

# Francois Lake Phytoplankton Summary Report 2021-2022

## Overview

Samples were collected from three sites on Francois 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
FRANCOIS LAKE EAST END DEEP STATION (E224946)	2021-08-17
	2022-05-30
	2022-08-18
FRANCOIS LAKE CENTRE DEEP STATION (E271703)	2021-05-11
	2021-08-17
	2022-05-30
FRANCOIS LAKE WEST END DEEP STATION (E224945)	2021-08-17
<b>Total= 8 samples</b>	

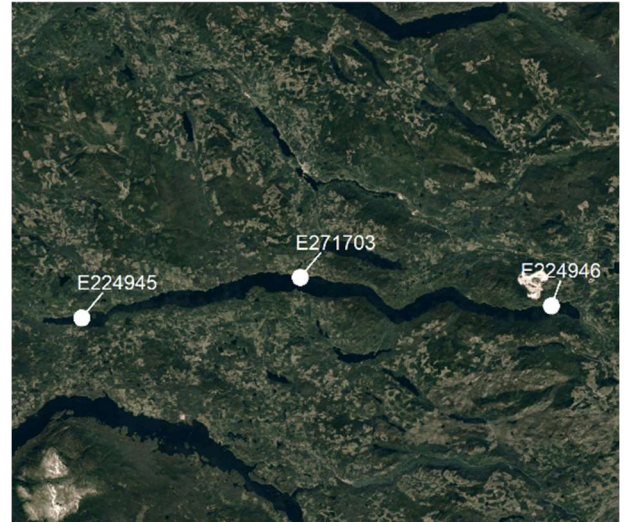


Figure 1: Aerial view of Francois Lake

Samples demonstrated stable levels of diatoms, green algae, Chrysophytes, and flagellates. Francois Lake had small increases in diatom density during spring; *Lindavia*, *Aulacoseira*, and *Tabellaria* were the dominant genera (Figure 2).

Spring blooms of diatoms are common and reflective of increased temperatures, light penetration, and silica in the water following ice thaw (Kong et al., 2021). Diatoms are integral to aquatic food webs because they are the foundation of the food web (jrobyn, 2019). Colony forming diatoms such as *Tabellaria* and *Aulacoseira* sp. can avoid grazing pressures by developing into large colonies reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012).

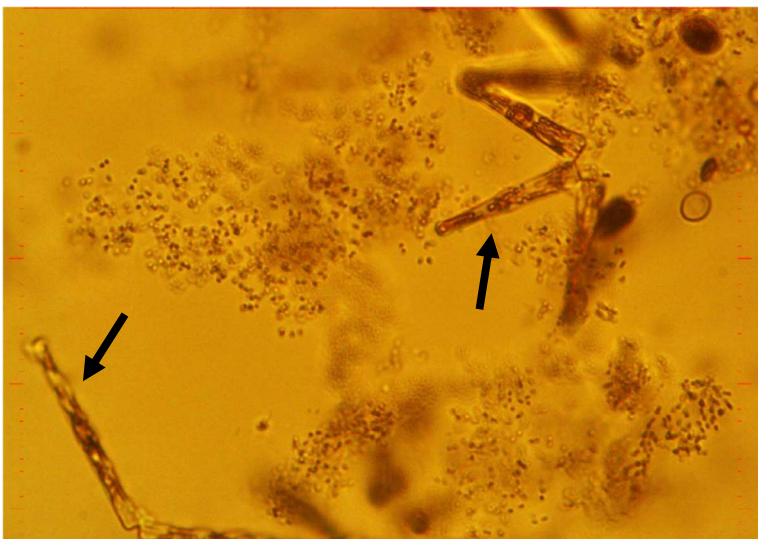


Figure 2: 400x magnification of *Tabellaria fenestrata* chains (black arrows)

## Overview (continued)

Samples contained low levels of flagellates; primarily Cryptomonads (genera *Cryptomonas* and *Rhodomonas*). Cryptomonads are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015).

Cyanobacteria and micro-flagellates frequently dominate algal communities in total cell count, but because of their small cell size their biomass is usually low relative to the other types of algae present (Figure 3; Figure 4). This can be seen in Figure 4 where the 16% of the dominant organisms was *Eremosphaera viridis* (green algae) however only two were counted.



