

Okanagan Lake (North) Phytoplankton Summary Report 2021-2022

Overview

Samples were collected from EMS site #0500730 on Okanagan Lake during 2021 and 2022 (Figure 1; Table 1). Algae were identified to the taxonomic level of species and grouped into broad alga types for analysis.

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

Sample Site (EMS#)	Dates
OKANAGAN L NORTH OKANAGAN CENTRE (0500730)	2021-03-10
	2021-09-07
	2022-03-09
	2022-04-13
	2022-05-18
	2022-06-14
	2022-07-13
	2022-08-17
	2022-09-07

Total= 9 samples

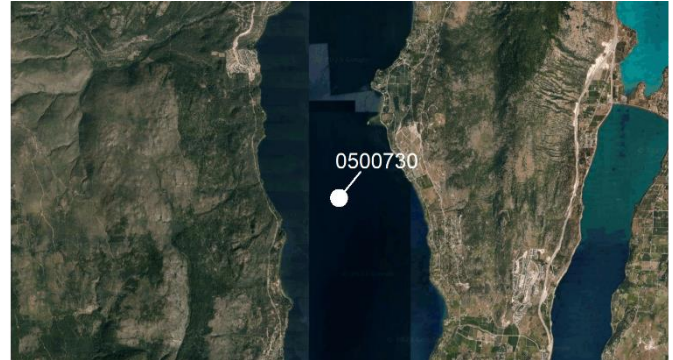


Figure 1: Aerial view of EMS site 0500730 on Okanagan Lake (North)

Samples demonstrated seasonal patterns with elevated diatoms in the spring and elevated cyanobacteria in the summer.

Diatom concentrations were slightly elevated from March to June compared to July, August, and September. 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).

Samples collected in July to September contained elevated concentrations of cyanobacteria compared to samples collected from March to June. EMS site 0500730 collected on 2022-09-07 contained large amorphous clouds of degraded cyanobacteria and bacteria (Figure 2). Degraded cyanobacteria could represent threats to public health as cyanotoxins are usually contained within the cyanobacterial cells to be released during cell death (EPA, 2022).

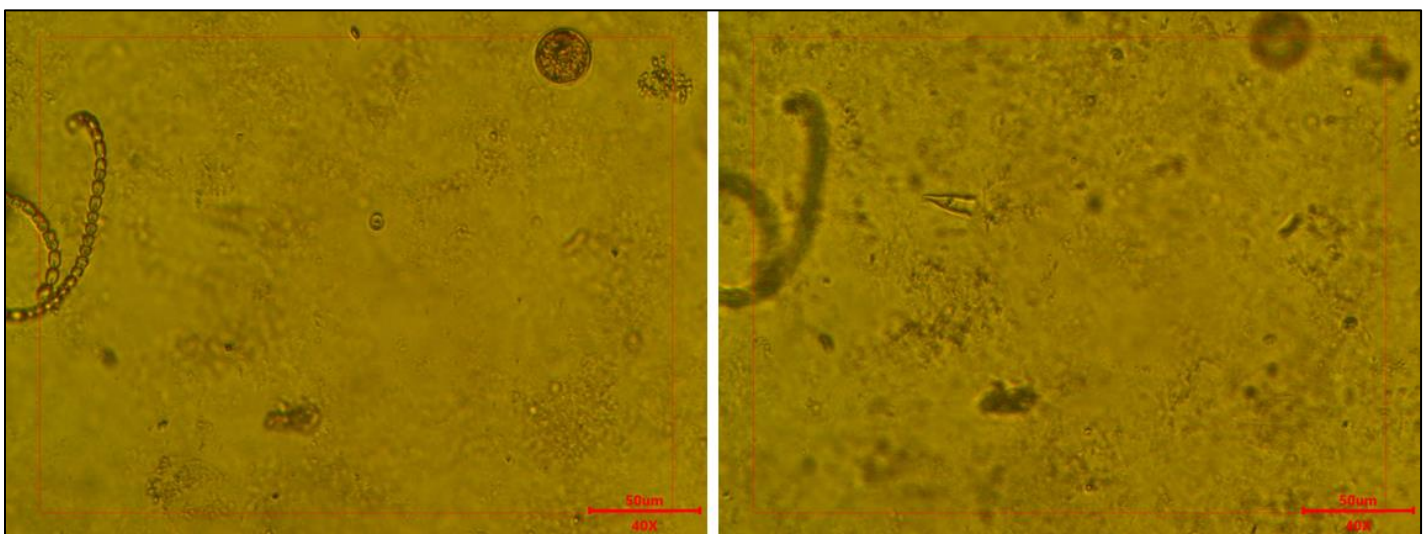


Figure 2: 400x magnification of a single frame of EMS site 0500730 collected on 2022-09-07 demonstrating degraded cyanobacteria/bacteria clouds creating visual obstruction (haze)

Overview (continued)

Diatoms dominated EMS site 0500730. Small quantities of the diatom *Stephanodiscus niagarae* were identified in Okanagan Lake (North). Despite low numbers, this diatom represented 16% of biovolumes because of its large size relative to other algae (Figure 3; Figure 4).

