Shuswap Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from two sites on Shuswap 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
SHUSWAP LK WEST OF SORRENTO (0500123)	2021-08-24 2022-04-12 2022-08-23
SHUSWAP LK OPPOSITE MARBLE PT. (0500124)	2021-04-12 2021-08-23 2022-04-11 2022-08-22
	Total= 7 samples

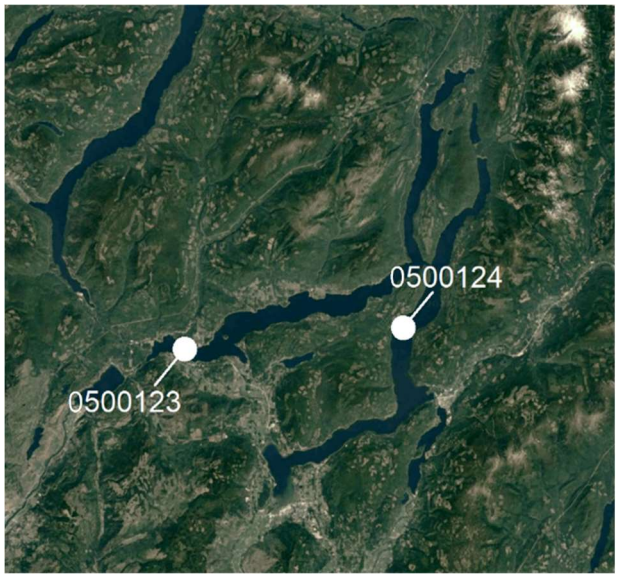

Figure 1: Aerial view of Shuswap Lake

Samples contained moderate concentrations of micro-flagellates and low concentrations of diatoms and green algae. Spring samples contained more diatoms relative to summer samples.

Samples collected during the summer months contained high densities of cyanobacteria compared to spring samples. One sample collected from site 0500124 contained amorphous clouds of degraded cyanobacteria on 2021-08-23 (Figure 2).

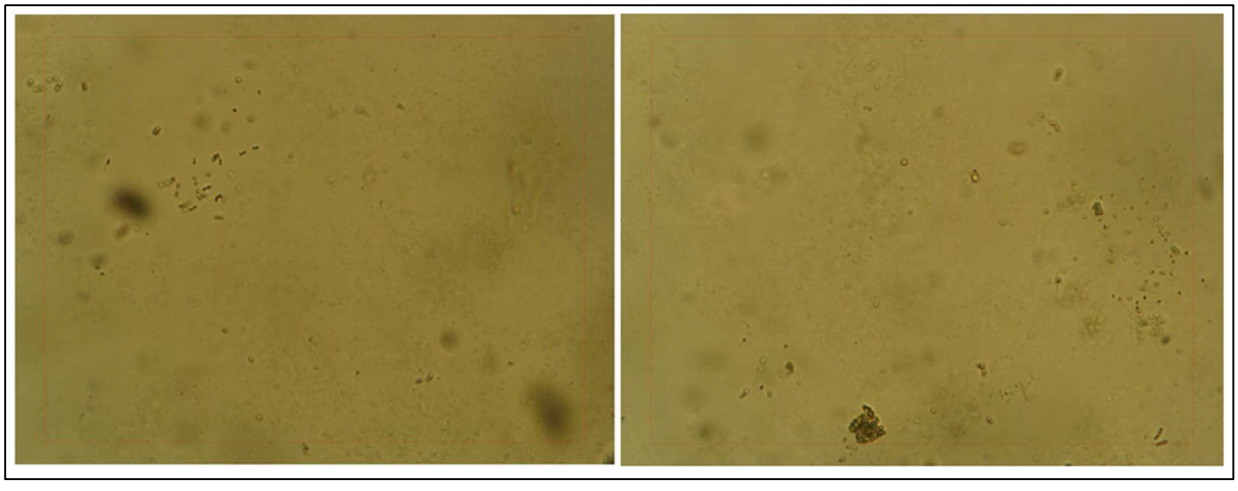

Figure 2: 400x magnification of small groupings of Anacystis sp. surrounded by amorphous clouds of degraded bacteria/cyanobacteria

Overview (continued)

Cryptomonas species from phylum Cryptophyta dominated total biovolumes in Shuswap Lake (Figure 3).

