# Bainbridge Lake Phytoplankton Summary Report 2021-2022

## Overview

Samples were collected from one site on Bainbridge 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 2021 and 2022*

| Sample Site (EMS#) | Dates |
|---|---|
| BAINBRIDGE LAKE; DEEP STN (E275463) | 2021-03-11 |
| | 2021-09-02 |
| | 2022-03-08 |
| | 2022-08-31 |
| | **Total= 4 samples** |


*Figure 1: Aerial view of Bainbridge Lake*

Samples contained moderate densities of micro-flagellates and low densities of green algae, dinoflagellates, and diatoms.

Samples collected in 2022 had low to moderate concentrations of Chrysophyta (genus *Dinobryon;* Figure 2).

High concentrations of *Dinobryon* species can result in unpleasant fishy odors, and one species of *Dinobryon* is linked with toxins that can affect fish vitality (Cantrell & Long, 2013; Conrad, 2013).

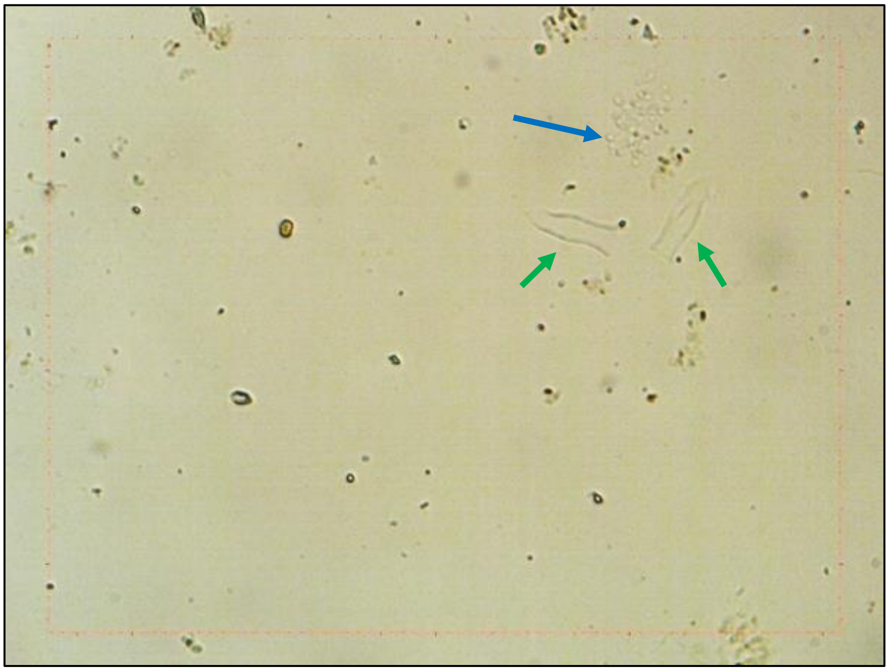

*Figure 2: 400x magnification of EMS #E275463 collected on 2022-08-31. This sample contained Dinobryon (green arrow) and Anacystis (blue arrow)*

## Overview (continued)

Chrysophyta dominated biovolumes in Bainbridge Lake (Figure 3). *Dinobryon* was the dominate genus observed but flagellates where also frequently observed; *Cryptomonas*, *Mallomonas* and *Chromulina* (Figure 4).

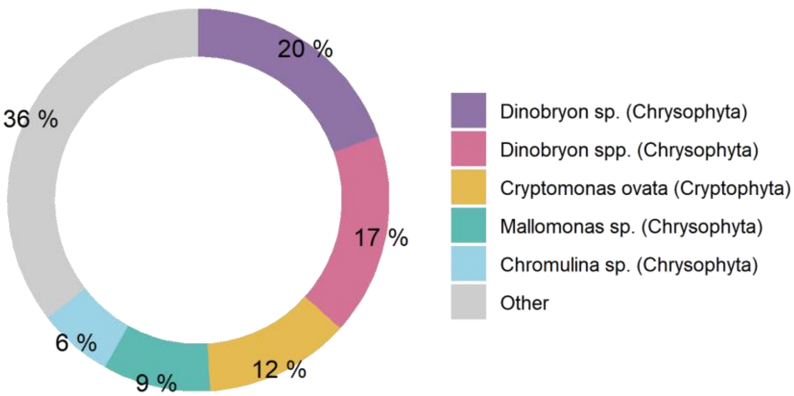


*Figure 3: Dominant organisms from Bainbridge Lake; Deep Stn (E275463) as percent of total biovolume*

