Dragon Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Dragon 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
DRAGON LK. AT MIDDLE (0603017)	2021-05-06
	2021-08-11
	2022-04-20
	2022-08-11
	Total= 4 samples

Figure 1: Aerial view of Dragon Lake

Algal composition in Dragon Lake experienced typical seasonal patterns of cyanobacteria blooms in the summer and micro-flagellate and *Dinobryon* blooms in the spring. Almost no diatoms were observed in Dragon Lake (Figure 2).

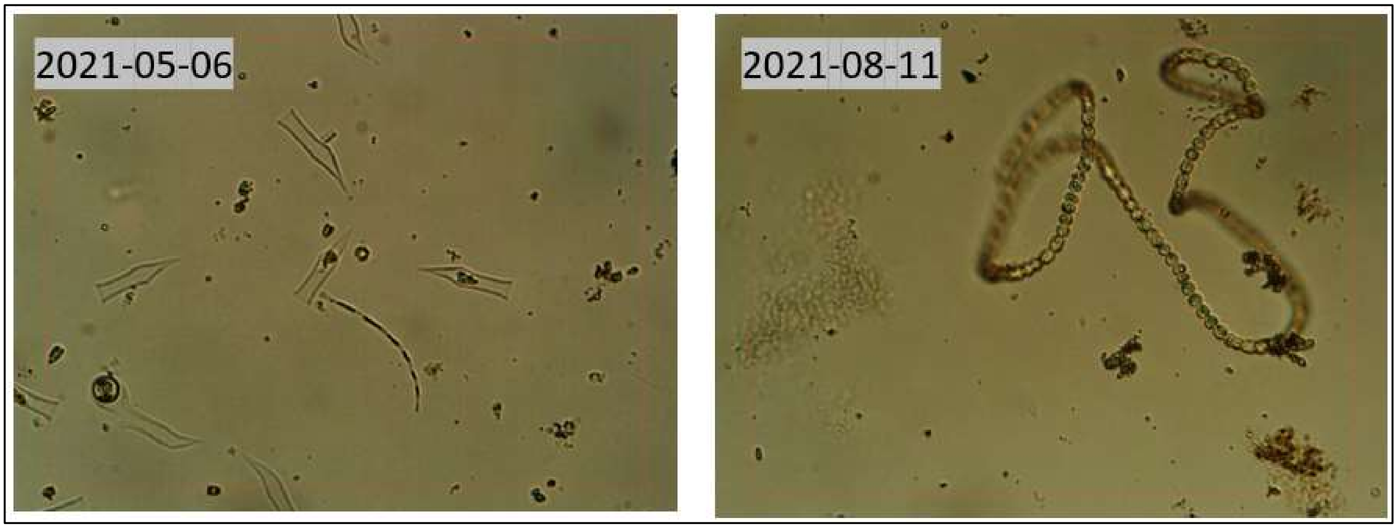

Figure 2: Compositional changes in algal population between spring (left) and summer (right)

Overview (continued)

Samples contained low levels of green algae, Desmids, and diatoms but moderate concentrations of Chrysophyta and Cryptophyta (Figure 3). Flagellates observed were dominantly composed of two groups Cryptomonads (including genus *Cryptomonas*) and Chromulinales (including genus *Dinobryon*).

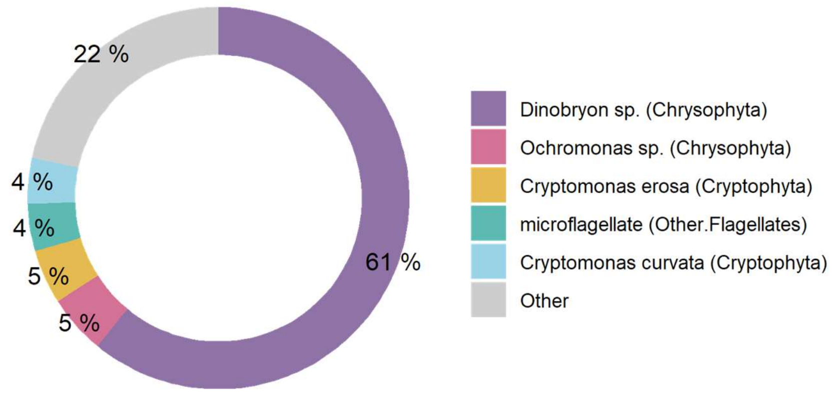

Figure 3: Dominant organisms from Dragon Lk. At Middle (0603017) as percent of total biovolume

