Chimney Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Chimney 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
CHIMNEY LK. AT NW END (0603097)	2021-05-04
	2021-08-25
	2022-05-03
	2022-08-23
	Total= 4 samples

Figure 1: Aerial view of Chimney Lake

Spring samples contained elevated concentrations of diatoms compared to summer samples. 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). Spring samples collected in Chimney Lake demonstrated diatom degradation reflective of lowering silica levels in the late spring (Figure 2).

Encyonema and *Stephanodiscus* were the dominant genera of diatoms. Diatoms increase the resiliency and health of water systems through their ability to bloom in early spring, reduce nutrient levels, and prevent monoculture blooms of less desirable algae (jrobyn, 2019). Diatoms are integral to aquatic food webs and the foundation of freshwater food webs are primarily composed of diatoms (jrobyn, 2019).

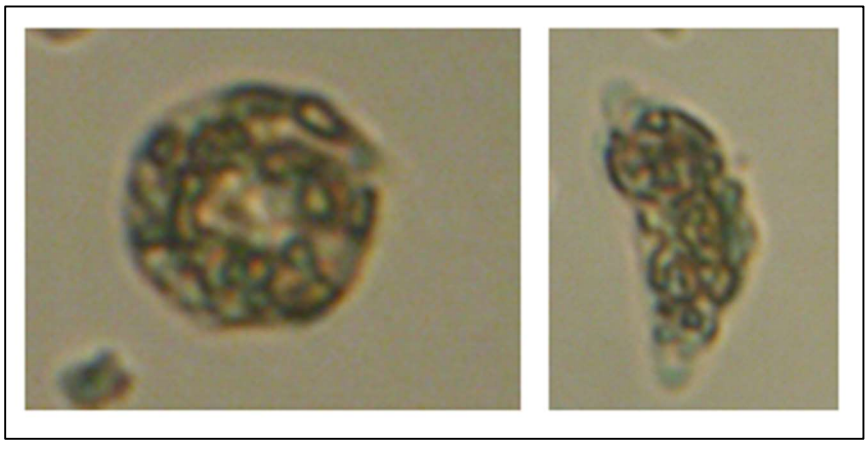

Figure 2: 400x magnification of degraded diatoms collected during spring sampling 2022

Overview (continued)

Chrysophyta genus *Chrysosphaerales* and Cryptophyta genus *Rhodomonas* represented a large portion of total biovolume in Chimney Lake (Figure 3).

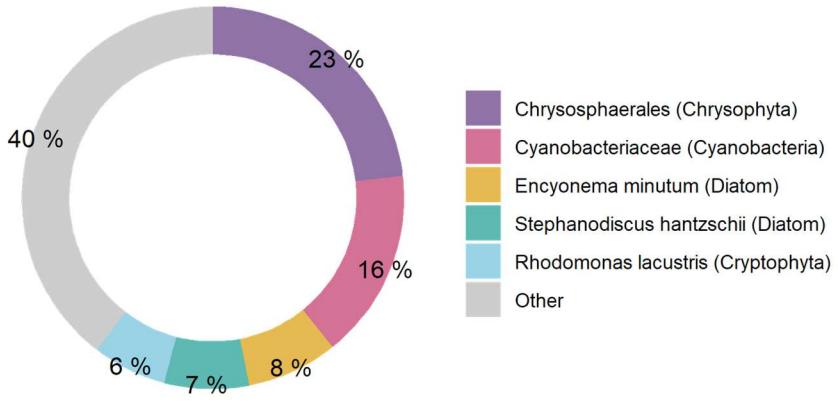

Figure 3: Dominant organisms from Chimney Lk. At Nw End (0603097) as percent of total biovolume

Chrysophyta taxa are advantageous and disadvantageous in freshwater systems, depending on their context. Some Chrysophytes are known to produce odor chemicals described as fishy, while others eat bacteria and reduce negative odor compounds (Wehr et al., 2015).

Cryptophyta are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015).