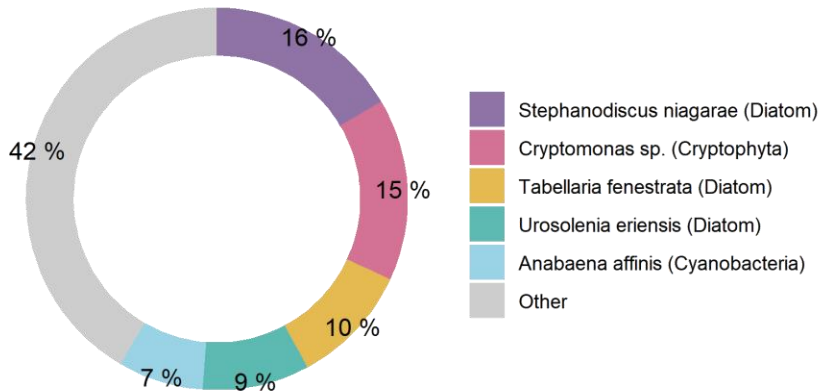


Figure 3: Dominant organisms from Okanagan Lake (Site 0500730) as percent of total biovolume

Samples collected in spring 2021 contained elevated densities of Cryptophyta (genus *Cryptomonas*; Figure 3). 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 EMS site 0500730 collected on 2022-04-13 demonstrating the size of one *Stephanodiscus niagarae* cell

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 densities of cyanobacteria. *Planktolyngbya* was the dominant genus counted, *Anacystis* and *Anathece* were also frequently encountered.

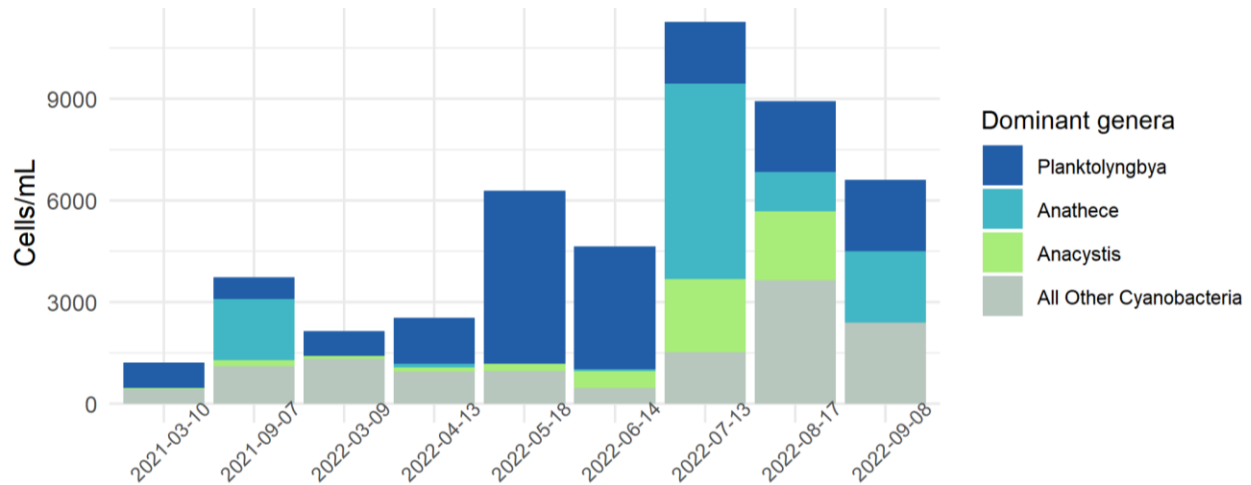


Figure 5: cell abundance for dominant cyanobacteria genera on Okanagan Lake (North)

Most dominant cyanobacteria identified in the summer samples are 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 Okanagan Lake (North) and their associated toxins

Genus	Maximum Abundance* (cells/mL)	Toxins Produced
<i>Anathece</i>	5768	No toxins identified
<i>Planktolyngbya</i>	4144	Lyngbyatoxin.LYN, Microcystin.MC, BMAA Lyngbyatoxin.LYN, Lipopolysaccharide.LPS, Microcystin.MC, Nodularins.NOD, Anatoxins...a..ATX, BMAA, Cyanopeptolins..CPL,
<i>Anacystis</i>	1821	Anabaenopeptins.APT

Note: * = counted in samples

Cyanobacterial Presence (Continued)

Dominant species of cyanobacteria found in Okanagan Lake (North) are capable of producing cyanotoxins (Table 2).

