Puntzi Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Puntzi 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
PUNTZI LAKE AT CENTRE (0803038)	2021-05-11
	2021-08-18
	2022-05-24
	2022-08-25
Total= 4 samples	

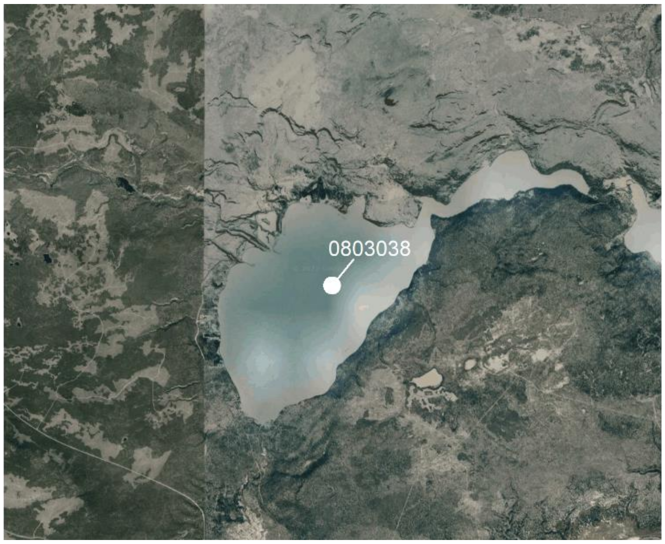

Figure 1: Aerial view of Puntzi Lake

Samples demonstrated seasonal shifts; Chrysophyta blooms in the spring and cyanobacteria blooms in the summer. Diatom concentrations were consistently low and spring diatoms demonstrated degradation, indicative of lowering silica levels in the late spring (Figure 2).

Summer samples contained large amorphous clouds of degraded cyanobacteria and bacteria. Degraded cyanobacteria could represent threats to public health as cyanotoxins are typically released from cyanobacterial cells during cell death (EPA, 2022).

Figure 2: 400x magnification of EMS site 0803038 collected on 2021-05-11 demonstrating degraded Stephanodiscus niagarae diatoms (red box) and a small bloom of Chrysophyte species Dinobryon cylindricum (yellow arrows)

Overview (continued)

Small quantities of the dinoflagellate *Ceratium* were identified in Puntzi Lake. Despite low numbers, this dinoflagellate represented 33% of biovolumes because of its large size relative to other algae (Figure 3).

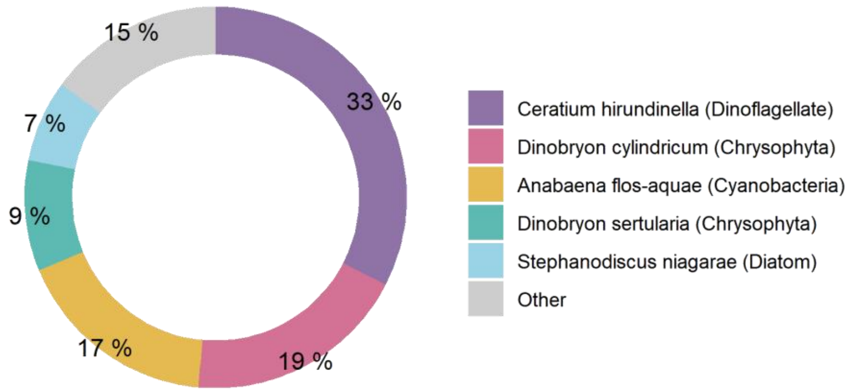

Figure 3: Dominant organisms from Puntzi Lake (0803038) as percent of total biovolume

Samples collected in spring 2021 contained elevated densities of Chromalinales (genus *Dinobryon;* Figure 3; Figure 4). *Dinobryon* blooms are associated with unpleasant fishy odors, and one species of *Dinobryon* is linked with toxins that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

The spring *Dinobryon* bloom included swarmers (sexual reproductive stages) and stomatocysts (asexual reproductive stages). Stomatocysts are normally produced at 0.05% the rate swarmers are produced (Lee, 2008). When *Dinobryon* populations are in a nitrogen-depleted environment, asexual stomatocysts rise from 0.05% to 4%.

