Brannen Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Brannen 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 2021 and 2022

Sample Site (EMS#)	Dates
BRANNEN LAKE (1100862)	2021-03-10
	2021-09-07
	2022-03-10
	2022-09-01
	Total= 4 samples

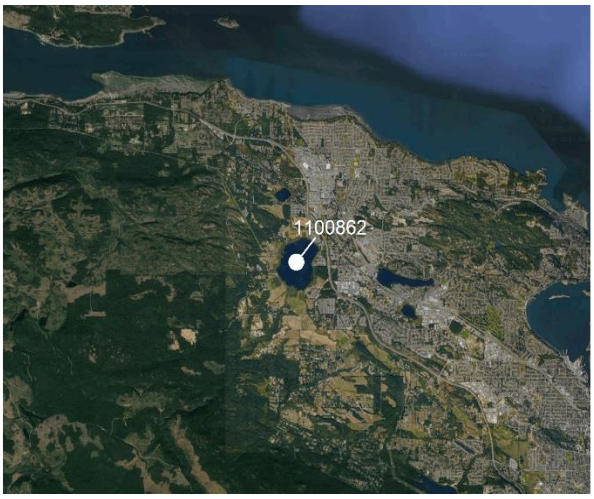

Figure 1: Aerial view of Brannen Lake

Samples contained low concentrations of diatoms; *Fragilaria* was the dominant genus present.

Summer samples contained elevated concentrations of algae compared to spring samples (Figure 2). Moderate concentrations of Chrysophyta were observed in all samples; *Dinobryon* was the dominant genus present.

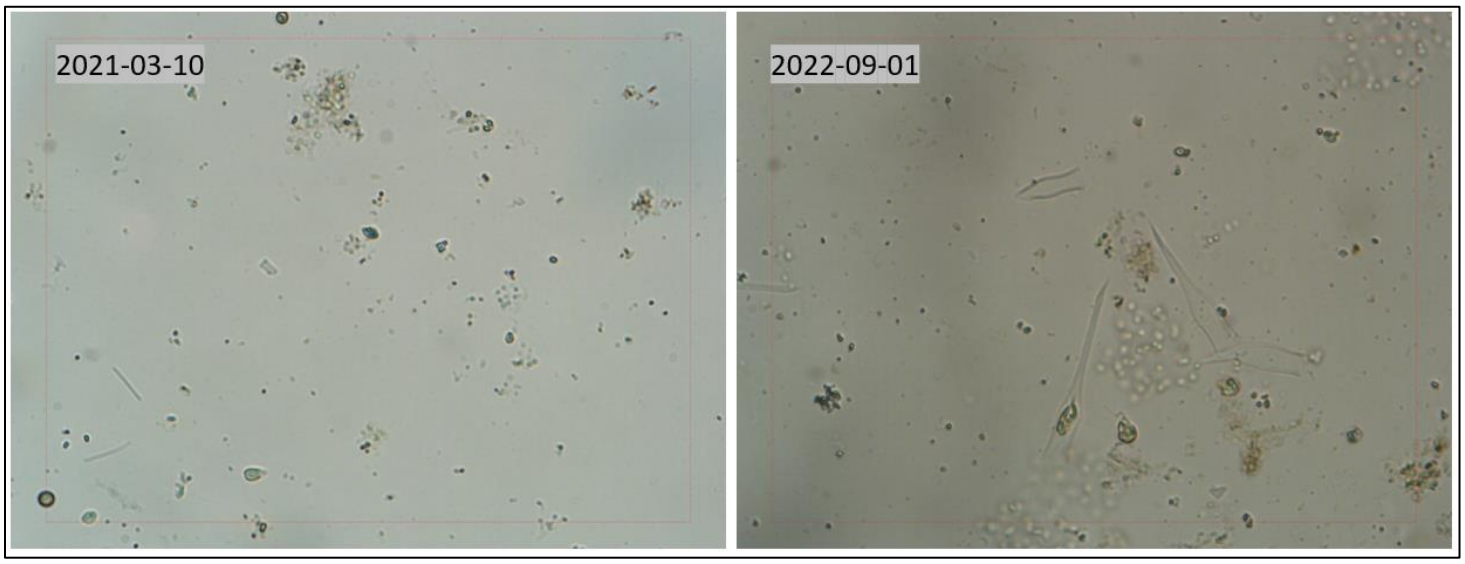

Figure 2: Compositional changes from low algae concentrations in a spring sample (left) vs a summer sample (right)

