Wood Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Wood Lake during 2021 and 2022 (Table 1; Figure 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
WOOD LAKE DEEP BASIN (0500848)	2021-03-24
	2021-08-31
	2022-03-22
	2022-08-30
	Total= 4 samples

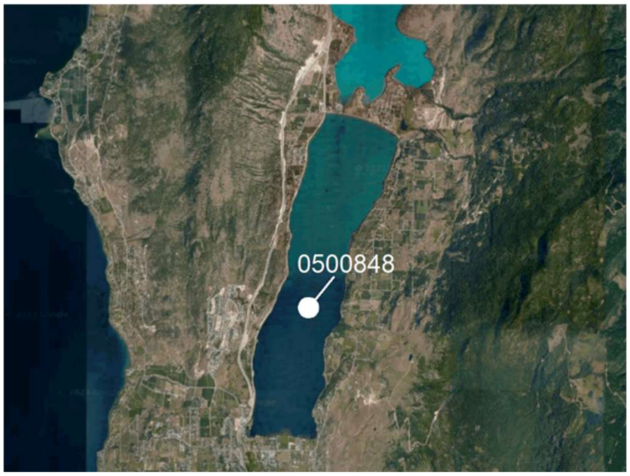

Figure 1: Aerial view of Wood Lake

Samples contained moderate concentrations of diatoms, green algae, and flagellates. Summer samples contained higher concentrations of cyanobacteria and spring samples contained higher concentrations of debris.

Summer diatoms were dominated by *Fragilaria crotenensis* and spring diatoms were dominated by *Tabellaria fenestrate.* Spring samples also demonstrated diatom degradation indicative of lowering silica levels in the late spring (Figure 2). 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).

Diatoms are integral to aquatic food webs because they are the foundation of the food web (jrobyn, 2019). Colony forming diatoms such as *Fragilaria* and *Tabellaria* can avoid grazing pressures by developing into large colonies, reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012).

Figure 2: Degraded Tabellaria collected on 2022-03-22 (left) vs. healthy Tabellaria (right)

Overview (continued)

Small quantities of the dinoflagellate *Ceratium* were identified in Wood Lake. Despite low numbers, this dinoflagellate represented 46% of biovolumes. This is because of *Ceratium's* large size relative to other algae (Figure 3; Figure 4).

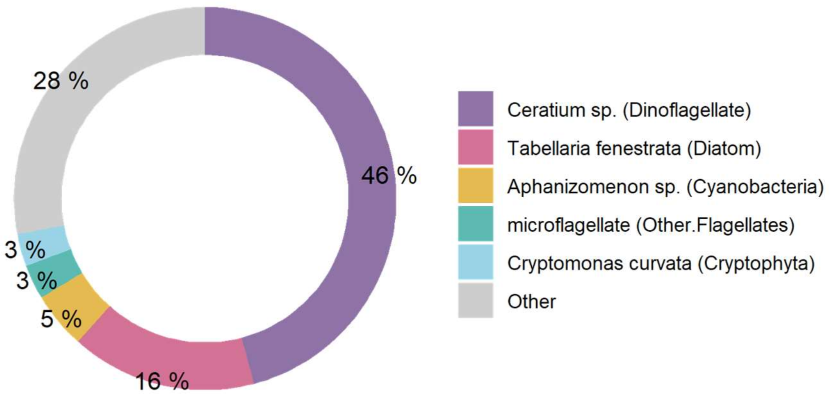

Figure 3: Dominant organisms from Wood Lake Deep Basin (0500848) as percent of total biovolume

