

Kalamalka Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from three sites on Kalamalka 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
KALAMALKA LK S END (0500246)	2021-08-31
	2022-03-15
	2022-08-30
KALAMALKA LAKE DEEP BASIN (0500847)	2021-03-16
	2021-08-31
	2022-03-15
	2022-08-30
KALAMALKA L SOUTH COLDSTREAM C (0500461)	2021-08-31
	2022-03-15
	2022-08-30
Total = 10 samples	



Figure 1: Aerial view of Kalamalka Lake

Samples contained low densities of diatoms and green algae but moderate densities of cyanobacteria and microflagellates. Seventy-four species were identified and sorted into nine categories of higher-level taxa (Figure 2). Cyanobacteria, diatoms, and Chrysophytes contained the highest number of species (Figure 2).

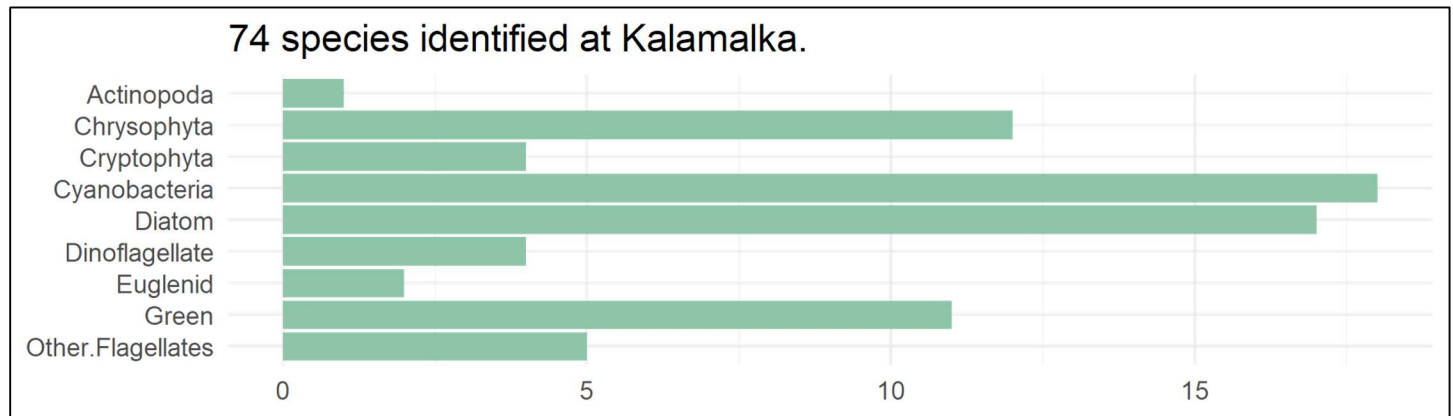


Figure 2: Identified agal organisms grouped into higher level taxa

Overview (continued)

Samples contained moderate concentrations of Chrysophyta; dominant Chrysophyta observed included *Dinobryon*, *Chromulina*, and *Ochromonas* (Figure 3).

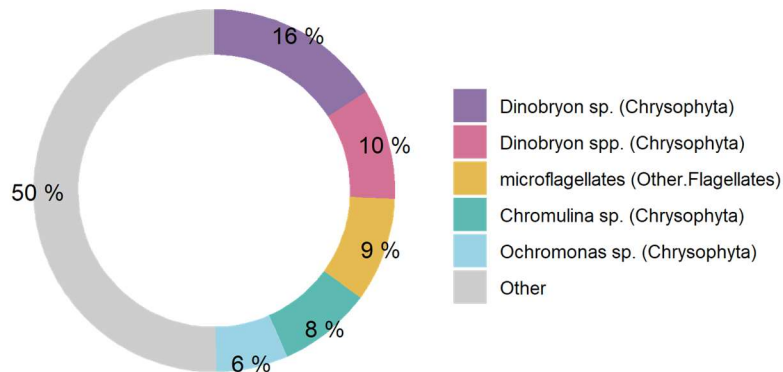


Figure 3: Dominant organisms from Kalamalka Lake (all samples / dates) as percent of total biovolume

