Williams Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Williams 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
WILLIAMS LAKE AT CENTER (0603019)	2021-04-21
	2021-08-17
	2022-04-13
	2022-08-23
	Total= 4 samples

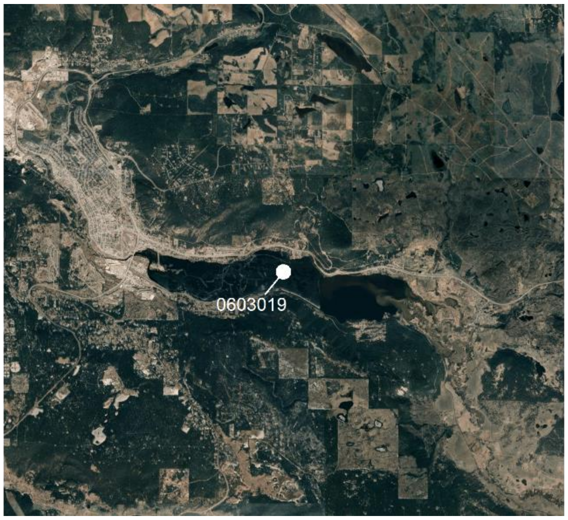

Figure 1: Aerial view of Williams Lake

Samples contained low concentrations of diatoms, green algae, and dinoflagellates. *Aulacoseira italica* was the dominant diatom present. Summer samples contained very high concentrations of cyanobacteria (Figure 2). Blooming cyanobacteria in Williams Lake can produce toxins.

Spring samples contained higher concentrations of detritus and lower concentrations of cyanobacteria relative to summer samples (Figure 2). Elevated quantities of suspended debris can affect the health and aesthetics of a water system. Particulates in the water column can cause cloudy hues and provide attachment zones for pollutants; notably metals and bacteria (Water Science School et al., 2018). Turbidity spikes during the spring are common due to elevated wind, rain, erosion, and runoff events (Card et al., 2014). Suspended materials can include clay, silt, organic and inorganic matter, algae, dissolved color compounds, and bacteria (Card et al., 2014).

Figure 2: Contrasting algal community composition in the spring (high concentrations of detritus) vs. summer (cyanobacteria bloom)

Overview (continued)

Cyanobacteria often dominate algae counts, but because of their small cell size cyanobacteria biovolume is typically low relative to other agal types. The large total biovolume of *Aphanizomenon flos-aquae* varieties (79%; cyanobacteria) reflects its dominance in Williams Lake (Figure 3).

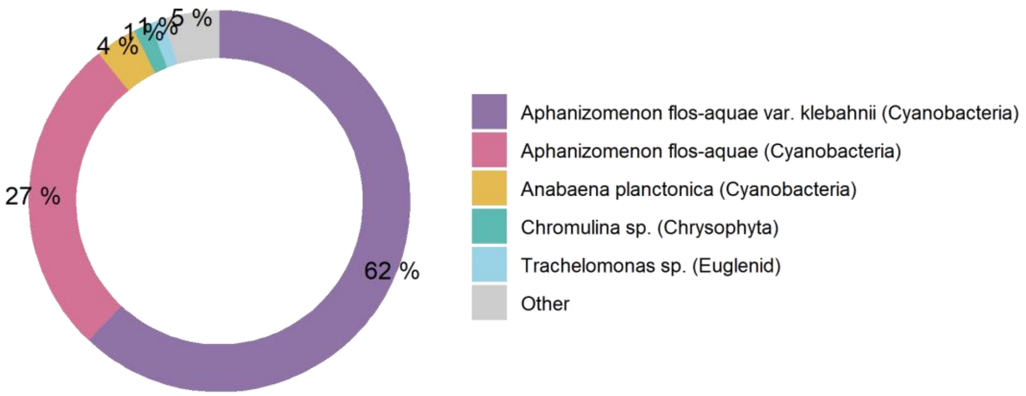

Figure 3: Dominant organisms from Swan L Center Deep Stn. (0603019) as percent of total biovolume

Spring samples contained low algae concentrations. Summer samples contained large blooms of *Aphanizomenon flos-aquae* varieties (Figure 3). The scale of cyanobacterial blooms recorded in Williams Lake could be reflective of nutrient imbalances.