Okanagan Lake (North) displayed cyanobacteria levels in the negligible to low-risk category, with a mean cyanobacteria abundance of 5,256 cells/mL (Figure 6). Figure 6 exhibits the range of cyanobacterial abundance observed in Okanagan Lake (North) compared to alert levels defined by several authorities including the WHO and EPA.

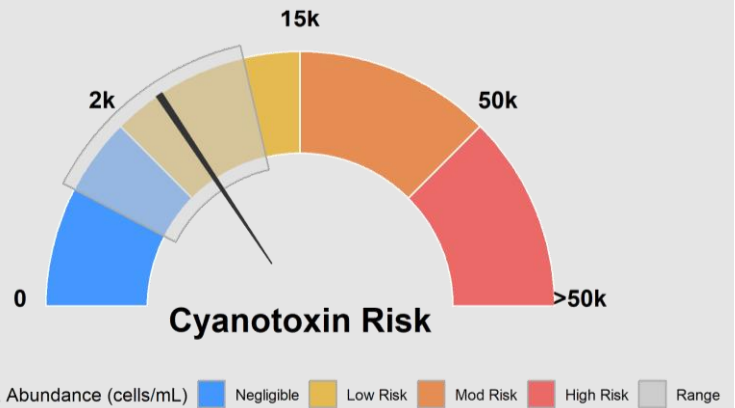


Figure 6: Cyanotoxin risk posed by cyanobacteria blooms in Okanagan Lake (North)

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 diatom cell is the same size as a colony of approximately 50 cyanobacteria.

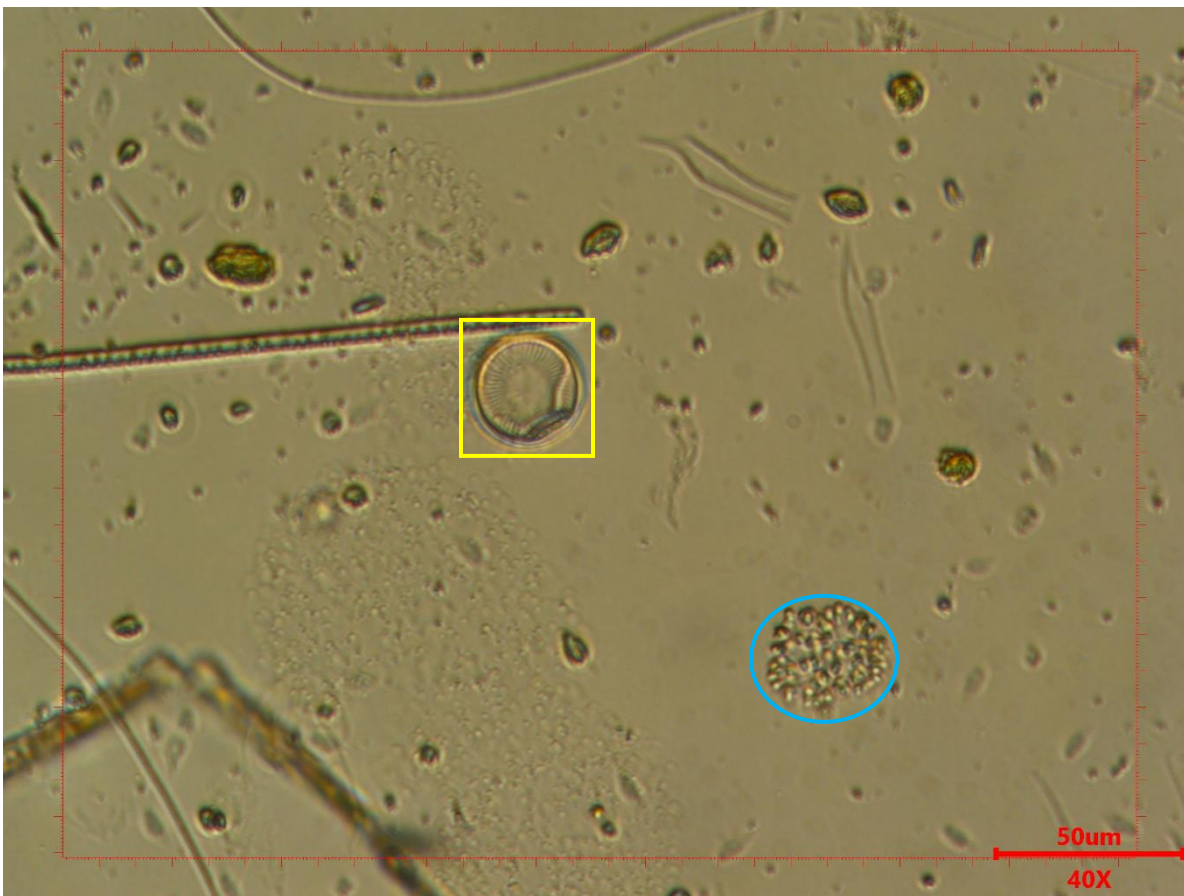


Figure 7: Size comparison of a diatom cell (yellow box) to a colony of approximately 50 cyanobacteria (blue circle)

Species Composition

Algae samples were identified to the species level and grouped into broad algae types for analysis. The figures below display the total cell counts for each broad algae group alongside the biovolume represented by each of these groups. The difference between Figure 8 (cell abundance) and Figure 9 (biovolume) illuminates the difference between cell abundance and biovolume.

