Quamichan Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Quamichan Lake during 2021 and 2022 (Table 1; Figure 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
QUAMICHAN LAKE; CENTRE (E207466)	2021-03-03
	2021-08-25
	2022-03-01
	2022-08-29
	Total= 4 samples

Figure 1: Aerial view of Quamichan Lake

Summer samples contained large blooms of toxin producing cyanobacteria; *Anabaena circinalis* and *Anabaena spiroides*. Spring samples contained low densities of cyanobacteria but high concentrations of Chrysophyta species, specifically *Campylomonas rostratiformis* and *Cryptomonas ovata* (Figure 2).

Spring samples collected in Quamichan Lake demonstrated diatom degradation, indicative of lowering silica levels in the late spring (Figure 2).

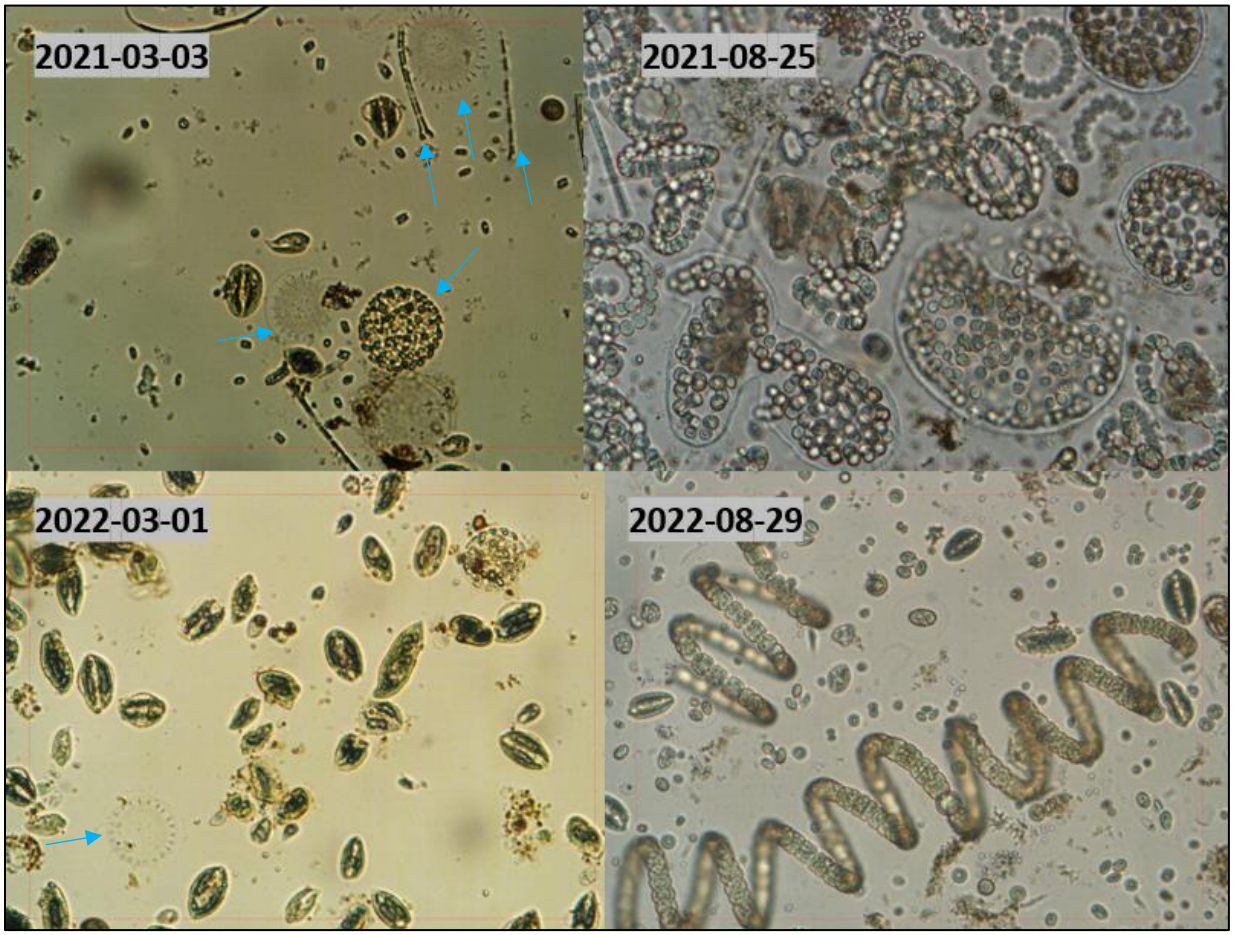

Figure 2: 400x magnification of a frame from each sample demonstrating compositional changes in the algal community in Quaminchan Lake. Note the diatom degradation in both spring samples (blue arrows)

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 biovolume of cyanobacteria *Anabaena* (38%) reflects its large abundance in Quamichan Lake (Figure 3).

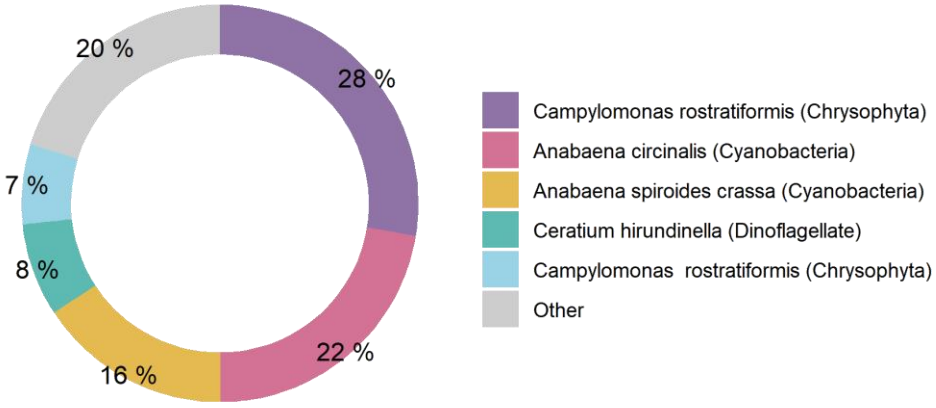

Figure 3: Dominant organisms from Quamichan L. Deep Station 1.2 Km East of Park (E207466) as percent of total biovolume

Samples from spring 2022 contained elevated densities of Chrysophyta (*Campylomonas rostratiformis;* Figure 4). 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).

