Premier Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Premier 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
PREMIER LAKE AT CENTRE (E303250)	2021-04-27
	2021-08-19
	2022-05-11
	2022-08-10
Total= 4 samples	

Figure 1: Aerial view of Premier Lake

Diatoms concentrations were low in all samples. Spring diatoms appeared degraded, indicating that spring silica concentrations were beginning to decline at the time of sampling (Figure 2). Summer samples contained elevated concentrations of cyanobacteria relative to spring. Samples collected in 2021 contained elevated concentrations of detritus and bacteria compared to 2022 (Figure 2).

Elevated quantities of 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). Suspended materials can include clay, silt, organic and inorganic matter, algae, dissolved color compounds, and bacteria (Card et al., 2014).

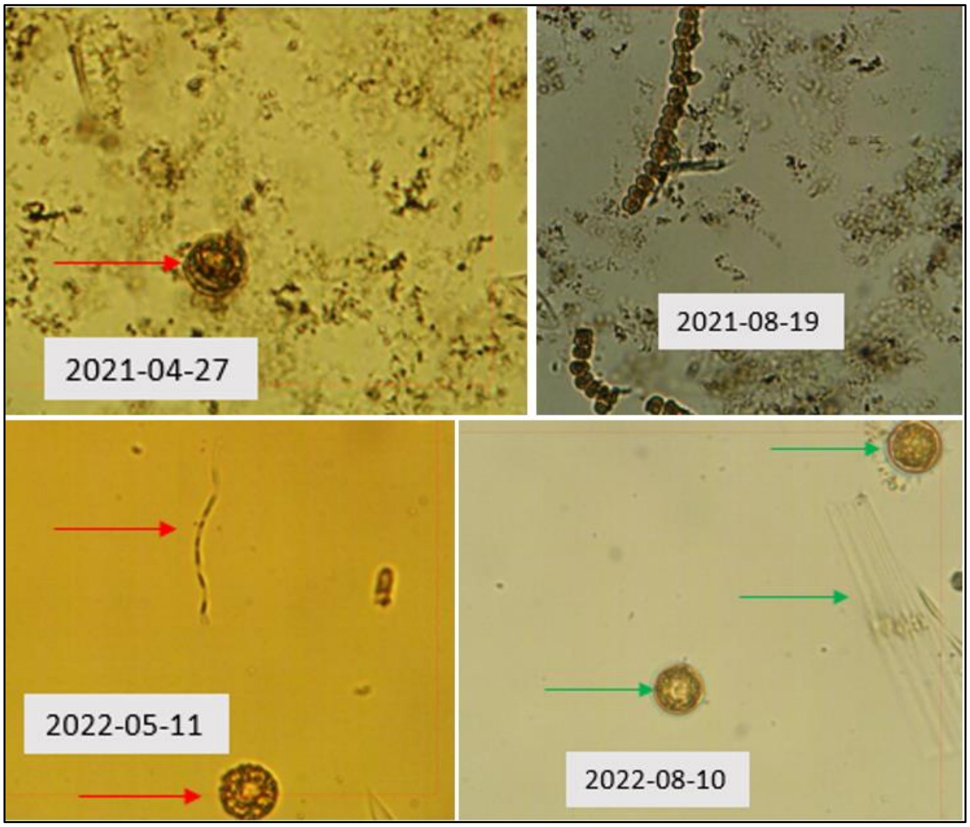

Figure 2: Comparison of 2021 samples (high levels of bacteria and detritus) to 2022 samples (low levels of detritus and bacteria) as wells as degraded spring diatoms (red arrows) to un-degraded summer diatoms (green arrows)

Overview (continued)

One sample, collected on 2022-05-11, contained elevated densities of Chrysophyta (*Dinobryon divergens* and *Dinobryon sertularia;* Figure 3; Figure 4). This bloom caused *Dinobryon divergens* and *Dinobryon sertularia* to dominate total biovolumes.

