Mara Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from two sites on Mara 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 2022

Sample Site (EMS#)	Dates
MARA LAKE OPPOSITE FOSSETT (0500128)	2021-04-12
	2021-08-23
	2022-04-11
	2022-08-22
MARA SOUTH OFF KINGBAKER C (E285689)	2021-08-23
	2022-04-11
	2022-08-22
	Total= 7 samples

Figure 1: Aerial view of Mara Lake

Overall samples contained low concentrations of algae. Summer samples contained relatively elevated densities of algae, but lower densities of detritus compared to spring samples (Figure 2). Small increases in cyanobacteria, micro-flagellates, green algae, and Chrysophytes were observed in summer samples.

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).

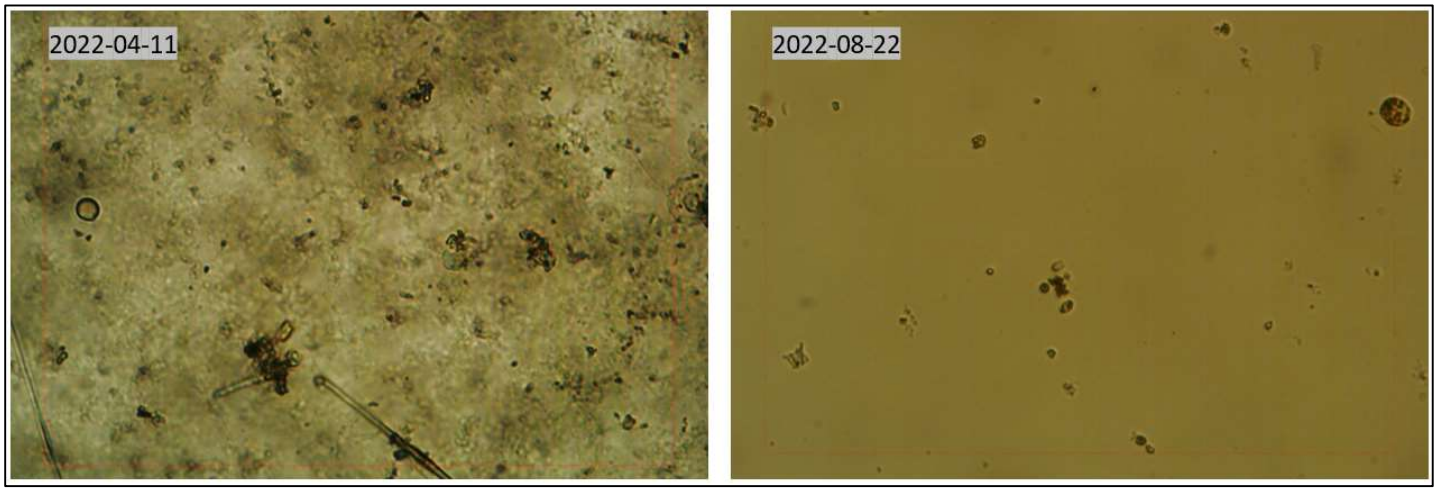

Figure 2: Spring sample containing elevated detritus (left) vs. summer sample containing low concentrations of detritus

Overview (continued)

Samples contained low concentrations of flagellates including Cryptomonads (Chrysophyta; Figure 3). Cryptomonads are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015).

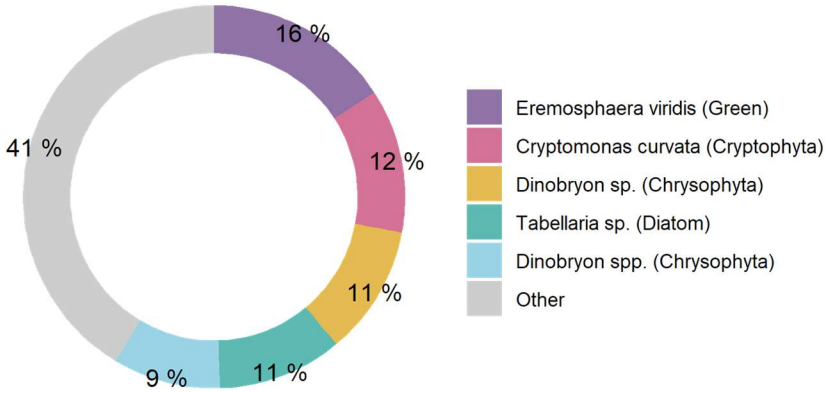

Figure 3: Dominant organisms from Mara L West Basin Deep Station (E105973) as percent of total biovolume