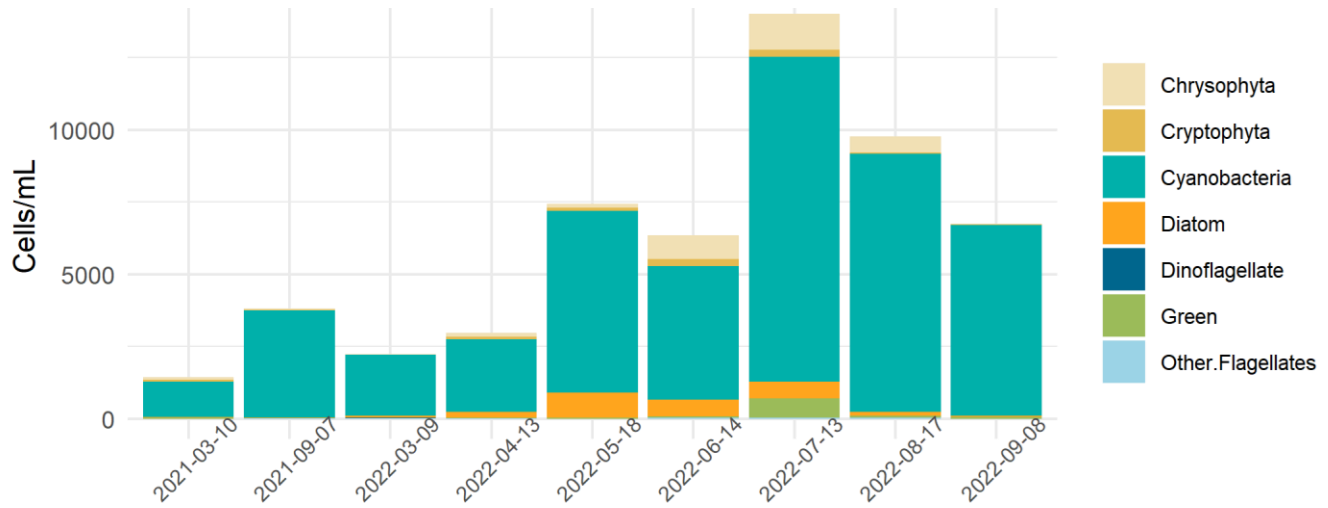


Figure 8: Cell abundance of high-level taxa groups on Okanagan Lake (North)

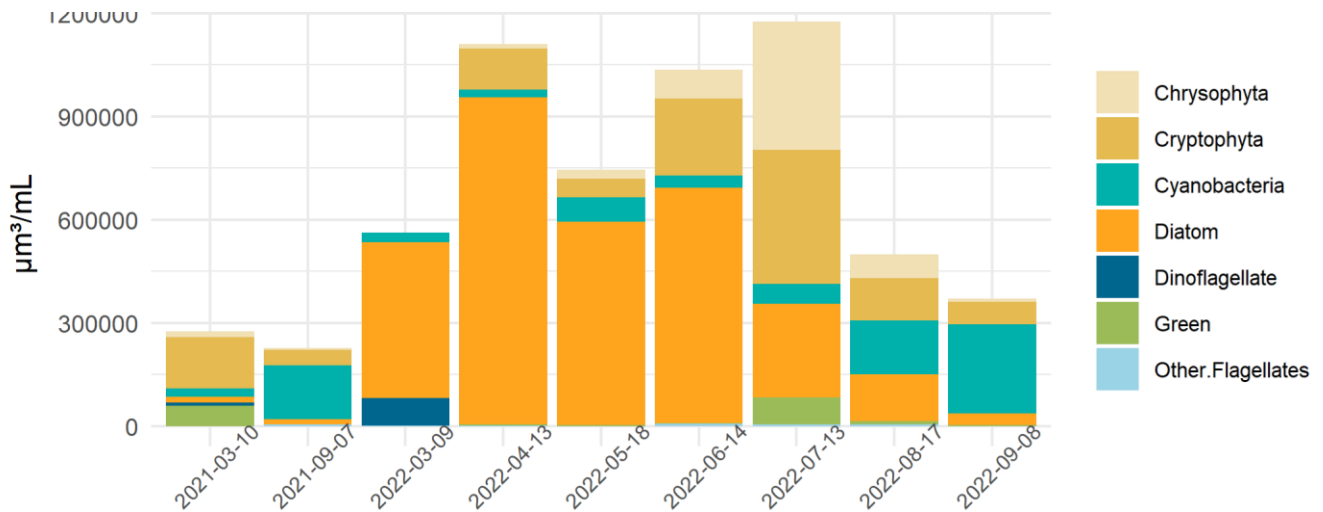


Figure 9: Biovolume of high-level taxa groups on Okanagan Lake (North)