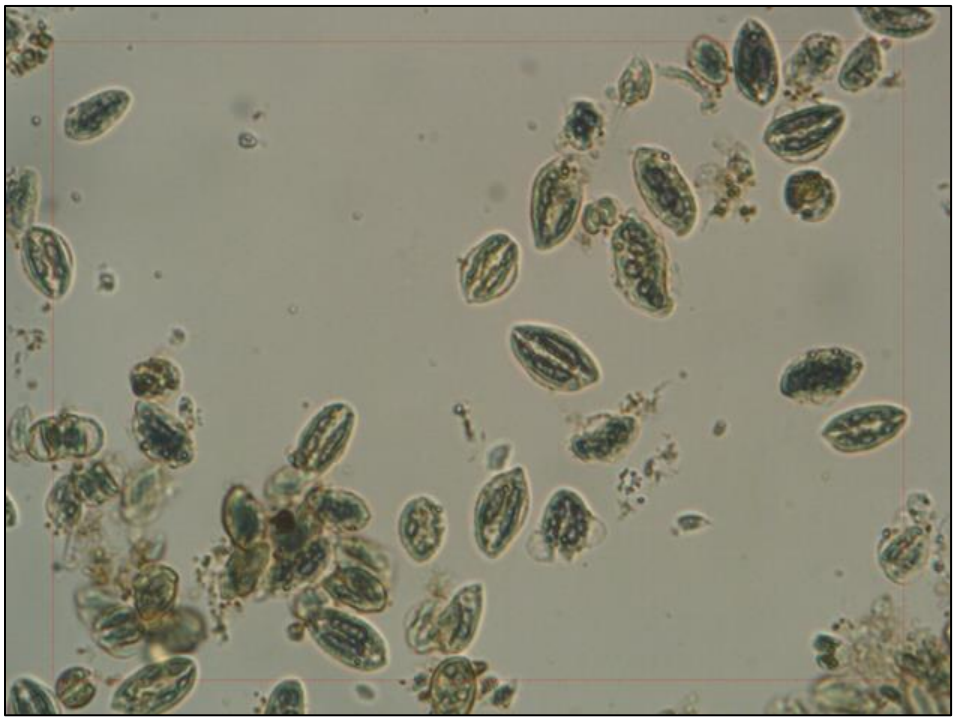

Figure 4: EMS site E207466 collected on 2022-03-01 demonstrating Campylomonas rostratiformis bloom

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 samples contained low concentrations of cyanobacteria and summer samples contained high concentrations of cyanobacteria (Figure 5).

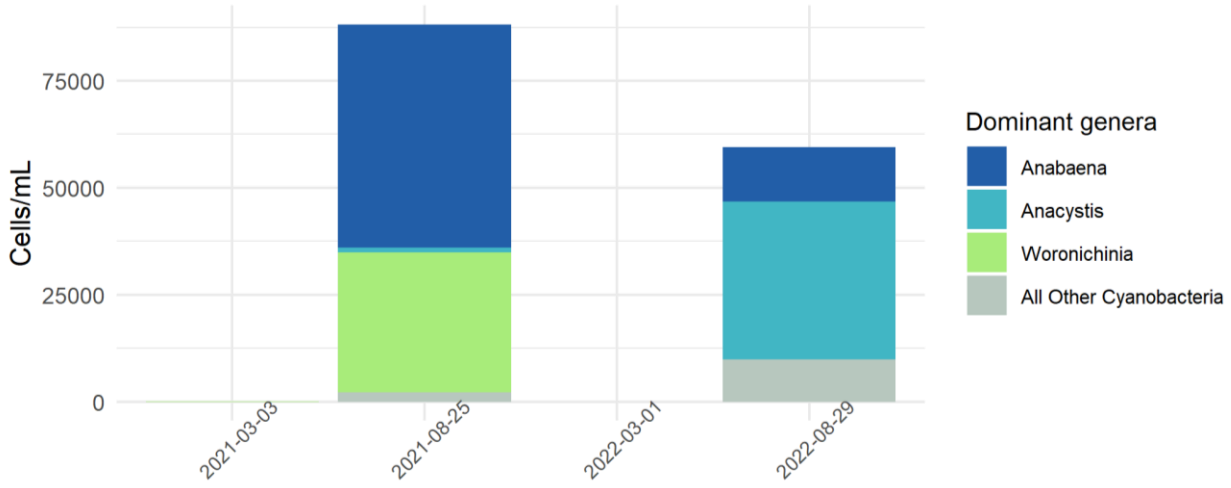

Figure 5: cell abundance for dominant cyanobacteria genera on Quamichan Lake

During cyanobacterial blooms, species of *Anabaena* can produce both negative odor/taste compounds and toxic secondary metabolites. *Anabaena* blooms can quickly accumulate, develop odor metabolites, and color water systems (EPA, 2022).

Other dominant cyanobacteria identified in 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 Quamichan Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anabaena	49178	Lyngbyatoxin LYN, Apoptogen Toxin (ApopTX), Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, NA, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT, Taste and Odor
Anacystis	18670	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Woronichinia	32786	No toxins identified

Note: * = counted in samples

Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria found in Quamichan Lake are capable of producing cyanotoxins (Table 2). Quamichan Lake displayed cyanobacteria levels in the negligible to high-risk category depending on the season (large cyanobaceria blooms in the summer).

Quamichan Lake has a mean cyanobacteria abundance of 49,269 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Quamichan Lake as compared to alert levels defined by several authorities including the WHO and EPA.

