Ellison Lake Phytoplankton Summary Report 2021-2022

Overview

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

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

Sample Site (EMS#)	Dates
ELLISON LAKE CENTRAL (0500265)	2021-03-23
	2021-08-30
	2022-03-22
	2022-08-29
	Total= 4 samples

Figure 1: Aerial view of Ellison Lake

Spring samples contained high densities of debris and low densities of algae. Summer samples contained elevated concentrations of diatoms, green algae, cyanobacteria, flagellates, and dinoflagellates (Figure 2).

Elevated quantities of suspended debris can affect the health and aesthetics of a water system. Particulates in the water column can cause cloudy hues and provide attachment zones for pollutants; notably metals and bacteria (Water Science School et al., 2018). Turbidity spikes during the spring are common due to elevated wind, rain, erosion, and runoff events (Card et al., 2014). Suspended materials can include clay, silt, organic and inorganic matter, algae, dissolved color compounds, and bacteria (Card et al., 2014).

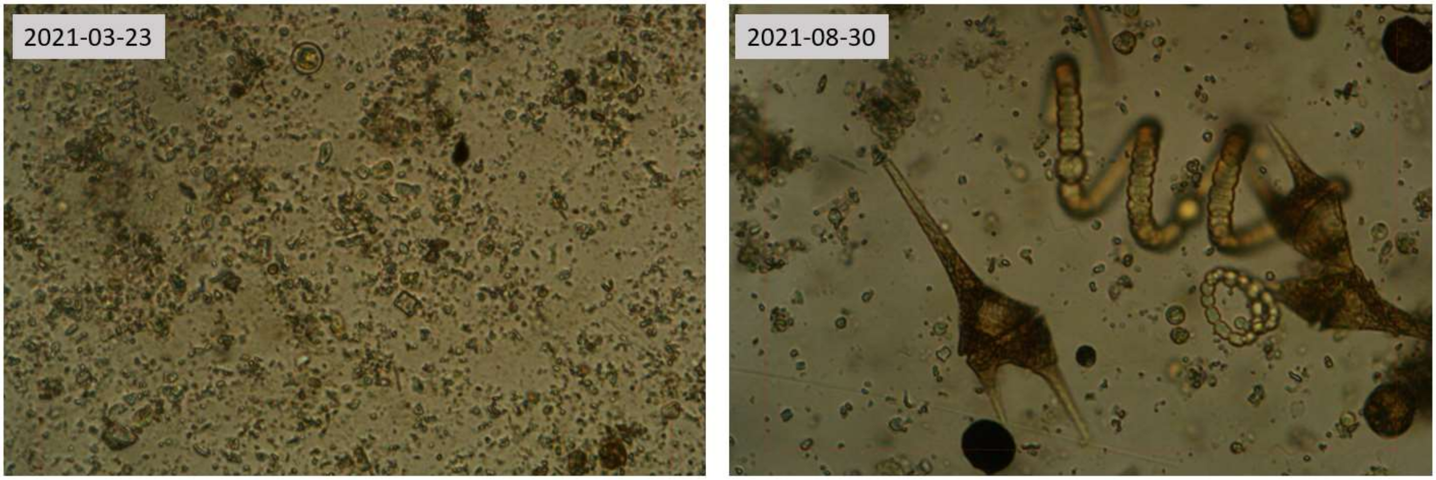

Figure 2: Spring sample with high concentrations of detritus (left) vs summer sample with high concentrations of algae (right)

Dominant diatoms included *Aulacosiera* and *Nitzschia* species. Diatoms are integral to aquatic food webs because they are the foundation of the food web (jrobyn, 2019). Colony forming diatoms, including *Aulacoseira* species, can avoid grazing pressures by developing into large colonies and reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012).

Overview (continued)

Moderate quantities of the Dinoflagellate *Ceratium* were identified in Ellison Lake (Figure 3). Despite moderate count numbers, this dinoflagellate represented 58% of biovolumes. This is due to *Ceratium's* large size relative to other algae.