References

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Appendix

Additional figures and raw data are listed below:

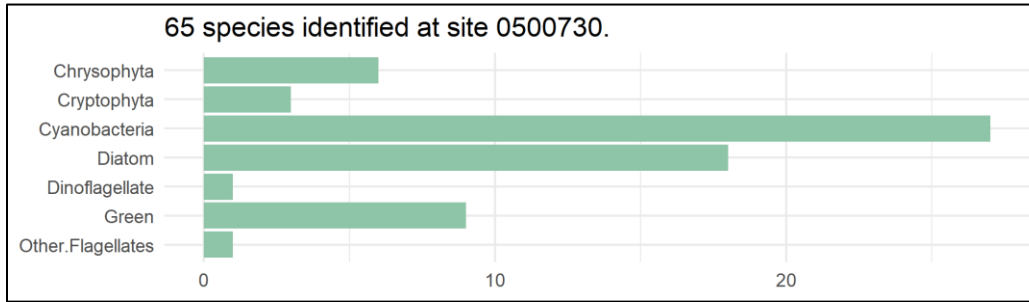


Figure 10: Unique species observed in Okanagan Lake (North) sorted into higher level taxa

Table 3: Raw data from 2021

Report Name	High Level Taxa	ITIS	Date Sampled	Abundance (cells/ mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)
		Genus Number			
Aulacoseira ambigua	Diatom	590863	2021-03-10	11	3403
Aulacoseira granulata	Diatom	590863	2021-03-10	11	3618
Tabellaria fenestrata	Diatom	3241	2021-03-10	4	10751
Chlorella vulgaris	Green	5811	2021-03-10	4	279
Elakatothrix gelatinosa	Green	9412	2021-03-10	19	3356
Closterium sp.	Green	7257	2021-03-10	4	55906
Anacystis sp.	Cyanobacteria	609	2021-03-10	38	72
Planktolyngbya sp.	Cyanobacteria	NA	2021-03-10	759	9434
Limnothrix sp.	Cyanobacteria	NA	2021-03-10	285	4029
Pseudanabaena sp.	Cyanobacteria	1175	2021-03-10	19	212
Pseudanabaena limnetica	Cyanobacteria	1175	2021-03-10	114	10476
Cryptomonas sp.	Cryptophyta	10635	2021-03-10	80	148163
Ochromonas sp.	Chrysophyta	1455	2021-03-10	72	15413
Chroomonas sp.	Chrysophyta	10613	2021-03-10	8	1819
Gymnodinium sp.	Dinoflagellate	10031	2021-03-10	4	8474
Cymbella sp.	Diatom	4795	2021-09-07	6	10160
Ulnaria acus	Diatom	970000	2021-09-07	6	6251
Anathece cf. clathrata	Cyanobacteria	NA	2021-09-07	1815	7603
Anacystis cyanea	Cyanobacteria	609	2021-09-07	182	274
Chroococcus limneticus	Cyanobacteria	654	2021-09-07	121	15451
Anabaena sp.	Cyanobacteria	1100	2021-09-07	134	10047
Anabaena affinis	Cyanobacteria	1100	2021-09-07	364	104322
Planktolyngbya sp.	Cyanobacteria	NA	2021-09-07	455	5656
Planktolyngbya limnetica	Cyanobacteria	NA	2021-09-07	182	931
Oscillatoria sp.	Cyanobacteria	917	2021-09-07	395	3537

Report Name	High Level Taxa	ITIS		Abundance (cells/ mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)
		Genus Number	Date Sampled		
Pseudanabaena limnetica	Cyanobacteria	1175	2021-09-07	79	7259
Cryptomonas sp.	Cryptophyta	10635	2021-09-07	24	44449
Ochromonas sp.	Chrysophyta	1455	2021-09-07	30	6422
UID flagellate	Other.Flagellates	NA	2021-09-07	12	4174

