# Horse Lake Phytoplankton Summary Report 2021-2022

## Overview

Samples were collected from one site on Horse 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 |
|---|---|
| HORSE LAKE AT DEEPEST PT (0603100) | 2021-05-11 |
| | 2021-08-19 |
| | 2022-05-08 |
| | 2022-08-24 |
| | **Total= 4 samples** |


*Figure 1: Aerial view of Horse Lake*

Horse Lake exhibited predictable seasonal patterns; elevated diatom density in the spring followed by cyanobacteria blooms in summer. Spring blooms of diatoms are common and reflective of increased temperatures, light penetration, and silica in the water following ice off (Kong et al., 2021). Diatoms increase the resiliency and health of water systems through their ability to bloom in early spring, reduce nutrient levels, and prevent monoculture blooms of less desirable algae (jrobyn, 2019). Dominant diatoms included species of *Aulacoseira, Lindavia,* and *Tabellaria*.

Diatoms are integral to aquatic food webs because they are the foundation of the food web (jrobyn, 2019). Colony forming diatoms such as *Aulacoseira* and *Tabellaria* can avoid grazing pressures by developing into large colonies reducing their availability for zooplankton and microscopic invertebrates (Baker, 2012). Spring samples collected in Horse Lake demonstrated diatom/silica degradation reflective of lowering silica levels in the late spring (Figure 2).

*Figure 2: Spring Lindavia (left) showing degradation vs. summer Lindavia (right) with intact silica shell*

## Overview (continued)

Samples contained elevated densities of Chromalinales (genus *Dinobryon;* 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).

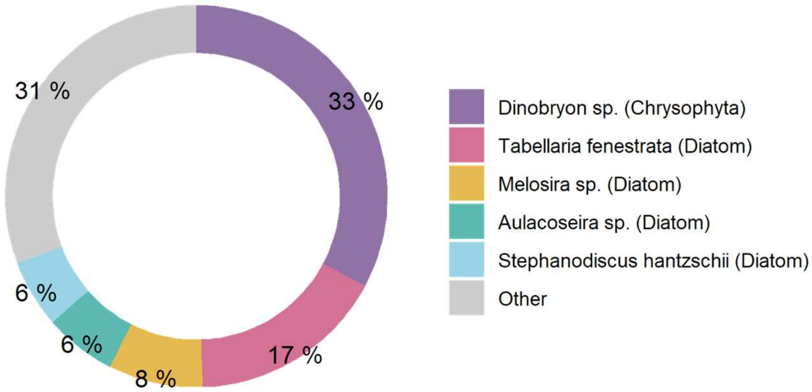


*Figure 3: Dominant organisms from Horse Lake (0603100) as percent of total biovolume*

Spring samples contained a *Dinobryon* bloom that included swarmers (sexual reproductive stages) and stomatocysts (asexual reproductive stages; Figure 4). Stomatocysts are normally produced at 0.05% the rate of swarmers (Lee, 2008). When *Dinobryon* populations are in a nitrogen-depleted environment, asexual stomatocysts rise from 0.05% to 4% (Lee, 2008).

*Figure 4: 400x magnification of Dinobyron species with internalized sexual Dinobryon swarmers (green arrows) compared to an asexual stomatocysts (blue 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 contained elevated concentrations of cyanobacteria; dominant genera include *Anabaena*, *Anacystis*, and *Aphanizomenon* (Figure 5).

