Slocan Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from two sites on Slocan Lake during 2021 and 2022 (Figure 1; Table 1). Algae were identified to the taxonomic level genus and grouped into broad alga types for analysis. Identifications in Slocan Lake samples were primarily based on shape and size of organism because of visual obstructions due to excess Lugols iodine solution.

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

Sample Site (EMS#)	Dates
SLOCAN LAKE; N. END (1130218)	2021-08-24
	2022-04-06
	2022-09-15
SLOCAN LAKE; S. END (1130219)	2021-04-13
	2021-08-24
	2022-04-06
	2022-09-15
	Total= 7 samples

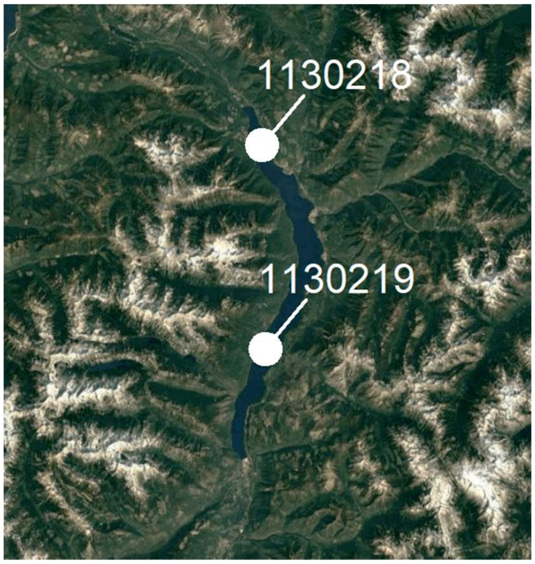

Figure 1: Aerial view of Slocan Lake

Samples contained low densities of algae and were heavily persevered with Lugols iodine solution. Algae create and store starch inside their cells (Matthews, 2016). Excess Lugols iodine solution causes starch within the cell to react with iodine causing cells to stain dark purple, brown, or in extreme cases black (Figure 2). Chlorophyta (green algae) and Rhodophyta (red algae) are particularly susceptible to starch staining (Matthews, 2016).

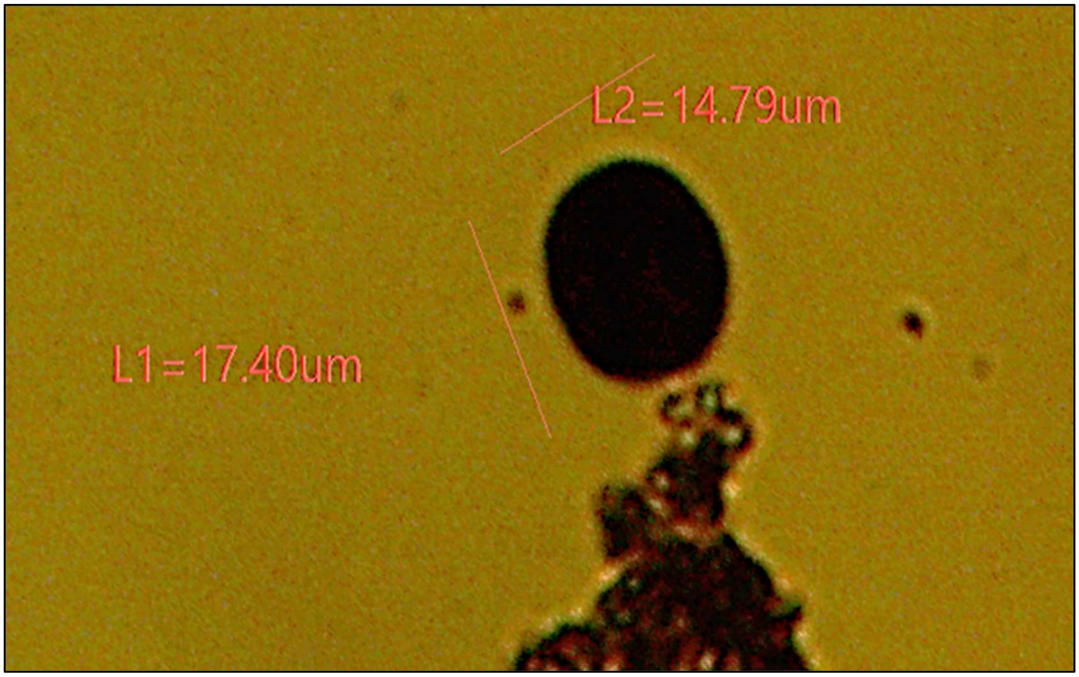

Figure 2: A stained Trachelomonas cell identified in Slocan Lake

Overview (continued)

Members of Cryptophyta and Chrysophyta dominated biovolumes in Slocan Lake (Figure 3). Dominant algae included *Cryptomonas* and *Dinobryon* species (Figure 4).

