Fraser Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from two sites on Fraser 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
FRASER L WEST BASIN DEEP STN (E105973)	2022-05-12 2022-08-16
FRASER L NEAR MIDDLE 3 KM E LOT 3229 (0400411)	2021-05-26 2021-08-16 2022-05-12 2022-08-16
	Total= 6 samples

Figure 1: Aerial view of Fraser Lake

Fraser Lake exhibited expected seasonal patterns; a small increase in diatom density in the spring followed by a cyanobacterial bloom in the summer (Figure 2). *Aulacoseira and Stephanodiscus* species were the dominant diatom genera observed.

Spring blooms of diatoms are common and are reflective of increased temperatures, light penetration, and silica in the water following ice thaw (Kong et al., 2021). Diatoms increase the resiliency and health 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* sp. can avoid grazing pressures by developing into large colonies reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012).

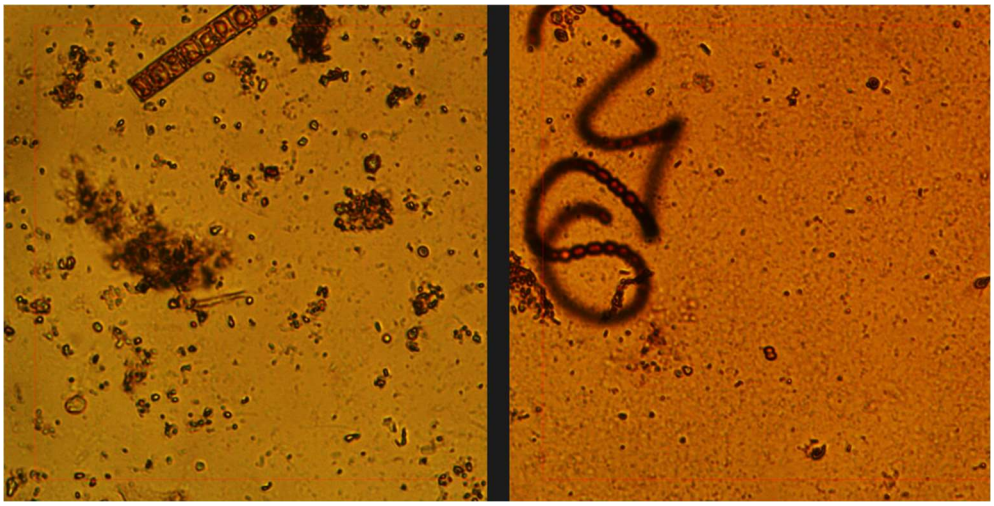

Figure 2: Diatom based spring (left) vs. cyanobacterial based summer (right) sample composition

Overview (continued)

Identified species of algae in Fraser Lake were sorted into nine groups of higher taxa. Species were dominantly identified as diatoms (Figure 3).

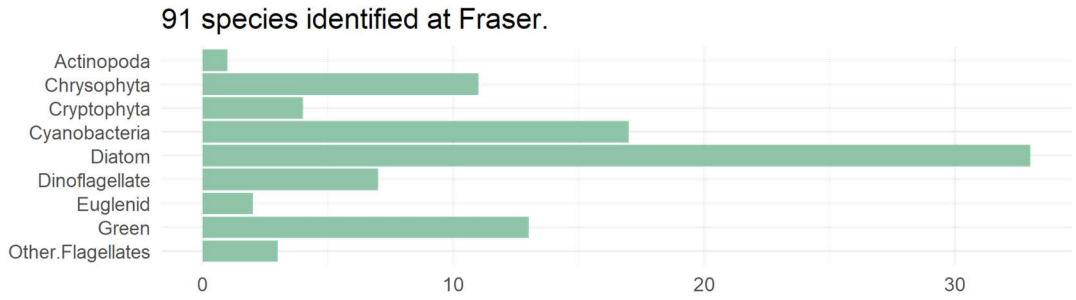

Figure 3: Number of identified species per higher level taxa

Ceratium and *Stephanodiscus* dominated biovolumes (Figure 4). Marine species of *Ceratium* are associated with toxic red tides, however little evidence exists linking *Ceratium* blooms in freshwater systems with the production of toxic secondary metabolites (*An Image-Based Key: Ceratium (Dinophyceae)*, 2017). Due to their size, *Ceratium* species often dominate biovolume counts even when concentrations are low.

