

# Moyie Lake Phytoplankton Summary Report 2021-2022

## Overview

Samples were collected from two sites on Moyie 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.

Table 1: Sample sites and dates sampled in 2022

Sample Site (EMS#)	Dates
MOYIE LAKE NORTH (E301590)	2021-04-26
	2021-09-01
	2022-04-19
	2022-08-09
MOYIE LAKE SOUTH (E301591)	2021-09-01
	2022-04-19
	2022-08-09
<b>Total= 7 samples</b>	

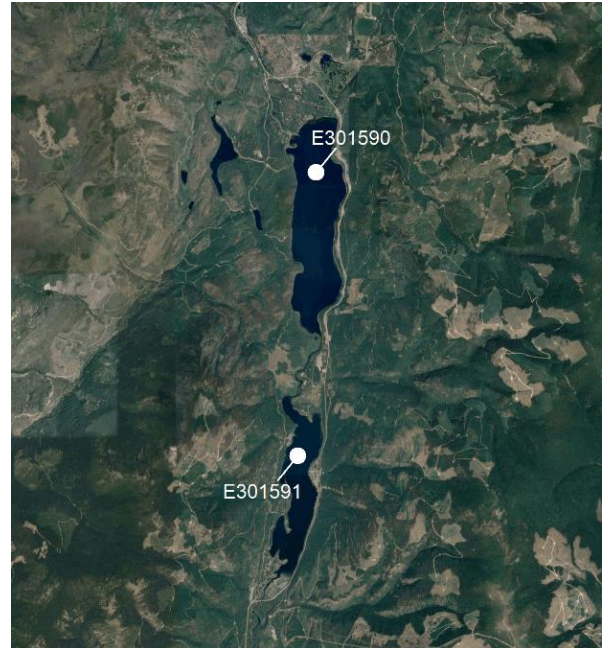


Figure 1: Aerial view of Moyie Lake

Samples held stable but low concentrations of diatoms, cyanobacteria, dinoflagellates, flagellates, and Chrysophyta. Few green algae were observed.

Spring diatoms were primarily composed of *Aulacoseira*, *Ulnaria*, *Fragilaria*, and *Asterionella* genera, while summer diatoms were predominately *Aulacoseira* and *Asterionella* (Figure 2).

Diatoms are integral to aquatic food webs because they are the foundation of the food web (Jrobyn, 2019). *Asterionella* species have been further studied for their ability to continue growth even in nutrient limiting conditions (Nicholls, 1992).

