Bowron Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Bowron 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
BOWRON LAKE @ DEEPEST PIT (E262699)	2021-05-16
	2021-08-16
	2022-05-30
	2022-08-24
	Total= 4 samples

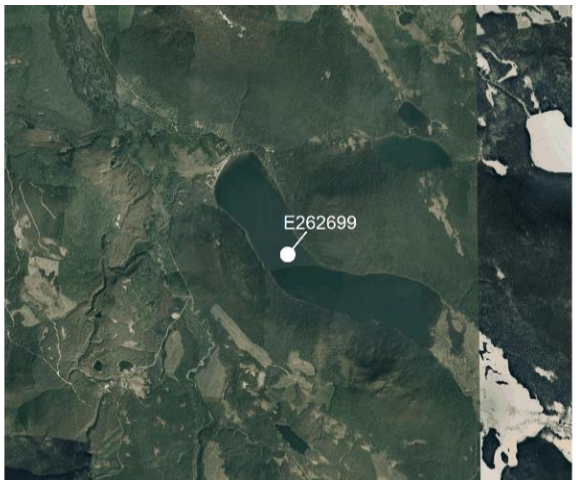

Figure 1: Aerial view of Bowron Lake

Site #E262699, collected on 2021-08-16, contained a sizable diatom bloom of *Asterionella formosa* (Figure 2). All other samples contained low levels of diatoms.

Diatoms are integral to aquatic food webs because they are the foundation of the food web (jrobyn, 2019). Colony forming diatoms such as *Asterionella sp*. can avoid grazing pressures by developing into large colonies reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012).

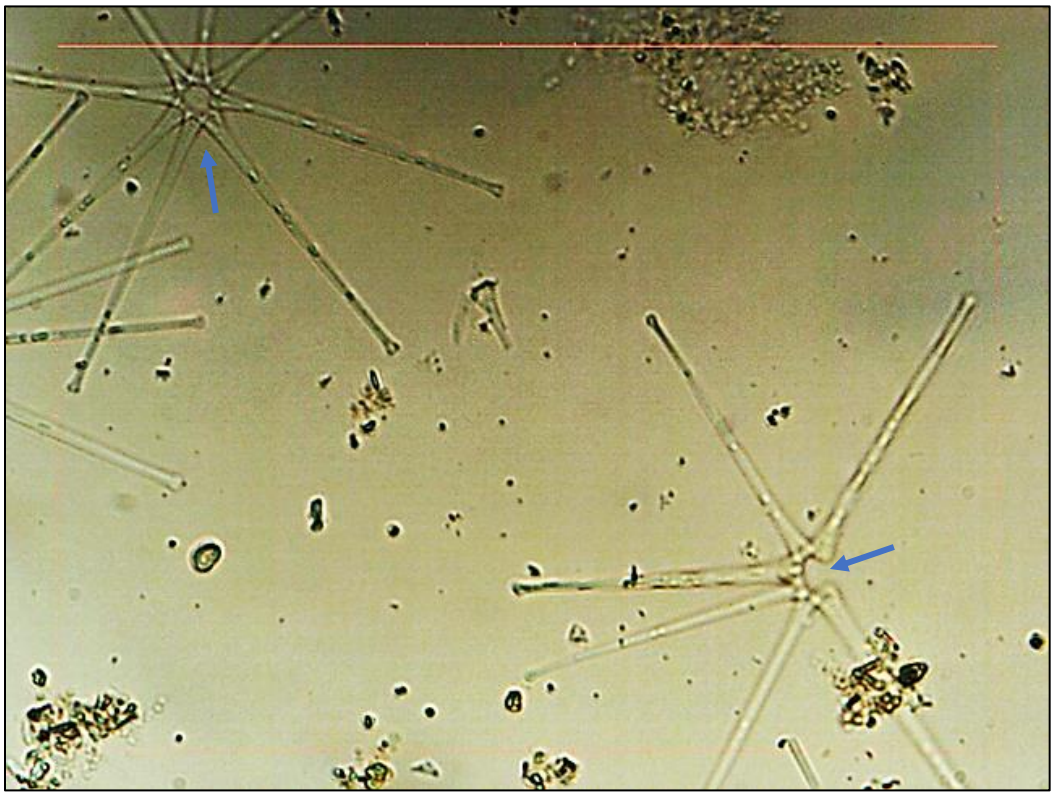

Figure 2: 400x magnification of EMS #E262699 collected on 2021-08-16 demonstrating the late summer Asterionella bloom

Overview (continued)

Algal blooms can influence total biovolume percentages. *Asterionella formosa* appeared to be the second dominant algae in Bowron Lake (31%), but its high percentage is attributed to a single large bloom that occurred at site #E262699 on 2021-08-16 (Figure 3). Other samples contained moderate levels of *Mallomonas*, *Dinobryon*, and micro-flagellates, specifically *Chromulina,* and *Chrysochomulina* (Chrysophyta, Figure 4).

