Stuart Lake Phytoplankton Summary Report 2021-2022

Overview

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

Table 1: Sample sites and dates sampled in 2020, 2021, and 2022

Sample Site (EMS#)	Dates
STUART LK EAST (MAIN) DEEP STN. (E206956)	2020-09-01
	2021-06-08
	2022-05-17
	2022-08-15
	Total= 4 samples

Figure 1: Aerial view of Stuart Lake

Samples contained moderate concentrations of cyanobacteria and low concentrations of green algae and desmids. Samples collected in 2021 contained more diatoms than 2022. Dominant diatoms included *Tabellaria fenestrate* (Figure 2).

Diatoms are integral to aquatic food webs because they are the foundation of the food web (jrobyn, 2019). Colony forming diatoms such as *Tabellaria* sp. can avoid grazing pressures by developing into large colonies, reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012). Dominant cyanobacteria genera identified in Stuart Lake also can form colonies (Figure 2).

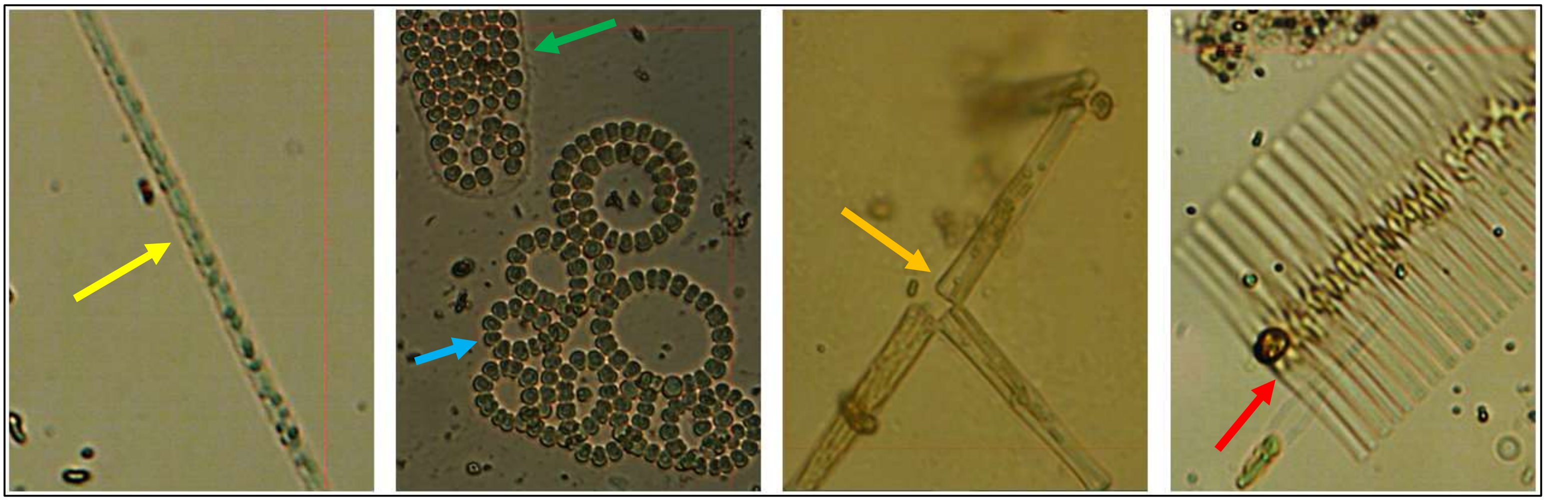

Figure 2: Colony forming algae identified in Stuart Lake; Planktothrix (Yellow arrow), Anabaena (blue arrow), Coelosphaerium (green arrow), Tabellaria (orange arrow), and Fragilaria (red arrow)

Overview (continued)

Diatoms and Cryptophyta dominated total biovolumes (Figure 3).