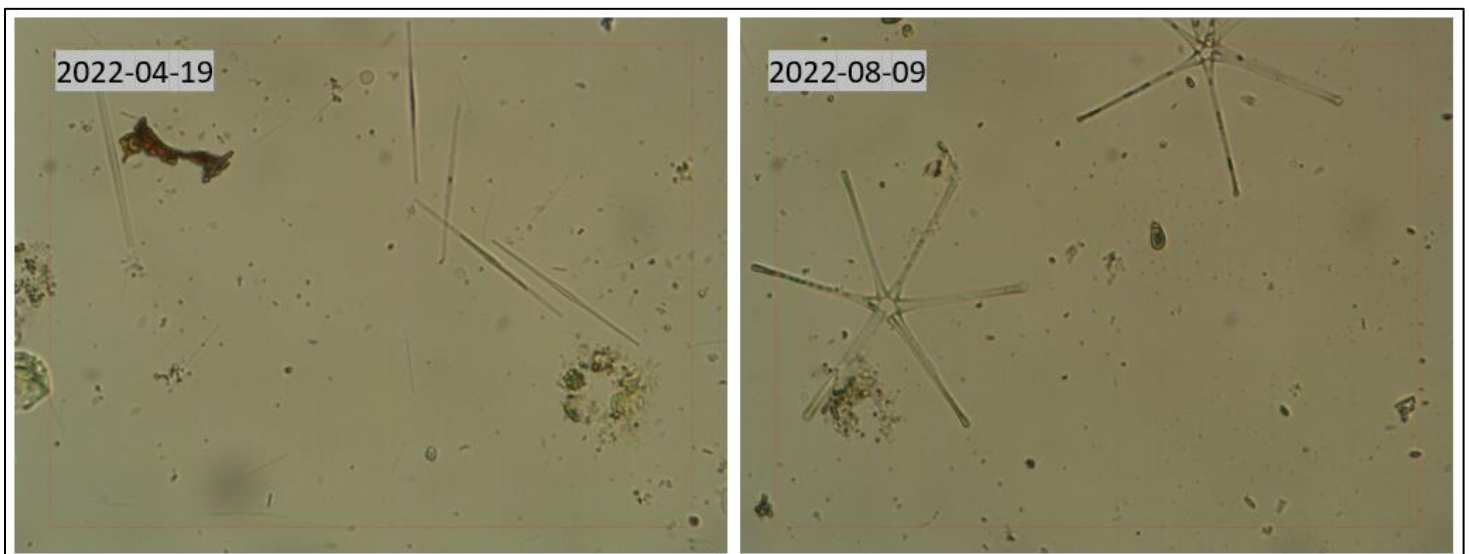


Figure 2: Diatom compositional changes between spring (left) and summer (right) samples

## Overview (continued)

*Dinobryon* exhibited a strong presence in all samples (Figure 3; Figure 4). *Dinobryon* blooms are 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). Flagellates including Chromulinales (genus *Chrysochromulina*) and Cryptomonads *Rhodomonas* and *Cryptomonas* were also frequently observed in Moyie Lake (Figure 4).

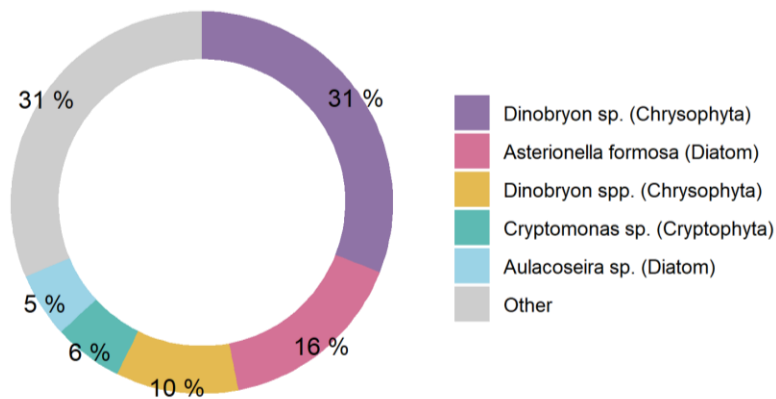


Figure 3: Dominant organisms from Moyie Lake (all sites / dates) as percent of total biovolume

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

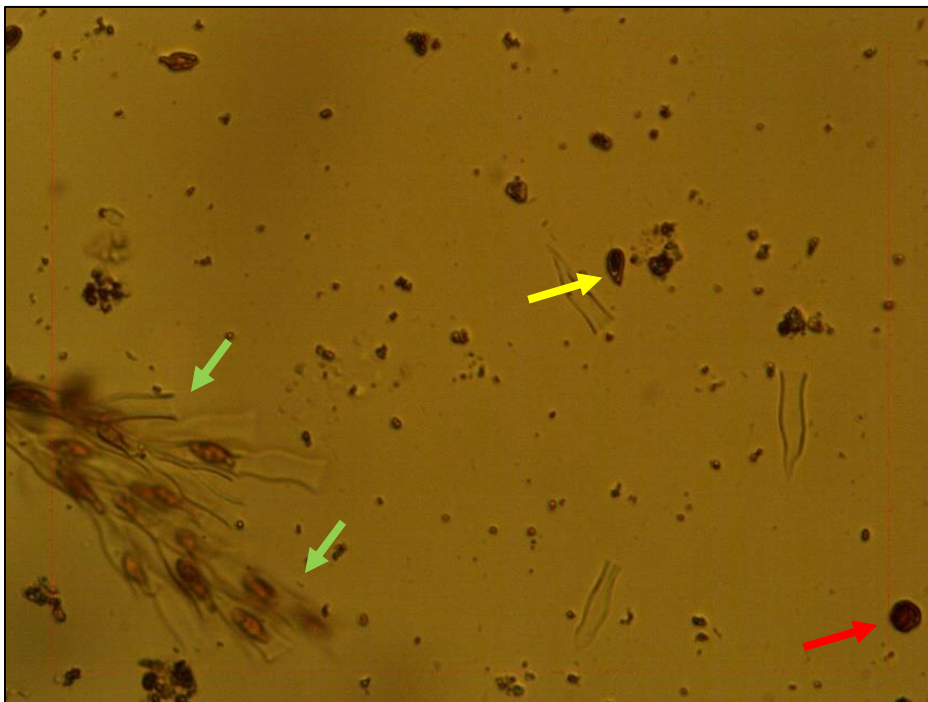


Figure 4: 400x magnification of *Dinobryon* tuft (green arrows) and several micro-flagellates; *Rhodomonas* (yellow arrow) and *Chrysochromulina* (red arrow)

