Naltesby Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Naltesby 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 2020, 2021, and 2022

Sample Site (EMS#)	Dates
NALTESBY LK. DEEP STN. NEAR MAIN ISLAND (E206955)	2021-05-10
	2021-09-16
	2022-05-11
	2022-08-08
	Total= 4 samples

Figure 1: Aerial view of Naltesby Lake

Cyanobacteria increased in the summer but flagellates and Cryptophyta increased in the spring.

Samples from site EMS#E206955 collected on 2021-09-16 contained diatoms with silica degradation (Figure 2). Diatom or silica degradation is reflective of seasonal lowering silica levels (Kong et al., 2021). It is uncommon for diatoms to degrade heavily in the summer; this phenomenon is frequently observed in the late winter and spring.

Figure 2: Tabellaria without silica degradation (left) vs degraded Tabellaria observed at EMS site #E206955 on 2021-09-16 (right)

Overview (continued)

Samples from EMS#E206955 site, collected on 2022-08-08, contained clouds of degraded cyanobacteria (Figure 3). Degraded cyanobacteria could represent a threat to public health because cyanotoxins are contained within cyanobacterial cells before cell death (EPA, 2022).

Cryptophyta genus Cryptomonas dominated total biovolumes (Figure 4). Cryptomonas are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015).

Small quantities of the dinoflagellate *Ceratium* were identified in Naltesby Lake. Despite low numbers, this dinoflagellate represented 14% of total biovolume. This is because of *Ceratium's* large size relative to other algae attributes to its large biovolume percentage (Figure 4).

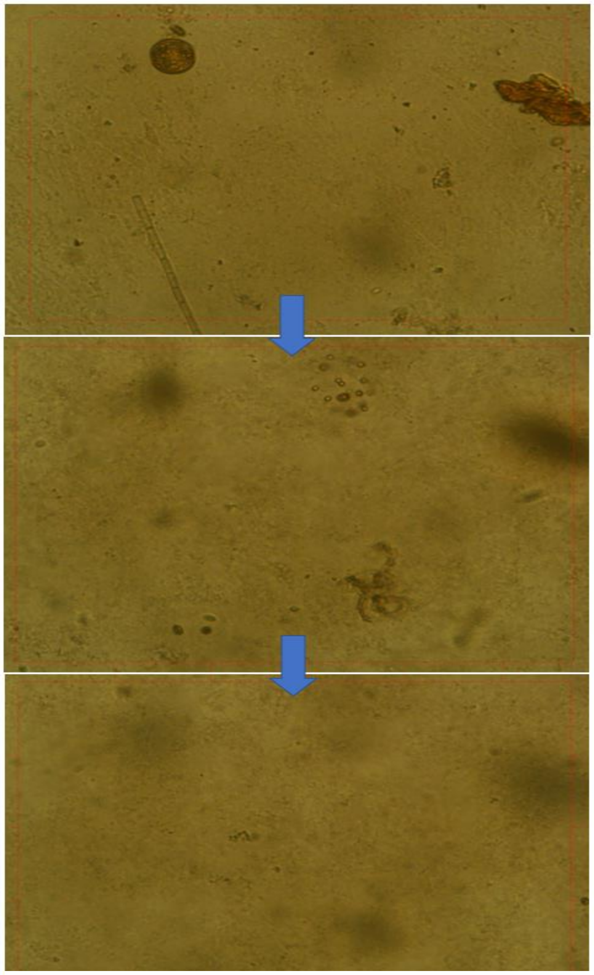

Figure 3: Visual obstruction by cloud of degraded cyanobacteria/bacteria. All photos were taken of from the same microscopic frame

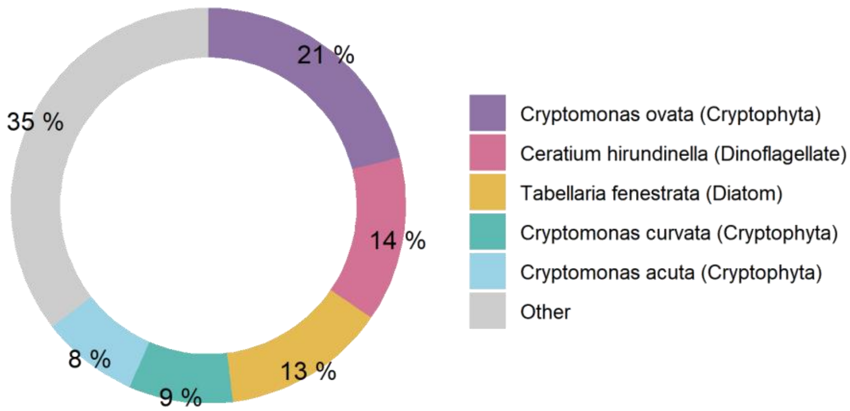

Figure 4: Dominant organisms from Naltesby Lk. Deep Stn. Near Main (E206955) as percent of total biovolume

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

Genus *Anacystis* dominated all cyanobacterial counts (Figure 5). The largest recoded bloom was 14,951 cells/mL on 2022-08-08.