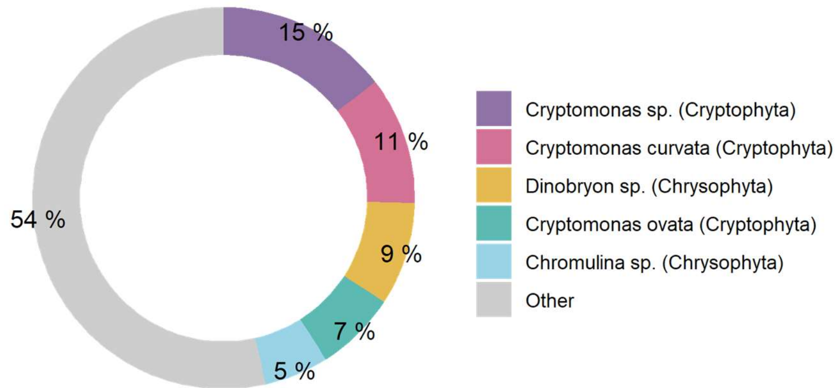

Figure 3: Dominant organisms from Slocan (all sites / dates) as percent of total biovolume

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

Chrysophyta taxa are advantageous and disadvantageous in freshwater systems, depending on their context. Some Chrysophyta are known to produce odor chemicals described as fishy, and others eat bacteria and reduce negative odor compounds (Wehr et al., 2015). *Dinobryon* blooms are associated with unpleasant fishy odors, and one species of *Dinobryon* is linked with toxins that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

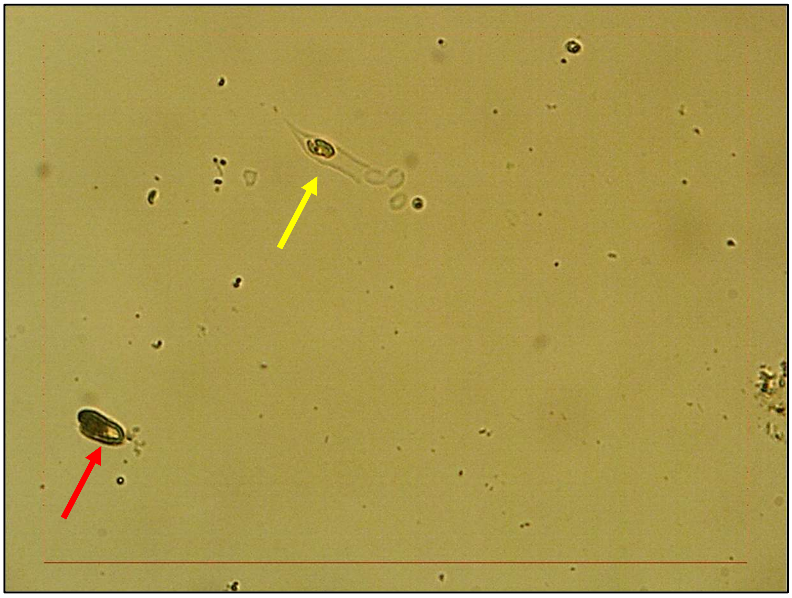

Figure 4: EMS site#1130219 collected on 2022-09-15 showing a Cryptomonas species (red arrow) and a Dinobryon species (yellow arrow)

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 low concentrations of cyanobacteria. Dominant genera included *Anacystis*, *Planktolyngbya*, and *Chlorogloea* (Figure 5).