### 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

*Anacystis* dominated all cyanobacteria counts but small amounts of *Planktolyngbya* and *Chroococcus* were also observed (Figure 5).

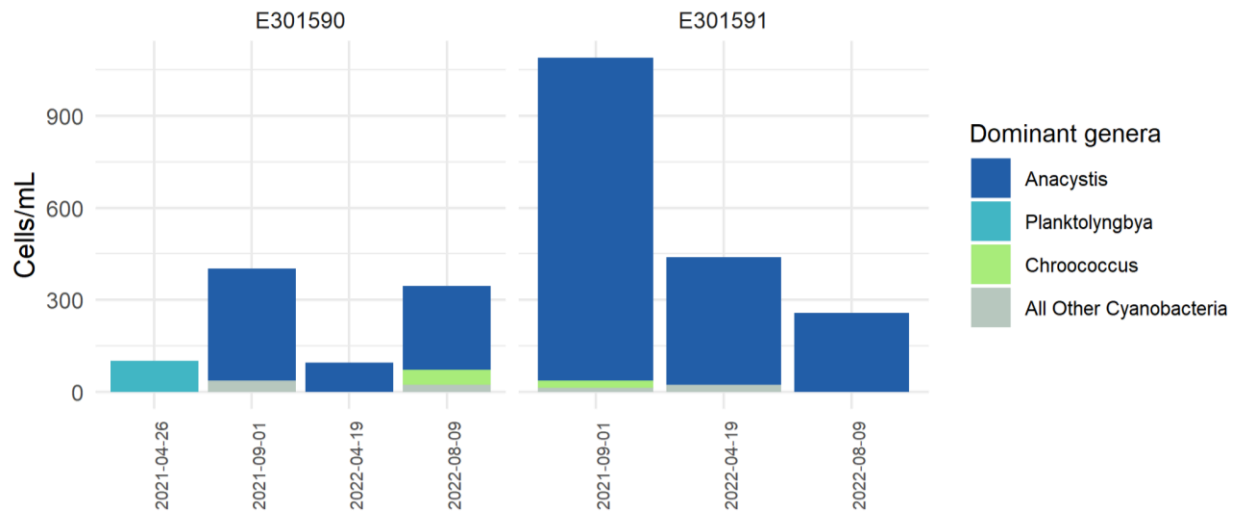


Figure 5: cell abundance for dominant cyanobacteria genera on Moyie Lake

*Anacystis*, *Planktolyngbya*, and *Chroococcus* 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 Moyie Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
<i>Anacystis</i>	1051	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
<i>Planktolyngbya</i>	102	Lyngbyatoxin LYN, Microcystin MC, BMAA
<i>Chroococcus</i>	49	Microcystin MC, BMAA

Note: \* = counted in samples

## Cyanobacterial Presence (Continued)

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

Moyie Lake displayed a range of cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 390 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Mabel Lake compared to authorities including the WHO and EPA.