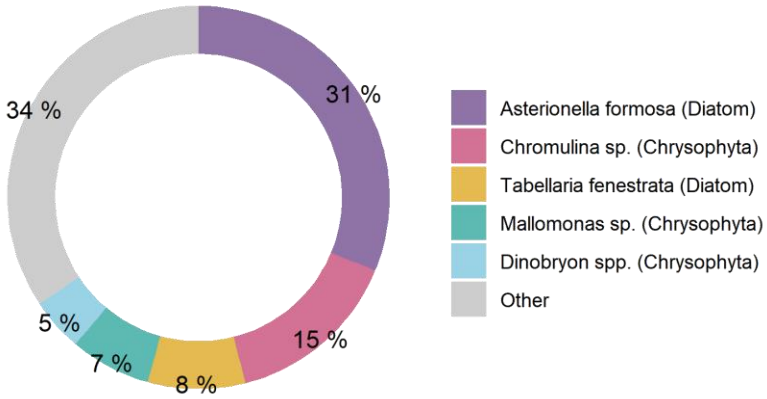

Figure 3: Dominant organisms from Bowron Lake @ Deepest Pit (E262699) as percent of total biovolume

Chrysophyta 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).

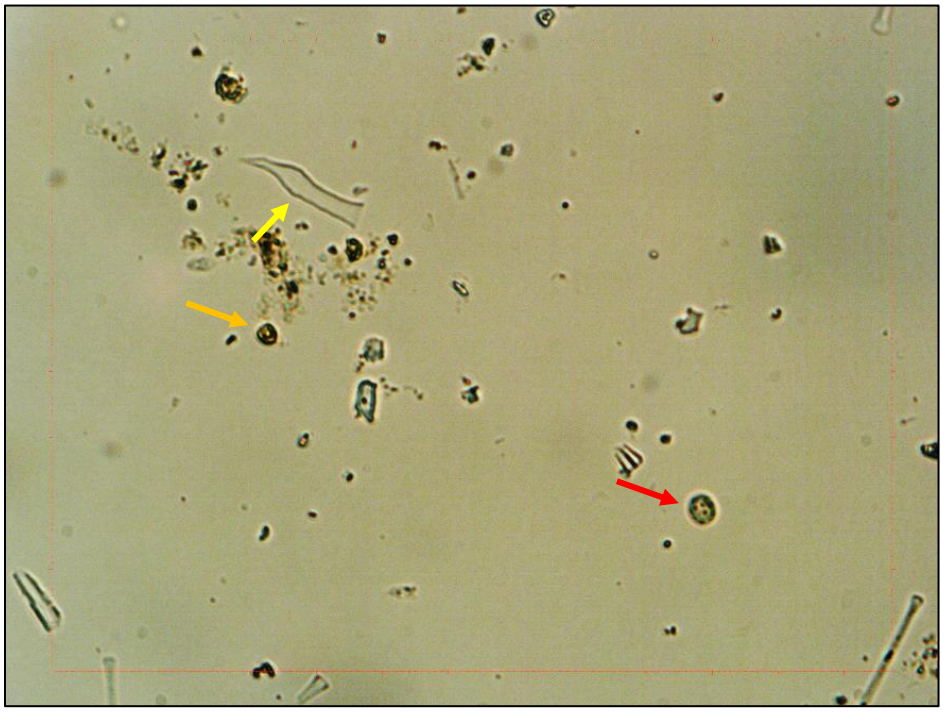

Figure 4: 400x magnification of a Dinobryon lorica (yellow arrow), a Chrysochomulina cell (orange arrow), and a Chromulina cell (red arrow)

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

Summer samples demonstrated elevated concentrations of cyanobacteria. Dominant genera included *Anabaena*, *Anacystis*, and *Snowella* (Figure 5).