Identified species of algae in Chimney Lake were distributed evenly across diatoms, Chlorophyta/ green algae, Chrysophyta, and cyanobacteria (Figure 4). Most species identified in Chimney Lake belonged to diatoms, cyanobacteria, Chlorophyta, or Chysophyta.

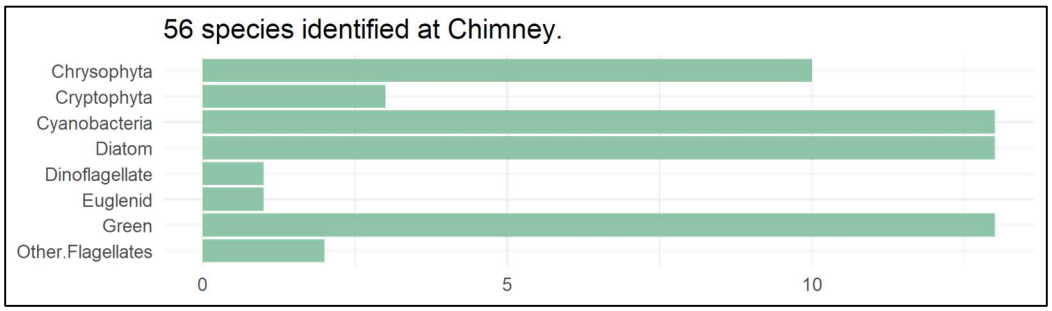

Figure 4: Species identified in Chimney Lake sorted into higher level taxa

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

Low concentrations of cyanobacteria occurred in the spring and cyanobacteria blooms occurred in the summer (Figure 5). Dominant genera included *Anacystis*, *Aphanocapsa*, and Cyanobacteriaceae (a family in order chroococcales).

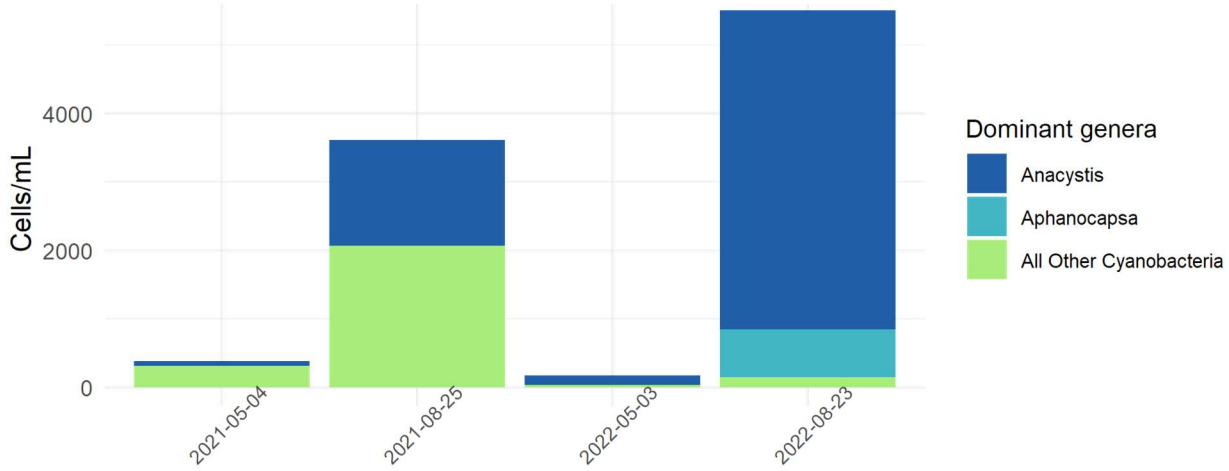

Figure 5: cell abundance for dominant cyanobacteria genera on Chimney Lake
Note: Cyanobacteriaceae was grouped into "all other cyanobacteria"

Anacystis and *Aphanocapsa* are associated with several cyanotoxins that represent risks to public health (Table 2). *Chroococcus* species were also present in samples and are associated with cyanotoxins Microcystin MC and BMAA. 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 Chimney Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	4667	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Aphanocapsa	702	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA

Note: * = counted in samples
Chroococcus not included because it was not truly dominant

Cyanobacterial Presence (Continued)

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

Chimney Lake displayed cyanobacteria levels in the negligible-low risk category, with a mean cyanobacteria abundance of 2,418 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Chimney Lake compared to alert levels defined by several authorities including the WHO and EPA.