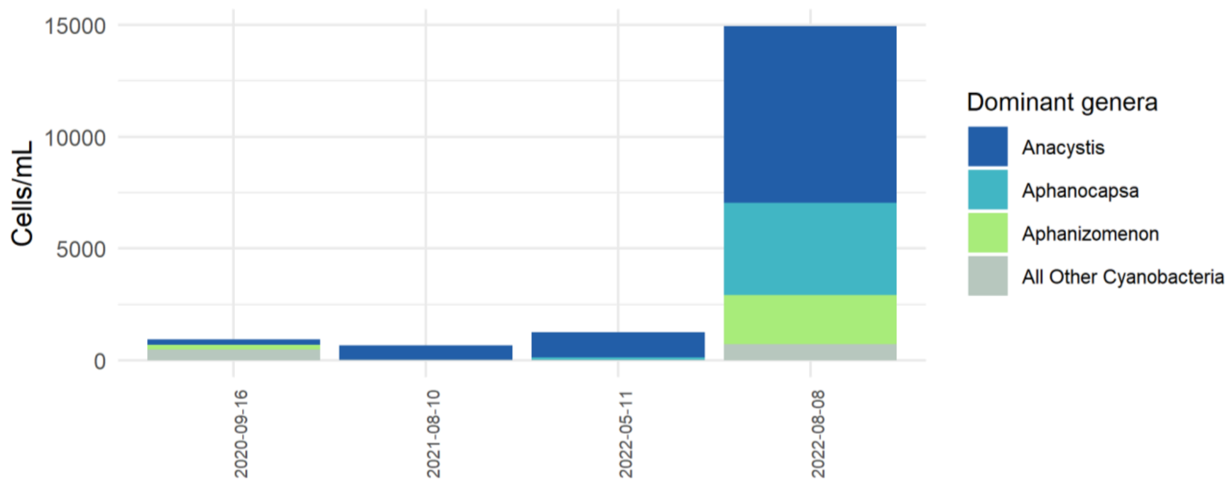

Figure 5: cell abundance for dominant cyanobacteria genera on Naltesby Lake

Anacystis dominated all samples and *Aphanizomenon* and *Aphanocapsa* were also observed. *Anacystis, Aphanizomenon*, and *Aphanocapsa* are 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 Naltesby Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	7893	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Aphanocapsa	4144	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Aphanizomenon	2197	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Naltesby Lake displayed a range of cyanobacteria levels in the negligible-low risk categories, approaching moderate risk during its peak bloom. Naltesby Lake samples had a mean cyanobacteria abundance of 4,457 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Naltesby Lake as compared to alert levels defined by authorities including the WHO and EPA.

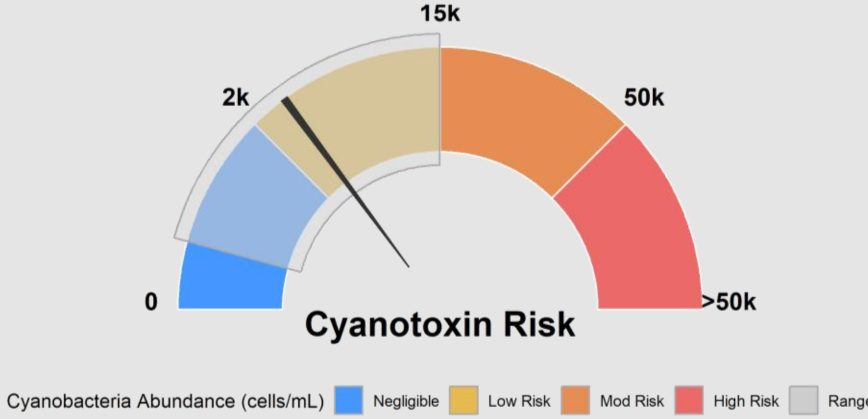

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Naltesby Lake

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 either variety of diatom dwarfs an entire colony of cyanobacteria (*Anacystis*).

