Moberly Lake Phytoplankton Summary Report 2021-2022

Overview

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

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

Sample Site (EMS#)	Dates
MOBERLY LAKE DEEP STN. (E207907)	2021-05-31
	2021-08-24
	2022-05-26
	2022-08-10
	Total= 4 samples

Figure 1: Aerial view of Moberly Lake

Samples collected contained low densities of algae but high densities of detritus and degraded cyanobacteria/bacteria clouds in the spring and summer samples respectively (Figure 2).

Degraded cyanobacteria could represent threats to public health as cyanotoxins are typically released from cyanobacterial cells during cell death (EPA, 2022).

Elevated quantities of suspended debris can affect the health and aesthetics of a water system. Particulates in the water column can cause turbidity and provide adhesive for pollutants including metals and bacteria (Water Science School et al., 2018). Turbidity spikes, from debris, during the spring are common due to elevated wind, rain, erosion, and runoff events (Card et al., 2014). Suspended materials can include clay, silt, organic and inorganic matter, algae, dissolved color compounds, and bacteria (Card et al., 2014).

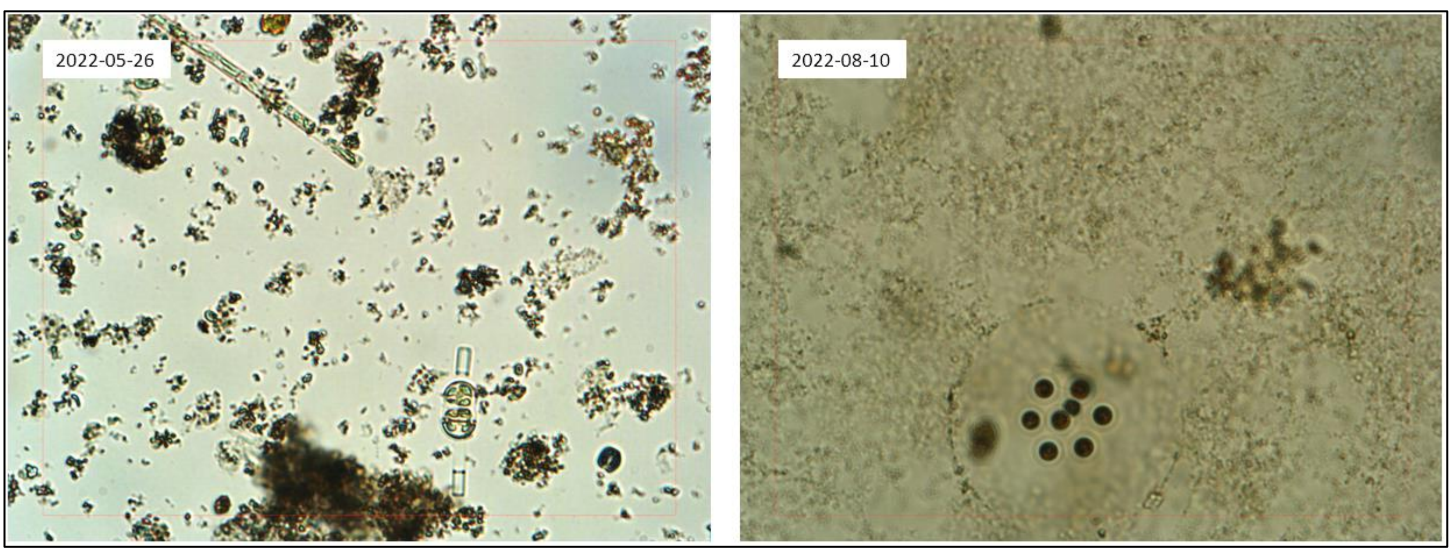

Figure 2: Comparison between spring detritus and summer bacteria

Overview (continued)

Diatoms dominated biovolumes in Moberly Lake samples (Figure 3).