Cyanobacteria and micro-flagellates regularly dominate algae counts but because of their small cell size, their biovolume is usually low relative to the other types of algae (Figure 3). This is emphasized in Figure 3 where 16% of the dominant biovolume is *Eremosphaera viridis*, however only two were counted. *Eremosphaera viridis* often dominates biovolumes of samples due to its size alone (Figure 4).

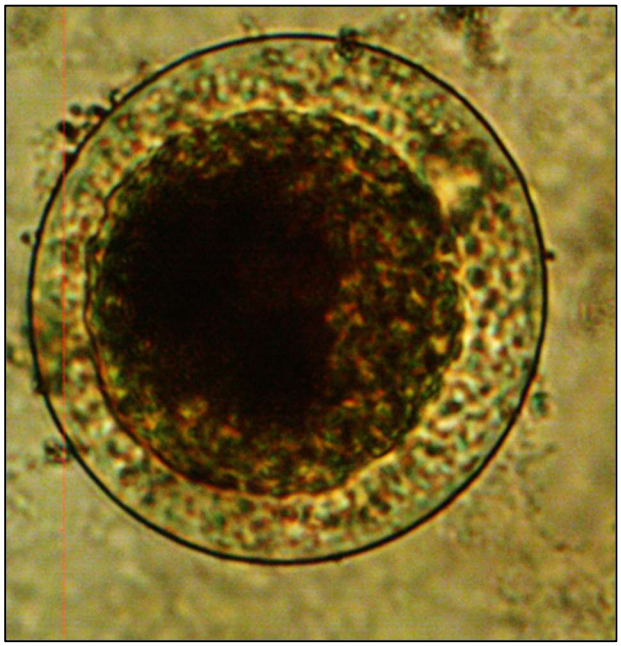

Figure 4: 400x magnificatioin of an Eremosphaera viridis

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

Samples contained low densities of cyanobacteria. Dominant genera included *Anacystis*, *Planktolyngbya*, and *Chroococcus* (Figure 5).

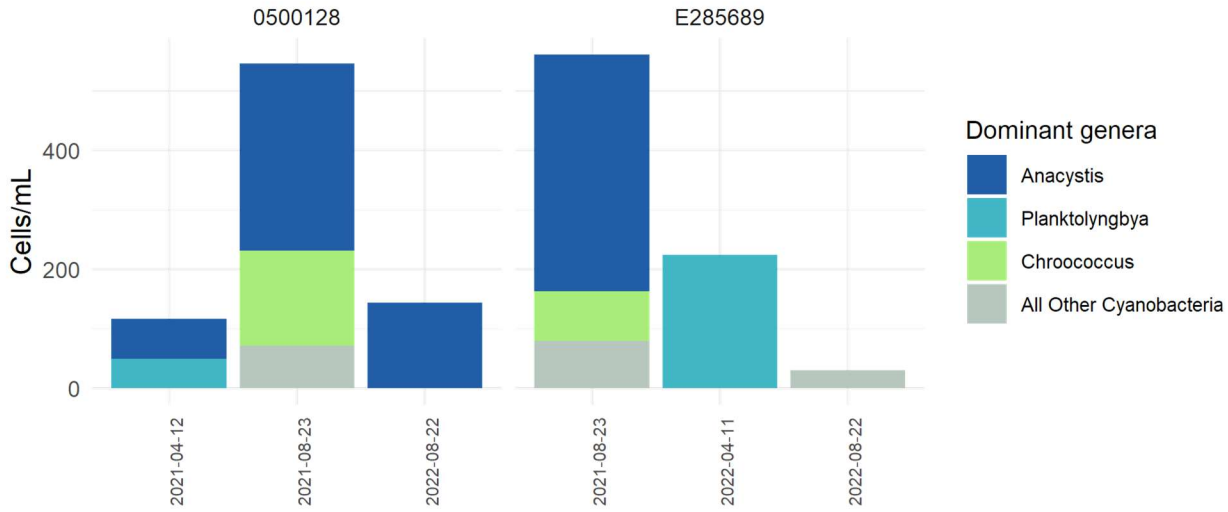

Figure 5: cell abundance for dominant cyanobacteria genera on Mara Lake

Anacystis, Planktolyngbya, and *Chroococcus* are associated with several cyanotoxins that represent risks to public health (Table 2). Illness related to cyanotoxins 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 Mara Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	398	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Planktolyngbya	224	Lyngbyatoxin LYN, Microcystin MC, BMAA
Chroococcus	159	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 Mara Lake can produce cyanotoxins (Table 2).