Chrysophyta are advantageous and disadvantageous in freshwater systems, depending on their context. Some Chrysophytes are known to produce odor compounds described as fishy, while others eat bacteria and reduce negative odor compounds (Wehr et al., 2015). Cryptomonads are favored elements of freshwater food chains and are selectively consumed by several zooplankton, ciliates, and dinoflagellates (Wehr et al., 2015).

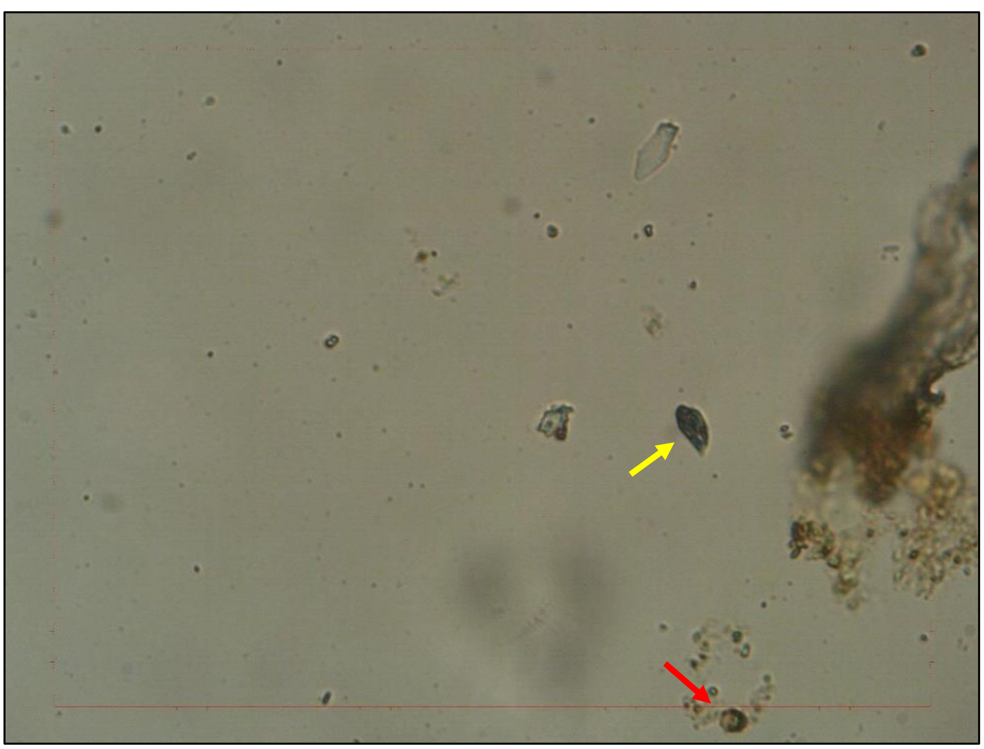

*Figure 4: 400x magnification of a Cryptomonad Chrysophyte (yellow arrow) and a micro-flagellate (red*

### 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 demonstrated moderate cyanobacteria densities; dominant genera included *Anacystis, Aphanocapsa,* and *Anabaena* (Figure 5).