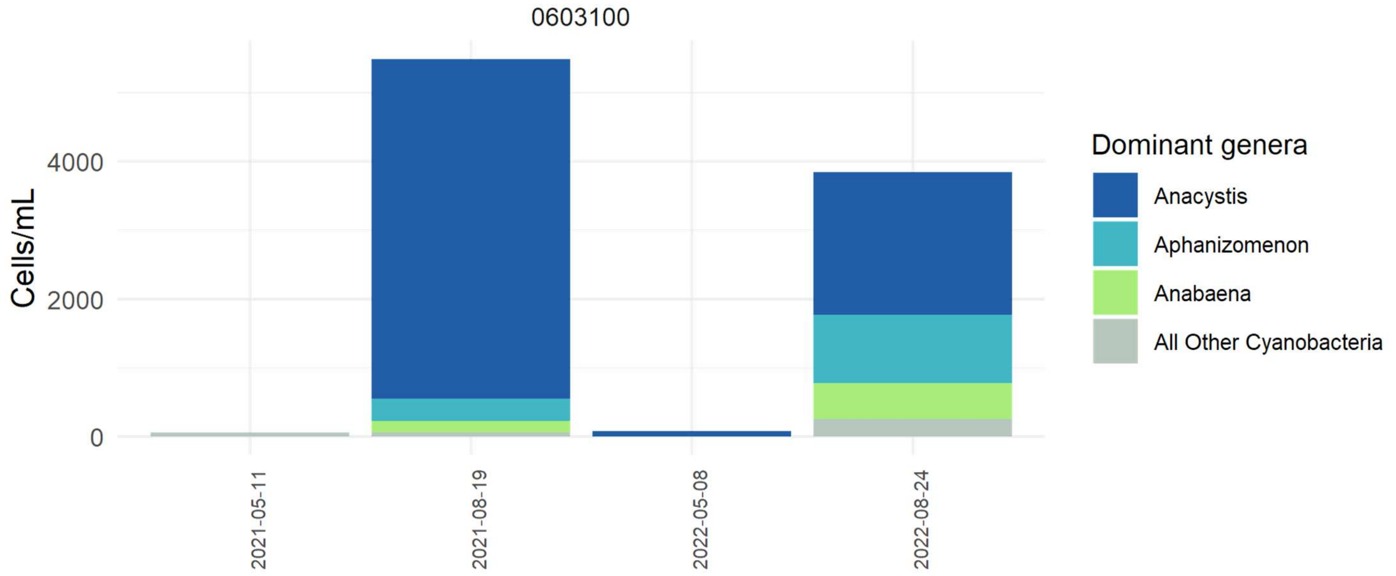


*Figure 5: Cell abundance for dominant cyanobacteria genera on Horse Lake*

During blooms, species of *Anabaena* and *Aphanizomenon* 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 summer samples are also associated with 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 Template Lake and their associated toxins*

| Genus | Maximum Abundance* (cells/mL) | Toxins Produced |
|---|---|---|
| ***Anacystis*** | 4827 | Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT |
| ***Aphanizomenon*** | 990 | Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor |
| ***Anabaena*** | 524 | 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 |

Note: * = counted in samples

## Cyanobacterial Presence (Continued)

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

Horse Lake displays a range of cyanobacteria levels in the negligible-low risk categories, with a mean cyanobacteria abundance of 2,371 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Horse Lake compared to alert levels defined by several authorities including the WHO and the EPA.

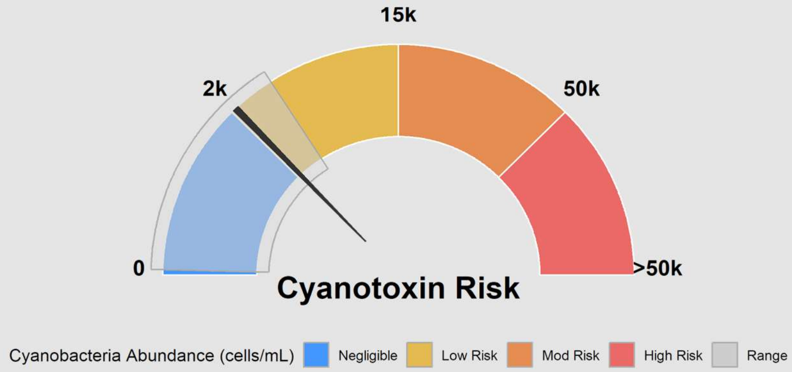


*Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Horse Lake*

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 can be seen in Figure 7 where two *Cosmarium* cells are similarly sized to approximately 75 cyanobacteria cells.