Sample site EMS #0500461 (2022-08-30) contained elevated densities of *Dinobryon* (Figure 4). The *Dinobryon* bloom was composed of only swarmers (sexual reproductive stages) and no stomatocysts (asexual reproductive stages). Stomatocysts are normally produced at 0.05% the of rate swarmers (Lee, 2008). When *Dinobryon* populations are in a nitrogen-depleted environment, stomatocyst production rises from 0.05% to 4%; suggesting that during sampling, the environment was not nitrogen-depleted. *Dinobryon* blooms are associated with unpleasant fishy odors, and one genus of *Dinobryon* is linked with a toxin that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

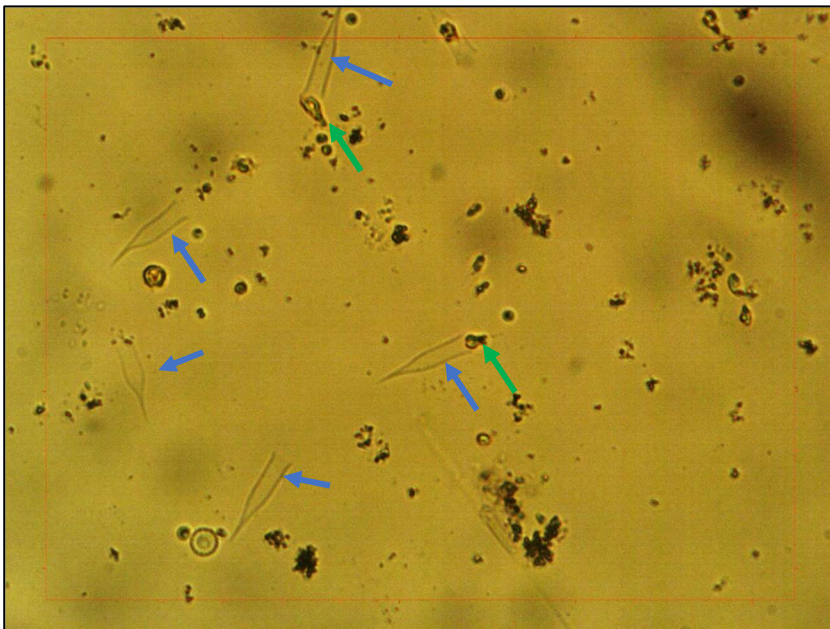


Figure 4: 400x magnification of EMS#0500461 (2022-08-30) containing an assortment of *Dinobryon* loricas (blue arrows) and *Dinobryon* swarmers (green arrows)

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 moderate levels of cyanobacteria *Planktolyngbya* and *Anacystis* were dominant, but *Planktothrix* and several other cyanobacteria were also observed in Kalamalka Lake (Figure 5).