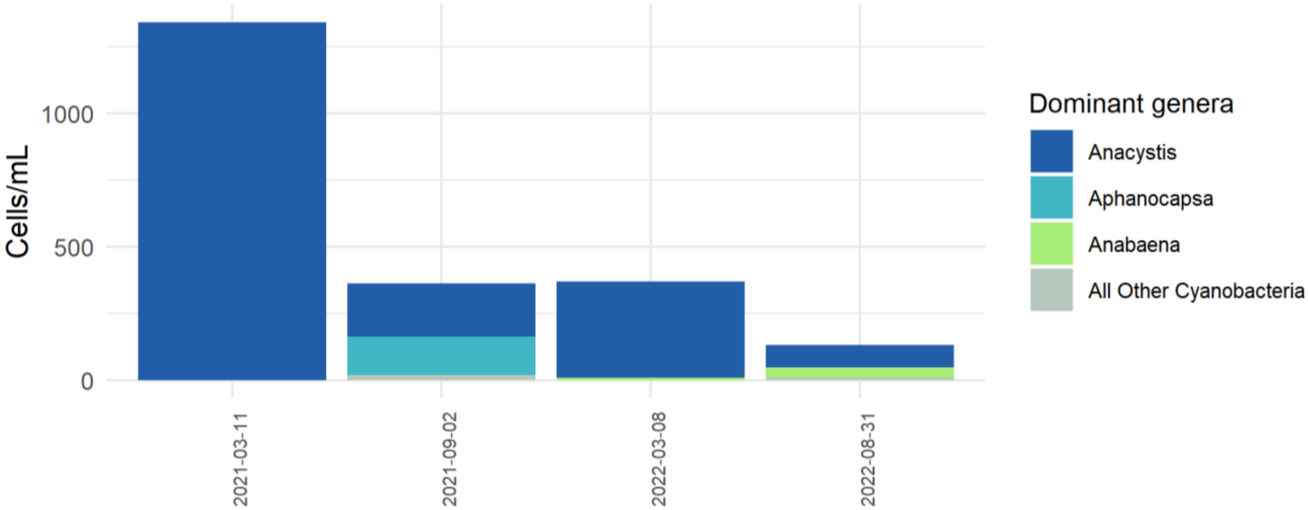


*Figure 5: cell abundance for dominant cyanobacteria genera on Bainbridge Lake*

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 Bainbridge Lake and their associated toxins*

| Genus | Maximum Abundance* (cells/mL) | Toxins Produced |
|---|---|---|
| **Anacystis** | 1343 | Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT |
| **Aphanocapsa** | 144 | Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, BMAA |
| **Anabaena** | 34 | 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 |

Note: * = counted in samples

## Cyanobacterial Presence (Continued)

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

Bainbridge Lake displayed cyanobacteria levels in the negligible risk category, with a mean cyanobacteria abundance of 289 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Bainbridge Lake compared to alert levels defined by several authorities including the WHO and the EPA.

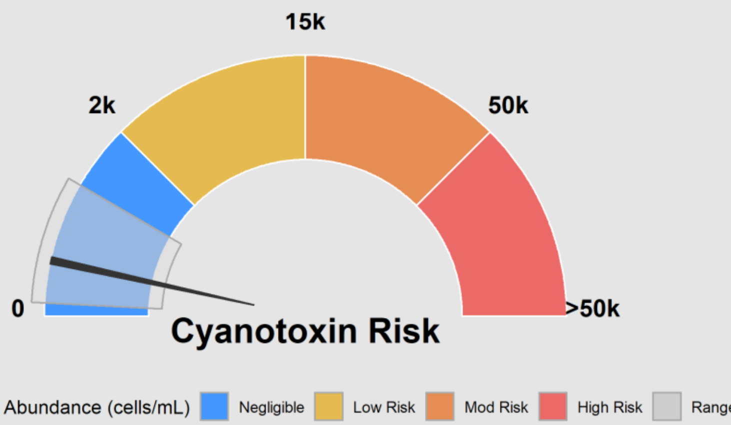


*Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Bainbridge Lake*

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 *Dinobryon* cell is an equivalent size to approximately 50 cyanobacteria cells.