Figure 3: Size comparison of a *Trachelomonas* cell (red box) to *Anabaena* cell (blue box)

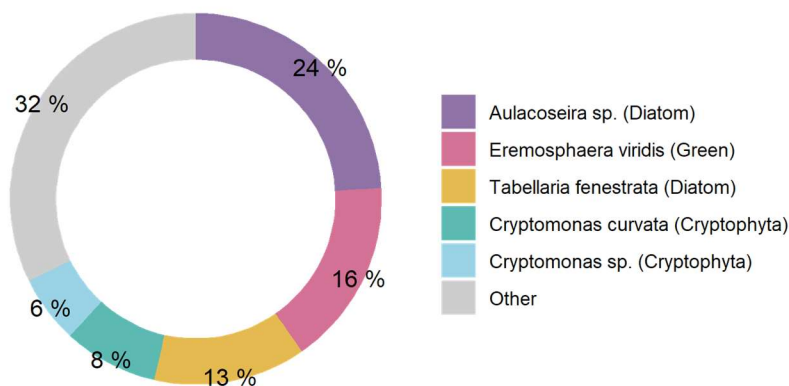


Figure 4: Dominant organisms from Francois Lake, as percent of total biovolume

## 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

Summer samples demonstrated high concentrations of cyanobacteria. *Anacystis* was the dominant genus, but *Aphanothece* and *Aphanocapsa* species were also observed (Figure 5). *Anacystis*, *Aphanothece*, and *Aphanocapsa* are linked with several cyanotoxins (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).

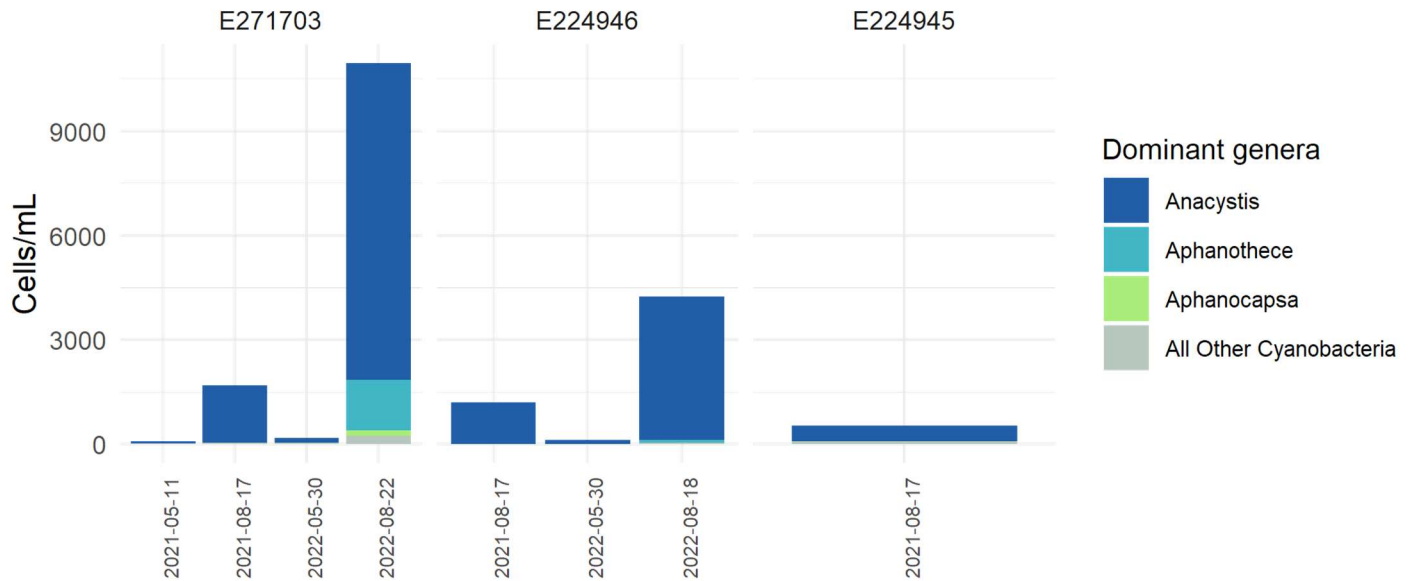


Figure 5: cell abundance for dominant cyanobacteria genera on Francois Lake

Table 2: Dominant Cyanobacteria Genus and Associated Toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
<i>Anacystis</i>	9122	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
<i>Aphanothece</i>	1438	Microcystin MC
<i>Aphanocapsa</i>	372	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA

Note: \* = counted in samples

## Cyanobacterial Presence (Continued)

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

Francois Lake samples displayed a range of cyanobacteria levels in the negligible-low risk categories, with a mean cyanobacteria abundance of 2,379 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Francois Lake compared to alert levels defined by several authorities including the WHO and the EPA.