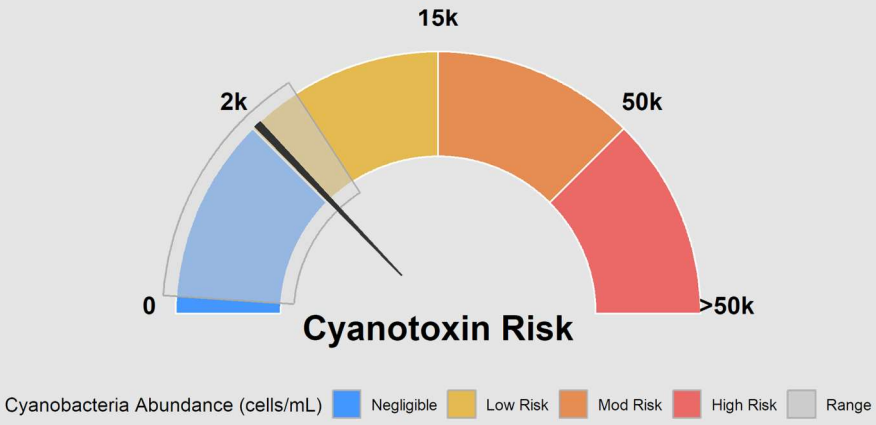

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Chimney Lake

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 *Encyonema* cell is over ten times the size of adjacent cyanobacteria.

