Nadsilnich Lake Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from one site on Nadsilnich 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
NADSILNICH (WEST) L DEEP STN CENTER N. END (0400489)	2021-05-13 2021-09-08 2022-05-04 2022-08-17
	Total= 4 samples

Figure 1: Aerial view of Nadsilnich Lake

Typical seasonal patters were observed in Nadsilnich Lake; diatom densities increased in the spring and cyanobacteria concentrations increased in the summer (Figure 2).

Spring blooms of diatoms are common and reflective of increased temperatures, light penetration, and silica in the water following ice thaw (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).

Diatoms are integral to aquatic food webs because they are the foundation of the food 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).

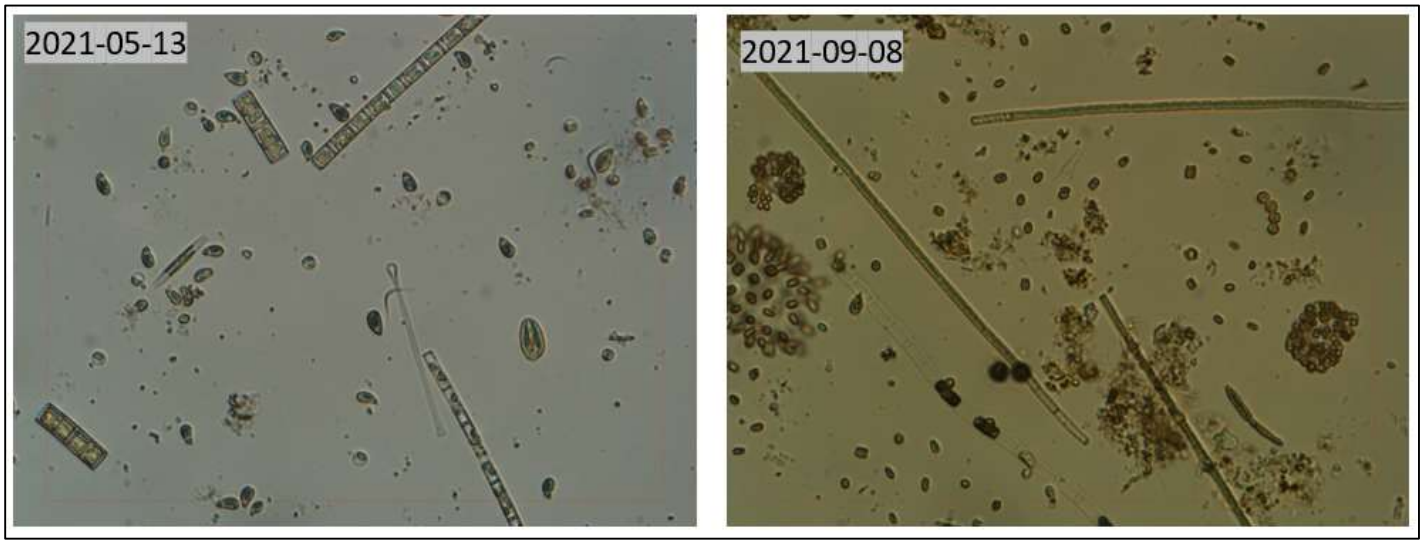

Figure 2: Compositional change from spring with high concentrations of diatoms (left) to summer with high concentrations of cyanobacteria (right)

Overview (continued)

Small quantities of the dinoflagellate *Ceratium* were identified in Nadsilnich Lake. Despite low numbers, this dinoflagellate represented 26% of total biovolume. *Ceratium's* large size relative to other algae attributes to its large biovolume percentage (Figure 3).