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

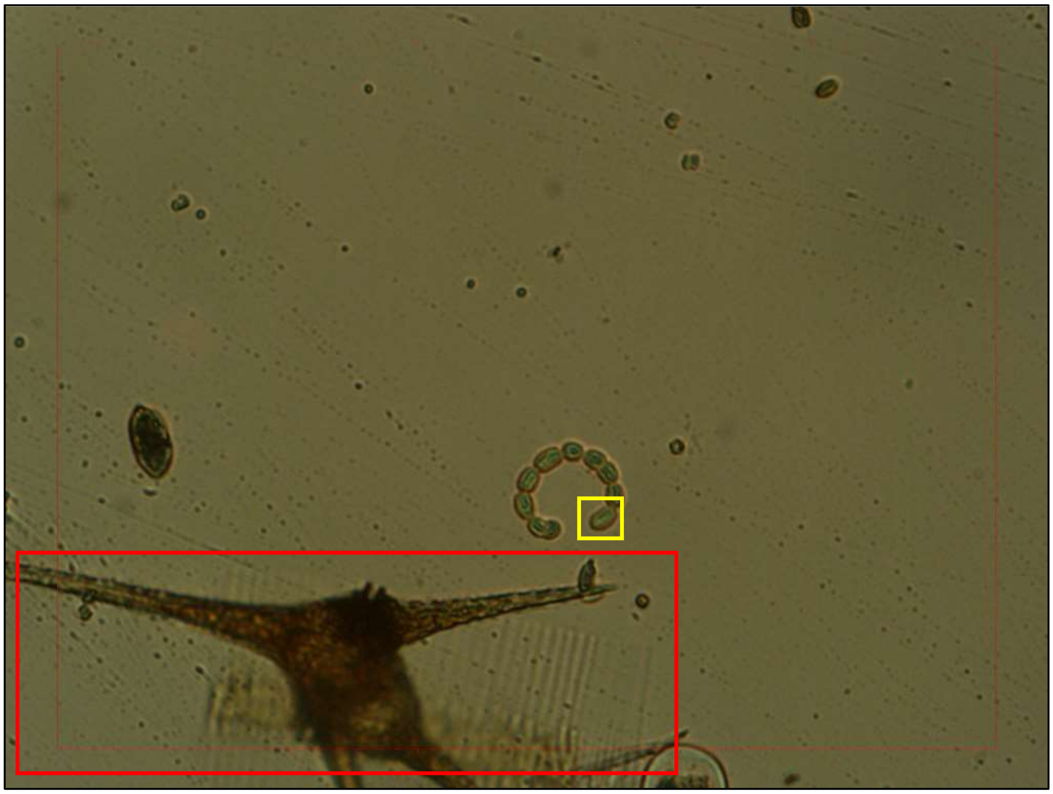

Figure 4: EMS Site #500848 collected on 2021-08-31 comparing the size of one Ceratium cell (red box) to one Anabaena cell (yellow box)

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

Dominant cyanobacteria genera included *Aphanizomenon*, *Planktolyngbya*, and *Synechocystis* (Figure 5). One large bloom was recorded on 2022-08-30 (>20,000 cyanobacterial cells/mL).

