Christina Lake Phytoplankton Summary Report 2021-2022

Overview

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

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

Sample Site (EMS#)	Dates
CHRISTINA LAKE NORTH BASIN DEEP CENTRE (E215758)	2021-03-25 2021-09-15 2022-04-05 2022-09-14
CHRISTINA L @ CHRISTINA (0200078)	2021-09-15 2022-04-05 2022-09-14
	Total= 7 samples

Figure 1: Aerial view of Christina Lake

Samples collected from Christina Lake contained few dinoflagellates, green algae, and diatoms; diatom numbers increased slightly in the spring. Elevated diatom concentrations in late winter and early spring are common and reflective of increased temperatures, light penetration, and silica in the water following ice thaw (Kong et al., 2021).

Spring samples also contained elevated levels of detritus possibly due to spring run off (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).

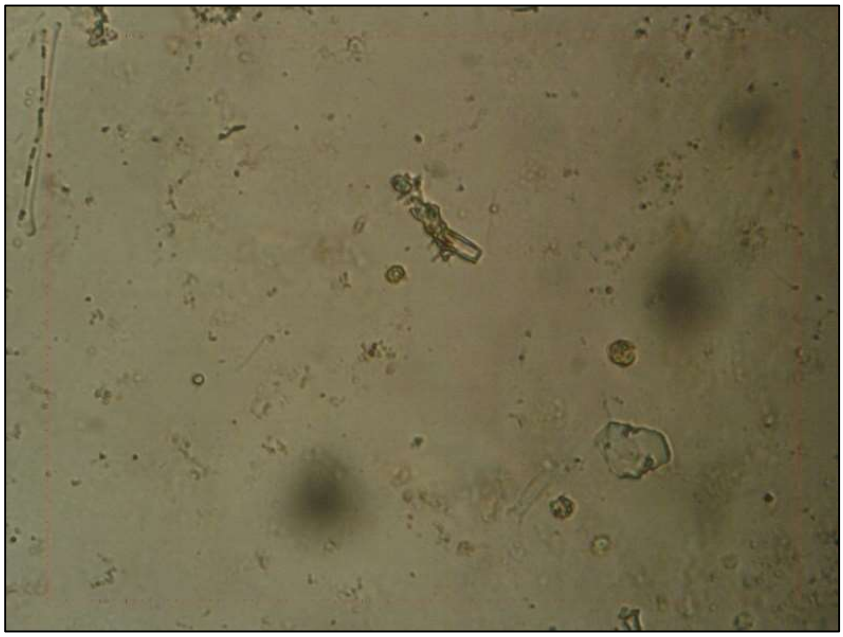

Figure 2: EMS Site# E215758 collected on 2022-04-05 containing high levels of film, detritus, and particles

Overview (continued)

Cryptomonad genera *Chromulina and Mallomonas* dominated summer samples (Figure 3).

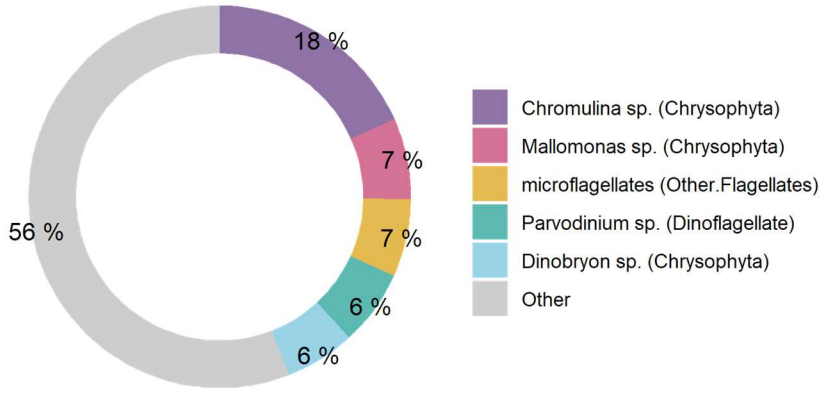

Figure 3: Dominant organisms from Christina Lake (all sites / dates) as percent of total biovolume

All sites contained moderate-low densities of Chrysophyta, specifically genera *Rhodomonas lacustris, Chromulina*, and *Mallomonas*. Cryptomonads are favored components of freshwater food webs and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015). Chrysophyta taxa are advantageous and disadvantageous in freshwater systems, depending on their context. Some Chrysophyta are known to produce odor chemicals described as fishy, while others eat bacteria and reduce negative odor compounds.