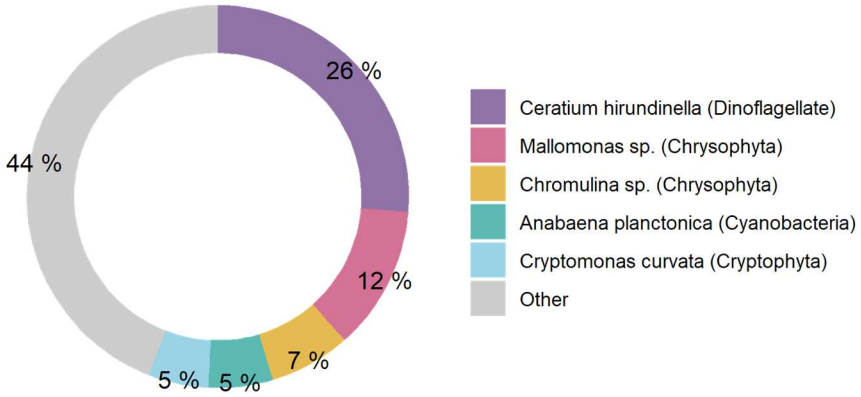

Figure 3: Dominant organisms Nadsilnich (West) L Deep Stn Center N. End as percent of total biovolume

Samples collected on 2022-05-04 contained elevated densities of Chrysophyta (genus *Mallomonas;* Figure 4). When densities are high, *Mallomonas* species cause water pigmentation and unpleasant odors through the production of secondary metabolites (Jo et al., 2016).

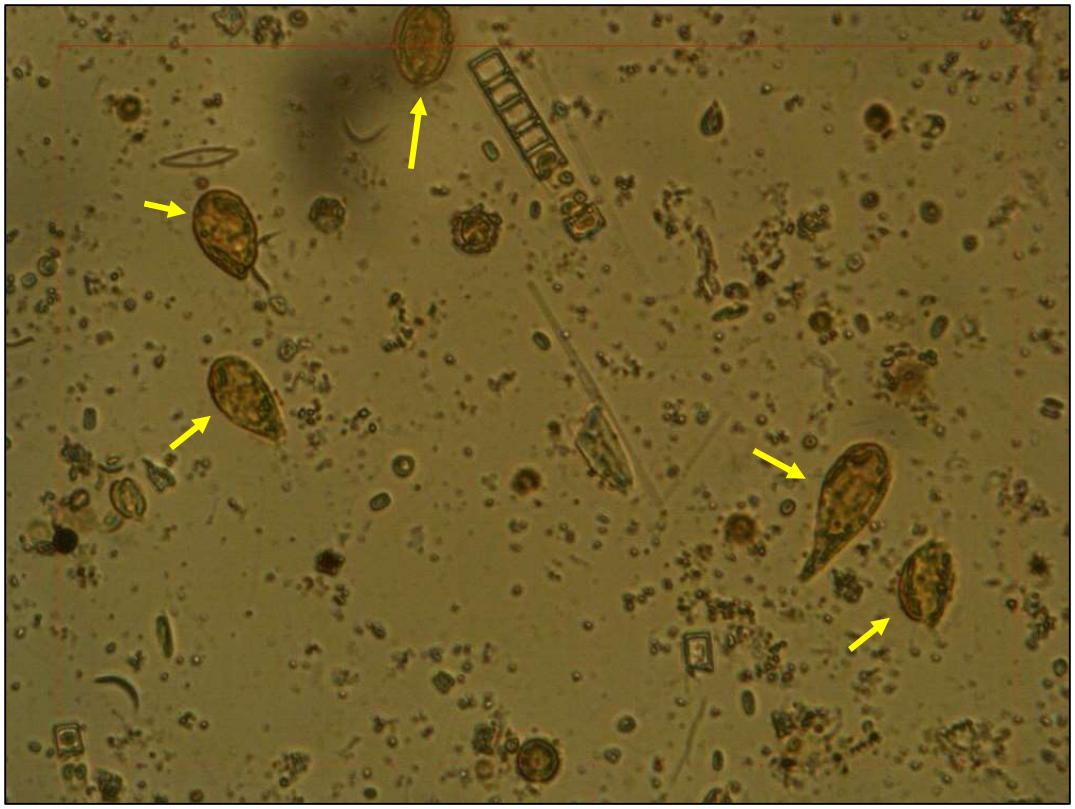

Figure 4: Sample site EMS#400489 collected on 2022-05-04 showing five Mallomonas species (yellow arrows)

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 levels of cyanobacteria relative to spring samples. Dominant genera included *Anacystis*, *Anabaena*, and *Aphanizomenon* (Figure 5).

