Nicola Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Nicola 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
NICOLA LK AT DEEPEST PT. (0603006)	2021-04-01
	2021-08-31
	2022-03-31
	2022-08-25
	Total= 4 samples

Figure 1: Aerial view of Nicola Lake

Samples exhibited typical seasonal patterns; rise in diatom density in the spring followed by cyanobacteria blooms in the summer.

Spring samples demonstrated diatom degradation reflective of lowering silica levels in the late spring. *Tabellaria*, *Aulacoseira*, and *Stephanodiscus* were the dominant genera of diatoms (Figure 2).

Spring blooms of diatoms are common and reflective increased temperatures, light penetration, and silica in the water following ice thaw (Kong et al., 2021). Diatoms increase the resiliency of water systems through their ability to bloom in early spring, reduce nutrient levels, and prevent monoculture blooms of less desirable algae (jrobyn, 2019).

Diatoms are integral to aquatic food webs because they are the foundation of the food web (jrobyn, 2019). Colony forming diatoms such as *Aulacoseira* and *Tabellaria* can avoid grazing pressures by developing into large colonies, reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012).

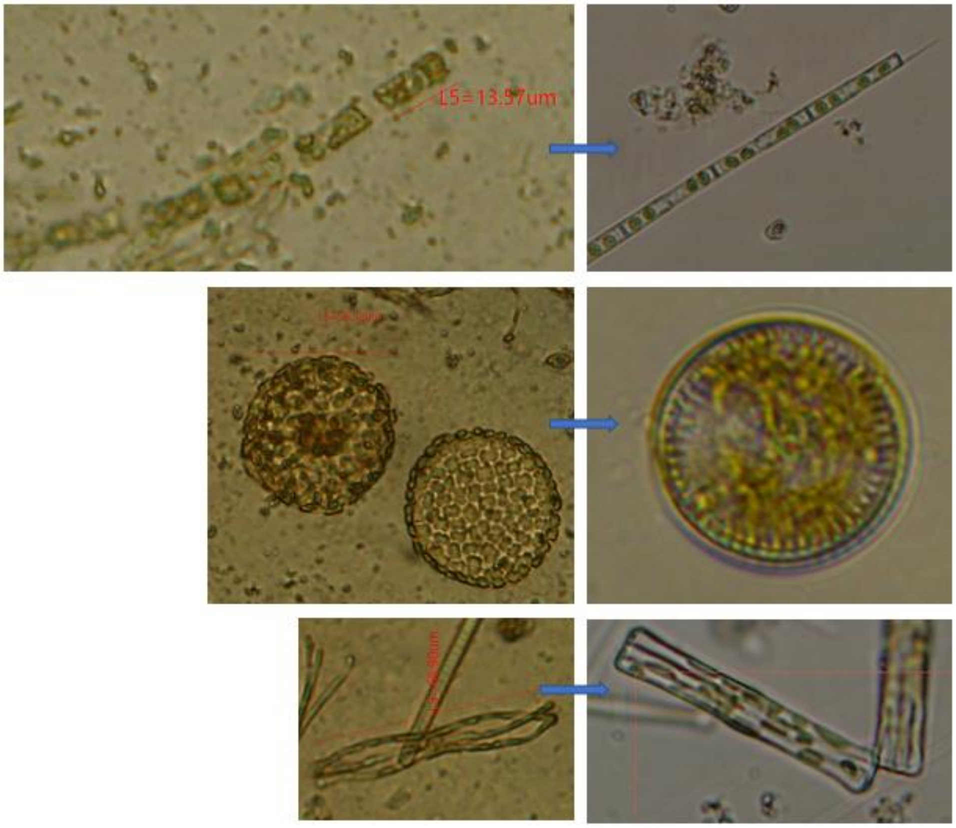

Figure 2: Degraded diatoms observed in spring samples (left) vs healthy diatoms of the same species (right)

Overview (continued)

Cyanobacteria frequently dominate algal communities in total cell count, but because of their small cell size, their biovolume is typically low relative to the other types of algae present. The large total biovolume of cyanobacteria (51%) in Nicola Lake emphasizes the high concentrations numerated (Figure 3).

