Charlie Lake Conservation Society
British Columbia

Eutrophication Analysis for Recreation Opportunities

Cyanobacteria/Blue Green Algae Survey of Charlie Lake 2022 Results

(Year 2)

Bruce Kosugi



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1. Introduction

This was the second year of a survey of algae, particularly cyanobacteria, and the factors that affect their abundance that was carried out in Charlie Lake. This survey was conducted during the growing season from June to September 2022.

The initial survey "*Eutrophication Analysis for Recreation Opportunities Cyanobacteria/ Blue Green Algae Survey of Charlie Lake, 2021"*, documented that algal blooms did appear for limited periods of time in localized areas on Charlie Lake particularly in July-September. Toxic levels (for recreational waters) of microcystin were not exceeded. No harmful declines in dissolved oxygen levels were observed during the algal blooms in early August and late September

"Harmful Algal Bloom," - the term "bloom" refers to an overgrowth of algae with often a burst of growth that can occur very rapidly. Blooms can appear differently from site to site, and at a given site their appearance can change throughout the day, as algae grow and die, or as they vertically migrate through the water column. The term "algal" refers to a very broad range of organisms, but especially dinoflagellates, diatoms, and cyanobacteria. "Harmful" is determined by toxins that can be produced. Some cyanobacteria produce various toxins - although many of the same cyanobacteria may or may not produce toxins. Cyanobacteria blooms have also been identified as responsible for skin rashes and allergic reactions after water based recreational activities as well as toxicity to pets and farm animals who drink lake water with cyanobacteria content.

Algal blooms may also result in fish kills in some lakes due to the rotting algae robbing dissolved oxygen from the water. In extreme cases, fish will be suffocated.

This project was sponsored by the Peace River Regional District.

2. **Conclusions and Recommendations**

Environmental conditions in 2022 resulted in much lower levels of cyanobacteria and associated properties such as toxicity (based on microcystin concentrations) and chlorophyll a, compared to the previous year (figure 4). The cyanobacteria species composition was similar in the two seasons of sampling with *Aphanizomenon* being the dominant species.

From a health perspective, toxicity levels (microcystin in recreational waters) were acceptable and were also significantly lower compared to 2021. Note that, due to lab capabilities microcystin, one of the most common toxins, is the only test commercially available to us at this time.

From a fish habitat perspective, the water quality was acceptable with no harmful declines in dissolved oxygen levels observed.

Weather was cooler in 2022 with less rainfall compared to 2021. The heat dome conditions in late June 2021 along with increased runoff carrying potential nutrients may have contributed to the increase in algal presence compared to 2022.

It is recommended that:

An appropriate monitoring program, including visual observations of algal density, in areas of higher recreational use, could reduce the potential risk of user exposure to harmful algal blooms during the swimming and recreational use in the summer season. Note that Northern Health typically issues a swimming advisory during the period of bloom development - in general, avoid contact with waters where a bloom exists. Avoid drinking untreated water from areas where blooms exist.

A comprehensive cyanobacteria survey should be completed in the future if environmental conditions change or level of blooms increase.

If future lab capabilities expand, additional potential cyanobacteria toxins, such as anatoxins, saxitoxins and cylindrospermopsin, should be considered for testing.

3. **Background**

Charlie Lake is located in northeastern British Columbia. Winters are long and cold. The summer growing season is warm, but short (Centre for Forest Conservation Genetics**).** There is significant precipitation throughout the year with July being the wettest month with an average of 82 mm of rain (climate-data.org).

Charlie Lake physical data includes:

- elevation of 691 m
- surface area of 18 km^2
- mean depth of 6.4 m
- Length 15 km and width 3 km
- shoreline perimeter of 38 km

Charlie Lake has two main inflows from Stoddart and Coffee Creeks. Fish Creek (Lower Stoddart Creek) is the lake's outlet where a weir was installed in the early 1980s. The flushing rate of Charlie Lake is 5-7 years.

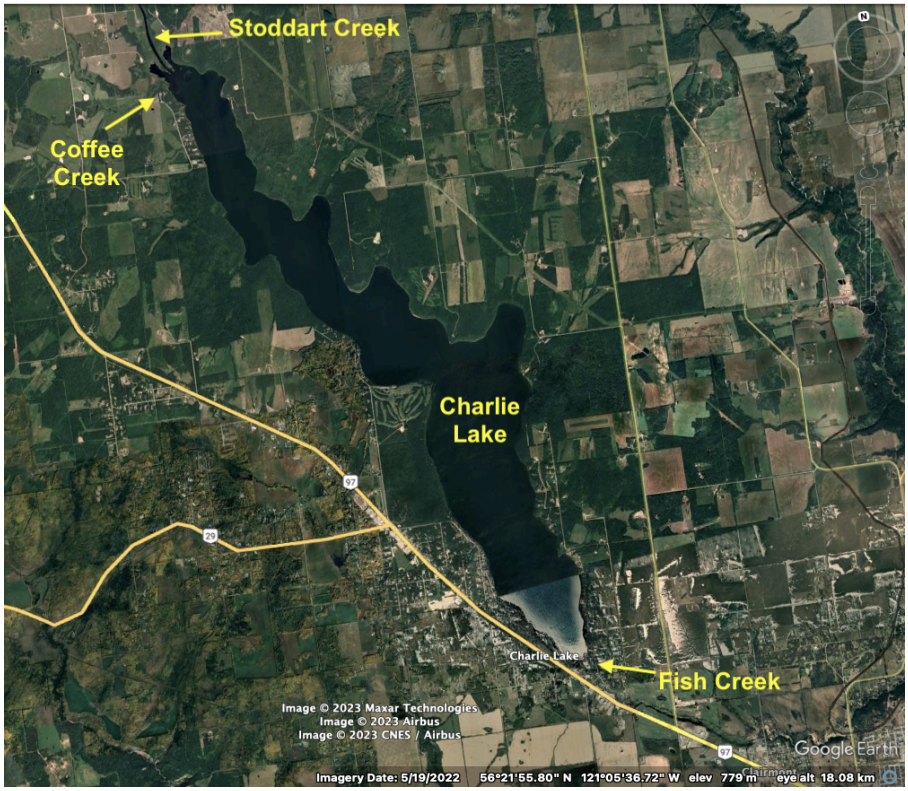


Figure 1 - Charlie Lake and Surrounding Lands

4. Sampling

3 sites were selected (Figure 2) for observations and sampling around the lake:

- Site 1 - Bruce's Place/Lake Point (100m offshore)
- Site 2 South end (dock)
- Site 3, Beatton Provincial Park (fishing dock)

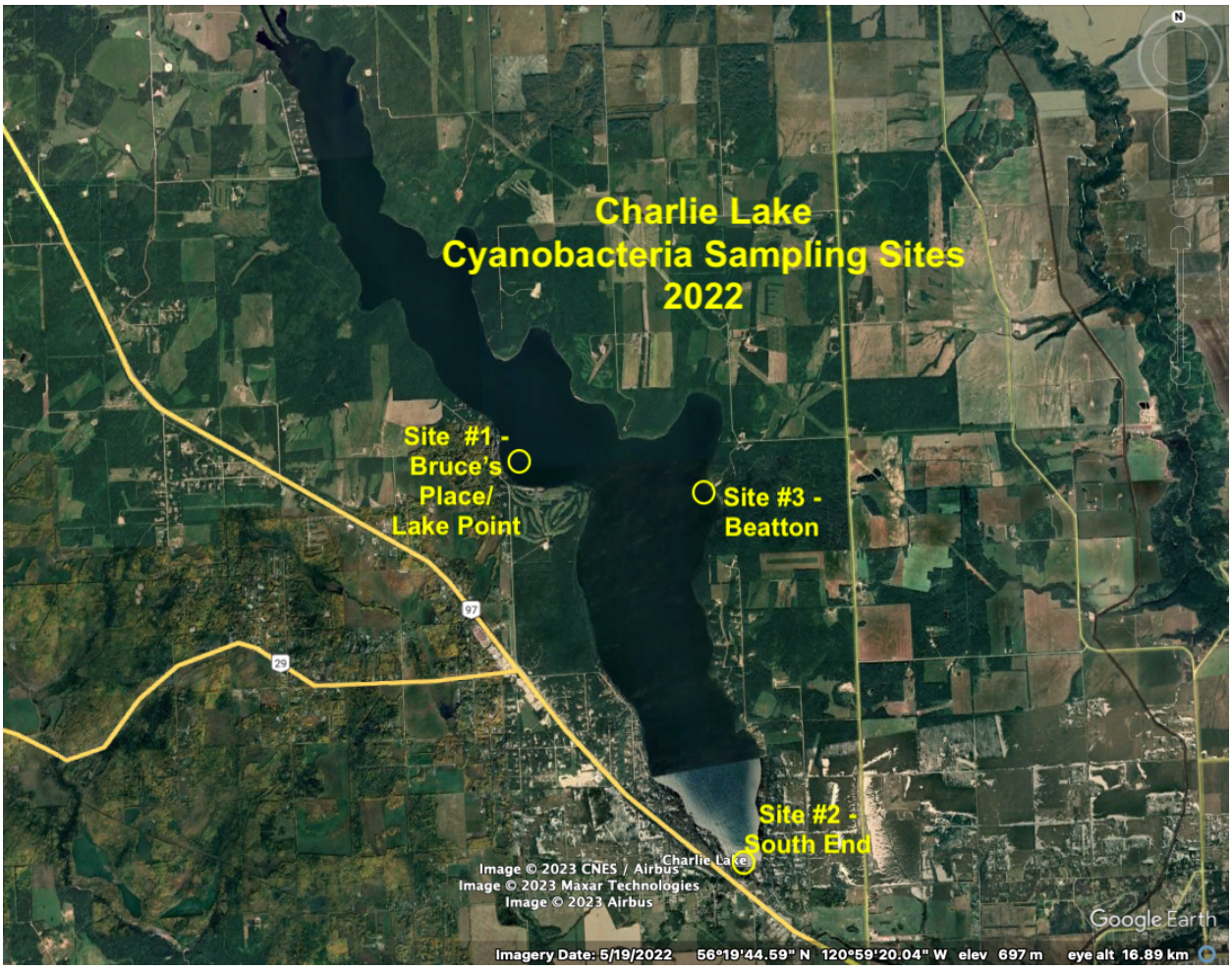


Figure 2 - Sampling Sites

The sites were sampled approximately each month during the active growing season from June to September. Observations (i.e. weather and water conditions, Secchi depth (water quality clarity), dissolved oxygen, and water grab samples taken at surface were done. See Appendix III - Sampling Observations and Lab Results)

Samples were sent by air courier to ALS testing lab in Winnipeg in coolers with ice packs. Note that due to airline limitations some chlorophyll *a* samples may have exceeded their recommended holding period.

Lab testing (Appendix II - Lab Testing and Equipment) was completed for:

- Algal Identification (identify potential problem, i.e. some cyanobacteria, and lesser concern algae)
- Cyanobacteria cell counts (quantify relative amounts of potential problem algae)
- Chlorophyll a (a measure of the amount of algae growing in a waterbody)
- Microcystin (one of the key toxins produced by some cyanobacteria) - note that there are additional cyanobacteria toxins but the lab could only test for microcystin. Microcystin, however, is considered one of the primary toxins with health guidelines.



Figure 3 - Water sample preparation

5. **Observations by Sampling Period**

(see section 7 Measurements taken 2022 and 2021)

June sampling (no blooms)

Overall there were lower levels of cyanobacteria compared to the previous year, when levels were low.

Cyanobacteria levels were low in June with the predominant genus being *Aphanizomenon*. Compared to 2021, *Anabaena* was not as abundant in June 2022. A variety of cyanobacteria genera were detected.

Cyanobacteria cell counts varied from 30 to 2,370 counts/mL. Compared to last year, cell counts were significantly reduced from a high of 25,770 counts/mL in 2021.

Chlorophyll a ranged from 2.2 to 8 µg/L. Chlorophyll a was reduced from a maximum of 13 µg/L in 2021.