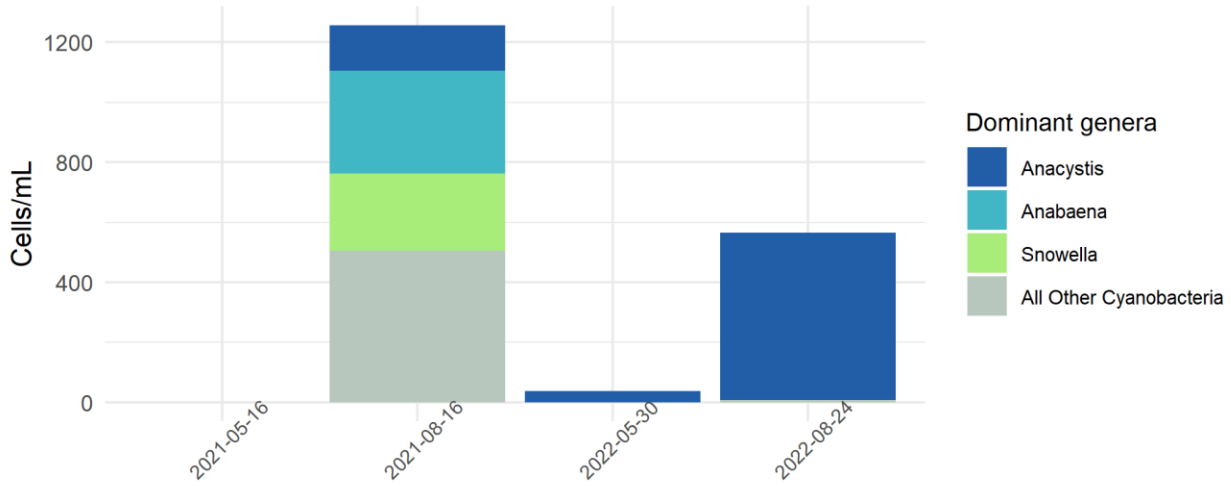

Figure 5: cell abundance for dominant cyanobacteria genera on Bowron Lake

During blooms, species of *Anabaena* produce both negative odor/taste compounds and toxic secondary metabolites. *Anabaena* blooms can quickly accumulate, produce odor compounds, and color water systems (EPA, 2022). Other dominant cyanobacteria identified in the summer samples are also associated with several cyanotoxins that represent risk 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 Bowron Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	558	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Anabaena	342	Lyngbyatoxin LYN, Apoptogen Toxin (ApopTX), Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT, Taste and Odor
Snowella	258	Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD

Note: * = counted in samples

Cyanobacterial Presence (continued)

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

Bowron Lake displayed a range of cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 620 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Bowron Lake compared to alert levels defined by several authorities including the WHO and the EPA.

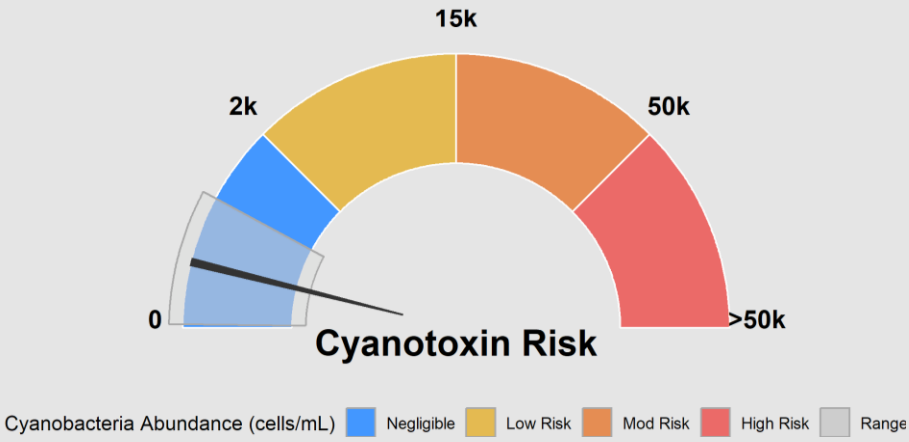

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Bowron Lake

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 *Asterionella* cell is an equivalent size to approximately 100 cyanobacteria cells.