Chysophyta species were identified in the spring samples, specifically *Chromulina* species (Figure 4).

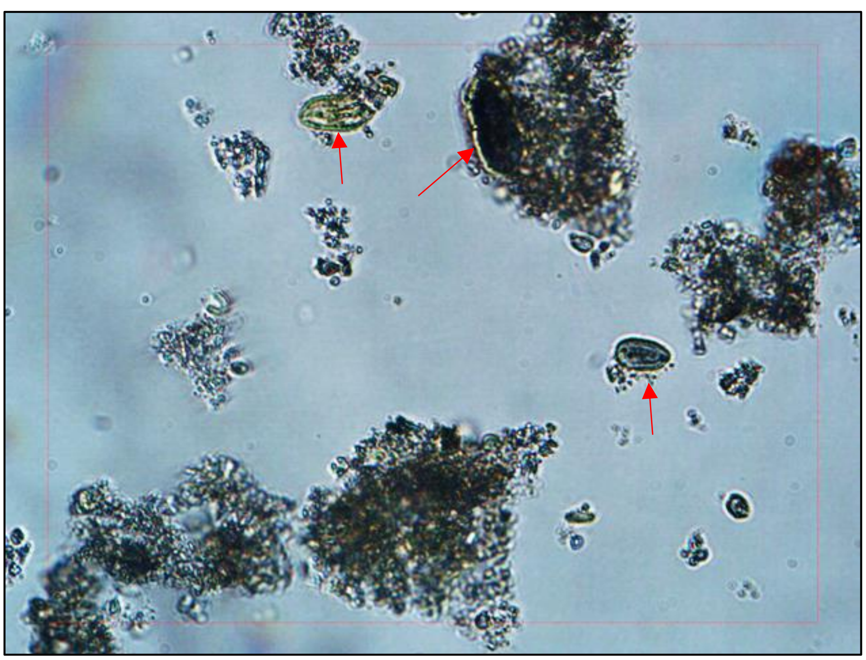

Figure 4: 400x magnification of EMS site 0603019 collected on 2021-04-21 showing small number of Chrysophytes (red arrows)

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

Spring contained low concentrations of cyanobacteria relative to summer (Figure 5). *Aphanizomenon flos-aquae* varieties dominated all summer counts but, *Planktolyngbya,* and *Anabaena* species were also observed (Figure 5).