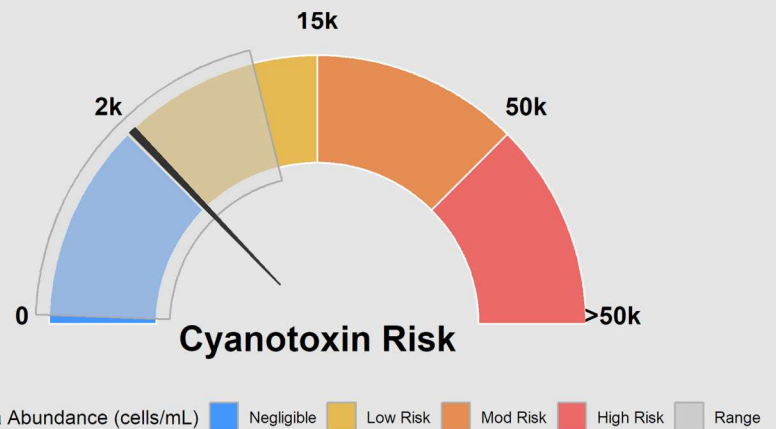


Figure 6: Cyanotoxin risk posed by cyanobacteria blooms on Francois Lake

Samples from EMS site #E224946 contained large amorphous clouds of degraded cyanobacteria and bacteria (2022-08-17; Figure 7). Degraded cyanobacteria could represent threats to public health because cyanotoxins are usually contained within cyanobacterial cells before cell death (EPA, 2022).

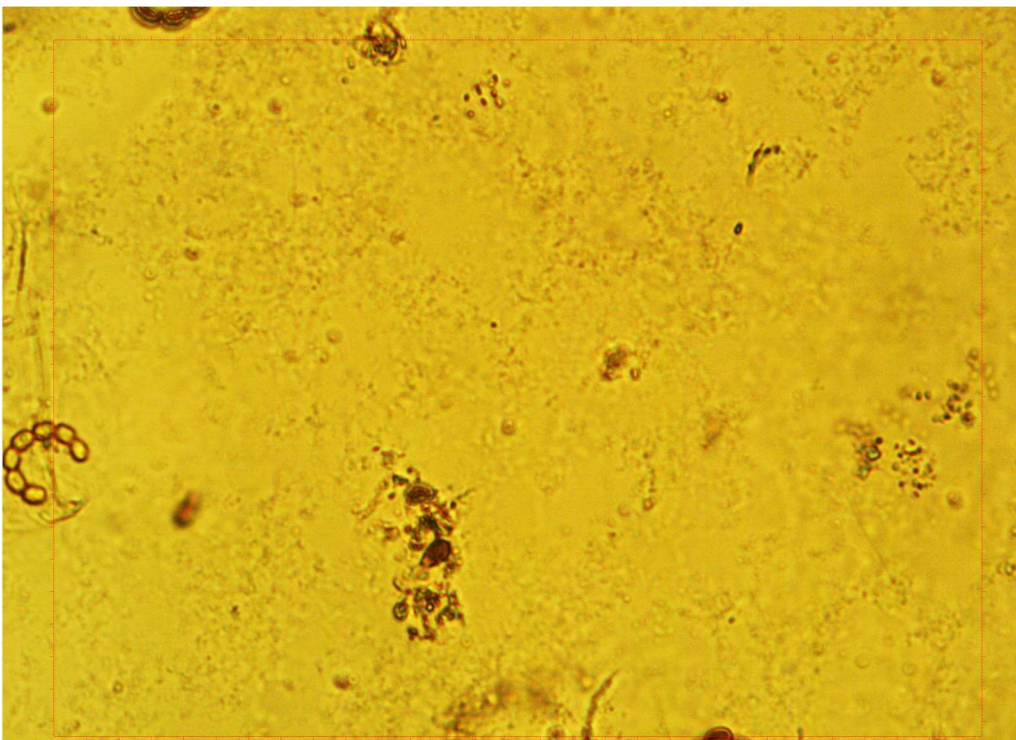


Figure 7: 400x magnification of degraded cyanobacteria film/cloud (integrated throughout the entire figure)

