Cultus Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Cultus Lake during 2021 and 2022 (Figure 1; Table 1). Algae were identified to the taxonomic level of species and grouped into broad alga types for analysis.

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

Sample Site (EMS#)	Dates
CULTUS LAKE AT CENTRE (0300037)	2021-04-06
	2021-08-17
	2022-03-28
	2022-08-16
Total= 4 samples	

Figure 1: Aerial view of Cultus Lake

Samples contained low densities of green algae, Desmids, Chrysophyta, Cryptophyta, Dinoflagellates, micro-flagellates, and diatoms. A small diatom bloom was observed at EMS site #0300037 on 2022-03-28. *Aulacoseira italica* was the dominant species during this bloom (Figure 2).

Moderate cyanobacteria blooms were observed in summer samples.

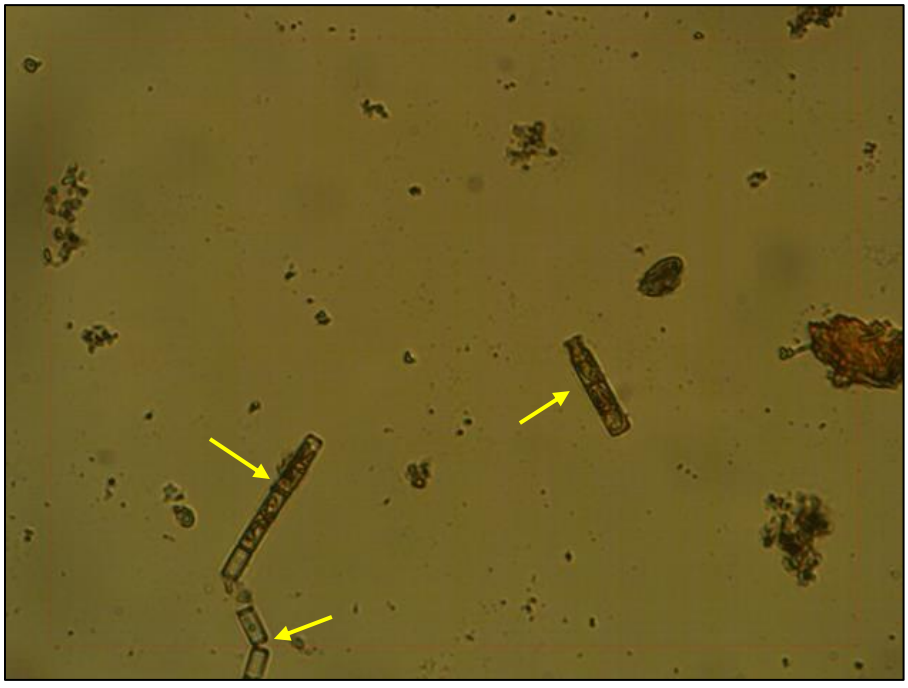

Figure 2: 400x magnification of EMS site #0300037 collected on 2022-03-28 demonstrating a small bloom of Aulacoseira italica (yellow arrows)

Overview (continued)

Cryptophyta dominated biovolumes; *Cryptomonas curvata* and *Cryptomonas ovata* comprised 41% of total biovolumes (Figure 3).

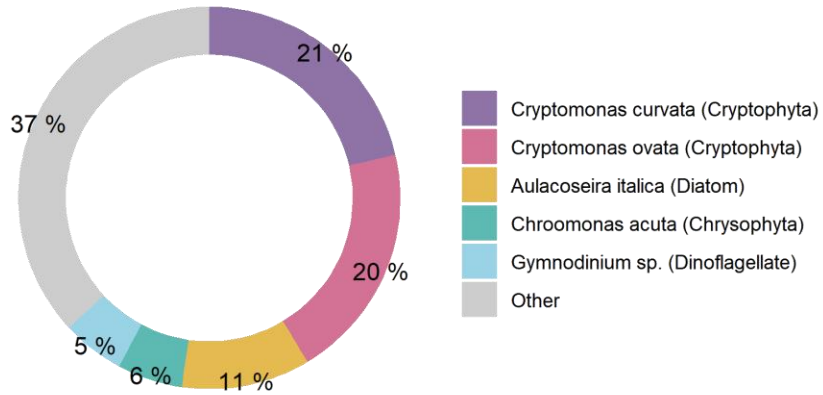

Figure 3: Dominant organisms from Cultus Lake (0300037) as percent of total biovolume

Cryptomonas curvata and *Cryptomonas ovata* were two of forty-eight species identified in Cultus Lake samples (Figure 4). Cryptomonas species (genus of Cryptophyta) are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015).