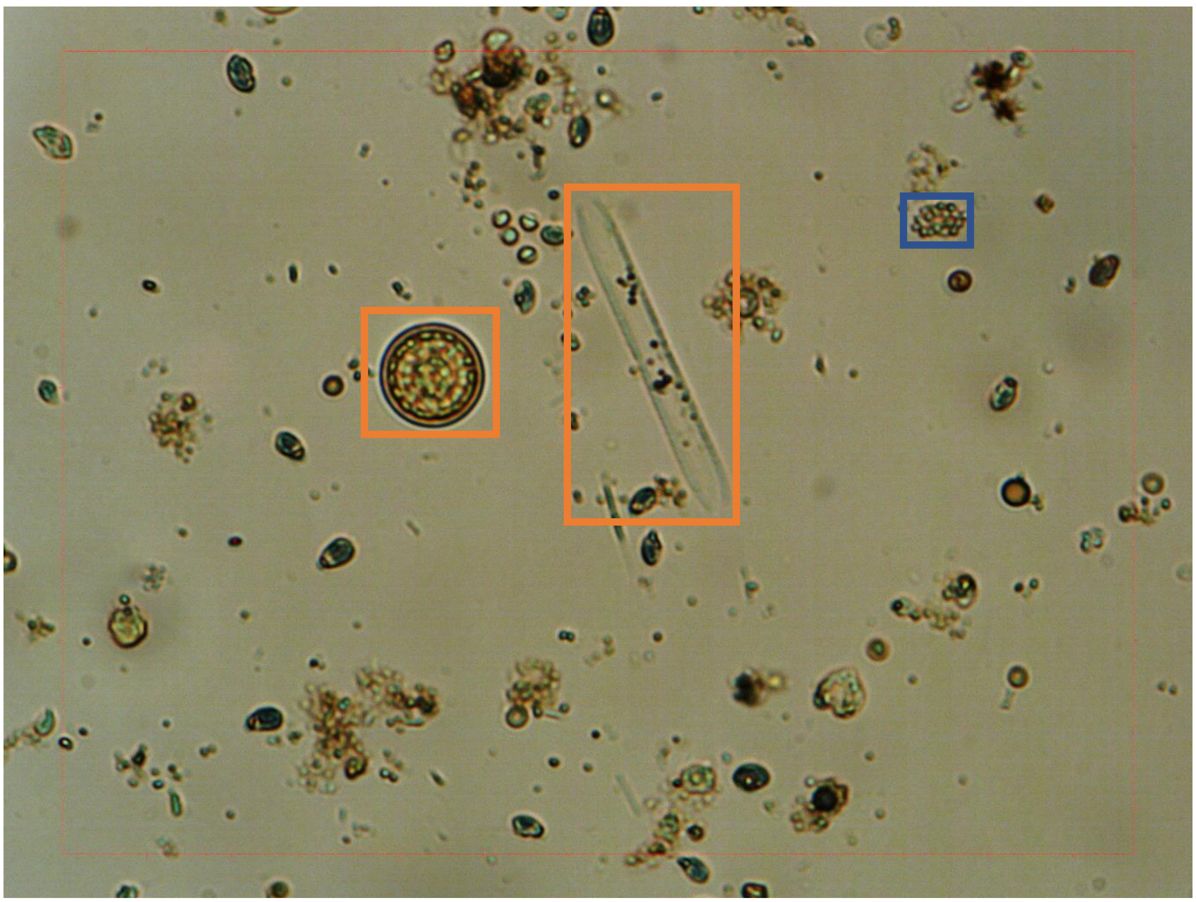

Figure 7: Size comparison of two different diatoms (orange boxes) to a colony of approximately 20 Anacyctis cells (blue box)

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.