Table 4: Raw data from 2022

Report Name	High Level Taxa	ITIS		Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)
		Genus Number	Date Sampled		
Achnanthydium sp.	Diatom	590864	2022-03-09	8	735
Aulacoseira ambigua	Diatom	590863	2022-03-09	30	25918
Stephanodiscus hantzschii	Diatom	2415	2022-03-09	8	22619
Stephanodiscus niagarae	Diatom	2415	2022-03-09	8	343612
Tabellaria fenestrata	Diatom	3241	2022-03-09	15	59606
Monoraphidium arcuatum	Green	5990	2022-03-09	8	851
Anacystis cyanea	Cyanobacteria	609	2022-03-09	83	147
Planktolyngbya sp.	Cyanobacteria	NA	2022-03-09	212	1332
Planktolyngbya limnetica	Cyanobacteria	NA	2022-03-09	516	4344
Pseudanabaena catenata	Cyanobacteria	1175	2022-03-09	212	5203
Phormidium granulatum	Cyanobacteria	992	2022-03-09	1108	17033
cf. Dinobryon cyst	Chrysophyta	NA	2022-03-09	8	733
UID flagellate	Other.Flagellates	NA	2022-03-09	8	1047
Gymnodinium sp.	Dinoflagellate	10031	2022-03-09	8	79432
Stephanodiscus hantzschii	Diatom	2415	2022-03-09	8	22619
Gloeocystis planctonica	Green	6355	2022-03-09	38	5464
Closteriopsis acicularis	Green	5926	2022-03-09	15	72106
Anathece clathrata	Cyanobacteria	NA	2022-03-09	76	80
Aphanothece sp.	Cyanobacteria	636	2022-03-09	61	383
Gloeothece rupestris	Cyanobacteria	703	2022-03-09	23	635
Planktolyngbya sp.	Cyanobacteria	NA	2022-03-09	933	5862
Planktolyngbya limnetica	Cyanobacteria	NA	2022-03-09	402	3384
Pseudanabaena limnetica	Cyanobacteria	1175	2022-03-09	266	4805
Phormidium granulatum	Cyanobacteria	992	2022-03-09	212	3259
Cryptomonas sp.	Cryptophyta	10635	2022-03-09	15	58167
Ochromonas sp.	Chrysophyta	1455	2022-03-09	15	1696
Gymnodinium sp.	Dinoflagellate	10031	2022-03-09	8	79432
Cymbella sp.	Diatom	4795	2022-09-08	15	25447
Ulnaria acus	Diatom	970000	2022-09-08	15	7580
Oocystis sp.	Green	5827	2022-09-08	61	2555
Anathece clathrata	Cyanobacteria	NA	2022-09-08	2110	2210

Report Name	High Level Taxa	ITIS		Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)
		Genus Number	Date Sampled		
Aphanocapsa sp.	Cyanobacteria	625	2022-09-08	668	3984
Chroococcus cf. dispersus	Cyanobacteria	654	2022-09-08	61	10955
Anabaena sp.	Cyanobacteria	1100	2022-09-08	410	17094
Anabaena affinis	Cyanobacteria	1100	2022-09-08	1245	211209
Planktolyngbya sp.	Cyanobacteria	NA	2022-09-08	1518	9538
Planktolyngbya limnetica	Cyanobacteria	NA	2022-09-08	592	4984
Dinobryon sertularia	Chrysophyta	1515	2022-09-08	15	5475
Dinobryon bavaricum	Chrysophyta	1515	2022-09-08	15	3110
Cryptomonas sp.	Cryptophyta	10635	2022-09-08	15	58167
Rhodomonas lacustris	Cryptophyta	10663	2022-09-08	15	7634
Aulacoseira granulata	Diatom	590863	2022-04-13	76	18653
Asterionella formosa	Diatom	3116	2022-04-13	15	2812
Cyclotella meneghiniana	Diatom	2439	2022-04-13	30	5890
Lindavia ocellata	Diatom	NA	2022-04-13	23	4516
Eunotia sp.	Diatom	3337	2022-04-13	15	2460
Urosolenia eriensis	Diatom	590843	2022-04-13	30	271434
Stephanodiscus niagarae	Diatom	2415	2022-04-13	15	644272
Ankistrodesmus falcatus	Green	5877	2022-04-13	8	2912
Chlorella vulgaris	Green	5811	2022-04-13	8	905
Anathece clathrata	Cyanobacteria	NA	2022-04-13	106	111
Anacystis cyanea	Cyanobacteria	609	2022-04-13	129	228
Lyngbya sp.	Cyanobacteria	870	2022-04-13	152	1910
Planktolyngbya sp.	Cyanobacteria	NA	2022-04-13	675	4241
Planktolyngbya limnetica	Cyanobacteria	NA	2022-04-13	524	4411
Planktolyngbya contorta	Cyanobacteria	NA	2022-04-13	152	1453
Merismopedia tenuissima	Cyanobacteria	727	2022-04-13	61	134
Oscillatoria sp.	Cyanobacteria	917	2022-04-13	569	7150
Pseudanabaena limnetica	Cyanobacteria	1175	2022-04-13	159	2872
cf. Dinobryon cyst	Chrysophyta	NA	2022-04-13	30	2749
Cryptomonas sp.	Cryptophyta	10635	2022-04-13	23	89189
Ochromonas sp.	Chrysophyta	1455	2022-04-13	76	8595
Rhodomonas lacustris	Cryptophyta	10663	2022-04-13	61	31045
Chrysochromulina sp.	Chrysophyta	2160	2022-04-13	15	337
UID flagellate	Other.Flagellates	NA	2022-04-13	8	1047
Aulacoseira granulata	Diatom	590863	2022-04-13	121	29698
Cyclotella meneghiniana	Diatom	2439	2022-04-13	68	13352
Lindavia bodanica	Diatom	NA	2022-04-13	8	12566
Lindavia ocellata	Diatom	NA	2022-04-13	8	1571
Entomoneis ornata	Diatom	4699	2022-04-13	8	301593
Fragilaria radians	Diatom	2932	2022-04-13	15	10500
Urosolenia eriensis	Diatom	590843	2022-04-13	15	135717
Ulnaria nana	Diatom	970000	2022-04-13	8	4800
Chlorella vulgaris	Green	5811	2022-04-13	15	1696
UID green coccoid	Green	NA	2022-04-13	30	7351
Aphanocapsa sp.	Cyanobacteria	625	2022-04-13	53	316