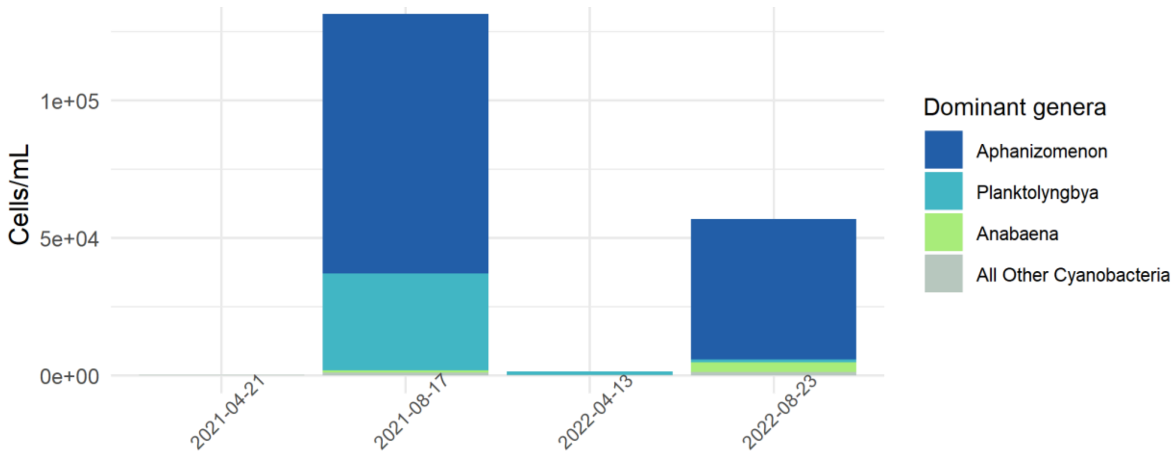

Figure 5: cell abundance for dominant cyanobacteria genera on Williams Lake

During blooms, species of *Aphanizomenon* and *Anabaena* can produce both negative odor/taste compounds and toxic secondary metabolites (EPA, 2022). *Aphanizomenon* is a filamentous, nitrogen-fixing cyanobacteria capable of forming dense, odorous, and toxic blooms. *Aphanizomenon* cells can produce liver toxins, nerve toxins, and skin irritants upon cell lysis (Cirés & Ballot, 2016). *Anabaena* blooms can quickly accumulate, develop odor metabolites, and color water systems (EPA, 2022).

Other dominant cyanobacteria identified in the summer samples are also 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 Williams Lake and their associated toxins

Genus	Maximum Abundance* (Cells/mL)	Toxins Produced
Aphanizomenon	69442	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor
Planktolyngbya	35290	Lyngbyatoxin LYN, Microcystin MC, BMAA
Anabaena	3438	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 Williams Lake can produce cyanotoxins (Table 2).

Williams Lake displayed a range of cyanobacteria levels from negligible to high risk depending on the season, with a mean cyanobacteria abundance of 47,468 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Williams Lake as compared to alert levels defined by authorities including the WHO and EPA.

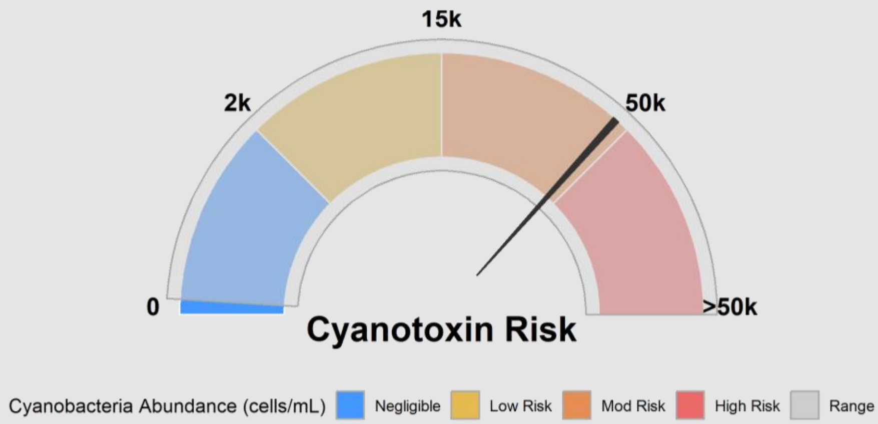

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Williams Lake

Williams Lake had high concentrations of cyanobacteria, and biovolume percentages were reflective of their dominance (Figure 8; Figure 5; Figure 3). The small cell size of cyanobacteria relative to other types of algae causes them to typically have a low biovolume percentage (Figure 7). The cyanobacterial blooms in Williams Lake were large enough to dominate biovolume; this is atypical.