Microcystin was below detection limits in all areas similar to 2021

July sampling (moderate bloom at Bruce's place/Lake Point)

Overall there were considerably lower levels of cyanobacteria compared to the previous year.

Similar to 2021, overall cyanobacteria levels showed a significant increase over June (large to massive) with the predominant strain being *Aphanizomenon*. The highest numbers were observed near Lake Point. A wide variety of cyanobacteria species were detected.

Cyanobacteria cell counts varied from 3,100 to 375,000 cells/mL, an order of magnitude smaller than in July 2021.

Chlorophyll a ranged from 10 to 362 µg/L (vs max of 14,000 µg/L in 2021)

Microcystin ranged from below detection limits to 0.29 µg/L at site #1 (Bruce's Place/ Lake Point). This also was significantly below the max of 1.6 µg/L in 2021."

August sampling (no blooms)

Similar to 2021, overall cyanobacteria levels showed a significant decrease over July (moderate to large), with the predominant strain being *Aphanizomenon*. A wide variety of cyanobacteria species were detected.

Cyanobacteria cell counts varied from 3,850-47,900 cells/mL, slightly higher than 2021 (max 38,4000 counts/mL)

Chlorophyll a ranged from 14-82 µg/L, also higher than 2021.

Microcystin was below or just above detection limits at all sites. This was similar to 2021.

September sampling (no blooms)

Overall cyanobacteria levels (small to large at Beatton) showed a decrease over August, and also less than observed in 2021, when a large bloom appeared at Beatton. A wide variety of cyanobacteria species were detected.

Maximum cyanobacteria cell counts were 26,300, much lower compared to 17,900,000 cells/mL in 2021. Chlorophyll a ranged from 8-29 µg/L

Microcystin was below detection limits at all sites.

6. **Overall Observations**

Environmental conditions in 2022 resulted in much lower levels of cyanobacteria and associated properties such as toxicity (based on microcystin) and chlorophyll a, compared to the previous year (figure 4). The cyanobacteria makeup was similar in the two seasons of sampling.

Cyanobacteria was evident in all samples from June to September (figure 5, Appendix I - Photos of Water Samples Showing Various Levels of Algae). The predominant genus was *Aphanizomenon*. Other cyanobacteria genera, such as *Anabaena, Microcystis, Pseudanabaena* and *Lyngbya* were also detected in a variety of small to moderate amounts over the season (Appendix III – Sampling Observations and lab results).

Cyanobacteria growth appeared to be influenced by warm temperatures through July to September (figure 9).

Cyanobacteria concentrations appeared to be influenced by wind (consistent winds tended to disperse the algae and also to cause migration) and calm (where the calm periods appeared to promote the localized concentration of algae) (see Appendix III Sampling Observations and Lab Results). Wind conditions were similar in 2022 and 2021 (figure 10).

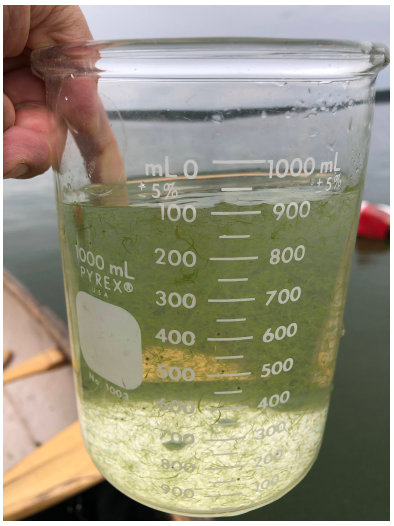
Most of the chlorophyll a readings (figure 6) indicated that conditions were right for algae scums and discolouration and favourable for nuisance/severe conditions in July August and late September.

Microcystin toxins (figure 7) were well below recreational water limits throughout the sampling period. Consistent with the lower cyanobacteria levels observed in 2022, microcystin levels were also lower (maximum 0.29 µg/L) than 2021 when the maximum concentration was 1.62 µg/L.

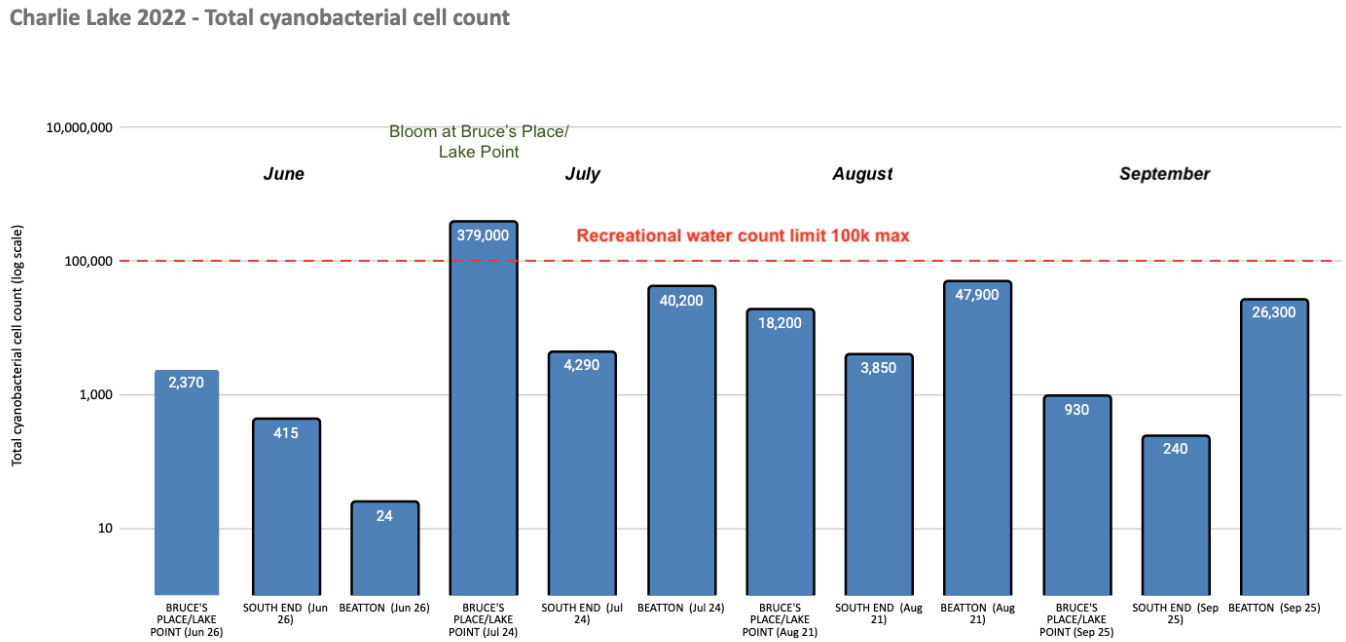
Dissolved oxygen levels were moderate to high range likely as a result of algal and aquatic plant growth in all sampling locations. No harmful declines in oxygen levels were observed during the algal blooms in early August and late September (figure 8).