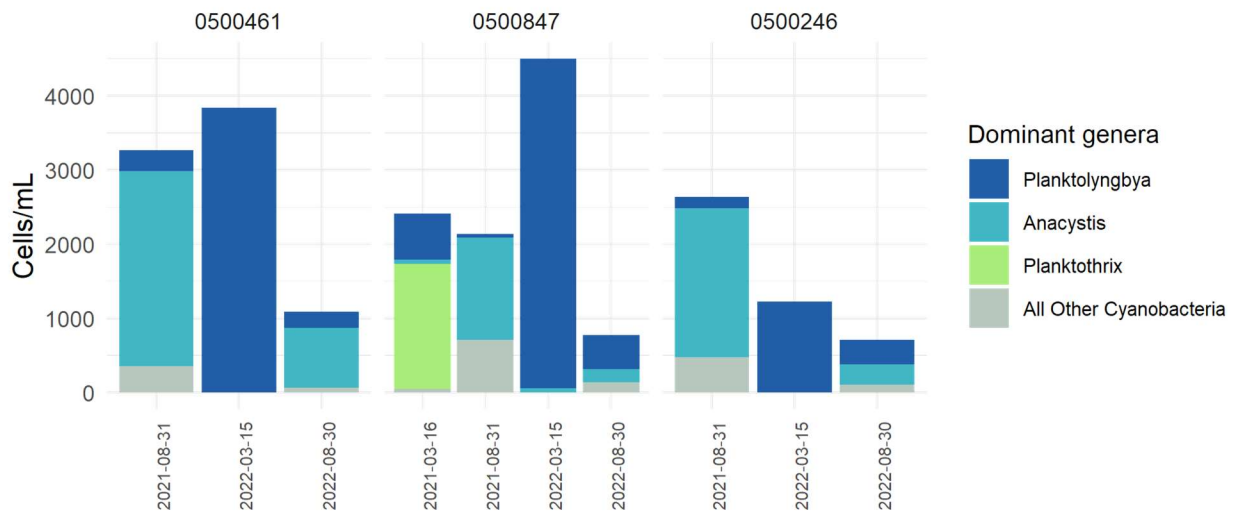


Figure 5: cell abundance for dominant cyanobacteria genera on Kalamalka Lake

Planktothrix species are long, slender, straight filaments that can form dense surface scums associated with strong earthy odors (EPA, 2022). *Planktolyngbya*, *Anacystis*, and *Planktothrix* are associated with several cyanotoxins that represent risk 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 Kalamalka Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
<i>Planktolyngbya</i>	4447	Lyngbyatoxin LYN, Microcystin MC, BMAA
<i>Anacystis</i>	2633	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
<i>Planktothrix</i>	1681	Lyngbyatoxin LYN, Aplysiatoxins APL, Lipopolysaccharide LPS, 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 found in Kalamalka Lake can produce cyanotoxins (Table 2).

Kalamalka Lake displayed a range of cyanobacteria levels in the low risk category, with a mean cyanobacteria abundance of 5,654 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Kalamalka Lake as compared to several authorities including the WHO and EPA.

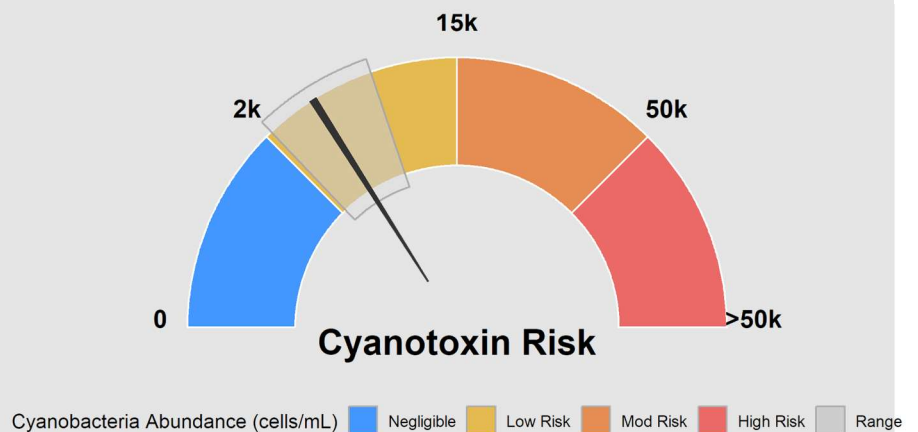


Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Kalamalka Lake

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 *Monoraphidium* cell dwarfs adjacent *Anacystis* cells (Figure 7).