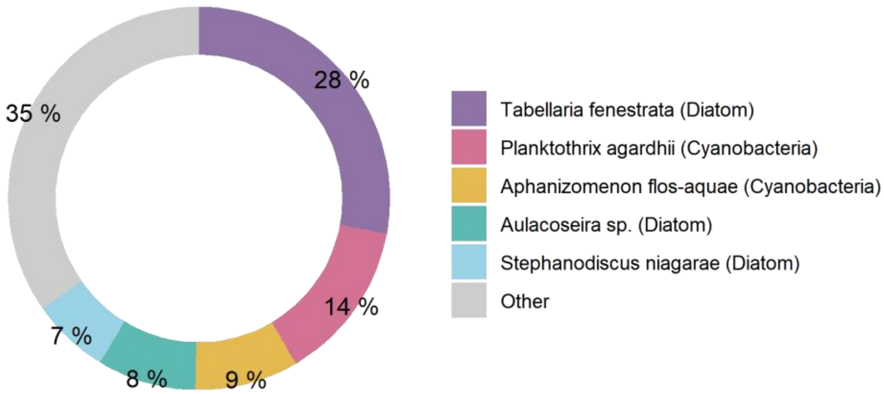

Figure 3: Dominant organisms from Nicola Lk at Deepest Pt. (0603006) as percent of total biovolume

Identified cyanobacteria species in Nicola Lake were *Planktothrix agarhdii* and *Aphanizomenon flos-aquae.* These species are larger than most cyanobacteria, attributing to increased biovolume percentages (Figure 4).

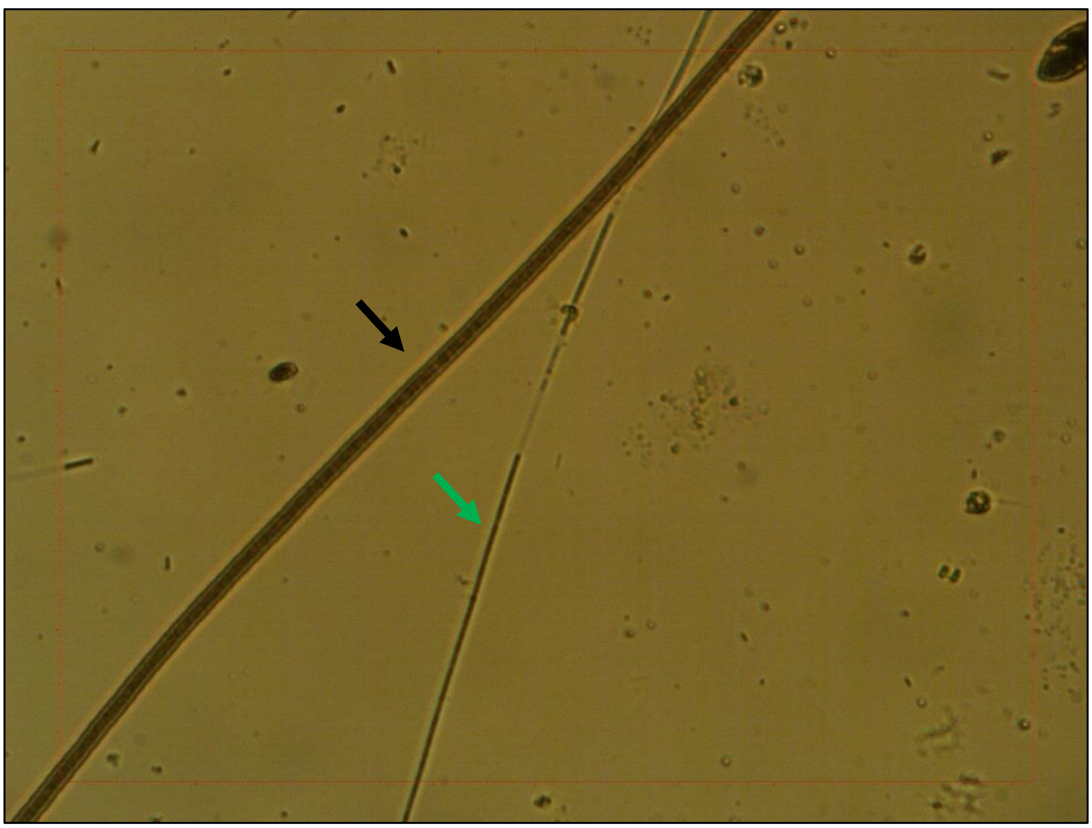

Figure 4: 400x magnification of EMS site #0603006 collected on 2022-08-25 displaying width difference between cyanobacteria Planktothrix agarhdii (black arrow) *and* Planktolyngbya limnetica (green arrow)

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

Summer samples contained high densities of cyanobacteria compared to spring samples. Dominant genera included *Planktolyngbya*, *Planktothrix,* and *Anacystis* (Figure 5).

