021 | Cyanobacteria |
| Gloeocapsa punctata | 68 | 285 | Cyanobacteria |
| Lyngbya limnetica | 247 | 250 | Cyanobacteria |
| Achnanthidium minutissimum | 19 | 3604 | Diatom |
| Amphora ovalis | 8 | 11665 | Diatom |
| Asterionella formosa | 11 | 7660 | Diatom |
| Brachysira cf. neoacuta | 4 | 7841 | Diatom |
| Lindavia bodanica | 8 | 8348 | Diatom |
| Lindavia ocellata | 8 | 1327 | Diatom |
| Fragilaria crotonensis | 38 | 18451 | Diatom |
| Gomphonema truncatum | 4 | 5508 | Diatom |
| Navicula gregaria | 4 | 1131 | Diatom |
| Nitzschia minuta | 4 | 1579 | Diatom |
| Nitzschia sp. small | 4 | 2827 | Diatom |
| Pinnularia viridis | 4 | 2576 | Diatom |
| Stauroneis gracilis | 4 | 76265 | Diatom |
| Ulnaria acus | 4 | 4167 | Diatom |
| Ulnaria ulna | 4 | 21019 | Diatom |
| Gymnodinium cf. aeruginosa | 11 | 101610 | Dinoflagellate |
| Peridinium inconspicuum | 4 | 7326 | Dinoflagellate |
| Chodatella quadriseta | 4 | 302 | Green |
| Closteriopsis sp. | 4 | 716 | Green |
| Crucigenia quadrata | 61 | 3730 | Green |
| Crucigenia rectangularis | 106 | 32465 | Green |
| Didymocystis bicellularis | 15 | 4041 | Green |
| Oocystis parva | 57 | 12814 | Green |
| Oocystis solitaria | 34 | 7833 | Green |
| Pediastrum boryanum | 23 | 39371 | Green |
| Pseudopediastrum subgranul. | 11 | 15046 | Green |
| Scenedesmus bijuga | 15 | 1636 | Green |
| Schroederia setigera | 4 | 1018 | Green |
| Tetraedron minimum | 11 | 1353 | Green |
| nanoflagellates | 49 | 1475 | Other.Flagellates |
| picoflagellates | 182 | 611 | Other.Flagellates |

*Figure 14: Raw data from 2022-08-11 EMS site 0200434*