Adams Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Adams 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
ADAMS LK OFF BRENNAN CK (E228889)	2021-04-04
	2021-08-24
	2022-04-12
	2022-08-23
	Total= 4 samples

Figure 1: Aerial view of Adams Lake

Samples contained low concentrations of diatoms, Cryptophyta, Chrysophyta, and green algae. Adams Lake had small increases in diatom density during spring. Spring diatoms are common and reflective of increased temperatures, light penetration, and silica in the water following ice thaw (Kong et al., 2021).

Summer samples contained cyanobacteria blooms composed of several cyanotoxin forming species (Figure 2).

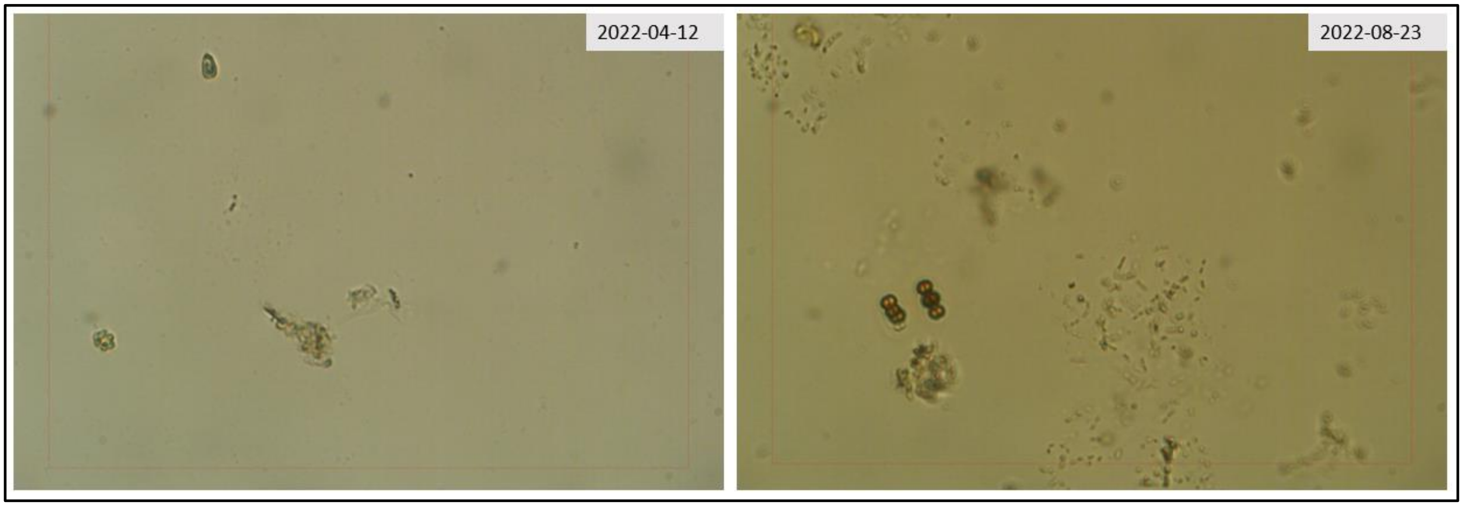

Figure 2: 400x magnification of EMS site E228889 contrasting low algal counts in the Spring 2022 sample (left) vs. a cyanobacteria bloom observed in the 2022 Summer sample (right)

Overview (continued)

Excluding summer cyanobacterial blooms, samples contained low algal counts (Figure 2; Figure 3). Green algae and Cryptophyta were the second and third dominant algae groups following cyanobacteria (Figure 3).

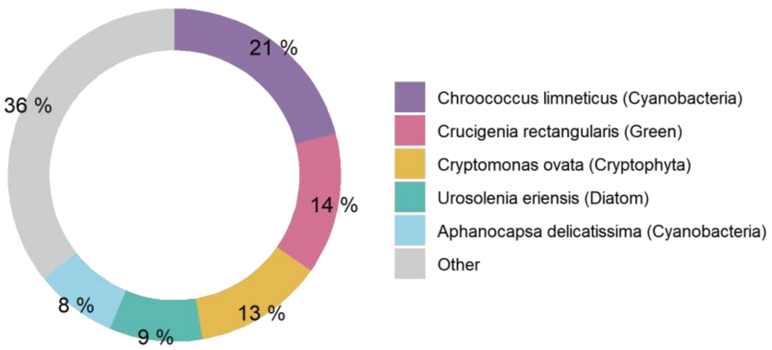

Figure 3: Dominant organisms from Adams Lake (EMS E228889) as percent of total biovolume