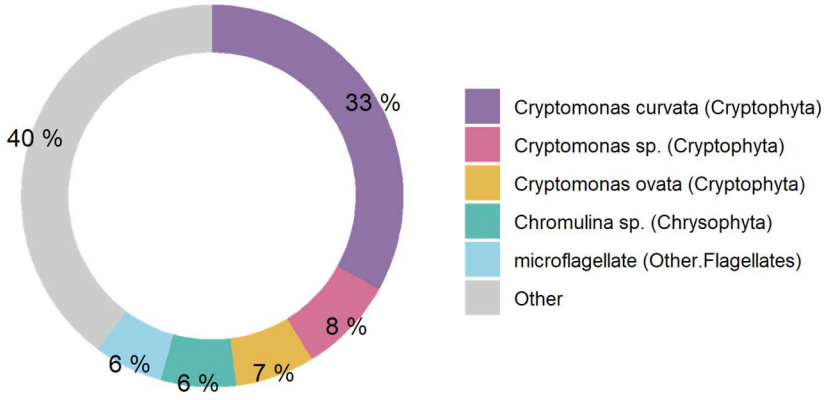

Figure 3: Dominant organisms from Shuswap Lake (all sites / dates) as percent of total biovolume

Cryptomonas species are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015). Identified species of algae in Shuswap Lake were predominantly diatoms and cyanobacteria (Figure 4).

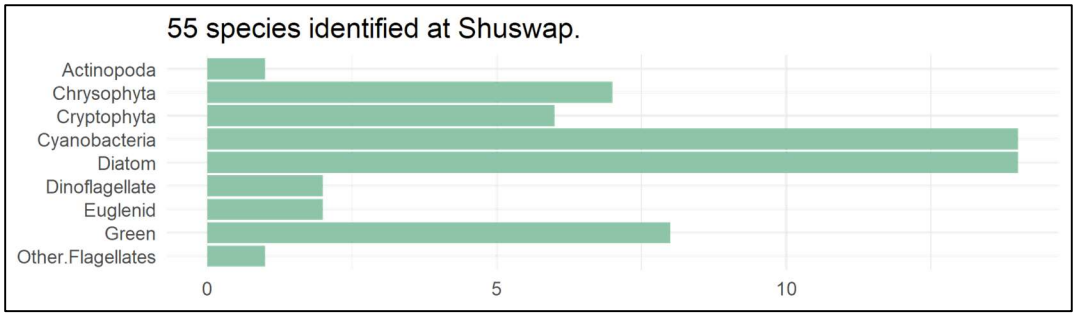

Figure 4: Identified species in Shuswap Lake sorted into categories of higher level taxa

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

Cyanobacteria concentrations were much higher in the summer than spring. Dominant genera included *Anacystis*, *Aphanocapsa*, and *Anabaena* (Figure 5).