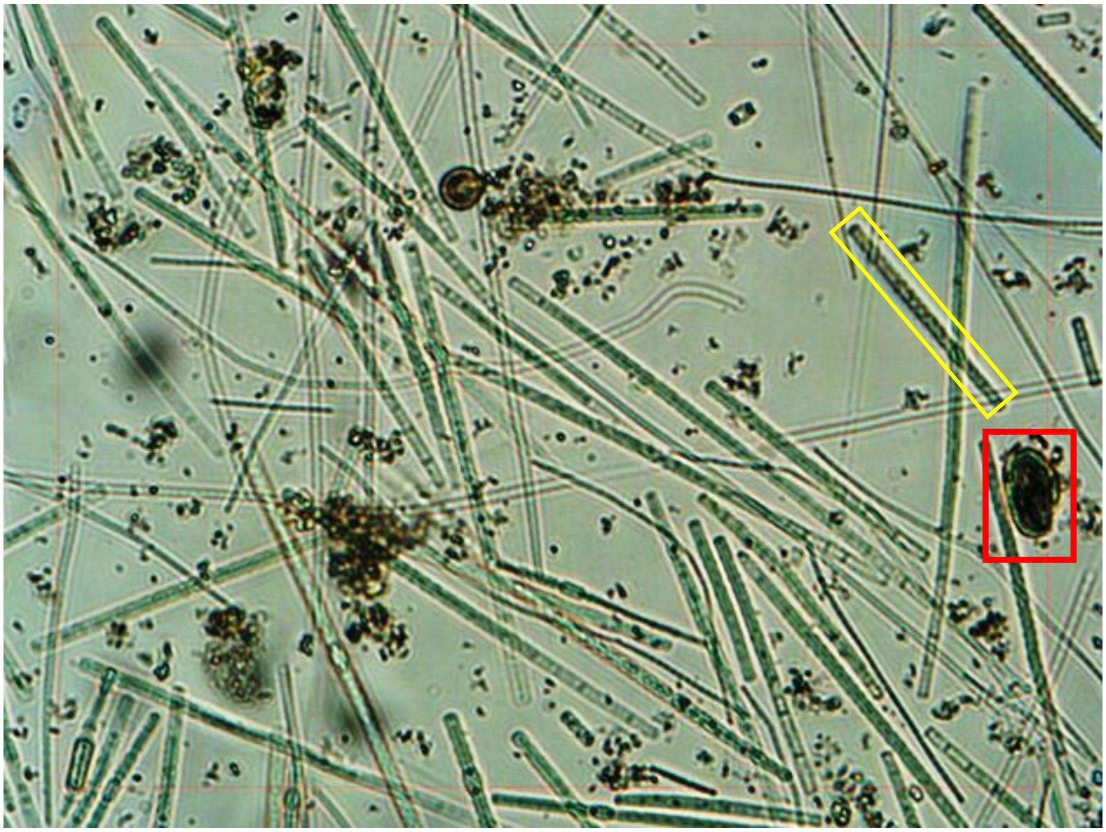

Figure 7: Size comparison of Crytomonas flagellate (red box) to approximately 25 Aphanizomenon cells (yellow box)

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 their biovolume. Note the dominance of cyanobacteria in both Figure 8 (cell abundance) and Figure 9 (biovolume).