Mara Lake displayed a range of cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 270 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Mabel Lake compared to several authorities including the WHO and EPA.

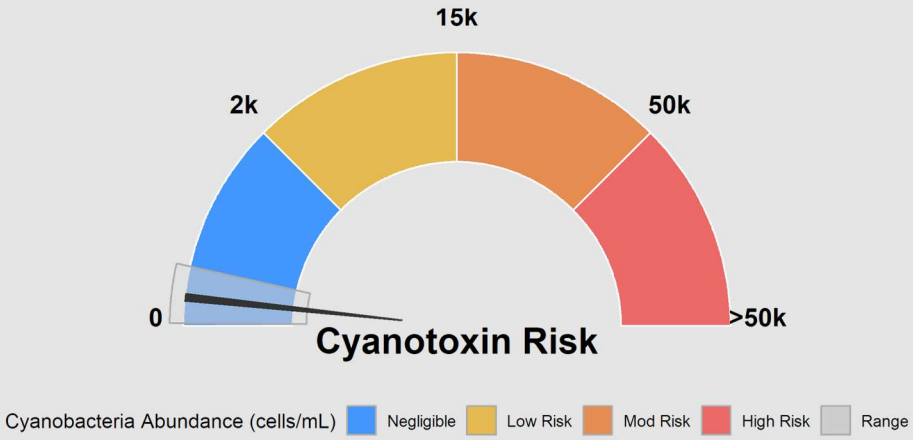

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Mara Lake

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 is highlighted in Figure 7 where a single *Dinobryon* cell is similar size to approximately 100 cyanobacteria cells on the adjacent filaments.