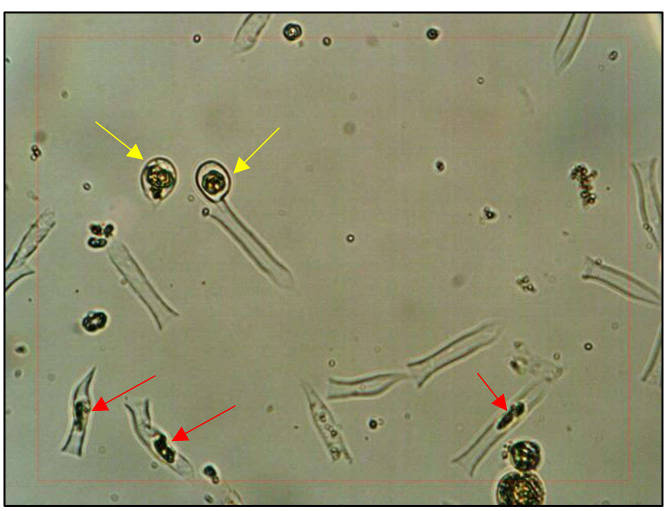

Figure 4: 400x magnification of EMS site 0803038 collected on 2021-05-11 demonstrating a Dinobryon bloom including swarmers (red arrows) and stomatocysts (yellow arrows)

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 densities of cyanobacteria. *Aphanocapsa* was the dominant genus counted (Figure 5), but *Anabaena* had the dominant biovolume due to size (Figure 3). *Aphanothece* were also frequently identified.

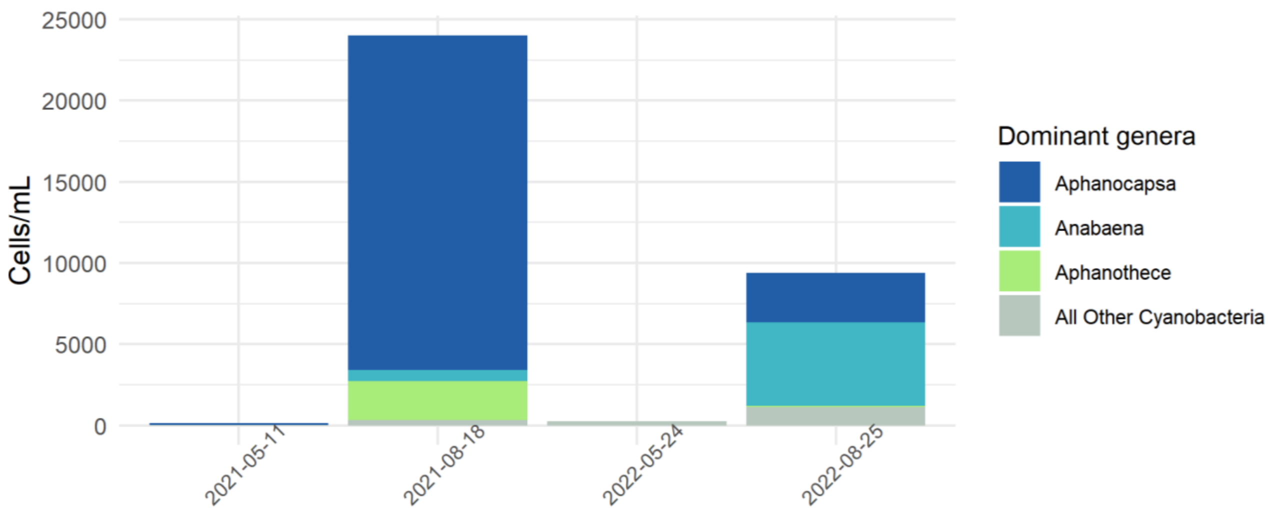

Figure 5: cell abundance for dominant cyanobacteria genera on Puntzi Lake

During blooms, species of *Anabaena* can produce both negative odor/taste compounds and toxic secondary metabolites. Species of *Anabaena* form slimy, green, colonies that can quickly accumulate and color a water system when conditions are favorable (EPA, 2022).

Other dominant cyanobacteria identified in the summer samples are also associated with several cyanotoxins that represent risks to public health (Table 2). Illness related to cyanotoxins can include liver, kidney, and nerve cell damage, cancer, skin and gut irritation, and neurological issues (Lance et al., 2014).

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

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Aphanocapsa	20605	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Anabaena	4975	Lyngbyatoxin LYN, Apoptogen Toxin (ApopTX), Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, NA, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT, Taste and Odor
Aphanothece	2391	Microcystin MC

Note: * = counted in samples

Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria found in Puntzi Lake are capable of producing cyanotoxins (Table 2).

