

# Cowichan Lake Phytoplankton Summary Report 2021-2022

## Overview

Samples were collected from three sites on Cowichan Lake during 2021 and 2022 (Figure 1; Table 1). Algae were identified to the taxonomic level of genus and grouped into broad alga types for analysis.

Table 1: Sample sites and dates sampled in 2021 and 2022

Sample Site (EMS#)	Dates
COWICHAN LAKE LIMNOLOGY STATION #1 (E217507)	2021-08-18
	2022-03-09
	2022-09-08
COWICHAN LAKE LIMNOLOGY STATION #2 (E217508)	2021-08-18
	2022-03-09
	2022-09-08
COWICHAN LAKE LIMNOLOGY STATION #3 (E217509)	2021-03-09
	2021-08-18
	2022-03-09
	2022-09-08
<b>Total= 10 samples</b>	



Figure 1: Aerial view of Cowichan Lake

All samples contained low densities of green algae, Desmids, Chrysophytes, Dinoflagellates, micro-flagellates, and diatoms. Cowichan Lake contained very low agal densities (Figure 2).

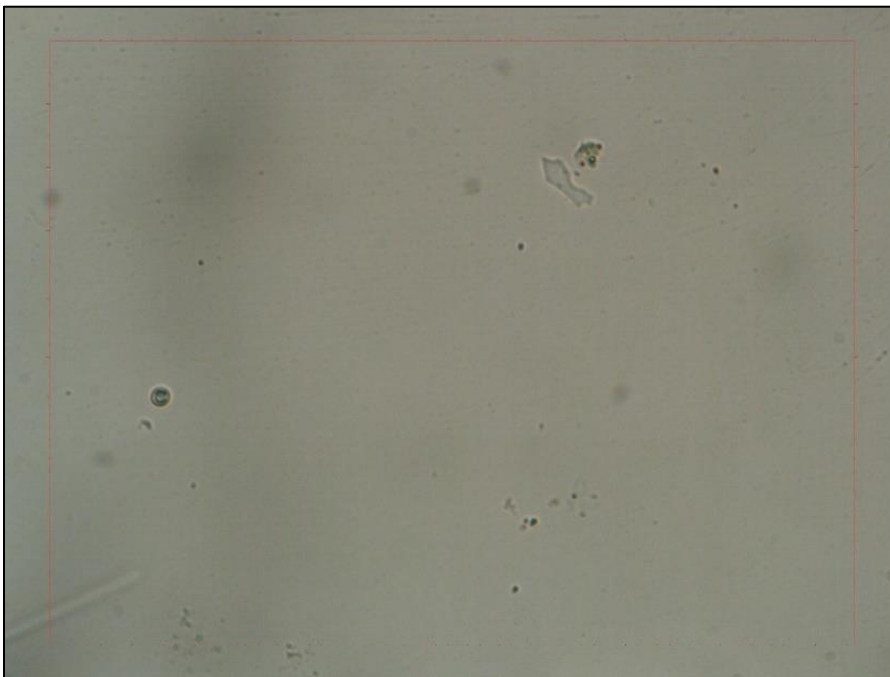


Figure 2: 400x magnification of a typical microscopic frame, note the low levels of detritus, algae, and bacteria

## Overview (continued)

Small quantities of algae skewed biovolume results. The dinoflagellate *Ceratium* represented 87% of the total biovolume because of its large size relative to other algae<sup>1</sup>. Very low densities of small algae outside of the dinoflagellate made quantities of *Ceratium* in biovolume appear larger than they are (Figure 3).