Most species identified in Cultus samples were cyanobacteria, Chrysophyta, diatoms, and green algae.

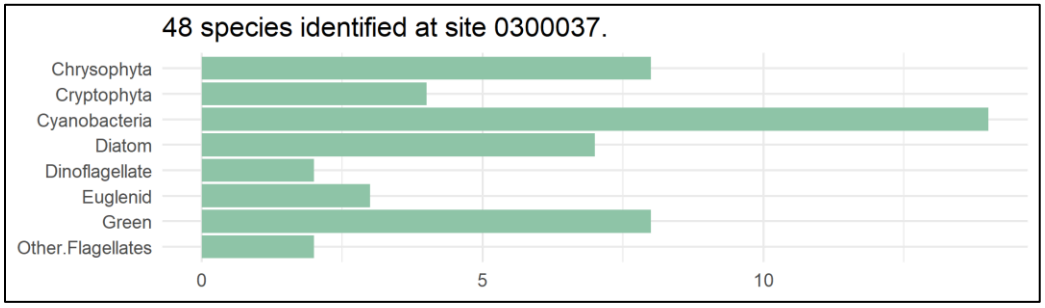

Figure 4: Unique species observed in Cultus Lake sorted into higher level taxa

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 elevated densities of cyanobacteria; *Anacystis* was the dominant genus. *Aphanothece* and *Aphanocapsa* species were also observed (Figure 5).

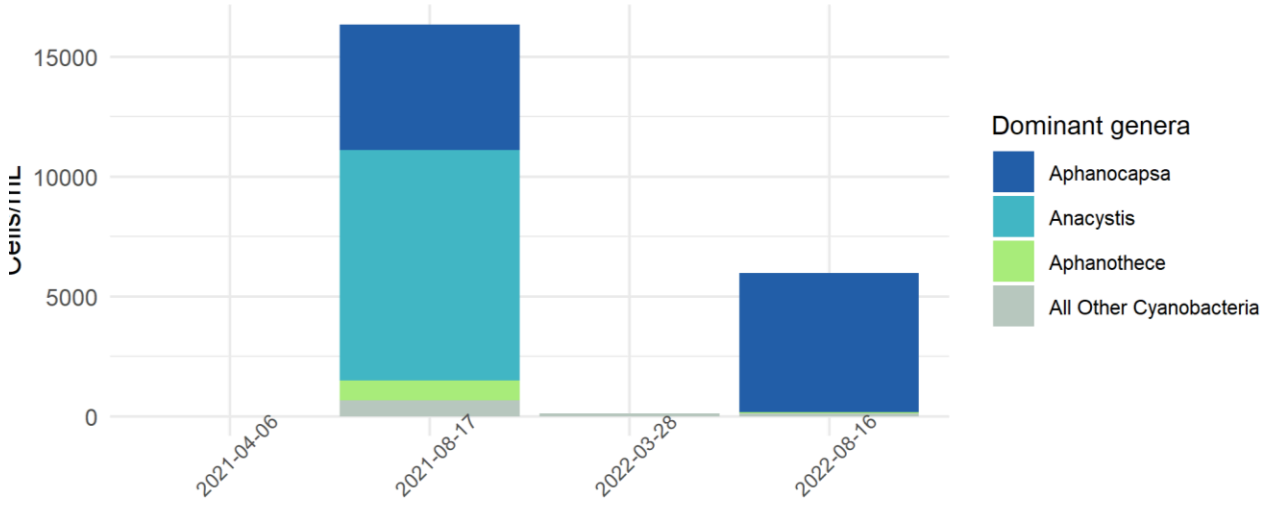

Figure 5: cell abundance for dominant cyanobacteria genera on Cultus Lake

When *Aphanocapsa*, *Anacystis*, and *Aphanothece* are present in high concentrations, they are 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 Cultus Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	9600	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Aphanocapsa	5798	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Aphanothece	835	Microcystin MC

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Cultus Lake displayed cyanobacteria levels in the negligible to low-risk category, with a mean cyanobacteria abundance of 7,474 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Cultus Lake compared to alert levels defined by several authorities including the WHO and EPA.