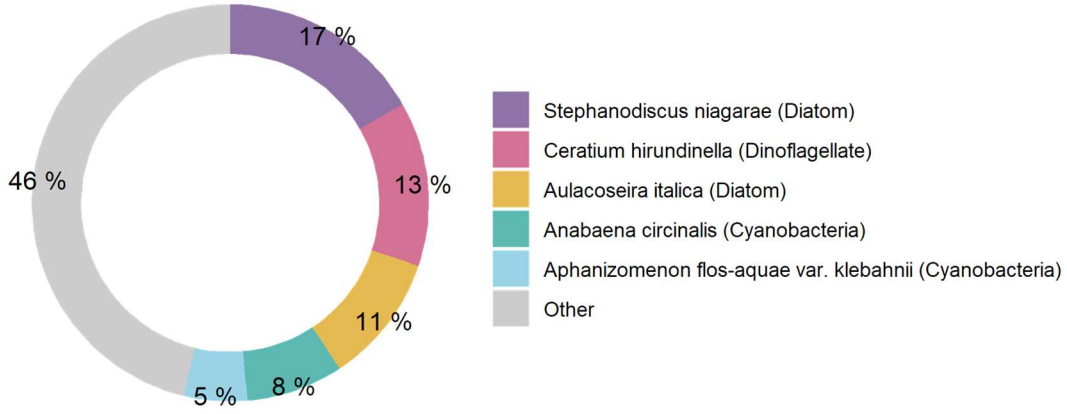

Figure 4: Dominant organisms from Fraser Lake, as percent of total biovolume

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

Anacystis, Aphanocapsa, and Anabaena were dominant cyanobacterial genera in the summer (Figure 5).