Cyanobacteria concentrations were high in summer samples (Figure 4; Figure 5; Figure 8). While algal community compositions respond rapidly to environmental changes (diatom blooms in the spring followed by elevated densities of cyanobacteria in the summer), the scale of the cyanobacteria increases observed in Adams Lake could be reflective of unbalanced nutrient swings between seasons.

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).

Figure 4: 400x magnification of EMS site E228889 contrasting low algal counts in the Spring 2021 sample (left) vs. a cyanobacteria bloom observed in the 2021 Summer sample (right)

Cyanobacterial Presence

Cyanobacteria concentrations were higher in summer samples than spring samples. Dominant genera included *Aphanocapsa*, *Aphanothece*, and *Anacystis* (Figure 5). *Anacystis*, *Aphanocapsa*, and *Aphanothece* are associated with 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).

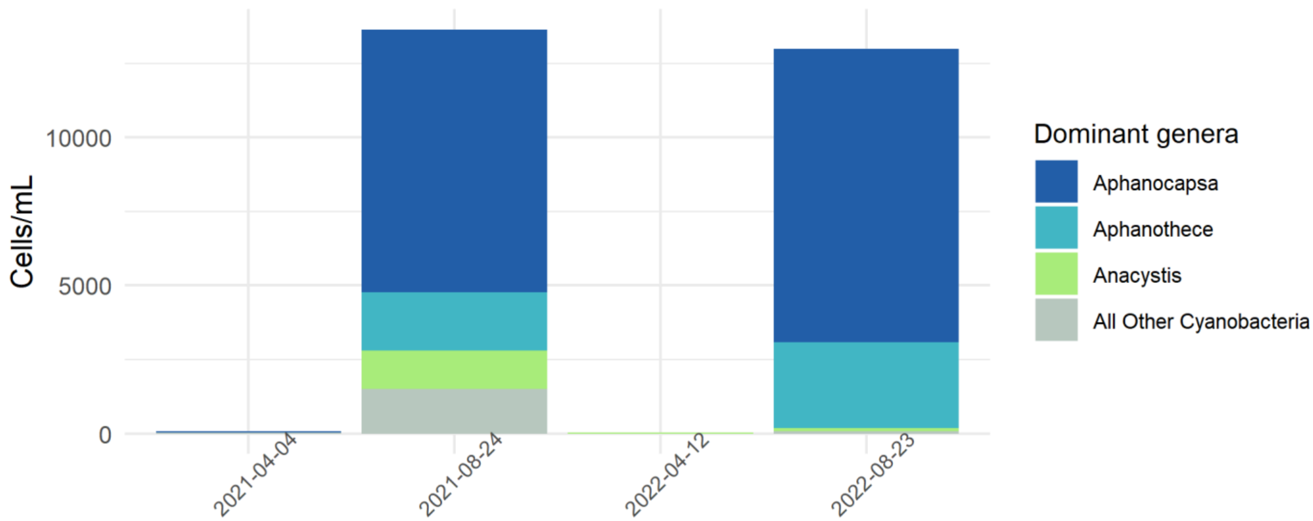

Figure 5: Cell abundance for dominant cyanobacteria genera on Adams Lake

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

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Aphanocapsa	9244 cells/mL	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA
Aphanothece	2884 cells/mL	Microcystin MC
Anacystis	1290 cells/mL	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Adams Lake contained cyanobacteria concentrations in the negligible to low-risk category, with a mean cyanobacteria abundance of 6,690 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Adams Lake compared to alert levels defined by several authorities including the WHO and EPA.