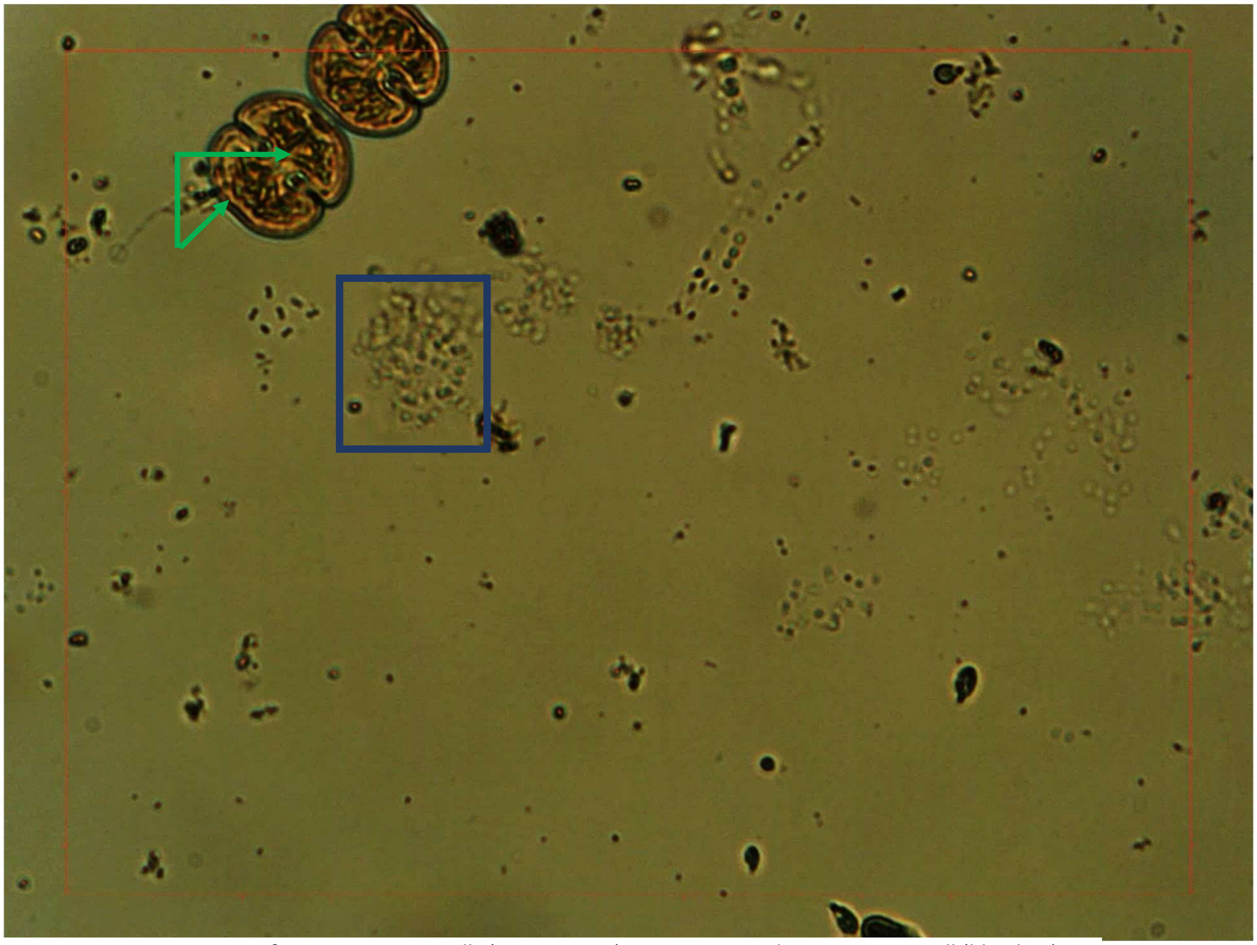

*Figure 7: Size comparison of two Cosmarium cells (green arrow) to approximately 45 Anacystis cell (blue box)*