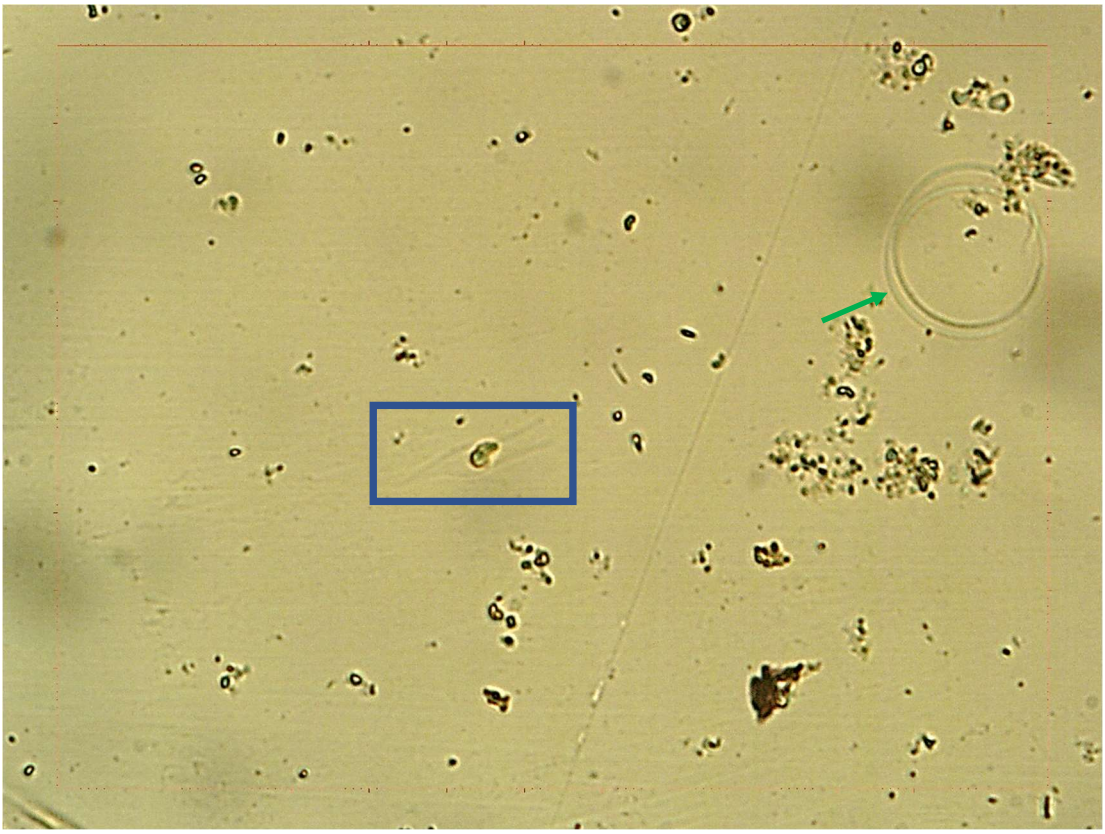

Figure 7: Size comparison of a single Dinobryon (blue box) to Planktolyngbya filament (green arrow)

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.