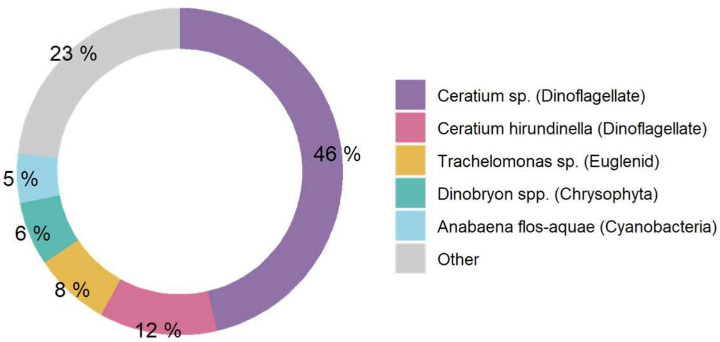

Figure 3: Dominant organisms from Ellison Lake Central (0500265) as percent of total biovolume

Marine species of *Ceratium* are associated with toxic red tides, however little evidence exists linking freshwater *Ceratium* blooms with the production of toxic secondary metabolites (An Image-Based Key: Ceratium [Dinophyceae], 2017).

Samples collected in spring 2021 contained elevated densities of Chromalinales (genus *Dinobryon;* Figure 4). The *Dinobryon* bloom included swarmers (sexual reproductive stages) and stomatocysts (asexual reproductive stages). Stomatocysts are normally produced at 0.05% the rate of swarmers (Lee, 2008). When *Dinobryon* populations are in a nitrogen-depleted environment, asexual stomatocysts rise from 0.05% to 4%. *Dinobryon* blooms are associated with unpleasant fishy odors, and one genus of *Dinobryon* is linked to toxins that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

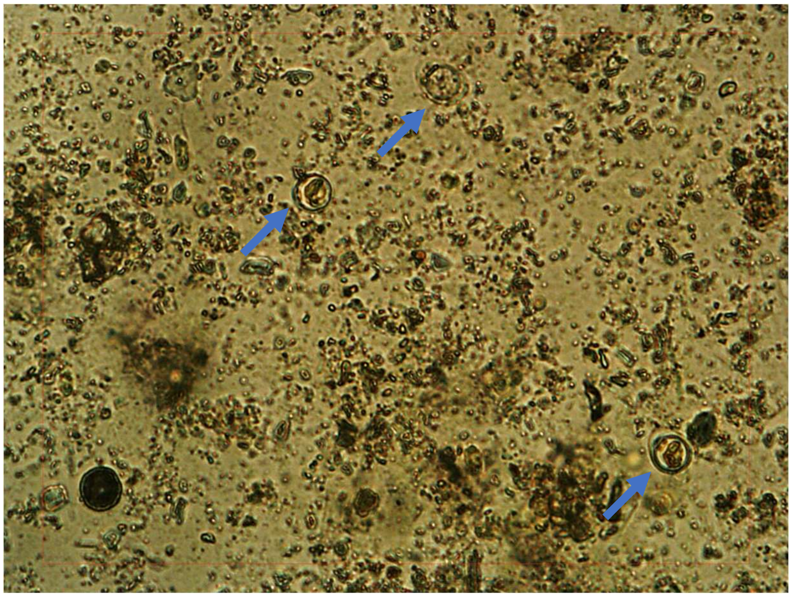

Figure 4: 400x magnification of EMS #0500265 taken on 2021-03-23 demonstrating Dinobryon stomatocysts

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 compared to spring samples. Dominant genera included *Anabaena*, *Anacystis*, and *Gomphospaeria* (Figure 5).