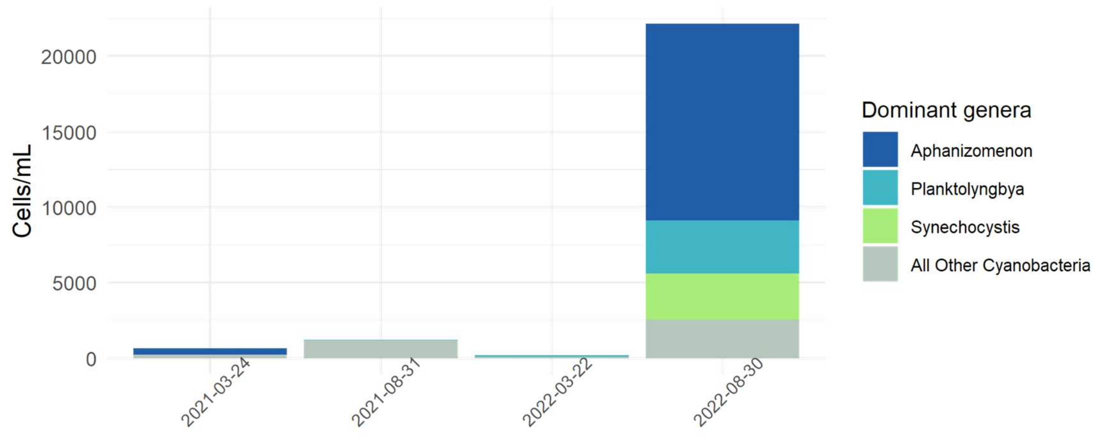

Figure 5: cell abundance for dominant cyanobacteria genera on Wood Lake

During blooms, species of *Aphanizomenon* 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. A*phanizomenon* cells can produce liver toxins, nerve toxins, and skin irritants upon cell lysis (Cirés & Ballot, 2016).

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 Wood Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Aphanizomenon	13050	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor
Planktolyngbya	3514	Lyngbyatoxin LYN, Microcystin MC, BMAA
Synechocystis	3047	Lipopolysaccharide LPS, Microcystin MC, BMAA

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Wood Lake displayed a range of cyanobacteria levels in the negligible-moderate risk categories, with a mean cyanobacteria abundance of 6,054 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Wood Lake compared to alert levels defined by several authorities including the WHO and EPA.

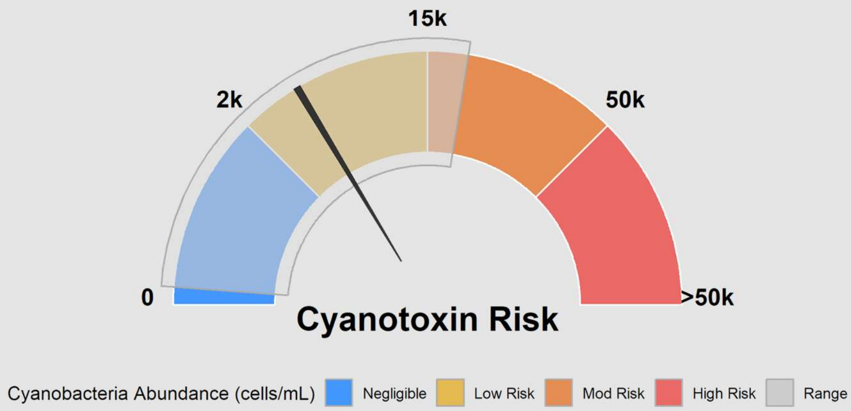

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Wood Lake

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 two cells of the Desmid *Staurastrum* are compared to two cells of the cyanobacteria *Synechocystis*.