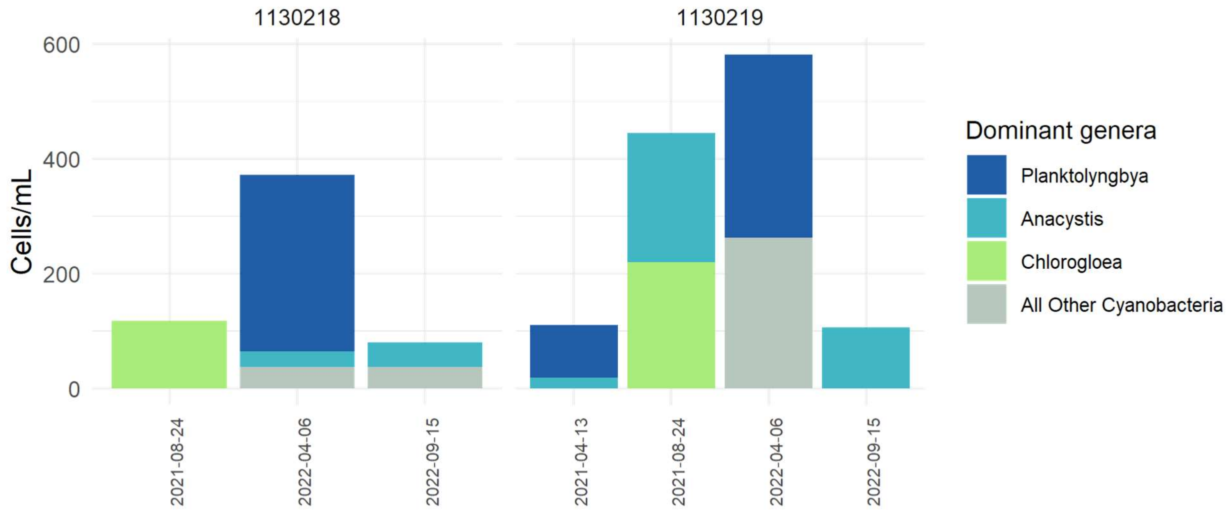

Figure 5: cell abundance for dominant cyanobacteria genera on Slocan Lake

Chlorogloea is not associated with negative taste, odor, or toxic metabolites. Other dominant cyanobacteria identified 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 Slocan Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Planktolyngbya	319	Lyngbyatoxin LYN, Microcystin MC, BMAA
Anacystis	224	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Chlorogloea	220	

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Slocan Lake displayed a range of cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 259 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Slocan Lake compared to alert levels defined by several authorities including the WHO and EPA.

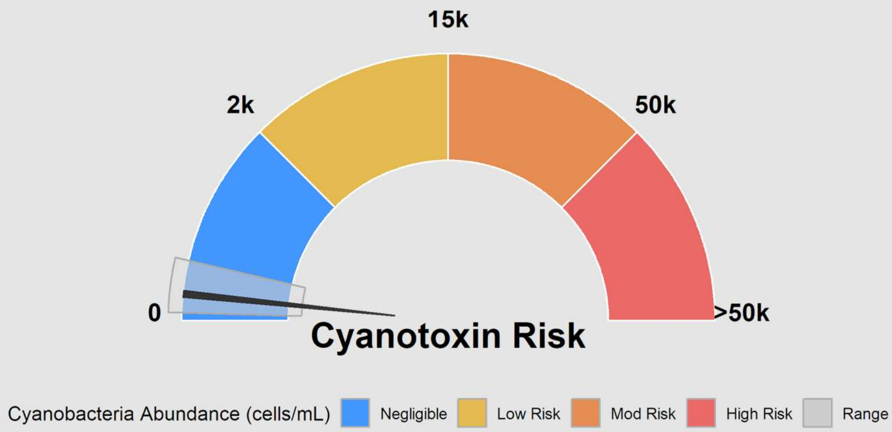

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Slocan Lake

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 *Neidium* cell is similar size to approximately 20 cells of the adjacent micro-flagellate.