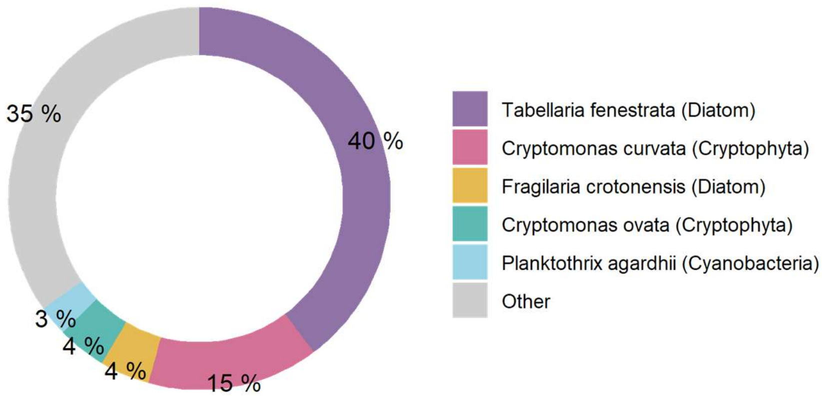

Figure 3: Dominant organisms from Stuart Lk East (Main) Deep Stn. (E206956) as percent of total biovolume

All sites had low densities of diatoms, but EMS site #E206956 contained a small *Tabellaria fenestrata* bloom on 2021-06-08. This bloom caused *Tabellaria fenestrata* to represent the majority of total biovolume (Figure 3; Figure 4).

Figure 4: EMS site #E206956 collected on 2021-06-08 displaying Tabellaria fenestrata (black arrow)

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

Samples contained moderate concentrations of cyanobacteria. Dominant genera included *Woronichinia*, *Anacystis*, and *Planktothrix* (Figure 5).

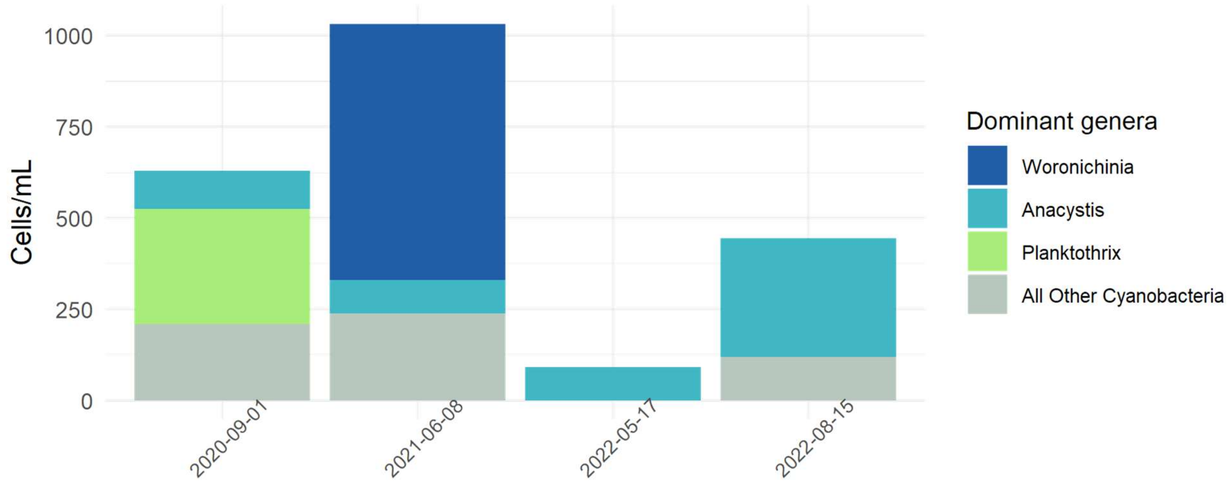

Figure 5: cell abundance for dominant cyanobacteria genera on Stuart Lake

One sample contained a *Woronichinia* bloom (2021-06-08). *Woronichinia* is not associated with cyanotoxin release but is known to bloom in association with cyanobacterial genera that produce toxins (Services CRD, 2018). Other dominant cyanobacteria identified in samples 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 Stuart Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Woronichinia	702	
Anacystis	326	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Planktothrix	315	Lyngbyatoxin LYN, Aplysiatoxins APL, Lipopolysaccharide LPS, 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 Stuart Lake can produce cyanotoxins (Table 2).

Stuart Lake displays a range of cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 550 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Stuart Lake as compared to alert levels defined by authorities including the WHO and EPA.