## 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.

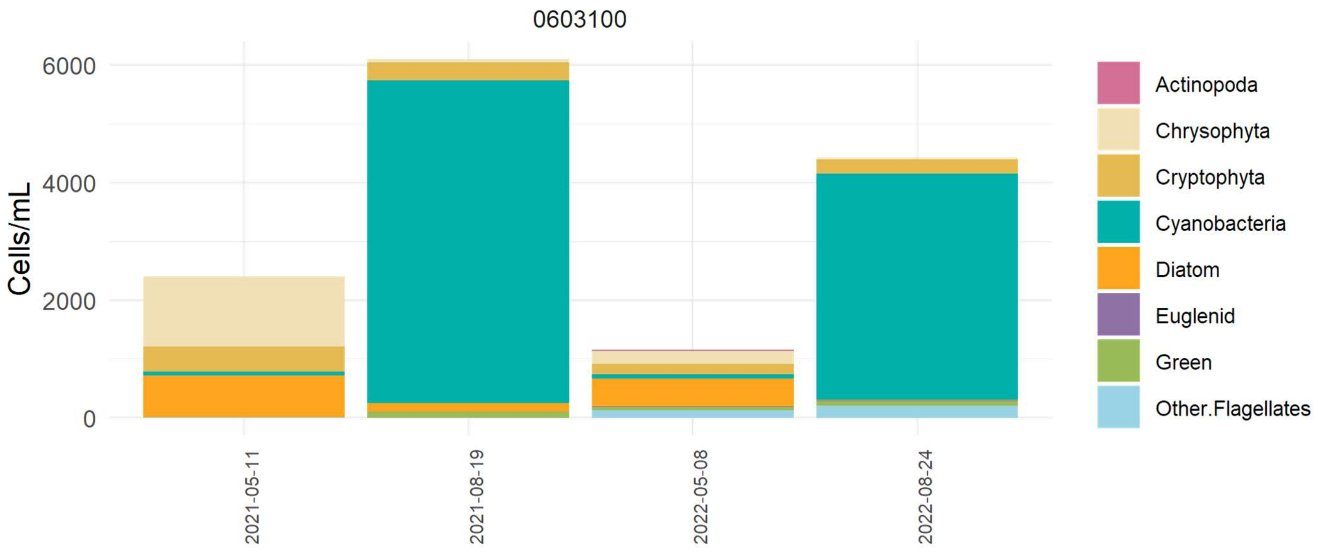


*Figure 8: Cell abundance of high-level taxa groups on Horse Lake*

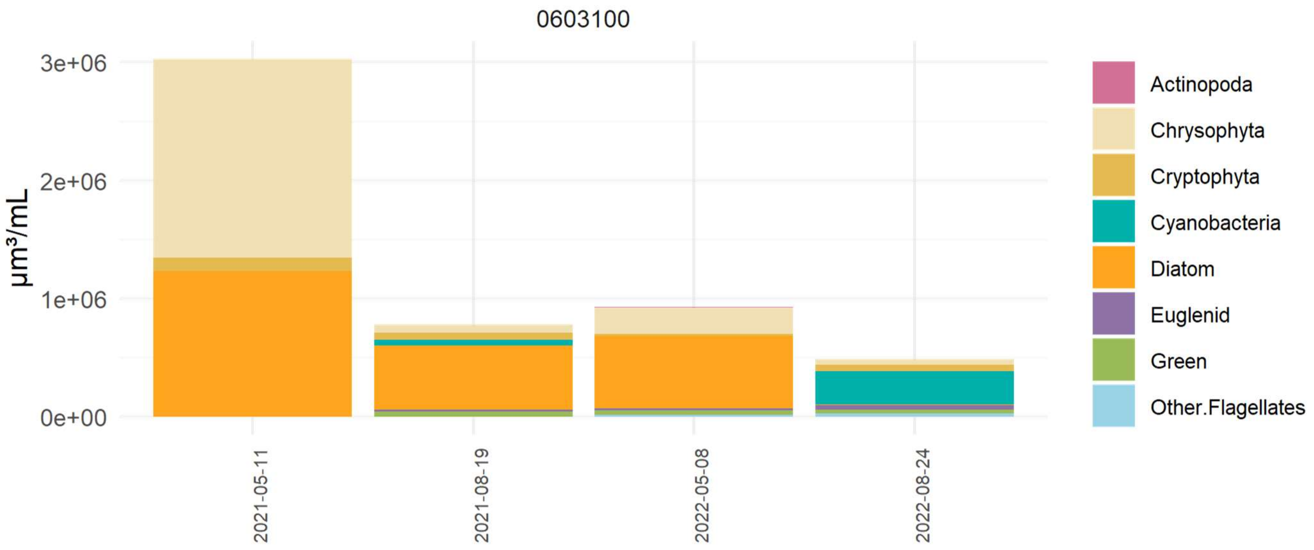


*Figure 9: Biovolume of high-level taxa groups on Horse Lake*

## References


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**Report prepared by: Larratt Aquatic Consulting Ltd.**

Stephanie Butt: Taxonomist, H. B.Sc., BIT.

Jamie Self: Senior Aquatic Biologist, R.P. Bio

Reviewed by:

Sara Knezevic: Field Biologist, B.Sc., BIT.