Dinobryon dominated the 2021-05-06 sample (Figure 4). The 2021 spring *Dinobryon* bloom included swarmers (sexual reproductive stages) and stomatocysts (asexual reproductive stages). Asexual stomatocysts are normally produced at 0.05% the rate that typical sexual swarmers are produced (Lee, 2008). When the population resides in a nitrogen-depleted environment asexual encystment rises to reach 4%. *Dinobryon* blooms are also associated with unpleasant fishy odors, and one genus of *Dinobryon* is linked with a toxin that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

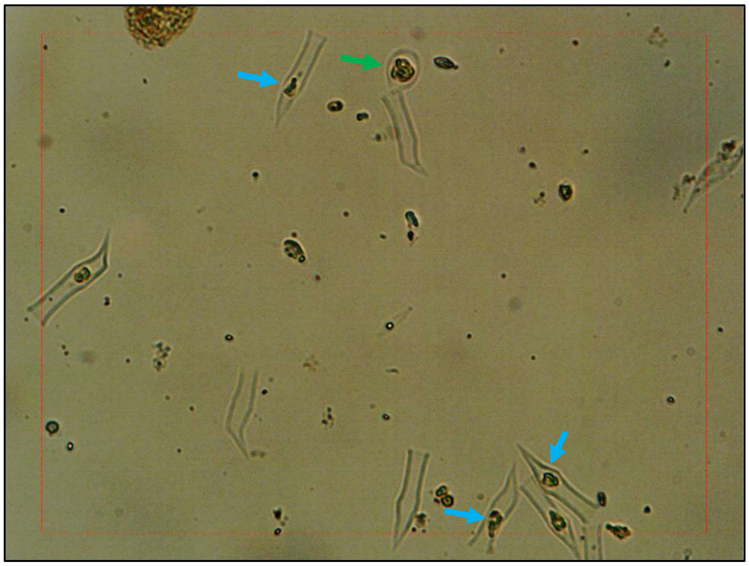

Figure 4: EMS Site #0603017 collected on 2021-05-06 demonstrating Dinobryon bloom with swarmers (blue arrows) and a stomatocyst (green

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 higher concentrations of cyanobacteria than spring samples. The dominant genera were *Anacystis,* but *Planktolynbya* and *Gomphosphaeria* were also observed (Figure 5).

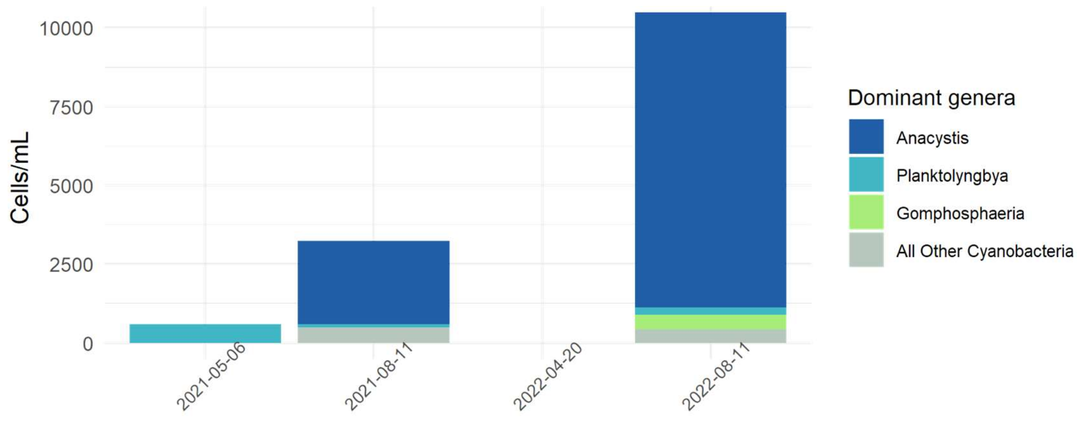

Figure 5: cell abundance for dominant cyanobacteria genera on Dragon Lake

Anacystis, *Gomphosphaeria*, and *Planktolynbya* are associated with cyanotoxins that represent risks to public health (Table 2). Illness related to cyanotoxins 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 Dragon Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	9373	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Planktolyngbya	292	Lyngbyatoxin LYN, Microcystin MC, BMAA
Gomphosphaeria	474	Microcystin MC

Note: * = counted in samples

Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria found in Dragon Lake can produce cyanotoxins (Table 2).