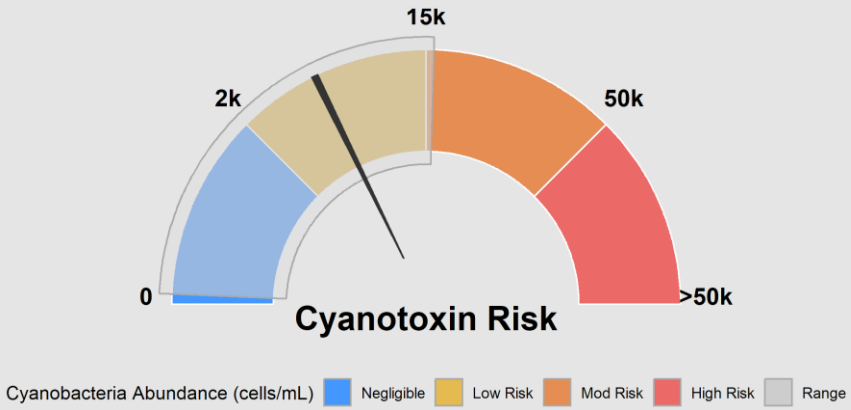

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Cultus Lake

Cyanobacteria and micro-flagellates 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 dinoflagellate cell dwarfs the adjacent cyanobacteria cell.