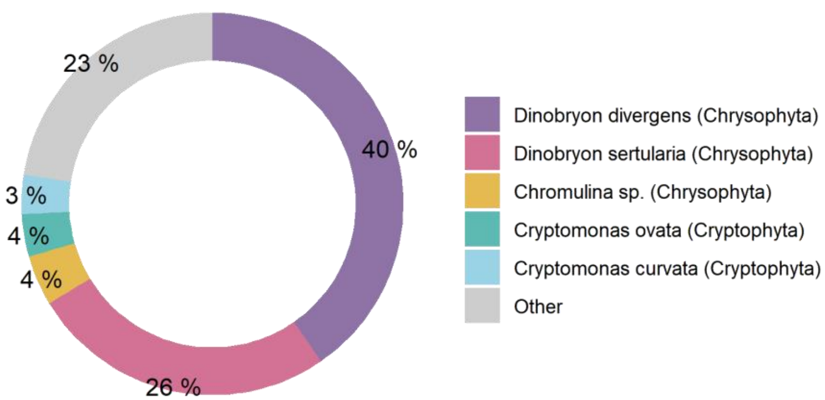

Figure 3: Dominant organisms from Premier Lake (E303250) as percent of total biovolume

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).

Cryptophyta, specifically *Cryptomonas curvata* and *Cryptomonas ovata,* were frequently enumerated in Premier Lake samples (Figure 3). Cryptomonas species are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015).

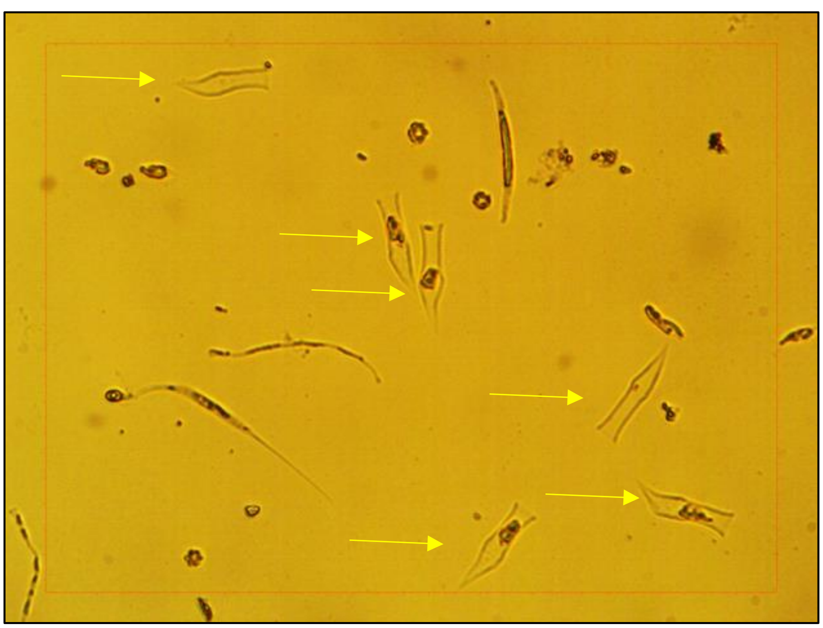

Figure 4: 400x magnification of EMS site E303250 collected on 2022-05-11 demonstrating Dinobryon bloom

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 high densities of cyanobacteria; *Anacystis* was the dominant genus. *Aphanocapsa* and *Aphanothece* were also common (Figure 5).