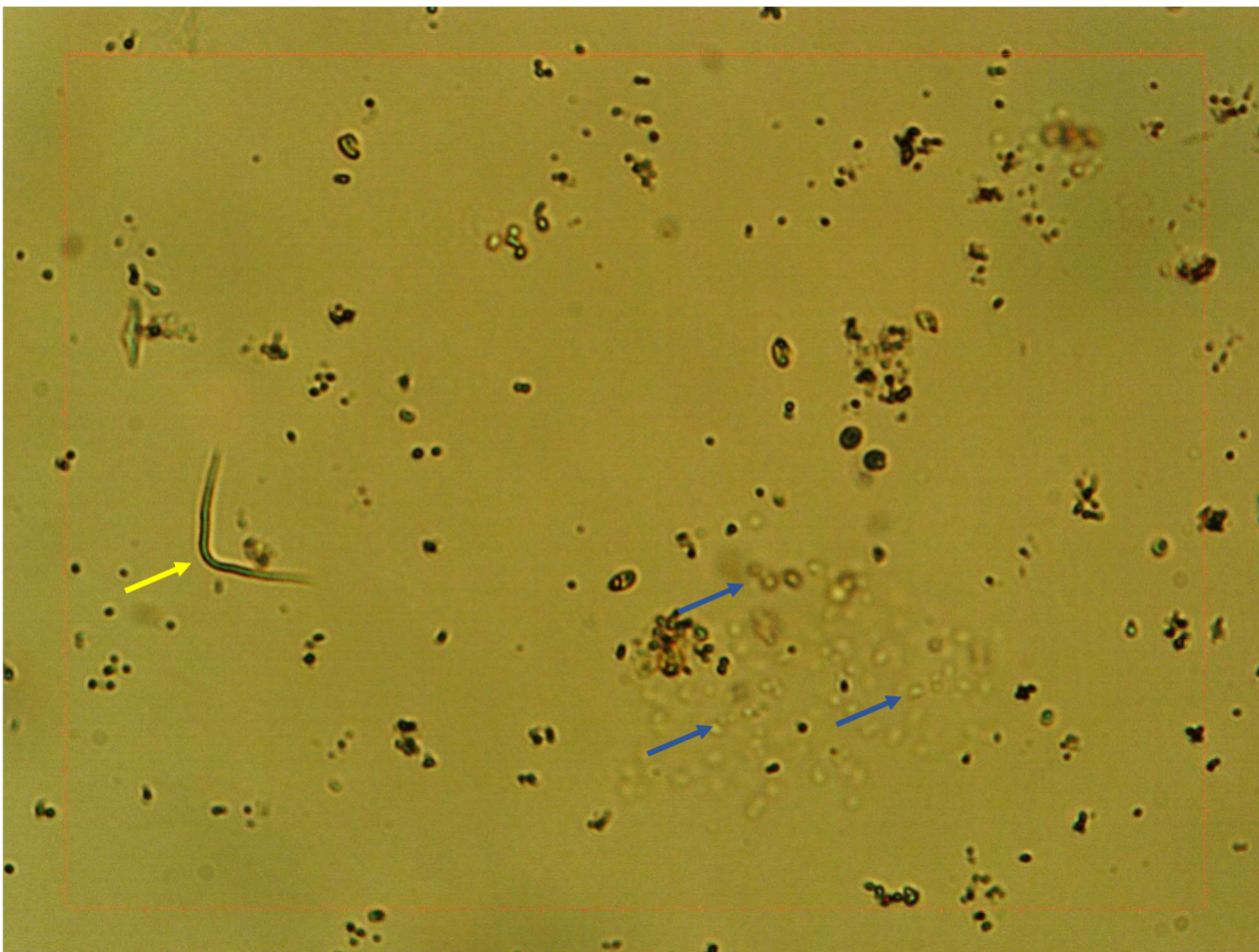


Figure 7: Size comparison of *Monoraphidium* (yellow arrow) to *Anacystis* cell (blue arrows)

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.