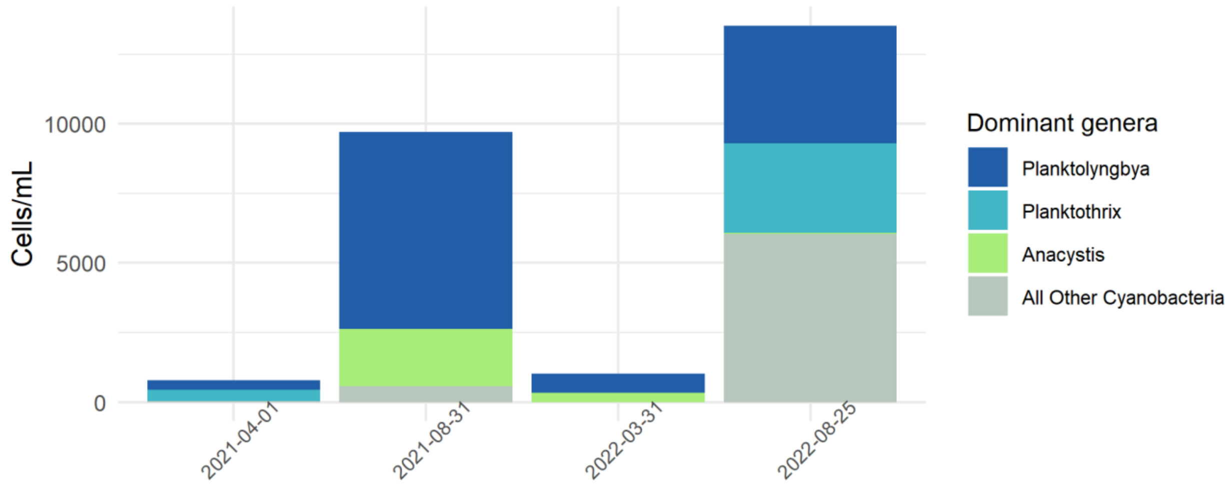

Figure 5: cell abundance for dominant cyanobacteria genera on Nicola Lake

Dominant cyanobacteria can produce a range of cyanotoxins (Table 2). *Planktothrix* species are also linked with aesthetic problems. *Planktothrix* blooms form dense surface scums associated with strong, unpleasant, and earthy odors (EPA, 2022). 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 Nicola Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Planktolyngbya	7085	Lyngbyatoxin LYN, Microcystin MC, BMAA
Planktothrix	3040	Lyngbyatoxin LYN, Aplysiatoxins APL, Lipopolysaccharide LPS, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT, Taste and Odor
Anacystis	2060	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Nicola Lake displayed a range of cyanobacteria levels in the negligible-low risk categories, with a mean cyanobacteria abundance of 6,264 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Nicola Lake compared to alert levels defined by several authorities including the WHO and EPA.