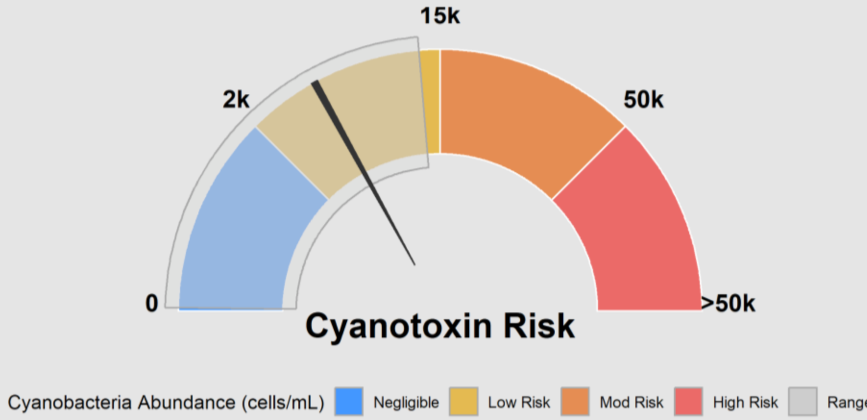

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms on Adams Lake

Cyanobacteria and micro-flagellates frequently dominated algal communities in total cell count. Because of their small cell size, their biovolume is usually low relative to the other types of algae present (Figure 7).