Overview (continued)

Chrysophyta, genus *Dinobryon,* dominated total biovolumes (36%; Figure 3). Cryptomonads (*Cryptomonas curvata* and *Rhodomonas lacustris)* and Chrysophyta *(Ochromonas* and *Chromulina)* were also observed frequently (Figure 3).

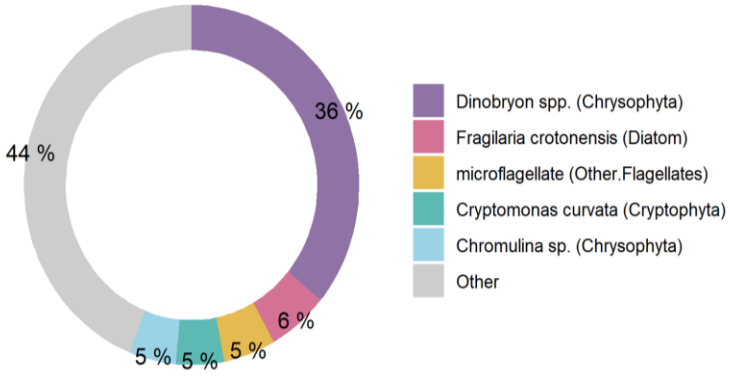

Figure 3: Dominant organisms from Brannen Lake (1100862) as percent of total biovolume

Chrysophyta are advantageous and detrimental in freshwater systems, depending on their context. Some Chrysophyta are known to produce odor metabolites described as fishy, while others eat bacteria and reduce negative odor metabolites (Wehr et al., 2015).

One sample contained elevated densities of Chrysophyta (genus *Dinobryon;* 2022-09-01; Figure 4). *Dinobryon* blooms are associated with unpleasant fishy odors, and one species of *Dinobryon* is linked to toxins that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

Figure 4: 400x magnification of EMS #1100862 collected on 2022-09-01 demonstrating high density of cyanobacteria Aphanocapsa (blue box) and Chrysophyta, genus Dinobryon (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

Summer samples contained high concentrations of cyanobacteria, dominant genera included *Anacystis*, *Aphanocapsa,* and *Snowella* (Figure 5).