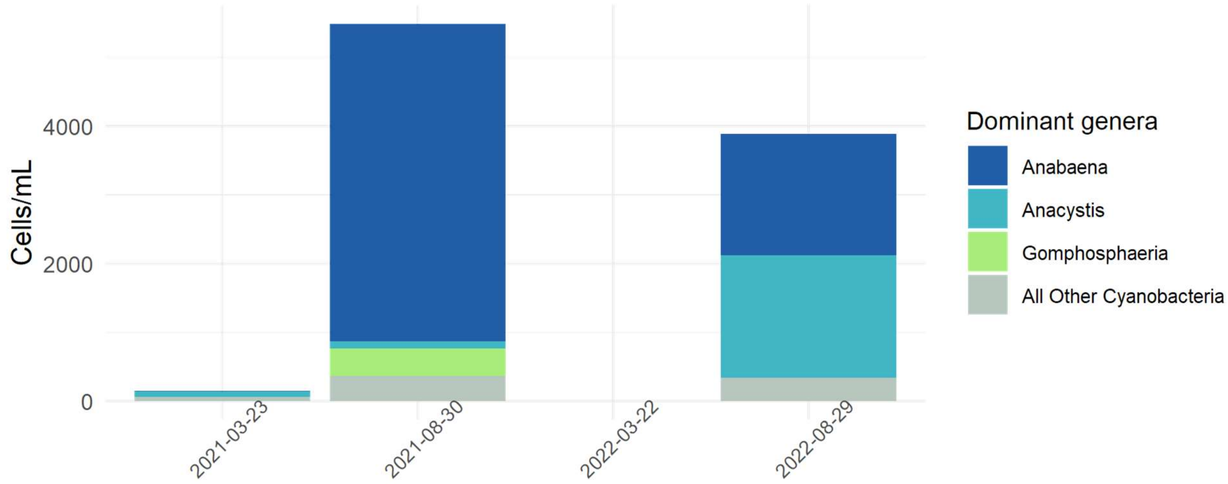

Figure 5: cell abundance for dominant cyanobacteria genera on Ellison Lake

During blooms, species of *Anabaena* produce both negative odor/taste compounds and toxic secondary metabolites. *Anabaena* blooms can quickly accumulate, produce odor compounds, and color water systems (EPA, 2022). Other dominant cyanobacteria identified in the summer samples are also associated with several cyanotoxins that represent risks to public health (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).

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

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anabaena	3700 cells/mL	Lyngbyatoxin LYN, Apoptogen Toxin (ApopTX), Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT, Taste and Odor
Gomphosphaeria	402 cells/mL	Microcystin MC
Anacystis	1324 cells/mL	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 Ellison Lake can produce cyanotoxins (Table 2).

Ellison Lake displayed a range of cyanobacteria levels in the negligible-low risk categories, with a mean cyanobacteria abundance of 3170 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Ellison Lake compared to alert levels defined by several authorities including the WHO and the EPA.

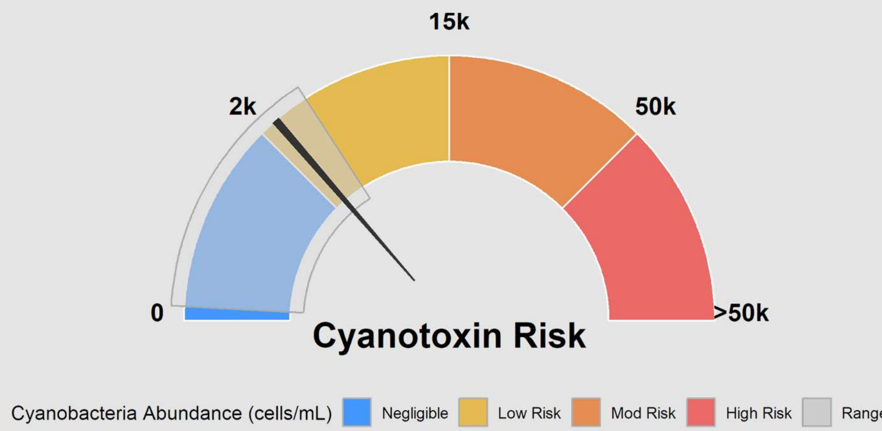

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Ellison Lake

Cyanobacteria frequently dominate algal communities in total cell count, but because of their small cell size their biovolume is usually low relative to other types of algae present. This can be seen in Figure 7 where a single *Ceratium* cell is similar size to approximately 100 cyanobacteria cells on the adjacent filaments.

Figure 7: Size comparison of Ceratium (green box) to Anabaena cell (blue box)

Species Composition

Algae samples were identified to the genus 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.