Between 2022 and 2021, lower rainfall and slightly cooler average temperatures in 2022 may reduced cyanobacteria growth (figures 8,12).

Figure 4 - Comparison of Highest Cyanobacteria Levels 2022 vs 2021

	2022	2021
Date	Jul 24 2022	Sep 26 2021
Location	Site #1 Bruce's Place/Lake Point	Site #3 Beatton
Sample		
Surface Water appearance		
Cyanobacteria counts (cells/mL)	379,000	17,900,000
Chlorophyll a (µg/L)	362	19,700,000
Microcystin (µg/L)	0.29	1.62

7. Measurements taken 2022 and 2021



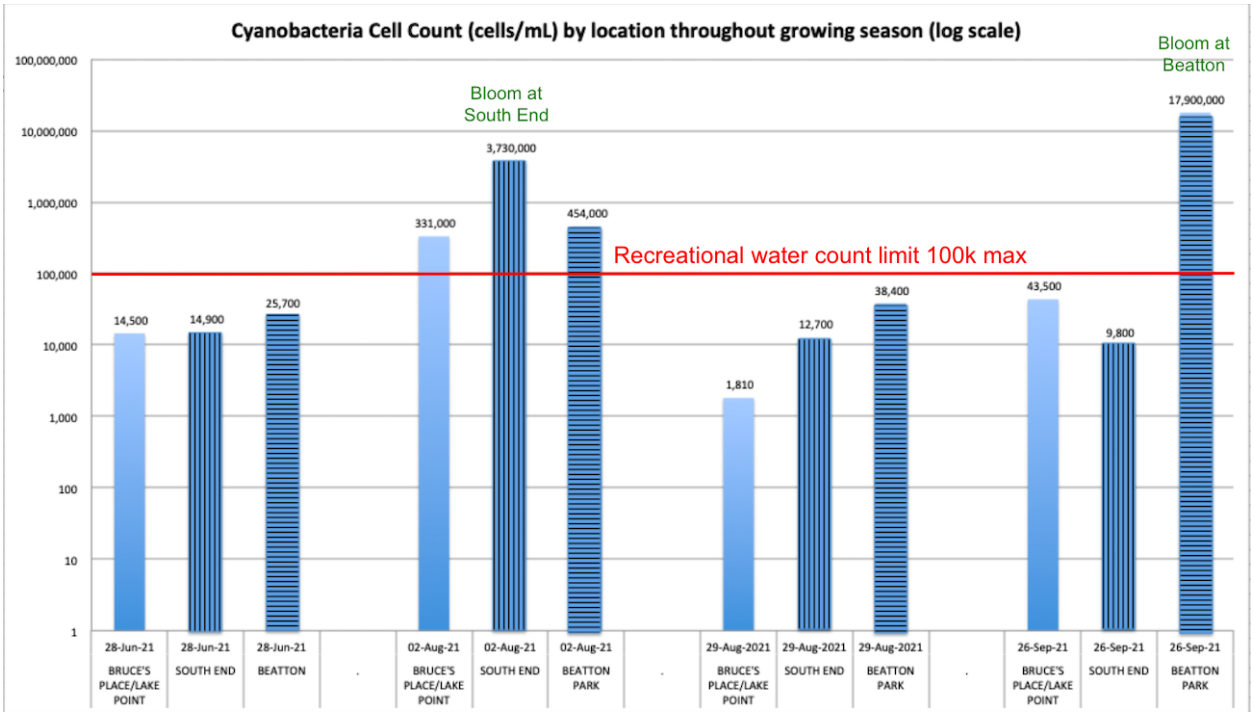


Figure 5 - Cyanobacteria Cell Counts (2022 and 2021)

Cell counts exceeded recreational water limits only once during July 2022, compared to four exceedances, with two of these being an order of magnitude larger in 2021.