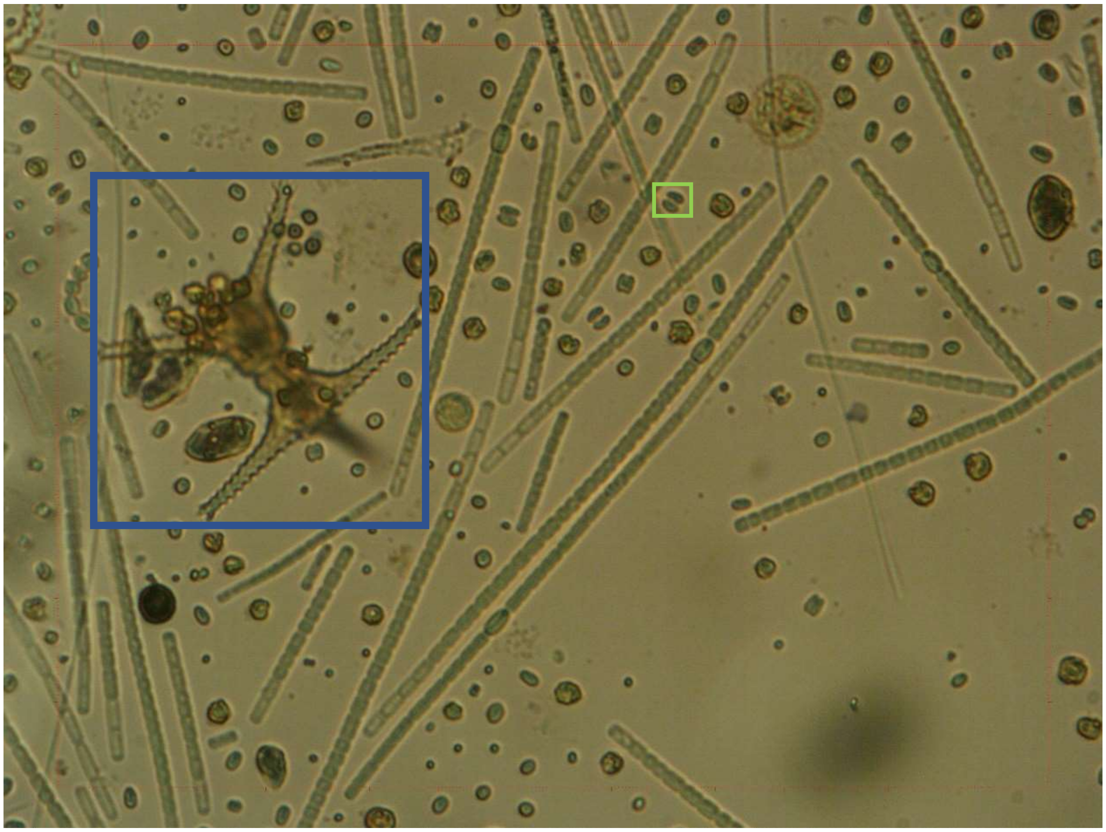

Figure 7: Size comparison of two cells of Staurastrum (blue box) to two cells of Synechocystis cell (green box)