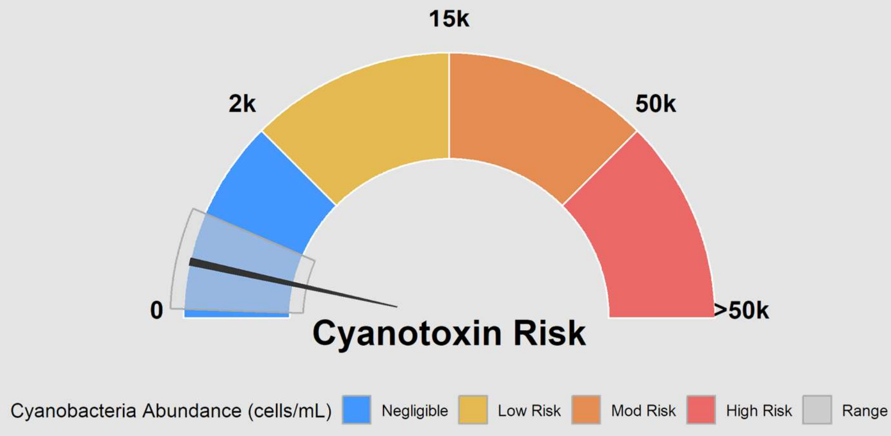

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Stuart Lake

Micro-flagellates and 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 is highlighted in Figure 7 where a single *Mougeotia* cell is an equivalent size to approximately 50 micro-flagellates.

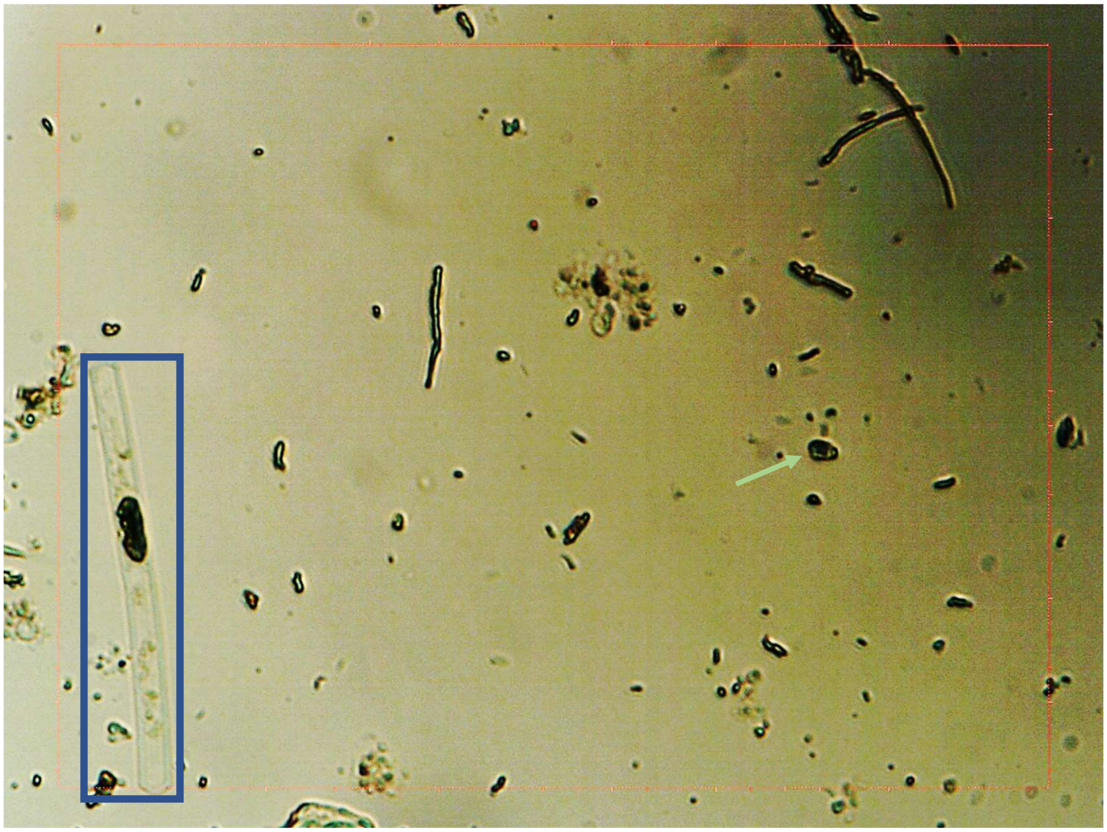

Figure 7: Size comparison of cell of green algae Mougeotia (blue box) to micro-flagellate cell (green arrow)

Species Composition

Algae samples were identified to the genus 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.

