Tabor Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Tabor 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
TABOR L DEEP STN (0400336)	2021-05-13
	2021-08-24
	2022-05-10
	2022-08-17
	Total= 4 samples

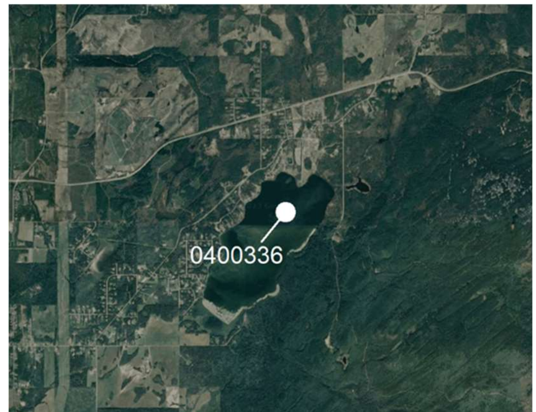

Figure 1: Aerial view of Tabor Lake

Algal community composition shifted between spring and summer samples. Spring samples contained elevated densities of diatoms, dinoflagellates, detritus, and flagellates but lower densities of cyanobacteria than summer (Figure 2). Summer samples contained high concentrations of cyanobacteria capable of producing toxins.

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).

Spring blooms of diatoms are common and reflective of increased temperatures, light penetration, and silica in the water following ice thaw (Kong et al., 2021). Diatoms can increase the resiliency and health of water systems through their ability to bloom in early spring, reduce nutrient levels, and prevent monoculture blooms of less desirable algae (jrobyn, 2019).

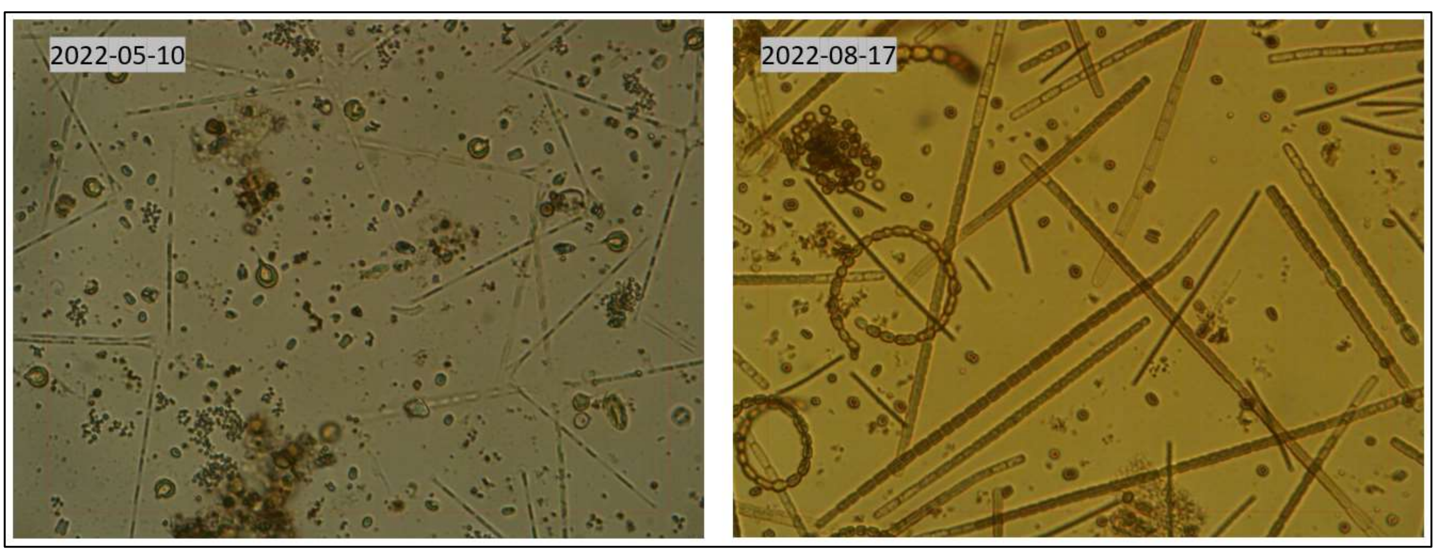

Figure 2: Contrasting algal community composition in the 2022 spring (Asterionella and micro-flagellate heavy) vs summer sample (cyanobacteria heavy)

Overview (continued)

Cyanobacteria often dominate algae counts, but because of their small cell size cyanobacteria biovolume is typically low relative to other agal types. The large biovolume percentage of cyanobacteria (68%) in Tabor Lake reflects the high concentrations recorded; specifically Aphanizomenon flos-aqaue (Figure 3; Figure 4; Figure 5).