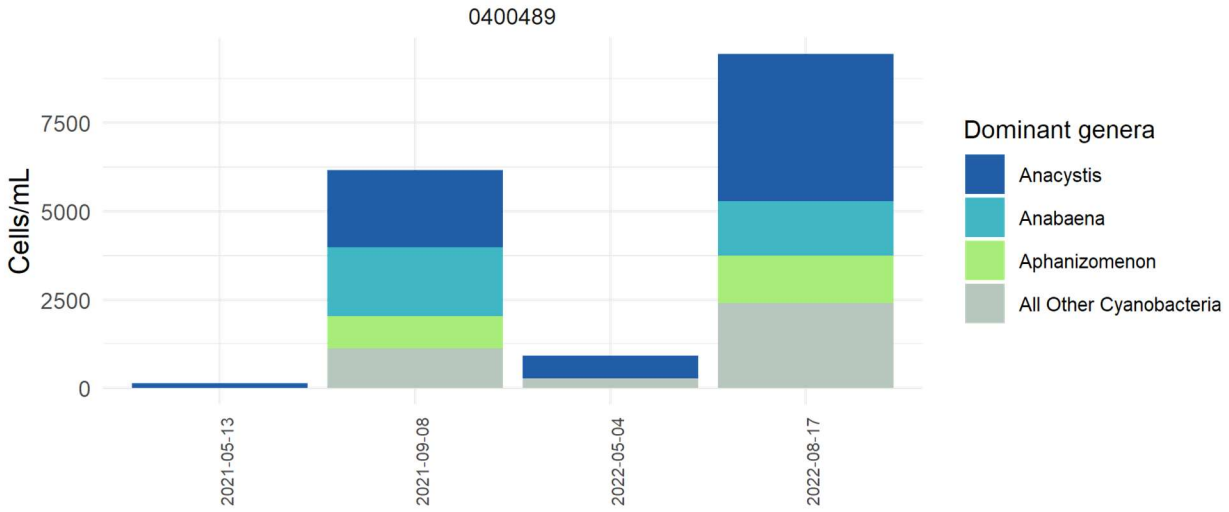

Figure 5: cell abundance for dominant cyanobacteria genera on Nadsilnich Lake

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, produce toxins, and color water systems (EPA, 2022). Other dominant cyanobacteria identified 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).

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

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
Anacystis	4174	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Microcystin MC, Nodularins NOD, Anatoxins (-a) ATX, BMAA, Cyanopeptolins CPL, Anabaenopeptins APT
Aphanizomenon	1340	Lyngbyatoxin LYN, Lipopolysaccharide LPS, Cylindospermopsin CYN, Microcystin MC, Anatoxins (-a) ATX, Saxitoxins SAX neosaxitoxin NEO, BMAA, Anabaenopeptins APT, Taste and Odor
Anabaena	1180	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 Nadsilnich Lake can produce cyanotoxins, listed above (Table 2).

Nadsilnich Lake displayed a range of cyanobacteria levels in the negligible-low risk categories, with a mean cyanobacteria abundance of 4,167 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Nadsilnich Lake as compared authorities including the WHO and EPA.