## 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.

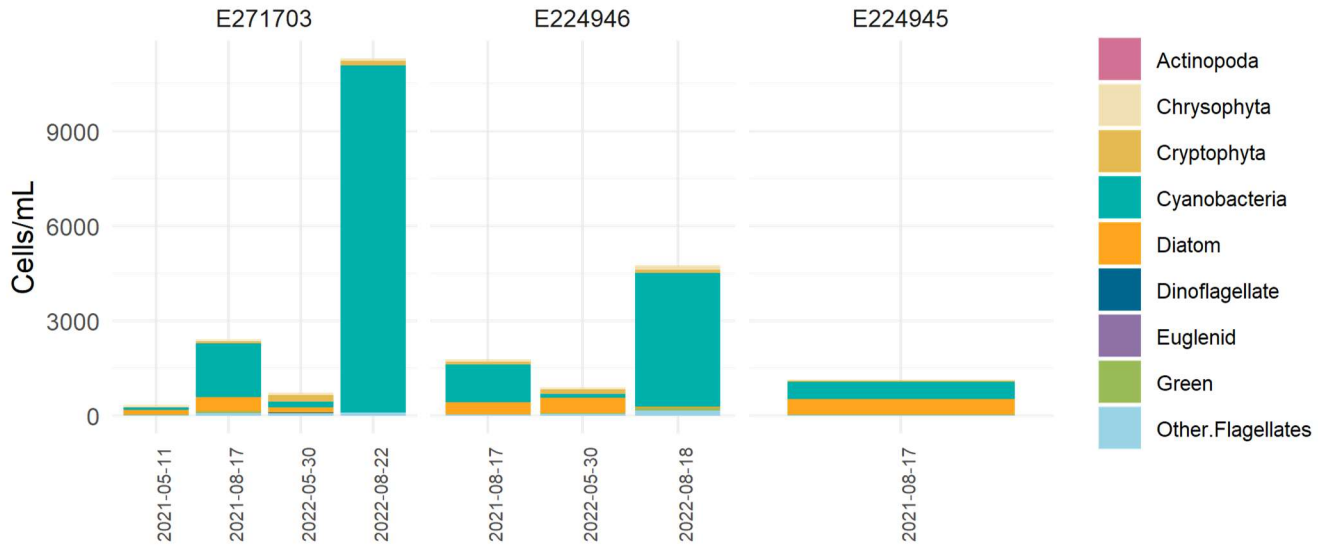


Figure 8: Cell abundance of high-level taxa groups on Francois Lake

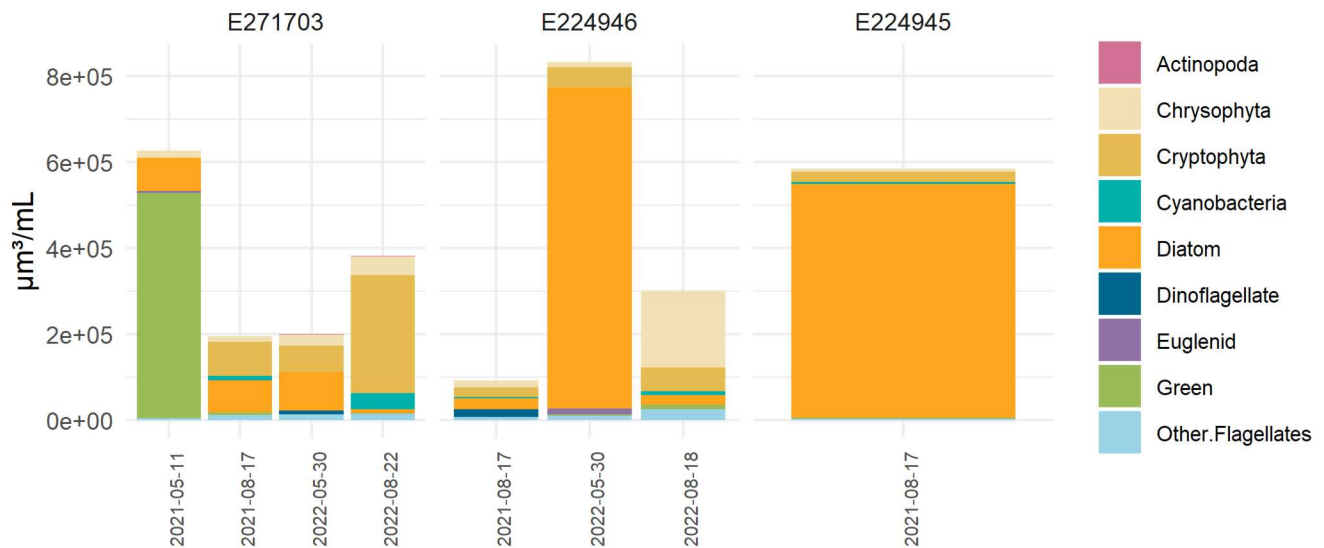


Figure 9: Biovolume of high-level taxa groups on Francois Lake

## References

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# Appendix

Additional figures and raw data are listed below:

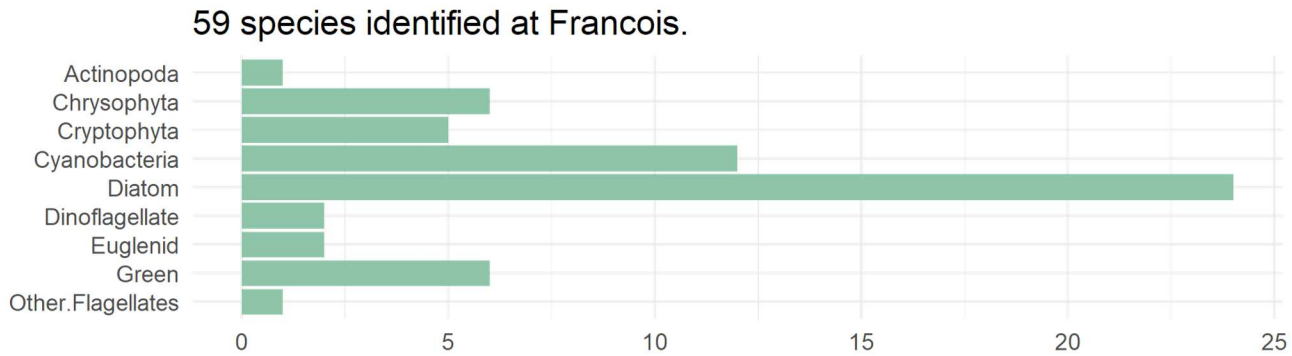


Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: E271703	<b>Total Abundance (cells/mL):</b>	<b>354</b>		
Collection Date: 2021-05-11	<b>Total Biovolume (<math>\mu\text{m}^3/\text{mL}</math>):</b>	<b>627751</b>		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Ochromonas sp.	76	16269	Chrysophyta	1455
Chrysochromulina sp.	8	308	Chrysophyta	2160
Rhodomonas lacustris	4	434	Cryptophyta	10663
Anacystis sp.	57	108	Cyanobacteria	609
Merismopedia punctata	30	194	Cyanobacteria	727
Aulacoseira italica	76	37940	Diatom	590863
Aulacoseira distans var. nivalis	34	6836	Diatom	590863
Cyclotella meneghiniana	15	6803	Diatom	2439
Rhizosolenia sp.	4	24932	Diatom	2879
Euglena sp.	8	4608	Euglenid	9620
Eremosphaera viridis	8	523599	Green	5984
microflagellate	34	5720	Other.Flagellates	