Puntzi Lake displayed cyanobacteria levels in the negligible to moderate-risk category, with a mean cyanobacteria abundance of 8,451 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Puntzi Lake compared to alert levels defined by several authorities including the WHO and EPA.

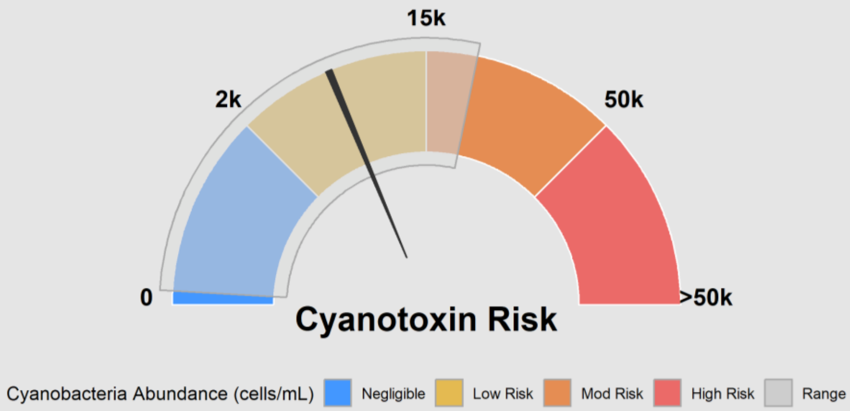

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Puntzi Lake

Puntzi Lake had moderate-high concentrations of cyanobacteria, but biovolume percentages were not reflective of their dominance (Figure 8; Figure 5; Figure 3). The small cell size of cyanobacteria relative to other types of algae causes them to have a low biovolume percentage. Size discrepancies can be seen in Figure 7 where half a Ceratium cell dwarfs the adjacent filamentous cyanobacteria.