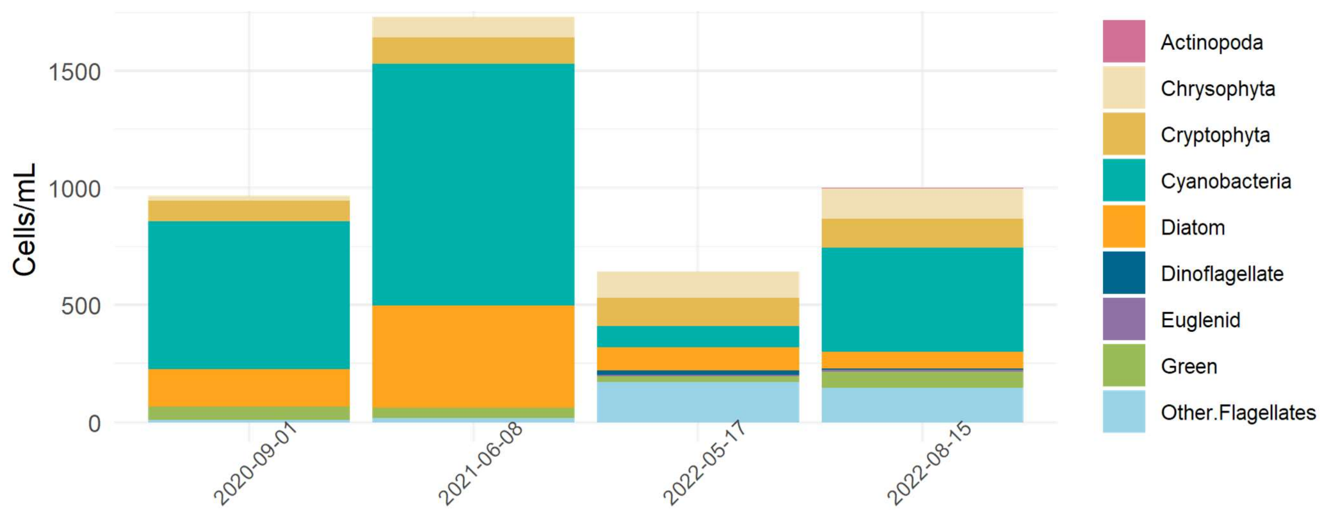

Figure 8: Cell abundance of high-level taxa groups on Stuart Lake

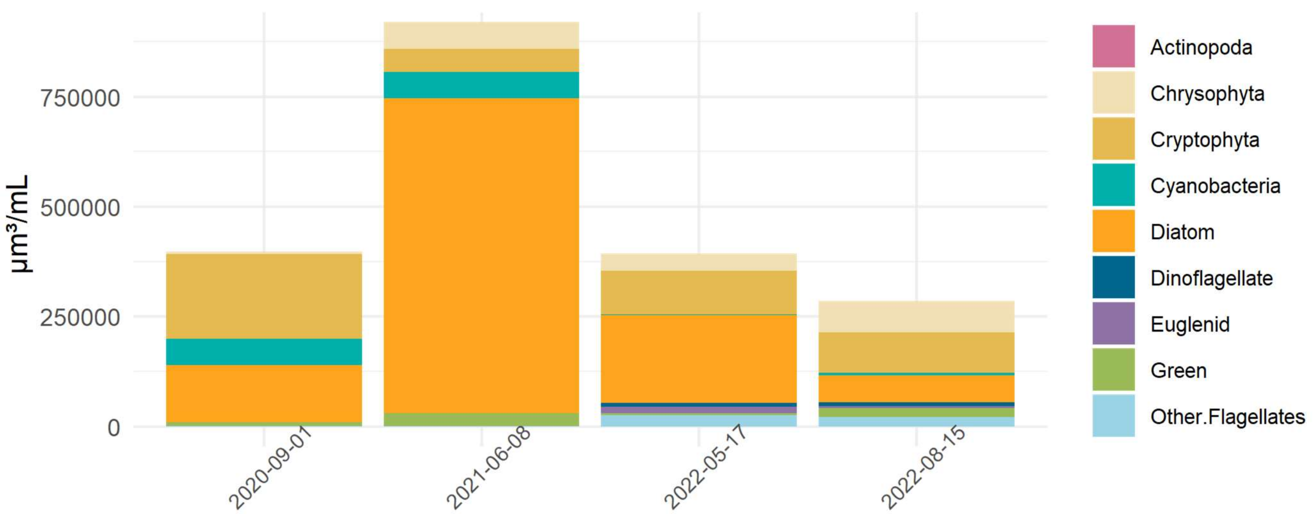

Figure 9: Biovolume of high-level taxa groups on Stuart Lake

References

Baker, A. L. et al. (2012). *Phycokey -- an image based key to Algae (PS Protista), Cyanobacteria, and other aquatic objects.* University of New Hampshire Center for Freshwater Biology. http://cfb.unh.edu/phycokey/phycokey.htm

DeColibus, D. (2013, April 5). *Tabellaria fenestrata*. Diatoms of North America.

Services CRD, E. (2018). *ELK/BEAVER LAKE Technical Report-Investigation of In-Lake Remediation Options*. 13–14.

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:

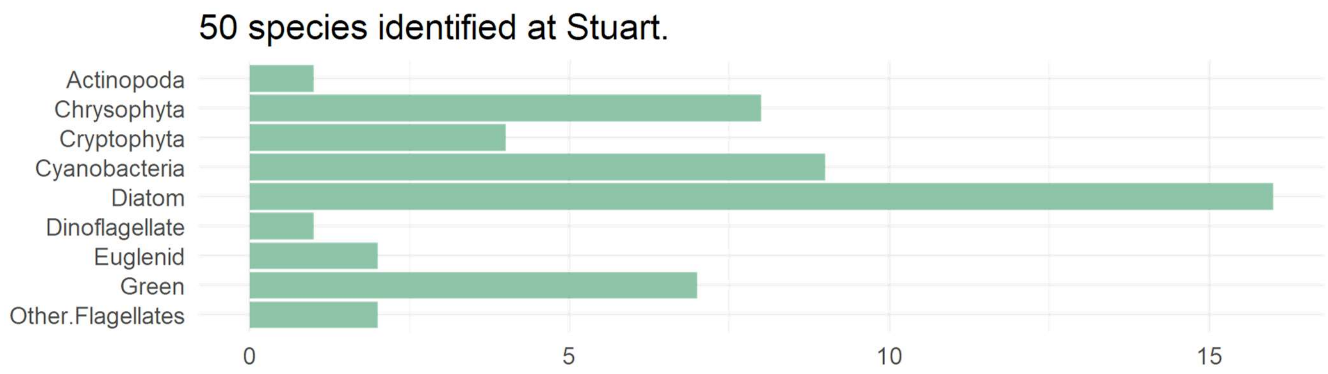

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: E206956	**Total Abundance (cells/mL):**	**1730**		
Collection Date: 2021-06-08	**Total Biovolume (µm³/mL):**	**925420**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	11	16522	Chrysophyta	1515
Dinobryon bavaricum	15	32648	Chrysophyta	1515
Ochromonas sp.	61	13058	Chrysophyta	1455
Dinobryopsis sp.	19	5104	Chrysophyta	1557
Cryptomonas ovata	19	41342	Cryptophyta	10635
Rhodomonas lacustris	95	10315	Cryptophyta	10663
Anacystis sp.	91	173	Cyanobacteria	609
Anabaena planctonica	144	49156	Cyanobacteria	1100
Woronichinia naegelianum	702	9559	Cyanobacteria	
Planktolyngbya limnetica	95	486	Cyanobacteria	
Aulacoseira granulata	38	12499	Diatom	590863
Asterionella formosa	15	10445	Diatom	3116
Lindavia bodanica	27	28174	Diatom	
Fragilaria crotonensis	121	58753	Diatom	2932
Ulnaria acus	15	15627	Diatom	970000
Tabellaria fenestrata	220	591311	Diatom	3241
Mougeotia sp.	38	29326	Green	7055
Oocystis solitaria	4	922	Green	5827