Species Composition

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

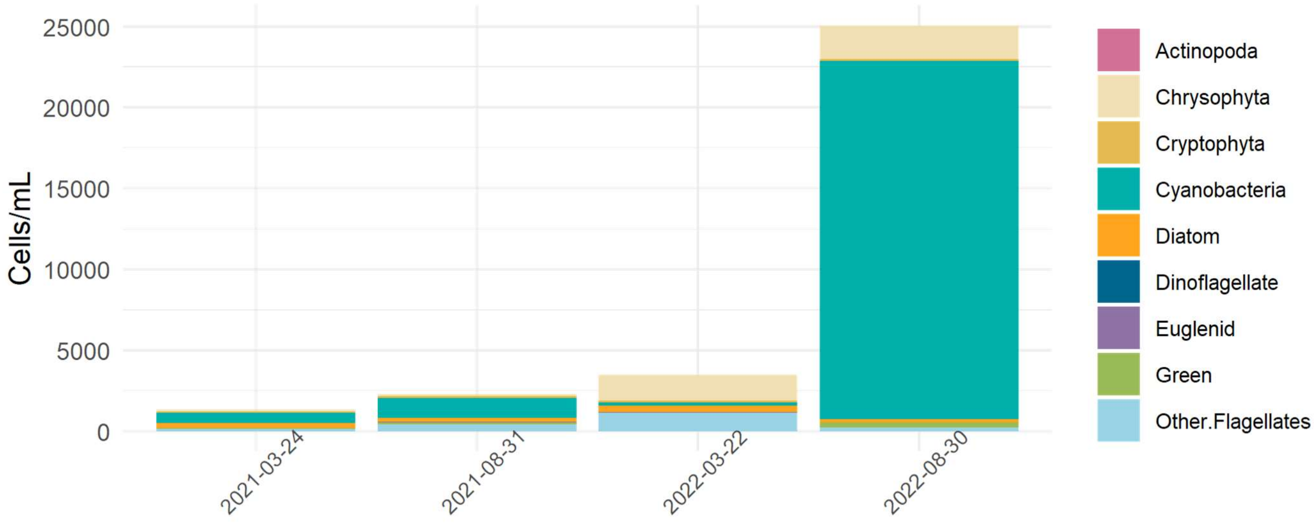

Figure 8: Cell abundance of high-level taxa groups on Wood Lake

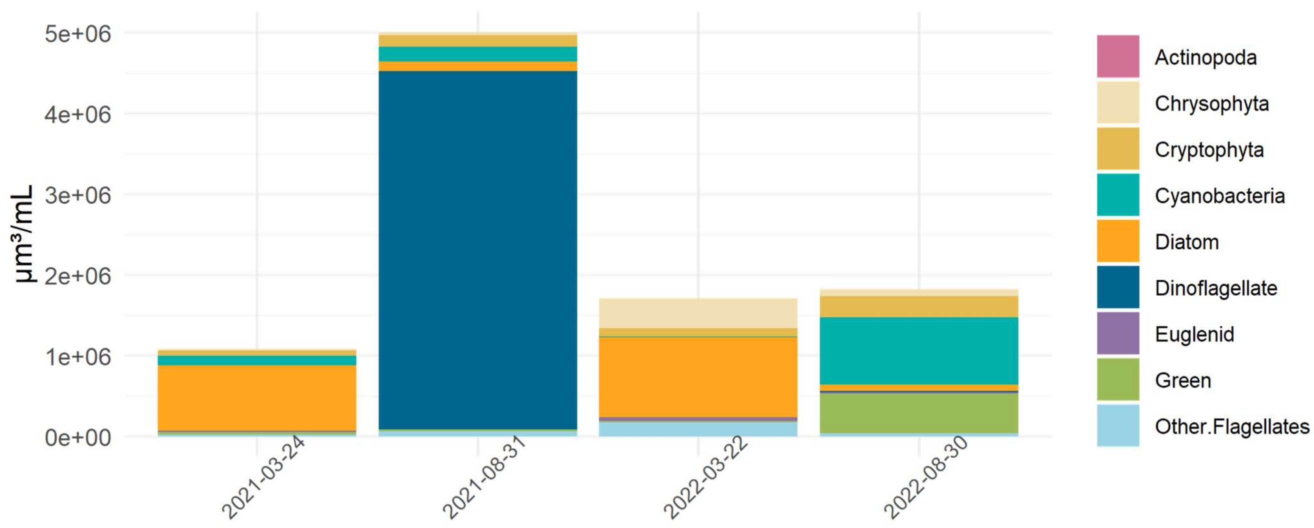

Figure 9: Biovolume of high-level taxa groups on Wood Lake

References

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

Baker, A. L. et al. (2012). *Phycokey -- an image based key to Algae (PS Protista), Cyanobacteria, and other aquatic objects.* University of New Hampshire Center for Freshwater Biology. http://cfb.unh.edu/phycokey/phycokey.htm

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

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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

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:

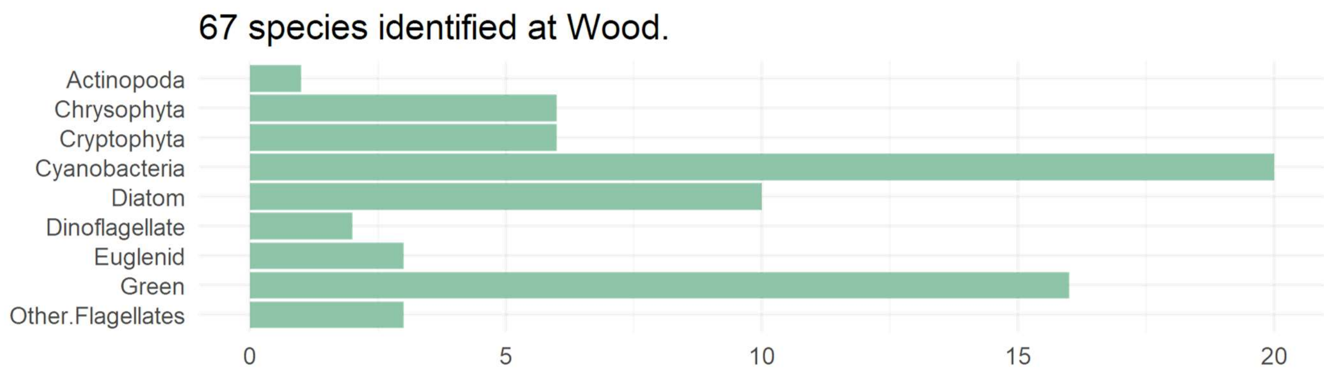

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 0500848	**Total Abundance (cells/mL):**	**1338**		
Collection Date: 2021-03-24	**Total Biovolume (µm³/mL):**	**1087795**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	80	17126	Chrysophyta	1455
Chrysococcus sp.	23	7637	Chrysophyta	1751
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Cryptomonas curvata	4	25200	Cryptophyta	10635
Cryptomonas ovata	11	23935	Cryptophyta	10635
Rhodomonas lacustris	83	9012	Cryptophyta	10663
Aphanizomenon flos-aquae	429	71430	Cyanobacteria	1191
Anacystis sp.	61	116	Cyanobacteria	609
Anabaena circinalis	156	48402	Cyanobacteria	1100
Asterionella formosa	8	5571	Diatom	3116
Cyclotella sp.	30	7964	Diatom	2439
Eunotia sp.	15	2232	Diatom	3337
Nitzschia sp.	15	1375	Diatom	5070
Stephanodiscus niagarae	19	199524	Diatom	2415
Tabellaria fenestrata	220	591311	Diatom	3241
Phacus sp.	4	16287	Euglenid	9766
Mougeotia sp.	23	17750	Green	7055
Monoraphidium indicum	15	9938	Green	5990
Scenedesmus sp.	8	1867	Green	6104
UID flagellate	8	2783	Other.Flagellates	
microflagellate	118	19853	Other.Flagellates	

Figure 11: Raw data from 2021-03-24 EMS site 0500848

EMS ID: 0500848	**Total Abundance (cells/mL):**	**2273**		
Collection Date: 2021-08-31	**Total Biovolume (µm³/mL):**	**5018576**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	72	15413	Chrysophyta	1455
Chrysococcus sp.	38	12617	Chrysophyta	1751
Dinobryopsis sp.	15	4029	Chrysophyta	1557
Cryptomonas curvata	8	50400	Cryptophyta	10635
Cryptomonas ovata	19	41342	Cryptophyta	10635
Cryptomonas marssonii	23	46963	Cryptophyta	10635
Rhodomonas lacustris	57	6189	Cryptophyta	10663
Anacystis sp.	243	462	Cyanobacteria	609
Anabaena circinalis	368	114179	Cyanobacteria	1100
Anabaena cylindrica	379	64296	Cyanobacteria	1100
Gloeocapsa punctata	137	574	Cyanobacteria	682
Gloeothece sp.	65	4254	Cyanobacteria	703
Planktolyngbya sp.	38	472	Cyanobacteria	
Achnanthidium minutissimum	4	759	Diatom	590864
Asterionella formosa	57	39690	Diatom	3116
Fragilaria crotonensis	163	79146	Diatom	2932
Ceratium sp.	27	4417865	Dinoflagellate	10397
Gymnodinium ordinatum	8	15599	Dinoflagellate	10031
Paranema sp.	4	2386	Euglenid	
Ankistrodesmus falcatus	4	565	Green	5877
Oocystis sp.	53	999	Green	5827
Oocystis parva	8	1798	Green	5827
Desmidium sp.	4	2592	Green	8844
Scenedesmus sp.	61	14235	Green	6104
microflagellate	414	69655	Other.Flagellates	