Dragon Lake displayed cyanobacteria levels in the negligible-low risk category, with a mean cyanobacteria abundance of 4,774 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Dragon Lake compared to alert levels defined by several authorities including the WHO and EPA.

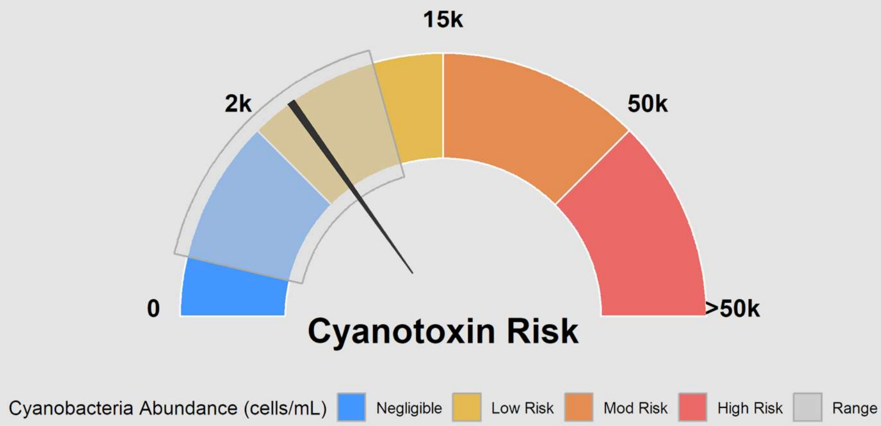

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Dragon Lake

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 *dinoflagellate* cell is similar in size to approximately 50 cyanobacteria cells.

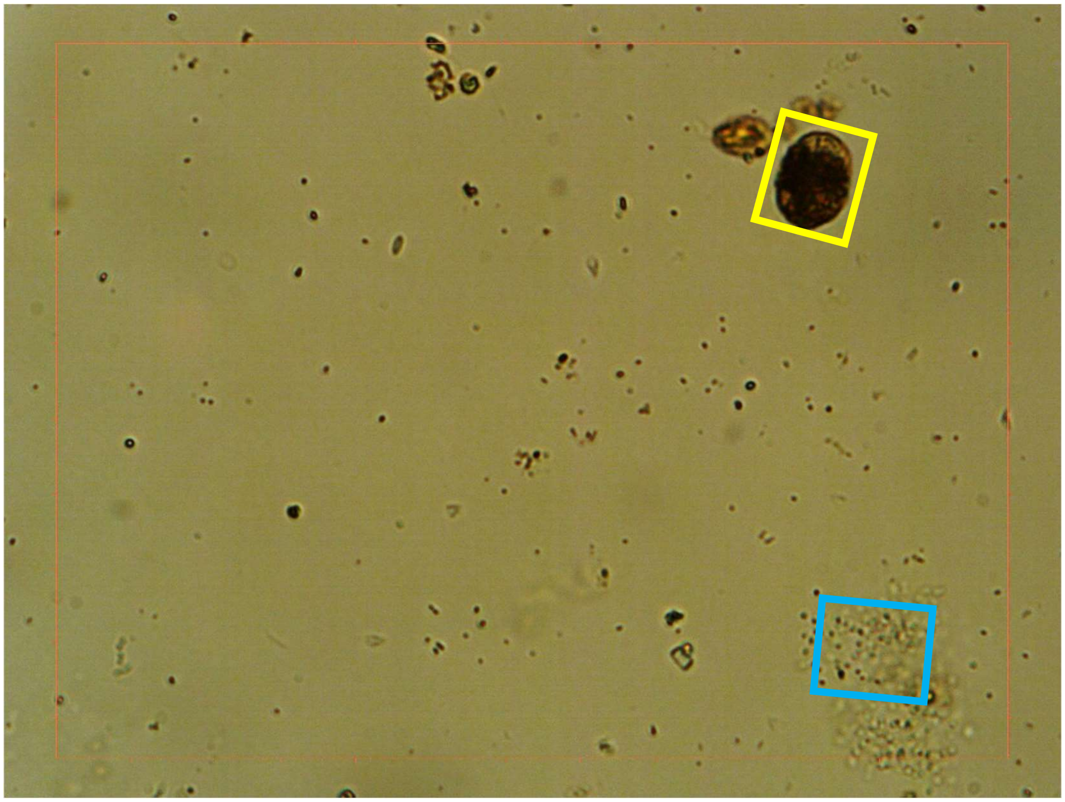
Figure 7: Size comparison of a dinoflagellate cell (yellow box) to fifty Anacystis cells (blue box)

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.