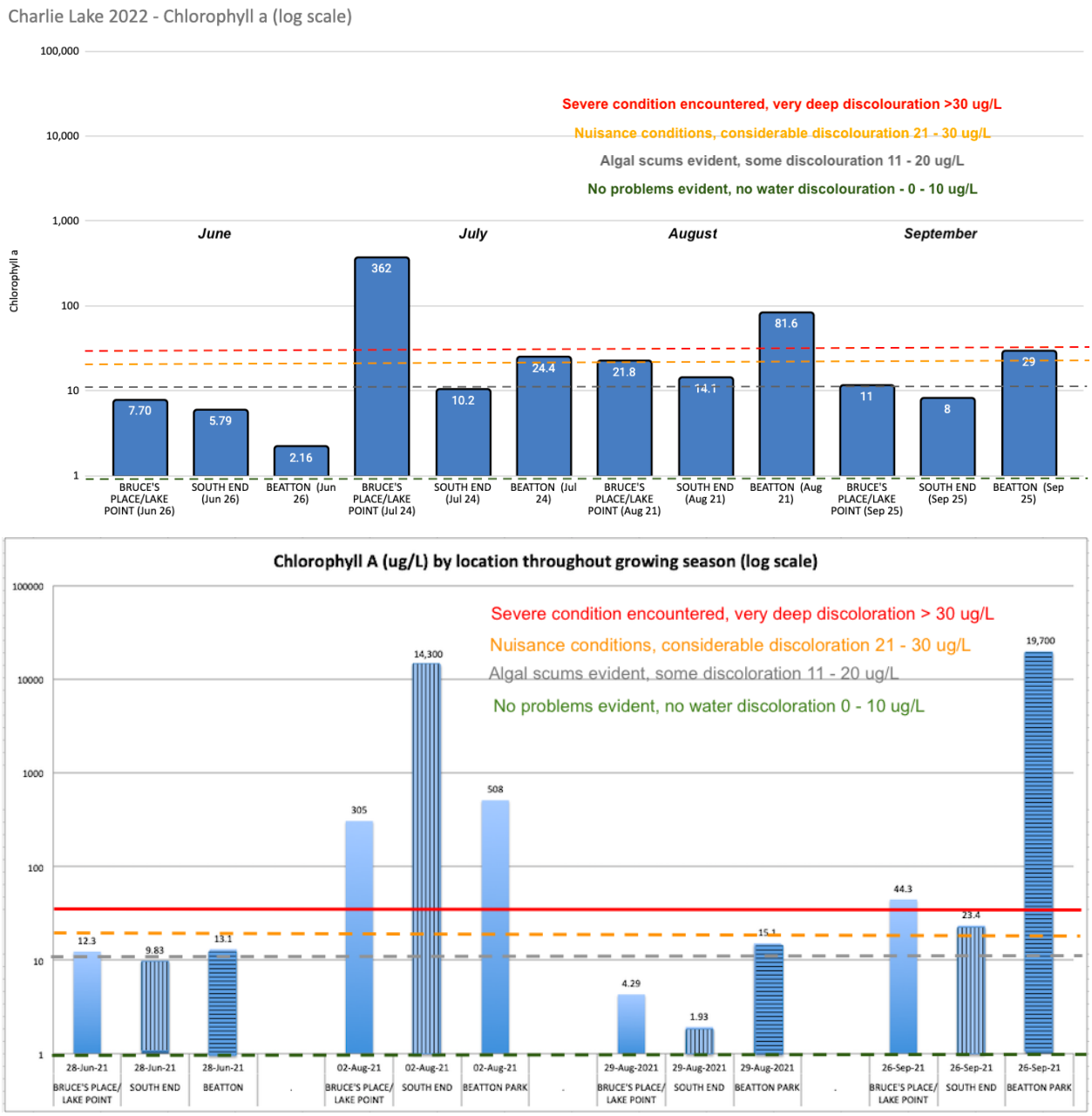


Figure 6 - Chlorophyll a (2022 and 2021)

Most readings indicate that conditions were right for algae scums and discolouration and favourable for nuisance/severe conditions in July through to September.

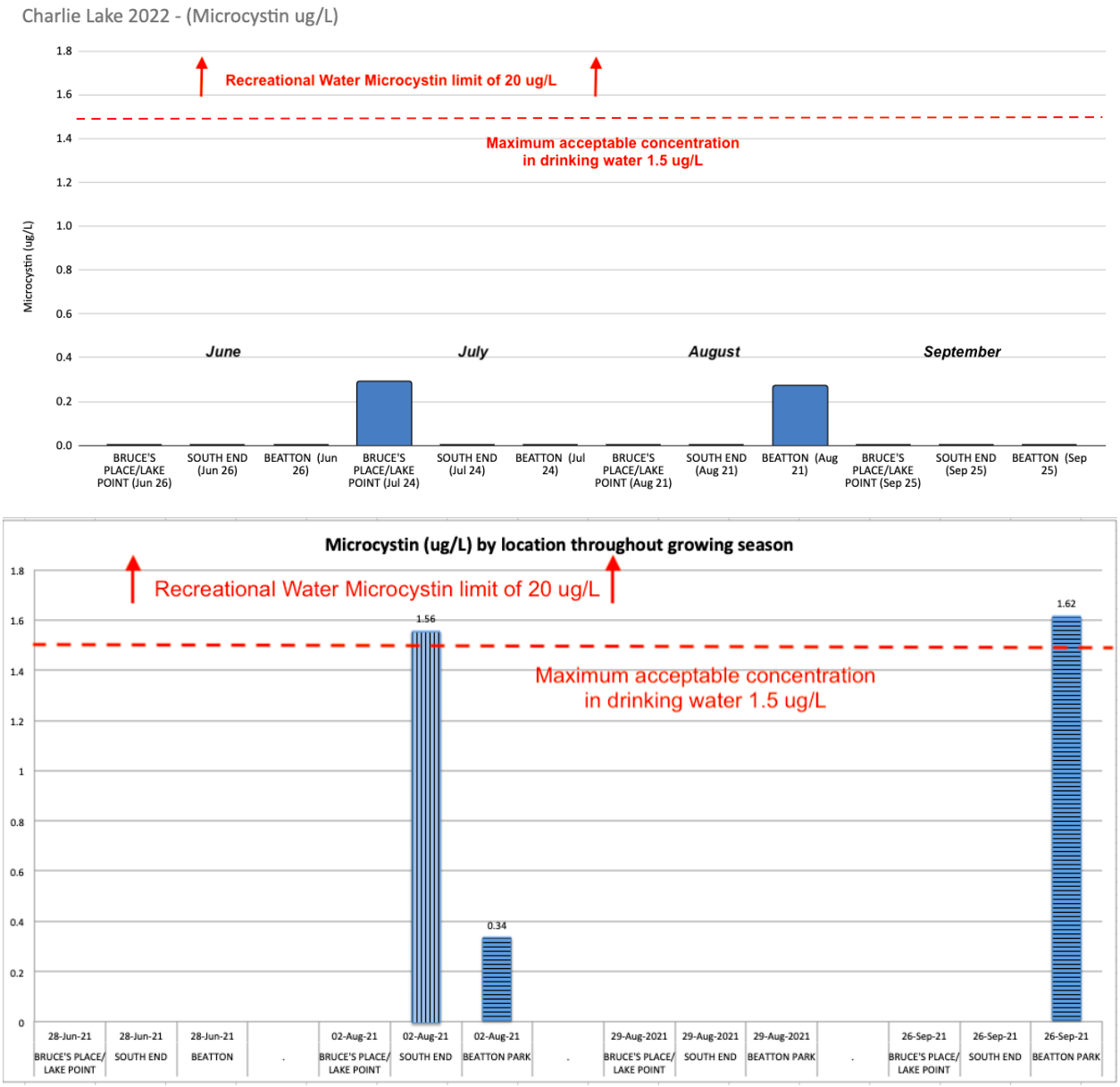
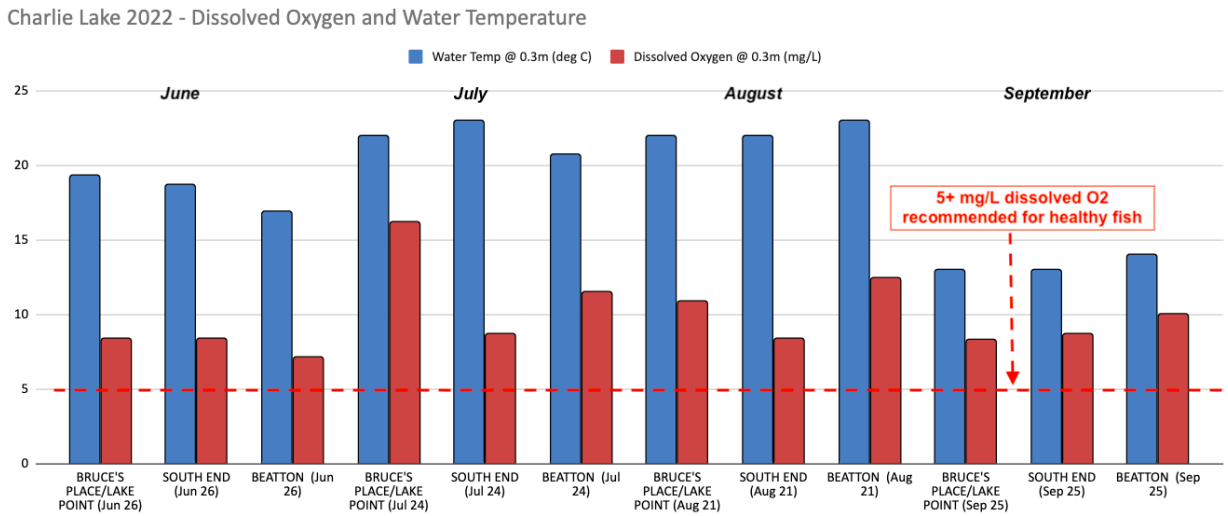