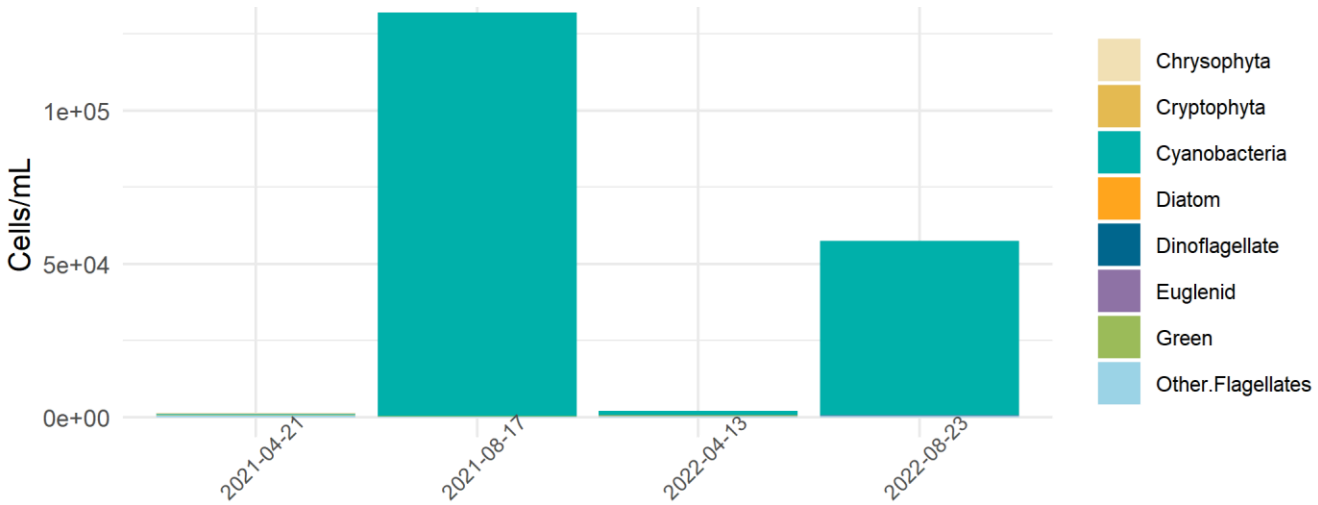

Figure 8: Cell abundance of high-level taxa groups on Williams Lake

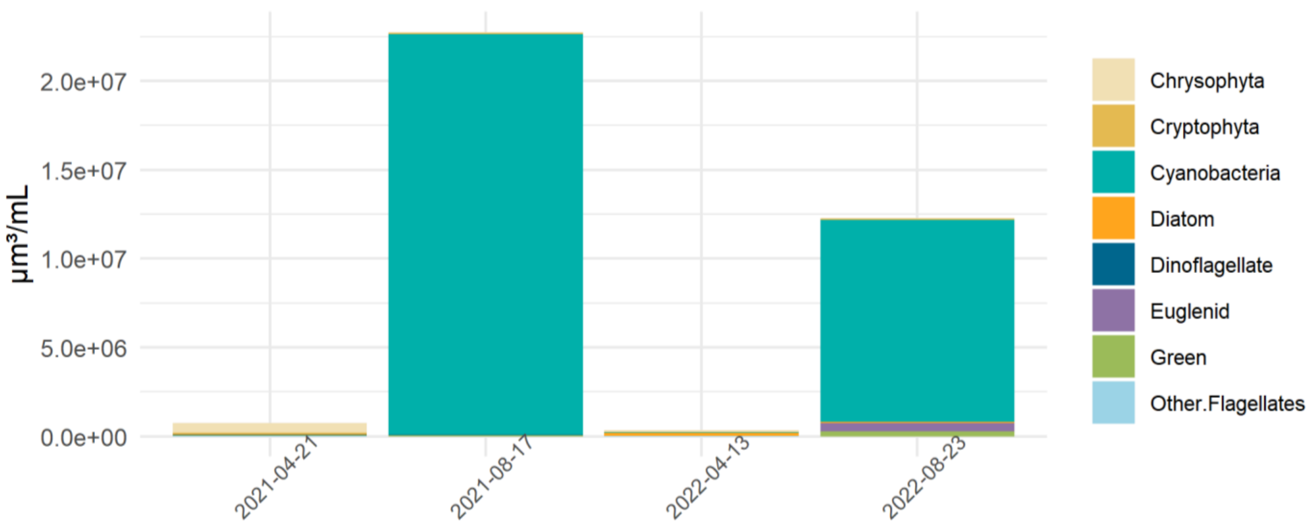

Figure 9: Biovolume of high-level taxa groups on Williams Lake

References

Card, A., Fitch, K., Kelly, D., Kemker, C., & Rose, K. (2014, June 13). *Turbidity, Total Suspended Solids & Water Clarity*. FONDRIEST.

Cirés, S., & Ballot, A. (2016). A review of the phylogeny, ecology and toxin production of bloom-forming Aphanizomenon spp. and related species within the Nostocales (cyanobacteria). *Harmful Algae*, *54*, 21–43. https://doi.org/10.1016/j.hal.2015.09.007

EPA. (2022, September). *Learn about Cyanobacteria and Cyanotoxins*. United States Environmental Protection Agency.

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

Water Science School, Swanson, H. A., & Baldwin, H. L. (2018, June 18). *Turbidity and Water*. USGS.

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:

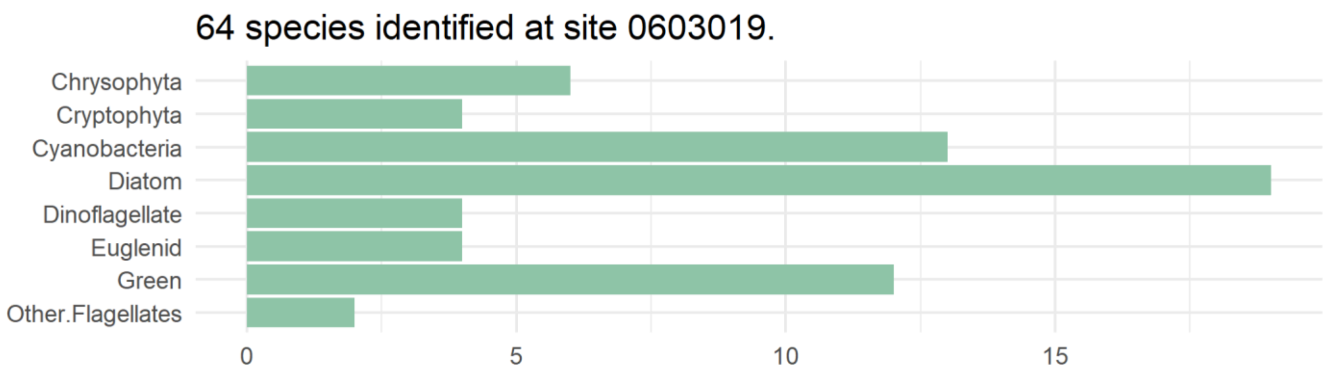

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 0603019	**Total Abundance (cells/mL):**	**1405**	
Collection Date: 2021-04-21	Total Biovolume (µm³/mL):	724651	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	87	46999	Chrysophyta
Dinobryon sertularia	15	18444	Chrysophyta
Chromulina sp.	254	448855	Chrysophyta
Ochromonas sp lrg pointed	4	2036	Chrysophyta
Ochromonas sp. Small	68	1851	Chrysophyta
Cryptomonas curvata	4	25200	Cryptophyta
Cryptomonas ovata	15	32638	Cryptophyta
Rhodomonas lacustris	53	5755	Cryptophyta
Anacystis cyanea	129	194	Cyanobacteria
Chroococcus limneticus	8	1022	Cyanobacteria
Chroococcus dispersus	15	212	Cyanobacteria
Asterionella formosa	4	2785	Diatom
Aulacoseira granulata	4	1316	Diatom
Cyclotella sp.	4	1062	Diatom
Lindavia bodanica	4	4174	Diatom
Frustulia rhomboides	4	16990	Diatom
Aulacoseira italica	8	3994	Diatom
Nitzschia palea	4	841	Diatom
Ulnaria acus	4	4167	Diatom
Staurosira sp.	4	1847	Diatom
Peridinium inconspicuum	8	14652	Dinoflagellate
Peridinium willei	4	8579	Dinoflagellate
Peridinium sp.	4	18043	Dinoflagellate
Euglena sp.	11	6336	Euglenid
Trachelomonas volvocina	11	8760	Euglenid
Ankistrodesmus falcatus	4	565	Green
Oocystis parva	8	1798	Green
Scenedesmus cf. acutiformis	15	3504	Green
Monoraphidium indicum	11	7708	Green
Chlamydomonas sp.	42	25130	Green
nanoflagellates	269	8100	Other.Flagellates
picoflagellates	326	1094	Other.Flagellates

Figure 11: Raw data from 2021-04-21 EMS site 0603019

EMS ID: 0603019	**Total Abundance (cells/mL):**	**131927**	
Collection Date: 2021-08-17	Total Biovolume (µm³/mL):	22745585	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	15	8103	Chrysophyta
Dinobryon sertularia	15	18444	Chrysophyta
Chromulina sp.	8	14137	Chrysophyta
Cryptomonas ovata	38	82684	Cryptophyta
Rhodomonas lacustris	8	869	Cryptophyta
Anagnostidinema acutissimum	152	1211	Cyanobacteria
Anabaena planctonica	311	106162	Cyanobacteria
Anabaena affinis	531	152184	Cyanobacteria
Aphanocapsa elachista	152	424	Cyanobacteria
Anabaena circinalis	46	14272	Cyanobacteria
Anacystis cyanea	379	571	Cyanobacteria
Aphanizomenon flos-aquae var. klebahnii	69442	17907175	Cyanobacteria
Aphanizomenon flos-aquae	24969	4157449	Cyanobacteria
Planktolyngbya limnetica	35290	180537	Cyanobacteria
Pseudanabaena catenata	273	19927	Cyanobacteria
Gymnodinium sp.	8	16948	Dinoflagellate
Euglena sp.	8	4608	Euglenid
Trachelomonas volvocina	8	6371	Euglenid
Crucigenia tetrapedia	15	1838	Green
Closterium cf. acutum	8	2401	Green
Gloeocystis planctonica	30	2913	Green
Nephrocytium sp.	61	30279	Green
Oocystis pusilla	8	1267	Green
Chlamydomonas sp.	8	4787	Green
Chlamydomonas sp.	15	8975	Green
nanoflagellates	23	693	Other.Flagellates
picoflagellates	106	356	Other.Flagellates