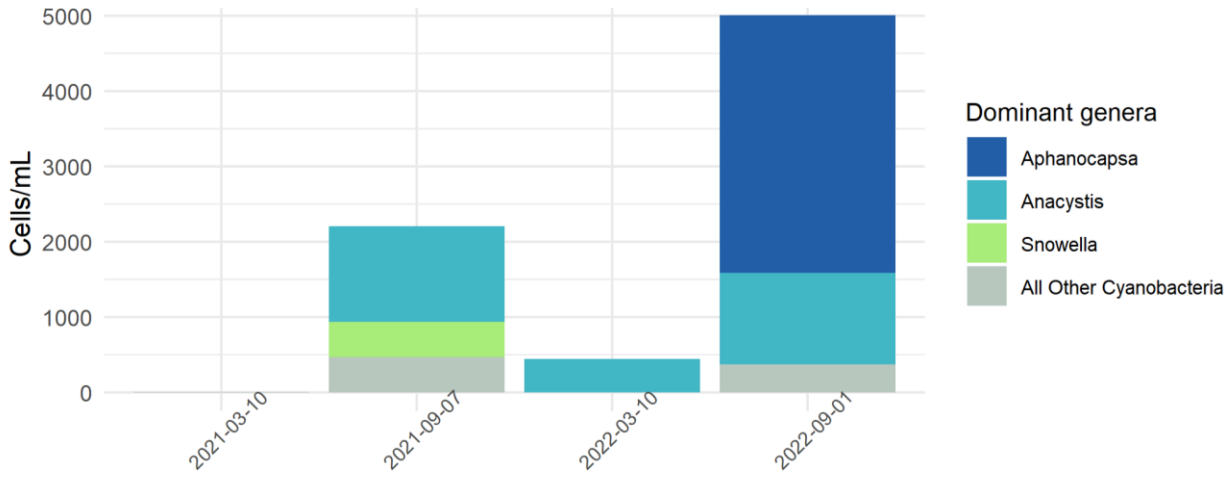

Figure 5: cell abundance for dominant cyanobacteria genera on Brannen Lake

Dominant cyanobacteria in Brannen Lake are associated with several cyanotoxins (Table 2). Illnesses 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 Brannen Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	209	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Aphanocapsa	144	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Anabaena	34	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 Brannen Lake can produce cyanotoxins (Table 2).

Brannen Lake displayed a range of cyanobacteria levels in the negligible-low risk category, with a mean cyanobacteria abundance of 1,917 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Brannen Lake compared to alert levels defined by several authorities including the WHO and the EPA.

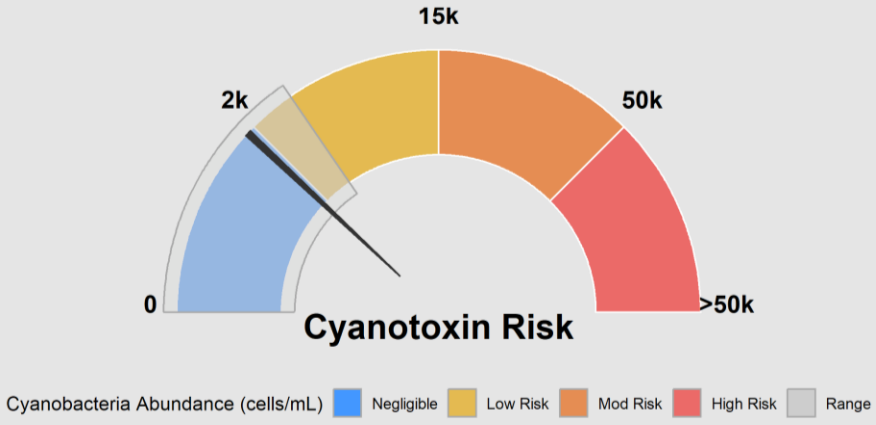

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Brannen Lake

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 diatom cell is an equivalent size to approximately 100 cyanobacteria cells.