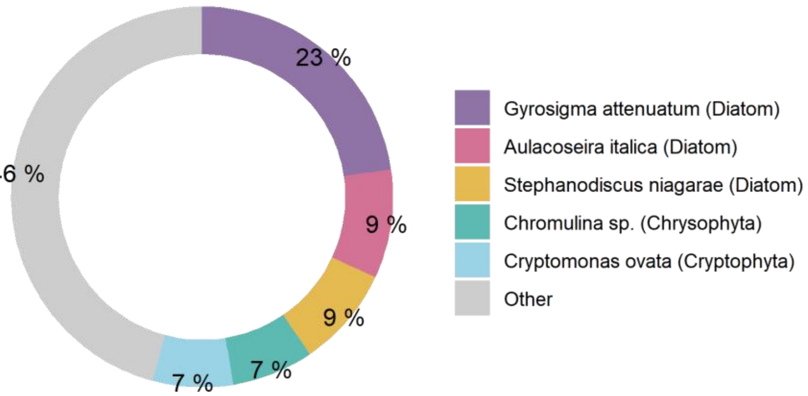

Figure 3: Dominant organisms from Moberly L. DEEP STN. *(E207907) as percent of total biovolume*

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

Moberly Lake had slightly higher diatom densities in 2021 compared to 2022 samples. *Aulacoseira italica* and *Aulacoseira* resting spores were dominant in the 2021-05-31 sample (Figure 4). *Aulacoseira* resting spores are rare and indicative of a decline in phosphate concentration (Jewson et al., 2008; Spaulding, 2021).

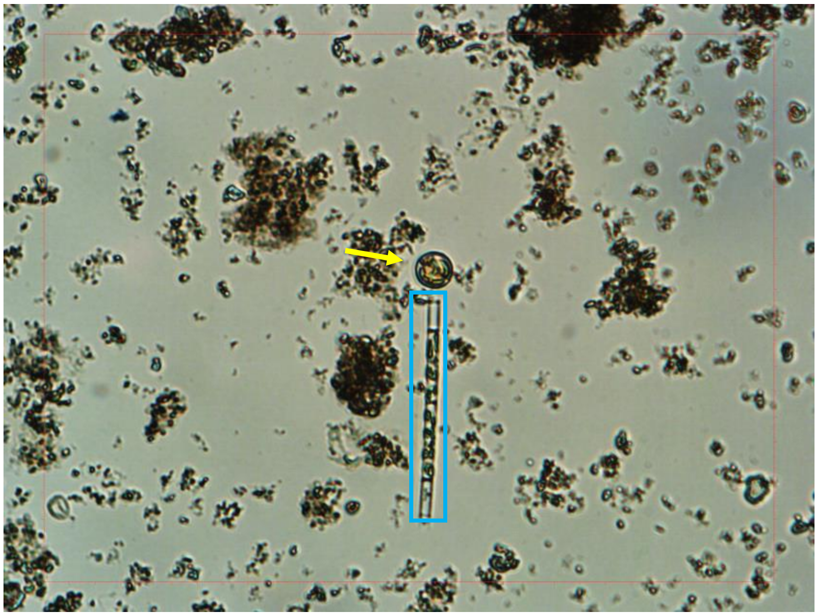

Figure 4: 400x magnification demonstrating the morphology of a strand of Aulacoseira italica (blue box) with a resting spore (yellow arrow)

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

One sample collected on 2022-05-25 contained elevated levels of cyanobacteria. Dominant genera among all samples included *Anacystis*, *Planktolyngbya*, and *Aphanizomenon* (Figure 5).