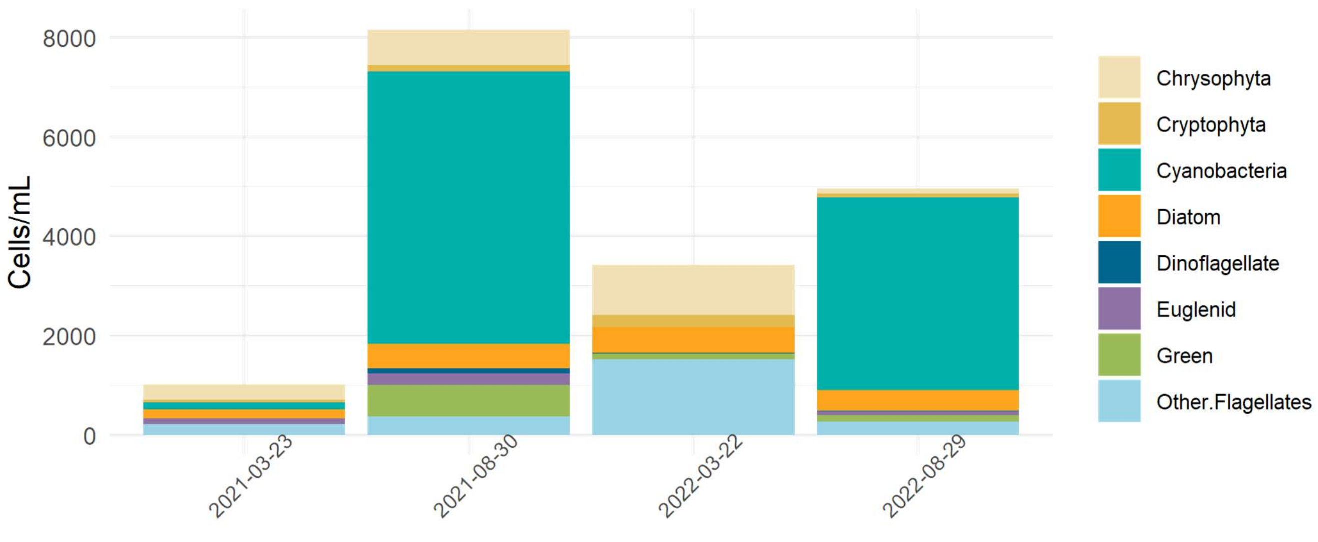

Figure 8: Cell abundance of high-level taxa groups on Ellison Lake

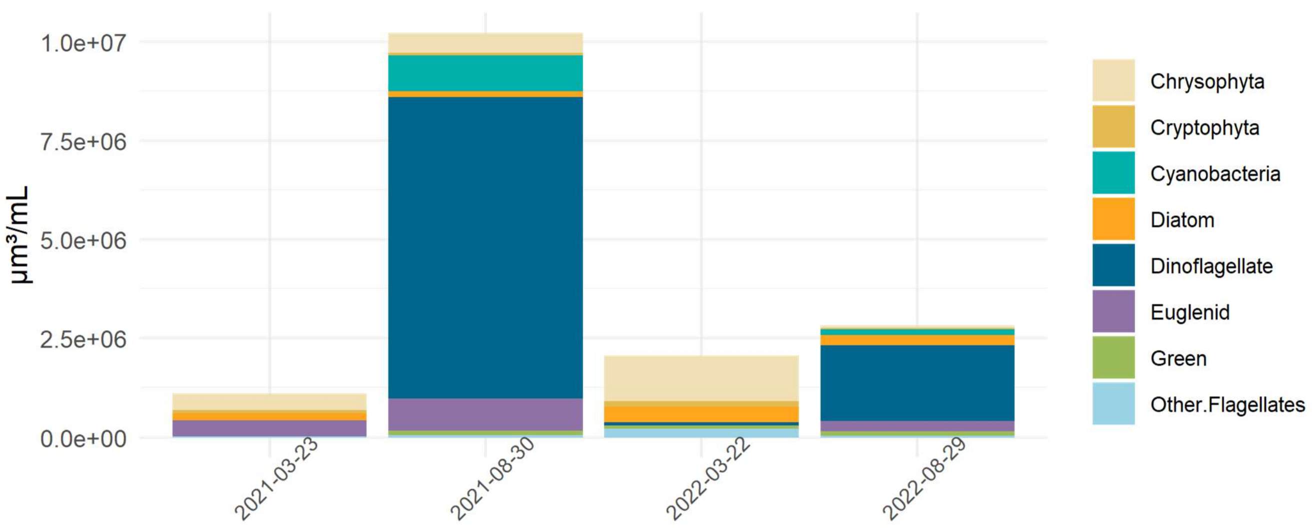

Figure 9: Biovolume of high-level taxa groups on Ellison Lake

References

An Image-Based Key: Ceratium (Dinophyceae). (2017, November). University of New Hampshire.