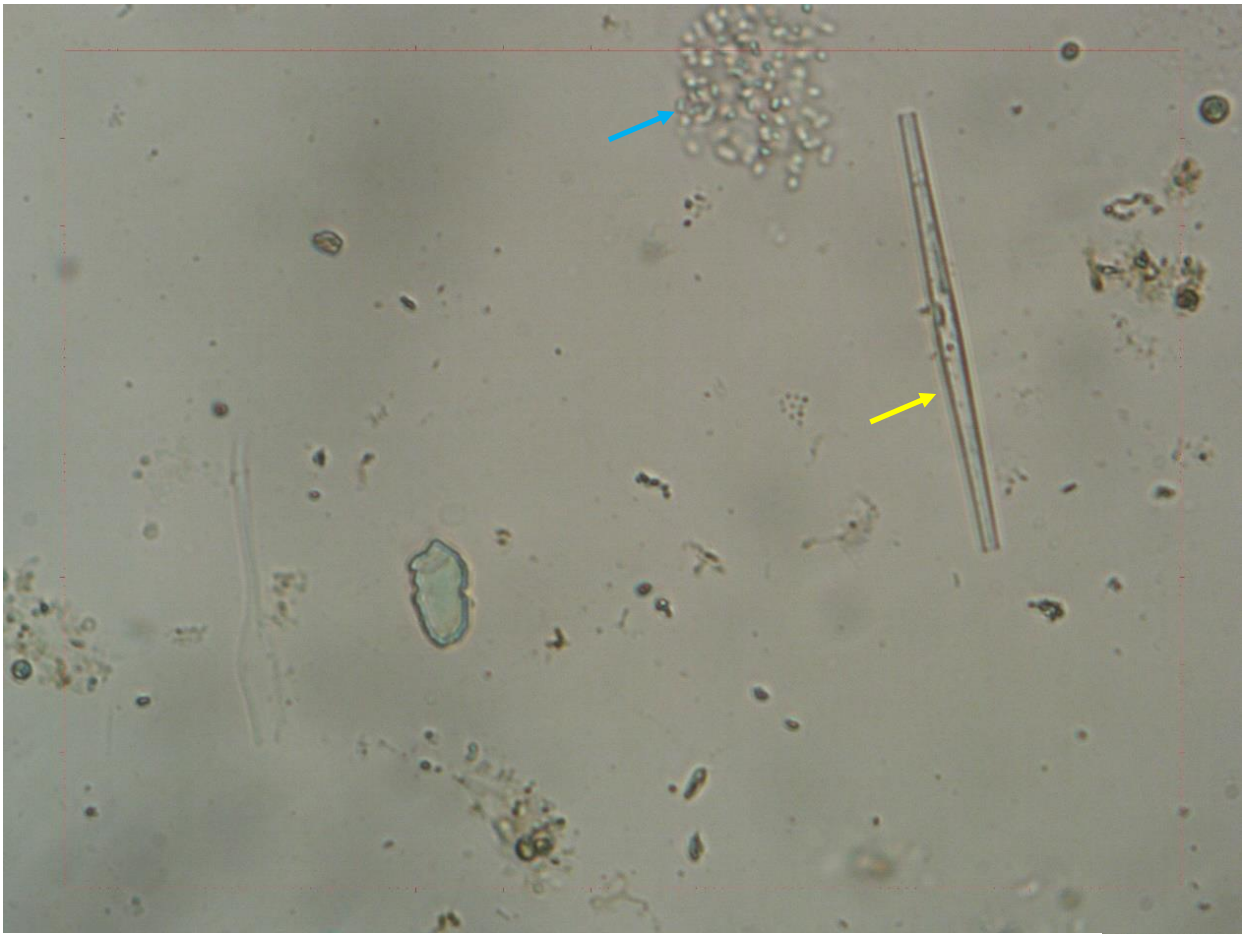

Figure 7: Size comparison of a Ulnaria cell (yellow arrow) to an Anacystis cell (blue arrow)

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.