Figure 7 - Microcystin (2022 and 2021)

Microcystin toxins were well below recreational water limits throughout the sampling period. Consistent with the lower cyanobacteria levels observed in 2022, microcystin levels were also lower (maximum 0.29 µg/L) than 2021 when the maximum concentration was 1.62 µg/L.



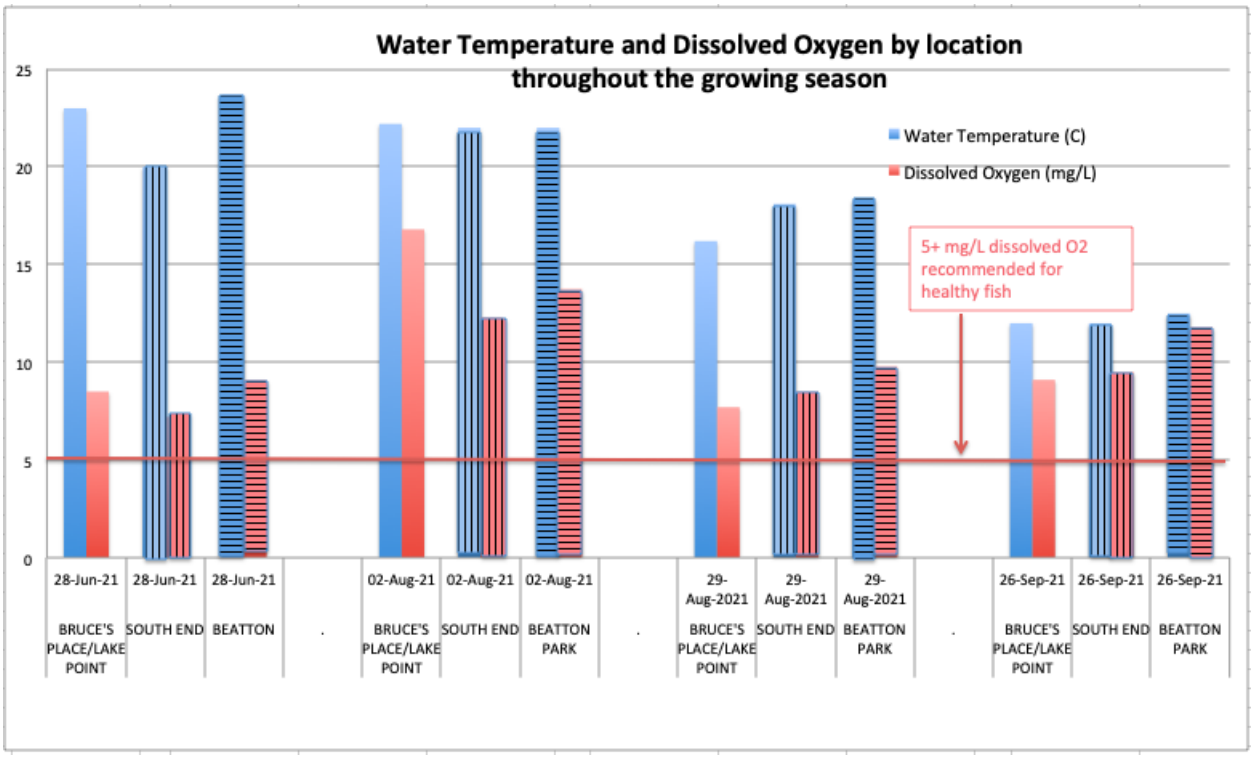
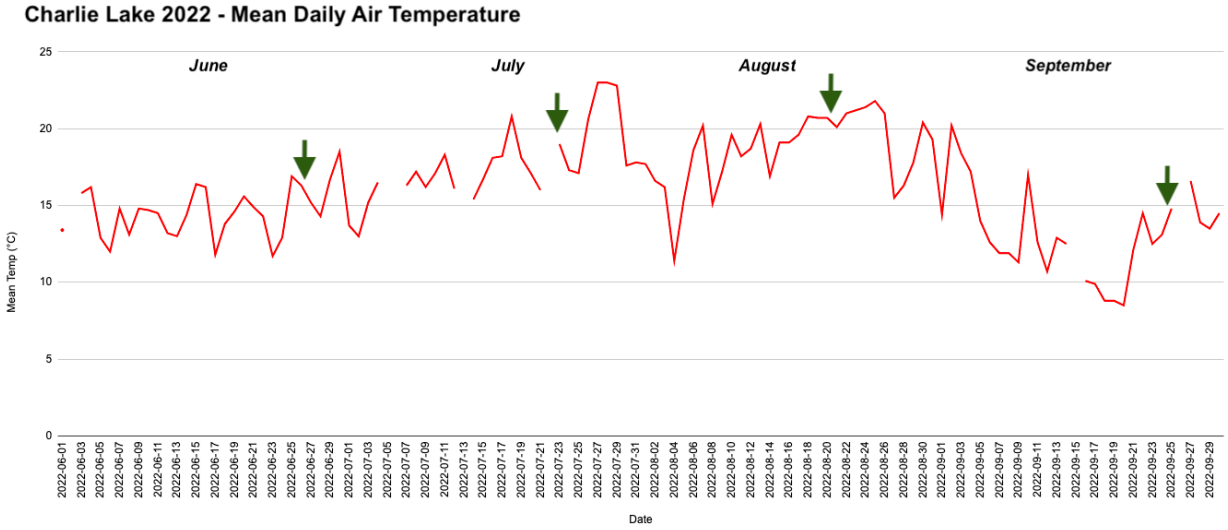