Sixty-five species were identified at Christina Lake and diatoms had the largest number of species identified (Figure 4).

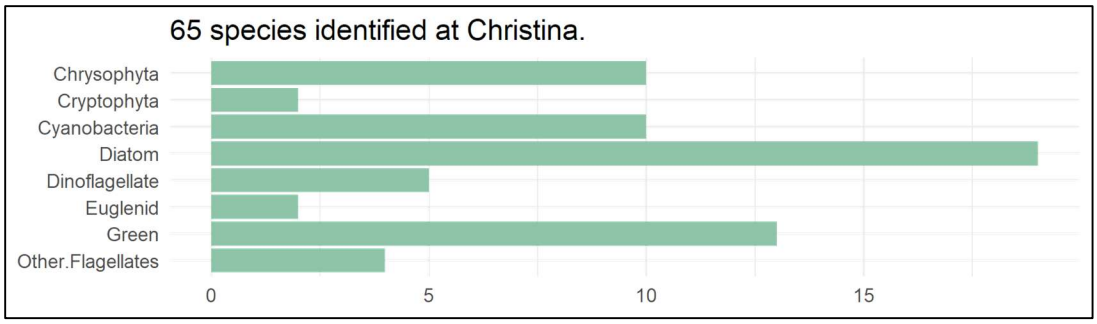

Figure 4: Species identified at Christina Lake sorted into nine groups of higher level taxa

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 levels of cyanobacteria; *Planktolyngbya*, *Anacystis,* and *Schizothrix* were the dominant genera in samples (Figure 5).

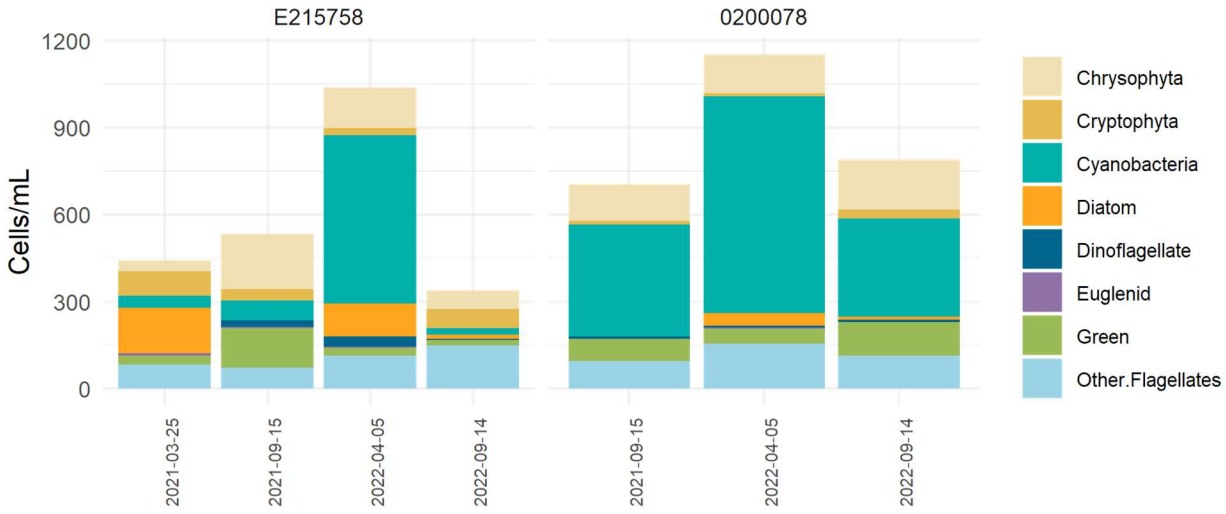

Figure 5: cell abundance for dominant cyanobacteria genera on Christina Lake

Planktolyngbya, *Anacystis,* and *Schizothrix* are associated with 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 Christina Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Planktolyngbya	376	Lyngbyatoxin LYN, Microcystin MC, BMAA
Anacystis	304	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Schizothrix	99	Lyngbyatoxin LYN, Aplysiatoxins APL, Lipopolysaccharide LPS, Microcystin MC, BMAA, Anabaenopeptins APT

Note: * = counted in samples

Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria found in Christina Lake are capable of producing cyanotoxins (Table 2).