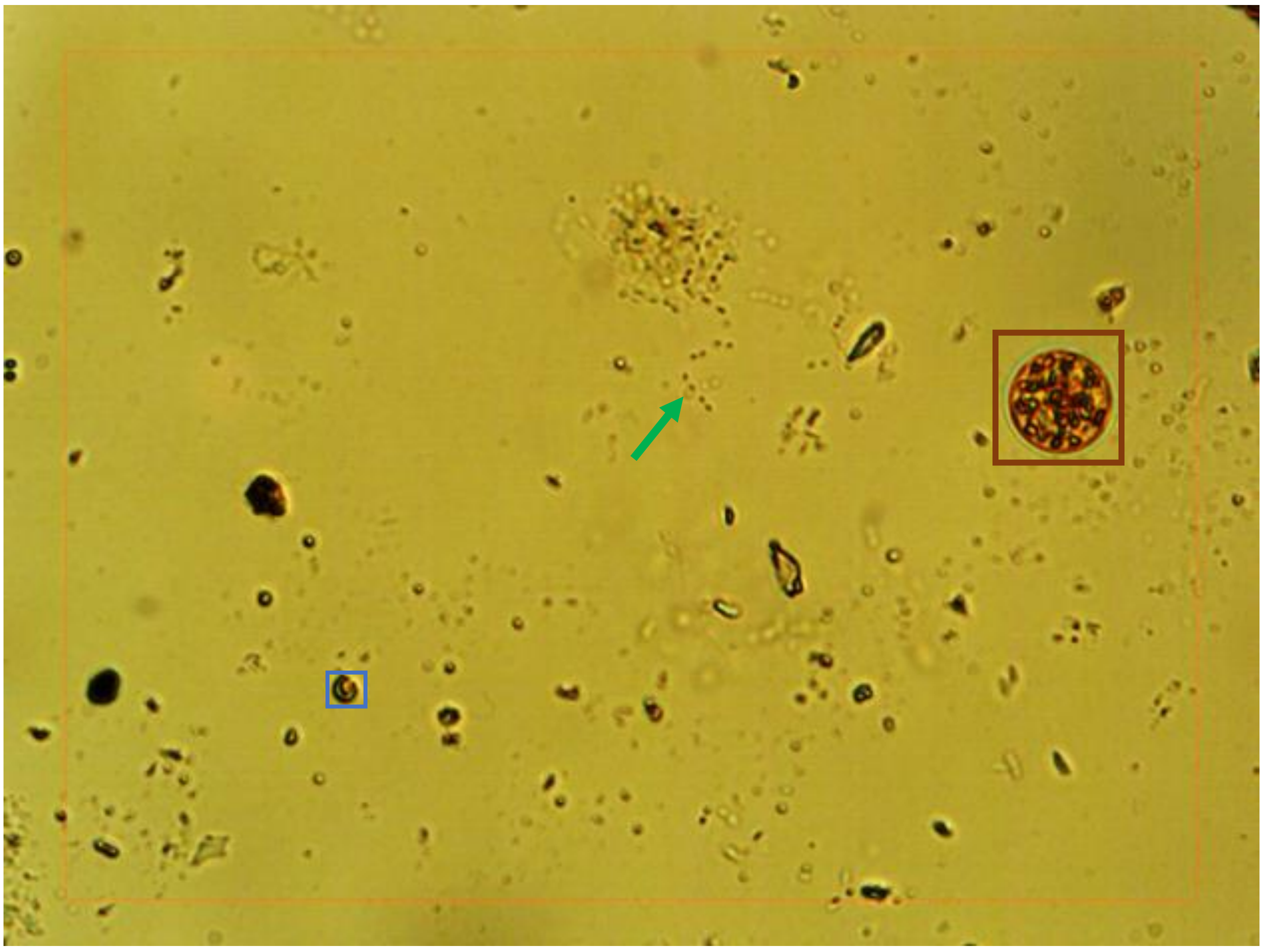

Figure 7: Size comparison of a cell of Lindavia cell (brown box) vs a micro-flagellate (blue box) vs a cyanobacteria cell (green arrow)

Species Composition

Algae samples were identified to the species level and grouped into broad alga types for analysis. The figures below display 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.