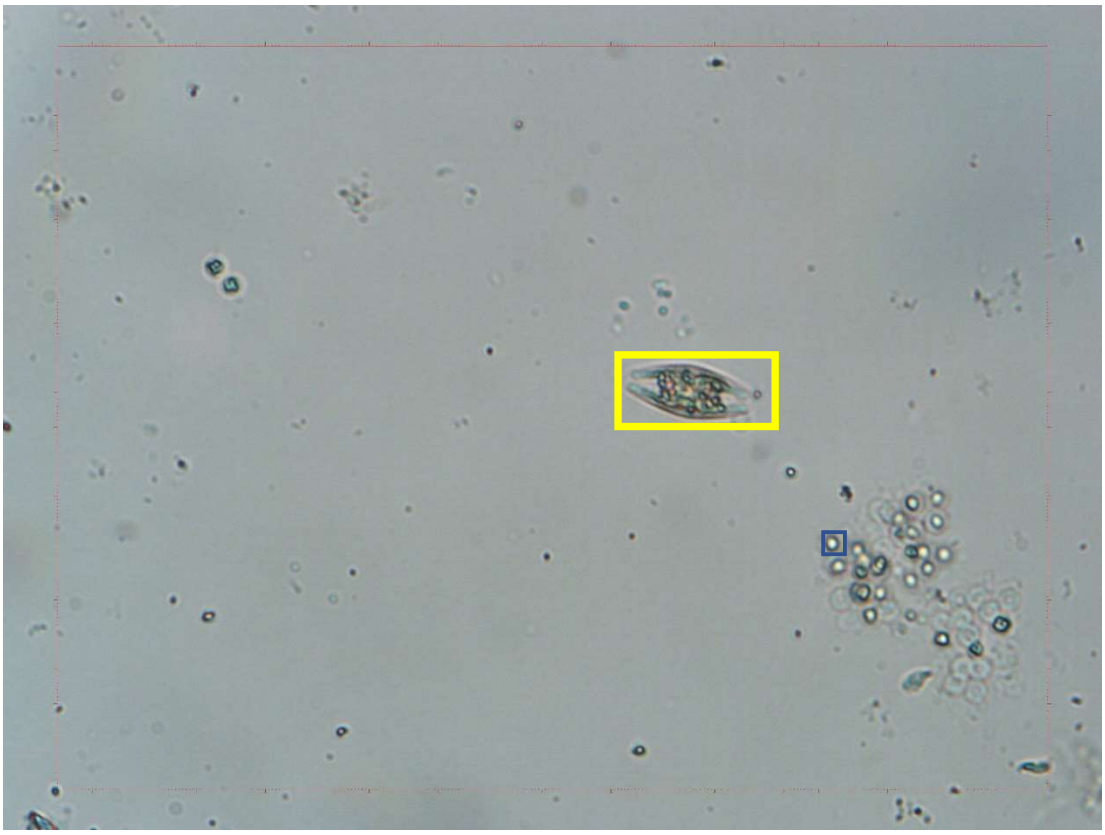

Figure 7: Size comparison of Encyonema (yellow box) to Gleocapsa cell (blue box)

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 their biovolume. The difference between Figure 8 (cell abundance) and Figure 9 (biovolume) illuminates the difference between cell abundance and biovolume.