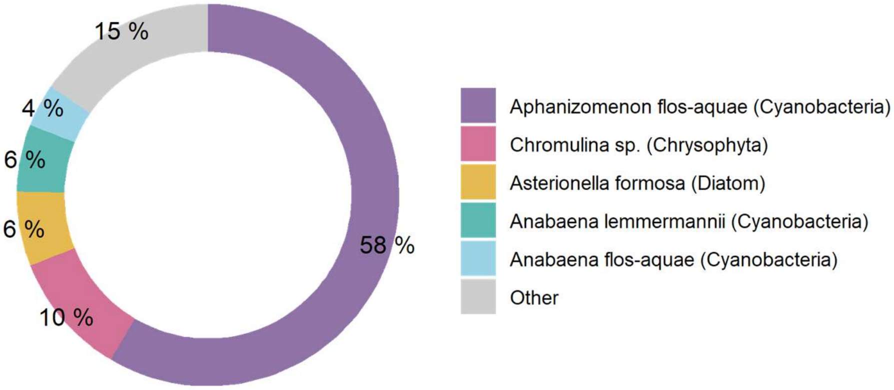

Figure 3: Dominant organisms from Tabor L Deep Stn (0400336) as percent of total biovolume

Spring samples contained low concentrations of cyanobacteria and high concentrations of diatoms. Summer samples contained large blooms of *Aphanizomenon, Anabaena* and other cyanobacteria (Figure 3). The large cyanobacterial blooms observed in Tabor Lake could be reflective of nutrient imbalances (Figure 4).

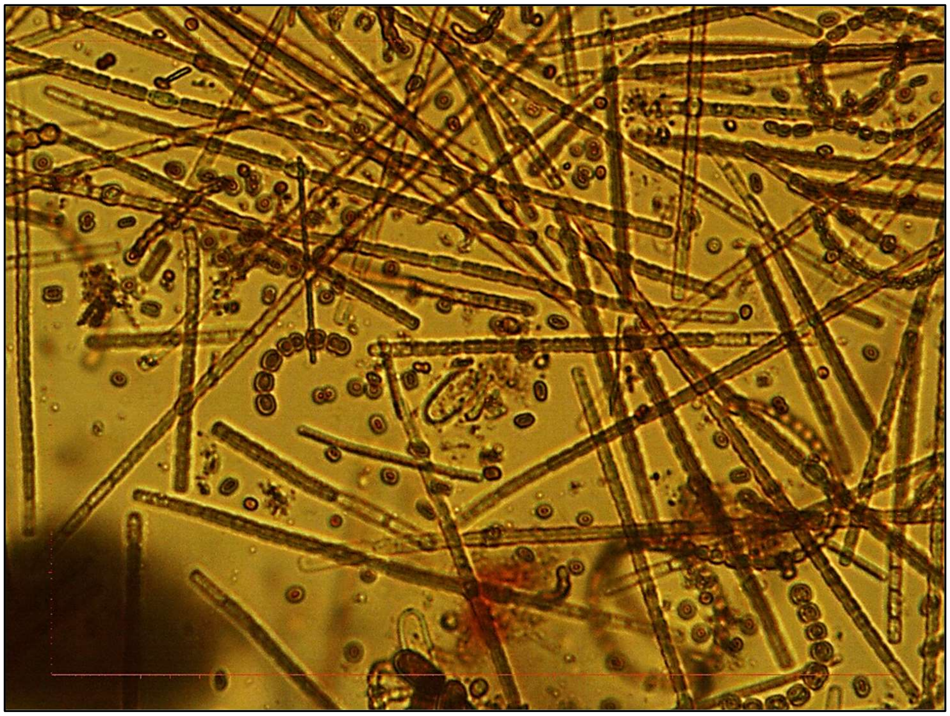

Figure 4: EMS site#0400336 collected on 2022-08-17 demonstrating the dominance of cyanobacteria

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 concentrations of cyanobacteria. Dominant genera include *Aphanizomenon, Anabaena* and *Pseudanabaena* (Figure 5).