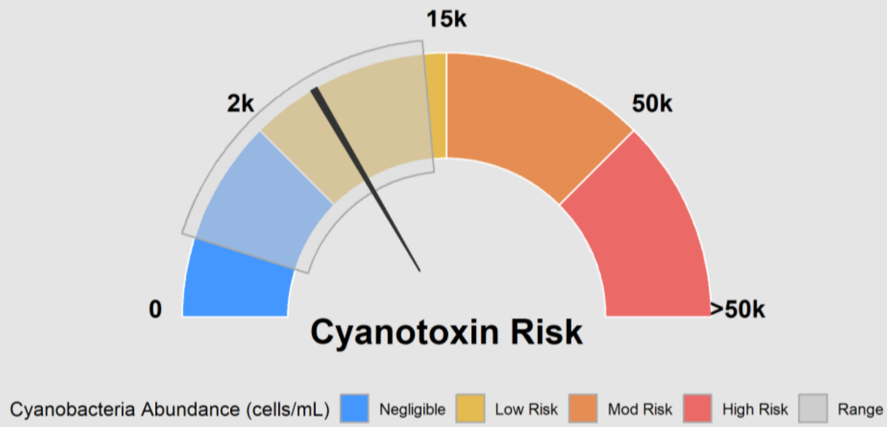

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Nicola Lake

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

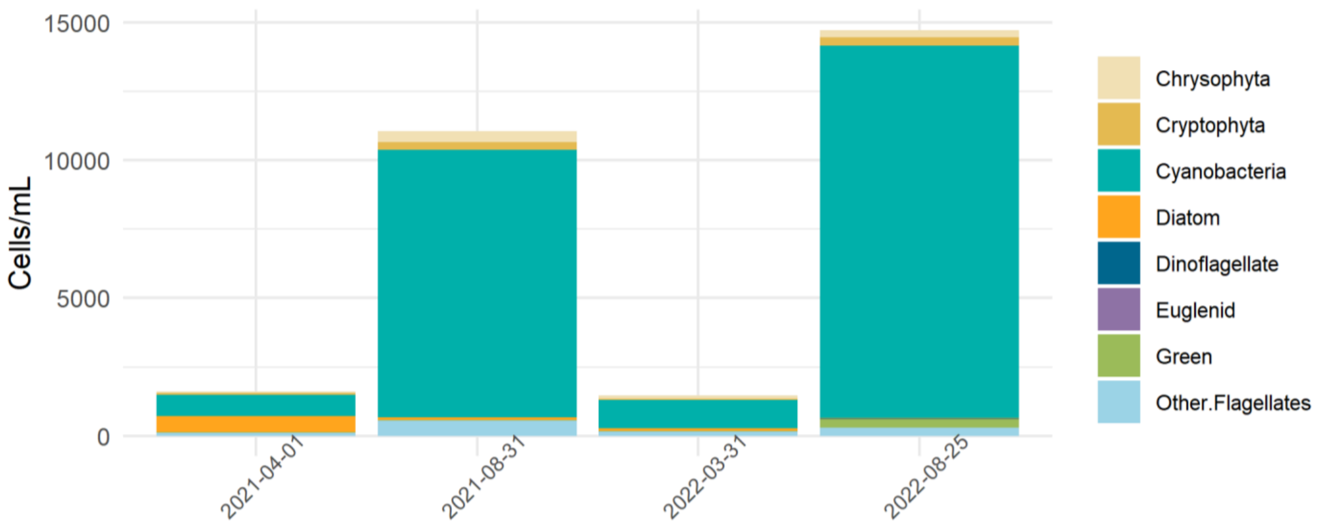

Figure 7: Cell abundance of high-level taxa groups on Nicola Lake

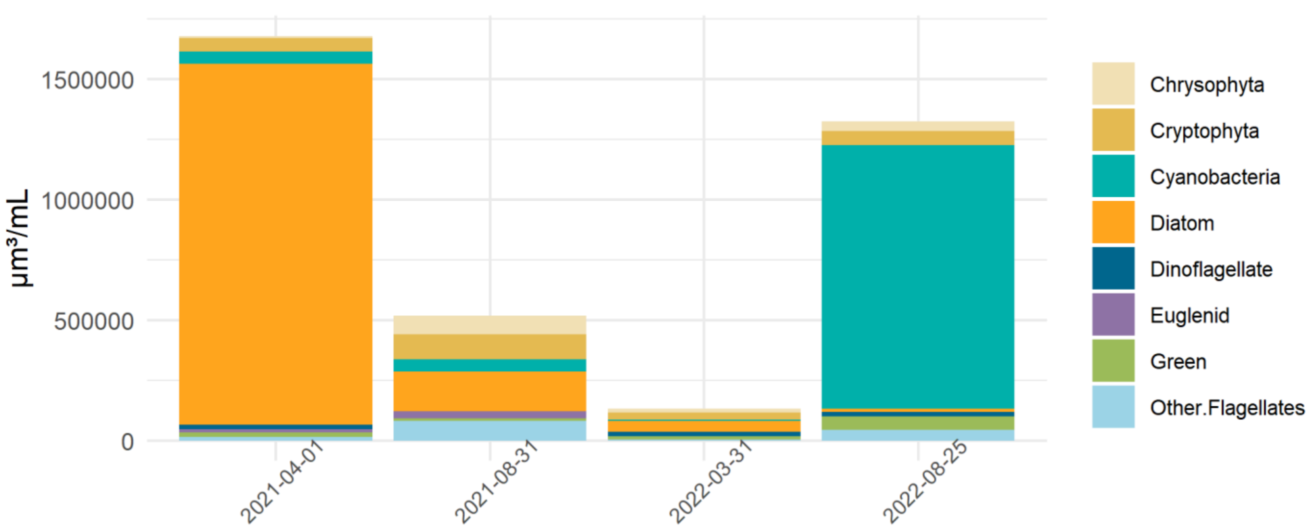

Figure 8: Biovolume of high-level taxa groups on Nicola Lake

References

Baker, A. L. et al. (2012). *Phycokey -- an image based key to Algae (PS Protista), Cyanobacteria, and other aquatic objects.* University of New Hampshire Center for Freshwater Biology. http://cfb.unh.edu/phycokey/phycokey.htm