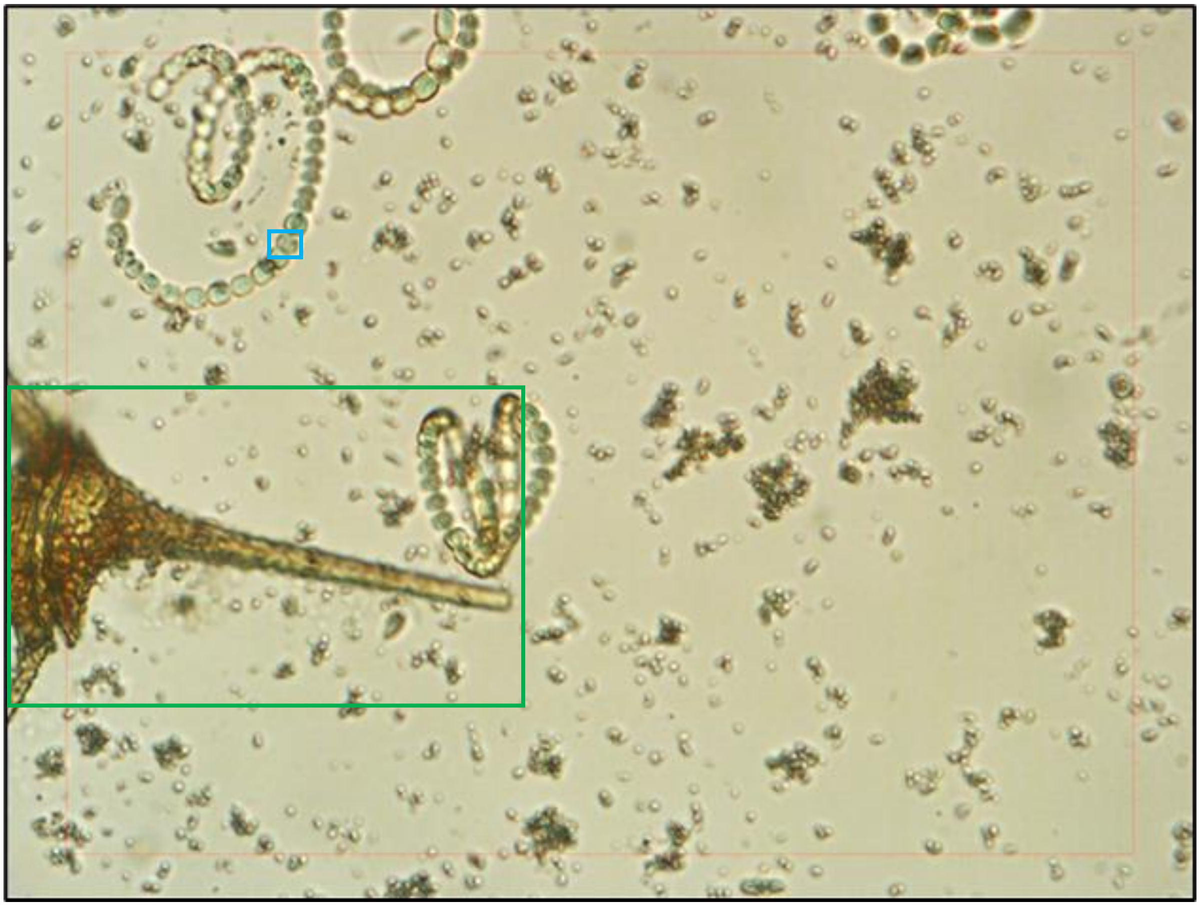

Figure 7: Size comparison of half a Ceratium cell (green box) and a cyanobacteria cell (blue box)