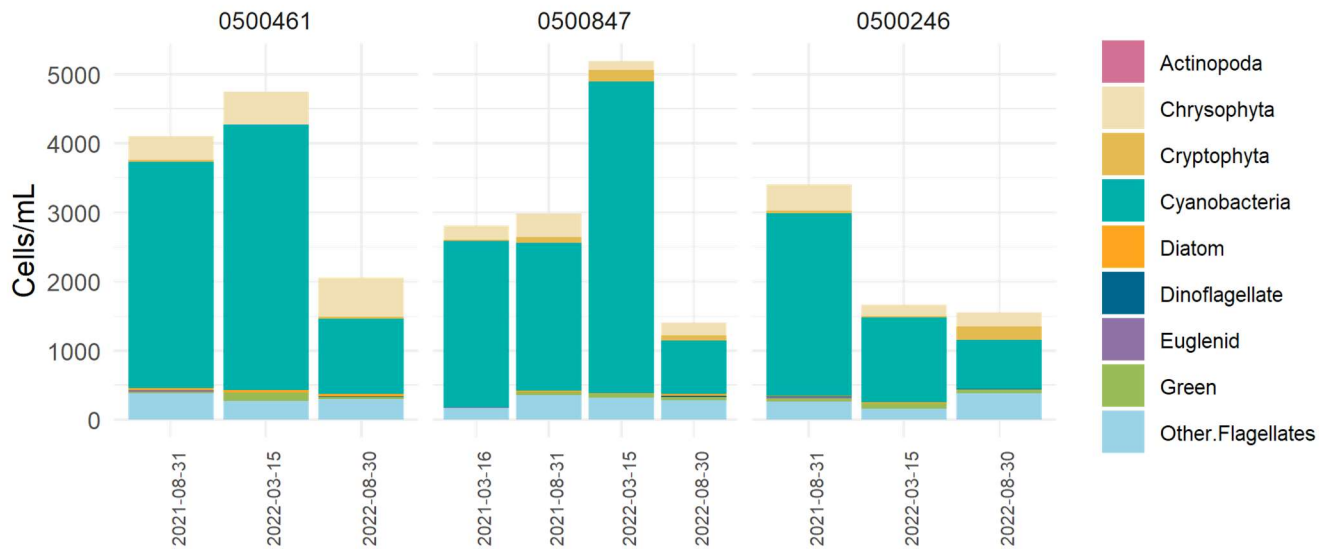


Figure 8: Cell abundance of high-level taxa groups on Kalamalka Lake

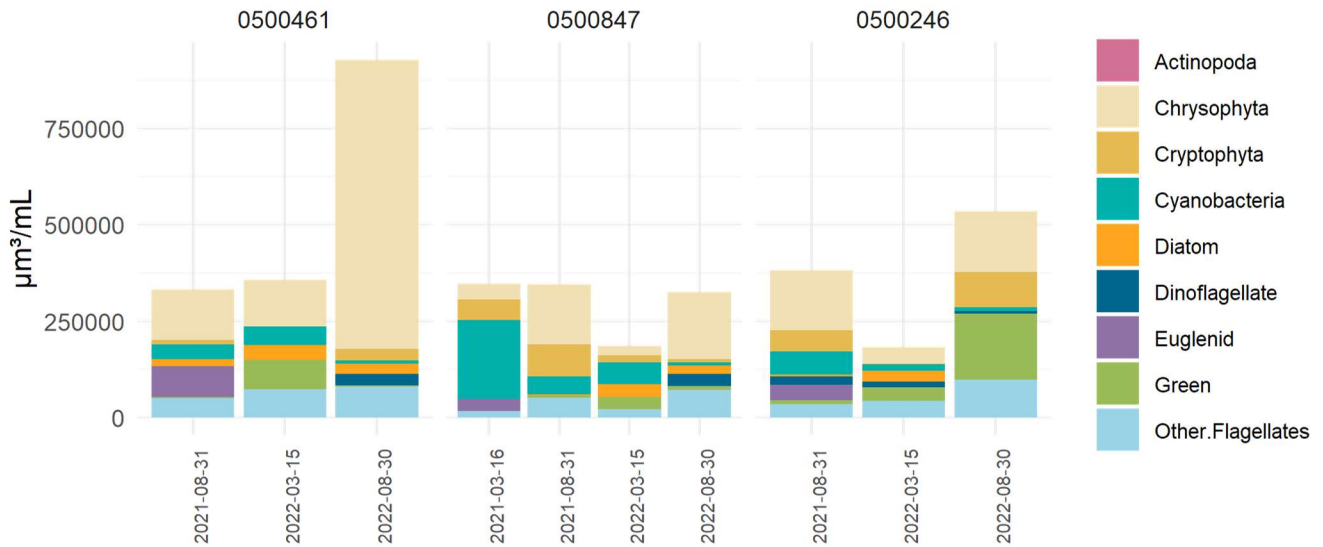


Figure 9: Biovolume of high-level taxa groups on Kalamalka Lake

References

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Appendix

Additional figures and raw data are listed below:

EMS ID: 0500246	Total Abundance (cells/mL):		3408		
Collection Date: 2021-08-31	Total Biovolume ($\mu\text{m}^3/\text{mL}$):		394552		
Report.Name	Abundance (cells/mL)		Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.		57	85614	Chrysophyta	1515
Bitrichia sp.		15	1720	Chrysophyta	
Ochromonas sp.		277	59297	Chrysophyta	1455
Chrysococcus sp.		30	9961	Chrysophyta	1751
Dinobryopsis sp.		27	7252	Chrysophyta	1557
Cryptomonas sp.		11	20372	Cryptophyta	10635
Cryptomonas ovata		15	32638	Cryptophyta	10635
Rhodomonas lacustris		19	2063	Cryptophyta	10663
Rhabdoderma sp.		23	394	Cyanobacteria	805
Aphanizomenon flos-aquae		23	3830	Cyanobacteria	1191
Anacystis sp.		2007	3819	Cyanobacteria	609
Anabaena flos-aquae		152	29583	Cyanobacteria	1100
Anabaena sp.		228	17095	Cyanobacteria	1100
Dactylococcopsis sp.		23	1566	Cyanobacteria	6446
Gloeotheca sp.		27	1767	Cyanobacteria	703
Planktolyngbya sp.		159	1976	Cyanobacteria	
Achnanthydium minutissimum		4	759	Diatom	590864
Ulnaria acus		4	4167	Diatom	970000
Gymnodinium ordinarum		11	21449	Dinoflagellate	10031
Trachelomonas sp.		11	38877	Euglenid	9690
Ankistrodesmus falcatus		23	3252	Green	5877
Oocystis parva		23	5170	Green	5827
Chlamydomonas sp.		4	2393	Green	5448
microflagellate		235	39538	Other.Flagellates	