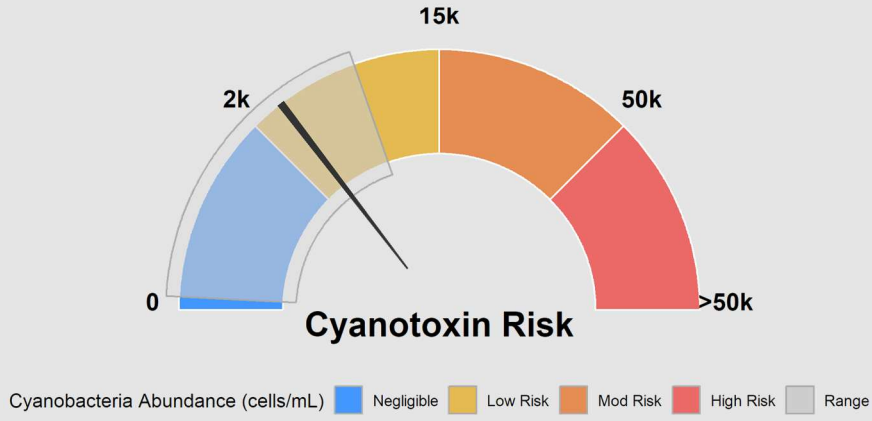

Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Nadsilnich Lake

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 (*Asterionella*) is approximately the size of 30 adjacent cyanobacterial cells (*Snowella*).

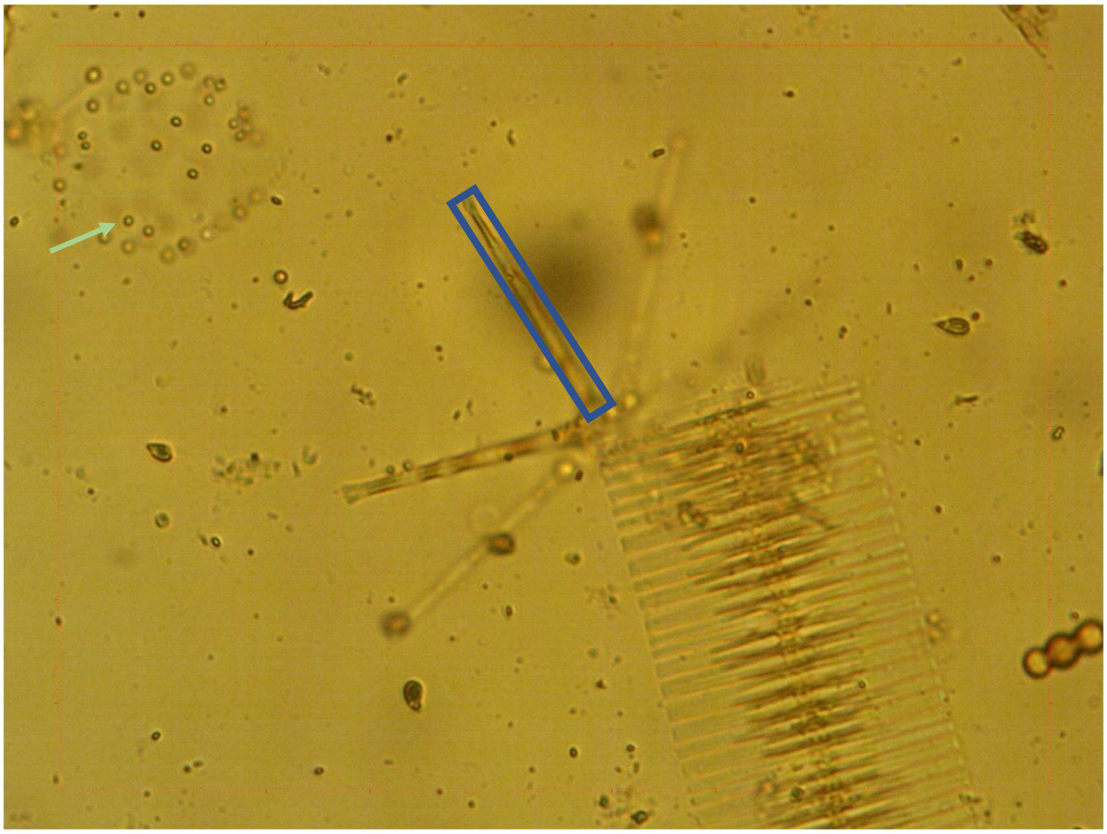

Figure 7: Size comparison of Asterionella (blue box) to a Snowella cell (green arrow)

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.