Species Composition

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

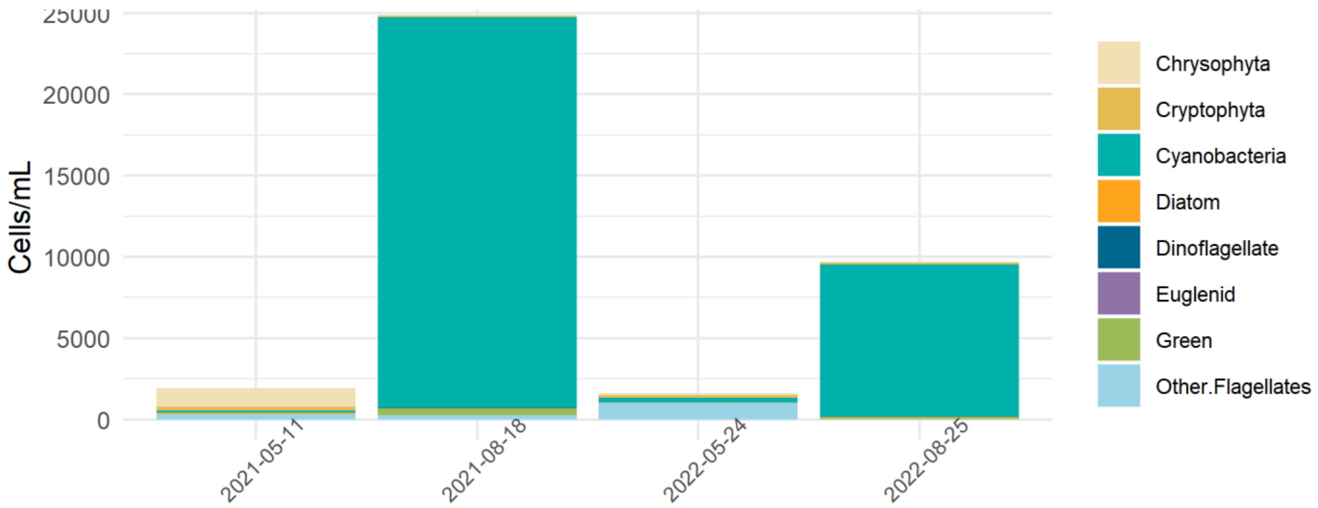

Figure 8: Cell abundance of high-level taxa groups on Puntzi Lake

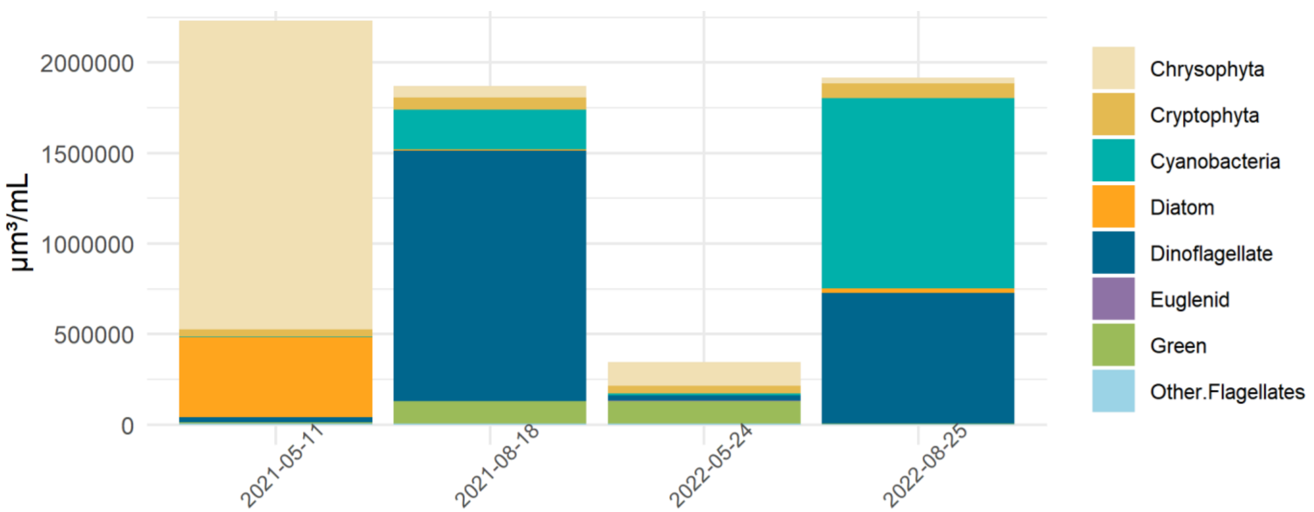

Figure 9: Biovolume of high-level taxa groups on Puntzi Lake

References

Cantrell, R., & Long, B. (2013). *Dinobryon*. PBWorks. http://ohapbio12.pbworks.com/w/page/51731561/Dinobryon

Conrad, J. (2013). *DINOBRYON, a Golden Alga*. Jim Conrad's Naturalist Newsletter. https://www.backyardnature.net/n/x/dinobryo.htm

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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

Lee, R. E. (2008). Phycology. In *Phycology* (Fourth, pp. 344–343). Cambridge University Press.

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:

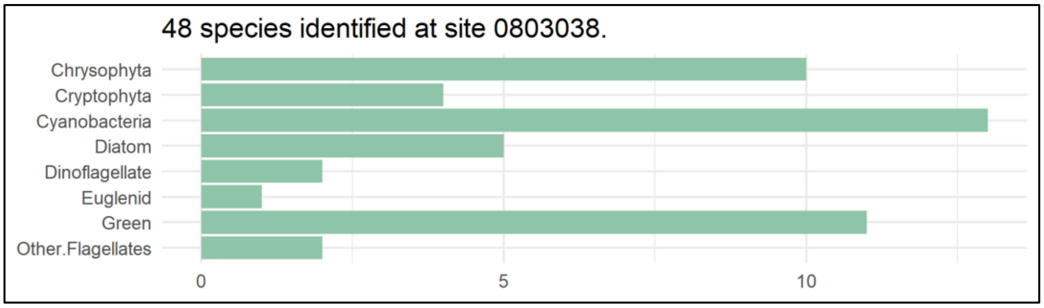

Figure 10: Unique species observed in Puntzi Lake sorted into higher level taxa

EMS ID: 0803038	**Total Abundance (cells/mL):**	**1907**	
Collection Date: 2021-05-11	Total Biovolume (µm³/mL):	2231322	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	15	8103	Chrysophyta
Dinobryon cylindricum	656	1093986	Chrysophyta
Dinobryon bavaricum	4	8706	Chrysophyta
Dinobryon divergens	4	3448	Chrysophyta
Dinobryon sertularia	459	564393	Chrysophyta
Mallomonas akrokomas	8	26356	Chrysophyta
Ochromonas sp.	4	856	Chrysophyta
Cryptomonas ovata	8	17407	Cryptophyta
Rhodomonas lacustris	201	21824	Cryptophyta
Planktosphaeria gelatinosa	30	1833	Cyanobacteria
Aphanocapsa elachista	114	318	Cyanobacteria
Cyclotella sp.	8	1977	Diatom
Stephanodiscus niagarae	42	441052	Diatom
Gymnodinium fuscum	4	28632	Dinoflagellate
Ankistrodesmus sp.	4	629	Green
Oocystis lacustris	4	1979	Green
Monoraphidium indicum	4	2803	Green
nanoflagellates	220	6624	Other.Flagellates
picoflagellates	118	396	Other.Flagellates