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Appendix

Additional figures and raw data are listed below:

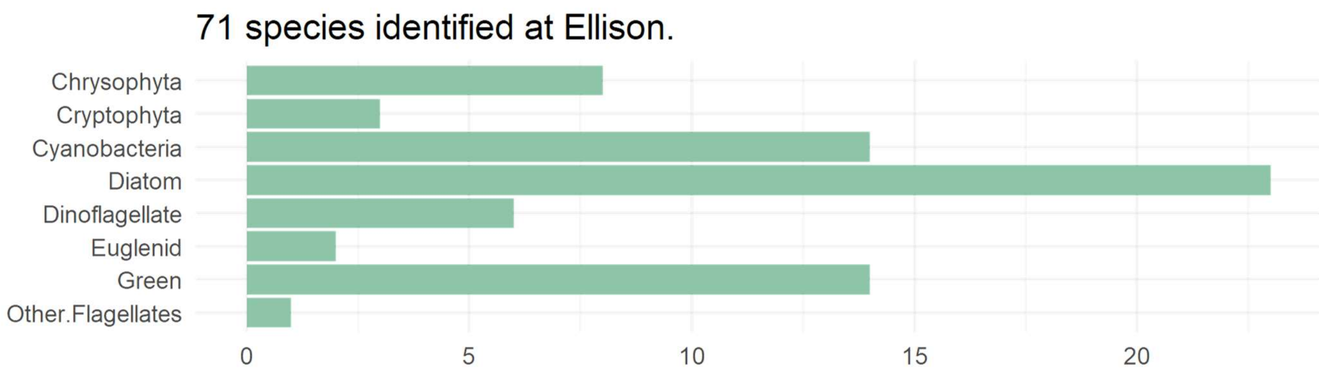

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 0500265	**Total Abundance (cells/mL):**	**582**		
Collection Date: 2021-03-23	**Total Biovolume (µm³/mL):**	**776493**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	129	193758	Chrysophyta	1515
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	23	4924	Chrysophyta	1455
Chrysococcus sp.	4	1328	Chrysophyta	1751
Cryptomonas sp.	30	55561	Cryptophyta	10635
Achnanthidium minutissimum	8	1517	Diatom	590864
Aulacoseira italica	34	16973	Diatom	590863
Cymbella sp.	19	32173	Diatom	4795
Diatoma moniliformis	23	48576	Diatom	3214
Diatoma vulgare	8	9724	Diatom	3214
Gomphonema sp.	4	5508	Diatom	4911
Nitzschia sp.	19	1742	Diatom	5070
Meridion sp.	4	3344	Diatom	
Trachelomonas sp.	102	360498	Euglenid	9690
microflagellate	171	28770	Other.Flagellates	

Figure 11: Raw data from 2021-03-23 EMS site 0500265

EMS ID: 500265	**Total Abundance (cells/mL):**	**8160**		
Collection Date: 2021-08-30	**Total Biovolume (µm³/mL):**	**10232205**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	99	148698	Chrysophyta	1515
Mallomonas sp.	83	251017	Chrysophyta	1598
Ochromonas sp.	125	26759	Chrysophyta	1455
Chrysochromulina sp.	212	8154	Chrysophyta	2160
Chrysococcus sp.	197	65409	Chrysophyta	1751
Cryptomonas sp.	34	62969	Cryptophyta	10635
Rhodomonas lacustris	87	9446	Cryptophyta	10663
Aphanizomenon flos-aquae	38	6327	Cyanobacteria	1191
Anacystis sp.	102	194	Cyanobacteria	609
Dactylococcopsis irregularis	152	9148	Cyanobacteria	6446
Anabaena cylindrica	918	155735	Cyanobacteria	1100
Anabaena flos-aquae	3700	720108	Cyanobacteria	1100
Gloeocapsa punctata	11	46	Cyanobacteria	682
Gloeothece sp.	4	262	Cyanobacteria	703
Gomphosphaeria sp.	402	17834	Cyanobacteria	714
Planktolyngbya sp.	159	1976	Cyanobacteria	
Achnanthidium minutissimum	27	5121	Diatom	590864
Aulacoseira italica	91	45428	Diatom	590863
Cyclotella sp.	190	50438	Diatom	2439
Diatoma vulgare	4	4862	Diatom	3214
Gomphonema sp.	8	11017	Diatom	4911
Nitzschia sp.	182	16687	Diatom	5070
Ceratium sp.	46	7526732	Dinoflagellate	10397
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Peridinium inconspicuum	15	27472	Dinoflagellate	10212
Glenodinium sp.	30	59942	Dinoflagellate	10174
Trachelomonas sp.	231	816421	Euglenid	9690
Ankistrodesmus falcatus	8	1131	Green	5877
Dictyosphaerium pulchellum	402	26311	Green	6297
Schroederia setigera	4	1018	Green	
Monoraphidium contortum	83	47055	Green	5990
Pediastrum duplex	91	25730	Green	6031
Scenedesmus sp.	53	12369	Green	6104
microflagellate	368	61915	Other.Flagellates	