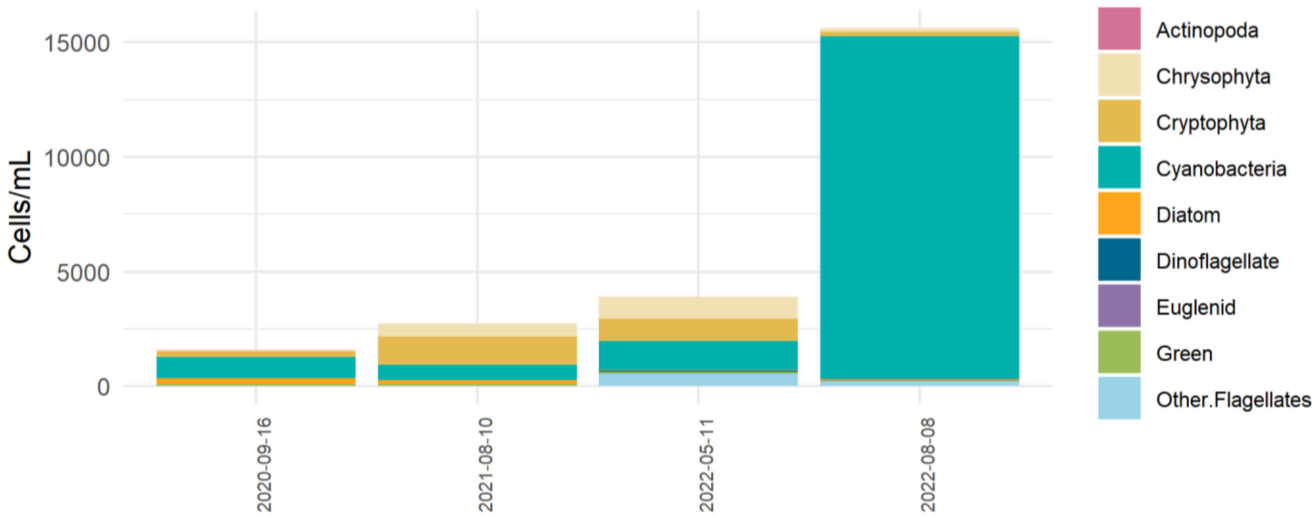

Figure 8: Cell abundance of high-level taxa groups on Naltesby Lake

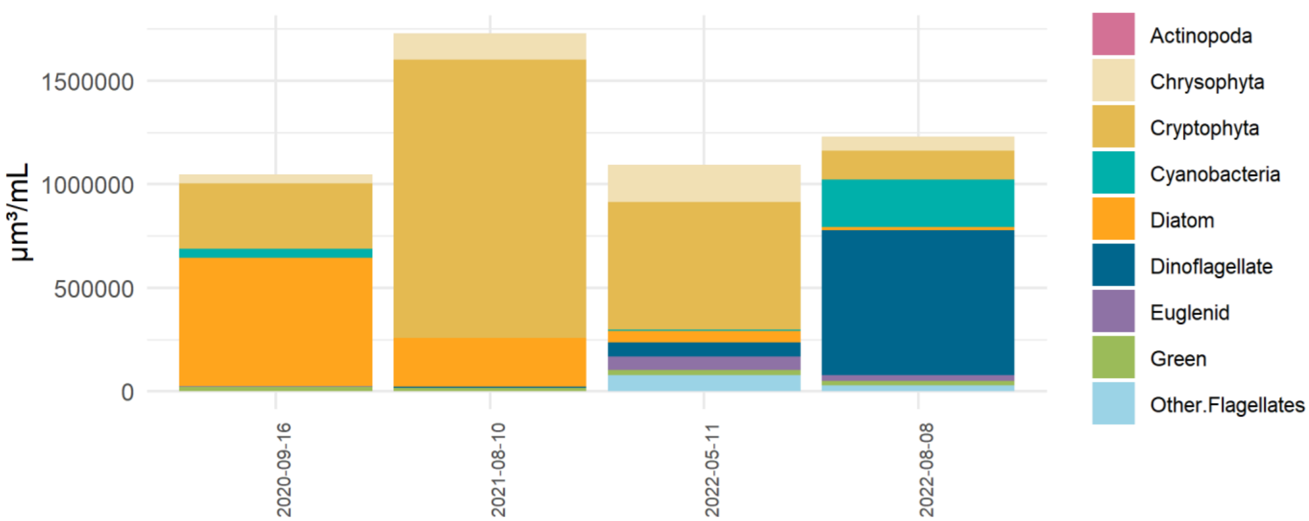

Figure 9: Biovolume of high-level taxa groups on Naltesby Lake

References

EPA. (2022, September). *Learn about Cyanobacteria and Cyanotoxins*. United States Environmental Protection Agency.

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

Wehr, J. D., Sheath, R. G., & Kociolek, P. (2015). *Freshwater Algae of North America* (Second). Elsevier Inc.