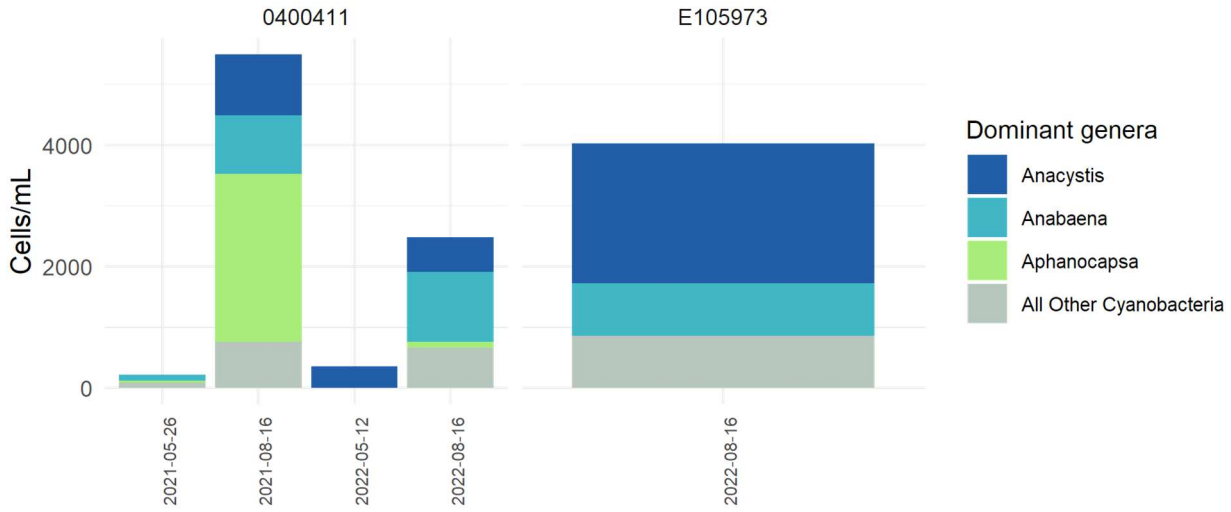

Figure 5: Cell abundance for dominant cyanobacteria genera on Fraser Lake

During blooms, species of *Anabaena* and *Aphanocapsa* can produce both negative odor/taste compounds and toxic secondary metabolites. *Anabaena* blooms can quickly accumulate, produce odor compounds, 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 Fraser Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Aphanocapsa	2766	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Anacystis	2300	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Anabaena	865	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 Fraser Lake can produce cyanotoxins (Table 2).

Fraser Lake displayed a range of cyanobacteria levels in the negligible to low risk category, with a mean cyanobacteria abundance of 2,516 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Fraser Lake compared to alert levels defined by several authorities including the WHO and the EPA.

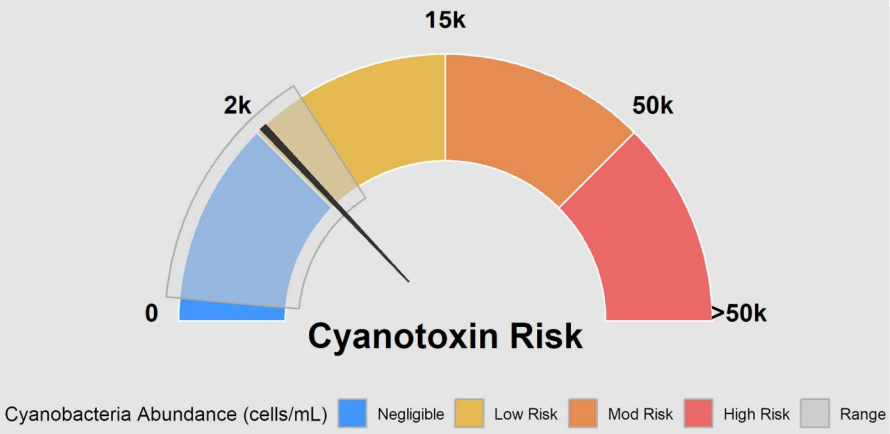

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Fraser Lake

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 can be seen in Figure 7 where a single *Asterionella* cell dwarfs the eleven adjacent *Anacystis* cells.