Figure 8 - Water Temperature and Dissolved Oxygen (2022 and 2021)

No harmful declines in dissolved oxygen levels were observed in 2022 or 2021. Water temperatures were cooler in June and warmer in August 2022 compared to the previous year.

Weather Patterns During 2022 and 2021 Sampling Seasons
(Environment Canada - FSJ, BC)



(green arrows indicate sampling dates)

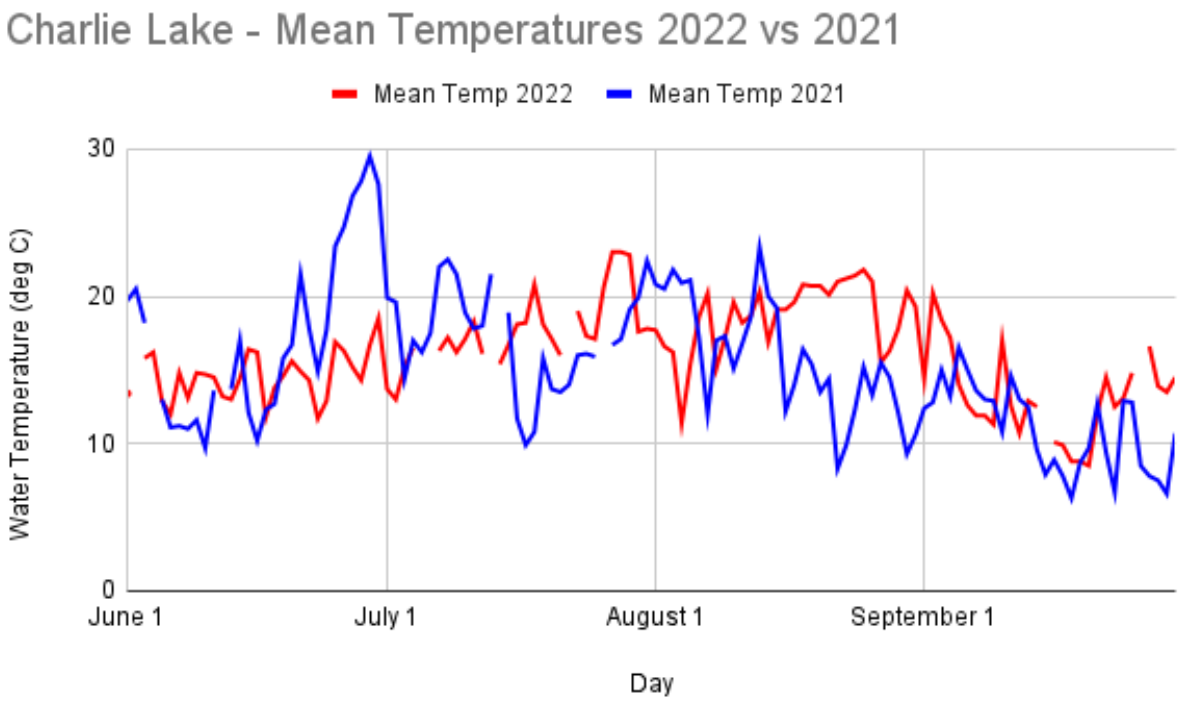


Figure 9- Mean Air Temperature

Temperatures in 2022 were more moderate in June compared to 2021 when a “heat dome” occurred in late June. August 2022 saw warmer temperatures through the month compared to the previous year.
The mean temperature for this period in 2022 was 15.1 deg C slightly lower than 2021 (16.1 deg C).