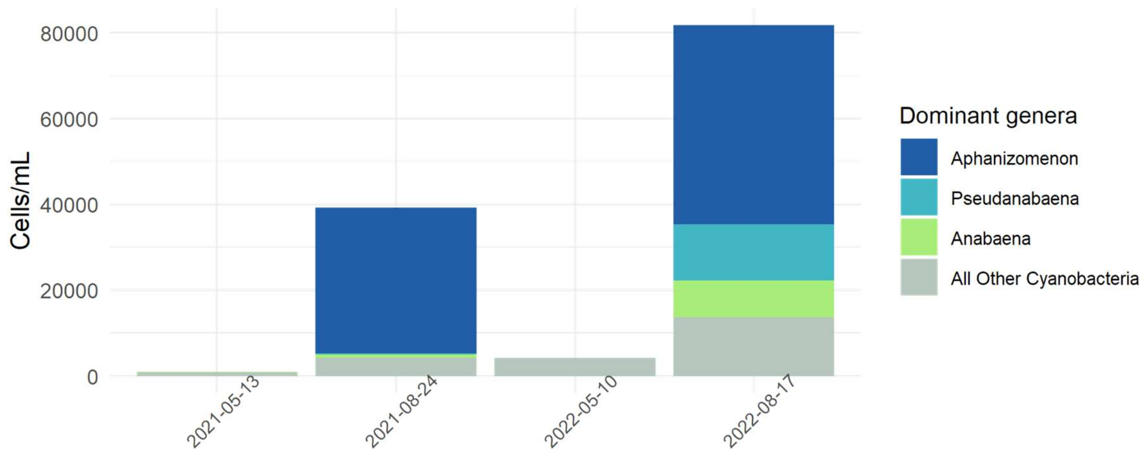

Figure 5: cell abundance for dominant cyanobacteria genera on Tabor Lake

During blooms, species of *Aphanizomenon, Anabaena* and *Pseudanabaena* can produce both negative odor/taste compounds and toxic secondary metabolites. *Aphanizomenon* is a filamentous, nitrogen-fixing cyanobacteria capable of forming dense, odorous, and toxic blooms (Cirés & Ballot, 2016). *Anabaena* blooms can quickly accumulate, develop odor metabolites, and color water systems (EPA, 2022). Other 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 Tabor Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Aphanizomenon	46424	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor
Pseudanabaena	13114	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Anatoxins (-a) ATX, BMAA, Taste and Odor
Anabaena	4903	Lyngbyatoxin LYN, Apoptogen Toxin (ApopTX), Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxin SAX neosaxitoxin NEO, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT, Taste and Odor

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Tabor Lake displayed a range of cyanobacteria levels from negligible to high risk depending on the season, with a mean cyanobacteria abundance of 31,547 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Tabor Lake compared to alert levels defined by authorities including the WHO and EPA.

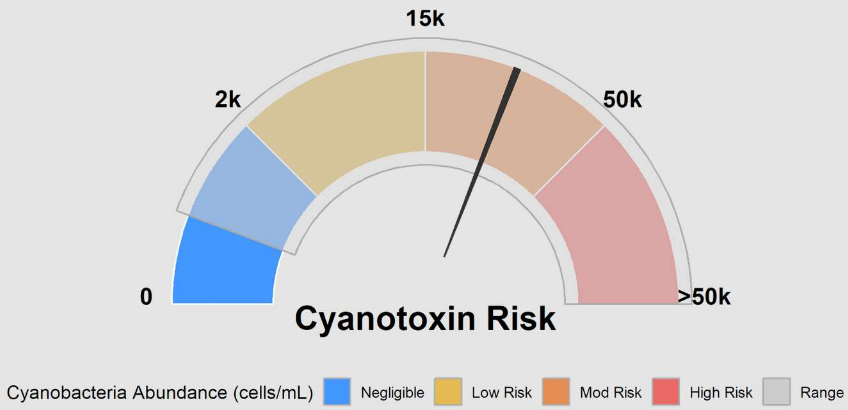

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Tabor Lake

Species Composition

Algae samples were identified to the genus level and grouped into broad alga types for analysis. The figures below display the total cell counts for each broad algae group alongside their biovolume. Note the dominance of cyanobacteria in both Figure 7 (cell abundance) and Figure 8 (biovolume).