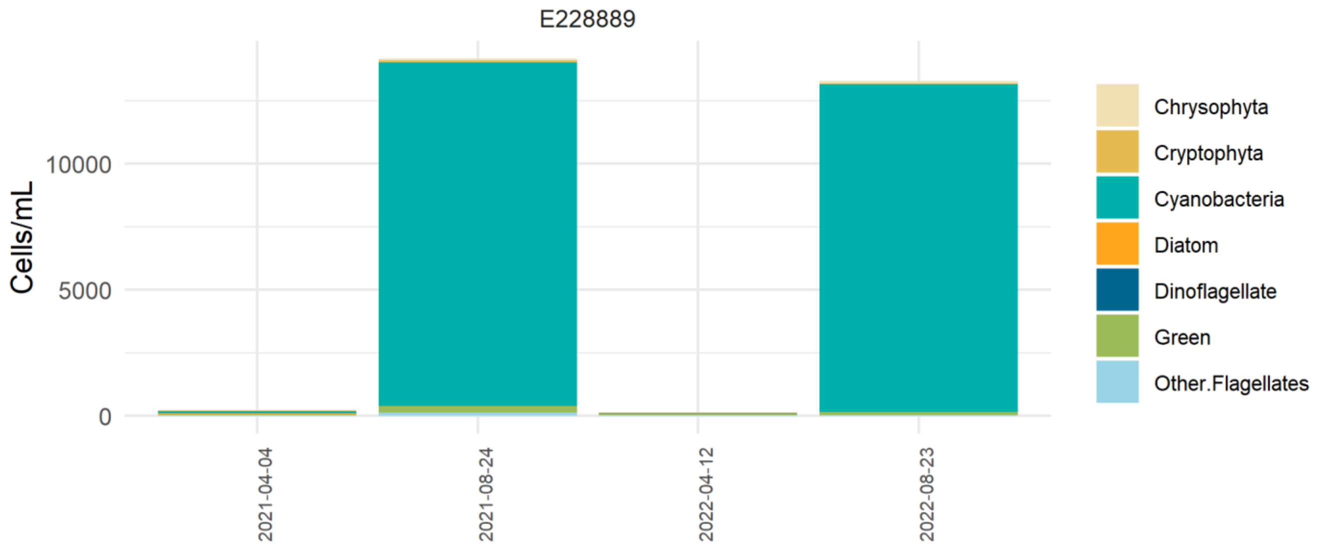

Figure 8: Cell abundance of high-level taxa groups on Adams Lake

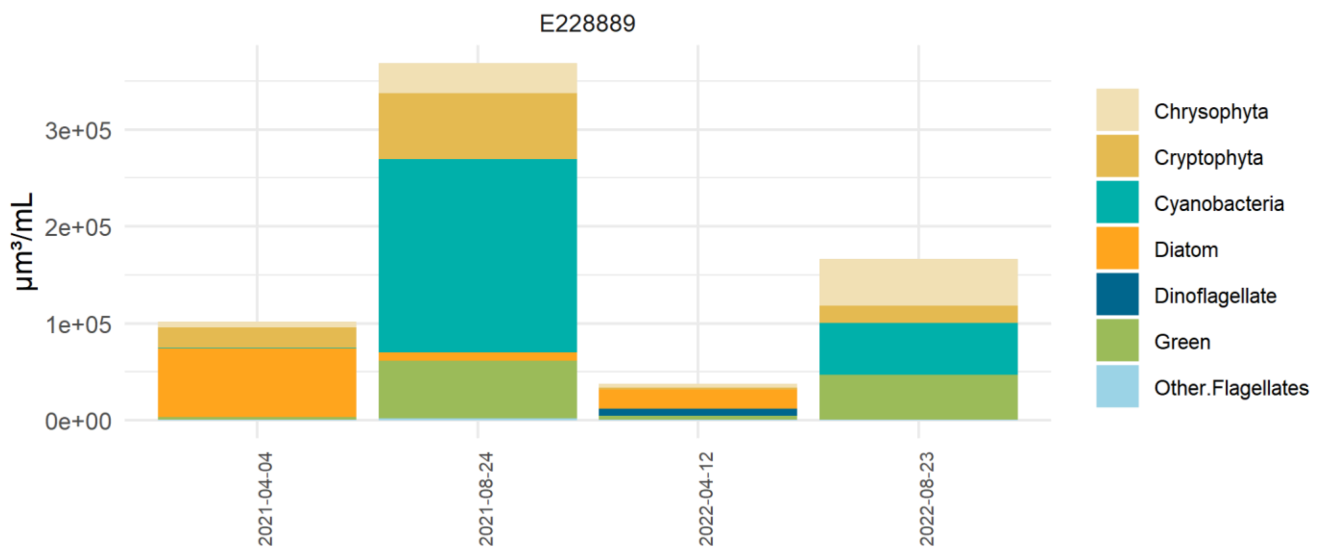

Figure 9: Biovolume of high-level taxa groups on Adams Lake

References

Kong, X., Seewald, M., Dadi, T., Friese, K., Mi, C., Boehrer, B., Schultze, M., Rinke, K., & Shatwell, T. (2021). Unravelling winter diatom blooms in temperate lakes using high frequency data and ecological modeling. *Water Research*, *190*, 116681. https://doi.org/10.1016/J.WATRES.2020.116681

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:

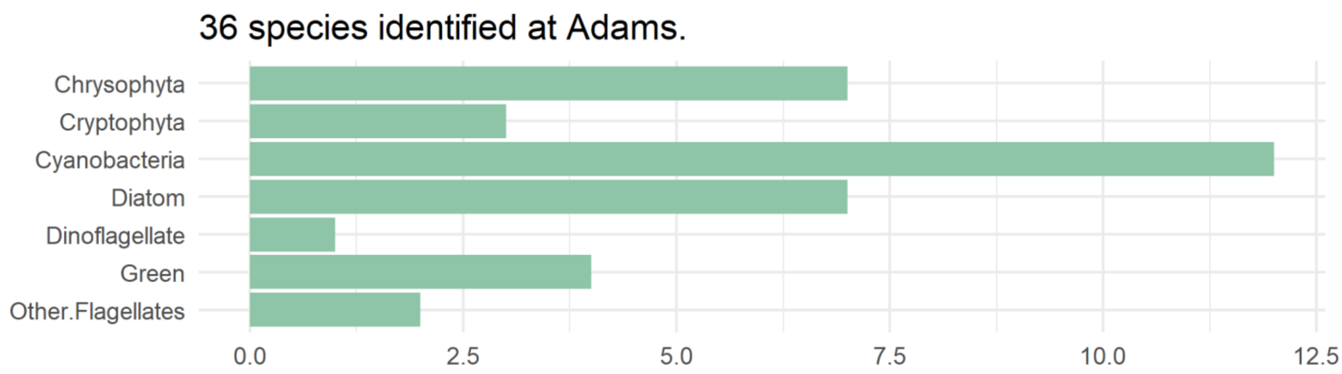

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID:E228889	**Total Abundance (cells/mL):**	**232**	
Collection Date: 2021-04-04	Total Biovolume (µm³/mL):	101822	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	8	4322	Chrysophyta
Kephyrion sp.	4	838	Chrysophyta
Ochromonas spp.	4	798	Chrysophyta
Cryptomonas ovata	8	17407	Cryptophyta
Rhodomonas lacustris	34	3692	Cryptophyta
Aphanocapsa elachista	38	106	Cyanobacteria
Aphanothece sp.	8	26	Cyanobacteria
Planktolyngbya sp.	19	236	Cyanobacteria
Romeria sp.	8	196	Cyanobacteria
Achnanthidium minutissima	4	424	Diatom
Asterionella formosa	8	5571	Diatom
Cyclotella ocellata	4	454	Diatom
Aulacoseira italica	8	3994	Diatom
Urosolenia eriensis	23	51979	Diatom
Ulnaria acus	8	8335	Diatom
Chlamydomonas sp.	4	2393	Green
nanoflagellates	34	1024	Other.Flagellates
picoflagellates	8	27	Other.Flagellates

Figure 11: Raw data from 2021-04-04 EMS site E228889

EMS ID: E228889	**Total Abundance (cells/mL):**	**14179**	
Collection Date: 2021-08-23	Total Biovolume (µm³/mL):	368560	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Bitrichia chodatii	8	2670	Chrysophyta
Chroomonas acuta	38	20528	Chrysophyta
Ochromonas spp.	38	7581	Chrysophyta
Chrysochromulina sp.	8	308	Chrysophyta
Cryptomonas ovata	23	50045	Cryptophyta
Cryptomonas sp.	8	14816	Cryptophyta
Rhodomonas lacustris	30	3257	Cryptophyta
Aphanocapsa elachista	5290	14772	Cyanobacteria
Aphanocapsa delicatissima	3590	15038	Cyanobacteria
Aphanothece sp.	1973	6291	Cyanobacteria
Anacystis cyanea	1290	1942	Cyanobacteria
Anabaena circinalis	53	16444	Cyanobacteria
Chroococcus dispersus	152	2149	Cyanobacteria
Chroococcus limneticus	1093	139573	Cyanobacteria
Rhabdoderma linearis	30	942	Cyanobacteria
Borzia sp.	23	1495	Cyanobacteria
Anathece sp.	152	637	Cyanobacteria
Lindavia bodanica	8	8348	Diatom
Crucigenia quadrata	61	3730	Green
Crucigenia rectangularis	182	55741	Green
nanoflagellates	68	2048	Other.Flagellates
picoflagellates	61	205	Other.Flagellates

Figure 12: Raw data from 2021-08-23 EMS site E228889

EMS ID: E228889	**Total Abundance (cells/mL):**	**134**	
Collection Date: 2022-04-12	**Total Biovolume (µm³/mL):**	**37998**	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	8	4322	Chrysophyta
Rhodomonas lacustris	19	2063	Cryptophyta
Anacystis cyanea	38	57	Cyanobacteria
Asterionella formosa	15	10445	Diatom
Urosolenia eriensis	4	9040	Diatom
Peridinium inconspicuum	4	7326	Dinoflagellate
Cosmarium sp.	8	4002	Green
nanoflagellates	23	693	Other.Flagellates
picoflagellates	15	50	Other.Flagellates

Figure 13: Raw data from 2022-04-12 EMS site E228889

EMS ID: E228889	**Total Abundance (cells/mL):**	**13291**	
Collection Date: 2022-08-23	**Total Biovolume (µm³/mL):**	**166334**	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Anabaena flosaquae	91	24465	Chrysophyta
Chroomonas acuta	8	4322	Chrysophyta
Dinobryon bavaricum	8	17412	Chrysophyta
Ochromonas spp.	8	1596	Chrysophyta
Cryptomonas ovata	8	17407	Cryptophyta
Rhodomonas lacustris	8	869	Cryptophyta
Aphanocapsa elachista	683	1907	Cyanobacteria
Aphanocapsa delicatissima	9244	38721	Cyanobacteria
Aphanothece sp.	2884	9196	Cyanobacteria
Anacystis cyanea	114	172	Cyanobacteria
Chroococcus dispersus	46	650	Cyanobacteria
Chroococcus limneticus	15	1915	Cyanobacteria
Borzia sp.	15	975	Cyanobacteria
Chlamydomonas sp.	15	8975	Green
Crucigenia rectangularis	121	37059	Green
nanoflagellates	23	693	Other.Flagellates

Figure 14: Raw data from 2022-08-23 EMS site E228889