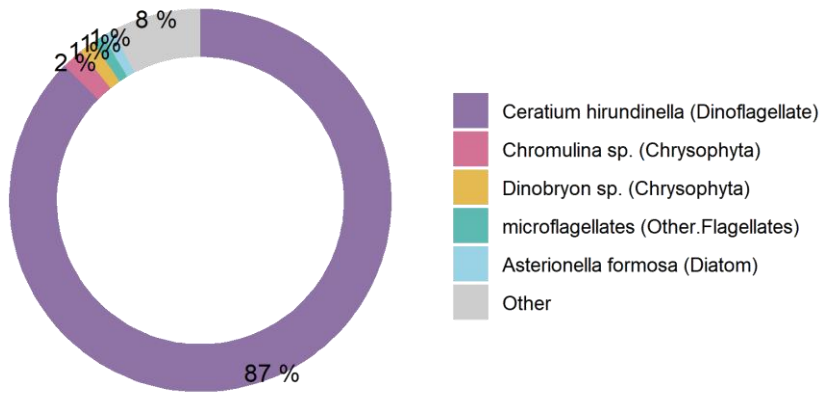


Figure 3: Dominant organisms from Cowichan Lake (all sites / dates) as percent of total biovolume

*Ceratium* was one of fifty-three species identified in Cowichan Lake (Figure 4). Diatoms, Chrysophytes and green algae groups contained the most species identified in Cowichan Lake samples.

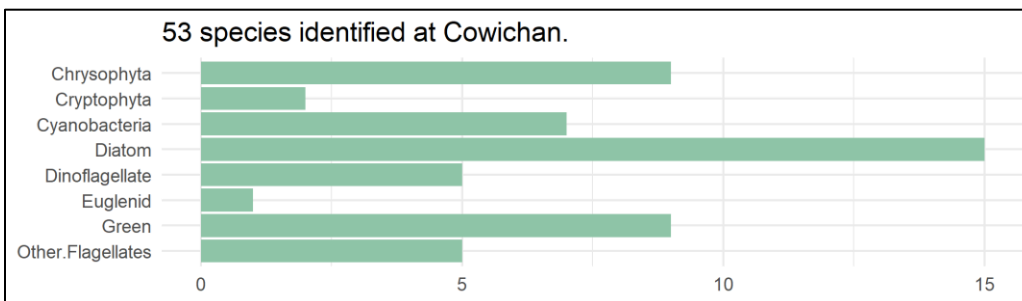


Figure 4: Unique species observed in Cowichan Lake sorted into higher level taxa

<sup>1</sup> Only one *Ceratium* was present in all the samples combined

### 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 demonstrated low cyanobacteria densities; *Anacystis* was the dominant genus, but *Aphanizomenon* and *Planktolyngbya* species were also observed. (Figure 5).

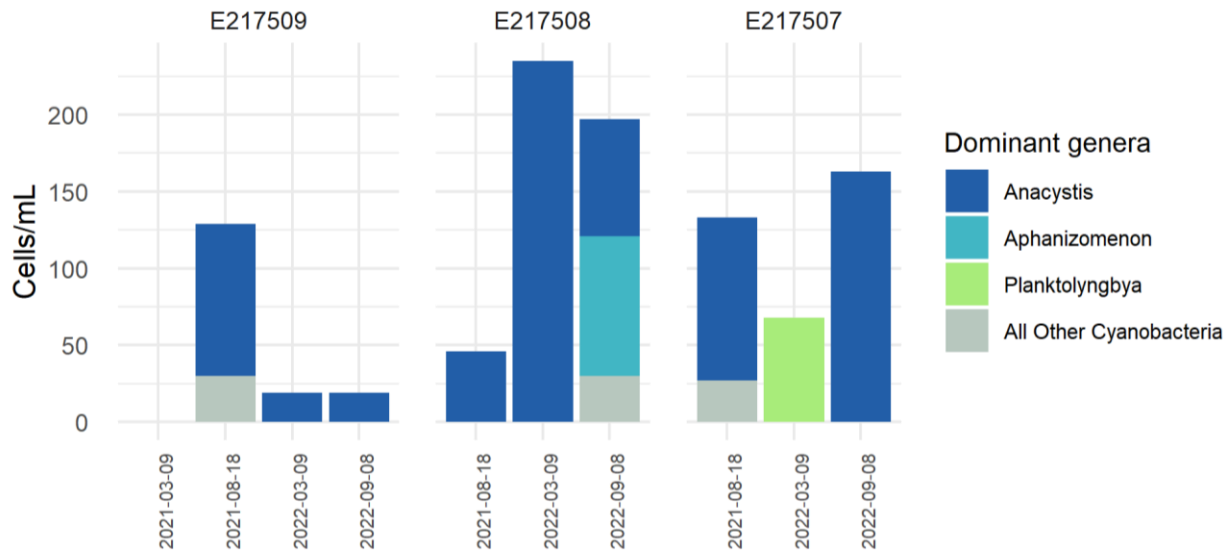


Figure 5: cell abundance for dominant cyanobacteria genera on Cowichan Lake

When *Anacystis* is present in high concentration it is associated with several cyanotoxins that represent risks to public health (Table 2). Concentration of *cyanobacteria* observed in Cowichan Lake were too low to represent risks to human health (Lance et al., 2014).