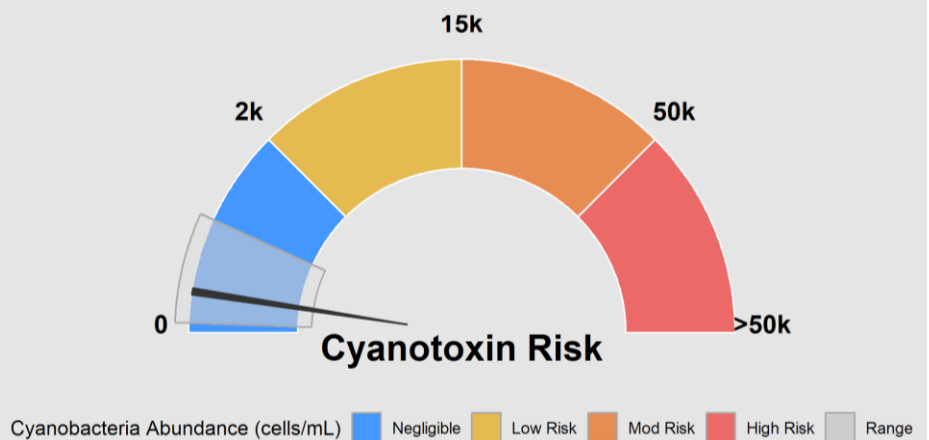


Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Moyie Lake

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 is highlighted in Figure 7 where a single *Ulnaria* cell is similar size to approximately 50 cyanobacteria cells on the adjacent filaments (*Planktolyngbya*).

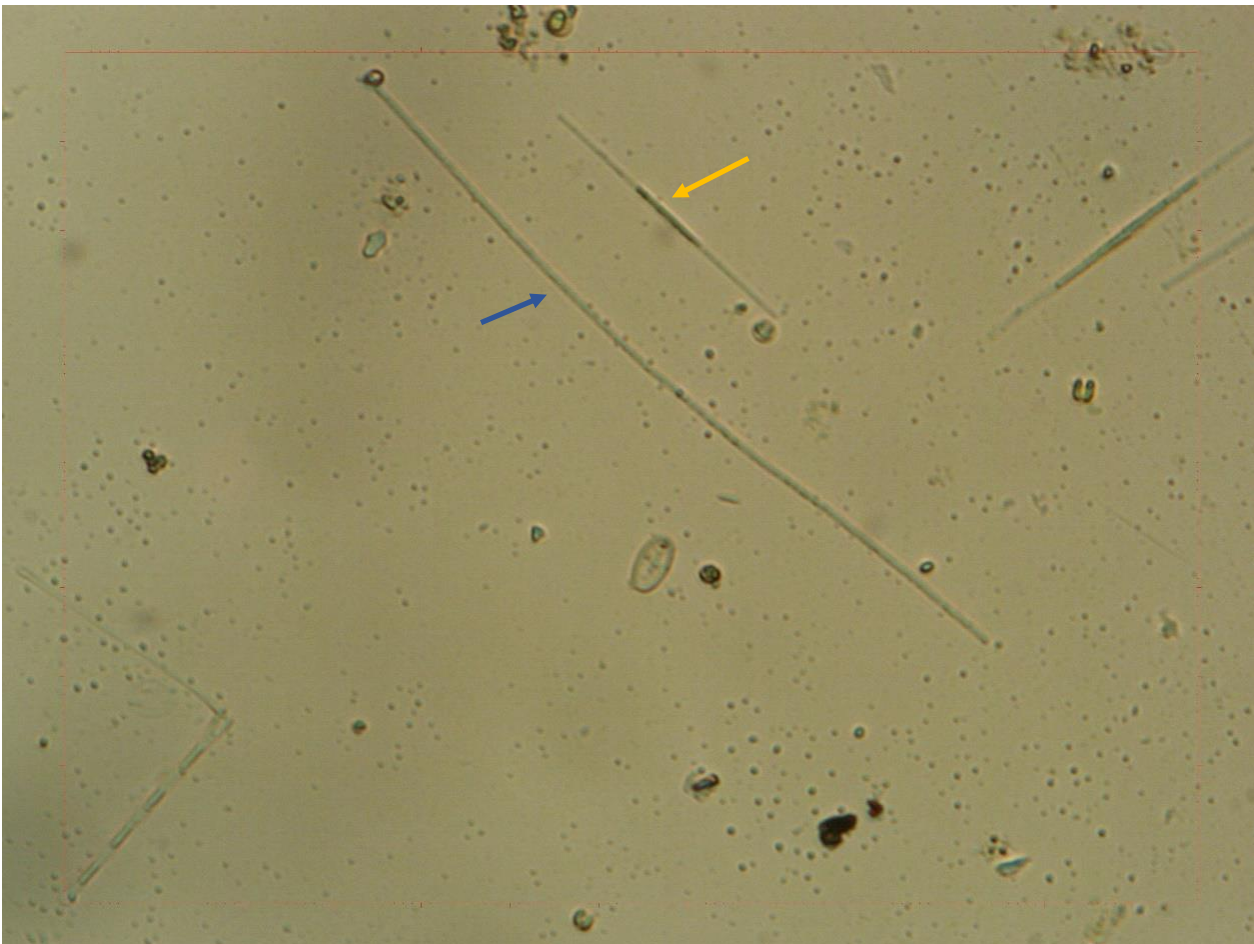


Figure 7: Size comparison of one *Ulnaria* cell (yellow arrow) to *Planktolyngbya* filament (blue arrow)