Report Name	High Level Taxa	ITIS		Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)
		Genus Number	Date Sampled		
Anacystis cyanea	Cyanobacteria	609	2022-04-13	349	617
Planktolyngbya sp.	Cyanobacteria	NA	2022-04-13	949	5963
Planktolyngbya limnetica	Cyanobacteria	NA	2022-04-13	774	6516
Merismopedia tenuissima	Cyanobacteria	727	2022-04-13	61	134
Pseudanabaena limnetica	Cyanobacteria	1175	2022-04-13	15	271
Phormidium granulatum	Cyanobacteria	992	2022-04-13	228	3505
cf. Dinobryon cyst	Chrysophyta	NA	2022-04-13	15	1374
Cryptomonas sp.	Cryptophyta	10635	2022-04-13	61	236544
Nano Cryptomonads	Cryptophyta	NA	2022-04-13	8	1466
Ochromonas sp.	Chrysophyta	1455	2022-04-13	114	12893
Rhodomonas lacustris	Cryptophyta	10663	2022-04-13	46	23411
Chrysochromulina sp.	Chrysophyta	2160	2022-04-13	8	180
nanoflagellates	Other.Flagellates	NA	2022-04-13	46	289
Aulacoseira ambigua	Diatom	590863	2022-05-18	137	118360
Aulacoseira granulata	Diatom	590863	2022-05-18	91	22335
Aulacoseira sp.	Diatom	590863	2022-05-18	15	8247
Asterionella formosa	Diatom	3116	2022-05-18	152	28500
Cyclotella meneghiniana	Diatom	2439	2022-05-18	30	5890
Lindavia ocellata	Diatom	NA	2022-05-18	334	65581
Fragilaria crotonensis	Diatom	2932	2022-05-18	30	7500
Urosolenia eriensis	Diatom	590843	2022-05-18	15	135717
Ulnaria acus	Diatom	970000	2022-05-18	15	7580
Ulnaria nana	Diatom	970000	2022-05-18	15	9000
Tabellaria fenestrata	Diatom	3241	2022-05-18	46	182792
Chlorella vulgaris	Green	5811	2022-05-18	15	1696
Oocystis sp.	Green	5827	2022-05-18	15	628
Anacystis cyanea	Cyanobacteria	609	2022-05-18	212	375
Planktolyngbya sp.	Cyanobacteria	NA	2022-05-18	4144	26038
Planktolyngbya limnetica	Cyanobacteria	NA	2022-05-18	971	8174
Merismopedia punctata	Cyanobacteria	727	2022-05-18	121	254
Oscillatoria tenuis	Cyanobacteria	917	2022-05-18	744	36256
Snowella litoralis	Cyanobacteria	NA	2022-05-18	91	381
Dinobryon sertularia	Chrysophyta	1515	2022-05-18	46	16791
cf. Dinobryon cyst	Chrysophyta	NA	2022-05-18	46	4215
Ochromonas sp.	Chrysophyta	1455	2022-05-18	46	5202
Rhodomonas lacustris	Cryptophyta	10663	2022-05-18	106	53947
Aulacoseira granulata	Diatom	590863	2022-06-14	182	44670
Asterionella formosa	Diatom	3116	2022-06-14	76	14250
Lindavia bodanica	Diatom	NA	2022-06-14	15	23562
Lindavia ocellata	Diatom	NA	2022-06-14	76	14923
Fragilaria crotonensis	Diatom	2932	2022-06-14	30	7500
Urosolenia eriensis	Diatom	590843	2022-06-14	15	135717
Stephanodiscus hantzschii	Diatom	2415	2022-06-14	15	42412
Ulnaria acus	Diatom	970000	2022-06-14	76	38404
Tabellaria fenestrata	Diatom	3241	2022-06-14	91	361611