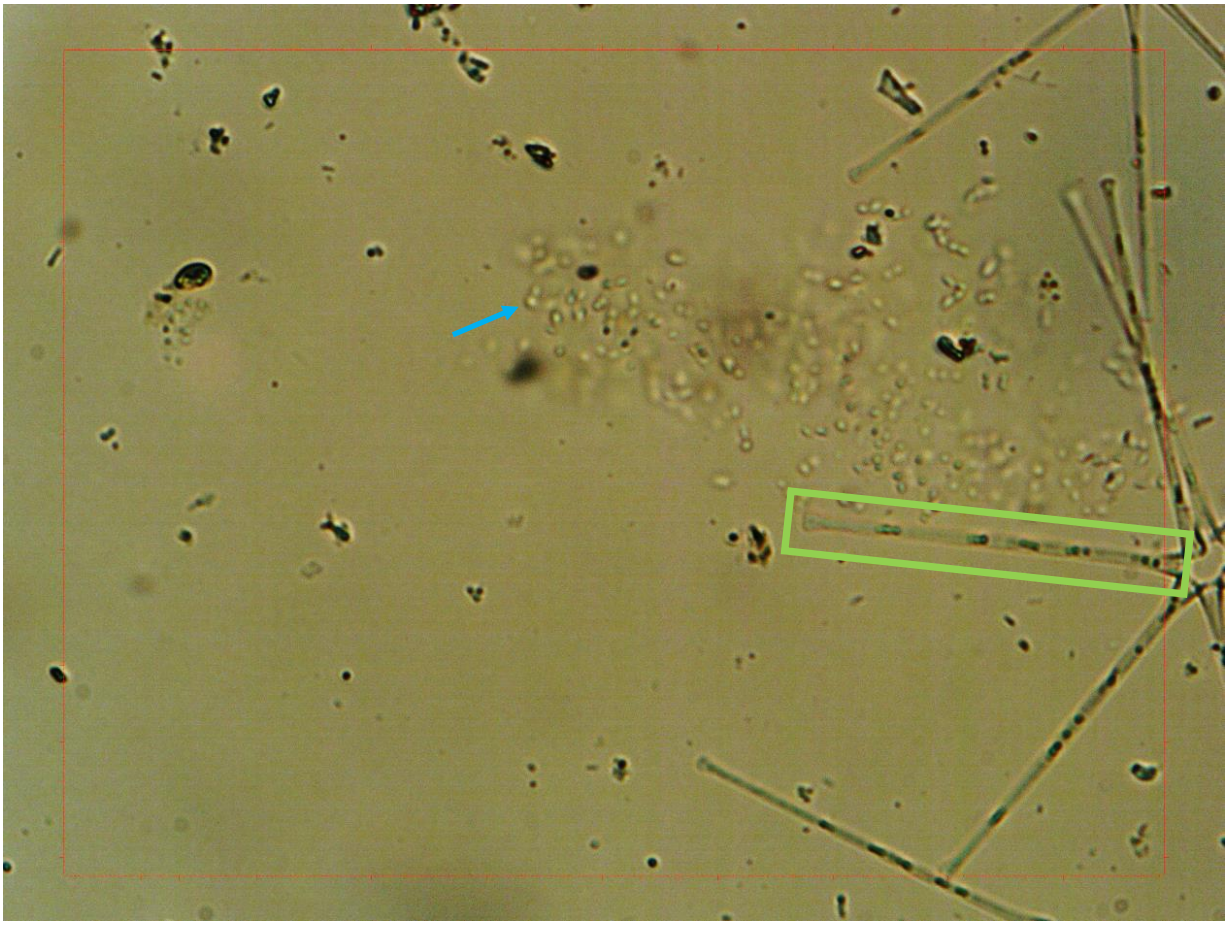

Figure 7: Size comparison of Asterionella (green box) to Anacystis cell (blue arrow)

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.