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:

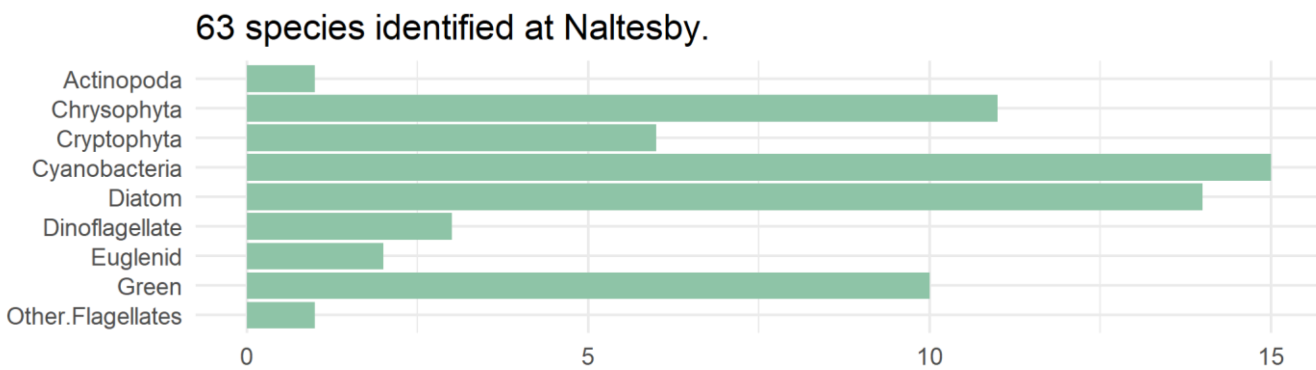

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: E206955	**Total Abundance (cells/mL):**	**2734**		
Collection Date: 2021-05-10	**Total Biovolume (µm³/mL):**	**1739430**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Kephyrion sp.	4	838	Chrysophyta	1764
Ochromonas sp.	546	116882	Chrysophyta	1455
Chrysococcus sp.	34	11289	Chrysophyta	1751
Cryptomonas acuta	186	415133	Cryptophyta	10635
Cryptomonas sp.	4	7408	Cryptophyta	10635
Cryptomonas erosa	23	40753	Cryptophyta	10635
Cryptomonas ovata	376	818131	Cryptophyta	10635
Rhodomonas lacustris	637	69164	Cryptophyta	10663
Anacystis sp.	645	1227	Cyanobacteria	609
Synechocystis sp.	27	905	Cyanobacteria	799
Asterionella formosa	8	5571	Diatom	3116
Cocconeis sp.	4	5655	Diatom	3577
Cyclotella meneghiniana	65	29480	Diatom	2439
Nitzschia sp.	11	1009	Diatom	5070
Stephanodiscus sp.	38	108785	Diatom	2415
Ulnaria ulna	4	21019	Diatom	970000
Tabellaria fenestrata	23	61819	Diatom	3241
Glenodinium sp.	4	7992	Dinoflagellate	10174
Ankistrodesmus sp.	19	2987	Green	5877
Closteriopsis longissima	4	1269	Green	5926
UID green coccoid	72	12114	Green	

Figure 11: Raw data from 2021-05-10 EMS site E206955

EMS ID: E206955	Total Abundance (cells/mL):	1591		
Collection Date: 2021-09-16	Total Biovolume (µm³/mL):	1049229		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	34	18367	Chrysophyta	10613
Dinobryon sp.	15	22530	Chrysophyta	1515
Ochromonas sp.	11	2355	Chrysophyta	1455
Cryptomonas erosa	61	108083	Cryptophyta	10635
Cryptomonas ovata	91	198005	Cryptophyta	10635
Rhodomonas lacustris	102	11075	Cryptophyta	10663
Anacystis sp.	228	434	Cyanobacteria	609
Aphanizomenon flos-aquae	231	38463	Cyanobacteria	1191
Chlorogloea sp.	190	4265	Cyanobacteria	824
Lyngbya sp.	212	167	Cyanobacteria	870
Synechocystis sp.	42	1407	Cyanobacteria	799
Snowella lacustris	38	417	Cyanobacteria	
Cocconeis sp.	4	5655	Diatom	3577
Nitzschia sp.	8	734	Diatom	5070
Tabellaria fenestrata	228	612813	Diatom	3241
Euglena sp.	4	2304	Euglenid	9620
Ankistrodesmus sp.	27	4245	Green	5877
Closteriopsis acicularis	4	4712	Green	5926
Sphaerocystis schroeteri	61	13198	Green	9169