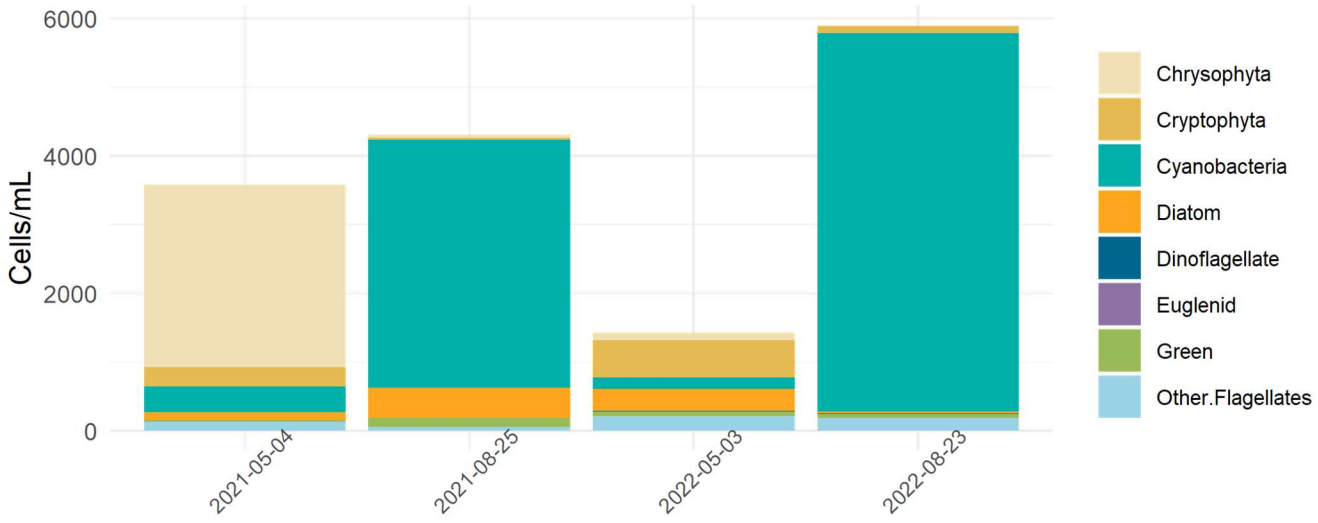

Figure 8: Cell abundance of high-level taxa groups on Chimney Lake

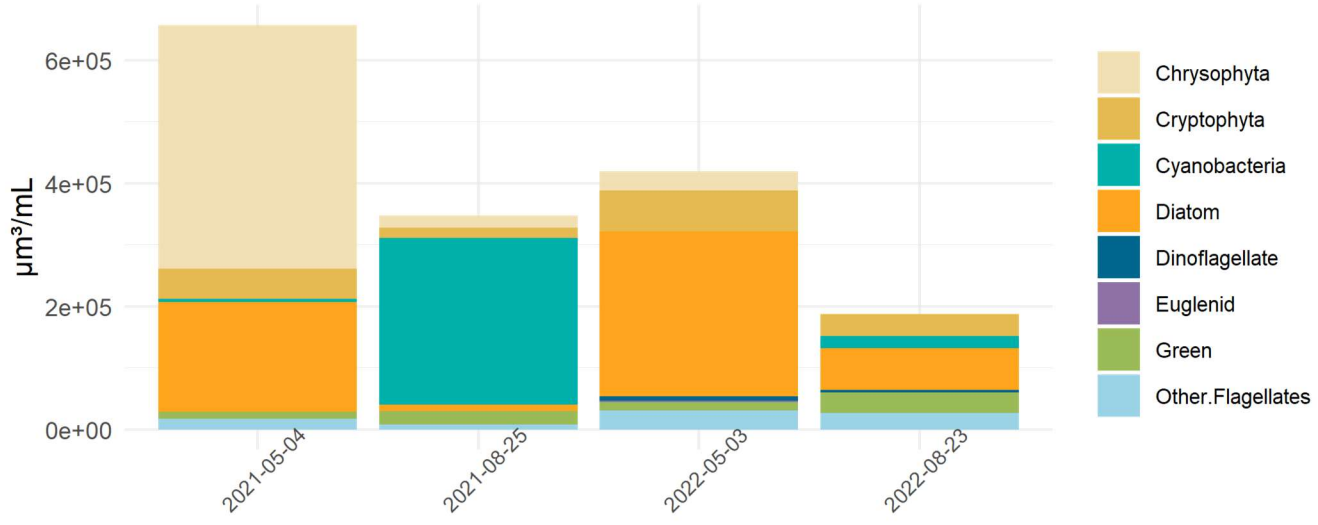

Figure 9: Biovolume of high-level taxa groups on Chimney Lake

References

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Appendix

Additional figures and raw data are listed below:

EMS ID: 603097	Total Abundance (cells/mL):	3575		
Collection Date: 2021-05-04	Total Biovolume (µm³/mL):	719949		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	61	13058	Chrysophyta	1455
Chroomonas sp.	11	2501	Chrysophyta	10613
Chrysococcus sp.	27	8965	Chrysophyta	1751
Dinobryopsis sp.	8	2149	Chrysophyta	1557
Chrysosphaerales	2550	429032	Chrysophyta	
Cryptomonas sp.	11	20372	Cryptophyta	10635
Rhodomonas lacustris	273	29642	Cryptophyta	10663
Anacystis sp.	68	129	Cyanobacteria	609
Cuspidothrix sp.	19	1352	Cyanobacteria	
Planktolyngbya sp.	231	2871	Cyanobacteria	
Merismopedia punctata	15	97	Cyanobacteria	727
Spirulina major	46	289	Cyanobacteria	1053
Achnanthes linearis	11	1361	Diatom	3429
Cyclotella sp.	4	1062	Diatom	2439
Lindavia bodanica	30	31305	Diatom	
Cymbopleura sp.	4	1781	Diatom	970020
Cymbella tumida	8	13547	Diatom	4795
Cymbella hantzschiana	42	71119	Diatom	4795
Nitzschia sp.	4	367	Diatom	5070
Stephanodiscus hantzschii	8	57669	Diatom	2415
Chlorella vulgaris	4	279	Green	5811
Elakatothrix gelatinosa	4	706	Green	9412
Monoraphidium fontinale	4	2650	Green	5990
Monoraphidium indicum	11	7288	Green	5990
microflagellate	121	20358	Other.Flagellates	