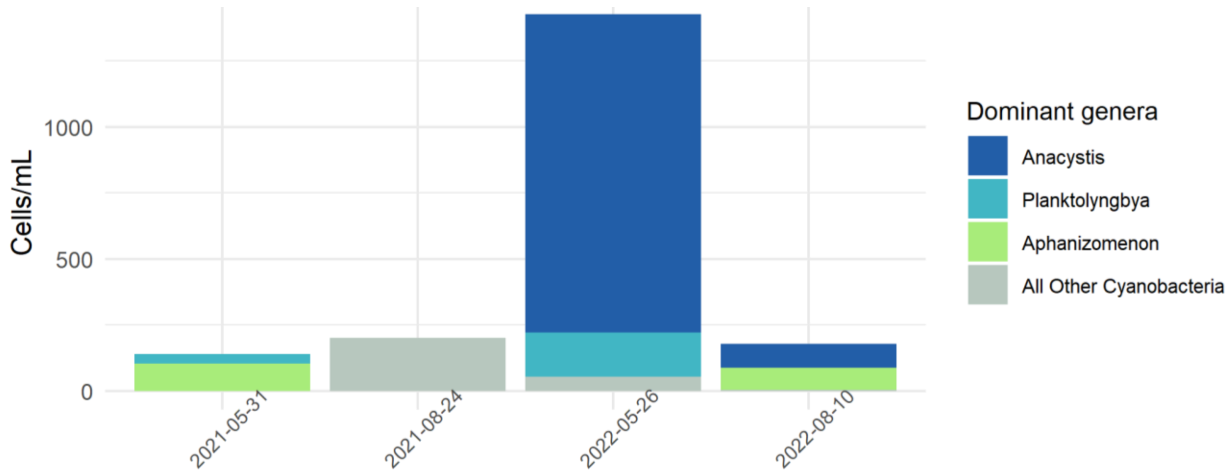

Figure 5: cell abundance for dominant cyanobacteria genera on Moberly Lake

During blooms, species of *Aphanizomenon* can produce both negative odor/taste compounds and toxic secondary metabolites. *Aphanizomenon* is a filamentous, nitrogen-fixing cyanobacteria capable of forming dense, odorous, and toxic blooms in both low and high inorganic nitrogen environments. A*phanizomenon* cells can produce liver toxins, nerve toxins, and skin irritants upon cell lysis (Cirés & Ballot, 2016; Table 2).

Other dominant cyanobacteria identified in 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). Concentration of cyanobacteria observed in Moberly Lake were too low to represent risks to human health (Lance et al., 2014).

Table 2: Dominant genera of cyanobacteria on Moberly Lake and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	1207	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Planktolyngbya	152	Lyngbyatoxin LYN, Microcystin MC, BMAA
Aphanizomenon	102	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor

Note: * = counted in samples

Cyanobacterial Presence (Continued)

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

Moberly Lake displayed a range of cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 486 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Moberly Lake as compared to alert levels defined by several authorities including the WHO and EPA.

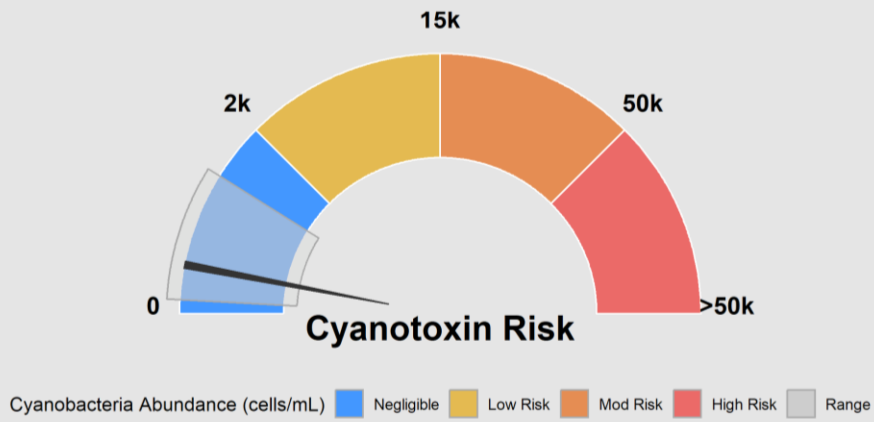

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Moberly Lake

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 diatom cell is an equivalent size to approximately fifty filamentous cyanobacteria cells.