Table 2: Dominant genera of cyanobacteria on Cowichan Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
<i>Anacystis</i>	235	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
<i>Aphanizomenon</i>	91	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor
<i>Planktolyngbya</i>	68	Lyngbyatoxin LYN, Microcystin MC, BMAA

Note: \* = counted in samples

## Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria found in Cowichan Lake are capable of producing (Table 2).

Cowichan Lake displayed cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 112 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Cowichan Lake compared to alert levels defined by several authorities including the WHO and EPA.

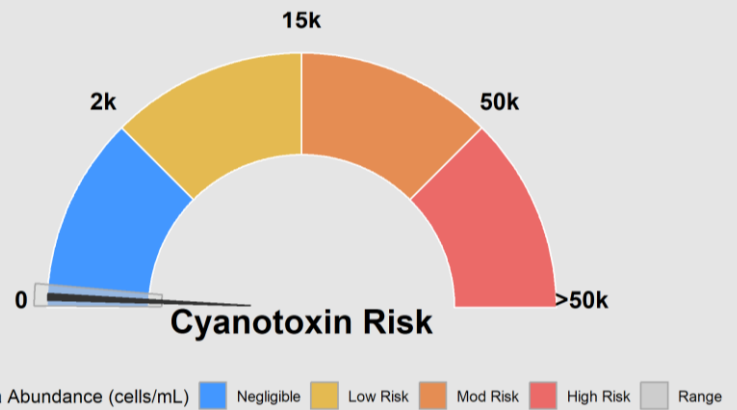


Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Cowichan Lake

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 *Ulnaria* cell dwarfs adjacent cyanobacteria cells.