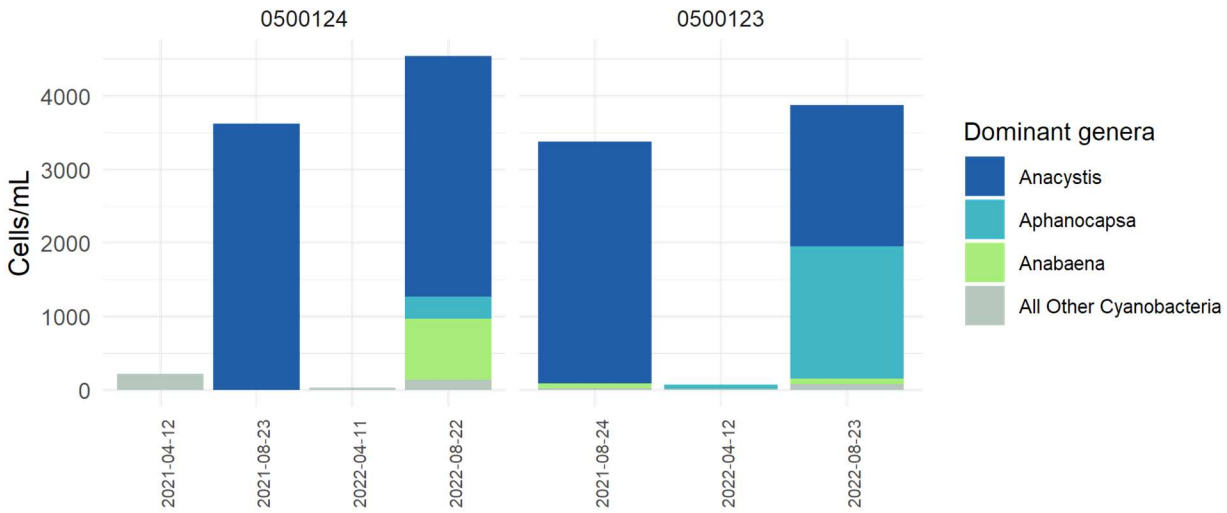

Figure 5: cell abundance for dominant cyanobacteria genera on Shuswap Lake

Algal community composition responds rapidly to environmental changes. The rate of increased cyanobacteria concentrations observed in Shuswap Lake were large and could be reflective of unbalanced nutrient swings between seasons (Figure 5).

During blooms, species of *Anabaena* produce both negative odor/taste compounds and toxic secondary metabolites. *Anabaena* blooms can quickly accumulate, develop odor metabolites, produce toxins and color water systems (EPA, 2022). 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 Shuswap Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	3271	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Aphanocapsa	1799	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Anabaena	827	Lyngbyatoxin LYN, Apoptogen Toxin (ApopTX), Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT, Taste and Odor

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Shuswap Lake displayed a range of cyanobacteria concentrations in the negligible-low risk categories, with a mean cyanobacteria abundance of 2,251 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Shuswap Lake as compared to alert levels defined by authorities including the WHO and EPA.

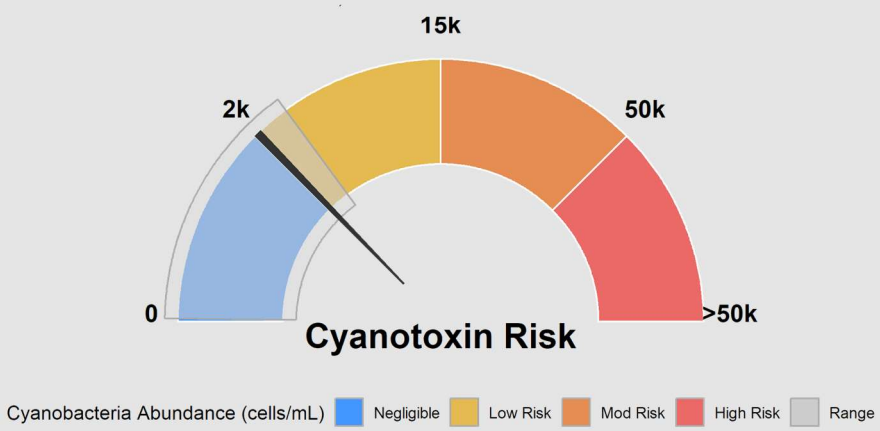

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Shuswap Lake

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 a single *Cryptomonas* cell is an equivalent size to approximately 25 cyanobacteria cells (*Anacystis*).