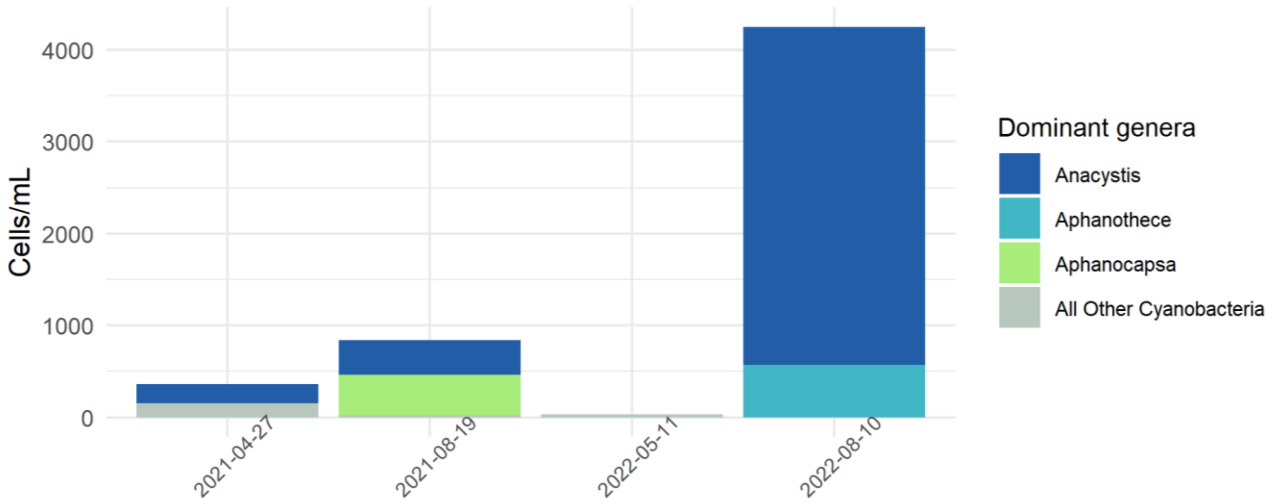

Figure 5: cell abundance for dominant cyanobacteria genera on Premier Lake

Dominant cyanobacteria identified in Premier Lake samples are associated with several cyanotoxins that represent risks to public health (**Error! Reference source not found.**). 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 Premier Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	3681	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Aphanocapsa	436	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Aphanothece	569	Microcystin MC

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Premier Lake displayed cyanobacteria levels in the negligible to low-risk category, with a mean cyanobacteria abundance of 1,370 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Premier Lake compared to alert levels defined by several authorities including the WHO and EPA.

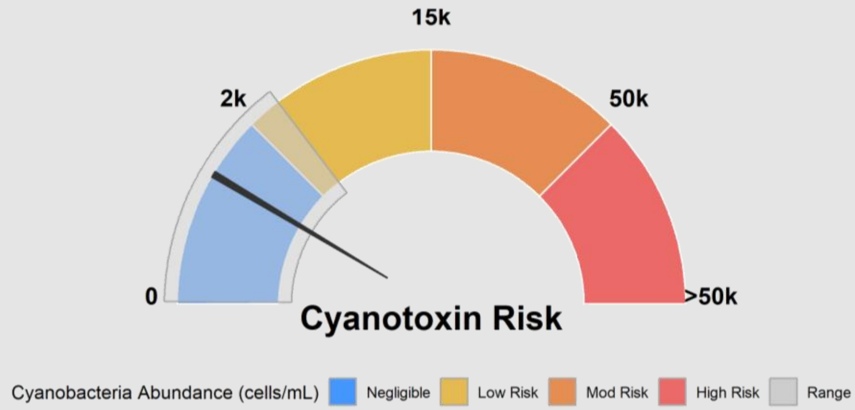

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Premier Lake

Premier Lake had moderate concentrations of cyanobacteria, but biovolume percentages were not reflective of their dominance (Figure 5; Figure 8; 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 a *Dinobryon* cell dwarfs the adjacent micro-flagellate cell.