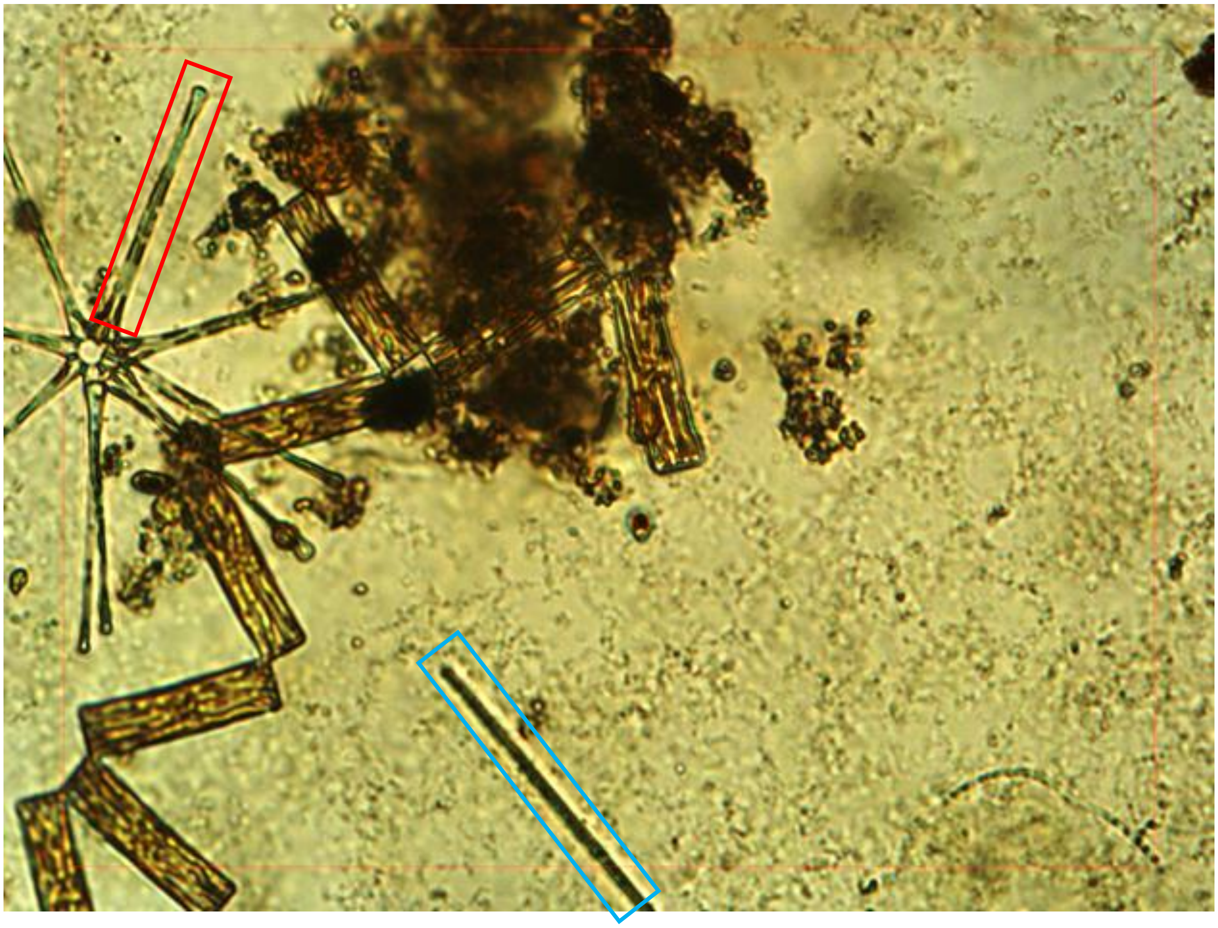

Figure 7: Size comparison of one Asterionella formosa cell (red box) to approximately fifty Lyngbya cells (blue box)

Species Composition

Algae samples were identified to the species 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.