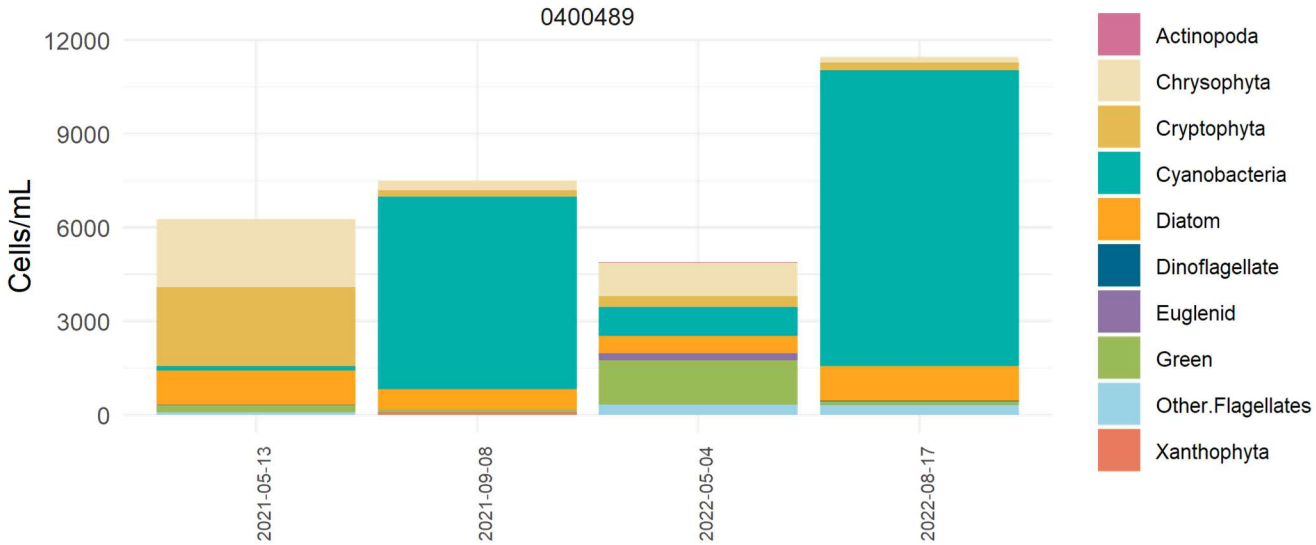

Figure 8: Cell abundance of high-level taxa groups on Nadsilnich Lake

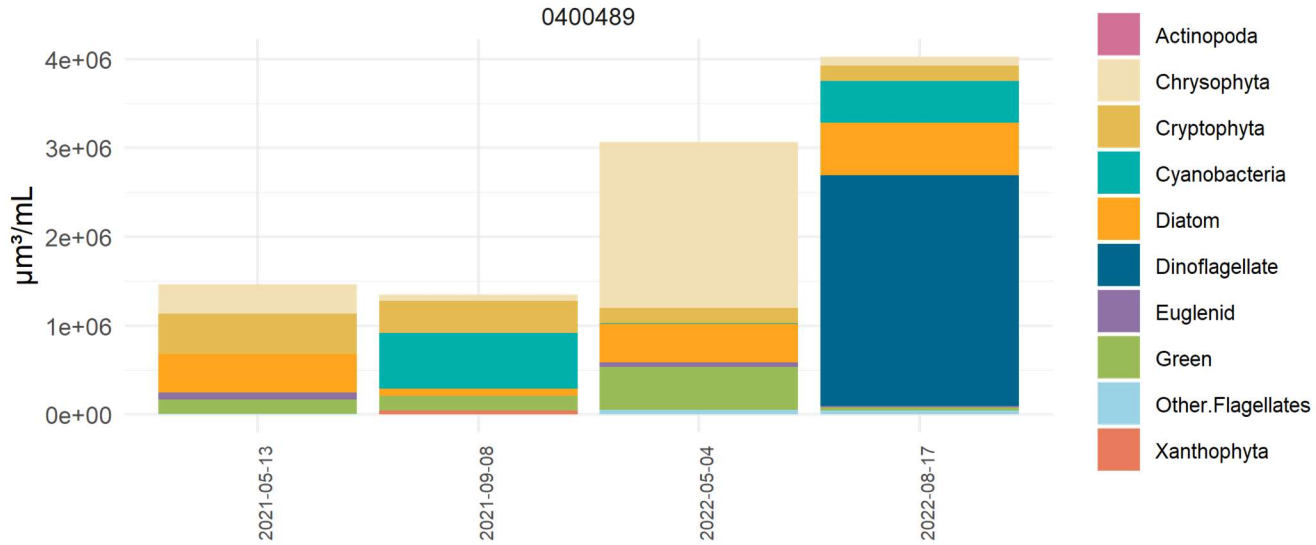

Figure 9: Biovolume of high-level taxa groups on Nadsilnich Lake

References

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Appendix

Additional figures and raw data are listed below:

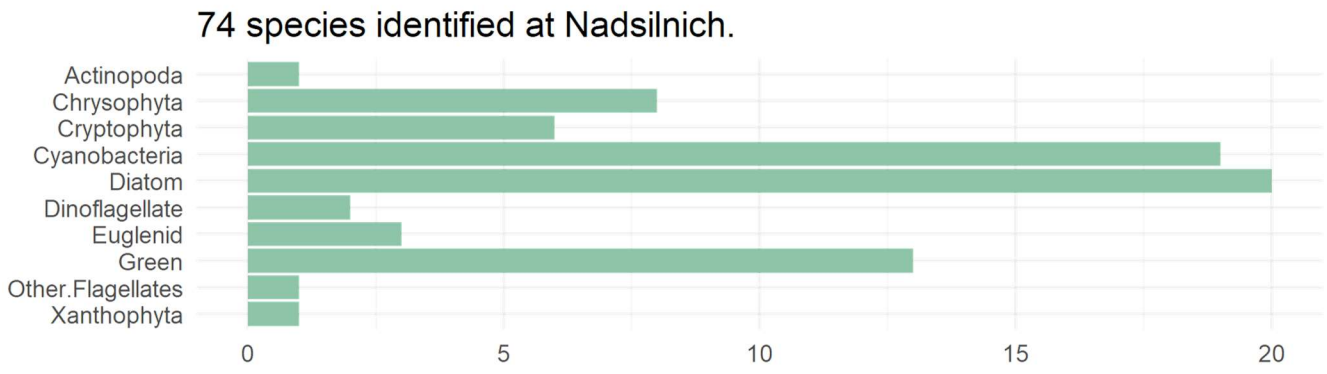

Figure 10: Identified species sorted into categories of higher-level taxa

EMS ID: 0400489	**Total Abundance (cells/mL):**	**6256**		
Collection Date: 2021-05-13	**Total Biovolume (µm³/mL):**	**1467747**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	1313	281073	Chrysophyta	1455
Chrysochromulina sp.	839	32270	Chrysophyta	2160
Chrysococcus sp.	19	6308	Chrysophyta	1751
Cryptomonas sp.	65	120383	Cryptophyta	10635
Cryptomonas curvata	11	69299	Cryptophyta	10635
Rhodomonas lacustris	2451	266124	Cryptophyta	10663
Anacystis sp.	133	253	Cyanobacteria	609
Aulacoseira alpigena	368	199562	Diatom	590863
Aulacoseira granulata	323	106244	Diatom	590863
Asterionella formosa	4	2785	Diatom	3116
Cyclotella sp.	15	3982	Diatom	2439
Lindavia bodanica	4	4174	Diatom	
Epithemia turgida	4	13195	Diatom	5005
Fragilaria capucina	8	3884	Diatom	2932
Nitzschia sp.	163	14945	Diatom	5070
Ulnaria acus	8	8335	Diatom	970000
Ulnaria nana	23	60375	Diatom	970000
Staurosira sp.	19	8774	Diatom	590848
Woronichinia sp.	144	1961	Diatom	
Trachelomonas sp.	23	81289	Euglenid	9690
Euglena sp.	8	4608	Euglenid	9620
Monoraphidium sp.	231	153040	Green	5990
microflagellate	76	12787	Other.Flagellates	