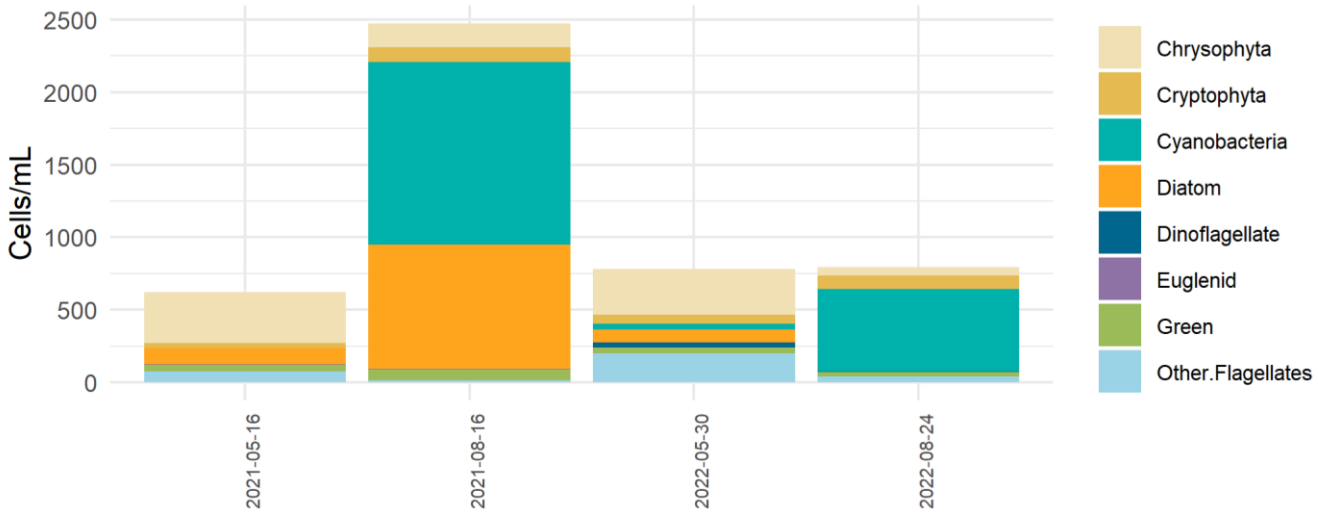

Figure 8: Cell abundance of high-level taxa groups on Bowron Lake

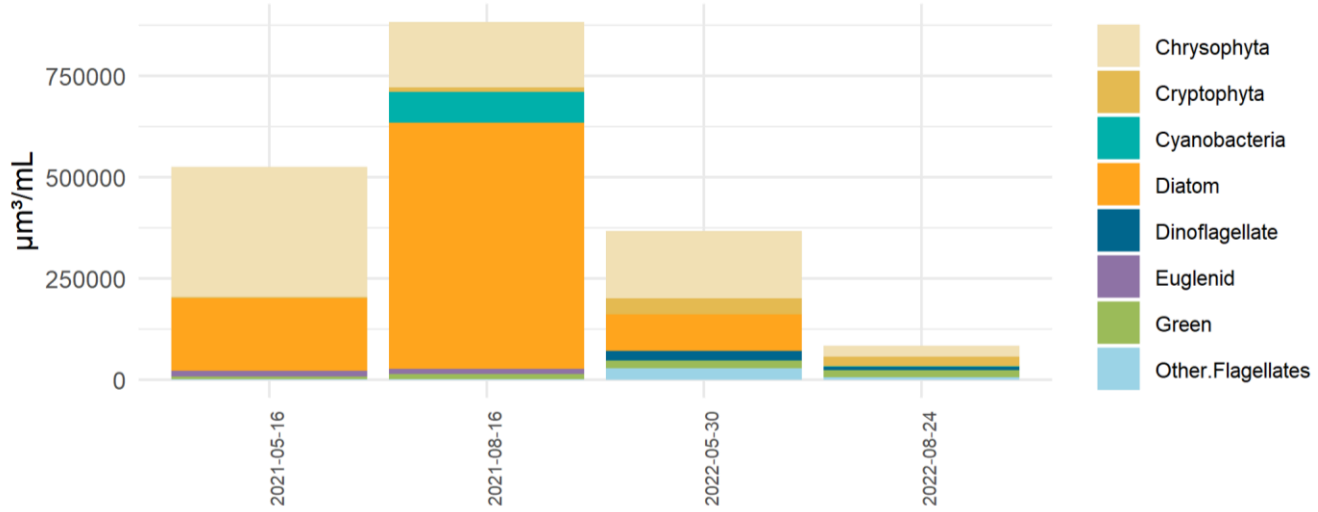

Figure 9: Biovolume of high-level taxa groups on Bowron Lake

References

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Appendix

Additional figures and raw data are listed below:

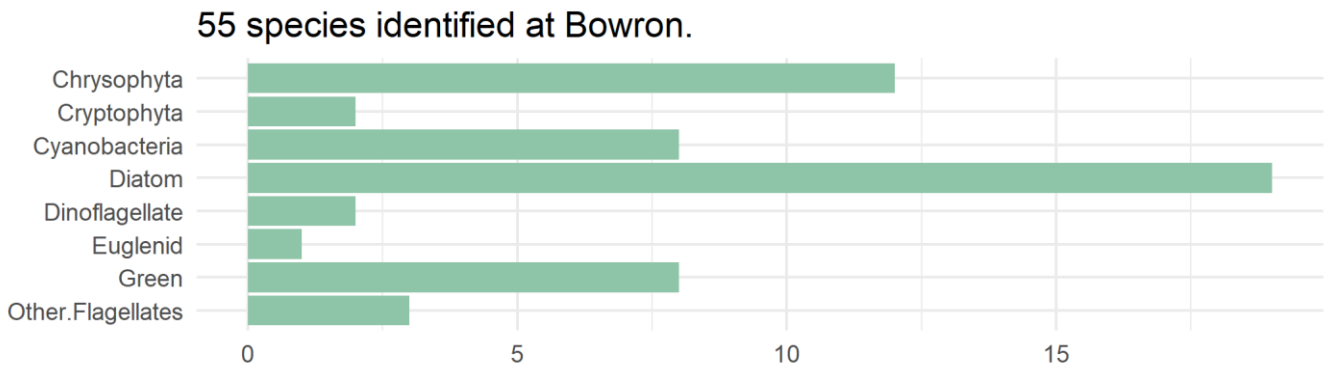

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: E262699	**Total Abundance (cells/mL):**	**620**		
Collection Date: 2021-05-16	**Total Biovolume (µm³/mL):**	**544788**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon divergens	38	32754	Chrysophyta	1515
Mallomonas sp.	34	102826	Chrysophyta	1598
Ochromonas sp.	23	4924	Chrysophyta	1455
Chromulina sp.	99	174947	Chrysophyta	1717
Chrysochromulina sp.	156	6000	Chrysophyta	2160
Dinobryopsis sp.	76	20414	Chrysophyta	1557
Rhodomonas lacustris	34	3692	Cryptophyta	10663
Achnanthidium minutissimum	11	2086	Diatom	590864
Cymbella sp.	8	13547	Diatom	4795
Nitzschia sp.	30	2751	Diatom	5070
Melosira sp.	11	35942	Diatom	2290
Tabellaria fenestrata	46	123638	Diatom	3241
Synedra famelica	4	558	Diatom	3013
Trachelomonas scabra	4	13270	Euglenid	9690
Chlorella vulgaris	38	2652	Green	5811
Chlamydomonas sp.	8	4787	Green	5448

Figure 11: Raw data from 2021-05-16 EMS site E262699

EMS ID: E262699	Total Abundance (cells/mL):	2474		
Collection Date: 2021-08-16	Total Biovolume (µm³/mL):	886586		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Dinobryon divergens	34	29306	Chrysophyta	1515
Dinobryon bavaricum	23	50060	Chrysophyta	1515
Mallomonas sp.	8	24194	Chrysophyta	1598
Ochromonas sp.	11	2355	Chrysophyta	1455
Chrysochromulina sp.	57	2192	Chrysophyta	2160
Chroomonas sp.	4	909	Chrysophyta	10613
Chromulina sp.	30	53014	Chrysophyta	1717
Dinobryopsis sp.	11	2955	Chrysophyta	1557
Rhodomonas lacustris	99	10749	Cryptophyta	10663
Aphanothece sp.	209	666	Cyanobacteria	636
Chroococcus dispersus	220	3110	Cyanobacteria	654
Anacystis cyanea	152	229	Cyanobacteria	609
Anabaena flos-aquae	342	66561	Cyanobacteria	1100
Gomphosphaeria sp.	76	3372	Cyanobacteria	714
Snowella lacustris	258	2829	Cyanobacteria	
Achnanthidium minutissimum	4	759	Diatom	590864
Aulacoseira granulata	4	1316	Diatom	590863
Asterionella formosa	820	570984	Diatom	3116
Cocconeis placentula	4	6517	Diatom	3577
Cymbella sp.	4	6773	Diatom	4795
Gomphonema sp.	11	15148	Diatom	4911
Navicula spp.	4	2356	Diatom	3649
Nitzschia sp.	4	367	Diatom	5070
Pinnularia sp.	4	2576	Diatom	4428
Trachelomonas scabra	4	13270	Euglenid	9690
Chlorella vulgaris	4	279	Green	5811
Oocystis parva	4	899	Green	5827
Tetraspora sp.	46	81	Green	9187
Chlamydomonas sp.	19	11369	Green	5448
UID flagellate	4	1391	Other.Flagellates	