## 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.

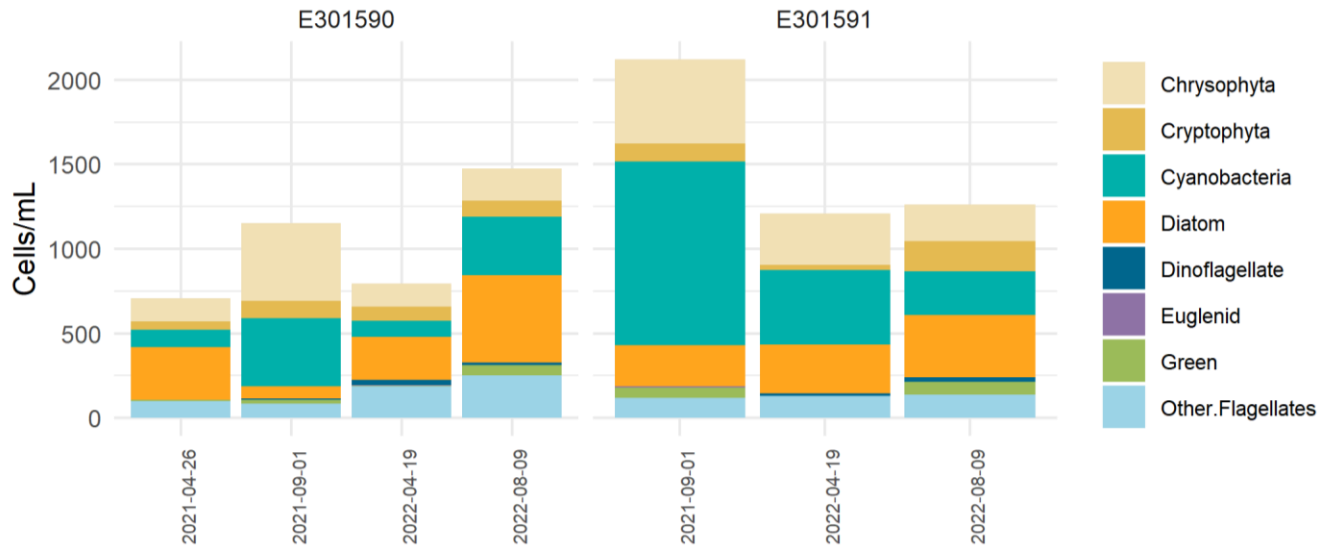


Figure 8: Cell abundance of high-level taxa groups on Moyie Lake

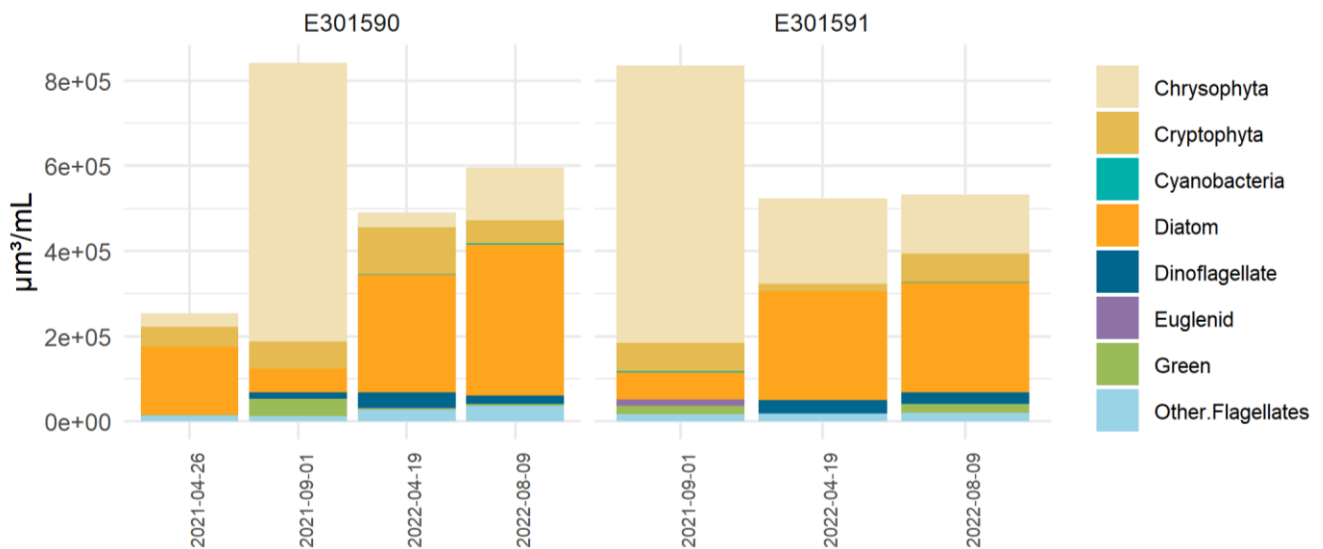


Figure 9: Biovolume of high-level taxa groups on Moyie Lake

## References

- Cantrell, R., & Long, B. (2013). *Dinobryon*. PBWorks. <http://ohapbio12.pbworks.com/w/page/51731561/Dinobryon>
- Conrad, J. (2013). *DINOBRION, 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>
- Nicholls, K. H. (1992). *CHRYSOPHYTE BLOOMS IN THE PLANKTON AND NEUSTON OF MARINE AND FRESHWATER SYSTEMS*.
- 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:

60 species identified at Moyie.

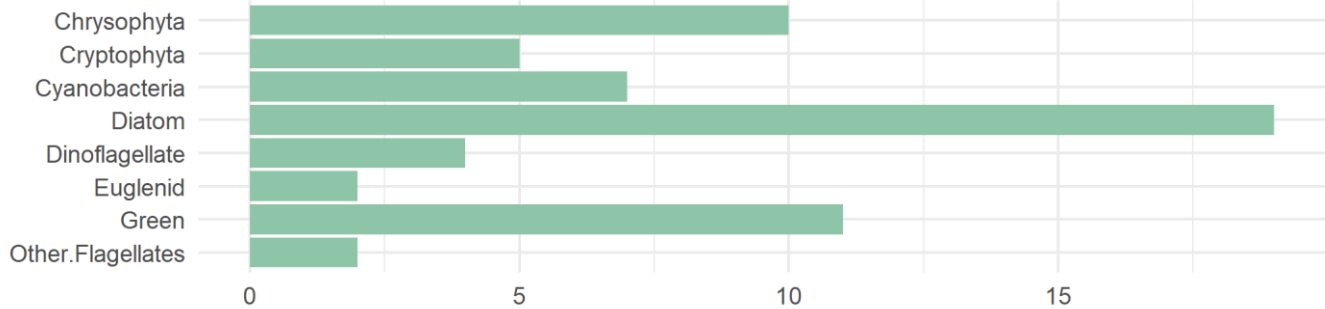


Figure 10: Identified species sorted into categories of higher-level taxa

Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	15	22530	Chrysophyta	1515
Ochromonas sp.	8	1713	Chrysophyta	1455
Chroomonas sp.	4	909	Chrysophyta	10613
Chrysochromulina sp.	102	3923	Chrysophyta	2160
Chrysococcus sp.	8	2656	Chrysophyta	1751
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	23	42597	Cryptophyta	10635
Rhodomonas lacustris	27	2932	Cryptophyta	10663
Planktolyngbya sp.	102	1268	Cyanobacteria	
Achnanthydium minutissimum	46	8725	Diatom	590864
Aulacoseira italica	4	1997	Diatom	590863
Aulacoseira distans var. nivalis	11	2212	Diatom	590863
Asterionella formosa	53	36905	Diatom	3116
Cocconeis pediculus	4	6318	Diatom	3577
Cyclotella meneghiniana	30	13606	Diatom	2439
Eunotia sp.	4	595	Diatom	3337
Frustulia vulgaris	8	17056	Diatom	4564
Nitzschia sp.	140	12836	Diatom	5070
Ulnaria ulna	11	57802	Diatom	970000
Ankistrodesmus sp.	8	1258	Green	5877
microflagellate	95	15984	Other.Flagellates	