Christina Lake displayed cyanobacteria levels in the negligible risk category, with mean cyanobacteria abundance of 312 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Christina Lake compared to alert levels defined by several authorities including the WHO and EPA.

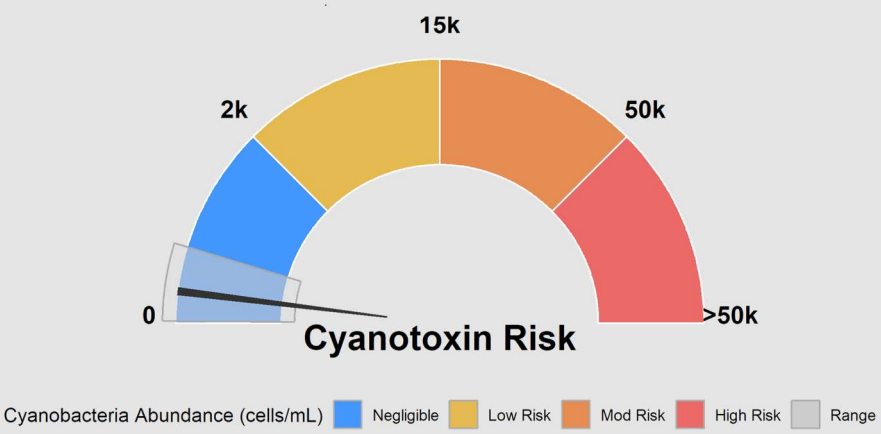

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Christina Lake

Micro-flagellates and cyanobacteria regularly dominate algae counts but because of their small cell size their biovolume is usually low relative to the other types of algae present. This can be seen in Figure 7 where a single Dinoflagellate cell is a similar size to approximately 50 micro-flagellate cells.