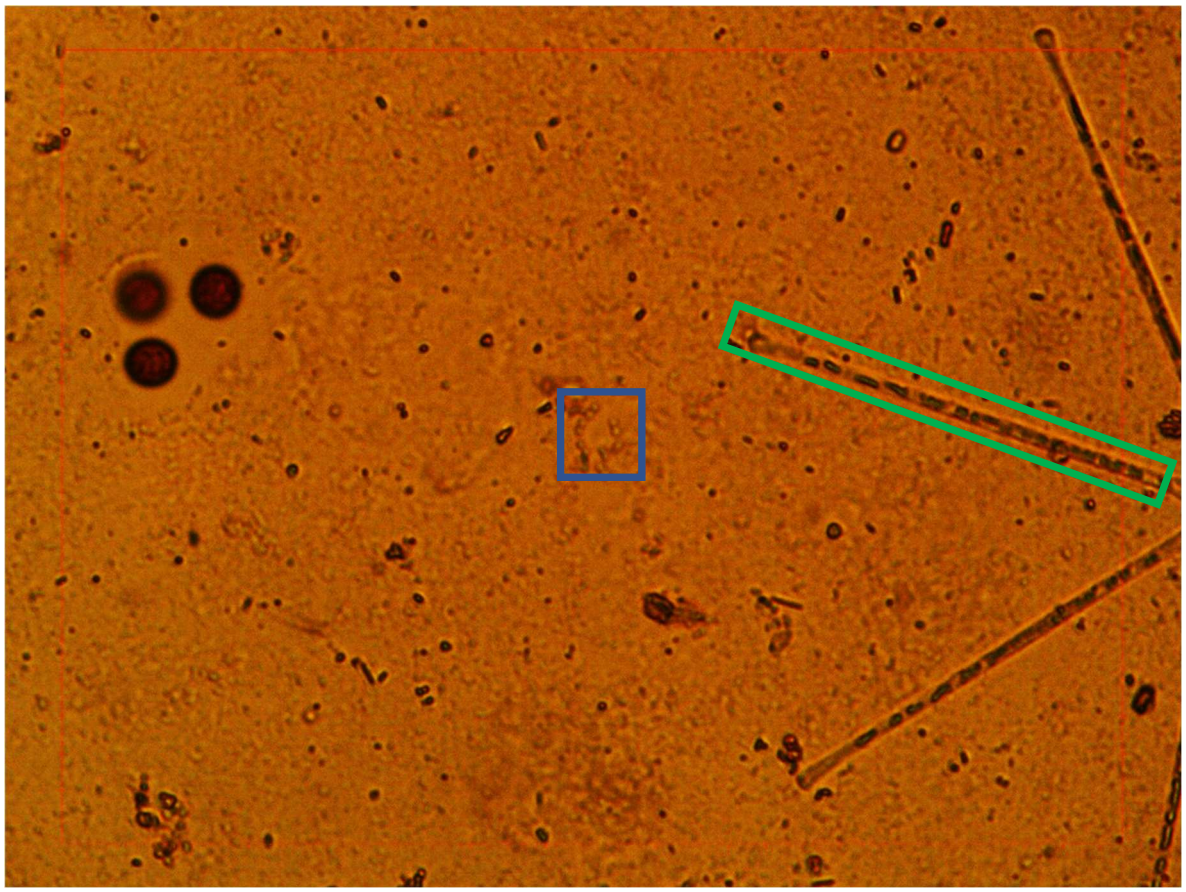

Figure 7: Size comparison of one Asterionella cell (green box) to eleven widely spaced Anacystis cells (blue box)

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.