Figure 10: Raw data from 2021-08-31 EMS site 0500246

EMS ID: 500461	Total Abundance (cells/mL):		4105		
Collection Date: 2021-08-31	Total Biovolume ($\mu\text{m}^3/\text{mL}$):		354483		
Report.Name	Abundance (cells/mL)		Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.		42	63084	Chrysophyta	1515
Bitrichia sp.		11	1261	Chrysophyta	
Ochromonas sp.		235	50306	Chrysophyta	1455
Chrysococcus sp.		53	17597	Chrysophyta	1751
Dinobryopsis sp.		57	15311	Chrysophyta	1557
Cryptomonas ovata		4	8704	Cryptophyta	10635
Rhodomonas lacustris		30	3257	Cryptophyta	10663
Anacystis sp.		2633	5010	Cyanobacteria	609
Anabaena helicoidea		49	6465	Cyanobacteria	1100
Anabaena sp.		288	21594	Cyanobacteria	1100
Gloeotheca sp.		8	524	Cyanobacteria	703
Homeothrix sp.		11	918	Cyanobacteria	
Planktolyngbya sp.		281	3493	Cyanobacteria	
Achnanthydium minutissimum		8	1517	Diatom	590864
Amphora ovalis		4	5833	Diatom	4705
Cymbella sp.		4	6773	Diatom	4795
Fragilaria capucina		4	1942	Diatom	2932
Nitzschia sp.		11	1009	Diatom	5070
Trachelomonas sp.		23	81289	Euglenid	9690
Ankistrodesmus falcatus		8	1131	Green	5877
Elakatothrix gelatinosa		11	1943	Green	9412
microflagellate		330	55522	Other.Flagellates	

Figure 11: Raw data from 2021-08-31 EMS site 0500461

EMS ID: 0500847	Total Abundance (cells/mL):	2808		
Collection Date: 2021-03-1	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	363308		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Ochromonas sp.	186	39817	Chrysophyta	1455
Chroomonas sp.	11	2501	Chrysophyta	10613
Dinobryopsis sp.	53	14236	Chrysophyta	1557
Cryptomonas curvata	8	50400	Cryptophyta	10635
Rhodomonas lacustris	15	1629	Cryptophyta	10663
Anacystis sp.	57	108	Cyanobacteria	609
Planktothrix rubescens	1681	192412	Cyanobacteria	189420
Planktolyngbya sp.	622	7731	Cyanobacteria	
Pseudanabaena limnetica	53	4870	Cyanobacteria	1175
Trachelomonas sp.	4	14137	Euglenid	9690
Phacus sp.	4	16287	Euglenid	9766
microflagellate	114	19180	Other.Flagellates	

Figure 12: Raw data from 2021-03-16 EMS site 0500847

EMS ID: 0500847	Total Abundance (cells/mL):	2979		
Collection Date: 2021-08-3	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	356415		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	65	97630	Chrysophyta	1515
Ochromonas sp.	273	58441	Chrysophyta	1455
Dinobryopsis sp.	11	2955	Chrysophyta	1557
Cryptomonas sp.	30	55561	Cryptophyta	10635
Cryptomonas ovata	11	23935	Cryptophyta	10635
Rhodomonas lacustris	42	4560	Cryptophyta	10663
Aphanothece sp.	129	411	Cyanobacteria	636
Anacystis sp.	1385	2635	Cyanobacteria	609
Anabaena sp.	501	37565	Cyanobacteria	1100
Dactylococopsis sp.	30	2042	Cyanobacteria	6446
Gloeotheca sp.	34	2225	Cyanobacteria	703
Planktolyngbya sp.	46	572	Cyanobacteria	
Romeria sp.	15	368	Cyanobacteria	1078
Cyclotella sp.	8	2124	Diatom	2439
Nitzschia sp.	8	734	Diatom	5070
Ankistrodesmus falcatus	42	5938	Green	5877
microflagellate	349	58719	Other.Flagellates	