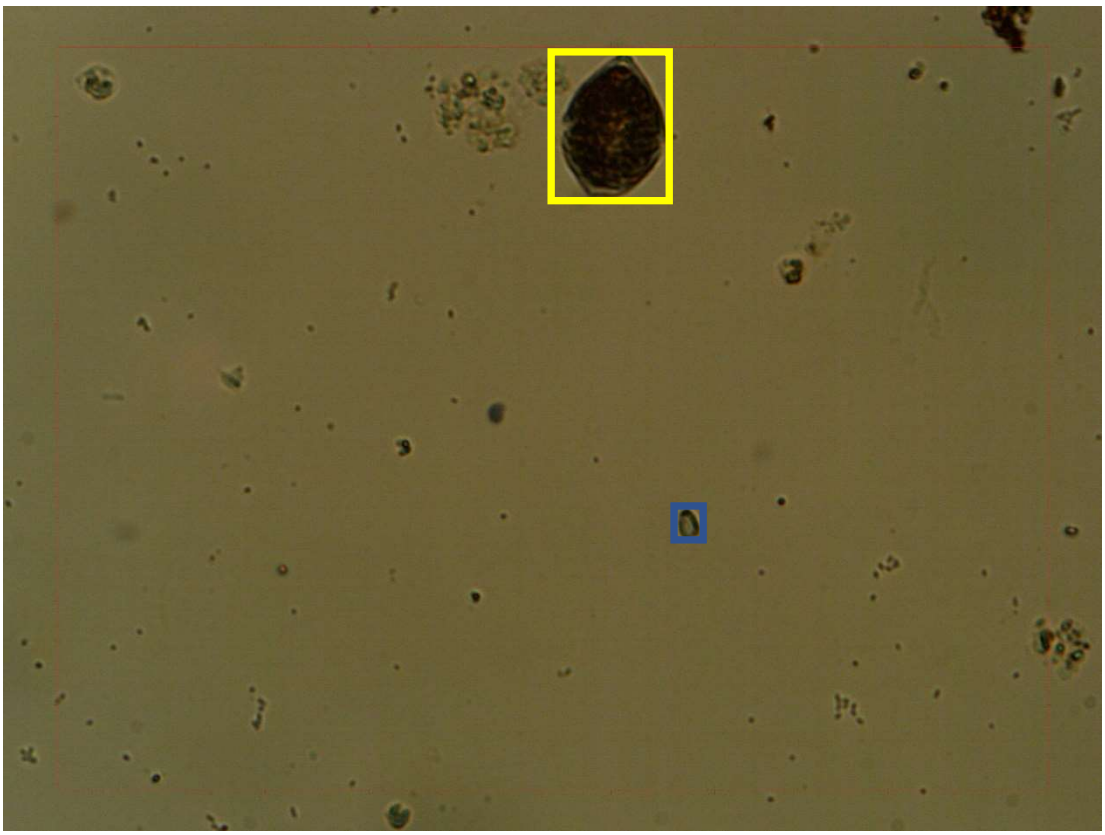

Figure 7: Size comparison of a dinoflagellate (yellow box) to a micro-flagellate (blue box)

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. The difference between Figure 8 (cell abundance) and Figure 9 (biovolume) illuminates the difference between cell abundance and biovolume.