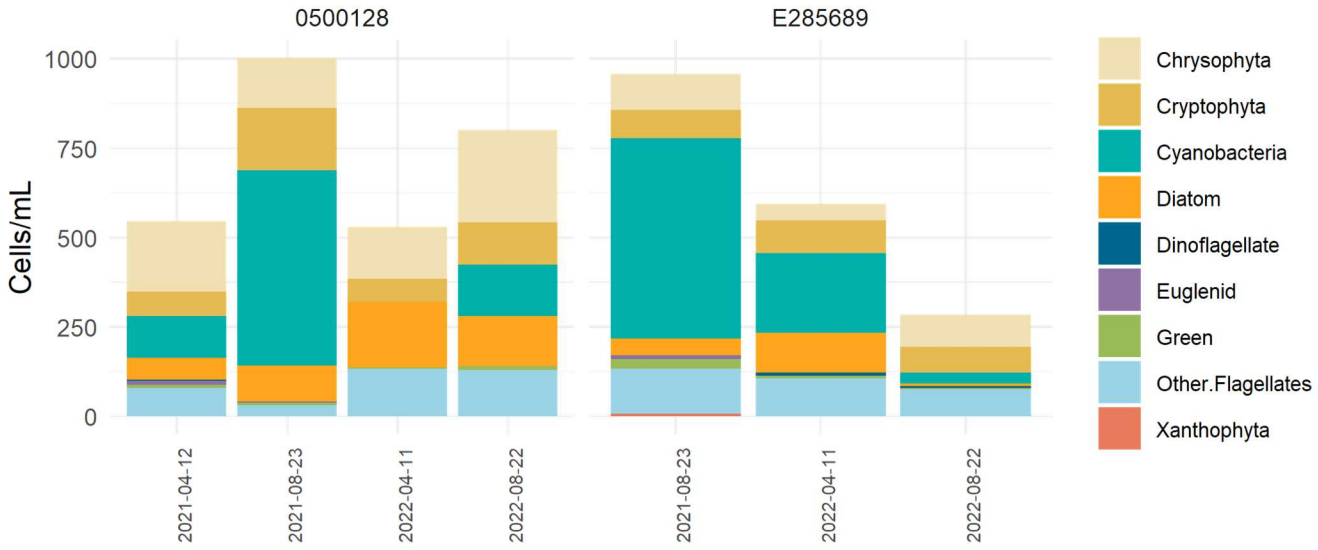

Figure 8: Cell abundance of high-level taxa groups on Mara Lake

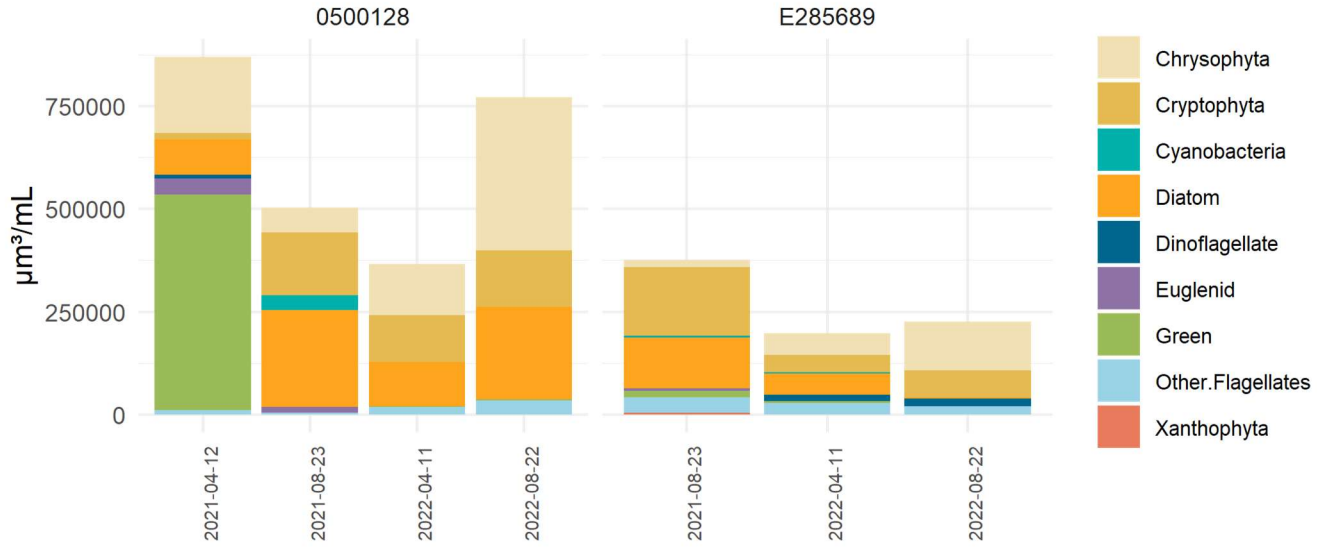

Figure 9: Biovolume of high-level taxa groups on Mara Lake

References

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

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

Water Science School, Swanson, H. A., & Baldwin, H. L. (2018, June 18). *Turbidity and Water* . USGS.

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

Report prepared by: Larratt Aquatic Consulting Ltd.

Stephanie Butt: Taxonomist, H. B.Sc., BIT.

Jamie Self: Senior Aquatic Biologist, R.P. Bio

Reviewed by:

Sara Knezevic: Field Biologist, B.Sc., BIT.

Appendix

Additional figures and raw data are listed below:

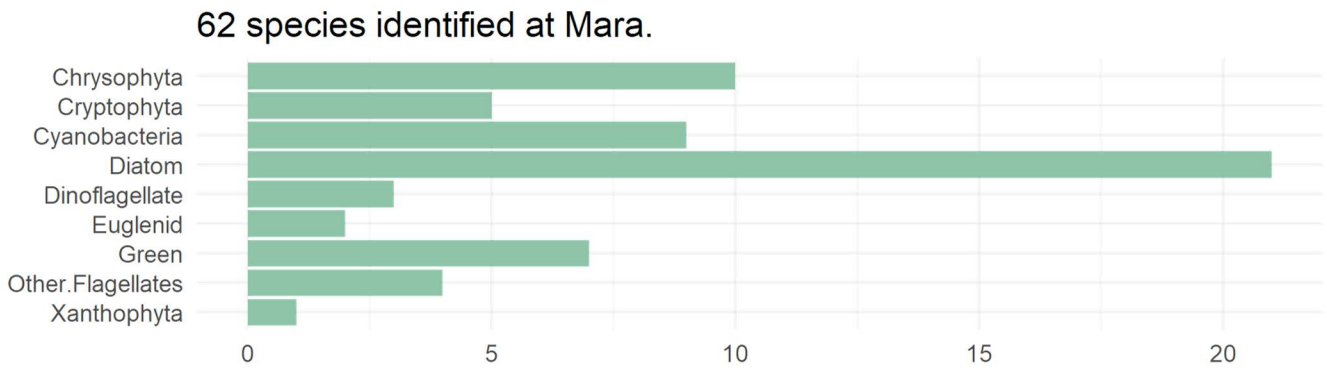

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 0500128	**Total Abundance (cells/mL):**	**547**		
Collection Date: 2021-04-12	**Total Biovolume (µm³/mL):**	**872502**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	102	153204	Chrysophyta	1515
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	65	13914	Chrysophyta	1455
Chroomonas sp.	19	4320	Chrysophyta	10613
Chrysococcus sp.	8	2656	Chrysophyta	1751
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Rhodomonas lacustris	65	7058	Cryptophyta	10663
Anacystis sp.	68	129	Cyanobacteria	609
Planktolyngbya sp.	49	609	Cyanobacteria	
Achnanthidium minutissimum	11	2086	Diatom	590864
Asterionella formosa	4	2785	Diatom	3116
Cyclotella sp.	11	2920	Diatom	2439
Cymbella sp.	11	18627	Diatom	4795
Frustulia rhomboides	8	33979	Diatom	4564
Gomphonema sp.	11	15148	Diatom	4911
Tabellaria sp.	4	10751	Diatom	3241
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Trachelomonas sp.	11	38877	Euglenid	9690
Eremosphaera viridis	8	523599	Green	5984
microflagellate	76	12787	Other.Flagellates	

Figure 11: Raw data from 2021-04-12 EMS site 0500128

EMS ID: 500128	Total Abundance (cells/mL):	1003		
Collection Date: 2021-08-23	Total Biovolume (µm³/mL):	503998		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	19	28538	Chrysophyta	1515
Dinobryon bavaricum	4	8706	Chrysophyta	1515
Ochromonas sp.	91	19480	Chrysophyta	1455
Chrysochromulina sp.	19	731	Chrysophyta	2160
Chrysococcus sp.	8	2656	Chrysophyta	1751
Cryptomonas sp.	38	70378	Cryptophyta	10635
Cryptomonas curvata	11	69299	Cryptophyta	10635
Rhodomonas lacustris	125	13572	Cryptophyta	10663
Anacystis sp.	315	599	Cyanobacteria	609
Chroococcus turgida	159	21405	Cyanobacteria	654
Anabaena flos-aquae	68	13234	Cyanobacteria	1100
Dactylococcopsis sp.	4	272	Cyanobacteria	6446
Achnanthidium minutissimum	4	759	Diatom	590864
Cocconeis placentula	4	6517	Diatom	3577
Lindavia bodanica	8	8348	Diatom	
Ulnaria acus	4	4167	Diatom	970000
Tabellaria sp.	80	215022	Diatom	3241
Trachelomonas sp.	4	14137	Euglenid	9690
Ankistrodesmus falcatus	8	1131	Green	5877
microflagellate	30	5047	Other.Flagellates	

Figure 12: Raw data from 2021-08-23 EMS site 0500128

EMS ID: E285689	Total Abundance (cells/mL):	957		
Collection Date: 2021-08-23	Total Biovolume (µm³/mL):	380404		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	72	15413	Chrysophyta	1455
Chrysochromulina sp.	27	1038	Chrysophyta	2160
Dinobryopsis sp.	19	5104	Chrysophyta	1557
Cryptomonas curvata	23	144899	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Rhodomonas lacustris	49	5320	Cryptophyta	10663
Chroococcus dispersus	83	1173	Cyanobacteria	654
Anacystis sp.	398	757	Cyanobacteria	609
Chlorogloea sp.	27	606	Cyanobacteria	824
Anabaena aequalis	53	1776	Cyanobacteria	1100
Tabellaria sp.	46	123638	Diatom	3241
Euglena sp.	11	6336	Euglenid	9620
Elakatothrix gelatinosa	4	706	Green	9412
Oocystis borgei	15	9503	Green	5827
Monoraphidium sp.	8	5300	Green	5990
UID flagellate	106	36873	Other.Flagellates	
Tribonema sp.	8	4555	Xanthophyta	2053