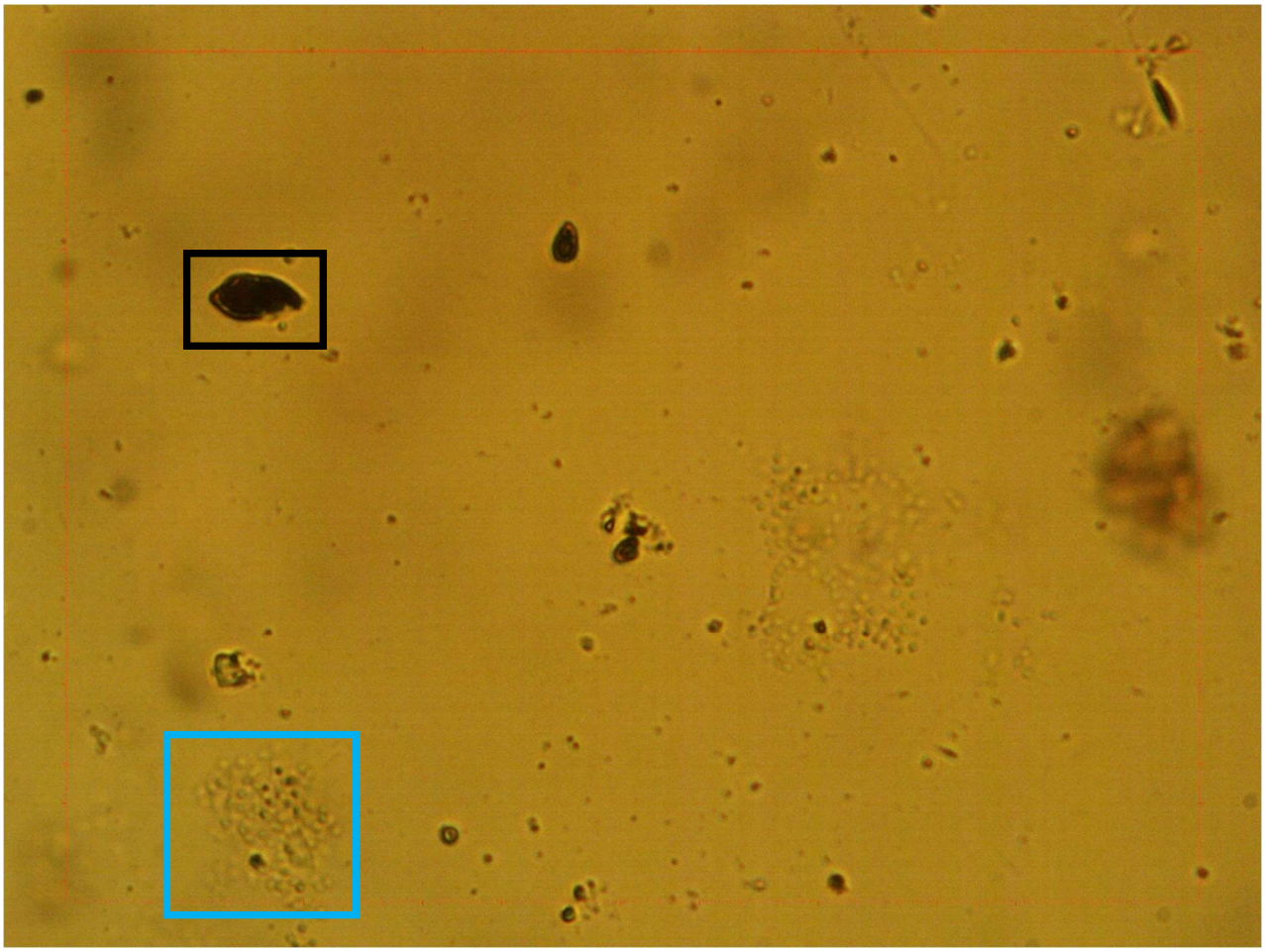

Figure 7: Size comparison of a Cryptomonas (black box) to an Anacystis colony of approximately 40 cells (blue box)

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.