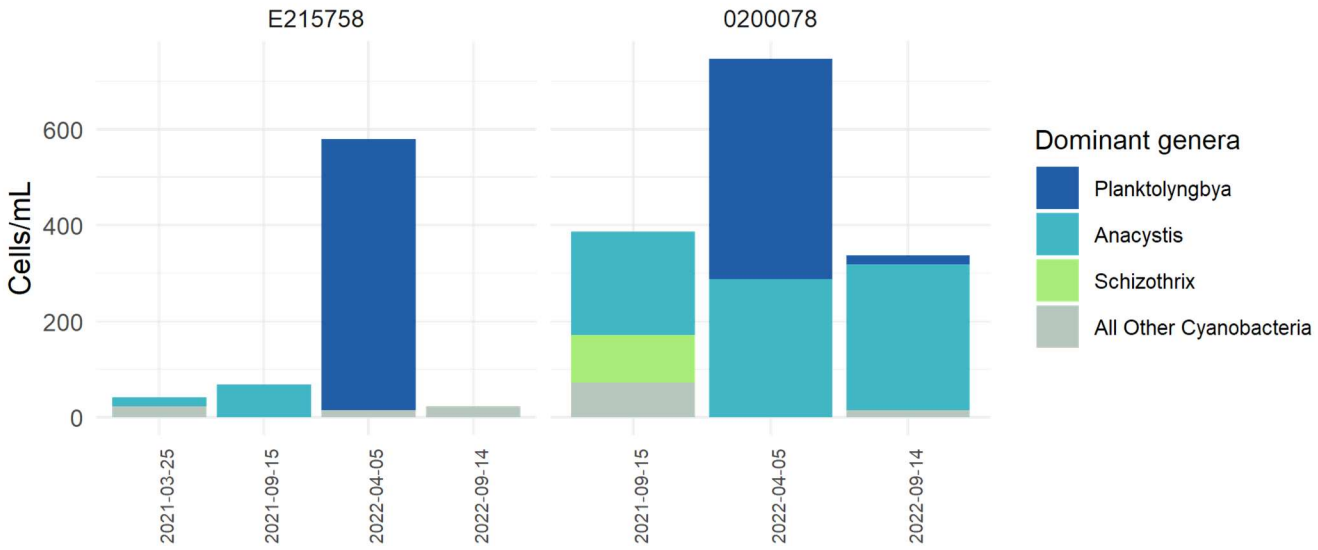

Figure 8: Cell abundance of high-level taxa groups on Christina Lake

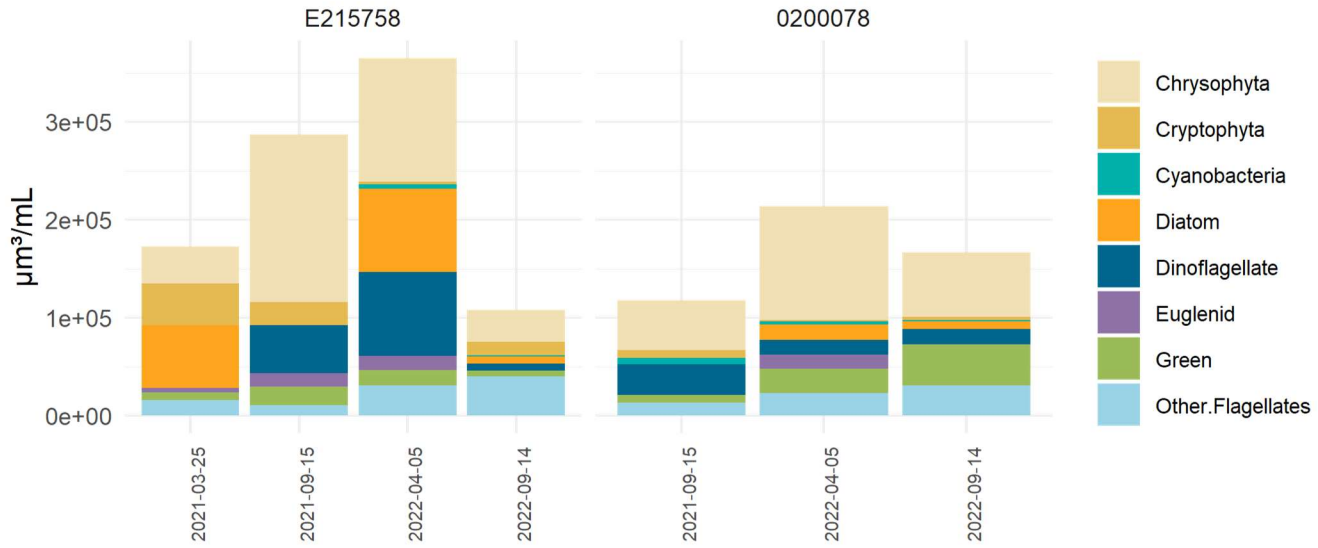

Figure 9: Biovolume of high-level taxa groups on Christina Lake

References

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Appendix

Additional figures and raw data are listed below:

EMS ID: E215758	Total Abundance (cells/mL):	442		
Collection Date: 2021-03-25	Total Biovolume (µm³/mL):	178024		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	15	3211	Chrysophyta	1455
Chromulina sp.	19	33576	Chrysophyta	1717
Chrysococcus sp.	4	1328	Chrysophyta	1751
Dinobryopsis sp.	19	5104	Chrysophyta	1557
Cryptomonas sp.	19	35189	Cryptophyta	10635
Rhodomonas lacustris	65	7058	Cryptophyta	10663
Anacystis sp.	19	36	Cyanobacteria	609
Gloeocapsa punctata	19	80	Cyanobacteria	682
Spirulina major	4	25	Cyanobacteria	1053
Aulacoseira granulata	137	45063	Diatom	590863
Asterionella formosa	11	7660	Diatom	3116
Eunotia sp.	4	595	Diatom	3337
Tabellaria sp.	4	10751	Diatom	3241
Euglena sp.	8	4608	Euglenid	9620
Ankistrodesmus sp.	4	629	Green	5877
Monoraphidium sp.	8	5300	Green	5990
Stichogloea doederleinii	19	1655	Green	1879
microflagellate	34	5720	Other.Flagellates	
UID flagellate	30	10436	Other.Flagellates	