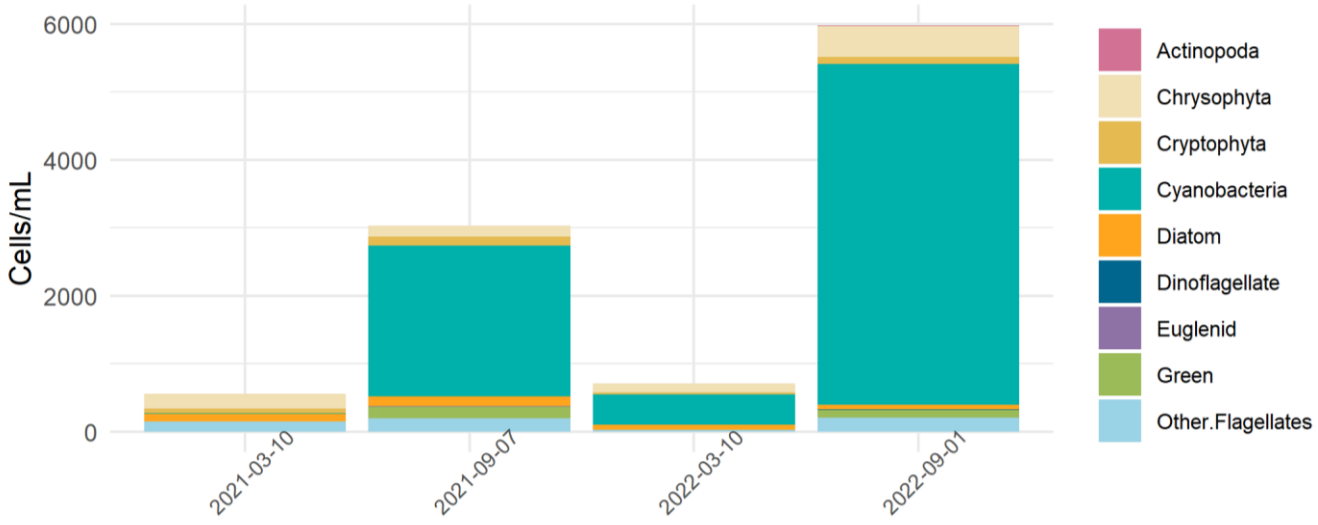

Figure 8: Cell abundance of high-level taxa groups on Brannen Lake

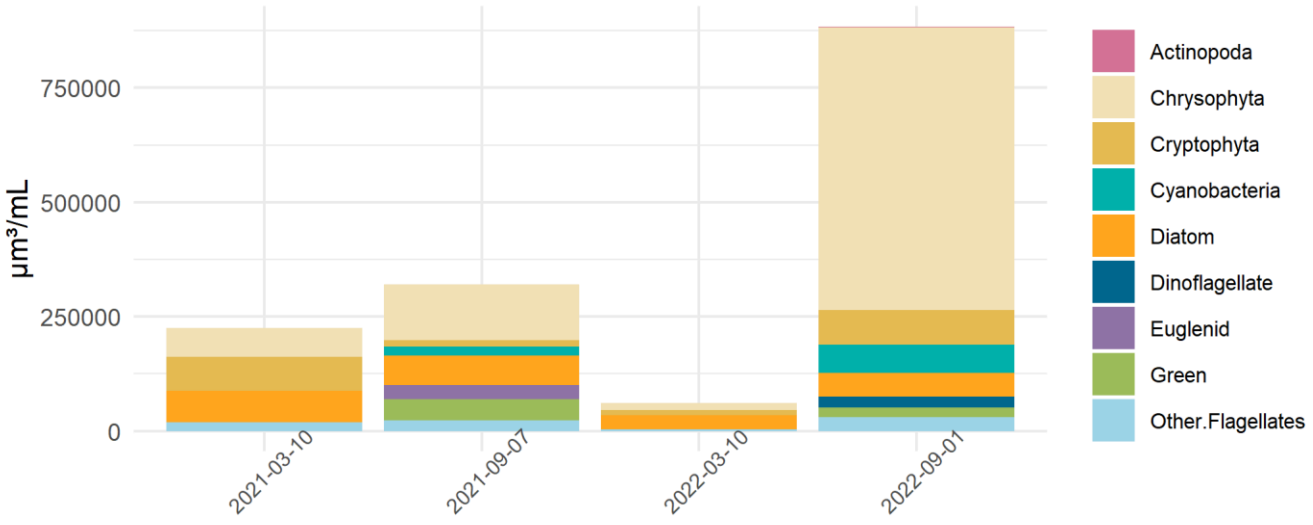

Figure 9: Biovolume of high-level taxa groups on Brannen Lake

References

Cantrell, R., & Long, B. (2013). *Dinobryon*. PBWorks. http://ohapbio12.pbworks.com/w/page/51731561/Dinobryon

Conrad, J. (2013). *DINOBRYON, a Golden Alga*. Jim Conrad's Naturalist Newsletter. https://www.backyardnature.net/n/x/dinobryo.htm

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

Wehr, J. D., Sheath, R. G., & Kociolek, P. (2015). *Freshwater Algae of North America* (Second). Elsevier Inc.