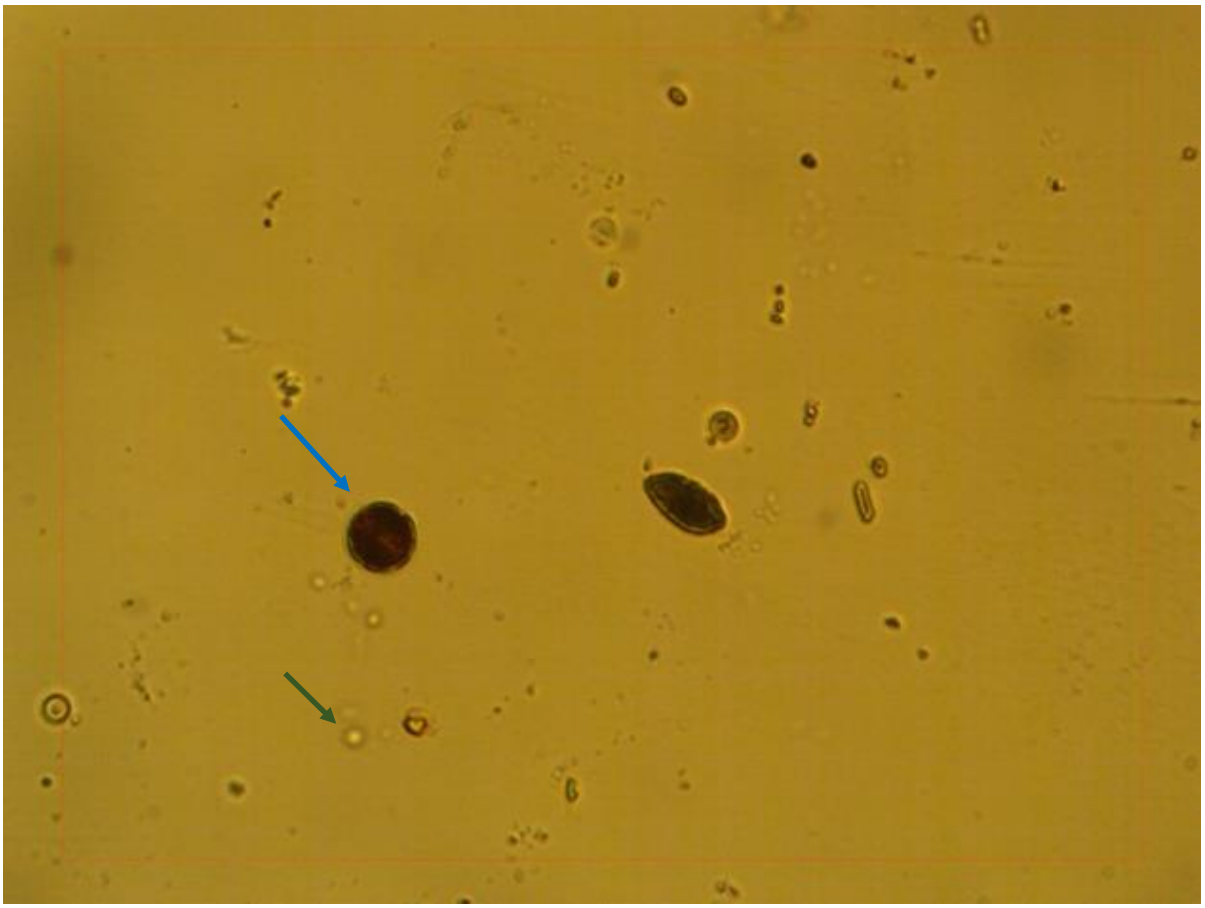

Figure 7: Size comparison of a Dinoflagellate (blue arrow) to a cyanobacteria cell (green arrow)

Species Composition

Algae samples were identified to the species 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.