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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:

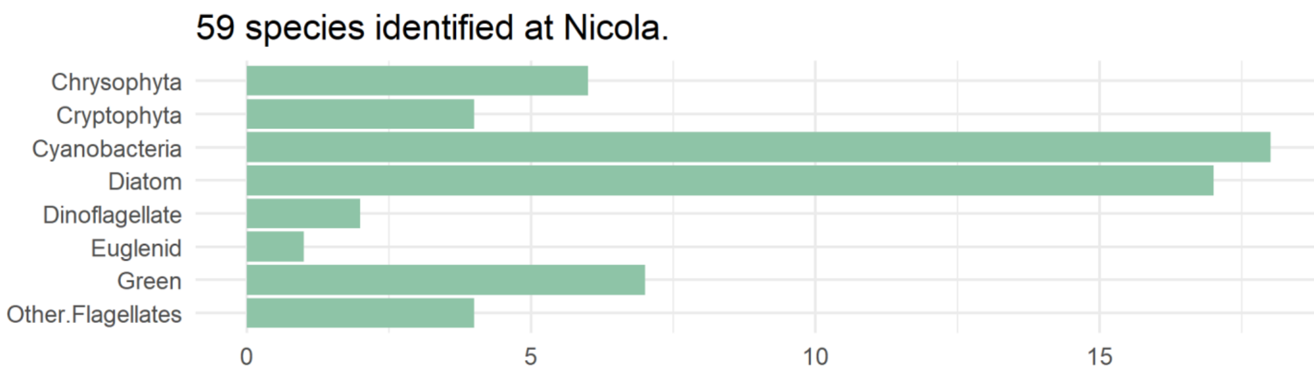

Figure 9: Identified species sorted into categories of higher-level taxa

EMS ID: 0603006	Total Abundance (cells/mL):	1600		
Collection Date: 2021-04-01	Total Biovolume (µm³/mL):	1681465		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	27	1038	Chrysophyta	2160
Ochromonas sp.	11	2355	Chrysophyta	1455
Chrysococcus sp.	11	3652	Chrysophyta	1751
Cryptomonas sp.	19	35189	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Cryptomonas marssonii	4	8167	Cryptophyta	10635
Rhodomonas lacustris	38	4126	Cryptophyta	10663
Gloeocapsa punctata	27	113	Cyanobacteria	682
Planktothrix rubescens	421	48189	Cyanobacteria	189420
Planktolyngbya limnetica	334	1709	Cyanobacteria	
Achnanthidium minutissimum	4	759	Diatom	590864
Aulacoseira sp.	114	187599	Diatom	590863
Lindavia intermedia	30	26518	Diatom	
Diatoma sp.	8	9724	Diatom	3214
Hannaea arcus	4	2875	Diatom	3320
Nitzschia sp.	4	367	Diatom	5070
Stephanodiscus niagarae	23	241529	Diatom	2415
Ulnaria ulna	4	21019	Diatom	970000
Tabellaria fenestrata	376	1010604	Diatom	3241
Peridinium sp.	4	18043	Dinoflagellate	10212
Trachelomonas sp.	4	14137	Euglenid	9690
Monoraphidium sp.	27	17888	Green	5990
microflagellate	102	17161	Other.Flagellates	