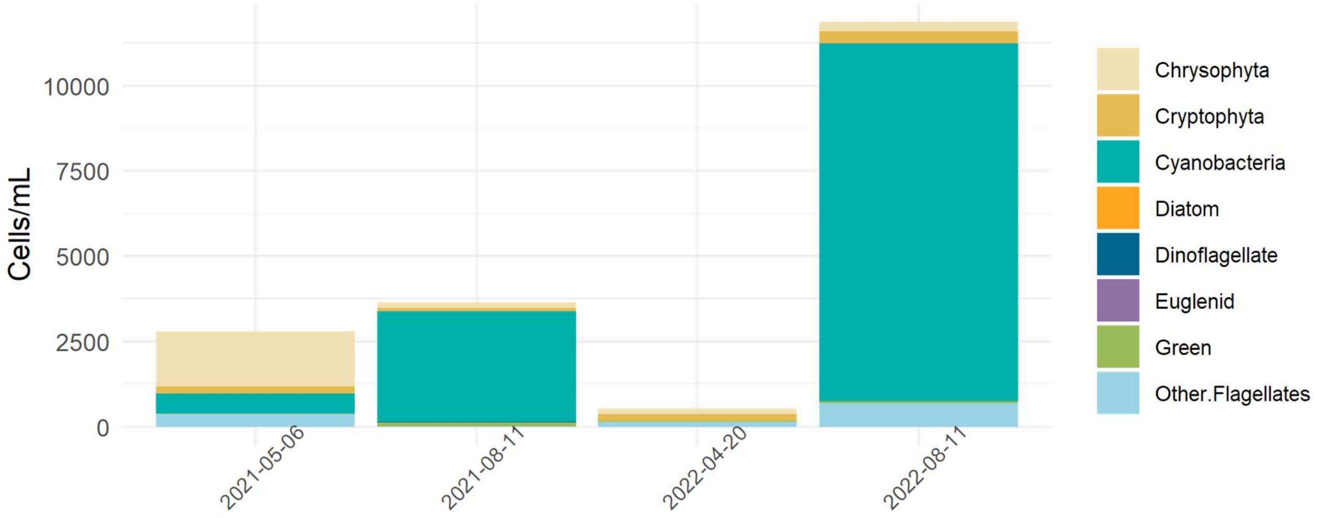

Figure 8: Cell abundance of high-level taxa groups on Dragon Lake

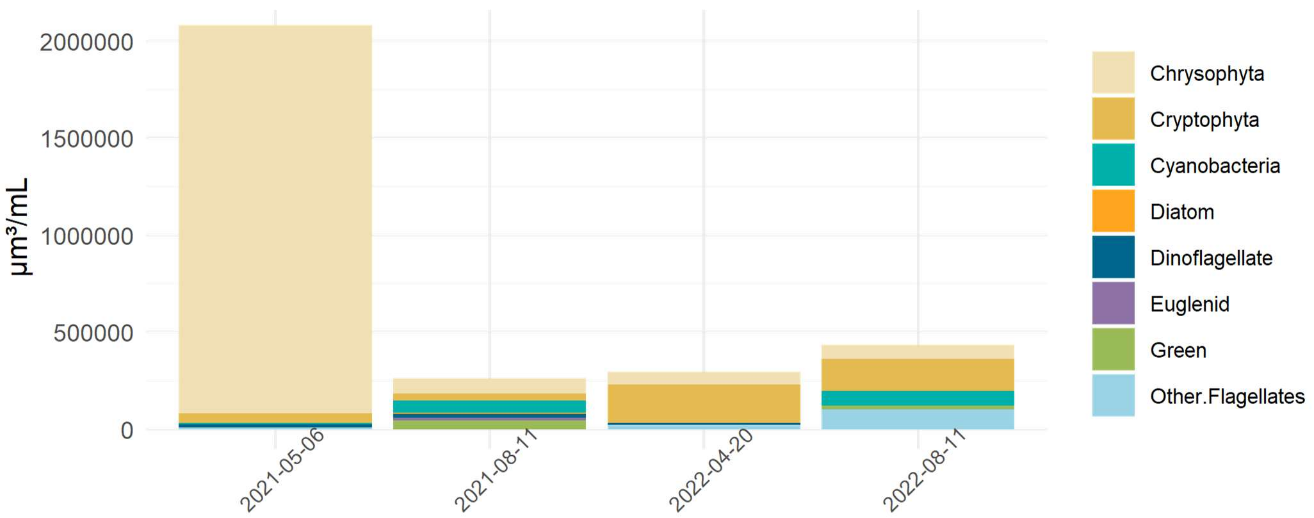

Figure 9: Biovolume of high-level taxa groups on Dragon Lake

References

Cantrell, R., & Long, B. (2013). *Dinobryon*. PBWorks. http://ohapbio12.pbworks.com/w/page/51731561/Dinobryon

Conrad, J. (2013). *DINOBRYON, a Golden Alga*. Jim Conrad's Naturalist Newsletter. https://www.backyardnature.net/n/x/dinobryo.htm

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

Lee, R. E. (2008). Phycology. In *Phycology* (Fourth, pp. 344–343). Cambridge University Press.

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Appendix

Additional figures and raw data are listed below:

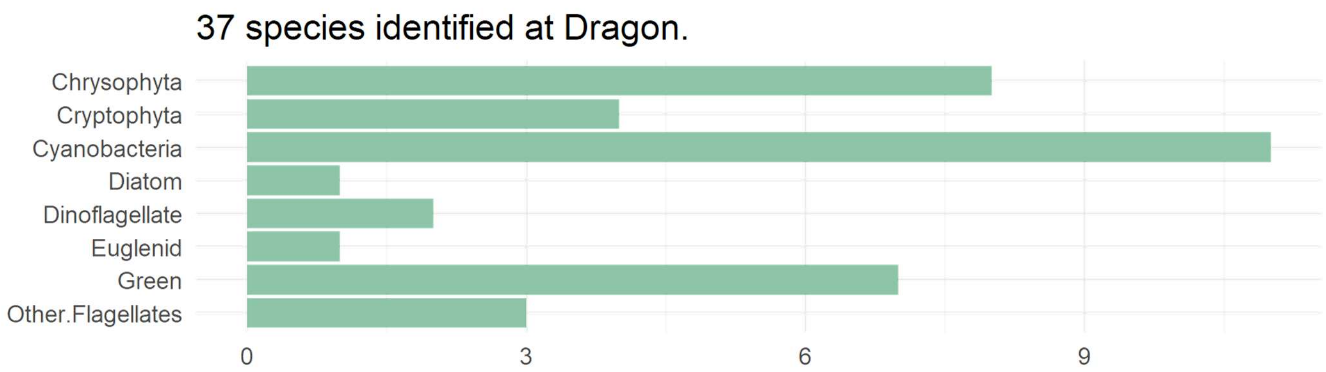

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 0603017	**Total Abundance (cells/mL):**	**2800**		
Collection Date: 2021-05	**Total Biovolume (µm³/mL):**	**2173708**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	584	877168	Chrysophyta	1515