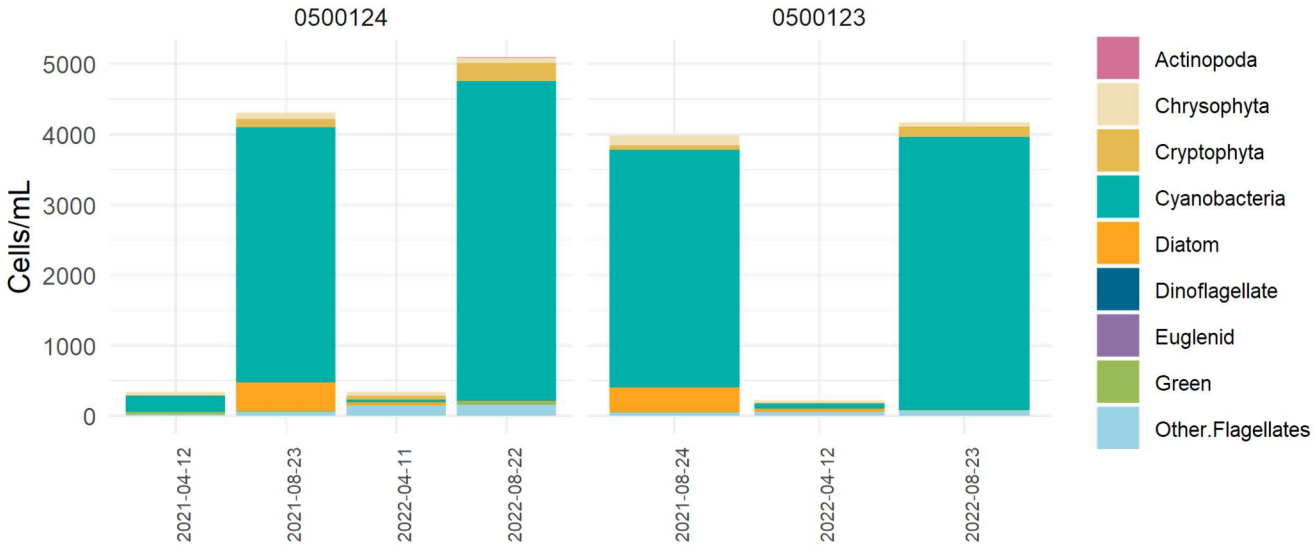

Figure 8: Cell abundance of high-level taxa groups on Shuswap Lake

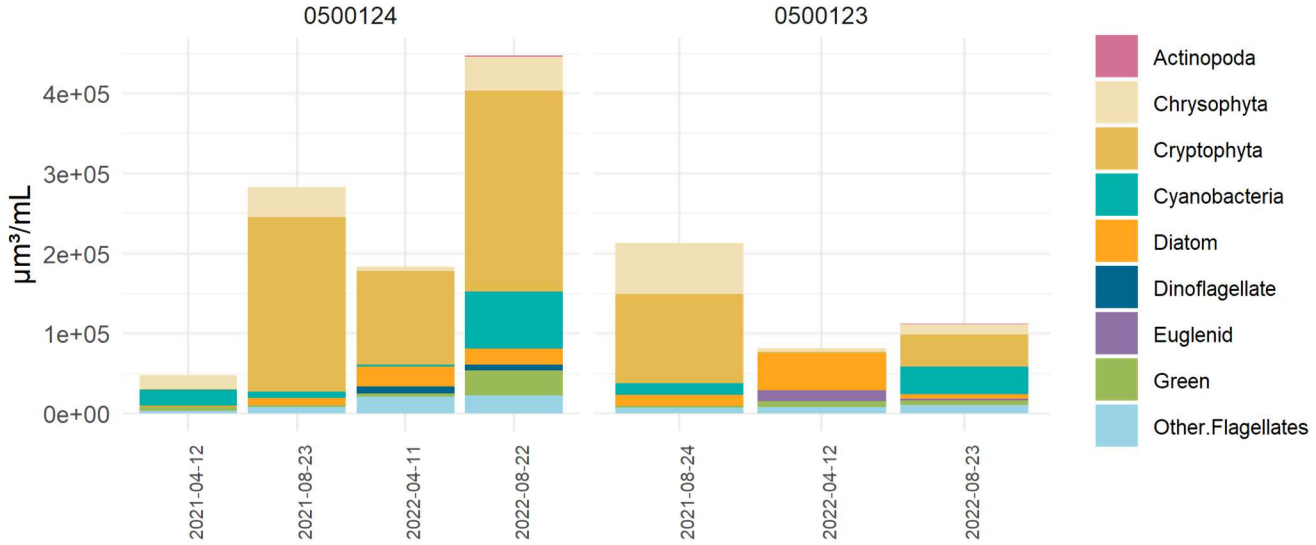

Figure 9: Biovolume of high-level taxa groups on Shuswap Lake

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

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Appendix

Additional figures and raw data are listed below:

EMS ID: 0500123	Total Abundance (cells/mL):	3979		
Collection Date: 2021-08-24	Total Biovolume (µm³/mL):	214902		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	72	15413	Chrysophyta	1455
Chrysochromulina sp.	34	1308	Chrysophyta	2160
Chromulina sp.	27	47713	Chrysophyta	1717
Cryptomonas sp.	11	20372	Cryptophyta	10635
Cryptomonas curvata	11	69299	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Rhodomonas lacustris	38	4126	Cryptophyta	10663
Aphanocapsa sp.	323	1020	Cyanobacteria	625
Anacystis cf. delicatissima	3138	6855	Cyanobacteria	609
Anacystis incerta	152	332	Cyanobacteria	609
Anabaena sp.	65	4874	Cyanobacteria	1100
Gloeothece sp.	8	524	Cyanobacteria	703
Synechococcales	15	2524	Cyanobacteria	
Achnanthidium minutissimum	8	1517	Diatom	590864
Lindavia bodanica	4	4174	Diatom	
Cymbella sp.	4	6773	Diatom	4795
Ankistrodesmus sp.	4	629	Green	5877
Oocystis parva	8	1798	Green	5827
microflagellate	49	8244	Other.Flagellates	

Figure 10: Raw data from 2021-08-24 EMS site 0500123

EMS ID: 0500124	Total Abundance (cells/mL):	343		
Collection Date: 2021-04-12	Total Biovolume (µm³/mL):	50862		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	11	2355	Chrysophyta	1455
Chrysochromulina sp.	34	1308	Chrysophyta	2160
Chromulina sp.	8	14137	Chrysophyta	1717
Rhodomonas lacustris	8	869	Cryptophyta	10663
Dactylococcopsis sp.	42	2859	Cyanobacteria	6446
Gloeothece sp.	11	720	Cyanobacteria	703
Planktolyngbya sp.	65	808	Cyanobacteria	
Synechococcales	106	17834	Cyanobacteria	
Cyclotella sp.	4	1062	Diatom	2439
Ankistrodesmus sp.	8	1258	Green	5877
Botryococcus sp.	23	3782	Green	6306
microflagellate	23	3870	Other.Flagellates	

Figure 11: Raw data from 2021-04-12 EMS site 0500124

EMS ID: 0500124	Total Abundance (cells/mL):	4311		
Collection Date: 2021-08-23	Total Biovolume (µm³/mL):	283850		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chromulina sp.	11	19439	Chrysophyta	1717
Ochromonas sp.	83	17768	Chrysophyta	1455
Cryptomonas sp.	8	14816	Cryptophyta	10635
Cryptomonas curvata	27	170098	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Cryptomonas marssonii	4	8167	Cryptophyta	10635
Rhodomonas lacustris	68	7383	Cryptophyta	10663
Aphanocapsa sp.	395	1248	Cyanobacteria	625
Anacystis cf. delicatissima	3108	6789	Cyanobacteria	609
Anacystis nidulans	212	463	Cyanobacteria	609
Anacystis incerta	304	664	Cyanobacteria	609
Asterionella formosa	11	7660	Diatom	3116
Ankistrodesmus sp.	15	2358	Green	5877
microflagellate	57	9590	Other.Flagellates	

Figure 12: Raw data from 2021-08-23 EMS site 0500124

EMS ID: 0500123	Total Abundance (cells/mL):	221		
Collection Date: 2022-04-12	Total Biovolume (µm³/mL):	83102		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	15	577	Chrysophyta	2160
Chroomonas acuta	4	2161	Chrysophyta	10613
Synura cf. peterseni	11	1976	Chrysophyta	1655
Rhodomonas lacustris	11	1194	Cryptophyta	10663
Aphanocapsa sp.	61	193	Cyanobacteria	625
Planktolyngbya limnetica	15	77	Cyanobacteria	
Achnanthidium minutissimum	4	759	Diatom	590864
Asterionella formosa	8	5571	Diatom	3116
Staurosira construens	4	170	Diatom	590848
Nitzschia acicularis	8	6316	Diatom	5070
Staurosira construens var. ventor	4	334	Diatom	4127
Tabellaria fenestrata	11	29566	Diatom	3241
Ulnaria acus	4	4167	Diatom	970000
Trachelomonas spp.	4	13270	Euglenid	9690
Closterium limneticum	4	7854	Green	7257
microflagellate	53	8917	Other.Flagellates	