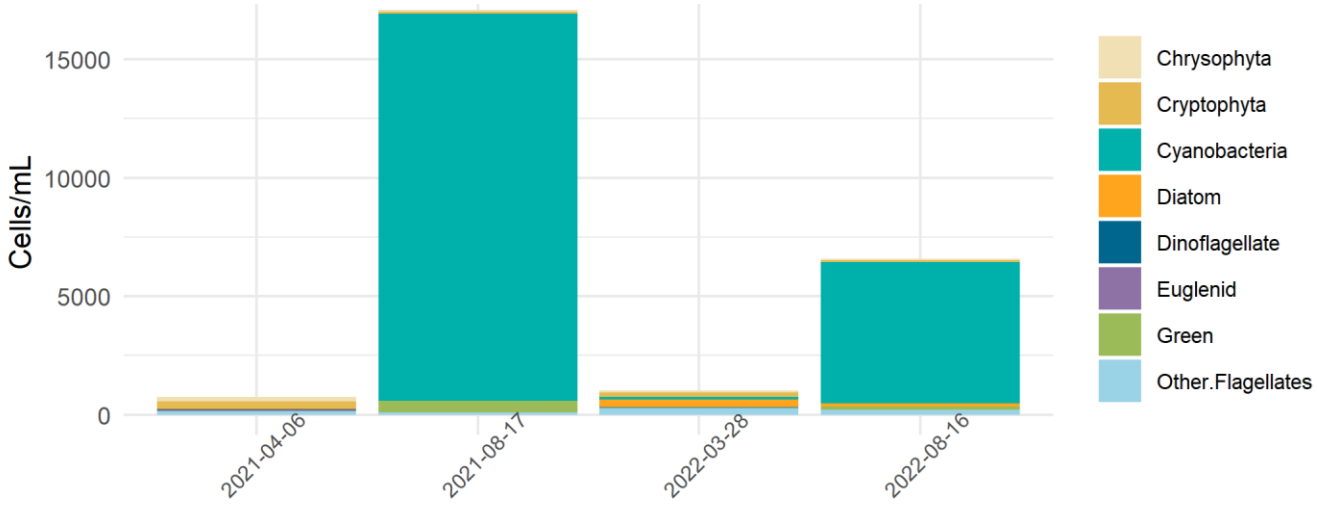

Figure 8: Cell abundance of high-level taxa groups on Cultus Lake

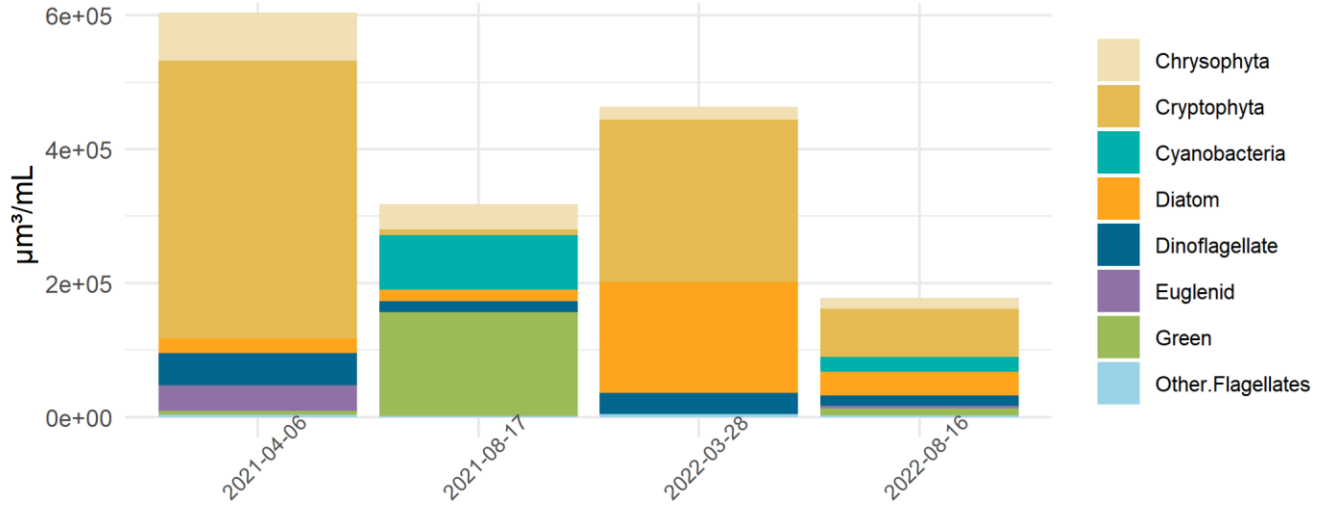

Figure 9: Biovolume of high-level taxa groups on Cultus Lake

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: 0300037	**Total Abundance (cells/mL):**	**745**	
Collection Date: 2021-04-06	Total Biovolume (µm³/mL):	604274	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	99	53482	Chrysophyta
Chromulina sp.	4	7069	Chrysophyta
Kephyrion obliquum	8	1676	Chrysophyta
Ochromonas sp. Small	38	1035	Chrysophyta
Chrysococcus sp.	19	6308	Chrysophyta
Ochromonas sp.	11	2355	Chrysophyta
Cryptomonas curvata	34	214198	Cryptophyta
Cryptomonas ovata	83	180598	Cryptophyta
Rhodomonas lacustris	186	20195	Cryptophyta
Cyclotella cf. meneghiniana	4	1414	Diatom
Aulacoseira italica	30	14976	Diatom
Nitzschia sp. small	4	2827	Diatom
Asterionella formosa	4	2785	Diatom
Gymnodinium sp.	19	40251	Dinoflagellate
Peridinium inconspicuum	4	7326	Dinoflagellate
Lepocinclis sp.	19	16377	Euglenid
Trachelomonas cf. volvocinopsis	11	19439	Euglenid
Trachelomonas volvocina	4	3185	Euglenid
Monoraphidium indicum	8	5606	Green
nanoflagellates	99	2981	Other.Flagellates
picoflagellates	57	191	Other.Flagellates