Dinobryon sp.	584	877168	Chrysophyta	1515
Dinobryon sp.	34	51068	Chrysophyta	1515
Dinobryon sp.	34	51068	Chrysophyta	1515
Mallomonas sp.	11	33267	Chrysophyta	1598
Mallomonas sp.	11	33267	Chrysophyta	1598
Ochromonas sp.	182	38961	Chrysophyta	1455
Ochromonas sp.	182	38961	Chrysophyta	1455
Dinobryopsis sp.	182	48886	Chrysophyta	1557
Dinobryopsis sp.	182	48886	Chrysophyta	1557
Cryptomonas sp.	8	14816	Cryptophyta	10635
Cryptomonas sp.	8	14816	Cryptophyta	10635
Rhodomonas lacustris	95	10315	Cryptophyta	10663
Rhodomonas lacustris	95	10315	Cryptophyta	10663
Planktolyngbya sp.	292	3630	Cyanobacteria	
Planktolyngbya sp.	292	3630	Cyanobacteria	
Gymnodinium ordinatur	4	7800	Dinoflagellate	10031
Gymnodinium ordinatur	4	7800	Dinoflagellate	10031
Ankistrodesmus sp.	4	629	Green	5877
Ankistrodesmus sp.	4	629	Green	5877
Cercomonadida sp.	4	314	Other.Flagellates	43801
Cercomonadida sp.	4	314	Other.Flagellates	43801