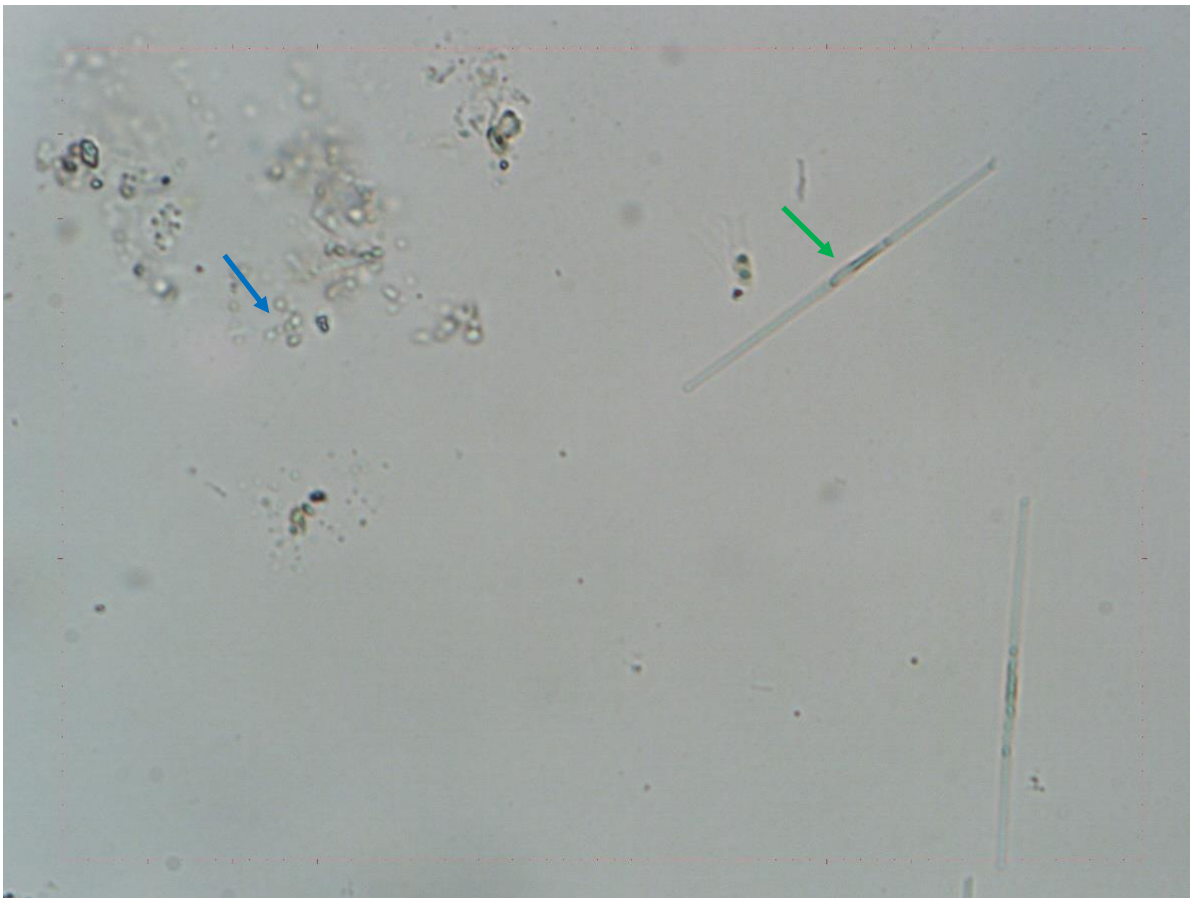


Figure 7: Size comparison of an *Ulnaria* (green arrow) to an *Anacystis* cell (blue arrow)

## Species Composition

Algae samples were identified to the genus level and grouped into broad alga types for analysis. The figures below display the total cell counts for each broad algae group alongside the biovolume represented by each of these groups. The difference between Figure 8 (cell abundance) and Figure 9 (biovolume) illuminates the difference between cell abundance and biovolume.