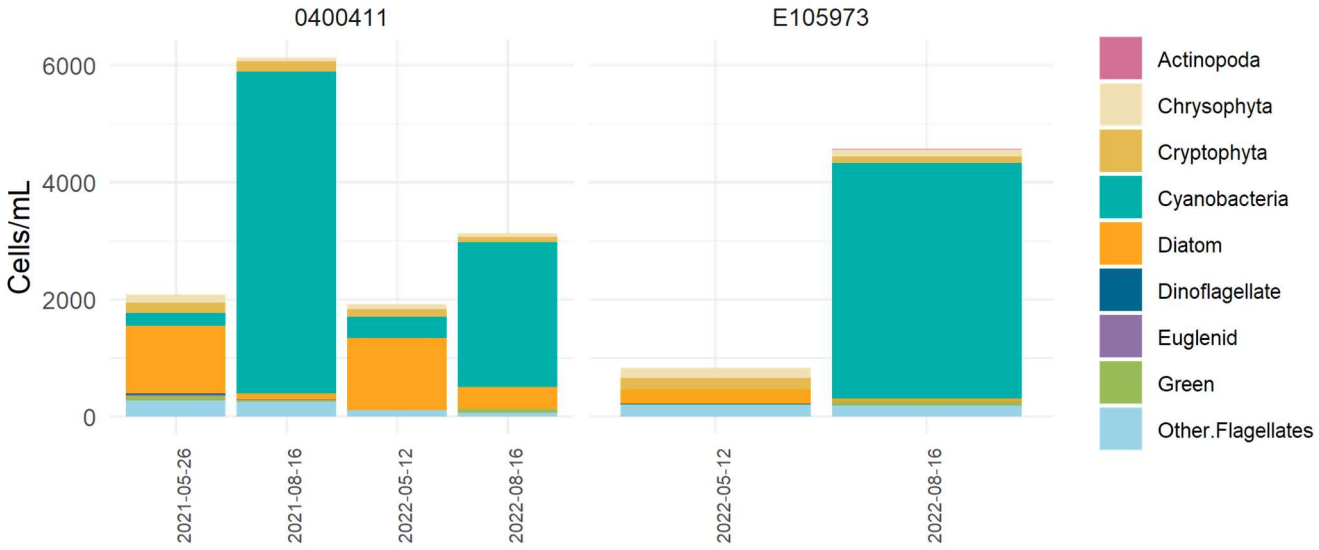

Figure 8: Cell abundance of high-level taxa groups on Fraser Lake (E105973)

Figure 9: Biovolume of high-level taxa groups on Fraser Lake (E105973)

References

An Image-Based Key: Ceratium (Dinophyceae). (2017, November). University of New Hampshire.

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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Appendix

Additional figures and raw data are listed below:

EMS ID: 0400411	Total Abundance (cells/mL):	2088	
Collection Date: 2021-05-26	Total Biovolume (µm³/mL):	1046780	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	76	41057	Chrysophyta
Chromulina sp.	8	14137	Chrysophyta
Dinobryon sertularia	11	13526	Chrysophyta
Chrysococcus sp.	15	4980	Chrysophyta
Ochromonas sp. Small	34	926	Chrysophyta
Cryptomonas ovata	23	50045	Cryptophyta
Rhodomonas lacustris	148	16070	Cryptophyta
Anabaena circinalis	99	30717	Cyanobacteria
Aphanocapsa elachista	30	84	Cyanobacteria
Gloeocapsa punctata	91	381	Cyanobacteria
Aulacoseira distans var. nivalis	247	49662	Diatom
Aulacoseira ambigua	72	22276	Diatom
Aulacoseira granulata	53	17433	Diatom
Asterionella formosa	11	7660	Diatom
Cocconeis placentula	8	13034	Diatom
Discostella stelligera	4	17804	Diatom
Cyclotella bodanica	4	1587	Diatom
Cyclotella glomerata	4	2517	Diatom
Fragilaria crotonensis	23	11168	Diatom
Gomphonema olivaceum	4	4149	Diatom
Aulacoseira italica	679	338960	Diatom
Neidium cf. dubium	4	18548	Diatom
Nitzschia acicularis	4	3158	Diatom
Stephanodiscus niagarae	19	199524	Diatom
Ulnaria acus	4	4167	Diatom
Ulnaria ulna	8	42038	Diatom
Nitzschia sp. small	8	5655	Diatom
Neidium sp.	4	5388	Diatom
Peridiniales	4	16755	Dinoflagellate
Peridinium willei	4	8579	Dinoflagellate
Peridinium inconspicuum	4	7326	Dinoflagellate
Gymnodinium fuscum	4	28632	Dinoflagellate
Lepocinclis ovum	19	16116	Euglenid
Closteriopsis sp.	8	1433	Green
Mougeotia gracilima	23	10910	Green
Oocystis solitaria	8	1843	Green
Monoraphidium kormakovae	4	413	Green
Monoraphidium contortum	15	8504	Green
Lagerheimiella genevensis	15	754	Green
Monoraphidium indicum	8	5606	Green
nanoflagellates	87	2620	Other.Flagellates
picoflagellates	190	638	Other.Flagellates