Zhao, Y., Yan, Y., Xie, L., Wang, L., He, Y., Wan, X., & Xue, Q. (2020). Long-term environmental exposure to microcystins increases the risk of nonalcoholic fatty liver disease in humans: A combined fisher-based investigation and murine model study. *Environment International*, *138*, 105648. https://doi.org/10.1016/J.ENVINT.2020.105648

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:

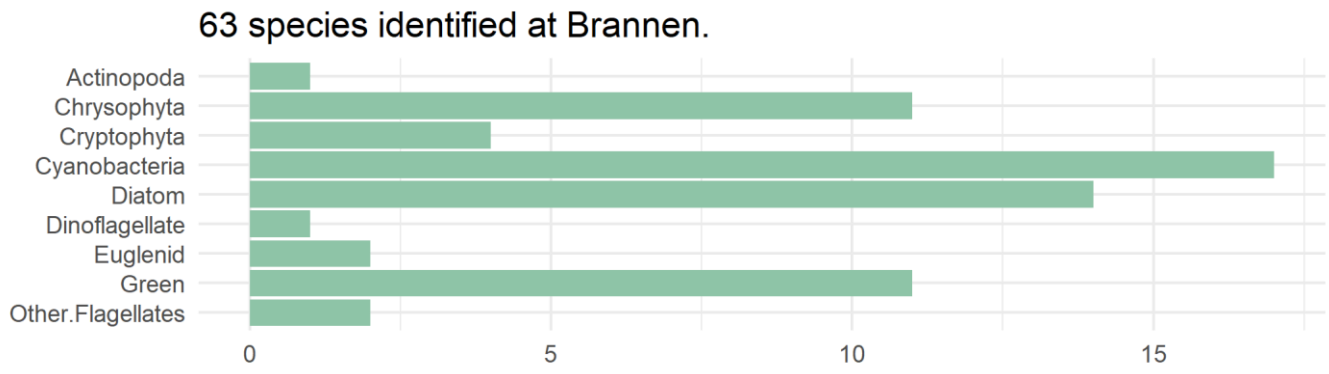

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 1100862	**Total Abundance (cells/mL):**	**558**		
Collection Date: 2021-03-10	**Total Biovolume (µm³/mL):**	**233371**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Mallomonas sp.	11	33267	Chrysophyta	1598
Bitrichia sp.	4	459	Chrysophyta	
Ochromonas sp.	114	24404	Chrysophyta	1455
Chrysochromulina sp.	91	3500	Chrysophyta	2160
Chrysococcus sp.	4	1328	Chrysophyta	1751
Dinobryopsis sp.	15	4029	Chrysophyta	1557
Cryptomonas curvata	11	69299	Cryptophyta	10635
Rhodomonas lacustris	53	5755	Cryptophyta	10663
Chlorogloea sp.	4	90	Cyanobacteria	824
Achnanthidium minutissimum	15	2845	Diatom	590864
Aulacoseira subarctica	27	14642	Diatom	590863
Asterionella formosa	38	26460	Diatom	3116
Cyclotella sp.	4	1062	Diatom	2439
Diatoma sp.	4	4862	Diatom	3214
Navicula spp.	4	2356	Diatom	3649
Nitzschia sp.	11	1009	Diatom	5070
Ulnaria acus	15	15627	Diatom	970000
microflagellate	133	22377	Other.Flagellates	

Figure 11: Raw data from 2021-03-10 EMS site 1100862

EMS ID: 1100862	Total Abundance (cells/mL):	3031		
Collection Date: 2021-09-07	Total Biovolume (µm³/mL):	334969		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sertularia	46	56562	Chrysophyta	1515
Dinobryon bavaricum	11	23942	Chrysophyta	1515
Dinobryon sp.	19	28538	Chrysophyta	1515
Bitrichia sp.	4	459	Chrysophyta	
Ochromonas sp.	53	11346	Chrysophyta	1455
Chrysochromulina sp.	34	1308	Chrysophyta	2160
Dinobryopsis sp.	42	11281	Chrysophyta	1557
Rhodomonas lacustris	133	14441	Cryptophyta	10663
Anacystis sp.	38	72	Cyanobacteria	609
Anacystis clathrata	125	273	Cyanobacteria	609
Anacystis nidulans	918	2005	Cyanobacteria	609
Anacystis incerta	186	406	Cyanobacteria	609
Anacystis limneticus	8	17	Cyanobacteria	609
Chlorogloea sp.	133	2986	Cyanobacteria	824
Anabaena circinalis	4	1241	Cyanobacteria	1100
Anabaena flos-aquae	30	5839	Cyanobacteria	1100
Gloeocapsa punctata	281	1177	Cyanobacteria	682
Gloeothece sp.	15	982	Cyanobacteria	703
Snowella lacustris	471	5165	Cyanobacteria	
Achnanthidium minutissimum	4	759	Diatom	590864
Cyclotella sp.	4	1062	Diatom	2439
Fragilaria crotonensis	125	60695	Diatom	2932
Nitzschia sp.	11	1009	Diatom	5070
Trachelomonas sp.	8	28274	Euglenid	9690
Euglena sp.	4	2304	Euglenid	9620
Ankistrodesmus falcatus	4	565	Green	5877
Crucigenia fenestrata	76	17432	Green	6225
Oocystis lacustris	46	22755	Green	5827
Oocystis solitaria	4	922	Green	5827
Tetraedron caudatum	38	5333	Green	5661
Tetmemorus sp.	4	245	Green	8483
microflagellate	152	25574	Other.Flagellates	