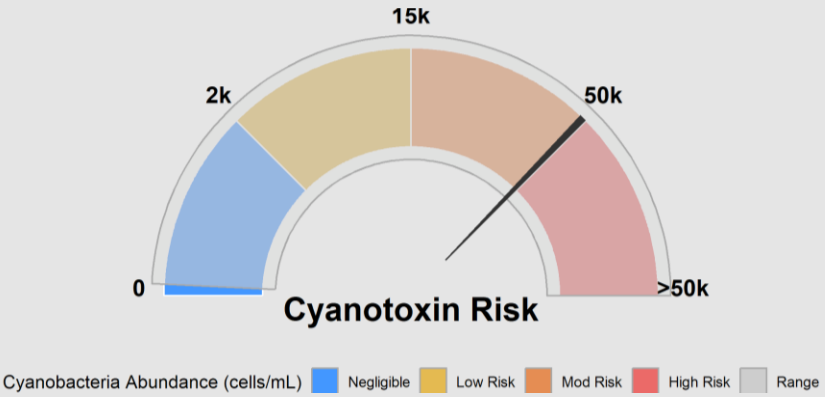

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Quamichan Lake

The cyanobacterial blooms in Quamichan Lake were large enough to dominate in biovolume. This is atypical as larger algae species tend to dominate in total biovolume (Figure 7). Due the blooming nature of Quamichan Lake, the cell abundance figures and biovolume both highlight cyanobacterial dominance in both summer samples (Figure 8; Figure 9).

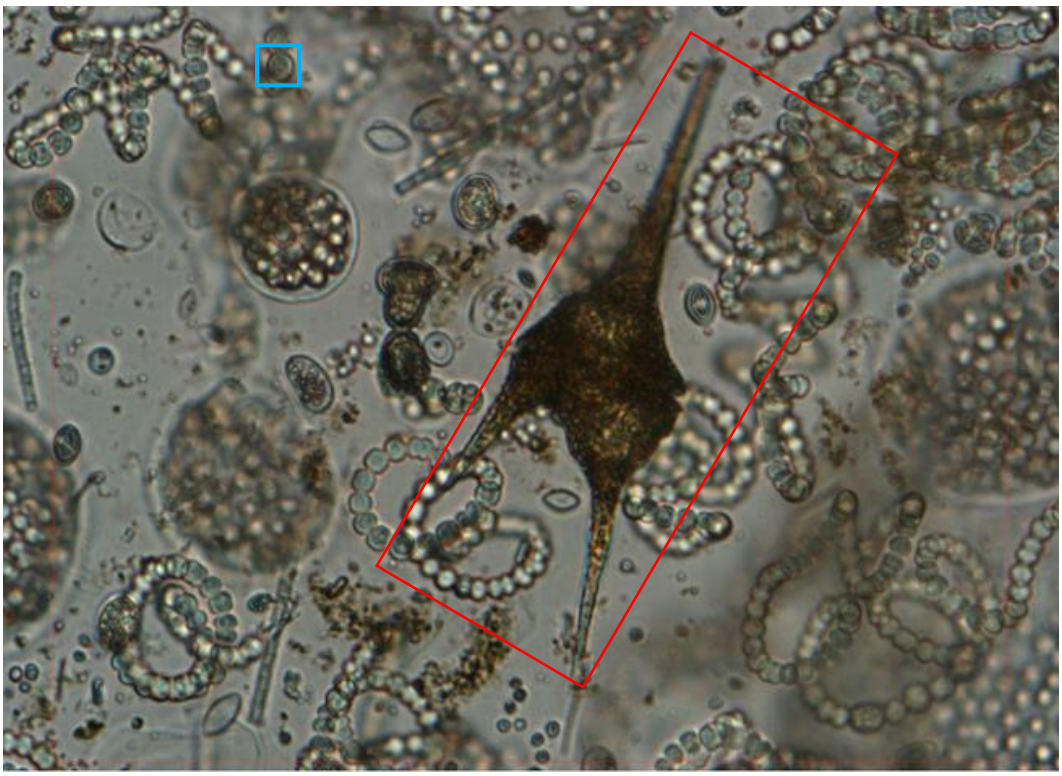

Figure 7: Size comparison of a Dinoflagellate Ceratium cell (red box) vs cyanobacteria Anabaena cell (blue box)

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).