Figure 11: Raw data from 2021-05-11 EMS site E271703

EMS ID: E271703	<b>Total Abundance (cells/mL):</b>	<b>2418</b>		
Collection Date: 2021-08-17	<b>Total Biovolume (<math>\mu\text{m}^3/\text{mL}</math>):</b>	<b>196954</b>		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Ochromonas sp.	57	12202	Chrysophyta	1455
Cryptomonas sp.	42	77786	Cryptophyta	10635
Rhodomonas lacustris	19	2063	Cryptophyta	10663
Aphanocapsa sp.	360	1137	Cyanobacteria	625
Aphanizomenon flos-aquae	38	6327	Cyanobacteria	1191
Anacystis sp.	1469	2795	Cyanobacteria	609
Anacystis incerta	182	398	Cyanobacteria	609
Dactylococcopsis sp.	11	749	Cyanobacteria	6446
Aulacoseira distans var. nivalis	8	1608	Diatom	590863
Cocconeis pediculus	4	6318	Diatom	3577
Cyclotella meneghiniana	8	3628	Diatom	2439
Lindavia bodanica	4	4174	Diatom	
Encyonema minutum	11	2822	Diatom	590838
Fragilaria crotonensis	57	27677	Diatom	2932
Navicula spp.	4	2356	Diatom	3649
Nitzschia sp.	4	367	Diatom	5070
Rhizosolenia sp.	4	24932	Diatom	2879
Gloeocystis sp.	53	5650	Green	6355
microflagellate	83	13965	Other.Flagellates	

Figure 12: Raw data from 2021-08-17 EMS site E271703

EMS ID: E224946	Total Abundance (cells/mL):	1780		
Collection Date: 2021-0	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	94242		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Ochromonas sp.	76	16269	Chrysoophyta	1455
Cryptomonas sp.	8	14816	Cryptophyta	10635
Rhodomonas lacustris	68	7383	Cryptophyta	10663
Aphanocapsa sp.	372	1175	Cyanobacteria	625
Anacystis sp.	1146	2181	Cyanobacteria	609
Anacystis incerta	38	83	Cyanobacteria	609
Dactylococcopsis sp.	11	749	Cyanobacteria	6446
Nitzschia sp.	4	367	Diatom	5070
Rhizosolenia sp.	4	24932	Diatom	2879
Peridinium sp.	4	18043	Dinoflagellate	10212
microflagellate	49	8244	Other.Flagellates	

Figure 13: Raw data from 2021-08-17 EMS site E224946

EMS ID: E224945	Total Abundance (cells/mL):	1128		
Collection Date: 2021-08	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	586477		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	4	6008	Chrysoophyta	1515
Ochromonas sp.	8	1713	Chrysoophyta	1455
Cryptomonas sp.	11	20372	Cryptophyta	10635
Rhodomonas lacustris	27	2932	Cryptophyta	10663
Aphanocapsa sp.	258	815	Cyanobacteria	625
Anacystis sp.	436	830	Cyanobacteria	609
Anacystis incerta	19	42	Cyanobacteria	609
Dactylococcopsis sp.	46	3131	Cyanobacteria	6446
Gloeocapsa sp.	23	1000	Cyanobacteria	682
Synechocystis sp.	15	503	Cyanobacteria	799
Aulacoseira sp.	61	100382	Diatom	590863
Cocconeis pediculus	4	6318	Diatom	3577
Navicula spp.	15	8836	Diatom	3649
Tabellaria fenestrata	159	427356	Diatom	3241
Tetrastrum sp.	15	1696	Green	6260
microflagellate	27	4543	Other.Flagellates	

Figure 14: Raw data from 2021-08-17 EMS site E224945



EMS ID: E271703	Total Abundance (cells/mL):	727		
Collection Date: 2022-0	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	206555		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Actinophryida	4	673	Actinopoda	
Chrysochromulina sp.	42	1615	Chrysophyta	2160
Chromulina sp.	11	19439	Chrysophyta	1717
Ochromonas sp.	23	4924	Chrysophyta	1455
Cryptomonas sp.	23	42597	Cryptophyta	10635
Rhodomonas lacustris	167	18133	Cryptophyta	10663
Anacystis sp.	144	274	Cyanobacteria	609
Planktolyngbya sp.	46	572	Cyanobacteria	
Achnantheidium sp.	4	759	Diatom	590864
Asterionella formosa	42	29246	Diatom	3116
Aulacoseira italica	49	24461	Diatom	590863
Aulacoseira cyst	11	5965	Diatom	590863
Aulacoseira distans	34	18438	Diatom	590863
Eunotia sp.	4	595	Diatom	3337
Fragilaria tenera	4	1942	Diatom	2932
Fragilaria sp.	8	3884	Diatom	2932
Lindavia bodanica	4	4174	Diatom	
Navicula sp.	4	2827	Diatom	3649
Nitzschia spp.	4	1579	Diatom	5070
Gymnodinium sp.	4	8474	Dinoflagellate	10031
microflagellate	95	15984	Other.Flagellates	