Figure 13: Raw data from 2021-08-31 EMS site 0500847

EMS ID: 0500246	Total Abundance (cells/mL):	1749		
Collection Date: 2022-03-15	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	189850		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Chromulina sp.	8	14137	Chrysophyta	1717
Mallomonas sp.	4	12097	Chrysophyta	1598
cf. Ochromonas sp.	80	4144	Chrysophyta	
Rhodomonas sp.	156	17779	Chrysophyta	10663
Rhodomonas lacustris	15	1629	Cryptophyta	10663
Gloeotheca sp.	4	262	Cyanobacteria	703
Planktolyngbya sp.	1222	15189	Cyanobacteria	
Achnanthyrium sp.	4	759	Diatom	590864
Aulacoseira sp.	8	13165	Diatom	590863
Lindavia bodanica	4	4174	Diatom	
Tabellaria fenestrata	4	10751	Diatom	3241
Gymnodinium helveticum	4	15811	Dinoflagellate	10031
Parvodinium sp.	4	2205	Dinoflagellate	
Ankistrodesmus sp.	19	2987	Green	5877
Elakatothrix sp.	8	1536	Green	9412
Monoraphidium indicum	46	30475	Green	5990
microflagellates	159	42750	Other.Flagellates	

Figure 14: Raw data from 2022-03-15 EMS site 0500246

EMS ID: 0500246	Total Abundance (cells/mL):	1559		
Collection Date: 2022-08-30	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	538274		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	106	4077	Chrysophyta	2160
Chromulina sp.	34	60083	Chrysophyta	1717
Chrysococcus sp.	8	2656	Chrysophyta	1751
Dinobryon spp.	57	90429	Chrysophyta	1515
Cryptomonas sp.	8	14816	Cryptophyta	10635
Cryptomonas curvata	8	50400	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Rhodomonas lacustris	171	18567	Cryptophyta	10663
Anacystis sp.	277	527	Cyanobacteria	609
Anabaena sp.	42	3149	Cyanobacteria	1100
Gloeocapsa aeruginosa	61	862	Cyanobacteria	682
Planktolyngbya sp.	334	4152	Cyanobacteria	
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Parvodinium sp.	4	2205	Dinoflagellate	
Ankistrodesmus sp.	23	3616	Green	5877
Crucigenia fenestrata	23	5276	Green	6225
Elakatothrix sp.	4	768	Green	9412
Closterium acutum	4	160836	Green	7257
Dinoflagellate cyst	42	7066	Other.Flagellates	
microflagellates	345	92759	Other.Flagellates	

Figure 15: Raw data from 2022-08-30 EMS site 0500246

EMS ID: 0500461	Total Abundance (cells/mL):	4745		
Collection Date: 2022-03-15	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	357263		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	19	731	Chrysophyta	2160
Chromulina sp.	19	33576	Chrysophyta	1717
Mallomonas sp.	8	24194	Chrysophyta	1598
Ochromonas sp.	137	29327	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Rhodomonas sp.	285	32481	Chrysophyta	10663
Planktolyngbya sp.	3844	47781	Cyanobacteria	
Asterionella formosa	19	13230	Diatom	3116
Aulacoseira sp.	15	24684	Diatom	590863
Ankistrodesmus sp.	8	1258	Green	5877
Monoraphidium sp.	4	2650	Green	5990
Monoraphidium indicum	110	72876	Green	5990
microflagellates	273	73401	Other.Flagellates	