Figure 13: Raw data from 2021-08-23 EMS site E285689

EMS ID: 0500128	Total Abundance (cells/mL):	531		
Collection Date: 2022-04-11	Total Biovolume (µm³/mL):	369851		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chromulina sp.	30	53014	Chrysophyta	1717
Chrysochromulina sp.	30	1154	Chrysophyta	2160
Chrysococcus sp.	8	2656	Chrysophyta	1751
Dinobryon sp.	19	28538	Chrysophyta	1515
Dinobryon sp.	11	16522	Chrysophyta	1515
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	30	6422	Chrysophyta	1455
Dinobryopsis sp.	15	4029	Chrysophyta	1557
Cryptomonas sp.	15	27781	Cryptophyta	10635
Cryptomonas erosa	8	14175	Cryptophyta	10635
Cryptomonas curvata	11	69299	Cryptophyta	10635
Rhodomonas lacustris	30	3257	Cryptophyta	10663
Achnanthales	19	3197	Diatom	
Asterionella formosa	8	5571	Diatom	3116
Aulacoseira sp.	19	31267	Diatom	590863
Diatoma sp.	4	4862	Diatom	3214
Fragilaria crotonensis	129	62637	Diatom	2932
Nitzschia sp.	4	367	Diatom	5070
Ankistrodesmus sp.	4	629	Green	5877
microflagellate	133	22377	Other.Flagellates	

Figure 14: Raw data from 2022-04-11 EMS site 0500128

EMS ID: 0500128	Total Abundance (cells/mL):	802		
Collection Date: 2022-08-22	Total Biovolume (µm³/mL):	771262		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chromulina sp.	23	40644	Chrysophyta	1717
Dinobryon sp.	91	136682	Chrysophyta	1515
Dinobryon spp.	118	187204	Chrysophyta	1515
Dinobryopsis sp.	27	7252	Chrysophyta	1557
Cryptomonas sp.	23	42597	Cryptophyta	10635
Cryptomonas curvata	11	69299	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Rhodomonas lacustris	76	8252	Cryptophyta	10663
Anacystis sp.	144	274	Cyanobacteria	609
Achnanthales	4	673	Diatom	
Amphora.sp	4	5833	Diatom	4705
Aulacoseira sp.	129	212283	Diatom	590863
Cocconeis sp.	4	5655	Diatom	3577
Crucigenia fenestrata	11	2523	Green	6225
microflagellates	129	34684	Other.Flagellates	

Figure 15: Raw data from 2022-08-22 EMS site 0500128

EMS ID: E285689	Total Abundance (cells/mL):	594		
Collection Date: 2022-04-11	Total Biovolume (µm³/mL):	198015		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	8	308	Chrysophyta	2160
Chromulina sp.	19	33576	Chrysophyta	1717
Dinobryon spp.	11	17451	Chrysophyta	1515
Dinobryopsis sp.	8	2149	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Cryptomonas curvata	4	25200	Cryptophyta	10635
Rhodomonas lacustris	83	9012	Cryptophyta	10663
Planktolyngbya sp.	224	2784	Cyanobacteria	
Achnanthidium sp.	42	7966	Diatom	590864
Fragilaria crotonensis	38	18451	Diatom	2932
Fragilaria sp.	8	3884	Diatom	2932
Gomphonema sp.	4	5508	Diatom	4911
Navicula sp.	4	2827	Diatom	3649
Nitzschia spp.	4	1579	Diatom	5070
Ulnaria acus	11	11460	Diatom	970000
Peridinium inconspicuum	8	14652	Dinoflagellate	10212
Monoraphidium sp.	8	5300	Green	5990
microflagellates	106	28500	Other.Flagellates	

Figure 16: Raw data from 2022-04-11 EMS site E285689

EMS ID: E285689	Total Abundance (cells/mL):	285		
Collection Date: 2022-08-22	Total Biovolume (µm³/mL):	226364		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	11	423	Chrysophyta	2160
Chromulina sp.	11	19439	Chrysophyta	1717
Dinobryon spp.	61	96775	Chrysophyta	1515
Dinobryopsis sp.	8	2149	Chrysophyta	1557
Cryptomonas sp.	19	35189	Cryptophyta	10635
Cryptomonas curvata	4	25200	Cryptophyta	10635
Rhodomonas lacustris	49	5320	Cryptophyta	10663
Gloeocapsa punctata	30	126	Cyanobacteria	682
Achnanthidium sp.	4	759	Diatom	590864
Fragilaria sp.	4	1942	Diatom	2932
Peridinium sp.	4	18043	Dinoflagellate	10212
Ankistrodesmus falcatus	4	565	Green	5877
microflagellates	76	20434	Other.Flagellates	

Figure 17: Raw data from 2022-08-22 EMS site E285689