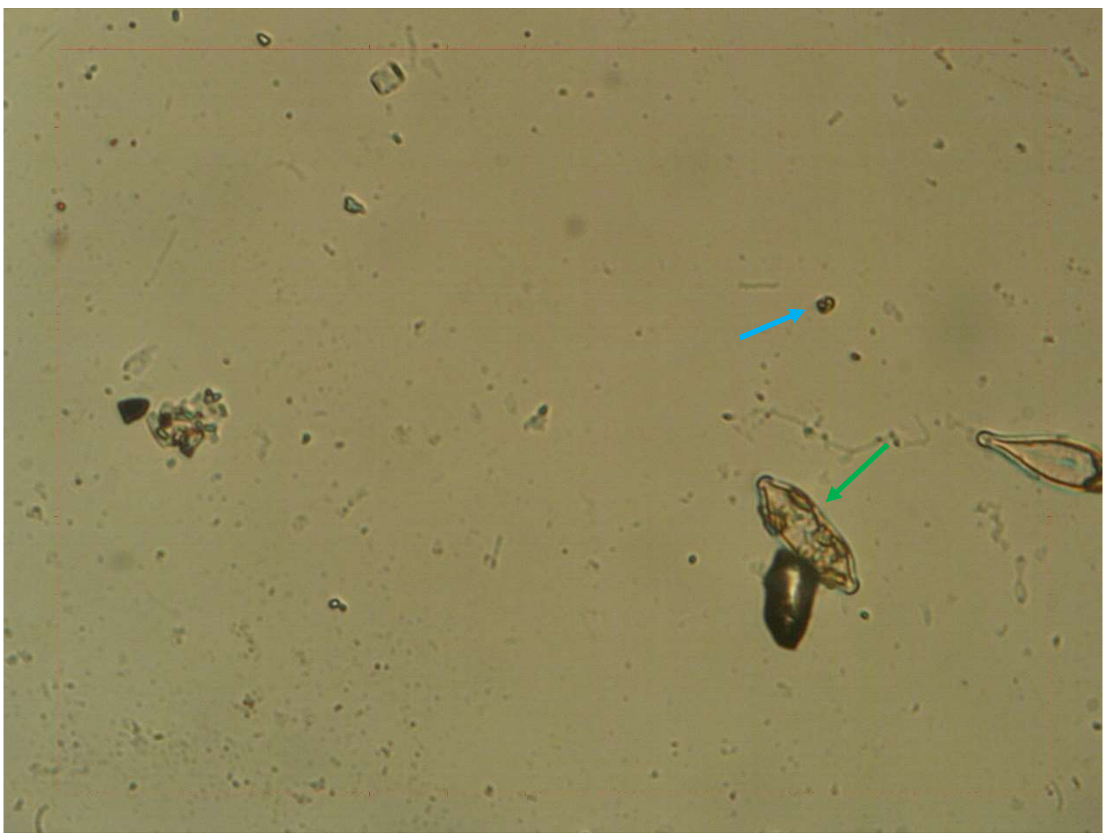

Figure 7: Size comparison of the diatom Neidium (green arrow) to a micro-flagellate (blue arrow)

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.