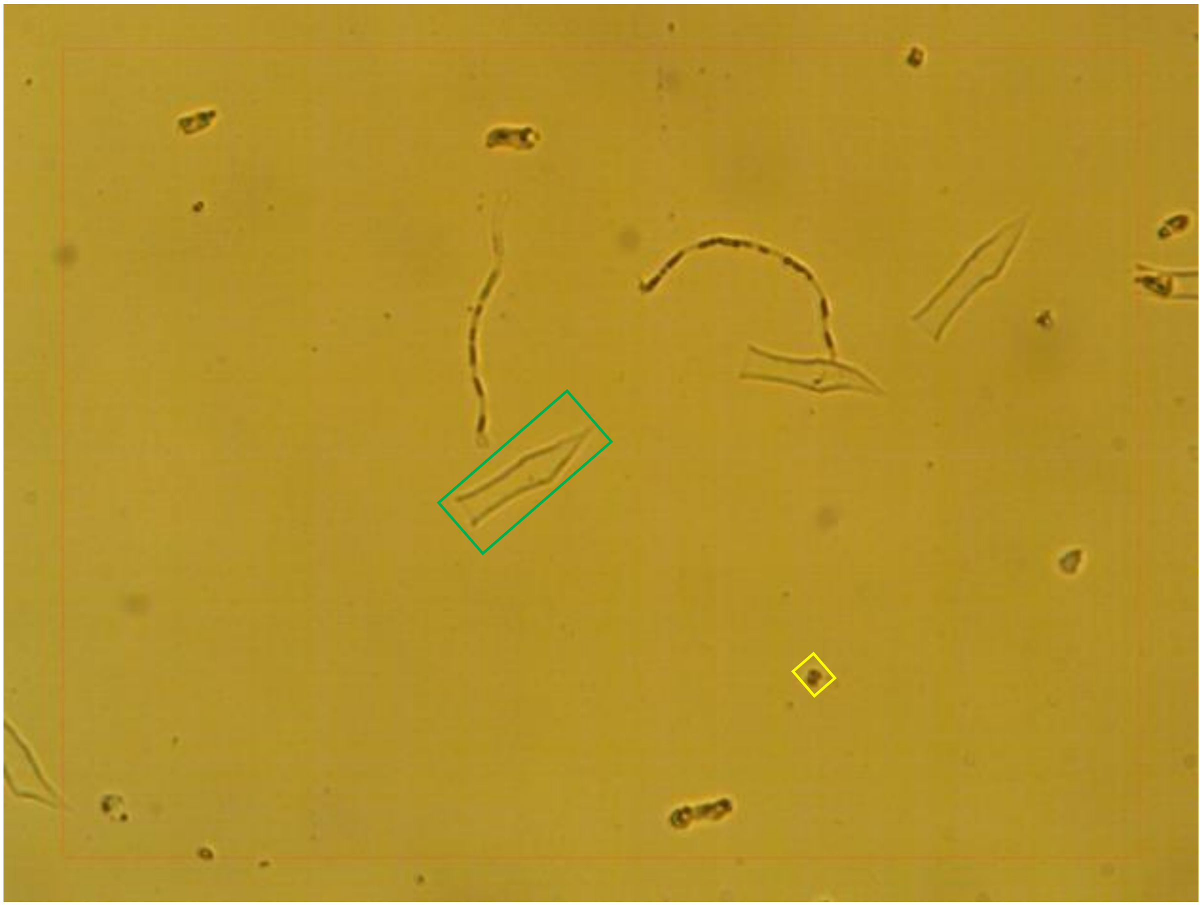

Figure 7: Size comparison of a Dinobryon cell (green box) a micro-flagellate (yellow box)
note: cyanobacteria tend to be smaller than micro-flagellates

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.