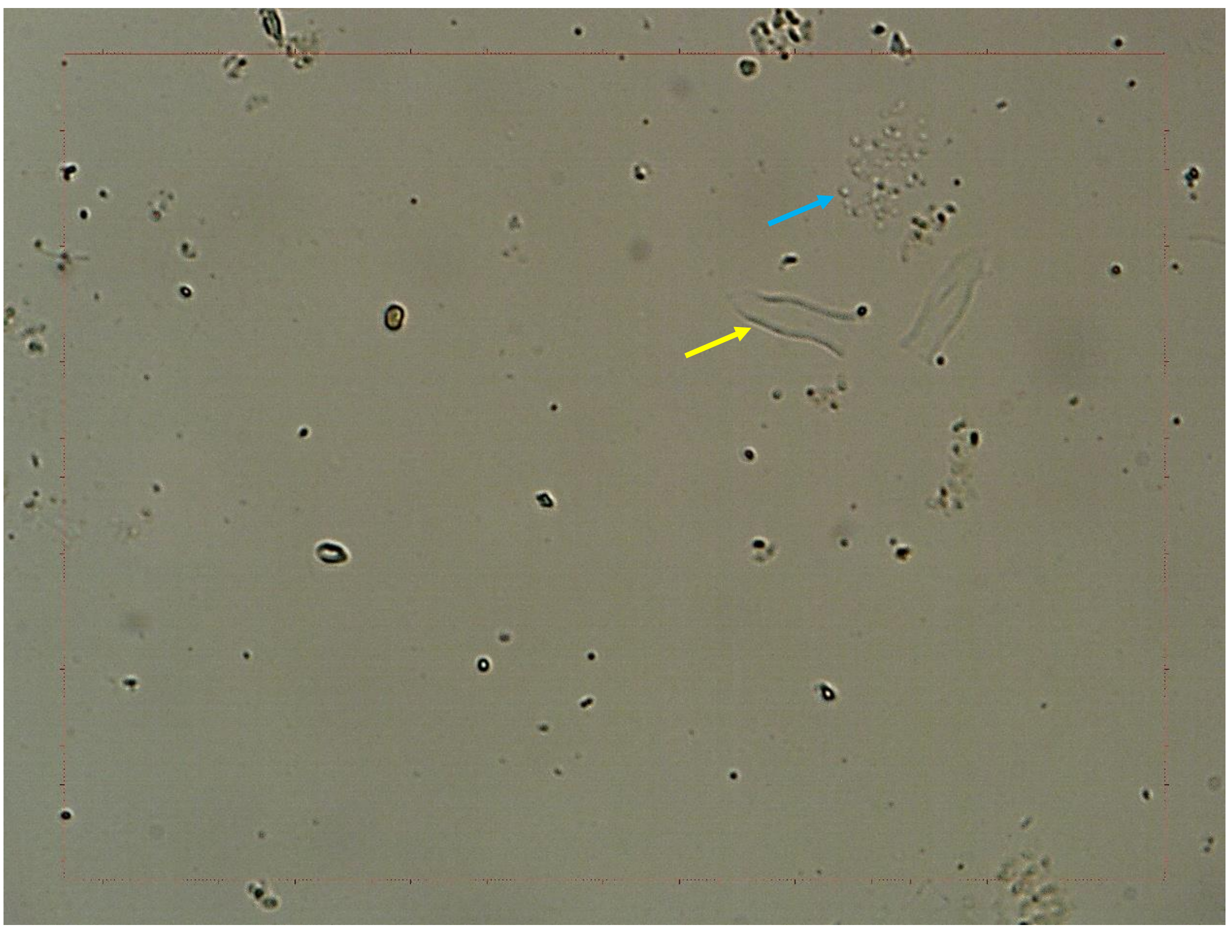

*Figure 7: Size comparison of Dinobryon (yellow arrow) to Anacystis cell (blue arrow)*