Figure 11: Raw data from 2021-05-06 EMS site 0603017

EMS ID: 0603017	Total Abundance (cells/mL):	3641		
Collection Date: 2021-08-1	Total Biovolume (µm³/mL):	266089		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	4	6008	Chrysophyta	1515
Dinobryon sp.	8	12016	Chrysophyta	1515
Mallomonas sp.	11	33267	Chrysophyta	1598
Ochromonas sp.	133	28471	Chrysophyta	1455
Dinobryopsis sp.	11	2955	Chrysophyta	1557
Cryptomonas sp.	15	27781	Cryptophyta	10635
Rhodomonas lacustris	80	8686	Cryptophyta	10663
Anacystis sp.	2535	4824	Cyanobacteria	609
Anacystis limneticus	118	258	Cyanobacteria	609
Anabaena sp.	53	3974	Cyanobacteria	1100
Anabaena flos-aquae	254	49434	Cyanobacteria	1100
Planktolyngbya sp.	95	1181	Cyanobacteria	
Pleurocapsa sp.	190	2686	Cyanobacteria	1435
Cocconeis placentula	4	6517	Diatom	3577
Gymnodinium ordinatum	11	21449	Dinoflagellate	10031
Trachelomonas scabra	4	13270	Euglenid	9690
Ankistrodesmus sp.	4	629	Green	5877
Crucigenia crucifera	46	4025	Green	6225
Gloeocystis gigas	27	14137	Green	6355
Oocystis sp.	8	151	Green	5827
Cosmarium cf. depressum	30	24370	Green	7848

Figure 12: Raw data from 2021-08-11 EMS site 0603017

EMS ID: 0603017	Total Abundance (cells/mL):	532			
Collection Date: 2022-0	Total Biovolume (µm³/mL):	298265			
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**	**kingdom**
Chrysococcus sp.	4	1328	Chrysophyta	1751	Chromista
Chrysochromulina sp.	49	1885	Chrysophyta	2160	Chromista
Chromulina sp.	15	26507	Chrysophyta	1717	Chromista
Dinobryon spp.	8	12692	Chrysophyta	1515	Chromista
Ochromonas sp.	30	6422	Chrysophyta	1455	Chromista
Dinobryopsis sp.	61	16385	Chrysophyta	1557	Chromista
Cryptomonas sp.	30	55561	Cryptophyta	10635	Chromista
Cryptomonas curvata	19	119699	Cryptophyta	10635	Chromista
Cryptomonas erosa	4	7087	Cryptophyta	10635	Chromista
Rhodomonas lacustris	152	16504	Cryptophyta	10663	Chromista
Glenodinium sp.	4	7992	Dinoflagellate	10174	Chromista
Ankistrodesmus sp.	4	629	Green	5877	Plantae
microflagellate	152	25574	Other.Flagellates		

Figure 13: Raw data from 2022-04-20 EMS site 0603017

EMS ID: 603017	**Total Abundance (cells/mL):**	**11898**	
Collection Date: 2022-08-1	**Total Biovolume (µm³/mL):**	**454538**	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chrysochromulina sp.	76	2923	Chrysophyta
Dinobryon spp.	19	30143	Chrysophyta
Ochromonas sp.	190	40673	Chrysophyta
Cryptomonas erosa	76	134661	Cryptophyta
Rhodomonas lacustris	285	30945	Cryptophyta
Anacystis delicatissima	9373	20475	Cyanobacteria
Gloeocapsa aeruginosa	57	806	Cyanobacteria
Gomphosphaeria sp.	474	21028	Cyanobacteria
Gloeothece sp.	152	9948	Cyanobacteria
Pseudanabaena limnetica	209	19205	Cyanobacteria
Planktolyngbya sp.	228	2834	Cyanobacteria
Achnanthes cf. linearis	19	4641	Diatom
Monoraphidium sp.	19	12588	Green
Oocystis solitaria	38	8755	Green
microflagellate	683	114913	Other.Flagellates

Figure 14: Raw data from 2022-08-11 EMS site 0603017