Figure 11: Raw data from 2021-06-08 EMS site E206956

EMS ID: E206956	Total Abundance (cells/mL):	968		
Collection Date: 2021-09-01	Total Biovolume (µm³/mL):	399021		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	23	4924	Chrysophyta	1455
Dinobryopsis sp.	11	2955	Chrysophyta	1557
Cryptomonas curvata	27	170098	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Rhodomonas lacustris	53	5755	Cryptophyta	10663
Anacystis sp.	106	202	Cyanobacteria	609
Aphanizomenon sp.	209	7387	Cyanobacteria	1191
Planktothrix agardhii	315	51490	Cyanobacteria	189420
Achnanthidium minutissimum	42	7966	Diatom	590864
Aulacoseira granulata	11	3618	Diatom	590863
Asterionella formosa	19	13230	Diatom	3116
Cyclotella sp.	11	2920	Diatom	2439
Lindavia bodanica	4	4174	Diatom	
Fragilaria crotonensis	53	25735	Diatom	2932
Nitzschia sp.	4	367	Diatom	5070
Stephanodiscus niagarae	4	42005	Diatom	2415
Tabellaria fenestrata	11	29566	Diatom	3241
Ankistrodesmus sp.	11	1729	Green	5877
Oocystis sp.	15	283	Green	5827
Oocystis solitaria	8	1843	Green	5827
Scenedesmus sp.	23	5367	Green	6104

Figure 12: Raw data from 2021-09-01 EMS site E206956

EMS ID: E206956	Total Abundance (cells/mL):	643		
Collection Date: 2022-05-17	Total Biovolume (µm³/mL):	398759		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	42	1615	Chrysophyta	2160
Chromulina sp.	4	7069	Chrysophyta	1717
Dinobryon spp.	4	6346	Chrysophyta	1515
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	53	11346	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	11	20372	Cryptophyta	10635
Cryptomonas curvata	11	69299	Cryptophyta	10635
Rhodomonas lacustris	99	10749	Cryptophyta	10663
Anacystis sp.	91	173	Cyanobacteria	609
Fragilaria tenera	8	3884	Diatom	2932
Gomphonema sp.	4	5508	Diatom	4911
Lindavia sp.	4	3536	Diatom	
Nitzschia spp.	11	4343	Diatom	5070
Tabellaria fenestrata	65	174705	Diatom	3241
Ulnaria acus	8	8335	Diatom	970000
Parvodinium sp.	19	10476	Dinoflagellate	
Trachelomonas sp.	4	14137	Euglenid	9690
Ankistrodesmus sp.	15	2358	Green	5877
Scenedesmus aculeolatus	11	2567	Green	6104
microflagellate	171	28770	Other.Flagellates	

Figure 13: Raw data from 2022-05-17 EMS site E206956

EMS ID: E206956	**Total Abundance (cells/mL):**	**1000**		
Collection Date: 2022-08-15	**Total Biovolume (µm³/mL):**	**289571**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	4	673	Actinopoda	
Chrysochromulina sp.	4	154	Chrysophyta	2160
Chromulina sp.	15	26507	Chrysophyta	1717
Dinobryon spp.	15	23797	Chrysophyta	1515
Ochromonas sp.	95	20337	Chrysophyta	1455
Cryptomonas sp.	4	7408	Cryptophyta	10635
Cryptomonas curvata	8	50400	Cryptophyta	10635
Cryptomonas ovata	11	23935	Cryptophyta	10635
Rhodomonas lacustris	99	10749	Cryptophyta	10663
Anacystis sp.	326	620	Cyanobacteria	609
Aphanizomenon flos-aquae	27	4496	Cyanobacteria	1191
Aphanocapsa sp.	46	145	Cyanobacteria	625
Snowella sp.	46	198	Cyanobacteria	
Asterionella formosa	19	13230	Diatom	3116
Aulacoseira sp.	15	24684	Diatom	590863
Aulacoseira distans	27	14642	Diatom	590863
Lindavia sp.	11	9723	Diatom	
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Euglena sp.	8	4608	Euglenid	9620
Quadrigula chodati	68	19890	Green	5938
microflagellate	148	24901	Other.Flagellates	

Figure 14: Raw data from 2022-08-15 EMS site E206956