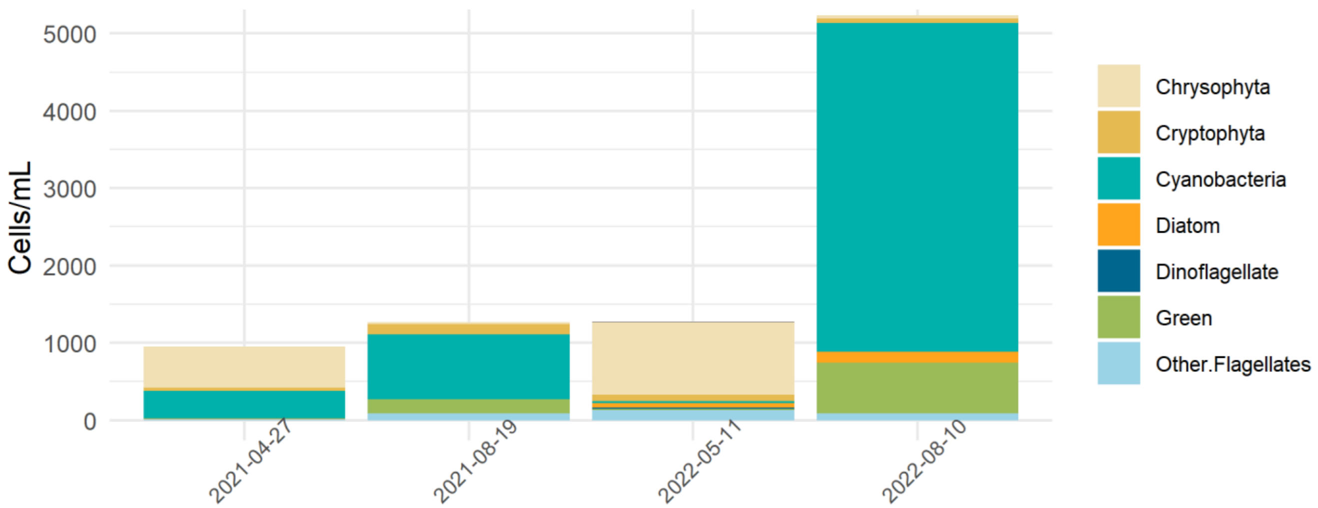

Figure 8: Cell abundance of high-level taxa groups on Premier Lake

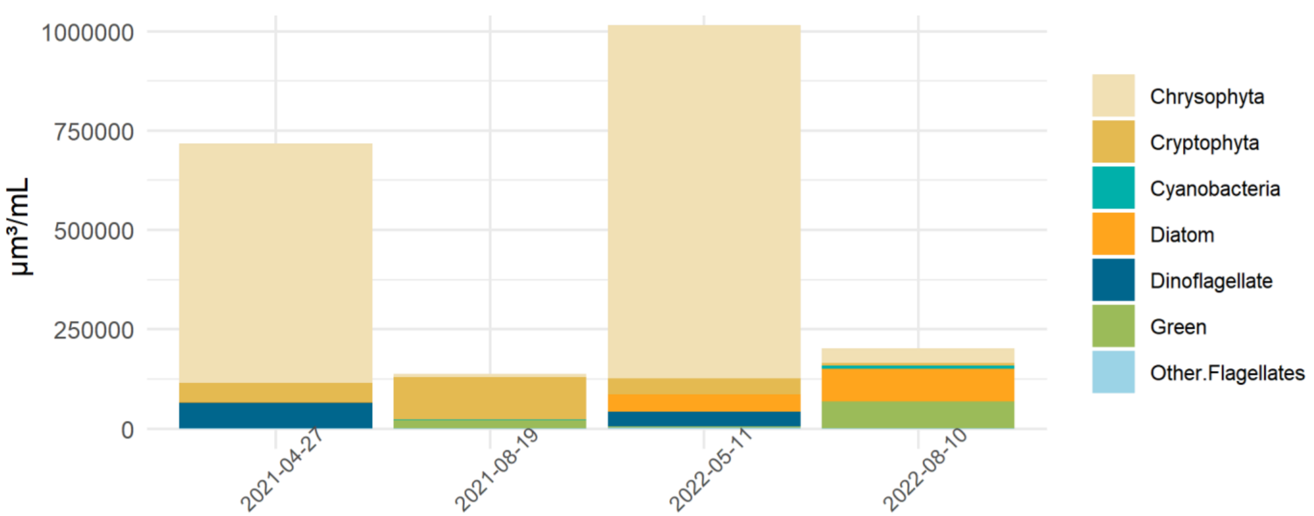

Figure 9: Biovolume of high-level taxa groups on Premier Lake

References

Cirés, S., & Ballot, A. (2016). A review of the phylogeny, ecology and toxin production of bloom-forming Aphanizomenon spp. and related species within the Nostocales (cyanobacteria). *Harmful Algae*, *54*, 21–43. https://doi.org/10.1016/j.hal.2015.09.007

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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

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Appendix

Additional figures and raw data are listed below:

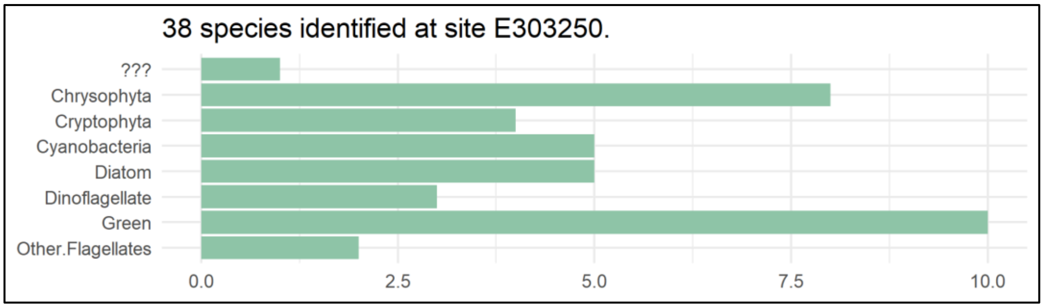

Figure 10: Unique species observed in Premier Lake sorted into higher level taxa

EMS ID: E303250	**Total Abundance (cells/mL):**	**955**	
Collection Date: 2021-04-2	Total Biovolume (µm³/mL):	717270	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	8	4322	Chrysophyta
Dinobryon divergens	178	153427	Chrysophyta
Dinobryon sertularia	315	387328	Chrysophyta
Dinobryon cylindricum	34	56701	Chrysophyta
Cryptomonas ovata	8	17407	Cryptophyta
Cryptomonas cf. curvata	4	27416	Cryptophyta
Rhodomonas lacustris	27	2932	Cryptophyta
Anacystis cyanea	209	315	Cyanobacteria
Lyngbya sp.	152	119	Cyanobacteria
Cyclotella bodanica	4	1587	Diatom
Peridinium cf. willei	4	65462	Dinoflagellate
nanoflagellates	8	241	Other.Flagellates
picoflagellates	4	13	Other.Flagellates

Figure 11: Raw data from 2021-04-27 EMS site E303250

EMS ID: E303250	**Total Abundance (cells/mL):**	**1267**	
Collection Date: 2021-08-19	Total Biovolume (µm³/mL):	137175	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	11	5942	Chrysophyta
Ochromonas spp.	4	798	Chrysophyta
Chrysochromulina spp.	8	1437	Chrysophyta
Cryptomonas ovata	11	23935	Cryptophyta
Cryptomonas curvata	11	69299	Cryptophyta
Rhodomonas lacustris	114	12378	Cryptophyta
Anacystis cyanea	379	571	Cyanobacteria
Aphanocapsa elachista	436	1217	Cyanobacteria
Gloeocapsa punctata	23	96	Cyanobacteria
Gloeocystis sp.	167	17802	Green
Oocystis sp.	4	75	Green
Scenedesmus arcuatus var. platydiscus	8	1901	Green
nanoflagellates	53	1596	Other.Flagellates
picoflagellates	38	128	Other.Flagellates

Figure 12: Raw data from 2021-08-19 EMS site E303250

EMS ID: E303250	Total Abundance (cells/mL):	1272		
Collection Date: 2022-05-11	Total Biovolume (µm³/mL):	1015715		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
UID cyst	4	589	???	
Dinobryon divergens	774	667148	Chrysophyta	1515
Dinobryon sertularia	114	140176	Chrysophyta	1515
Spumella sp.	4	29	Chrysophyta	1491
Chromulina sp.	46	81289	Chrysophyta	1717
Cryptomonas ovata	15	32638	Cryptophyta	10635
Rhodomonas lacustris	68	7383	Cryptophyta	10663
Gloeocapsa punctata	30	126	Cyanobacteria	682
Asterionella formosa	34	23675	Diatom	3116
Lindavia bodanica	19	19826	Diatom	
Gymnodinium cf. helveticum	4	15811	Dinoflagellate	10031
Glenodinium sp.	11	21979	Dinoflagellate	10174
Schroederia setigera	8	2036	Green	
Monoraphidium kormakovae	8	825	Green	5990
nanoflagellates	65	1957	Other.Flagellates	
picoflagellates	68	228	Other.Flagellates	

Figure 13: Raw data from 2022-05-11 EMS site E303250

EMS ID: E303250	Total Abundance (cells/mL):	5236		
Collection Date: 2022-08-10	Total Biovolume (µm³/mL):	202739		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	8	4322	Chrysophyta	10613
Dinobryon divergens	19	16377	Chrysophyta	1515
Dinobryon sertularia	8	9837	Chrysophyta	1515
Spumella sp.	4	29	Chrysophyta	1491
Chromulina sp.	4	7069	Chrysophyta	1717
Rhodomonas lacustris	61	6623	Cryptophyta	10663
Anacystis cyanea	3681	5541	Cyanobacteria	609
Aphanothece sp.	569	1814	Cyanobacteria	636
Lindavia bodanica	8	8348	Diatom	
Fragilaria crotonensis	129	62637	Diatom	2932
Stephanodiscus sp.	4	11451	Diatom	2415
Elakatothrix gelatinosa	4	706	Green	9412
Gloeocystis cf. vesiculosa	577	50265	Green	6355
Oocystis parva	19	4271	Green	5827
Oocystis solitaria	23	5299	Green	5827
Scenedesmus arcuatus var. platydiscus	23	5464	Green	6104
Spondylosium planum	4	1872	Green	8468
nanoflagellates	19	572	Other.Flagellates	
picoflagellates	72	242	Other.Flagellates	

Figure 14: Raw data from 2022-08-10 EMS site E303250