Figure 12: Raw data from 2021-08-30 EMS site 0500265

EMS ID: 0500265	**Total Abundance (cells/mL):**	**3607**		
Collection Date: 2022-03-22	**Total Biovolume (µm³/mL):**	**2183630**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysococcus sp.	57	18925	Chrysophyta	1751
Chrysochromulina sp.	247	9500	Chrysophyta	2160
Chromulina sp.	19	33576	Chrysophyta	1717
Dinobryon spp.	645	1023273	Chrysophyta	1515
Mallomonas sp.	19	57462	Chrysophyta	1598
Dinobryopsis sp.	19	5104	Chrysophyta	1557
Cryptomonas curvata	19	119699	Cryptophyta	10635
Rhodomonas lacustris	228	24756	Cryptophyta	10663
Achnanthidium sp.	19	3604	Diatom	590864
Asterionella formosa	114	79381	Diatom	3116
Fragilaria tenera	228	110707	Diatom	2932
Placoneis exigua	19	66614	Diatom	590835
Neidium sp.	19	25592	Diatom	3269
Staurosira sp.	76	35098	Diatom	590848
Staurosira construens var. ventor	171	14278	Diatom	4127
Ulnaria acus	38	39589	Diatom	970000
Ulnaria ulna	19	99839	Diatom	970000
Peridinium sp.	19	85707	Dinoflagellate	10212
Monoraphidium sp.	114	75526	Green	5990
microflagellate	1518	255400	Other.Flagellates	

Figure 13: Raw data from 2022-03-22 EMS site 0500265

EMS ID: 500265	**Total Abundance (cells/mL):**	**8297**		
Collection Date: 2022-08-29	**Total Biovolume (µm³/mL):**	**3303184**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	65	2500	Chrysophyta	2160
Chromulina sp.	38	67152	Chrysophyta	1717
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	15	27781	Cryptophyta	10635
Rhodomonas lacustris	68	7383	Cryptophyta	10663
Anabaena sp. Small	1283	19952	Cyanobacteria	1100
Dolichospermum crassum	782	351056	Cyanobacteria	
Anabaena flos-aquae	360	70065	Cyanobacteria	1100
Anabaena planctonica	121	41304	Cyanobacteria	1100
Anacystis sp.	95	181	Cyanobacteria	609
Anacystis sp.	364	693	Cyanobacteria	609
Anacystis delicatissima	1324	2892	Cyanobacteria	609
Aphanizomenon sp.	163	5761	Cyanobacteria	1191
Cuspidothrix sp.	1476	61368	Cyanobacteria	
Gloeocapsa punctata	11	46	Cyanobacteria	682
Gloeothece sp.	30	1963	Cyanobacteria	703
Planktolyngbya sp.	133	1653	Cyanobacteria	
cf. Microcystis sp.	664	2781	Cyanobacteria	
Aulacoseira sp.	4	6582	Diatom	590863
Aulacoseira granulata	144	47366	Diatom	590863
Cocconeis neodiminuta	4	6318	Diatom	3577
Nitzschia palea	11	2312	Diatom	5070
Nitzschia sp. small	228	161164	Diatom	5070
Ulnaria acus	8	8335	Diatom	970000
Ulnaria ulna	4	21019	Diatom	970000
Ceratium hirundinella	11	1899192	Dinoflagellate	10397
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Parvodinium sp.	8	4411	Dinoflagellate	
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Trachelomonas sp.	4	14137	Euglenid	9690
Trachelomonas hispida	72	238866	Euglenid	9690
Elakatothrix sp.	8	1536	Green	9412
Golenkinia sp.	8	14137	Green	6314
Monoraphidium sp.	4	2650	Green	5990
Monoraphidium contortum	23	13039	Green	5990
Monoraphidium indicum	4	2650	Green	5990
Monoraphidium minutum	19	12588	Green	5990
Oocystis solitaria	4	922	Green	5827
Scenedesmus arcuatus	53	3847	Green	6104
Staurodesmus subtriangularis	8	70941	Green	7182
Coelosphaerium dubium	398	45013	Green	791
microflagellate	266	44754	Other.Flagellates	

Figure 14: Raw data from 2022-08-29 EMS site 0500265