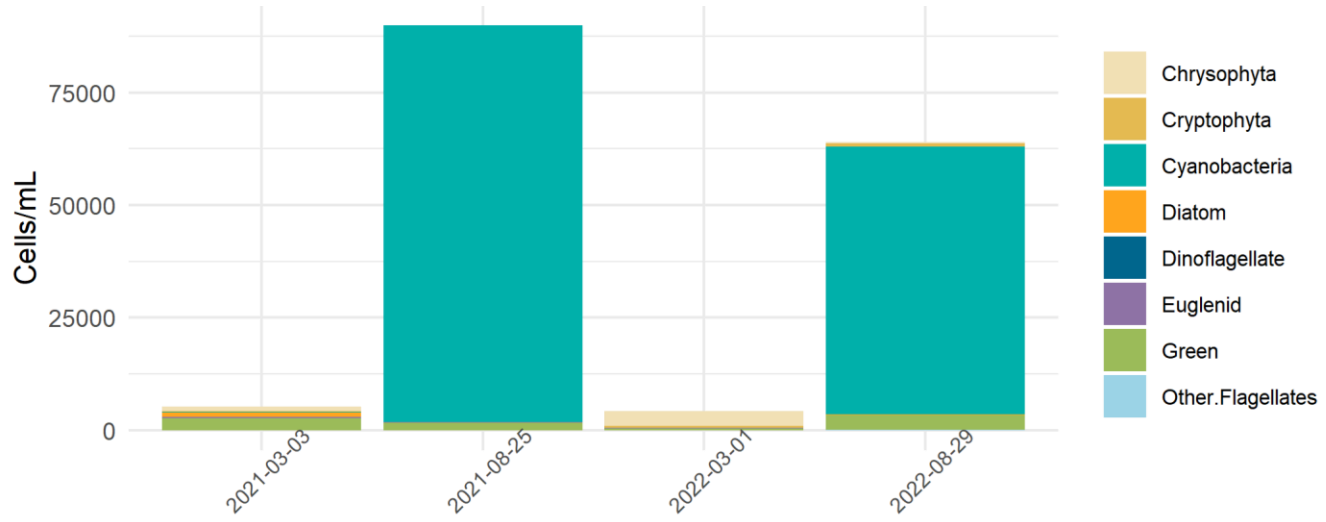

Figure 8: Cell abundance of high-level taxa groups on Quamichan Lake

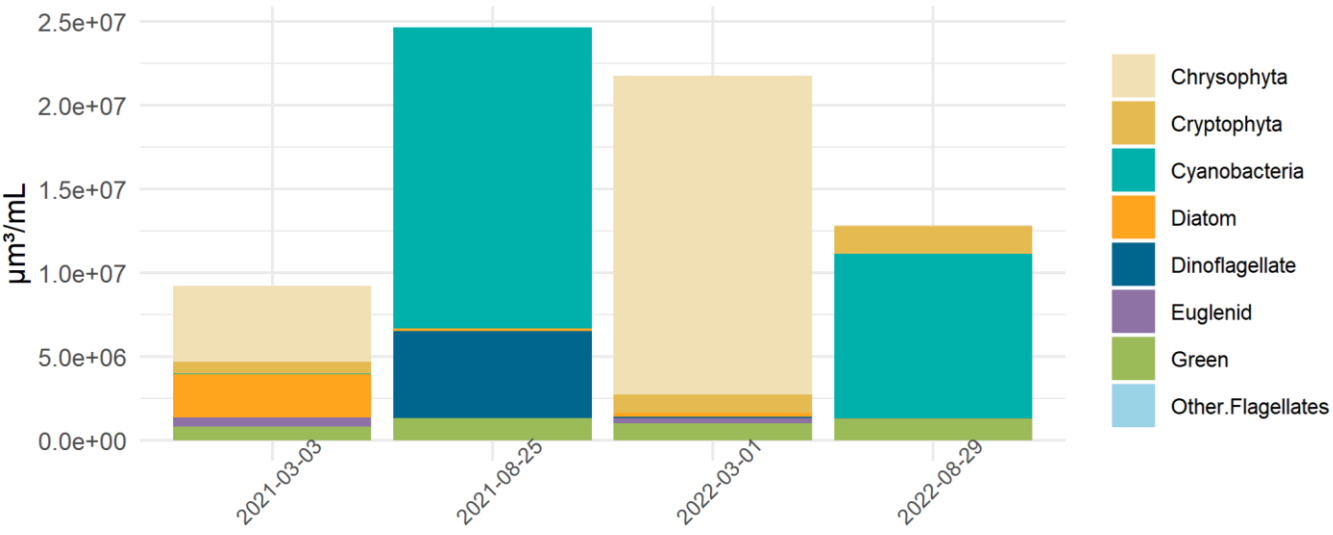

Figure 9: Biovolume of high-level taxa groups on Quamichan Lake

References

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

Wehr, J. D., Sheath, R. G., & Kociolek, P. (2015). *Freshwater Algae of North America* (Second). Elsevier Inc.

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:

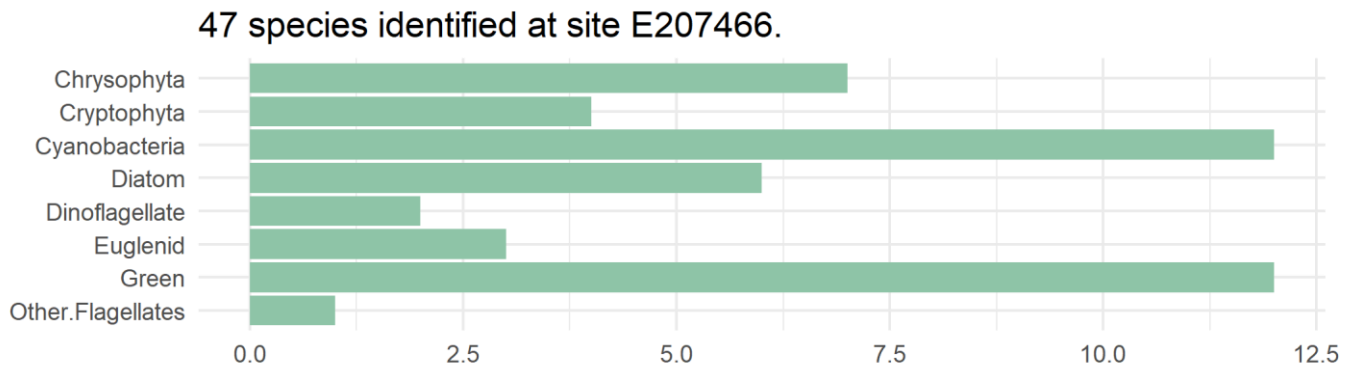

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: E207466	**Total Abundance (cells/mL):**	**5199**	
Collection Date: 2021-03-03	Total Biovolume (µm³/mL):	9219396	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Campylomonas rostratiformis	691	4454565	Chrysophyta
Chroomonas acuta	144	77791	Chrysophyta
Ochromonas spp.	15	2992	Chrysophyta
Chrysocapsa planktonica	15	4021	Chrysophyta
Dinobryon sertularia	8	9837	Chrysophyta
Rhodomonas sp.	106	12637	Chrysophyta
Cryptomonas curvata	68	428396	Cryptophyta
Cryptomonas marssonii	137	279736	Cryptophyta
Woronichinia naegelianum	121	1648	Cyanobacteria
Asterionella formosa	15	10445	Diatom
Eunotia cf. zasuminensis	751	141217	Diatom
Stephanodiscus niagarae	228	2394284	Diatom
Stephanodiscus sp.	15	42942	Diatom
Phacus sp.	121	492673	Euglenid
Trachelomonas volvocina	76	60521	Euglenid
Euglena sp.	30	17279	Euglenid
Didymocystis bicellularis	2596	699341	Green
Schroederia setigera	46	11706	Green
Sphaerocystis schroeteri	8	1731	Green
Staurastrum chaetoceras	8	75634	Green