Figure 10: Raw data from 2021-05-26 EMS site 0400411

EMS ID: 0400411	Total Abundance (cells/mL):	6138	
Collection Date: 2021-08-16	Total Biovolume (µm³/mL):	622672	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	34	18367	Chrysophyta
Chromulina sp.	4	7069	Chrysophyta
Dinobryon sertularia	4	4918	Chrysophyta
Chrysococcus sp.	19	6308	Chrysophyta
Ochromonas sp lrg pointed	4	2036	Chrysophyta
Ochromonas sp. Small	8	218	Chrysophyta
Cryptomonas ovata	23	50045	Cryptophyta
Rhodomonas lacustris	148	16070	Cryptophyta
Anabaena cylindrica	114	19340	Cyanobacteria
Anabaena circinalis	850	263730	Cyanobacteria
Anacystis cyanea	1006	1514	Cyanobacteria
Aphanizomenon flos-aquae var. klebahnii	444	114495	Cyanobacteria
Aphanocapsa elachista	2766	7724	Cyanobacteria
Dactylococcopsis acicularis	11	402	Cyanobacteria
Planktolyngbya limnetica	277	1417	Cyanobacteria
Chroococcus limneticus	30	3831	Cyanobacteria
Aulacoseira distans var. nivalis	11	2212	Diatom
Aulacoseira granulata	4	1316	Diatom
Asterionella formosa	15	10445	Diatom
Craticula sp.	4	33477	Diatom
Aulacoseira italica	61	30451	Diatom
Peridinium willei	4	8579	Dinoflagellate
Lepocinclis ovum	8	6786	Euglenid
Monoraphidium kormakovae	23	2373	Green
Monoraphidium contortum	4	2268	Green
Lagerheimiella genevensis	8	402	Green
Monoraphidium indicum	4	2803	Green
nanoflagellates	121	3643	Other.Flagellates
picoflagellates	129	433	Other.Flagellates

Figure 11: Raw data from 2021-08-16 EMS site 0400411

EMS ID: 0400411	Total Abundance (cells/mL):	1924		
Collection Date: 2022-05-12	Total Biovolume (µm³/mL):	1162972		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	23	12425	Chrysophyta	10613
Ochromonas sp lrg pointed	8	4072	Chrysophyta	1455
Ochromonas sp. Small	53	1443	Chrysophyta	1455
Cryptomonas sp.	23	42597	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Rhodomonas lacustris	106	11509	Cryptophyta	10663
Anacystis cyanea	220	331	Cyanobacteria	609
Anacystis delicatissima	137	299	Cyanobacteria	609
Aulacoseira distans var. nivalis	38	7640	Diatom	590863
Aulacoseira ambigua	531	164287	Diatom	590863
Aulacoseira italica	311	155253	Diatom	590863
Aulacoseira cf. lacustris	228	123642	Diatom	590863
Aulacoseira cyst	46	24945	Diatom	590863
Cocconeis placentula	8	13034	Diatom	3577
Cyclotella glomerata	8	5034	Diatom	2439
Nitzschia acicularis	8	6316	Diatom	5070
Stephanodiscus niagarae	53	556566	Diatom	2415
Gymnodinium ordinatum	8	15599	Dinoflagellate	10031
nanoflagellates	8	241	Other.Flagellates	
picoflagellates	99	332	Other.Flagellates	

Figure 12: Raw data from 2022-05-12 EMS site 0400411

EMS ID: E105973	Total Abundance (cells/mL):	866		
Collection Date: 2022-05-12	Total Biovolume (µm³/mL):	411500		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas sp.	4	909	Chrysophyta	10613
Chrysococcus sp.	8	2656	Chrysophyta	1751
Chrysochromulina sp.	57	2192	Chrysophyta	2160
Chromulina sp.	11	19439	Chrysophyta	1717
Dinobryon spp.	4	6346	Chrysophyta	1515
Ochromonas sp.	91	19480	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	49	90750	Cryptophyta	10635
Rhodomonas lacustris	148	16070	Cryptophyta	10663
Achnanthidium minutissimum	49	9294	Diatom	590864
Asterionella formosa	4	2785	Diatom	3116
Aulacoseira sp.	42	69115	Diatom	590863
Aulacoseira cf. lacustris	65	35249	Diatom	590863
Aulacoseira italica	11	5491	Diatom	590863
Aulacoseira cyst	4	2169	Diatom	590863
Cocconeis sp.	4	5655	Diatom	3577
Cyclotella sp.	11	2920	Diatom	2439
UID cymbelloid	11	1851	Diatom	
Epithemia sp.	4	13195	Diatom	5005
Fragilaria sp.	11	5341	Diatom	2932
Navicula cryptotenella	4	3084	Diatom	3649
Nitzschia spp.	8	3158	Diatom	5070
Stephanodiscus sp.	8	22902	Diatom	2415
Parvodinium sp.	30	16540	Dinoflagellate	
Glenodinium sp.	8	15984	Dinoflagellate	10174
Euglena sp.	4	2304	Euglenid	9620
Ankistrodesmus sp.	11	1729	Green	5877
microflagellate	201	33818	Other.Flagellates	