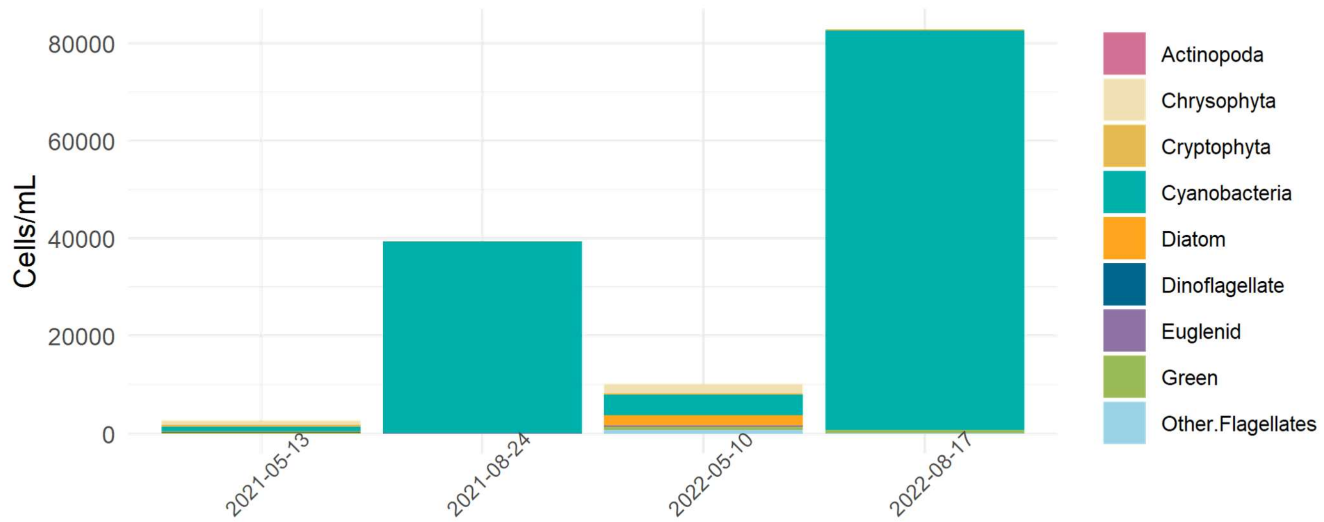

Figure 7: Cell abundance of high-level taxa groups on Tabor Lake

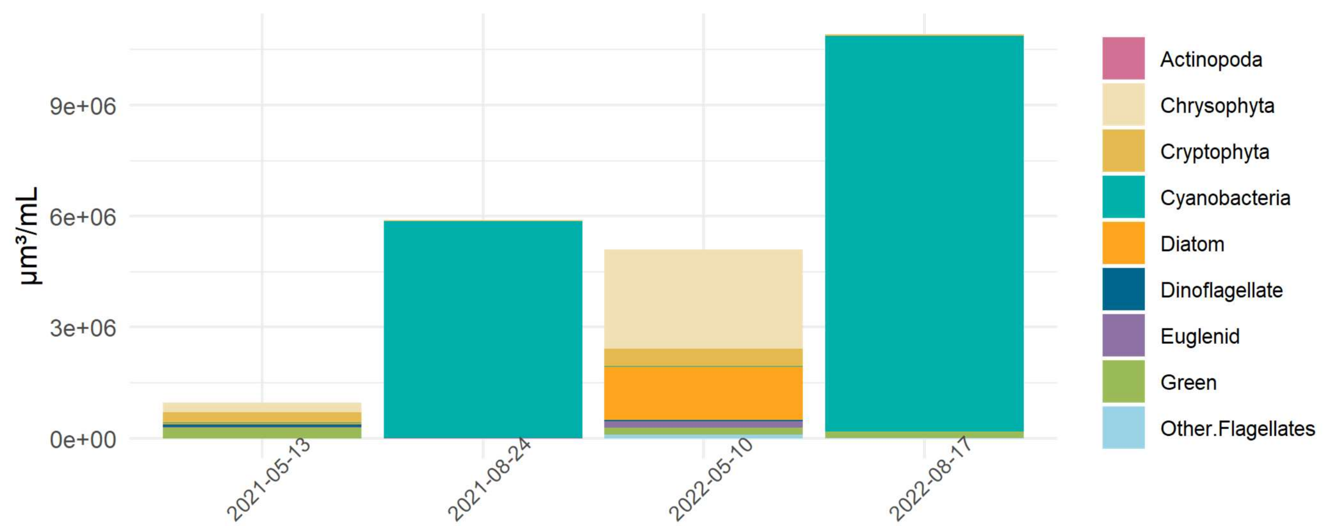

Figure 8: Biovolume of high-level taxa groups on Tabor Lake

References

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Appendix

Additional figures and raw data are listed below:

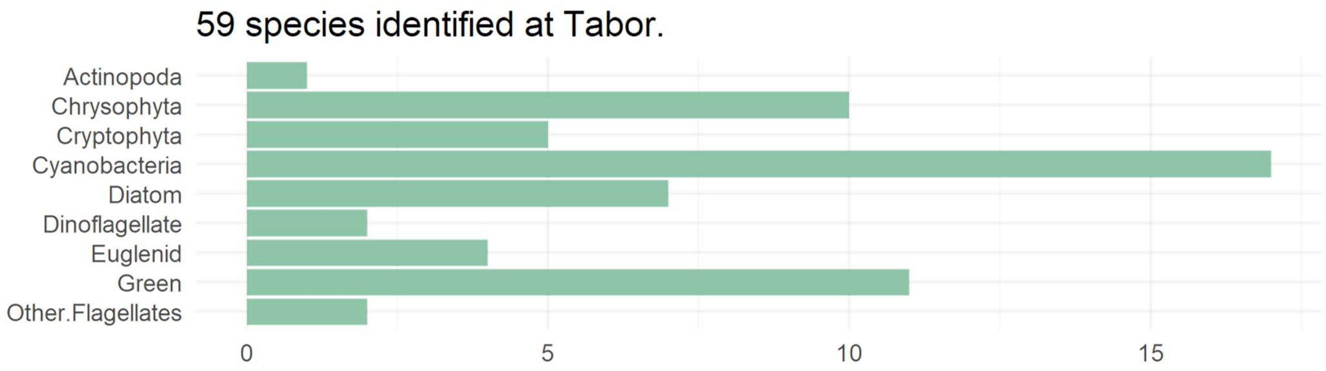

Figure 9: Identified species sorted into categories of higher-level taxa

EMS ID: 0400336	**Total Abundance (cells/mL):**	**2705**		
Collection Date: 2021-05-13	**Total Biovolume (µm³/mL):**	**1034581**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	23	34546	Chrysophyta	1515
Ochromonas sp.	300	64221	Chrysophyta	1455
Chrysococcus sp.	436	144763	Chrysophyta	1751
Pseudokephyrion entzii	133	1671	Chrysophyta	
Mallomonas sp.	8	24194	Chrysophyta	1598
Cryptomonas sp.	8	14816	Cryptophyta	10635
Cryptomonas ovata	99	215412	Cryptophyta	10635
Rhodomonas lacustris	360	39088	Cryptophyta	10663
Anabaena flos-aquae	57	11094	Cyanobacteria	1100
Anacystis sp.	861	1638	Cyanobacteria	609
Asterionella formosa	30	20890	Diatom	3116
Cyclotella sp.	91	24157	Diatom	2439
Nitzschia sp.	19	1742	Diatom	5070
Gymnodinium sp.	30	63554	Dinoflagellate	10031
Trachelomonas volvocina	30	23890	Euglenid	9690
Ankistrodesmus sp.	8	1258	Green	5877
Closterium aciculare	15	277067	Green	7257
Chlorella sp.	38	2652	Green	5811
Oocystis sp.	15	283	Green	5827
Scenedesmus quadricauda	8	1307	Green	6104
Tetraedron sp.	30	5250	Green	5661
Chlamydomonas sp.	102	61031	Green	5448
Scourfieldia sp.	4	57	Other.Flagellates	5561

Figure 10: Raw data from 2021-05-13 EMS site 0400336

EMS ID: 0400336	**Total Abundance (cells/mL):**	**39438**		
Collection Date: 2021-08-24	**Total Biovolume (µm³/mL):**	**5893873**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas sp.	83	18872	Chrysophyta	10613
Cryptomonas ovata	4	8704	Cryptophyta	10635
Rhodomonas lacustris	42	4560	Cryptophyta	10663
Anabaena circinalis	76	23581	Cyanobacteria	1100
Anabaena flos-aquae	702	136626	Cyanobacteria	1100
Anacystis cyanea	57	86	Cyanobacteria	609
Aphanizomenon flos-aquae	33970	5656155	Cyanobacteria	1191
Lyngbya sp.	417	328	Cyanobacteria	870
Lyngbya wollei	474	444	Cyanobacteria	870
Woronichinia naegelianum	744	10131	Cyanobacteria	
Pseudanabaena sp.	258	2875	Cyanobacteria	1175
Synechococcus sp.	2372	10195	Cyanobacteria	773
Chlorogloea sp.	220	4939	Cyanobacteria	824
Lepocinclis sp.	19	16377	Euglenid	9758