Figure 12: Raw data from 2021-09-07 EMS site 1100862

EMS ID: 1100862	Total Abundance (cells/mL):	711		
Collection Date: 2022-03-10	Total Biovolume (µm³/mL):	61186		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	91	3500	Chrysophyta	2160
Chrysococcus sp.	30	9961	Chrysophyta	1751
Ochromonas sp.	11	2355	Chrysophyta	1455
Cryptomonas sp.	4	7408	Cryptophyta	10635
Rhodomonas lacustris	27	2932	Cryptophyta	10663
Anacystis sp.	444	845	Cyanobacteria	609
Achnanthidium minutissimum	8	1517	Diatom	590864
Aulacoseira distans var. nivalis	57	11461	Diatom	590863
Aulacoseira italica	4	1997	Diatom	590863
Ulnaria acus	4	4167	Diatom	970000
Ulnaria nana	4	10500	Diatom	970000
microflagellate	27	4543	Other.Flagellates	

Figure 13: Raw data from 2022-03-10 EMS site 1100862

EMS ID: 1100862	Total Abundance (cells/mL):	5979		
Collection Date: 2022-09-01	Total Biovolume (µm³/mL):	887420		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	8	1346	Actinopoda	
Chrysococcus sp.	4	1328	Chrysophyta	1751
Chrysochromulina sp.	19	731	Chrysophyta	2160
Chromulina sp.	38	67152	Chrysophyta	1717
Dinobryon spp.	338	536227	Chrysophyta	1515
Ochromonas sp.	53	11346	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	23	42597	Cryptophyta	10635
Cryptomonas ovata	11	23935	Cryptophyta	10635
Rhodomonas lacustris	76	8252	Cryptophyta	10663
Anacystis sp.	83	158	Cyanobacteria	609
Anacystis sp.	125	238	Cyanobacteria	609
Anacystis delicatissima	1009	2204	Cyanobacteria	609
Aphanizomenon flos-aquae	4	666	Cyanobacteria	1191
Aphanocapsa elachista var. planctonica	3423	28004	Cyanobacteria	625
Chroococcus dispersus var. minor	91	1286	Cyanobacteria	654
Chroococcus turgidus	83	28120	Cyanobacteria	654
Gloeocapsa punctata	106	444	Cyanobacteria	682
Planktolyngbya sp.	87	1081	Cyanobacteria	
Fragilaria crotonensis	53	25735	Diatom	2932
Navicula sp.	8	5655	Diatom	3649
Ulnaria ulna	4	21019	Diatom	970000
Gymnodinium sp.	11	23303	Dinoflagellate	10031
Ankistrodesmus sp.	4	629	Green	5877
Crucigenia tetrapedia	15	1838	Green	6225
Elakatothrix sp.	53	10176	Green	9412
Oocystis sp.	15	283	Green	5827
Quadrigula chodati	30	8775	Green	5938
microflagellate	201	33818	Other.Flagellates	

Figure 14: Raw data from 2022-09-01 EMS site 1100862