Figure 11: Raw data from 2021-04-26 EMS site E301590

EMS ID: E301590	Total Abundance (cells/mL):	1151		
Collection Date: 2021-09-01	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	843631		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	433	650366	Chrysophyta	1515
Ochromonas sp.	4	856	Chrysophyta	1455
Chrysochromulina sp.	15	577	Chrysophyta	2160
Chrysococcus sp.	8	2656	Chrysophyta	1751
Cryptomonas sp.	30	55561	Cryptophyta	10635
Rhodomonas lacustris	72	7818	Cryptophyta	10663
Anacystis sp.	364	693	Cyanobacteria	609
Snowella lacustris	38	417	Cyanobacteria	
Achnantheidium minutissimum	19	3604	Diatom	590864
Asterionella formosa	15	10445	Diatom	3116
Cocconeis pediculus	4	6318	Diatom	3577
Diatoma sp.	27	32819	Diatom	3214
Nitzschia sp.	8	734	Diatom	5070
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Arthrodesmus incus	11	34558	Green	8276
Asterococcus sp.	4	4601	Green	9178
Oocystis solitaria	8	1843	Green	5827
microflagellate	83	13965	Other.Flagellates	

Figure 12: Raw data from 2021-09-01 EMS site E301590

EMS ID: E301591	Total Abundance (cells/mL):	2122		
Collection Date: 2021-09-01	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	838363		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Dinobryon sp.	391	587282	Chrysophyta	1515
Ochromonas sp.	15	3211	Chrysophyta	1455
Chrysochromulina sp.	30	1154	Chrysophyta	2160
Chromulina sp.	27	47713	Chrysophyta	1717
Chrysococcus sp.	34	11289	Chrysophyta	1751
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	23	42597	Cryptophyta	10635
Cryptomonas marssonii	8	16335	Cryptophyta	10635
Rhodomonas lacustris	76	8252	Cryptophyta	10663
Anacystis sp.	1051	2000	Cyanobacteria	609
Chroococcus minutus	23	868	Cyanobacteria	654
Merismopedia punctata	15	97	Cyanobacteria	727
Achnantheidium minutissimum	15	2845	Diatom	590864
Aulacoseira distans var. nivalis	209	42022	Diatom	590863
Cocconeis pediculus	4	6318	Diatom	3577
Cyclotella meneghiniana	11	4989	Diatom	2439
Gomphonema sp.	4	5508	Diatom	4911
Trachelomonas sp.	4	14137	Euglenid	9690
Euglena sp.	4	2304	Euglenid	9620
Asterococcus sp.	4	4601	Green	9178
Crucigenia rectangularis	30	9188	Green	6225
Elakatothrix gelatinosa	11	1943	Green	9412
Oocystis solitaria	15	3456	Green	5827
microflagellate	114	19180	Other.Flagellates	

Figure 13: Raw data from 2021-09-01 EMS site E301591



EMS ID: E301590	Total Abundance (cells/mL):	795		
Collection Date: 2022-04-19	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	493628		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysococcus sp.	8	2656	Chrysophyta	1751
Chrysochromulina sp.	114	4385	Chrysophyta	2160
Chromulina sp.	8	14137	Chrysophyta	1717
Dinobryon spp.	8	12692	Chrysophyta	1515
Cryptomonas sp.	30	55561	Cryptophyta	10635
Cryptomonas curvata	8	50400	Cryptophyta	10635
Rhodomonas lacustris	46	4995	Cryptophyta	10663
Anacystis sp.	95	181	Cyanobacteria	609
Achnanthydium exiguum	4	759	Diatom	590864
Aulacoseira sp.	102	167852	Diatom	590863
Fragilaria tenera	83	40301	Diatom	2932
Ulnaria acus	65	67719	Diatom	970000
Parvodinium sp.	15	8270	Dinoflagellate	
Peridinium inconspicuum	15	27472	Dinoflagellate	10212
Euglena sp.	4	2304	Euglenid	9620
Monoraphidium sp.	4	2650	Green	5990
microflagellate	186	31294	Other.Flagellates	