Report Name	High Level Taxa	ITIS		Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)
		Genus Number	Date Sampled		
cf. Coelastrum microporum	Green	NA	2022-06-14	30	3393
Anathece clathrata	Cyanobacteria	NA	2022-06-14	61	64
Anacystis cyanea	Cyanobacteria	609	2022-06-14	349	617
Anacystis cf. delicatissima	Cyanobacteria	609	2022-06-14	152	138
Gloeothece rupestris	Cyanobacteria	703	2022-06-14	61	1684
Planktolyngbya sp.	Cyanobacteria	NA	2022-06-14	1563	9821
Planktolyngbya limnetica	Cyanobacteria	NA	2022-06-14	2049	17249
Pseudanabaena limnetica	Cyanobacteria	1175	2022-06-14	334	6033
Snowella lacustris	Cyanobacteria	NA	2022-06-14	61	256
cf. Dinobryon cyst	Chrysophyta	NA	2022-06-14	212	19426
Cryptomonas sp.	Cryptophyta	10635	2022-06-14	30	116333
Ochromonas sp.	Chrysophyta	1455	2022-06-14	531	60055
Rhodomonas lacustris	Cryptophyta	10663	2022-06-14	212	107895
Chrysochromulina sp.	Chrysophyta	2160	2022-06-14	61	1369
Chroomonas sp.	Chrysophyta	10613	2022-06-14	15	1838
UID flagellate	Other.Flagellates	NA	2022-06-14	46	6021
Lindavia bodanica	Diatom	NA	2022-07-13	91	142942
Fragilaria crotonensis	Diatom	2932	2022-07-13	455	113750
Ulnaria acus	Diatom	970000	2022-07-13	30	15159
cf. Coelastrum microporum	Green	NA	2022-07-13	546	61751
Oocystis parva	Green	5827	2022-07-13	121	17423
Anathece clathrata	Cyanobacteria	NA	2022-07-13	5768	6040
Aphanocapsa sp.	Cyanobacteria	625	2022-07-13	668	3984
Anacystis cyanea	Cyanobacteria	609	2022-07-13	395	698
Anacystis cf. delicatissima	Cyanobacteria	609	2022-07-13	1761	1593
Chroococcus cf. dispersus	Cyanobacteria	654	2022-07-13	121	21731
Gloeocapsa cf. aeruginosa	Cyanobacteria	682	2022-07-13	61	2910
Planktolyngbya sp.	Cyanobacteria	NA	2022-07-13	304	1910
Planktolyngbya limnetica	Cyanobacteria	NA	2022-07-13	1518	12779
Merismopedia punctata	Cyanobacteria	727	2022-07-13	364	764
Pseudanabaena limnetica	Cyanobacteria	1175	2022-07-13	304	5492
Dinobryon sertularia	Chrysophyta	1515	2022-07-13	911	332528
Dinobryon bavaricum	Chrysophyta	1515	2022-07-13	30	6220
cf. Dinobryon cyst	Chrysophyta	NA	2022-07-13	30	2749
Cryptomonas sp.	Cryptophyta	10635	2022-07-13	91	352877
Nano Cryptomonads	Cryptophyta	NA	2022-07-13	121	22174
Ochromonas sp.	Chrysophyta	1455	2022-07-13	273	30876
Rhodomonas lacustris	Cryptophyta	10663	2022-07-13	30	15268
UID flagellate	Other.Flagellates	NA	2022-07-13	30	3927
Fragilaria crotonensis	Diatom	2932	2022-08-17	61	15250
Fragilaria radians	Diatom	2932	2022-08-17	30	21000
Stephanodiscus hantzschii	Diatom	2415	2022-08-17	30	84823
Ulnaria acus	Diatom	970000	2022-08-17	30	15159
Crucigenia rectangularis	Green	6225	2022-08-17	61	9662
Anathece clathrata	Cyanobacteria	NA	2022-08-17	1154	1208

Report Name	High Level Taxa	ITIS		Date Sampled	Abundance (cells/mL)	Biovolume ($\mu\text{m}^3/\text{mL}$)
		Genus Number				
Aphanocapsa sp.	Cyanobacteria	625		2022-08-17	2884	17201
Anacystis cyanea	Cyanobacteria	609		2022-08-17	1821	3218
Anacystis cf. delicatissima	Cyanobacteria	609		2022-08-17	212	192
Anabaena affinis	Cyanobacteria	1100		2022-08-17	698	118413
Gloeocapsa cf. aeruginosa	Cyanobacteria	682		2022-08-17	61	2910
Planktolyngbya sp.	Cyanobacteria	NA		2022-08-17	1457	9155
Planktolyngbya limnetica	Cyanobacteria	NA		2022-08-17	637	5363
Dinobryon sertularia	Chrysophyta	1515		2022-08-17	30	10950
Cryptomonas sp.	Cryptophyta	10635		2022-08-17	30	116333
Nano Cryptomonads	Cryptophyta	NA		2022-08-17	30	5498
Ochromonas sp.	Chrysophyta	1455		2022-08-17	516	58358
UID flagellate	Other.Flagellates	NA		2022-08-17	30	3927