Figure 10: Raw data from 2021-04-06 EMS site 0300037

EMS ID: 0300037	**Total Abundance (cells/mL):**	**17089**	
Collection Date: 2021-08-17	Total Biovolume (µm³/mL):	317358	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	42	22689	Chrysophyta
Chromulina sp.	4	7069	Chrysophyta
Dinobryon sertularia	4	4918	Chrysophyta
Ochromonas sp. Small	23	626	Chrysophyta
Chrysococcus sp.	4	1328	Chrysophyta
Rhodomonas lacustris	80	8686	Cryptophyta
Anabaena cf. levanderi	72	12441	Cyanobacteria
Chroococcus limneticus	61	8771	Cyanobacteria
Aphanocapsa elachista	5248	14655	Cyanobacteria
Aphanothece sp.	835	2663	Cyanobacteria
Gloeocapsa aeruginosa	137	1937	Cyanobacteria
Gloeocapsa punctata	114	478	Cyanobacteria
Gloeocapsa rupestris	27	14137	Cyanobacteria
Gomphosphaeria aponina	91	3935	Cyanobacteria
Planktolyngbya limnetica	83	425	Cyanobacteria
Anacystis cyanea	9600	14451	Cyanobacteria
Chroococcus limneticus	46	5874	Cyanobacteria
Planktosphaeria gelatinosa	30	1833	Cyanobacteria
Frustulia rhomboides	4	16990	Diatom
Gymnodinium sp.	8	16948	Dinoflagellate
Crucigenia rectangularis	23	7044	Green
Gloeocystis ampla	182	72043	Green
Gloeocystis planctonica	30	2913	Green
Golenkiniopsis longispina	8	2572	Green
Monoraphidium indicum	11	7708	Green
Gloeocystis vesiculosa	212	62330	Green
nanoflagellates	57	1716	Other.Flagellates
picoflagellates	53	178	Other.Flagellates

Figure 11: Raw data from 2021-08-17 EMS site 0300037

EMS ID: 0300037	**Total Abundance (cells/mL):**	**1011**	
Collection Date: 2022-03-28	**Total Biovolume (µm³/mL):**	**463154**	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	19	10264	Chrysophyta
Ochromonas sp. Small	8	218	Chrysophyta
Ochromonas sp.	38	8135	Chrysophyta
Cryptomonas curvata	19	119699	Cryptophyta
Cryptomonas ovata	38	82684	Cryptophyta
Cryptomonas erosa	15	26578	Cryptophyta
Rhodomonas lacustris	129	14007	Cryptophyta
Lyngbya limnetica	106	107	Cyanobacteria
Aulacoseira italica	311	155253	Diatom
Nitzschia sp. small	8	5655	Diatom
Aulacoseira granulata	15	4934	Diatom
Gymnodinium sp.	8	16948	Dinoflagellate
Peridinium inconspicuum	8	14652	Dinoflagellate
nanoflagellates	114	3433	Other.Flagellates
picoflagellates	175	587	Other.Flagellates

Figure 12: Raw data from 2022-03-28 EMS site 0300037

EMS ID: 0300037	Total Abundance (cells/mL):	6566	
Collection Date: 2022-08-16	Total Biovolume (µm³/mL):	177974	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Dinobryon divergens	11	9481	Chrysophyta
Ochromonas sp. Small	19	517	Chrysophyta
Chrysococcus sp.	4	1328	Chrysophyta
Ochromonas sp.	23	4924	Chrysophyta
Cryptomonas ovata	23	50045	Cryptophyta
Cryptomonas erosa	11	19490	Cryptophyta
Rhodomonas lacustris	27	2932	Cryptophyta
Aphanocapsa elachista	5798	16190	Cyanobacteria
Aphanothece sp.	68	217	Cyanobacteria
Gloeocapsa rupestris	8	4189	Cyanobacteria
Planktolyngbya limnetica	38	194	Cyanobacteria
Chroococcus dispersus var. minor	61	862	Cyanobacteria
Cyclotella sp.	133	35307	Diatom
Gymnodinium sp.	4	8474	Dinoflagellate
Peridinium inconspicuum	4	7326	Dinoflagellate
Trachelomonas volvocina	4	3185	Euglenid
Crucigenia quadrata	15	917	Green
Chlorella sp.	102	7118	Green
Monoraphidium indicum	4	2650	Green
nanoflagellates	72	2168	Other.Flagellates
picoflagellates	137	460	Other.Flagellates

Figure 13: Raw data from 2022-08-16 EMS site 0300037