Figure 11: Raw data from 2022-03-03 EMS site E207466

EMS ID:E207466	**Total Abundance (cells/mL):**	**89961**	
Collection Date: 2021-08-25	Total Biovolume (µm³/mL):	24641312	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	15	8103	Chrysophyta
Rhodomonas sp.	15	1788	Chrysophyta
Anabaena circinalis	49178	15258461	Cyanobacteria
Anabaena spiroides crassa	2929	2041249	Cyanobacteria
Anacystis aeruginosa	1138	6002	Cyanobacteria
Aphanizomenon flos-aquae	1108	184487	Cyanobacteria
Aphanocapsa elachista var. planctonica	987	8075	Cyanobacteria
Chroococcus turgidus	30	27143	Cyanobacteria
Woronichinia naegelianum	32786	446455	Cyanobacteria
Stephanodiscus niagarae	15	157519	Diatom
Ceratium hirundinella	30	5179614	Dinoflagellate
Trachelomonas volvocina	15	11945	Euglenid
Oocystis parva	1032	231992	Green
Pediastrum boryanum	395	676151	Green
Scenedesmus bicaudatus	243	254024	Green
Sphaerocystis schroeteri	30	6491	Green
Staurastrum chaetoceras	15	141813	Green

Figure 12: Raw data from 2021-08-25 EMS site E207466

EMS ID: E207466	**Total Abundance (cells/mL):**	**4167**		
Collection Date: 2022-03-01	**Total Biovolume (µm³/mL):**	**21756167**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Campylomonas rostratiformis	2929	18881939	Chrysophyta	
Chroomonas acuta	205	110745	Chrysophyta	10613
Ochromonas spp.	91	18154	Chrysophyta	1455
Chrysocapsa planktonica	46	12332	Chrysophyta	1860
Cryptomonas curvata	159	1001691	Cryptophyta	10635
Cryptomonas marssonii	53	108219	Cryptophyta	10635
Rhodomonas lacustris	137	14875	Cryptophyta	10663
Lindavia bodanica	8	8348	Diatom	
Eunotia cf. zasuminensis	23	3938	Diatom	3337
Stephanodiscus niagarae	15	157519	Diatom	2415
Stephanodiscus sp.	15	42942	Diatom	2415
Peridinium sp.	15	67663	Dinoflagellate	10212
Phacus sp.	83	337949	Euglenid	9766
Oocystis parva	53	11914	Green	5827
Pediastrum boryanum	46	78742	Green	6031
Staurastrum chaetoceras	15	141813	Green	7440
Staurastrum paradoxum	8	234572	Green	7440
Spirogyra sp.	23	499221	Green	6996
Gloeocystis planctonica	243	23591	Green	6355

Figure 13: Raw data from 2022-03-01 EMS site E207466

EMS ID: E207466	Total Abundance (cells/mL):	64041		
Collection Date: 2022-08-29	Total Biovolume (µm³/mL):	12839385		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chroomonas acuta	61	32953	Chrysophyta	10613
Chrysocapsa planktonica	228	61123	Chrysophyta	1860
Cryptomonas ovata	744	1618856	Cryptophyta	10635
Anabaena circinalis	152	47161	Cyanobacteria	1100
Anabaena spiroides crassa	12598	8779672	Cyanobacteria	1100
Anacystis aeruginosa	18290	96466	Cyanobacteria	609
Chroococcus limneticus	304	38820	Cyanobacteria	654
Aphanizomenon flos-aquae	4189	697487	Cyanobacteria	1191
Aphanocapsa elachista	1184	3306	Cyanobacteria	625
Anacystis aeruginosa	18670	98470	Cyanobacteria	609
Lyngbya limnetica	759	767	Cyanobacteria	870
Planktothrix sp.	106	5901	Cyanobacteria	189420
Cyanobium sp.	3279	73611	Cyanobacteria	
Aulacoseira granulata	106	34866	Diatom	590863
Lindavia bodanica	30	31305	Diatom	
Oocystis lacustris	1670	826099	Green	5827
Oocystis parva	820	184335	Green	5827
Oocystis solitaria	334	76948	Green	5827
Scenedesmus bicaudatus	61	63767	Green	6104
Schroederia setigera	167	42496	Green	
Gloeocystis planctonica	243	23591	Green	6355
nanoflagellates	46	1385	Other.Flagellates	

Figure 14: Raw data from 2022-08-29 EMS site E207466