Figure 10: Raw data from 2021-03-25 EMS site E215758

EMS ID: E215758	Total Abundance (cells/mL):	533		
Collection Date: 2021-09-15	Total Biovolume (µm³/mL):	288211		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	30	45060	Chrysophyta	1515
Epipyxis sp.	34	3560	Chrysophyta	1574
Dinobryon sp.	27	40554	Chrysophyta	1515
Bitrichia sp.	8	917	Chrysophyta	
Ochromonas sp.	27	5780	Chrysophyta	1455
Chrysochromulina sp.	23	885	Chrysophyta	2160
Chromulina sp.	42	74220	Chrysophyta	1717
Cryptomonas sp.	11	20372	Cryptophyta	10635
Rhodomonas lacustris	27	2932	Cryptophyta	10663
Anacystis sp.	68	129	Cyanobacteria	609
Gymnodinium sp.	23	48725	Dinoflagellate	10031
Trachelomonas sp.	4	14137	Euglenid	9690
Ankistrodesmus sp.	27	4245	Green	5877
Crucigenia fenestrata	15	3441	Green	6225
Monoraphidium sp.	4	2650	Green	5990
Desmodesmus sp.	11	1521	Green	
Stichogloea doederleinii	80	6969	Green	1879
microflagellate	72	12114	Other.Flagellates	

Figure 11: Raw data from 2021-09-15 EMS site E215758

EMS ID: 200078	Total Abundance (cells/mL):	704		
Collection Date: 2021-09-15	Total Biovolume (µm³/mL):	120791		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	4	6008	Chrysophyta	1515
Epipyxis sp.	46	4817	Chrysophyta	1574
Bitrichia sp.	4	459	Chrysophyta	
Ochromonas sp.	23	4924	Chrysophyta	1455
Chrysochromulina sp.	30	1154	Chrysophyta	2160
Chromulina sp.	19	33576	Chrysophyta	1717
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Rhodomonas lacustris	8	869	Cryptophyta	10663
Anacystis sp.	216	411	Cyanobacteria	609
Anabaena sp.	57	4274	Cyanobacteria	1100
Schizothrix calcicola	99	1400	Cyanobacteria	
Spirulina major	15	94	Cyanobacteria	1053
Gymnodinium uliginosa	8	31621	Dinoflagellate	10031
Ankistrodesmus sp.	11	1729	Green	5877
Stichogloea doederleinii	65	5662	Green	1879
microflagellate	91	15311	Other.Flagellates	

Figure 12: Raw data from 2021-09-15 EMS site 0200078

EMS ID: E215758	Total Abundance (cells/mL):	1221		
Collection Date: 2022-04-05	Total Biovolume (µm³/mL):	424188		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	49	1885	Chrysophyta	2160
Chromulina sp.	34	60083	Chrysophyta	1717
Chrysococcus sp.	27	8965	Chrysophyta	1751
Dinobryon spp.	19	30143	Chrysophyta	1515
Epipyxis sp.	46	5973	Chrysophyta	1574
Mallomonas sp.	8	24194	Chrysophyta	1598
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Rhodomonas lacustris	23	2497	Cryptophyta	10663
Planktolyngbya contorta	212	1971	Cyanobacteria	
Planktolyngbya limnetica	353	1806	Cyanobacteria	
Synechocystis sp.	15	503	Cyanobacteria	799
Achnanthidium minutissimum	4	759	Diatom	590864
Achnanthidium rivulare	11	2086	Diatom	590864
Achnanthidium sp.	11	2086	Diatom	590864
Amphora ovalis	4	5833	Diatom	4705
Cocconeis sp.	4	5655	Diatom	3577
Cymbella cistula	4	6773	Diatom	4795
Epithemia adnata	4	13195	Diatom	5005
Fragilaria sp.	42	20393	Diatom	2932
Gomphonema sp.	4	5508	Diatom	4911
Navicula lancelota	11	8482	Diatom	3649
Navicula cryptocephala	4	3084	Diatom	3649
Staurosirella pinnata	46	3179	Diatom	590855
Ulnaria acus	11	11460	Diatom	970000
Glenodinium cinctum	27	53947	Dinoflagellate	10174
Gymnodinium helveticum	8	31621	Dinoflagellate	10031
Parvodinium sp.	91	50173	Dinoflagellate	
Trachelomonas sp.	4	14137	Euglenid	9690
Monoraphidium sp.	8	5300	Green	5990
Monoraphidium contortum	19	10772	Green	5990
microflagellates	114	30651	Other.Flagellates	