Figure 11: Raw data from 2021-05-13 EMS site 0400489

EMS ID: 0400489	Total Abundance (cells/mL):	7488		
Collection Date: 2021-09-08	Total Biovolume (µm³/mL):	1352188		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Mallomonas sp.	4	12097	Chrysophyta	1598
Ochromonas sp.	262	56086	Chrysophyta	1455
Chrysochromulina sp.	23	885	Chrysophyta	2160
Chrysococcus sp.	8	2656	Chrysophyta	1751
Cryptomonas sp.	15	27781	Cryptophyta	10635
Cryptomonas curvata	42	264597	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Cryptomonas marssonii	23	46963	Cryptophyta	10635
Rhodomonas lacustris	121	13138	Cryptophyta	10663
Aphanizomenon flos-aquae	918	152851	Cyanobacteria	1191
Anacystis sp.	2083	3964	Cyanobacteria	609
Anacystis incerta	91	199	Cyanobacteria	609
Chlorogloea sp.	129	2896	Cyanobacteria	824
Anabaena planctonica	1180	402803	Cyanobacteria	1100
Anabaena sp.	767	57509	Cyanobacteria	1100
Gloeocapsa punctata	11	46	Cyanobacteria	682
Pseudanabaena sp.	288	3209	Cyanobacteria	1175
Snowella lacustris	691	7577	Cyanobacteria	
Asterionella formosa	42	29246	Diatom	3116
Stephanodiscus niagarae	4	42005	Diatom	2415
Woronichinia sp.	619	8429	Diatom	
Oocystis sp.	15	283	Green	5827
Sphaerocystis sp.	4	865	Green	9169
Closterium sp.	8	147769	Green	7257
Scenedesmus sp.	53	12369	Green	6104
Tribonema sp.	83	47261	Xanthophyta	2053

Figure 12: Raw data from 2021-09-08 EMS site 0400489

EMS ID: 0400489	Total Abundance (cells/mL):	4882		
Collection Date: 2022-05-04	Total Biovolume (µm³/mL):	3079761		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	11	1851	Actinopoda	
Chromulina sp.	372	657378	Chrysophyta	1717
Chrysococcus sp.	11	3652	Chrysophyta	1751
Chrysochromulina sp.	137	5269	Chrysophyta	2160
Chromulina sp.	8	14137	Chrysophyta	1717
Dinobryon spp.	30	47594	Chrysophyta	1515
Mallomonas sp.	368	1112945	Chrysophyta	1598
Ochromonas sp.	137	29327	Chrysophyta	1455
Cryptomonas sp.	19	35189	Cryptophyta	10635
Cryptomonas curvata	8	50400	Cryptophyta	10635
Cryptomonas ovata	4	8704	Cryptophyta	10635
Cryptomonas erosa	4	7087	Cryptophyta	10635
Cryptomonas marssonii	19	38796	Cryptophyta	10635
Rhodomonas lacustris	300	32573	Cryptophyta	10663
Anacystis sp.	656	1248	Cyanobacteria	609
Synechocystis sp.	8	268	Cyanobacteria	799
Snowella sp.	114	489	Cyanobacteria	
Planktolyngbya sp.	68	845	Cyanobacteria	
Woronichinia sp.	76	1035	Cyanobacteria	
Aulacoseira sp.	140	230385	Diatom	590863
Aulacoseira granulata	273	89797	Diatom	590863
Aulacoseira granulata var. angustissima	91	49348	Diatom	590863
Fragilaria capucina	8	3884	Diatom	2932
Nitzschia acicularis	8	6316	Diatom	5070
Nitzschia spp.	8	3158	Diatom	5070
Tabellaria fenestrata	15	40317	Diatom	3241
Ulnaria acus	11	11460	Diatom	970000
Trachelomonas sp.	4	14137	Euglenid	9690
UID Euglenoid	220	37015	Euglenid	
Ankistrodesmus sp.	99	15565	Green	5877
Monoraphidium sp.	300	198753	Green	5990
Didymocystis planctonica	1017	273971	Green	55858
microflagellate	338	56868	Other.Flagellates	