Figure 12: Raw data from 2021-08-31 EMS site 0500848

EMS ID: 0500848	**Total Abundance (cells/mL):**	**3476**		
Collection Date: 2022-03-22	**Total Biovolume (µm³/mL):**	**1736350**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysococcus sp.	99	32870	Chrysophyta	1751
Chrysochromulina sp.	615	23655	Chrysophyta	2160
Chromulina sp.	53	93659	Chrysophyta	1717
Mallomonas sp.	23	69559	Chrysophyta	1598
Ochromonas sp.	630	134863	Chrysophyta	1455
Rhodomonas sp.	159	18121	Chrysophyta	10663
Cryptomonas curvata	15	94499	Cryptophyta	10635
Rhodomonas lacustris	114	12378	Cryptophyta	10663
Merismopedia sp.	91	589	Cyanobacteria	727
Synechocystis sp.	15	503	Cyanobacteria	799
Planktolyngbya sp.	76	945	Cyanobacteria	
Asterionella formosa	30	20890	Diatom	3116
Cyclotella sp.	30	7964	Diatom	2439
Lindavia intermedia	8	7072	Diatom	
Tabellaria fenestrata	342	919220	Diatom	3241
Ulnaria nana	15	39375	Diatom	970000
Trachelomonas sp.	15	53014	Euglenid	9690
Closterium limneticum	8	15708	Green	7257
microflagellate	1138	191466	Other.Flagellates	

Figure 13: Raw data from 2022-03-22 EMS site 0500848

EMS ID: 0500848	**Total Abundance (cells/mL):**	**25067**		
Collection Date: 2022-08-30	**Total Biovolume (µm³/mL):**	**1829412**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	11	1851	Actinopoda	
Chrysochromulina sp.	2038	78387	Chrysophyta	2160
Mallomonas sp.	4	12097	Chrysophyta	1598
Cryptomonas sp.	53	98158	Cryptophyta	10635
Cryptomonas curvata	15	94499	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Cryptomonas erosa	27	47840	Cryptophyta	10635
Rhodomonas lacustris	34	3692	Cryptophyta	10663
Anabaena sp.	235	17620	Cyanobacteria	1100
Anabaena helicoidea	774	102127	Cyanobacteria	1100
Anabaena affinis	118	33819	Cyanobacteria	1100
Anabaena spiroides	125	33606	Cyanobacteria	1100
Aphanizomenon sp.	13050	461225	Cyanobacteria	1191
Aphanocapsa sp.	508	1605	Cyanobacteria	625
Chroococcus limneticus	114	14557	Cyanobacteria	654
Gloeocapsa punctata	114	478	Cyanobacteria	682
Gloeocapsa aeruginosa	46	650	Cyanobacteria	682
Gloeothece sp.	46	3011	Cyanobacteria	703
Synechocystis sp.	3047	102106	Cyanobacteria	799
Snowella sp.	76	326	Cyanobacteria	
Planktolyngbya sp.	3514	43679	Cyanobacteria	
Planktothrix sp.	228	12692	Cyanobacteria	189420
Woronichinia sp.	163	2220	Cyanobacteria	
Fragilaria crotonensis	175	84973	Diatom	2932
Parvodinium sp.	19	10476	Dinoflagellate	
Trachelomonas sp.	4	14137	Euglenid	9690
Coenococcus sp.	38	537	Green	
Elakatothrix sp.	4	768	Green	9412
Mougeotia sp.	65	50163	Green	7055
Monoraphidium indicum	4	2650	Green	5990
Oocystis cf. borgei	8	2359	Green	5827
Oocystis solitaria	4	922	Green	5827
Cosmarium cf. bioculatum	34	7245	Green	7848
Cosmarium cf. subcostatum	8	4484	Green	7848
Didymocystis planctonica	15	4041	Green	55858
Euastrum sp.	8	240790	Green	8525
Staurodesmus subtriangularis	15	133015	Green	7182
Chlamydomonas sp.	83	49662	Green	5448
microflagellate	235	39538	Other.Flagellates	

Figure 14: Raw data from 2022-08-30 EMS site 0500848