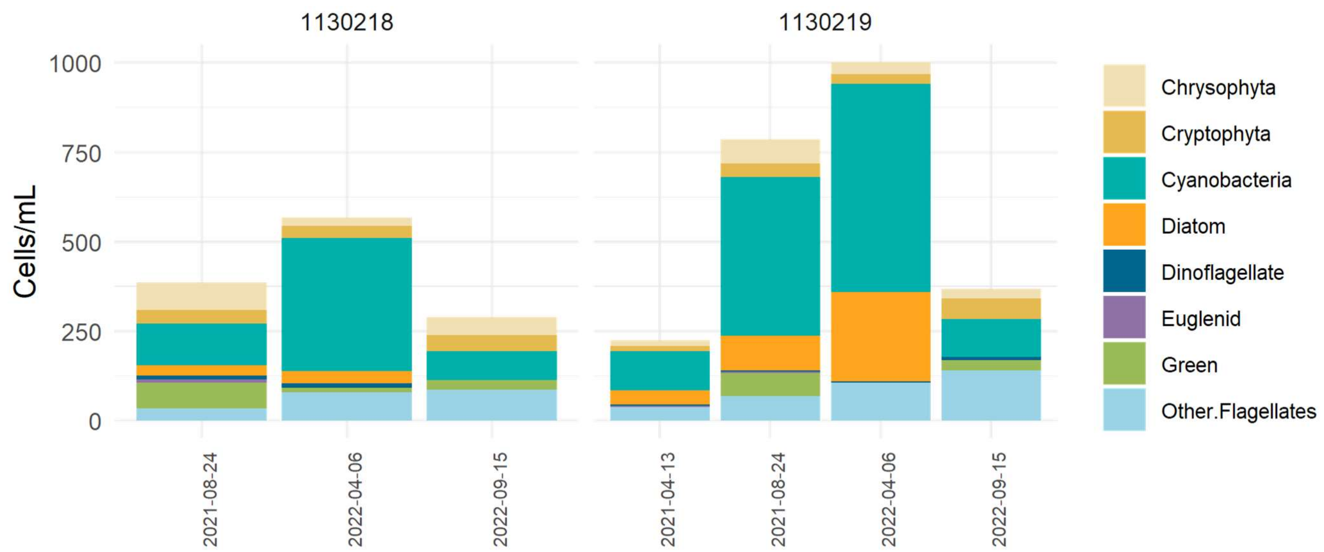

Figure 8: Cell abundance of high-level taxa groups on Slocan Lake

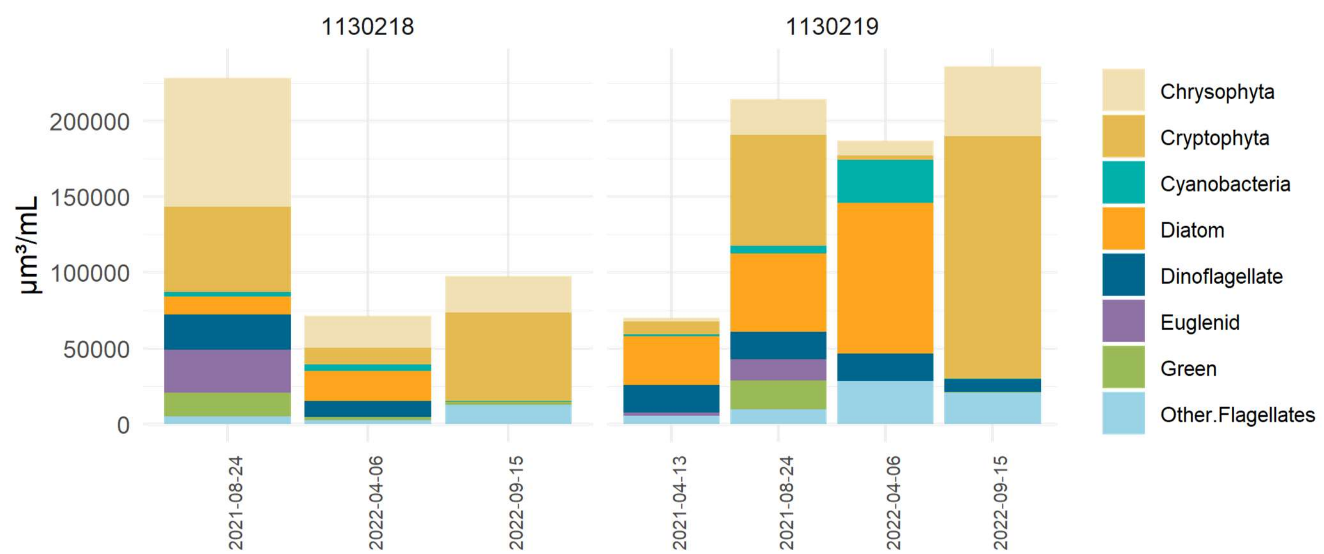

Figure 9: Biovolume of high-level taxa groups on Slocan Lake

References

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

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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

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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:

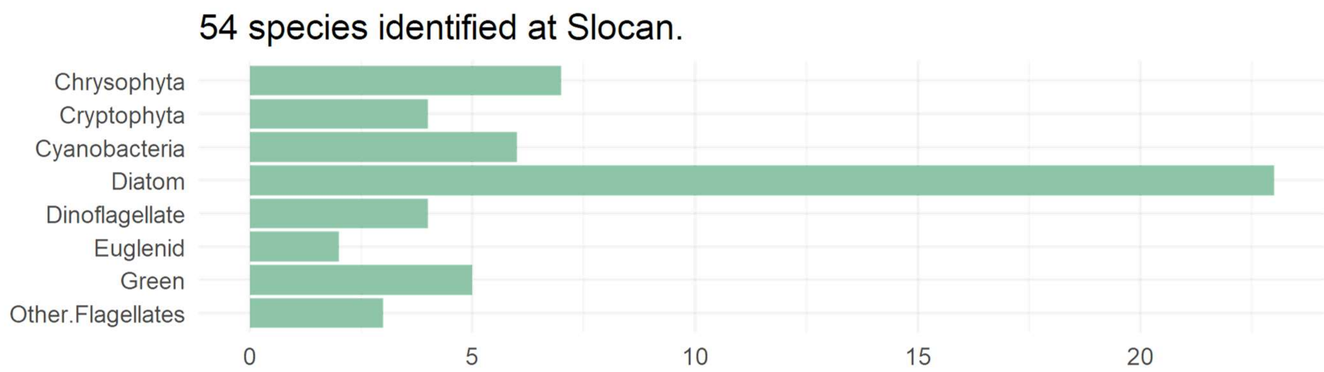

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 1130219	Total Abundance (cells/mL):	225		
Collection Date: 2021-04-13	Total Biovolume (µm³/mL):	71067		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Ochromonas sp.	4	856	Chrysophyta	1455
Chrysochromulina sp.	8	308	Chrysophyta	2160
Chrysococcus sp.	4	1328	Chrysophyta	1751
Cryptomonas sp.	4	7408	Cryptophyta	10635
Rhodomonas lacustris	11	1194	Cryptophyta	10663
Anacystis sp.	19	36	Cyanobacteria	609
Planktolyngbya sp.	91	1131	Cyanobacteria	
Asterionella formosa	15	10445	Diatom	3116
Lindavia ocellata	4	664	Diatom	
Ulnaria sp.	19	20957	Diatom	970000
Peridinium sp.	4	18043	Dinoflagellate	10212
Euglena sp.	4	2304	Euglenid	9620
microflagellate	38	6393	Other.Flagellates	

Figure 11: Raw data from 2021-04-13 EMS site 1130219

EMS ID: 1130219	Total Abundance (cells/mL):	787		
Collection Date: 2021-08-24	Total Biovolume (µm³/mL):	215439		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	11	16522	Chrysophyta	1515
Ochromonas sp.	27	5780	Chrysophyta	1455
Chrysochromulina sp.	30	1154	Chrysophyta	2160
Cryptomonas sp.	30	55561	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Anacystis sp.	224	426	Cyanobacteria	609
Chlorogloea sp.	220	4939	Cyanobacteria	824
Achnanthidium minutissimum	8	1517	Diatom	590864
Asterionella formosa	4	2785	Diatom	3116
Cocconeis sp.	4	5655	Diatom	3577
Fragilaria crotonensis	76	36902	Diatom	2932
Ulnaria sp.	4	4412	Diatom	970000
Peridinium sp.	4	18043	Dinoflagellate	10212
Trachelomonas sp.	4	14137	Euglenid	9690
Crucigenia rectangularis	61	18683	Green	6225
Oocystis sp.	4	75	Green	5827
microflagellate	68	11441	Other.Flagellates	

Figure 12: Raw data from 2021-08-24 EMS site 1130219

EMS ID: 1130218	Total Abundance (cells/mL):	386		
Collection Date: 2021-08-24	Total Biovolume (µm³/mL):	228971		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon sp.	49	73598	Chrysophyta	1515
Ochromonas sp.	19	4067	Chrysophyta	1455
Chrysochromulina sp.	4	154	Chrysophyta	2160
Chromulina sp.	4	7069	Chrysophyta	1717
Cryptomonas sp.	30	55561	Cryptophyta	10635
Rhodomonas lacustris	8	869	Cryptophyta	10663
Chlorogloea sp.	118	2649	Cyanobacteria	824
Asterionella formosa	8	5571	Diatom	3116
Cyclotella meneghiniana	4	1814	Diatom	2439
Fragilaria crotonensis	8	3884	Diatom	2932
Nitzschia sp.	8	734	Diatom	5070
Gymnodinium sp.	11	23303	Dinoflagellate	10031
Trachelomonas sp.	8	28274	Euglenid	9690
Ankistrodesmus sp.	8	1258	Green	5877
Crucigenia rectangularis	46	14088	Green	6225
Oocystis sp.	19	358	Green	5827
microflagellate	34	5720	Other.Flagellates	