Figure 13: Raw data from 2022-04-12 EMS site 0500123

EMS ID: 0500123	Total Abundance (cells/mL):	4183		
Collection Date: 2022-08-23	Total Biovolume (µm³/mL):	118347		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	4	673	Actinopoda	
Chrysochromulina sp.	46	1769	Chrysophyta	2160
Chromulina sp.	4	7069	Chrysophyta	1717
Dinobryopsis sp.	15	4029	Chrysophyta	1557
Cryptomonas curvata	4	25200	Cryptophyta	10635
Rhodomonas lacustris	140	15201	Cryptophyta	10663
Anabaena flos-aquae	76	14791	Cyanobacteria	1100
Anacystis incerta	76	166	Cyanobacteria	609
Anacystis delicatissima	1840	4019	Cyanobacteria	609
Aphanocapsa elachista var. planctonica	1799	14718	Cyanobacteria	625
Aphanothece sp.	83	265	Cyanobacteria	636
Cocconeis neodiminuta	4	6318	Diatom	3577
Parvodinium sp.	8	4411	Dinoflagellate	
Euglena sp.	4	2304	Euglenid	9620
Monoraphidium sp.	8	5300	Green	5990
microflagellate	72	12114	Other.Flagellates	

Figure 14: Raw data from 2022-08-23 EMS site 0500123

EMS ID: 0500124	Total Abundance (cells/mL):	371		
Collection Date: 2022-04-11	Total Biovolume (µm³/mL):	205785		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	38	1462	Chrysophyta	2160
Ochromonas sp.	19	4067	Chrysophyta	1455
Cryptomonas curvata	8	50400	Cryptophyta	10635
Cryptomonas ovata	23	50045	Cryptophyta	10635
Cryptomonas erosa	8	14175	Cryptophyta	10635
Rhodomonas lacustris	19	2063	Cryptophyta	10663
Planktolyngbya limnetica	19	97	Cyanobacteria	
Synechococcales	15	2524	Cyanobacteria	
Achnanthidium minutissimum	8	1517	Diatom	590864
Asterionella formosa	19	13230	Diatom	3116
Cyclostephanos dubius	4	4973	Diatom	590827
Encyonema minutum	4	3637	Diatom	590838
Staurosira construens	4	170	Diatom	590848
Fragilaria sp.	4	1942	Diatom	2932
Ulnaria acus	8	8335	Diatom	970000
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Parvodinium sp.	19	10476	Dinoflagellate	
Chlamydomonas spp.	4	3970	Green	5448
microflagellate	144	24228	Other.Flagellates	

Figure 15: Raw data from 2022-04-11 EMS site 0500124

EMS ID: 0500124	Total Abundance (cells/mL):	5097		
Collection Date: 2022-08-22	Total Biovolume (µm³/mL):	450977		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	11	1851	Actinopoda	
Chrysochromulina sp.	34	1308	Chrysophyta	2160
Dinobryon spp.	23	36489	Chrysophyta	1515
Ochromonas sp.	4	856	Chrysophyta	1455
Dinobryopsis sp.	15	4029	Chrysophyta	1557
Cryptomonas sp.	42	77786	Cryptophyta	10635
Cryptomonas curvata	23	144899	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Rhodomonas lacustris	182	19761	Cryptophyta	10663
Anabaena sp.	827	62008	Cyanobacteria	1100
Anacystis sp.	3271	6224	Cyanobacteria	609
Aphanocapsa elachista var. planctonica	307	2512	Cyanobacteria	625
Aphanothece sp.	140	446	Cyanobacteria	636
Ulnaria nana	4	10500	Diatom	970000
Urosolenia eriensis	4	9040	Diatom	590843
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Ankistrodesmus sp.	4	629	Green	5877
Elakatothrix sp.	4	768	Green	9412
Golenkinia sp.	4	7069	Green	6314
Monoraphidium sp.	34	22525	Green	5990
microflagellate	156	26247	Other.Flagellates	

Figure 16: Raw data from 2022-08-22 EMS site 0500124