## 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.

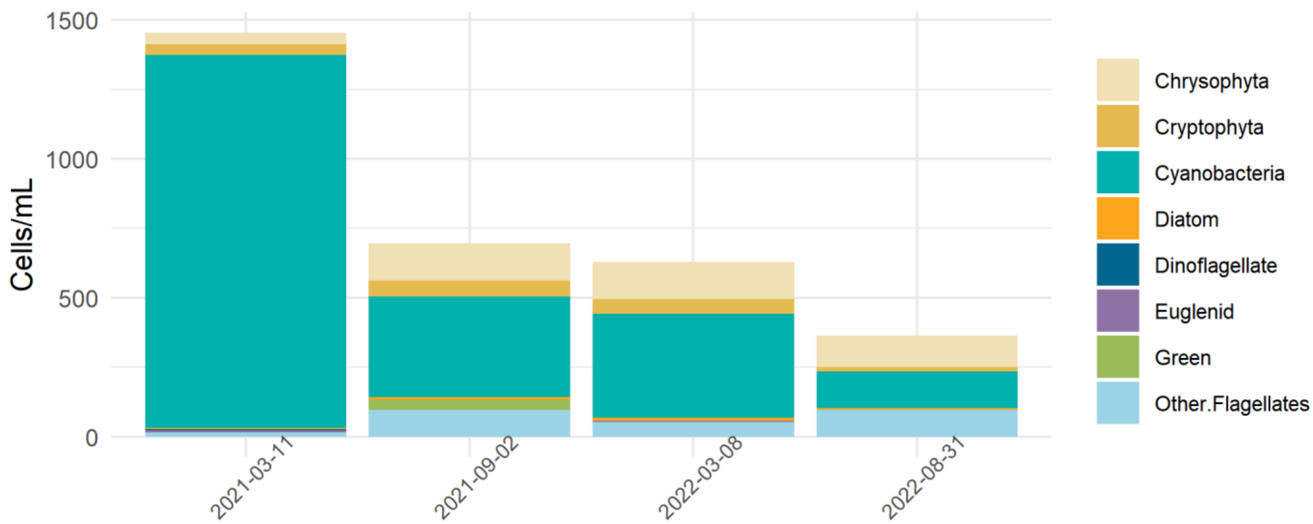


*Figure 8: Cell abundance of high-level taxa groups on Bainbridge Lake*

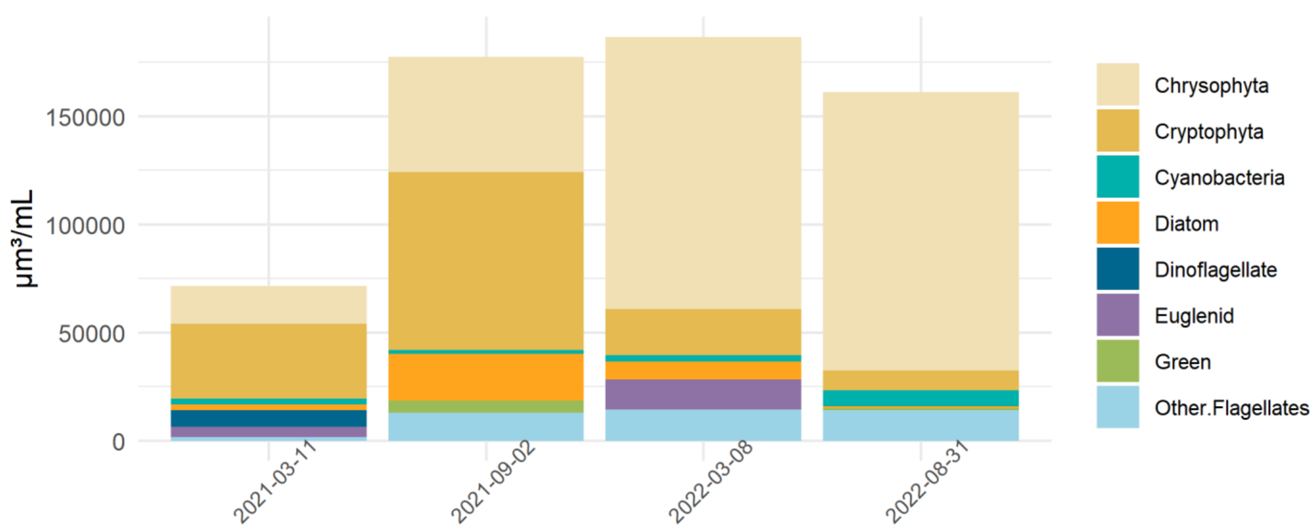


*Figure 9: Biovolume of high-level taxa groups on Bainbridge Lake*

## References


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

Conrad, J. (2013). *DINOBRYON, a Golden Alga*. Jim Conrad's Naturalist Newsletter. https://www.backyardnature.net/n/x/dinobryo.htm

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:

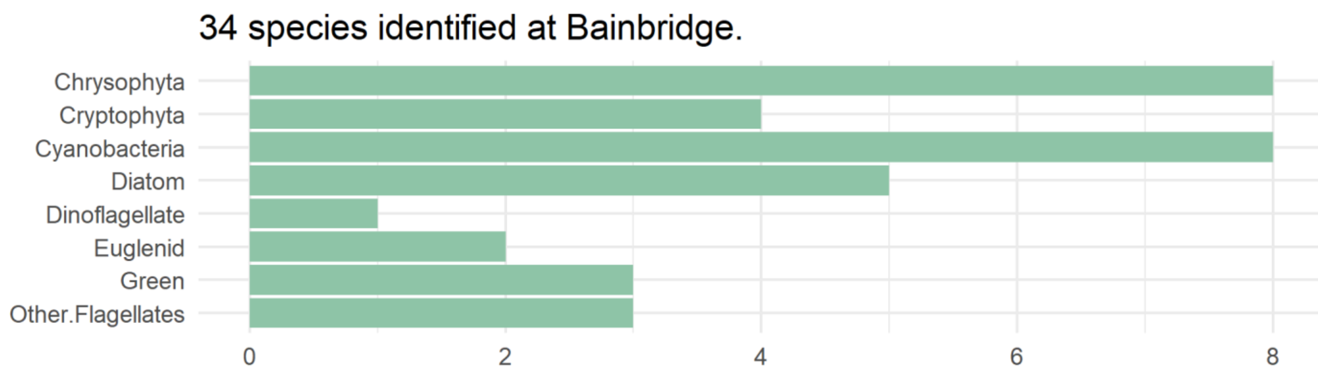


*Figure 10: Identified species sorted into categories of higher-level taxa*

| EMS ID: E275463 | Total Abundance (cells/mL): | 1455 | | |
|---|---|---|---|---|
| Collection Date: 2021-03 | **Total Biovolume (µm³/mL):** | **72862** | | |
| | | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** | **ITIS Genus Number** |
| Dinobryon sp. | 8 | 12016 | Chrysophyta | 1515 |
| Ochromonas sp. | 15 | 3211 | Chrysophyta | 1455 |
| Chrysochromulina sp. | 11 | 423 | Chrysophyta | 2160 |
| Chroomonas sp. | 8 | 1819 | Chrysophyta | 10613 |
| Dinobryopsis sp. | 4 | 1074 | Chrysophyta | 1557 |
| Cryptomonas sp. | 8 | 14816 | Cryptophyta | 10635 |
| Cryptomonas ovata | 8 | 17407 | Cryptophyta | 10635 |
| Rhodomonas lacustris | 23 | 2497 | Cryptophyta | 10663 |
| Anacystis sp. | 1343 | 2555 | Cyanobacteria | 609 |
| Asterionella formosa | 4 | 2785 | Diatom | 3116 |
| Gymnodinium ordinatur | 4 | 7800 | Dinoflagellate | 10031 |
| Euglena sp. | 8 | 4608 | Euglenid | 9620 |
| microflagellate | 11 | 1851 | Other.Flagellates | |

*Figure 11: Raw data from 2021-03-11 EMS site E275463*

| Collection Date: 2021-09-02+ | Total Abundance (cells/mL): | 696 | | |
|---|---|---|---|---|
| EMS ID: E275463 | Total Biovolume (µm³/mL): | 181334 | | |
| | | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** | **ITIS Genus Number** |
| Dinobryon sp. | 8 | 12016 | Chrysophyta | 1515 |
| Mallomonas sp. | 8 | 24194 | Chrysophyta | 1598 |
| Ochromonas sp. | 57 | 12202 | Chrysophyta | 1455 |
| Dinobryopsis sp. | 8 | 2149 | Chrysophyta | 1557 |
| Chrysochromulina sp. | 49 | 1885 | Chrysophyta | 2160 |
| Chroomonas sp. | 8 | 1819 | Chrysophyta | 10613 |
| Chrysococcus sp. | 4 | 1328 | Chrysophyta | 1751 |
| Cryptomonas sp. | 8 | 14816 | Cryptophyta | 10635 |
| Cryptomonas ovata | 30 | 65276 | Cryptophyta | 10635 |
| Rhodomonas lacustris | 19 | 2063 | Cryptophyta | 10663 |
| Aphanocapsa delicatissima | 144 | 603 | Cyanobacteria | 625 |
| Anacystis sp. | 201 | 382 | Cyanobacteria | 609 |
| Gloeothece sp. | 8 | 524 | Cyanobacteria | 703 |
| Planktolyngbya sp. | 11 | 137 | Cyanobacteria | |
| Diatoma sp. | 4 | 4862 | Diatom | 3214 |
| Frustulia rhomboides | 4 | 16990 | Diatom | 4564 |
| Elakatothrix gelatinosa | 30 | 5299 | Green | 9412 |
| Oocystis sp. | 8 | 151 | Green | 5827 |
| microflagellate | 87 | 14638 | Other.Flagellates | |