Figure 12: Raw data from 2021-08-16 EMS site E262699

EMS ID: E262699	Total Abundance (cells/mL):	780		
Collection Date: 2022-05-30	Total Biovolume (µm³/mL):	370637		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysococcus sp.	4	1328	Chrysophyta	1751
Chrysochromulina sp.	144	5539	Chrysophyta	2160
Chromulina sp.	23	40644	Chrysophyta	1717
Dinobryon spp.	42	66632	Chrysophyta	1515
Dinobryon sp.	19	28538	Chrysophyta	1515
Dinobryopsis sp.	83	22294	Chrysophyta	1557
Cryptomonas sp.	19	35189	Cryptophyta	10635
Rhodomonas lacustris	42	4560	Cryptophyta	10663
Anacystis sp.	38	72	Cyanobacteria	609
Achnanthidium minutissimum	19	3604	Diatom	590864
Asterionella formosa	15	10445	Diatom	3116
Aulacoseira distans var. nivalis	4	804	Diatom	590863
Cymbella tumida	4	6773	Diatom	4795
Lindavia intermedia	4	3536	Diatom	
Sellaphora pupula	4	3507	Diatom	590842
Navicula sp.	4	2827	Diatom	3649
Nitzschia palea	19	3994	Diatom	5070
Tabellaria fenestrata	11	29566	Diatom	3241
Ulnaria acus	4	4167	Diatom	970000
Ulnaria ulna	4	21019	Diatom	970000
Parvodinium sp.	30	16540	Dinoflagellate	
Peridinium inconspicuum	4	7326	Dinoflagellate	10212
Ankistrodesmus falcatus	8	1131	Green	5877
Ankistrodesmus sp.	4	629	Green	5877
Chlamydomonas sp.	27	16155	Green	5448
microflagellate	201	33818	Other.Flagellates	

Figure 13:Raw data from 2022-05-30 EMS site E262699

EMS ID: E262699	Total Abundance (cells/mL):	3713		
Collection Date: 2022-08-24	Total Biovolume (µm³/mL):	1198044		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Chrysochromulina sp.	19	731	Chrysophyta	2160
Chromulina sp.	4	7069	Chrysophyta	1717
Dinobryon spp.	72	114226	Chrysophyta	1515
Mallomonas sp.	8	24194	Chrysophyta	1598
Dinobryopsis sp.	4	1074	Chrysophyta	1557
Cryptomonas sp.	30	55561	Cryptophyta	10635
Cryptomonas curvata	11	69299	Cryptophyta	10635
Cryptomonas erosa	19	33665	Cryptophyta	10635
Rhodomonas lacustris	277	30076	Cryptophyta	10663
Anabaena sp.	121	9073	Cyanobacteria	1100
Anacystis delicatissima	2660	5811	Cyanobacteria	609
Aphanocapsa elachista var. planctonica	8	65	Cyanobacteria	625
Chroococcus dispersus var. minor	46	650	Cyanobacteria	654
Gloeocapsa punctata	133	557	Cyanobacteria	682
Achnanthidium minutissimum	4	759	Diatom	590864
Asterionella formosa	57	39690	Diatom	3116
Fragilaria sp.	4	1942	Diatom	2932
Ceratium hirundinella	4	690615	Dinoflagellate	10397
Glenodinium sp.	8	15984	Dinoflagellate	10174
Euglena sp.	4	2304	Euglenid	9620
Ankistrodesmus sp.	4	629	Green	5877
Crucigenia apiculata	30	6881	Green	6225
Elakatothrix sp.	19	3648	Green	9412
Monoraphidium sp.	38	25175	Green	5990
Quadrigula chodati	15	4388	Green	5938
Staurodesmus subtriangularis	4	35471	Green	7182
microflagellate	110	18507	Other.Flagellates	

Figure 14: Raw data from 2022-08-24 EMS site E262699