Figure 13: Raw data from 2022-05-12 EMS site E105973

EMS ID: 0400411	Total Abundance (cells/mL):	3136		
Collection Date: 2022-08-16	Total Biovolume (µm³/mL):	881945		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sertularia	30	36888	Chrysophyta	1515
Ochromonas sp. Small	40	1089	Chrysophyta	1455
Cryptomonas erosa	10	17719	Cryptophyta	10635
Rhodomonas lacustris	71	7709	Cryptophyta	10663
Anabaena cf. cylindrica	789	212120	Cyanobacteria	1100
Anabaena circinalis	364	112938	Cyanobacteria	1100
Anacystis cyanea	506	762	Cyanobacteria	609
Anacystis delicatissima	61	133	Cyanobacteria	609
Aphanizomenon flos-aquae var. klebahnii	587	151371	Cyanobacteria	1191
Aphanocapsa elachista	101	282	Cyanobacteria	625
Gomphosphaeria sp.	51	2262	Cyanobacteria	714
Chroococcus limneticus	20	2554	Cyanobacteria	654
Aulacoseira ambigua	71	21967	Diatom	590863
Aulacoseira italica	30	14976	Diatom	590863
Asterionella formosa	61	42476	Diatom	3116
Discostella stelligera	10	44509	Diatom	970023
Fragilaria crotonensis	192	93227	Diatom	2932
Stephanodiscus niagarae	10	105012	Diatom	2415
Oocystis parva	61	13713	Green	5827
picoflagellates	71	238	Other.Flagellates	

Figure 14: Raw data from 2022-08-16 EMS site 0400411

EMS ID: E105973	Total Abundance (cells/mL):	4570		
Collection Date: 2022-08-16	Total Biovolume (µm³/mL):	1050512		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	4	673	Actinopoda	
Chrysochromulina sp.	23	885	Chrysophyta	2160
Dinobryon spp.	4	6346	Chrysophyta	1515
Ochromonas sp.	91	19480	Chrysophyta	1455
Cryptomonas sp.	8	14816	Cryptophyta	10635
Rhodomonas lacustris	106	11509	Cryptophyta	10663
Anabaena sp.	865	64857	Cyanobacteria	1100
Anacystis sp.	2300	4376	Cyanobacteria	609
Aphanizomenon flos-aquae	751	125045	Cyanobacteria	1191
Synechocystis sp.	87	2915	Cyanobacteria	799
Planktolyngbya sp.	23	286	Cyanobacteria	
Asterionella formosa	11	7660	Diatom	3116
Aulacoseira sp.	19	31267	Diatom	590863
Cyclotella sp.	4	1062	Diatom	2439
Tabellaria fenestrata	4	10751	Diatom	3241
Ceratium hirundinella	4	690615	Dinoflagellate	10397
Gloeocystis sp.	11	1173	Green	6355
Monoraphidium sp.	30	19875	Green	5990
Oocystis sp.	15	283	Green	5827
Oocystis solitaria	8	1843	Green	5827
Didymocystis fina	8	2155	Green	55858
microflagellate	194	32640	Other.Flagellates	

Figure 15: Raw data from 2022-08-16 EMS site E105973