Figure 14: Raw data from 2022-04-19 EMS site E301590

EMS ID: E301590	Total Abundance (cells/mL):	1477		
Collection Date: 2022-08-09	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	601390		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	83	3192	Chrysophyta	2160
Dinobryon spp.	61	96775	Chrysophyta	1515
Mallomonas sp.	4	12097	Chrysophyta	1598
Dinobryopsis sp.	42	11281	Chrysophyta	1557
Cryptomonas sp.	11	20372	Cryptophyta	10635
Cryptomonas curvata	4	25200	Cryptophyta	10635
Rhodomonas lacustris	83	9012	Cryptophyta	10663
Anacystis sp.	273	519	Cyanobacteria	609
Chroococcus minutus	49	1850	Cyanobacteria	654
Gloeocapsa punctata	23	96	Cyanobacteria	682
Achnanthydium minutissimum	11	2086	Diatom	590864
Asterionella formosa	497	346072	Diatom	3116
Navicula sp.	4	2827	Diatom	3649
Ulnaria acus	4	4167	Diatom	970000
Parvodinium sp.	8	4411	Dinoflagellate	
Glenodinium sp.	4	7992	Dinoflagellate	10174
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Coenococcus sp.	46	650	Green	
Elakatothrix sp.	8	1536	Green	9412
Scenedesmus aculeolatus	8	1867	Green	6104
microflagellate	250	42062	Other.Flagellates	

Figure 15: Raw data from 2022-08-09 EMS site E301590

EMS ID: E301591	Total Abundance (cells/mL):	1209		
Collection Date: 2022-04-19	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	526608		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysococcus sp.	27	8965	Chrysophyta	1751
Chrysochromulina sp.	137	5269	Chrysophyta	2160
Dinobryon spp.	114	180858	Chrysophyta	1515
Ochromonas sp.	11	2355	Chrysophyta	1455
Dinobryopsis sp.	15	4029	Chrysophyta	1557
Cryptomonas sp.	8	14816	Cryptophyta	10635
Rhodomonas lacustris	23	2497	Cryptophyta	10663
Anacystis sp.	417	793	Cyanobacteria	609
Snowella sp.	23	99	Cyanobacteria	
Achnantheidium sp.	4	759	Diatom	590864
Asterionella formosa	8	5571	Diatom	3116
Aulacoseira sp.	34	55951	Diatom	590863
Fragilaria tenera	102	49527	Diatom	2932
Navicula sp.	4	2827	Diatom	3649
Nitzschia spp.	4	1579	Diatom	5070
Ulnaria acus	133	138563	Diatom	970000
Parvodinium sp.	8	4411	Dinoflagellate	
Glenodinium sp.	4	7992	Dinoflagellate	10174
Peridinium sp.	4	18043	Dinoflagellate	10212
microflagellate	129	21704	Other.Flagellates	

Figure 16: Raw data from 2022-04-19 EMS site E301591

EMS ID: E301591	Total Abundance (cells/mL):	1261		
Collection Date: 2022-08-09	Total Biovolume ( $\mu\text{m}^3/\text{mL}$ ):	536051		
Report.Name	Abundance (cells/mL)	Biovolume ( $\mu\text{m}^3/\text{mL}$ )	High.Level.Taxa	ITIS Genus Number
Chrysochromulina sp.	121	4654	Chrysophyta	2160
Dinobryon spp.	83	131677	Chrysophyta	1515
Dinobryopsis sp.	8	2149	Chrysophyta	1557
Spumella sp.	4	29	Chrysophyta	1491
Cryptomonas sp.	4	7408	Cryptophyta	10635
Cryptomonas curvata	4	25200	Cryptophyta	10635
Cryptomonas ovata	8	17407	Cryptophyta	10635
Rhodomonas lacustris	163	17698	Cryptophyta	10663
Anacystis sp.	258	491	Cyanobacteria	609
Asterionella formosa	364	253461	Diatom	3116
Ulnaria acus	4	4167	Diatom	970000
Parvodinium sp.	15	8270	Dinoflagellate	
Peridinium inconspicuum	11	20146	Dinoflagellate	10212
Elakathrix sp.	61	11712	Green	9412
Spondylosium sp.	8	3745	Green	8468
Chlamydomonas sp.	8	4787	Green	5448
microflagellate	137	23050	Other.Flagellates	

Figure 17: Raw data from 2022-08-09 EMS site E301591