Figure 13: Raw data from 2022-05-04 EMS site 0400489

EMS ID: 0400489	**Total Abundance (cells/mL):**	**12805**		
Collection Date: 2022-08-17	**Total Biovolume (µm³/mL):**	**4054260**		
Report.Name	**Abundance (cells/mL)**	**Biovolume (µm³/mL)**	**High.Level.Taxa**	**ITIS Genus Number**
Actinophryida	8	1346	Actinopoda	
Chrysococcus sp.	4	1328	Chrysophyta	1751
Chrysochromulina sp.	49	1885	Chrysophyta	2160
Chromulina sp.	4	7069	Chrysophyta	1717
Mallomonas sp.	8	24194	Chrysophyta	1598
Mallomonas sp.	15	45365	Chrysophyta	1598
Ochromonas sp.	83	17768	Chrysophyta	1455
Dinobryopsis sp.	8	2149	Chrysophyta	1557
Spumella sp.	8	59	Chrysophyta	1491
Cryptomonas sp.	19	35189	Cryptophyta	10635
Cryptomonas curvata	19	119699	Cryptophyta	10635
Rhodomonas lacustris	216	23453	Cryptophyta	10663
Anabaena sp.	23	1725	Cyanobacteria	1100
Anabaena lemmermannii	220	59146	Cyanobacteria	1100
Anabaena spiroides	323	86837	Cyanobacteria	1100
Anabaena flos-aquae	573	111519	Cyanobacteria	1100
Anabaena planctonica	391	133471	Cyanobacteria	1100
Anacystis sp.	4174	7942	Cyanobacteria	609
Aphanizomenon sp.	1340	47360	Cyanobacteria	1191
Aphanocapsa sp.	1059	3346	Cyanobacteria	625
Chroococcus sp.	83	2781	Cyanobacteria	654
Gloeocapsa sp.	87	3784	Cyanobacteria	682
Synechocystis sp.	8	268	Cyanobacteria	799
Snowella sp.	850	3649	Cyanobacteria	
Planktolyngbya sp.	61	758	Cyanobacteria	
Woronichinia sp.	262	3568	Cyanobacteria	
Asterionella formosa	144	100270	Diatom	3116
Aulacoseira sp.	4	6582	Diatom	590863
Fragilaria crotonensis	937	454968	Diatom	2932
Lindavia intermedia	8	7072	Diatom	
Nitzschia acicularis	4	3158	Diatom	5070
Ulnaria acus	19	19795	Diatom	970000
Ceratium hirundinella	15	2589807	Dinoflagellate	10397
Gymnodinium sp.	4	8474	Dinoflagellate	10031
Trachelomonas sp.	4	14137	Euglenid	9690
Coenococcus sp.	34	481	Green	
Crucigenia tetrapedia	15	1838	Green	6225
Dictyosphaerium sp.	34	2621	Green	6297
Gloeocystis ampla	30	11875	Green	6355
Nephrocytium sp.	30	14891	Green	5964
Oocystis solitaria	4	922	Green	5827
Didymocystis fina	8	2155	Green	55858
Coelosphaerium naegelian	182	8684	Green	791
Coelosphaerium kuetzingia	1127	9220	Green	791
microflagellate	307	51652	Other.Flagellates	

Figure 14: Raw data from 2022-08-17 EMS site 0400489