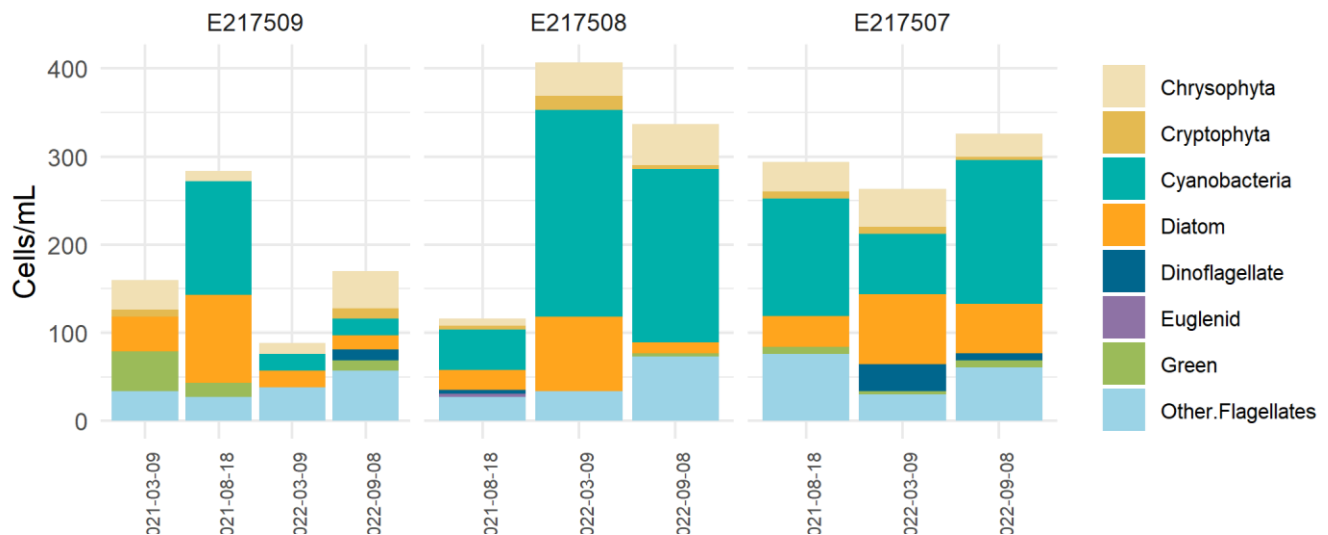


Figure 8: Cell abundance of high-level taxa groups on Cowichan Lake

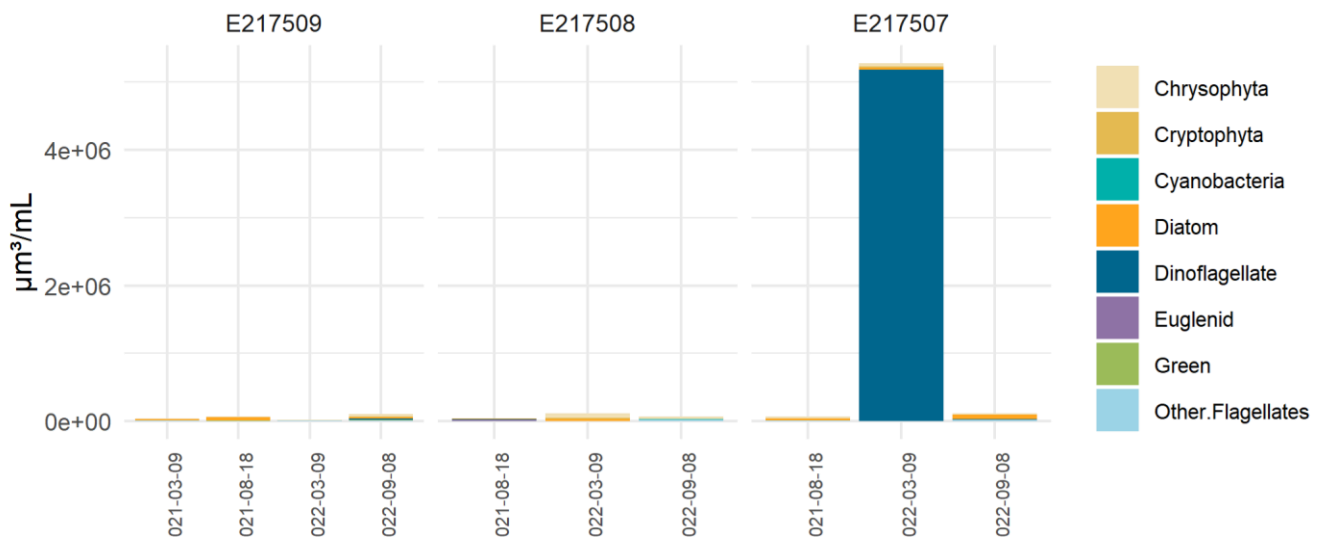


Figure 9: Biovolume of high-level taxa groups on Cowichan Lake

## References

- 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>
- 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>

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# Appendix

Additional figures and raw data are listed below:

EMS ID: E217507	Total Abundance (cells/mL):	294		
Collection Date: 2021-08-18	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	67484		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	15	22530	Chrysophyta	1515
Ochromonas sp.	8	1713	Chrysophyta	1455
Chrysochromulina sp.	11	423	Chrysophyta	2160
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Rhodomonas lacustris	8	869	Cryptophyta	10663
Aphanothece sp.	27	86	Cyanobacteria	636
Anacystis sp.	38	72	Cyanobacteria	609
Anacystis nidulans	68	149	Cyanobacteria	609
Achnanthyidium minutissimum	4	759	Diatom	590864
Asterionella formosa	8	5571	Diatom	3116
Cyclotella sp.	4	1062	Diatom	2439
Ulnaria acus	19	19795	Diatom	970000
Elakatothrix gelatinosa	4	706	Green	9412
Tetraedron lunula	4	561	Green	5661
microflagellate	72	12114	Other.Flagellates	