*Figure 12: Raw data from 2021-09-02 EMS site E275463*

| EMS ID: E275463 | Total Abundance (cells/mL): | 637 | | |
|---|---|---|---|---|
| Collection Date: 2022-03-0: | Total Biovolume (µm³/mL): | 188650 | | |
| | | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** | **ITIS Genus Number** |
| Chroomonas sp. | 4 | 909 | Chrysophyta | 10613 |
| Chrysochromulina sp. | 27 | 1038 | Chrysophyta | 2160 |
| Chromulina sp. | 15 | 26507 | Chrysophyta | 1717 |
| Ochromonas sp. | 27 | 5780 | Chrysophyta | 1455 |
| Dinobryon sp. | 61 | 91622 | Chrysophyta | 1515 |
| Cryptomonas marssonii | 8 | 16335 | Cryptophyta | 10635 |
| Rhodomonas lacustris | 46 | 4995 | Cryptophyta | 10663 |
| Anacystis sp. | 209 | 398 | Cyanobacteria | 609 |
| Anacystis delicatissima | 152 | 332 | Cyanobacteria | 609 |
| Anabaena flos-aquae | 11 | 2141 | Cyanobacteria | 1100 |
| Asterionella formosa | 4 | 2785 | Diatom | 3116 |
| Cyclotella sp. | 4 | 1062 | Diatom | 2439 |
| Platessa sp. | 8 | 1947 | Diatom | |
| Ulnaria sp. | 4 | 4412 | Diatom | 970000 |
| Trachelomonas sp. | 4 | 14137 | Euglenid | 9690 |
| microflagellates | 53 | 14250 | Other.Flagellates | |

*Figure 13: Raw data from 2022-03-08 EMS site E275463*

| EMS ID: E275463 | **Total Abundance (cells/mL):** | **368** | | |
|---|---|---|---|---|
| Collection Date: 2022-08 | **Total Biovolume (µm³/mL):** | **165399** | | |
| | | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** | **ITIS Genus Number** |
| Chrysochromulina sp. | 15 | 577 | Chrysophyta | 2160 |
| Chromulina sp. | 4 | 7069 | Chrysophyta | 1717 |
| Dinobryon spp. | 57 | 90429 | Chrysophyta | 1515 |
| Mallomonas sp. | 8 | 24194 | Chrysophyta | 1598 |
| Ochromonas sp. | 30 | 6422 | Chrysophyta | 1455 |
| Cryptomonas marssonii | 4 | 8167 | Cryptophyta | 10635 |
| Rhodomonas lacustris | 11 | 1194 | Cryptophyta | 10663 |
| Anabaena sp. | 4 | 300 | Cyanobacteria | 1100 |
| Anabaena flos-aquae | 34 | 6617 | Cyanobacteria | 1100 |
| Anacystis sp. | 83 | 158 | Cyanobacteria | 609 |
| Gloeocapsa aeruginosa | 11 | 156 | Cyanobacteria | 682 |
| Cyclotella sp. | 4 | 1062 | Diatom | 2439 |
| Parvodinium sp. | 4 | 2205 | Dinoflagellate | |
| Sphaerocystis sp. | 4 | 865 | Green | 9169 |
| microflagellate | 95 | 15984 | Other.Flagellates | |

*Figure 14: Raw data from 2022-08-31 EMS site E275463*