Figure 13: Raw data from 2022-04-05 EMS site E215758

EMS ID: E215758	Total Abundance (cells/mL):	338		
Collection Date: 2022-09-1	Total Biovolume (µm³/mL):	107876		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	34	1308	Chrysophyta	2160
Chromulina sp.	15	26507	Chrysophyta	1717
Chrysococcus sp.	11	3652	Chrysophyta	1751
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Rhodomonas lacustris	61	6623	Cryptophyta	10663
Anabaena sp.	8	600	Cyanobacteria	1100
Gloeocapsa aeruginosa	15	212	Cyanobacteria	682
Fragilaria sp.	15	7283	Diatom	2932
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Crucigenia fenestrata	15	3441	Green	6225
Monoraphidium sp.	4	2650	Green	5990
microflagellates	148	39792	Other.Flagellates	

Figure 14: Raw data from 2022-09-14 EMS site E215758

EMS ID: 200078	Total Abundance (cells/mL):	1273		
Collection Date: 2022-04-05	Total Biovolume (µm³/mL):	284012		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysococcus sp.	27	8965	Chrysophyta	1751
Chrysochromulina sp.	53	2039	Chrysophyta	2160
Chromulina sp.	8	14137	Chrysophyta	1717
Dinobryon spp.	4	6346	Chrysophyta	1515
Ochromonas sp.	15	3211	Chrysophyta	1455
Mallomonas sp.	27	81656	Chrysophyta	1598
Rhodomonas lacustris	11	1194	Cryptophyta	10663
Anacystis sp.	288	548	Cyanobacteria	609
Planktolyngbya limnetica	376	1924	Cyanobacteria	
Planktolyngbya contorta	83	772	Cyanobacteria	
Achnanthidium rivulare	4	759	Diatom	590864
Aulacoseira granulata	15	4934	Diatom	590863
Asterionella formosa	11	7660	Diatom	3116
Cyclotella sp.	8	2124	Diatom	2439
Nitzschia sp.	4	367	Diatom	5070
Glenodinium cinctum	4	7992	Dinoflagellate	10174
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Parvodinium sp.	121	66713	Dinoflagellate	
Trachelomonas sp.	4	14137	Euglenid	9690
Ankistrodesmus falcatus	4	565	Green	5877
Ankistrodesmus sp.	11	1729	Green	5877
Chodatella ciliata	8	3217	Green	5866
Mougeotia sp.	19	14663	Green	7055
Chlamydomonas sp.	8	4787	Green	5448
microflagellate	156	26247	Other.Flagellates	

Figure 15: Raw data from 2022-04-05 EMS site 0200078

EMS ID: 200078	Total Abundance (cells/mL):	879		
Collection Date: 2022-09-14	Total Biovolume (µm³/mL):	181828		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	72	2769	Chrysophyta	2160
Chromulina sp.	23	40644	Chrysophyta	1717
Chrysococcus sp.	30	9961	Chrysophyta	1751
Dinobryopsis sp.	46	12356	Chrysophyta	1557
Rhodomonas lacustris	30	3257	Cryptophyta	10663
Anacystis sp.	304	578	Cyanobacteria	609
Gloeothece sp.	15	982	Cyanobacteria	703
Planktolyngbya limnetica	19	97	Cyanobacteria	
Achnanthidium minutissimum	4	759	Diatom	590864
Navicula sp.	4	2827	Diatom	3649
Ulnaria acus	4	4167	Diatom	970000
Glenodinium cinctum	4	7992	Dinoflagellate	10174
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Parvodinium sp.	15	8270	Dinoflagellate	
Crucigenia fenestrata	61	13992	Green	6225
Elakatothrix sp.	4	768	Green	9412
Monoraphidium indicum	34	22525	Green	5990
Oocystis sp.	8	151	Green	5827
Desmodesmus sp.	23	2890	Green	
Chlamydomonas sp.	8	4787	Green	5448
Chlorogonium sp.	53	4079	Green	5539
microflagellates	114	30651	Other.Flagellates	

Figure 16: Raw data from 2022-09-14 EMS site 0200078