Figure 10: Raw data from 2021-05-04 EMS site 0603097

EMS ID: 603097	Total Abundance (cells/mL):	4308		
Collection Date: 2021-08-2	Total Biovolume (µm³/mL):	392103		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	4	154	Chrysophyta	2160
Chrysococcus sp.	15	4980	Chrysophyta	1751
Chrysosphaerales	15	2524	Chrysophyta	
Dinobryon sp.	8	12016	Chrysophyta	1515
Cryptomonas sp.	8	14816	Cryptophyta	10635
Rhodomonas lacustris	23	2497	Cryptophyta	10663
Anacystis sp.	1548	2946	Cyanobacteria	609
Anathece sp.	114	478	Cyanobacteria	
Gomphosphaeria sp.	167	7409	Cyanobacteria	714
Cyanobacteriaceae	1783	299986	Cyanobacteria	
Aphanocapsa sp.	425	1343	Cyanobacteria	625
Cyclotella sp.	4	1062	Diatom	2439
Cymbopleura sp.	4	1781	Diatom	970020
Cymbella sp.	4	6773	Diatom	4795
Crucigenia sp.	121	20358	Green	
Elakatothrix gelatinosa	8	1413	Green	9412
Monoraphidium indicum	4	2650	Green	5990
microflagellate	53	8917	Other.Flagellates	

Figure 11: Raw data from 2021-08-25 EMS site 0603097

EMS ID: 603097	Total Abundance (cells/mL):	1425		
Collection Date: 2022-05-03	Total Biovolume (µm³/mL):	425289		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysococcus sp.	8	2656	Chrysophyta	1751
Chrysochromulina sp.	83	3192	Chrysophyta	2160
Chromulina sp.	4	7069	Chrysophyta	1717
Dinobryon spp.	11	17451	Chrysophyta	1515
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Rhodomonas lacustris	539	58523	Cryptophyta	10663
Anacystis sp.	137	261	Cyanobacteria	609
Gloeocapsa punctata	34	142	Cyanobacteria	682
Encyonema minutum	137	124560	Diatom	590838
Encyonema cf. silesiacum	118	96338	Diatom	590838
Lindavia intermedia	27	23866	Diatom	
Navicula sp.	34	24033	Diatom	3649
Glenodinium sp.	4	7992	Dinoflagellate	10174
Euglena sp.	4	2304	Euglenid	9620
Crucigenia tetrapedia	30	3675	Green	6225
Elakatothrix sp.	4	768	Green	9412
Monoraphidium indicum	4	2650	Green	5990
Monoraphidium minutum	8	5300	Green	5990
Oocystis sp.	19	358	Green	5827
microflagellate	212	35669	Other.Flagellates	

Figure 12: Raw data from 2022-05-03 EMS site 0603097

EMS ID: 603097	Total Abundance (cells/mL):	5900		
Collection Date: 2022-08-23	Total Biovolume (µm³/mL):	193069		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Spumella sp.	8	59	Chrysophyta	1491
Cryptomonas curvata	4	25200	Cryptophyta	10635
Rhodomonas lacustris	99	10749	Cryptophyta	10663
Anacystis sp.	4667	8880	Cyanobacteria	609
Aphanocapsa elachista var. planctonica	702	5743	Cyanobacteria	625
Chroococcus minutus	46	1737	Cyanobacteria	654
Gloeocapsa aeruginosa	27	382	Cyanobacteria	682
Gomphosphaeria sp.	65	2884	Cyanobacteria	714
Gloeothece sp.	4	262	Cyanobacteria	703
Achnanthales	4	673	Diatom	
Lindavia intermedia	11	9723	Diatom	
Stephanodiscus hantzschii	8	57669	Diatom	2415
Parvodinium sp.	8	4411	Dinoflagellate	
Monoraphidium sp.	11	7288	Green	5990
Oocystis crassa	4	1179	Green	5827
Oocystis parva	8	1798	Green	5827
Chlamydomonas sp.	38	22737	Green	5448
microflagellate	182	30621	Other.Flagellates	

Figure 13: Raw data from 2022-08-23 EMS site 0603097