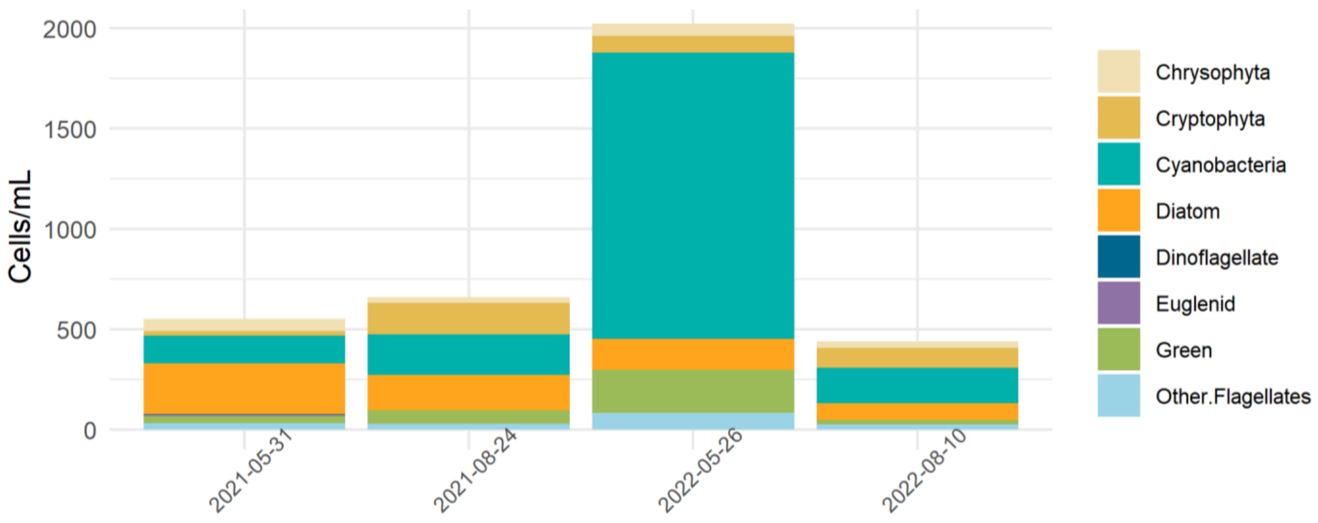

Figure 8: Cell abundance of high-level taxa groups on Moberly Lake

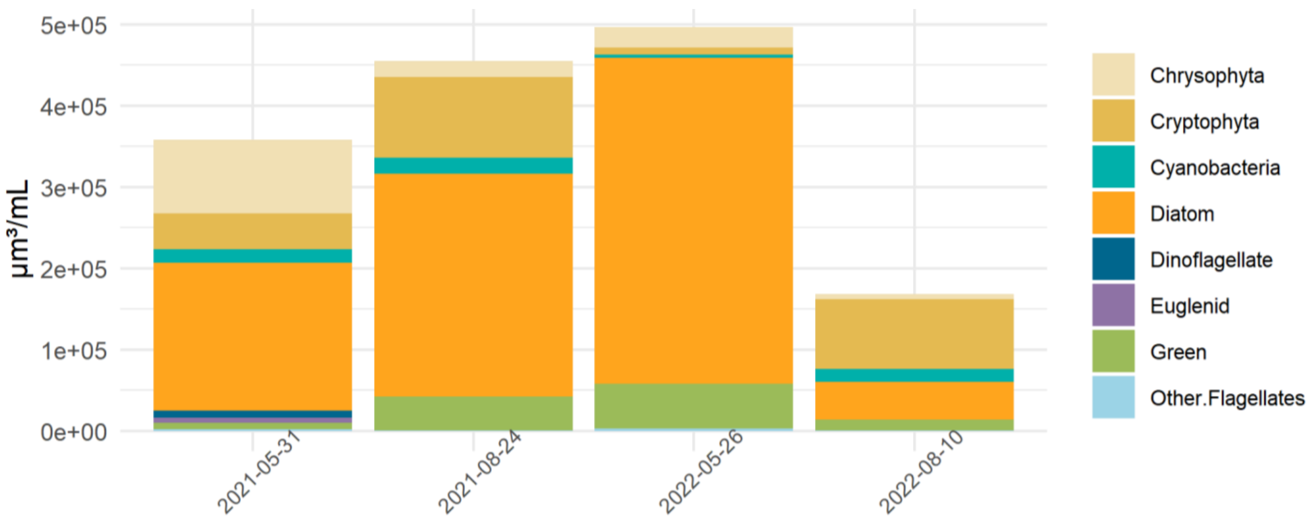

Figure 9: Biovolume of high-level taxa groups on Moberly Lake

References

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Appendix

Additional figures and raw data are listed below:

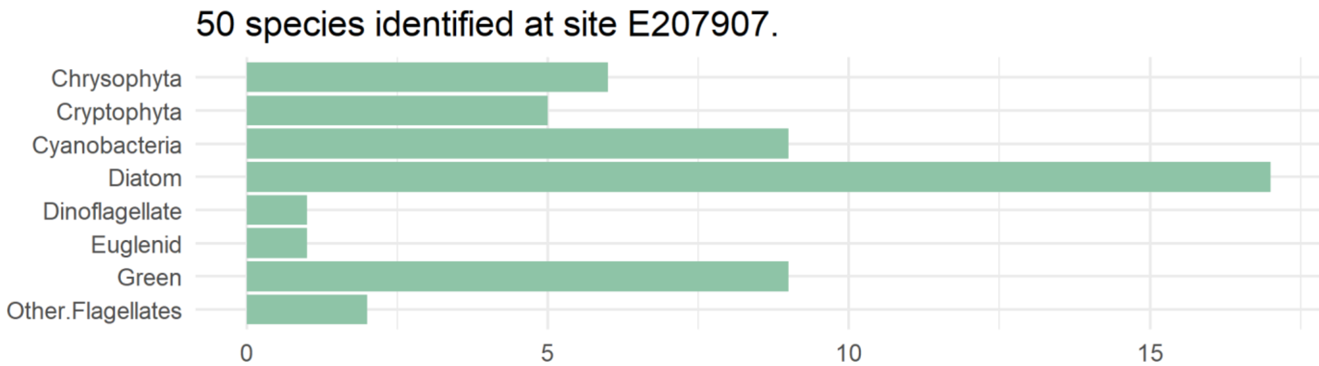

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: E207907	**Total Abundance (cells/mL):**	**549**	
Collection Date: 2021-05-31	Total Biovolume (µm³/mL):	357811	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	11	5942	Chrysophyta
Dinobryon divergens	4	3448	Chrysophyta
Chromulina sp.	46	81289	Chrysophyta
Cryptomonas ovata	8	17407	Cryptophyta
Cryptomonas curvata	4	25200	Cryptophyta
Rhodomonas lacustris	8	869	Cryptophyta
Planktolyngbya limnetica	38	194	Cyanobacteria
Aphanizomenon flos-aquae	102	16983	Cyanobacteria
Aulacoseira ambigua	15	4641	Diatom
Aulacoseira italica	190	94849	Diatom
Asterionella formosa	11	7660	Diatom
Fragilariforma sp.	4	21780	Diatom
Gomphonema parvulum	4	2255	Diatom
Nitzschia sp.	15	1375	Diatom
Nitzschia acicularis	4	3158	Diatom
Stephanodiscus niagarae	4	42005	Diatom
Ulnaria acus	4	4167	Diatom
Gymnodinium sp.	4	8474	Dinoflagellate
Trachelomonas volvocina	8	6371	Euglenid
Ankistrodesmus sp.	8	1258	Green
Ankistrodesmus falcatus	8	1131	Green
Ankistrodesmus falcatus var. mirabilis	4	1627	Green
Oocystis parva	15	3372	Green
UID flagellate small	30	2356	Other.Flagellates