Figure 11: Raw data from 2021-08-24 EMS site 0400336

EMS ID: 0400336	**Total Abundance (cells/mL):**	**10164**		
Collection Date: 2022-05-10	**Total Biovolume (µm³/mL):**	**5114544**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	11	1851	Actinopoda	
Chrysococcus sp.	19	6308	Chrysophyta	1751
Chrysochromulina sp.	243	9346	Chrysophyta	2160
Chromulina sp.	8	14137	Chrysophyta	1717
Chromulina sp.	1351	2387414	Chrysophyta	1717
Dinobryon spp.	144	228452	Chrysophyta	1515
Epipyxis sp.	4	519	Chrysophyta	1574
Ochromonas sp.	129	27615	Chrysophyta	1455
Dinobryopsis sp.	38	10207	Chrysophyta	1557
Cryptomonas sp.	80	148163	Cryptophyta	10635
Cryptomonas curvata	34	214198	Cryptophyta	10635
Cryptomonas ovata	23	50045	Cryptophyta	10635
Cryptomonas erosa	19	33665	Cryptophyta	10635
Rhodomonas lacustris	167	18133	Cryptophyta	10663
Anacystis sp.	3867	7358	Cyanobacteria	609
Synechocystis sp.	178	5965	Cyanobacteria	799
Planktolyngbya sp.	137	1703	Cyanobacteria	
Achnanthidium sp.	8	1517	Diatom	590864
Asterionella formosa	2038	1419104	Diatom	3116
Aulacoseira granulata	8	2631	Diatom	590863
Cocconeis neodiminuta	11	17374	Diatom	3577
Nitzschia spp.	8	3158	Diatom	5070
Gymnodinium ordinatum	15	29248	Dinoflagellate	10031
Parvodinium sp.	11	6065	Dinoflagellate	
Trachelomonas sp.	8	28274	Euglenid	9690
Trachelomonas volvocina	171	136172	Euglenid	9690
Euglena sp.	4	2304	Euglenid	9620
Asterococcus sp.	4	4601	Green	9178
Ankistrodesmus falcatus	30	4241	Green	5877
Ankistrodesmus sp.	53	8333	Green	5877
Didymocystis bicellularis	664	178876	Green	55858
microflagellate	558	93882	Other.Flagellates	
Scourfieldia sp.	121	13685	Other.Flagellates	5561

Figure 12: Raw data from 2022-05-10 EMS site 0400336

EMS ID: 0400336	**Total Abundance (cells/mL):**	**82861**		
Collection Date: 2022-08-17	**Total Biovolume (µm³/mL):**	**10234795**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysococcus sp.	8	2656	Chrysophyta	1751
Chrysochromulina sp.	15	577	Chrysophyta	2160
Ochromonas sp.	38	8135	Chrysophyta	1455
Cryptomonas erosa	15	26578	Cryptophyta	10635
Rhodomonas lacustris	228	24756	Cryptophyta	10663
Anabaena sp.	76	5698	Cyanobacteria	1100
Anabaena flos-aquae	3537	688385	Cyanobacteria	1100
Anabaena lemmermannii	4903	1318153	Cyanobacteria	1100
Anacystis delicatissima	3908	8537	Cyanobacteria	609
Aphanizomenon flos-aquae	46424	7729801	Cyanobacteria	1191
Lyngbya wollei	296	277	Cyanobacteria	870
Microcystis sp.	8917	72952	Cyanobacteria	747
Pseudanabaena sp.	13114	146119	Cyanobacteria	1175
Woronichinia naegeliana	622	8470	Cyanobacteria	
Ankistrodesmus falcatus	8	1131	Green	5877
Didymocystis fina	653	175913	Green	55858
microflagellate	99	16657	Other.Flagellates	

Figure 13: Raw data from 2022-08-17 EMS site 0400336