Figure 13: Raw data from 2021-08-24 EMS site 1130218

EMS ID: 1130218	Total Abundance (cells/mL):	568		
Collection Date: 2022-04-06	Total Biovolume (µm³/mL):	73711		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	4	154	Chrysophyta	2160
Chromulina sp.	11	19439	Chrysophyta	1717
Ochromonas sp.	4	856	Chrysophyta	1455
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	4	7408	Cryptophyta	10635
Rhodomonas lacustris	30	3257	Cryptophyta	10663
Anacystis sp.	27	51	Cyanobacteria	609
Aphanocapsa elachista var. planctonica	38	311	Cyanobacteria	625
Planktolyngbya sp.	307	3816	Cyanobacteria	
Asterionella formosa	8	5571	Diatom	3116
Cyclotella sp.	4	1062	Diatom	2439
Fragilaria crotonensis	15	7283	Diatom	2932
Fragilaria tenera	4	1942	Diatom	2932
Ulnaria acus	4	4167	Diatom	970000
Parvodinium sp.	8	4411	Dinoflagellate	
Glenodinium sp.	4	7992	Dinoflagellate	10174
Ankistrodesmus sp.	8	1258	Green	5877
Crucigenia fenestrata	4	917	Green	6225
microflagellate	15	2524	Other.Flagellates	
picoflagellates	65	218	Other.Flagellates	

Figure 14: Raw data from 2022-04-06 EMS site 1130218

EMS ID: 1130218	Total Abundance (cells/mL):	289		
Collection Date: 2022-09-15	Total Biovolume (µm³/mL):	99576		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	15	577	Chrysophyta	2160
Dinobryon spp.	11	17451	Chrysophyta	1515
Dinobryopsis sp.	23	6178	Chrysophyta	1557
Cryptomonas sp.	8	14816	Cryptophyta	10635
Cryptomonas ovata	19	41342	Cryptophyta	10635
Rhodomonas lacustris	19	2063	Cryptophyta	10663
Anacystis sp.	42	80	Cyanobacteria	609
Gloeocapsa aeruginosa	38	537	Cyanobacteria	682
Elakatothrix sp.	8	1536	Green	9412
Oocystis sp.	19	358	Green	5827
microflagellate	87	14638	Other.Flagellates	

Figure 15: Raw data from 2022-09-15 EMS site 1130218

EMS ID: 1130219	Total Abundance (cells/mL):	1003		
Collection Date: 2022-04-06	Total Biovolume (µm³/mL):	186027		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	19	731	Chrysophyta	2160
Chrysococcus sp.	4	1328	Chrysophyta	1751
Dinobryon sp.	4	6008	Chrysophyta	1515
Ochromonas sp.	8	1713	Chrysophyta	1455
Rhodomonas lacustris	27	2932	Cryptophyta	10663
Pseudanabaena limnetica	262	24076	Cyanobacteria	1175
Planktolyngbya sp.	319	3965	Cyanobacteria	
Achnanthes cf. linearis	8	1954	Diatom	3429
Achnanthidium sp.	4	759	Diatom	590864
Achnanthidium minutissimum	27	5121	Diatom	590864
Asterionella formosa	8	5571	Diatom	3116
Cocconeis neodiminuta	8	12636	Diatom	3577
Diatoma cf. hiemale	4	4862	Diatom	3214
Fragilaria crotonensis	15	7283	Diatom	2932
Fragilaria capucina	8	3884	Diatom	2932
Fragilaria tenera	11	5341	Diatom	2932
Fragilaria sp.	8	3884	Diatom	2932
Geissleria decussis	4	2463	Diatom	590834
Gomphonema ventricosum	8	11017	Diatom	4911
Navicula capitatoradiata	4	3084	Diatom	3649
Neidium dubium	4	8678	Diatom	3269
Nitzschia cf. closterium	4	1579	Diatom	5070
Nitzschia spp.	4	1579	Diatom	5070
Staurosira construens	30	1272	Diatom	590848
Staurosira construens var. ventor	87	7264	Diatom	4127
Ulnaria nana	4	10500	Diatom	970000
Peridinium sp.	4	18043	Dinoflagellate	10212
microflagellates	106	28500	Other.Flagellates	

Figure 16: Raw data from 2022-04-06 EMS site 1130219

EMS ID: 1130219	Total Abundance (cells/mL):	368		
Collection Date: 2022-09-15	Total Biovolume (µm³/mL):	239662		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chromulina sp.	19	33576	Chrysophyta	1717
Dinobryon spp.	8	12692	Chrysophyta	1515
Cryptomonas sp.	11	20372	Cryptophyta	10635
Cryptomonas curvata	19	119699	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Rhodomonas lacustris	19	2063	Cryptophyta	10663
Anacystis sp.	106	202	Cyanobacteria	609
Parvodinium sp.	4	2205	Dinoflagellate	
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Oocystis sp.	30	565	Green	5827
microflagellate	140	23555	Other.Flagellates	

Figure 17: Raw data from 2022-09-15 EMS site 1130219