Figure 10: Raw data from 2021-08-18 EMS site E217507

EMS ID: E217508	Total Abundance (cells/mL):	116		
Collection Date: 2021-08-18	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	43388		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Ochromonas sp.	4	856	Chrysophyta	1455
Chrysochromulina sp.	4	154	Chrysophyta	2160
Rhodomonas lacustris	4	434	Cryptophyta	10663
Anacystis sp.	46	88	Cyanobacteria	609
Asterionella formosa	11	7660	Diatom	3116
Cyclotella sp.	4	1062	Diatom	2439
Gomphonema sp.	4	5508	Diatom	4911
Nitzschia sp.	4	367	Diatom	5070
Peridinium willei	4	8579	Dinoflagellate	10212
Trachelomonas sp.	4	14137	Euglenid	9690
microflagellate	27	4543	Other.Flagellates	

Figure 11: Raw data from 2021-08-18 EMS site E217508

EMS ID: E217509	Total Abundance (cells/mL):	160		
Collection Date: 2021-03-09	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	43154		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	4	6008	Chrysophyta	1515
Ochromonas sp.	19	4067	Chrysophyta	1455
Chrysochromulina sp.	11	423	Chrysophyta	2160
Rhodomonas lacustris	8	869	Cryptophyta	10663
Cyclotella sp.	4	1062	Diatom	2439
Lindavia intermedia	8	7072	Diatom	
Lindavia ocellata	15	2489	Diatom	
Ulnaria acus	8	8335	Diatom	970000
Staurosirella sp.	4	212	Diatom	590855
Ankistrodesmus falcatus	4	565	Green	5877
Chlorella vulgaris	30	2093	Green	5811
Tetraedron lunula	11	1544	Green	5661
microflagellate	19	3197	Other.Flagellates	
UID flagellate	15	5218	Other.Flagellates	

Figure 12: Raw data from 2021-03-09 EMS site E217509

EMS ID: E217509	Total Abundance (cells/mL):	284		
Collection Date: 2021-08-18	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	72565		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	8	12016	Chrysophyta	1515
Bitrichia sp.	4	459	Chrysophyta	
Anacystis sp.	38	72	Cyanobacteria	609
Anacystis nidulans	61	133	Cyanobacteria	609
Merismopedia punctata	30	194	Cyanobacteria	727
Achnanthydium minutissimum	4	759	Diatom	590864
Asterionella formosa	57	39690	Diatom	3116
Cyclotella sp.	4	1062	Diatom	2439
Nitzschia sp.	4	367	Diatom	5070
Ulnaria acus	4	4167	Diatom	970000
Synedra filiformis	27	2734	Diatom	3013
Chlorella vulgaris	4	279	Green	5811
Gonatozygon sp.	8	5529	Green	8922
Tetraedron lunula	4	561	Green	5661
microflagellate	27	4543	Other.Flagellates	

Figure 13: Raw data from 2021-08-18 EMS site E217509

EMS ID: E217507	Total Abundance (cells/mL):	263		
Collection Date: 2022-03-09	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	5277314		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	15	22530	Chrysophyta	1515
Mallomonas sp.	4	12097	Chrysophyta	1598
Kephyrion sp.	4	838	Chrysophyta	1764
Chromulina sp.	8	14137	Chrysophyta	1717
Chrysochromulina sp.	4	154	Chrysophyta	2160
Ochromonas sp.	8	1713	Chrysophyta	1455
Cryptomonas sp.	8	14816	Cryptophyta	10635
Planktolyngbya sp.	68	845	Cyanobacteria	
Asterionella formosa	4	2785	Diatom	3116
Cyclotella sp.	11	2920	Diatom	2439
Nitzschia sp.	4	367	Diatom	5070
Lindavia ocellata	34	5641	Diatom	
Fragilaria crotonensis	27	13110	Diatom	2932
Ceratium hirundinella	30	5179614	Dinoflagellate	10397
Tetraedron sp.	4	700	Green	5661
microflagellate	30	5047	Other.Flagellates	