Figure 10: Raw data from 2021-04-11 EMS site 0603006

EMS ID: 0603006	**Total Abundance (cells/mL):**	**11052**		
Collection Date: 2021-08-31	**Total Biovolume (µm³/mL):**	**530743**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	277	59297	Chrysophyta	1455
Chrysochromulina sp.	83	3192	Chrysophyta	2160
Chrysococcus sp.	42	13945	Chrysophyta	1751
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	38	70378	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Rhodomonas lacustris	224	24321	Cryptophyta	10663
Anacystis sp.	2060	3920	Cyanobacteria	609
Chroococcus sp.	8	268	Cyanobacteria	654
Gloeocapsa punctata	83	348	Cyanobacteria	682
Planktolyngbya limnetica	7085	36246	Cyanobacteria	
Snowella lacustris	250	2741	Cyanobacteria	
Synechocystis sp.	228	7640	Cyanobacteria	799
Aulacoseira sp.	72	118484	Diatom	590863
Cocconeis sp.	4	5655	Diatom	3577
Cyclotella meneghiniana	4	1814	Diatom	2439
Nitzschia sp.	4	367	Diatom	5070
Stephanodiscus hantzschii	4	28835	Diatom	2415
Tabellaria fenestrata	4	10751	Diatom	3241
Trachelomonas sp.	8	28274	Euglenid	9690
Tetraedron lunula	4	561	Green	5661
Monoraphidium sp.	15	9938	Green	5990
Scenedesmus sp.	8	1867	Green	6104
UID flagellate	8	2783	Other.Flagellates	
microflagellate	531	89340	Other.Flagellates	

Figure 11: Raw data from 2021-08-31 EMS site 0603006

EMS ID: 0603006	**Total Abundance (cells/mL):**	**1464**		
Collection Date: 2022-03-31	**Total Biovolume (µm³/mL):**	**134760**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	46	1769	Chrysophyta	2160
Ochromonas sp.	68	14557	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	8	14816	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Rhodomonas lacustris	42	4560	Cryptophyta	10663
Anacystis sp.	342	651	Cyanobacteria	609
Planktolyngbya limnetica	478	2445	Cyanobacteria	
Planktolyngbya contorta	209	1943	Cyanobacteria	
Aulacoseira subarctica	46	24945	Diatom	590863
Aulacoseira granulata	15	4934	Diatom	590863
Cocconeis fluviatilis	4	6318	Diatom	3577
Lindavia intermedia	8	7072	Diatom	
Navicula veneta	4	3084	Diatom	3649
Peridinium sp.	4	18043	Dinoflagellate	10212
Ankistrodesmus fractus	11	1979	Green	5877
Monoraphidium contortum	19	10772	Green	5990
Desmodesmus sp.	8	1005	Green	
microflagellate	34	5720	Other.Flagellates	
picoflagellates	110	369	Other.Flagellates	

Figure 12: Raw data from 2022-03-31 EMS site 0603006

EMS ID: 0603006	**Total Abundance (cells/mL):**	**14726**		
Collection Date: 2022-08-25	**Total Biovolume (µm³/mL):**	**1333833**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	129	4962	Chrysophyta	2160
Chromulina sp.	19	33576	Chrysophyta	1717
Spumella sp.	102	748	Chrysophyta	1491
Cryptomonas sp.	15	27781	Cryptophyta	10635
Rhodomonas lacustris	288	31270	Cryptophyta	10663
Anacystis sp.	34	65	Cyanobacteria	609
Anabaena sp.	1097	82252	Cyanobacteria	1100
Anabaena helicoidea	516	68085	Cyanobacteria	1100
Anabaena spiroides	258	69362	Cyanobacteria	1100
Anabaena solitaria	23	6183	Cyanobacteria	1100
Aphanizomenon flos-aquae	1924	320354	Cyanobacteria	1191
Gomphosphaeria sp.	190	8429	Cyanobacteria	714
Gloeothece sp.	76	4974	Cyanobacteria	703
Leptolyngbya sp.	1730	4586	Cyanobacteria	189418
Synechocystis sp.	27	905	Cyanobacteria	799
Snowella sp.	209	897	Cyanobacteria	
Planktolyngbya limnetica	3704	18949	Cyanobacteria	
Planktolyngbya contorta	516	4796	Cyanobacteria	
Planktothrix sp.	186	10354	Cyanobacteria	189420
Planktothrix agardhii	3040	496921	Cyanobacteria	189420
Aulacoseira granulata	19	6250	Diatom	590863
Navicula sp.	8	5655	Diatom	3649
Glenodinium cinctum	8	15984	Dinoflagellate	10174
Parvodinium sp.	8	4411	Dinoflagellate	
Sphaerocystis sp.	197	42623	Green	9169
Dictyosphaerium sp.	91	7014	Green	6297
Monoraphidium sp.	8	5300	Green	5990
microflagellate	304	51147	Other.Flagellates	

Figure 13: Raw data from 2022-08-25 EMS site 0603006