## Appendix

Additional figures and raw data are listed below:

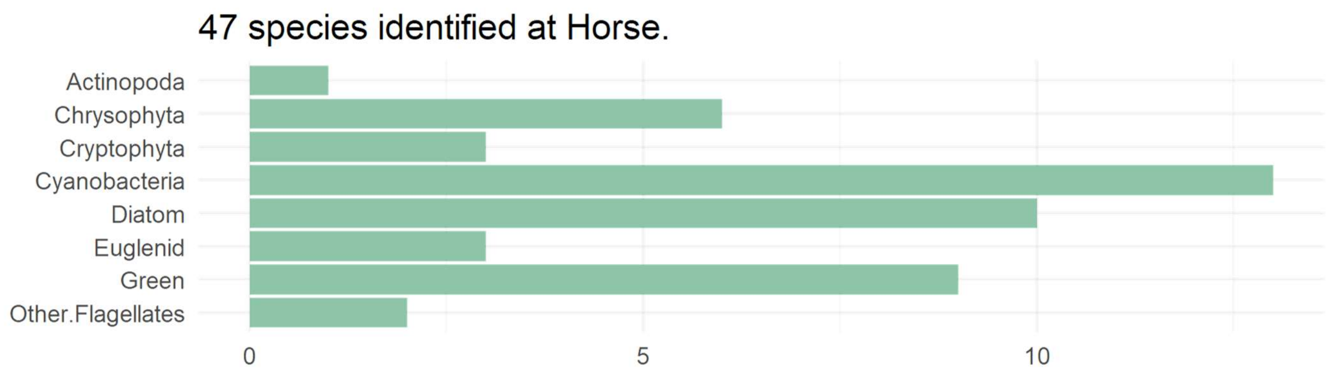


*Figure 10: Identified species sorted into categories of higher-level taxa*

| | | | | |
|---|---|---|---|---|
| EMS ID: 603100 | **Total Abundance (cells/mL):** | **2408** | | |
| Collection Date: 2021-05-1 | **Total Biovolume (µm³/mL):** | **3034711** | | |
| | | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** | **ITIS Genus Number** |
| Dinobryon sp. | 205 | 307910 | Chrysophyta | 1515 |
| Dinobryon sp. | 907 | 1362314 | Chrysophyta | 1515 |
| Ochromonas sp. | 72 | 15413 | Chrysophyta | 1455 |
| Chrysochromulina sp. | 4 | 154 | Chrysophyta | 2160 |
| Dinobryopsis sp. | 15 | 4029 | Chrysophyta | 1557 |
| Cryptomonas sp. | 38 | 70378 | Cryptophyta | 10635 |
| Rhodomonas lacustris | 395 | 42888 | Cryptophyta | 10663 |
| Planktolyngbya sp. | 65 | 808 | Cyanobacteria | |
| Aulacoseira granulata | 342 | 112493 | Diatom | 590863 |
| Melosira sp. | 129 | 421501 | Diatom | 2290 |
| Stephanodiscus niagarae | 8 | 84010 | Diatom | 2415 |
| Tabellaria fenestrata | 228 | 612813 | Diatom | 3241 |

*Figure 11: Raw data from 2021-05-11 EMS site 0603100*

| EMS ID: 0603100 | Total Abundance (cells/mL): | 6105 | |
|---|---|---|---|
| Collection Date: 2021-08-19 | Total Biovolume (µm³/mL): | 782551 | |
| | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** |
| Dinobryon sp. | 4 | 6008 | Chrysophyta |
| Dinobryon sp. | 23 | 34546 | Chrysophyta |
| Mallomonas sp. | 8 | 24194 | Chrysophyta |
| Ochromonas sp. | 27 | 5780 | Chrysophyta |
| Cryptomonas sp. | 15 | 27781 | Cryptophyta |
| Rhodomonas lacustris | 281 | 30510 | Cryptophyta |
| Aphanizomenon sp. | 319 | 11274 | Cyanobacteria |
| Anacystis microscopica | 114 | 249 | Cyanobacteria |
| Anacystis cyanea | 4827 | 7266 | Cyanobacteria |
| Anabaena sp. | 34 | 2549 | Cyanobacteria |
| Anabaena flos-aquae | 133 | 25885 | Cyanobacteria |
| Gloeothece sp. | 65 | 4254 | Cyanobacteria |
| Aulacoseira granulata | 4 | 1316 | Diatom |
| Asterionella formosa | 8 | 5571 | Diatom |
| Stephanodiscus hantzschii | 42 | 302764 | Diatom |
| Tabellaria fenestrata | 87 | 233837 | Diatom |
| Trachelomonas scabra | 4 | 13270 | Euglenid |
| Ankistrodesmus sp. | 19 | 2987 | Green |
| Closteriopsis acicularis | 8 | 9425 | Green |
| Cosmarium cf. depressum | 30 | 24370 | Green |
| Botryococcus braunii | 53 | 8715 | Green |