Figure 11: Raw data from 2021-05-11 EMS site 0803038

EMS ID: 0803038	**Total Abundance (cells/mL):**	**24871**	
Collection Date: 2021-08-18	Total Biovolume (µm³/mL):	1869853	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	8	4322	Chrysophyta
Chromulina sp.	15	26507	Chrysophyta
Dinobryon sertularia	23	28281	Chrysophyta
Kephyrion sp.	8	1676	Chrysophyta
Ochromonas sp.	8	1713	Chrysophyta
Cryptomonas ovata	30	65276	Cryptophyta
Rhodomonas lacustris	30	3257	Cryptophyta
Planktosphaeria sp.	152	9363	Cyanobacteria
Anabaena flos-aquae	683	132928	Cyanobacteria
Aphanocapsa elachista	20605	57537	Cyanobacteria
Aphanothece nidiculans	2391	19561	Cyanobacteria
Planktolyngbya limnetica	190	972	Cyanobacteria
Fragilaria crotonensis	15	7283	Diatom
Ceratium hirundinella	8	1381231	Dinoflagellate
Nephrocytium agardhianum	30	6557	Green
Oocystis lacustris	61	30175	Green
Schroederia setigera	243	61836	Green
Monoraphidium indicum	15	10511	Green
Monoraphidium arcuatum	15	4245	Green
Botryococcus braunii	76	12496	Green
nanoflagellates	121	3643	Other.Flagellates
picoflagellates	144	483	Other.Flagellates

Figure 12: Raw data from 2021-08-18 EMS site 0803038

EMS ID: 0803038	**Total Abundance (cells/mL):**	**2013**		
Collection Date: 2022-05-24	**Total Biovolume (µm³/mL):**	**83902**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sertularia	4	4918	Chrysophyta	1515
Pseudokephyrion entzii	8	660	Chrysophyta	
Ochromonas sp.	8	1713	Chrysophyta	1455
Cryptomonas cf. erosa	4	8928	Cryptophyta	10635
Rhodomonas lacustris	95	10315	Cryptophyta	10663
Planktosphaeria gelatinosa	30	1833	Cyanobacteria	5909
Stephanodiscus niagarae	4	42005	Diatom	2415
Elakatothrix gelatinosa	11	1943	Green	9412
Monoraphidium indicum	8	5300	Green	5990
nanoflagellates	4	120	Other.Flagellates	
picoflagellates	1837	6167	Other.Flagellates	

Figure 13: Raw data from 2022-05-24 EMS site 0803038

EMS ID: 0803038	**Total Abundance (cells/mL):**	**9684**		
Collection Date: 2022-08-2	**Total Biovolume (µm³/mL):**	**1914879**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	46	24850	Chrysophyta	10613
Dinobryon cylindricum	4	6671	Chrysophyta	1515
Cryptomonas curvata	11	69299	Cryptophyta	10635
Rhodomonas lacustris	99	10749	Cryptophyta	10663
Gloeocapsa sp.	15	652	Cyanobacteria	682
Anabaena cf. levanderi	194	33521	Cyanobacteria	1100
Anabaena flos-aquae	4975	968254	Cyanobacteria	1100
Anacystis cyanea	175	263	Cyanobacteria	609
Aphanocapsa elachista	3040	8489	Cyanobacteria	625
Aphanothece nidiculans	72	589	Cyanobacteria	636
Chroococcus limneticus	61	7790	Cyanobacteria	654
Gloeocapsa aeruginosa	250	3534	Cyanobacteria	682
Gloeocapsa punctata	46	193	Cyanobacteria	682
Snowella litoralis	569	27149	Cyanobacteria	
Lindavia bodanica	4	4174	Diatom	
Aulacoseira cf. distans	42	22776	Diatom	590863
Ceratium hirundinella	4	690615	Dinoflagellate	10397
Gymnodinium fuscum	4	28632	Dinoflagellate	10031
Ankistrodesmus sp.	27	4245	Green	5877
Oocystis parva	8	1798	Green	5827
nanoflagellates	19	572	Other.Flagellates	
picoflagellates	19	64	Other.Flagellates	

Figure 14: Raw data from 2022-08-25 EMS site 0803038