Figure 15: Raw data from 2022-05-30 EMS site E271703

EMS ID: E271703	Total Abundance (cells/mL):	11303		
Collection Date: 2022-08-22	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	384447		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Actinophryida	8	1346	Actinopoda	
Chrysochromulina sp.	4	154	Chrysophyta	2160
Dinobryon spp.	19	30143	Chrysophyta	1515
Ochromonas sp.	49	10489	Chrysophyta	1455
Dinobryopsis sp.	8	2149	Chrysophyta	1557
Cryptomonas sp.	11	20372	Cryptophyta	10635
Cryptomonas curvata	34	214198	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Cryptomonas erosa	8	14175	Cryptophyta	10635
Rhodomonas lacustris	76	8252	Cryptophyta	10663
Anabaena sp.	8	600	Cyanobacteria	1100
Anacystis sp.	9122	17357	Cyanobacteria	609
Aphanizomenon flos-aquae	72	11988	Cyanobacteria	1191
Aphanocapsa sp.	167	528	Cyanobacteria	625
Aphanothece sp.	1438	4585	Cyanobacteria	636
Gloeocapsa sp.	4	174	Cyanobacteria	682
Woronichinia sp.	152	2070	Cyanobacteria	
Cyclotella sp.	4	1062	Diatom	2439
Lindavia bodanica	8	8348	Diatom	
Chlamydomonas sp.	4	2393	Green	5448
microflagellate	99	16657	Other.Flagellates	

Figure 16: Raw data from 2022-08-22 EMS site E271703

EMS ID: E224946	Total Abundance (cells/mL):	898		
Collection Date: 2022-05-30	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	835437		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Actinophryida	4	673	Actinopoda	
Chrysochromulina sp.	8	308	Chrysophyta	2160
Ochromonas sp.	46	9847	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Cryptomonas curvata	4	25200	Cryptophyta	10635
Rhodomonas lacustris	140	15201	Cryptophyta	10663
Anacystis delicatissima	114	249	Cyanobacteria	609
Synechocystis sp.	8	268	Cyanobacteria	799
Aulacoseira sp.	410	674698	Diatom	590863
Aulacoseira italica	42	20967	Diatom	590863
Fragilaria sp.	4	1942	Diatom	2932
Lindavia bodanica	19	19826	Diatom	
Ulnaria nana	11	28875	Diatom	970000
Trachelomonas sp.	4	14137	Euglenid	9690
Monoraphidium sp.	4	2650	Green	5990
microflagellate	72	12114	Other.Flagellates	

Figure 17: Raw data from 2022-05-30 EMS site E224946

EMS ID: E224946	Total Abundance (cells/mL):	4766		
Collection Date: 2022-08-18	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	306316		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Actinophryida	8	1346	Actinopoda	
Chrysochromulina sp.	15	577	Chrysophyta	2160
Chromulina sp.	23	40644	Chrysophyta	1717
Dinobryon spp.	83	131677	Chrysophyta	1515
Ochromonas sp.	23	4924	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Cryptomonas curvata	4	25200	Cryptophyta	10635
Cryptomonas erosa	8	14175	Cryptophyta	10635
Rhodomonas lacustris	68	7383	Cryptophyta	10663
Anabaena sp.	11	825	Cyanobacteria	1100
Anacystis sp.	4121	7842	Cyanobacteria	609
Aphanothece sp.	83	265	Cyanobacteria	636
Gloeocapsa sp.	23	1000	Cyanobacteria	682
Asterionella formosa	11	7660	Diatom	3116
Fragilaria crotonensis	30	14567	Diatom	2932
Monoraphidium sp.	4	2650	Green	5990
Oocystis sp.	57	1074	Green	5827
Chlamydomonas sp.	11	6582	Green	5448
microflagellate	175	29443	Other.Flagellates	

Figure 18: Raw data from 2022-08-18 EMS site E224946