Figure 14: Raw data from 2022-03-09 EMS site E217507

EMS ID: E217507	Total Abundance (cells/mL):	326		
Collection Date: 2022-09-08	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	116084		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	15	577	Chrysophyta	2160
Dinobryon spp.	11	17451	Chrysophyta	1515
Rhodomonas lacustris	4	434	Cryptophyta	10663
Anacystis sp.	163	310	Cyanobacteria	609
Achnanthydium sp.	11	2086	Diatom	590864
Cyclotella sp.	15	3982	Diatom	2439
Fragilaria crotonensis	11	5341	Diatom	2932
Nitzschia spp.	11	4343	Diatom	5070
Urosolenia sp.	8	50328	Diatom	590843
Parvodinium sp.	4	2205	Dinoflagellate	
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Monoraphidium sp.	8	5300	Green	5990
microflagellates	61	16401	Other.Flagellates	

Figure 15: Raw data from 2022-09-08 EMS site E217507



EMS ID: E217508	Total Abundance (cells/mL):	407		
Collection Date: 2022-03-09	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	116463		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	4	6008	Chrysophyta	1515
Chromulina sp.	34	60083	Chrysophyta	1717
Cryptomonas sp.	8	14816	Cryptophyta	10635
Rhodomonas lacustris	8	869	Cryptophyta	10663
Anacystis sp.	235	447	Cyanobacteria	609
Cyclotella sp.	27	7168	Diatom	2439
Nitzschia sp.	4	367	Diatom	5070
Ulnaria acus	11	11460	Diatom	97000
Lindavia ocellata	34	5641	Diatom	
Fragilaria crotonensis	8	3884	Diatom	2932
microflagellate	34	5720	Other.Flagellates	

Figure 16: Raw data from 2022-03-09 EMS site E217508

EMS ID: E217508	Total Abundance (cells/mL):	337		
Collection Date: 2022-09-08	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	67138		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	8	308	Chrysophyta	2160
Chromulina sp.	8	14137	Chrysophyta	1717
Dinobryon spp.	8	12692	Chrysophyta	1515
Ochromonas sp.	23	4924	Chrysophyta	1455
Cryptomonas sp.	4	7408	Cryptophyta	10635
Anacystis sp.	76	145	Cyanobacteria	609
Aphanizomenon sp.	91	3216	Cyanobacteria	1191
Pseudanabaena sp.	30	334	Cyanobacteria	1175
Achnanthyrium sp.	4	759	Diatom	590864
Fragilaria crotonensis	8	3884	Diatom	2932
Ankistrodesmus falcatus	4	565	Green	5877
Kephyrion ampulla	4	838	Other.Flagellates	1764
microflagellates	65	17476	Other.Flagellates	
Scourfieldia sp.	4	452	Other.Flagellates	5561

Figure 17: Raw data from 2022-09-08 EMS site E217508

EMS ID: E217509	Total Abundance (cells/mL):	88		
Collection Date: 2022-03-09	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	22069		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysococcus sp.	8	2656	Chrysophyta	1751
Dinobryon sp.	4	6008	Chrysophyta	1515
Anacystis sp.	19	36	Cyanobacteria	609
Lindavia ocellata	19	3152	Diatom	
microflagellates	38	10217	Other.Flagellates	

Figure 18: Raw data from 2022-03-09 EMS site E217509

EMS ID: E217509	Total Abundance (cells/mL):	170		
Collection Date: 2022-09-08	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	105276		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	15	577	Chrysophyta	2160
Chromulina sp.	11	19439	Chrysophyta	1717
Chrysococcus sp.	4	1328	Chrysophyta	1751
Dinobryon spp.	8	12692	Chrysophyta	1515
Ochromonas sp.	4	856	Chrysophyta	1455
Cryptomonas sp.	8	14816	Cryptophyta	10635
Rhodomonas lacustris	4	434	Cryptophyta	10663
Anacystis sp.	19	36	Cyanobacteria	609
Fragilaria crotonensis	8	3884	Diatom	2932
Lindavia sp.	4	3536	Diatom	
Ulnaria acus	4	4167	Diatom	970000
Glenodinium sp.	4	7992	Dinoflagellate	10174
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Ankistrodesmus sp.	4	629	Green	5877
Cosmarium sp.	8	4002	Green	7848
Kephyrion ampulla	4	838	Other.Flagellates	1764
microflagellates	53	14250	Other.Flagellates	

Figure 19: Raw data from 2022-09-08 EMS site E217509