Figure 16: Raw data from 2022-03-15 EMS site 0500461

EMS ID: 0500461	Total Abundance (cells/mL):	2060		
Collection Date: 2022-08-30	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	928047		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Actinophryida	4	673	Actinopoda	
Chrysochromulina sp.	72	2769	Chrysophyta	2160
Chromulina sp.	80	141372	Chrysophyta	1717
Bitrichia chodatii	8	2670	Chrysophyta	
Dinobryon spp.	137	217346	Chrysophyta	1515
Dinobryon sp.	254	381508	Chrysophyta	1515
Dinobryopsis sp.	11	2955	Chrysophyta	1557
Cryptomonas sp.	11	20372	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Rhodomonas lacustris	19	2063	Cryptophyta	10663
Anacystis sp.	801	1524	Cyanobacteria	609
Chroococcus sp.	38	1273	Cyanobacteria	654
Gloeothoece sp.	15	982	Cyanobacteria	703
Synechocystis sp.	15	503	Cyanobacteria	799
Planktolyngbya sp.	220	2735	Cyanobacteria	
Cyclotella sp.	8	2124	Diatom	2439
Fragilaria crotonensis	8	3884	Diatom	2932
Gomphonema ventricosum	8	11017	Diatom	4911
Navicula capitatoradiata	8	6168	Diatom	3649
Ulnaria acus	4	4167	Diatom	970000
Gymnodinium helveticum	4	15811	Dinoflagellate	10031
Peridinium inconspicuum	8	14652	Dinoflagellate	10212
Ankistrodesmus falcatus	4	565	Green	5877
Elakatothrix sp.	8	1536	Green	9412
Scenedesmus arcuatus	15	1089	Green	6104
microflagellates	296	79585	Other.Flagellates	

Figure 17: Raw data from 2022-08-30 EMS site 0500461

EMS ID: 0500847	Total Abundance (cells/mL):	5195		
Collection Date: 2022-03-15	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	187043		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	27	1038	Chrysophyta	2160
Chrysococcus sp.	19	6308	Chrysophyta	1751
Ochromonas sp.	87	18624	Chrysophyta	1455
Rhodomonas lacustris	171	18567	Cryptophyta	10663
Anacystis sp.	57	108	Cyanobacteria	609
Planktolyngbya sp.	4447	55276	Cyanobacteria	
Tabellaria fenestrata	11	29566	Diatom	3241
Ulnaria acus	4	4167	Diatom	970000
Ankistrodesmus sp.	11	1729	Green	5877
Monoraphidium sp.	46	30475	Green	5990
microflagellates	49	13175	Other.Flagellates	
nanoflagellates	266	8010	Other.Flagellates	

Figure 18: Raw data from 2022-03-15 EMS site 0500847

EMS ID: 0500847	Total Abundance (cells/mL):	1491		
Collection Date: 2022-08-30	Total Biovolume ($\mu\text{m}^3/\text{mL}$):	349743		
Report.Name	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	65	2500	Chrysophyta	2160
Chromulina sp.	46	81289	Chrysophyta	1717
Chrysococcus sp.	4	1328	Chrysophyta	1751
Bitrichia chodatii	4	1335	Chrysophyta	
Dinobryon spp.	53	84083	Chrysophyta	1515
Dinobryaceae sp.	76	19335	Chrysophyta	1514
Dinobryopsis sp.	11	2955	Chrysophyta	1557
Rhodomonas lacustris	80	8686	Cryptophyta	10663
Anacystis sp.	178	339	Cyanobacteria	609
Aphanocapsa elachista var. planctonica	114	933	Cyanobacteria	625
Gloeocapsa aeruginosa	19	269	Cyanobacteria	682
Gloeotheca sp.	8	524	Cyanobacteria	703
Planktolyngbya sp.	455	5656	Cyanobacteria	
Gomphonema ventricosum	8	11017	Diatom	4911
Navicula capitatoradiata	8	6168	Diatom	3649
Navicula cryptocephala	4	3084	Diatom	3649
Nitzschia spp.	4	1579	Diatom	5070
Gymnodinium sp.	8	16948	Dinoflagellate	10031
Peridinium inconspicuum	8	14652	Dinoflagellate	10212
Parvodinium sp.	8	4411	Dinoflagellate	
Ankistrodesmus falcatus	8	1131	Green	5877
Crucigenia fenestrata	30	6881	Green	6225
Elakatothrix sp.	15	2880	Green	9412
microflagellates	250	67217	Other.Flagellates	
Dinoflagellate cyst	27	4543	Other.Flagellates	

Figure 19: Raw data from 2022-08-30 EMS site 0500847