Figure 12: Raw data from 2021-08-17 EMS site 0603019

EMS ID: 0603019	Total Abundance (cells/mL):	2091		
Collection Date: 2022-04-13	Total Biovolume (µm³/mL):	360046		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	30	16207	Chrysophyta	10613
Dinobryon sertularia	4	4918	Chrysophyta	1515
Chromulina sp.	34	60083	Chrysophyta	1717
Mallomonas akrokomas	15	49417	Chrysophyta	1598
Ochromonas sp. Small	38	1035	Chrysophyta	1455
Rhodomonas lacustris	27	2932	Cryptophyta	10663
Anacystis cyanea	34	51	Cyanobacteria	609
Limnothrix redekei	152	19101	Cyanobacteria	
Planktolyngbya limnetica	1184	6057	Cyanobacteria	
Asterionella formosa	11	7660	Diatom	3116
Achnanthidium microcephalum	4	580	Diatom	590864
Aulacoseira italica	72	35943	Diatom	590863
Aulacoseira granulata	11	3618	Diatom	590863
Cyclostephanos dubius	8	201	Diatom	590827
Diatoma hiemale	38	40014	Diatom	3214
Epithemia sorex	8	26389	Diatom	5005
Fragilaria crotonensis	30	14567	Diatom	2932
Fragilaria vaucheriae	30	14567	Diatom	2932
Navicula spp.	4	2356	Diatom	3649
Nitzschia palea	8	1682	Diatom	5070
Ulnaria ulna	4	21019	Diatom	970000
UID diatom	4	589	Diatom	
Monoraphidium indicum	11	7288	Green	5990
Chlamydomonas sp.	34	20344	Green	5448
nanoflagellates	91	2740	Other.Flagellates	
picoflagellates	205	688	Other.Flagellates	

Figure 13: Raw data from 2022-04-13 EMS site 0603019

EMS ID: 0603019	Total Abundance (cells/mL):	57474		
Collection Date: 2022-08-23	Total Biovolume (µm³/mL):	12275833		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	15	8103	Chrysophyta	10613
Ochromonas sp lrg pointed	23	11706	Chrysophyta	1455
Cryptomonas marssonii	8	16335	Cryptophyta	10635
Cryptomonas ovata	30	65276	Cryptophyta	10635
Rhodomonas lacustris	46	4995	Cryptophyta	10663
Anabaena planctonica	3438	1173590	Cyanobacteria	1100
Anabaena affinis	137	39264	Cyanobacteria	1100
Aphanocapsa elachista	152	424	Cyanobacteria	625
Anacystis cyanea	721	1085	Cyanobacteria	609
Aphanizomenon flos-aquae var. klebahnii	17341	4471765	Cyanobacteria	1191
Aphanizomenon flos-aquae	33772	5623187	Cyanobacteria	1191
Limnothrix redekei	152	19101	Cyanobacteria	
Planktolyngbya limnetica	1025	5244	Cyanobacteria	
Pseudanabaena catenata	53	3869	Cyanobacteria	1175
Chroococcus limneticus	15	1915	Cyanobacteria	654
Synedra acus var angustissima	15	54000	Diatom	3013
Ulnaria ulna	8	42038	Diatom	970000
Phacus sp.	8	32573	Euglenid	9766
Trachelomonas sp.	121	427649	Euglenid	9690
Elakatothrix gelatinosa	99	17486	Green	9412
Staurastrum planctonicum	15	235619	Green	7440
Chlamydomonas sp.	30	17950	Green	5448
nanoflagellates	68	2048	Other.Flagellates	
picoflagellates	182	611	Other.Flagellates	

Figure 14: Raw data from 2022-08-23 EMS site 0603019