*Figure 12: Raw data from 2021-08-19 EMS site 0603100*

| EMS ID: 0603100 | Total Abundance (cells/mL): | 1179 | | |
|---|---|---|---|---|
| Collection Date: 2022-05 | Total Biovolume (µm³/mL): | 956635 | | |
| | | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** | **ITIS Genus Number** |
| Actinophryida | 15 | 2524 | Actinopoda | |
| Chrysochromulina sp. | 80 | 3077 | Chrysophyta | 2160 |
| Chromulina sp. | 15 | 26507 | Chrysophyta | 1717 |
| Dinobryon spp. | 114 | 180858 | Chrysophyta | 1515 |
| Dinobryon sp. | 8 | 12016 | Chrysophyta | 1515 |
| Rhodomonas lacustris | 175 | 19001 | Cryptophyta | 10663 |
| Anacystis sp. | 80 | 152 | Cyanobacteria | 609 |
| Aulacoseira sp. | 194 | 319247 | Diatom | 590863 |
| Lindavia intermedia | 68 | 60108 | Diatom | |
| Lindavia bodanica | 190 | 198265 | Diatom | |
| Tabellaria fenestrata | 11 | 29566 | Diatom | 3241 |
| Ulnaria acus | 4 | 4167 | Diatom | 970000 |
| Strombomonas spp. | 4 | 26463 | Euglenid | 9740 |
| Trachelomonas sp. | 4 | 14137 | Euglenid | 9690 |
| Euglena sp. | 8 | 4608 | Euglenid | 9620 |
| Coenococcus sp. | 19 | 269 | Green | |
| Elakatothrix sp. | 8 | 1536 | Green | 9412 |
| Monoraphidium sp. | 34 | 22525 | Green | 5990 |
| Monoraphidium indicum | 4 | 2650 | Green | 5990 |
| Chlamydomonas sp. | 11 | 6582 | Green | 5448 |
| microflagellate | 133 | 22377 | Other.Flagellates | |

*Figure 13: Raw data from 2022-05-08 EMS site 0603100*

| EMS ID: 0603100 | **Total Abundance (cells/mL):** | **4430** | | |
|---|---|---|---|---|
| Collection Date: 2022-08-24 | **Total Biovolume (µm³/mL):** | **495965** | | |
| | | | | |
| **Report.Name** | **Abundance (cells/mL)** | **Biovolume (µm³/mL)** | **High.Level.Taxa** | **ITIS Genus Number** |
| Chromulina sp. | 4 | 7069 | Chrysophyta | 1717 |
| Dinobryon spp. | 27 | 42835 | Chrysophyta | 1515 |
| Cryptomonas sp. | 4 | 7408 | Cryptophyta | 10635 |
| Cryptomonas ovata | 11 | 23935 | Cryptophyta | 10635 |
| Rhodomonas lacustris | 228 | 24756 | Cryptophyta | 10663 |
| Anabaena flos-aquae | 524 | 101983 | Cyanobacteria | 1100 |
| Anacystis sp. | 664 | 1263 | Cyanobacteria | 609 |
| Anacystis delicatissima | 1412 | 3084 | Cyanobacteria | 609 |
| Aphanizomenon flos-aquae | 990 | 164839 | Cyanobacteria | 1191 |
| Gloeocapsa punctata | 61 | 256 | Cyanobacteria | 682 |
| Gloeocapsa aeruginosa | 38 | 537 | Cyanobacteria | 682 |
| Gomphosphaeria sp. | 159 | 7054 | Cyanobacteria | 714 |
| Lindavia bodanica | 8 | 8348 | Diatom | |
| Trachelomonas sp. | 11 | 38877 | Euglenid | 9690 |
| Crucigenia apiculata | 61 | 13992 | Green | 6225 |
| Monoraphidium sp. | 23 | 15238 | Green | 5990 |
| microflagellate | 205 | 34491 | Other.Flagellates | |

*Figure 14: Raw data from 2022-08-24 EMS site 0603100*