Figure 11: Raw data from 2021-05-31 EMS site E207907

EMS ID: E207907	**Total Abundance (cells/mL):**	**658**	
Collection Date: 2021-08-24	Total Biovolume (µm³/mL):	454716	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chroomonas acuta	23	12425	Chrysophyta
Chromulina sp.	4	7069	Chrysophyta
Cryptomonas ovata	19	41342	Cryptophyta
Cryptomonas curvata	4	25200	Cryptophyta
Cryptomonas erosa	11	19490	Cryptophyta
Rhodomonas lacustris	125	13572	Cryptophyta
Planktosphaeria gelatinosa	30	1833	Cyanobacteria
Anabaena helicoidea	133	17549	Cyanobacteria
Lyngbya sp.	38	30	Cyanobacteria
Asterionella formosa	68	47350	Diatom
Lindavia bodanica	8	8348	Diatom
Cymbella sp.	4	6773	Diatom
Fragilaria crotonensis	53	25735	Diatom
Stephanodiscus niagarae	8	84010	Diatom
Ulnaria ulna	4	21019	Diatom
Tabellaria fenestrata	30	80633	Diatom
Ankistrodesmus falcatus	8	1131	Green
Ankistrodesmus falcatus var. mirabilis	8	3255	Green
Monoraphidium sp.	53	37139	Green
nanoflagellates	27	813	Other.Flagellates

Figure 12: Raw data from 2021-08-24 EMS site E207907

EMS ID: E207907	**Total Abundance (cells/mL):**	**2023**	
Collection Date: 2022-05-26	**Total Biovolume (µm³/mL):**	**496715**	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Chrysococcus sp.	8	2656	Chrysophyta
Ochromonas sp.	38	8135	Chrysophyta
Chromulina sp.	8	14137	Chrysophyta
Spumella sp.	8	59	Chrysophyta
Rhodomonas lacustris	83	9012	Cryptophyta
Planktolyngbya contorta	152	1413	Cyanobacteria
Lyngbya sp.	53	42	Cyanobacteria
Planktolyngbya limnetica	15	77	Cyanobacteria
Anacystis sp.	1207	2297	Cyanobacteria
Aulacoseira italica	76	37940	Diatom
Aulacoseira ambigua	46	14232	Diatom
Asterionella formosa	8	5571	Diatom
Gyrosigma attenuatum	8	334928	Diatom
Sellaphora pupula	8	7081	Diatom
cf. Dinobryon cyst	8	905	Diatom
Ankistrodesmus sp.	23	3616	Green
Ankistrodesmus falcatus	8	1131	Green
Ankistrodesmus falcatus var. mirabilis	8	3255	Green
Didymocystis bicellularis	137	36907	Green
Didymocystis planctonica	15	4041	Green
Oocystis cf. solitaria	23	6781	Green
nanoflagellates	83	2499	Other.Flagellates

Figure 13: Raw data from 2022-05-26 EMS site E207907

EMS ID: E207907	**Total Abundance (cells/mL):**	**437**	
Collection Date: 2022-08-10	**Total Biovolume (µm³/mL):**	**168286**	
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**
Ochromonas sp.	30	6422	Chrysophyta
Cryptomonas ovata	19	41342	Cryptophyta
Cryptomonas erosa	4	7087	Cryptophyta
Cryptomonas marssonii	15	30628	Cryptophyta
Rhodomonas lacustris	61	6623	Cryptophyta
Planktosphaeria gelatinosa	4	244	Cyanobacteria
Aphanizomenon cf. flos-aquae	83	15303	Cyanobacteria
Anacystis cyanea	83	125	Cyanobacteria
Anacystis sp.	8	15	Cyanobacteria
Aulacoseira italica	8	3994	Diatom
Asterionella formosa	27	18801	Diatom
Fragilaria crotonensis	49	23792	Diatom
Ankistrodesmus sp.	4	629	Green
Monoraphidium cf. griffithii	19	12588	Green
nanoflagellates	23	693	Other.Flagellates

Figure 14: Raw data from 2022-08-10 EMS site E207907