Figure 12: Raw data from 2021-09-16 EMS site E206955

EMS ID: E206955	Total Abundance (cells/mL):	3901		
Collection Date: 2022-05-11	Total Biovolume (µm³/mL):	1106096		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	11	1851	Actinopoda	
Chrysococcus sp.	15	4980	Chrysophyta	1751
Chrysochromulina sp.	228	8769	Chrysophyta	2160
Chromulina sp.	15	26507	Chrysophyta	1717
Dinobryon spp.	15	23797	Chrysophyta	1515
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	201	43028	Chrysophyta	1455
Dinobryopsis sp.	38	10207	Chrysophyta	1557
Rhodomonas sp.	440	50146	Chrysophyta	10663
Cryptomonas sp.	42	77786	Cryptophyta	10635
Cryptomonas curvata	61	384296	Cryptophyta	10635
Cryptomonas ovata	23	50045	Cryptophyta	10635
Cryptomonas erosa	8	14175	Cryptophyta	10635
Rhodomonas lacustris	827	89794	Cryptophyta	10663
Anabaena sp.	27	2024	Cyanobacteria	1100
Anacystis sp.	1123	2137	Cyanobacteria	609
Aphanocapsa elachista var. planctonica	114	933	Cyanobacteria	625
Asterionella formosa	11	7660	Diatom	3116
Aulacoseira sp.	23	37849	Diatom	590863
Cyclotella sp.	4	1062	Diatom	2439
Tabellaria fenestrata	4	10751	Diatom	3241
Gymnodinium ordinatum	34	66296	Dinoflagellate	10031
Trachelomonas sp.	19	67152	Euglenid	9690
Ankistrodesmus sp.	19	2987	Green	5877
Monoraphidium sp.	11	7288	Green	5990
Tetrastrum sp.	15	270	Green	6260
Didymocystis fina	30	8082	Green	55858
Chlamydomonas sp.	8	4787	Green	5448
microflagellate	531	89340	Other.Flagellates	

Figure 13: Raw data from 2021-05-11 EMS site E206955

EMS ID: E206955	**Total Abundance (cells/mL):**	**15635**		
Collection Date: 2022-08-08	**Total Biovolume (µm³/mL):**	**1234766**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	8	1346	Actinopoda	
Chrysococcus sp.	4	1328	Chrysophyta	1751
Chrysochromulina sp.	34	1308	Chrysophyta	2160
Chromulina sp.	4	7069	Chrysophyta	1717
Dinobryon spp.	8	12692	Chrysophyta	1515
Mallomonas sp.	8	24194	Chrysophyta	1598
Ochromonas sp.	99	21193	Chrysophyta	1455
Cryptomonas sp.	15	27781	Cryptophyta	10635
Cryptomonas curvata	8	50400	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Cryptomonas erosa	19	33665	Cryptophyta	10635
Rhodomonas lacustris	171	18567	Cryptophyta	10663
Anabaena sp.	152	11397	Cyanobacteria	1100
Anabaena flos-aquae	182	35422	Cyanobacteria	1100
Anabaena planctonica	201	68613	Cyanobacteria	1100
Anacystis sp.	7893	15019	Cyanobacteria	609
Aphanizomenon sp.	2197	77648	Cyanobacteria	1191
Aphanocapsa sp.	4144	13092	Cyanobacteria	625
Aphanothece sp.	53	169	Cyanobacteria	636
Chroococcus turgidus	15	5082	Cyanobacteria	654
Gloeocapsa punctata	114	478	Cyanobacteria	682
Gomphonema sp.	4	5508	Diatom	4911
Lindavia intermedia	4	3536	Diatom	
Lindavia bodanica	4	4174	Diatom	
Nitzschia palea	4	841	Diatom	5070
Ulnaria acus	4	4167	Diatom	970000
Ceratium hirundinella	4	690615	Dinoflagellate	10397
Gymnodinium ordinatum	4	7800	Dinoflagellate	10031
Trachelomonas sp.	8	28274	Euglenid	9690
Gloeocystis planctonica	30	2913	Green	6355
Monoraphidium sp.	19	12588	Green	5990
Quadrigula chodati	15	4388	Green	5938
Didymocystis fina	8	2155	Green	55858
microflagellate	194	32640	Other.Flagellates	

Figure 14: Raw data from 2021-08-08 EMS site E206955