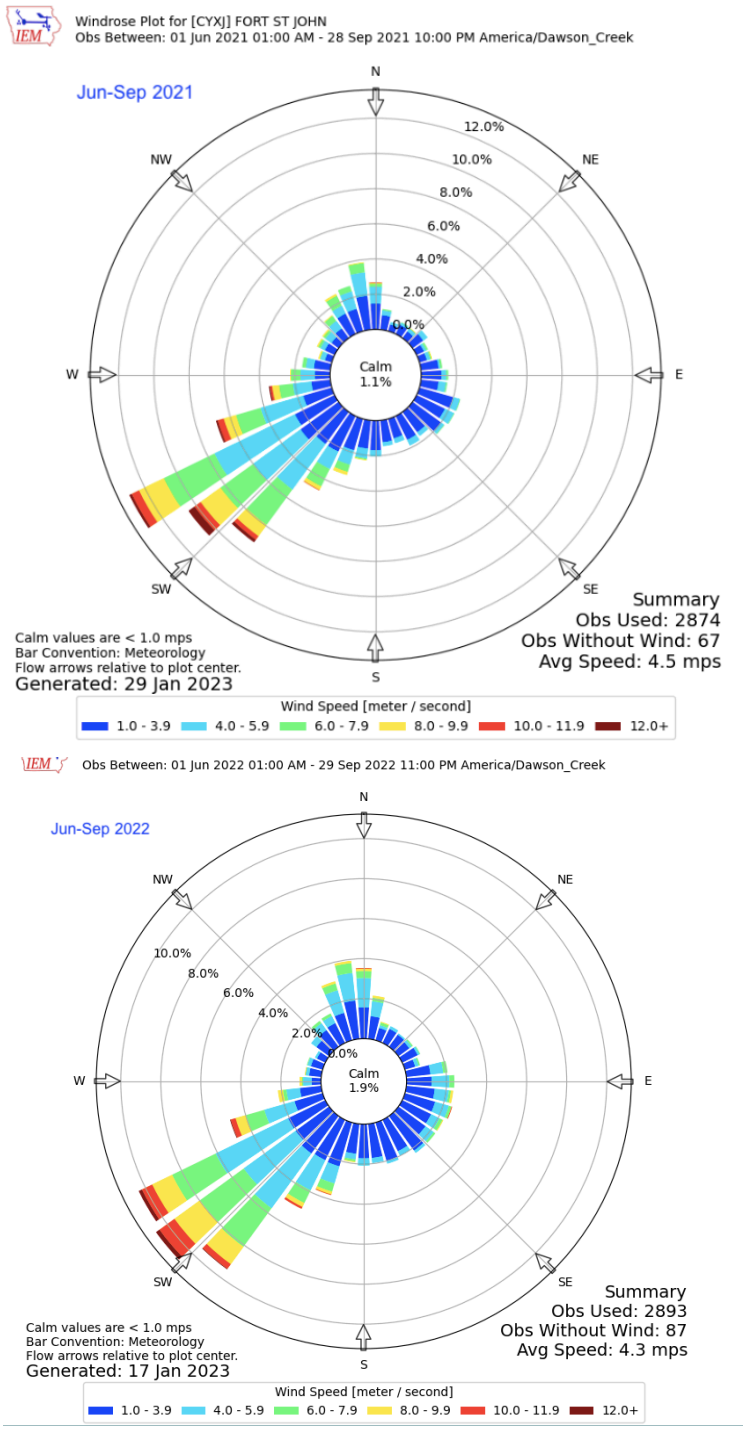


Figure 10 - Wind Speed and Direction (2022 and 2021)

Winds throughout the sampling period predominantly blew from the NW, W and SW in a similar pattern over the two years.

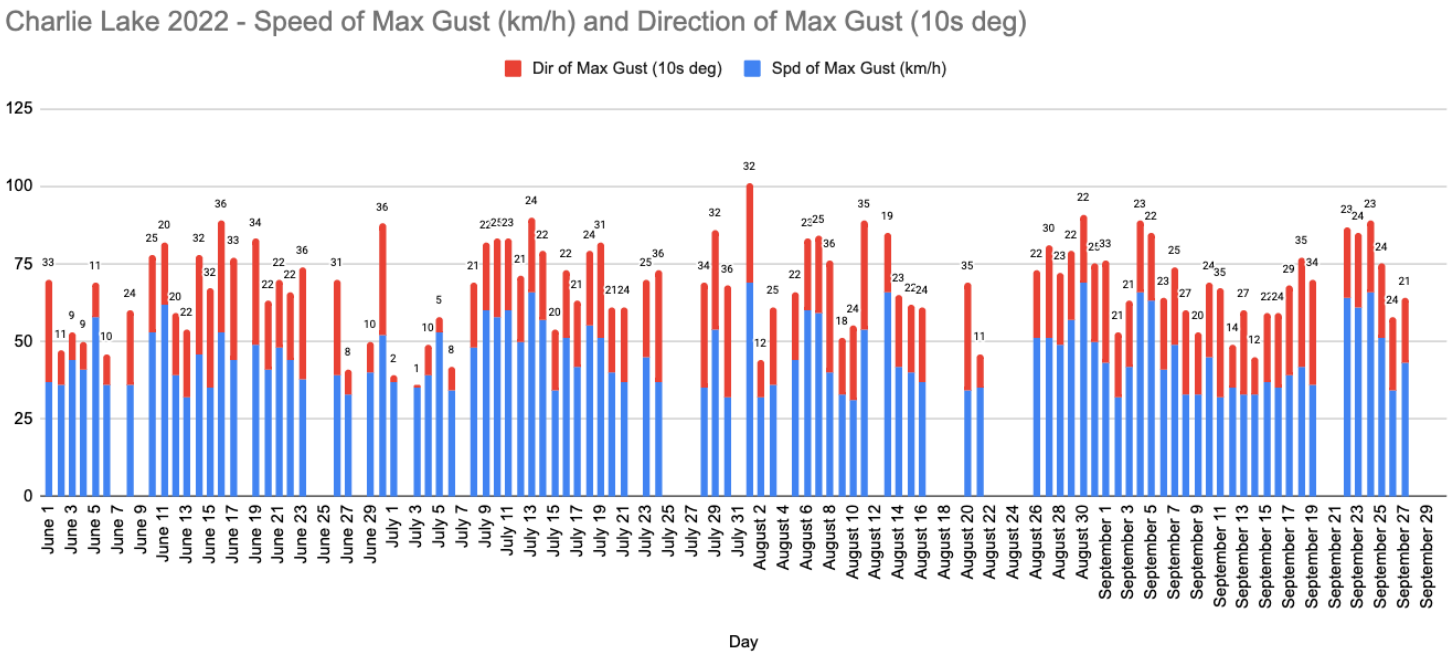


Figure 11 - Maximum Daily Wind Gusts and Direction (2022)

Only one bloom was observed at Site #1 Bruce's Place / Lake Point in July. The conditions observed were calm prior to sampling, but wind gusts developed later as recorded in the maximum daily gust.

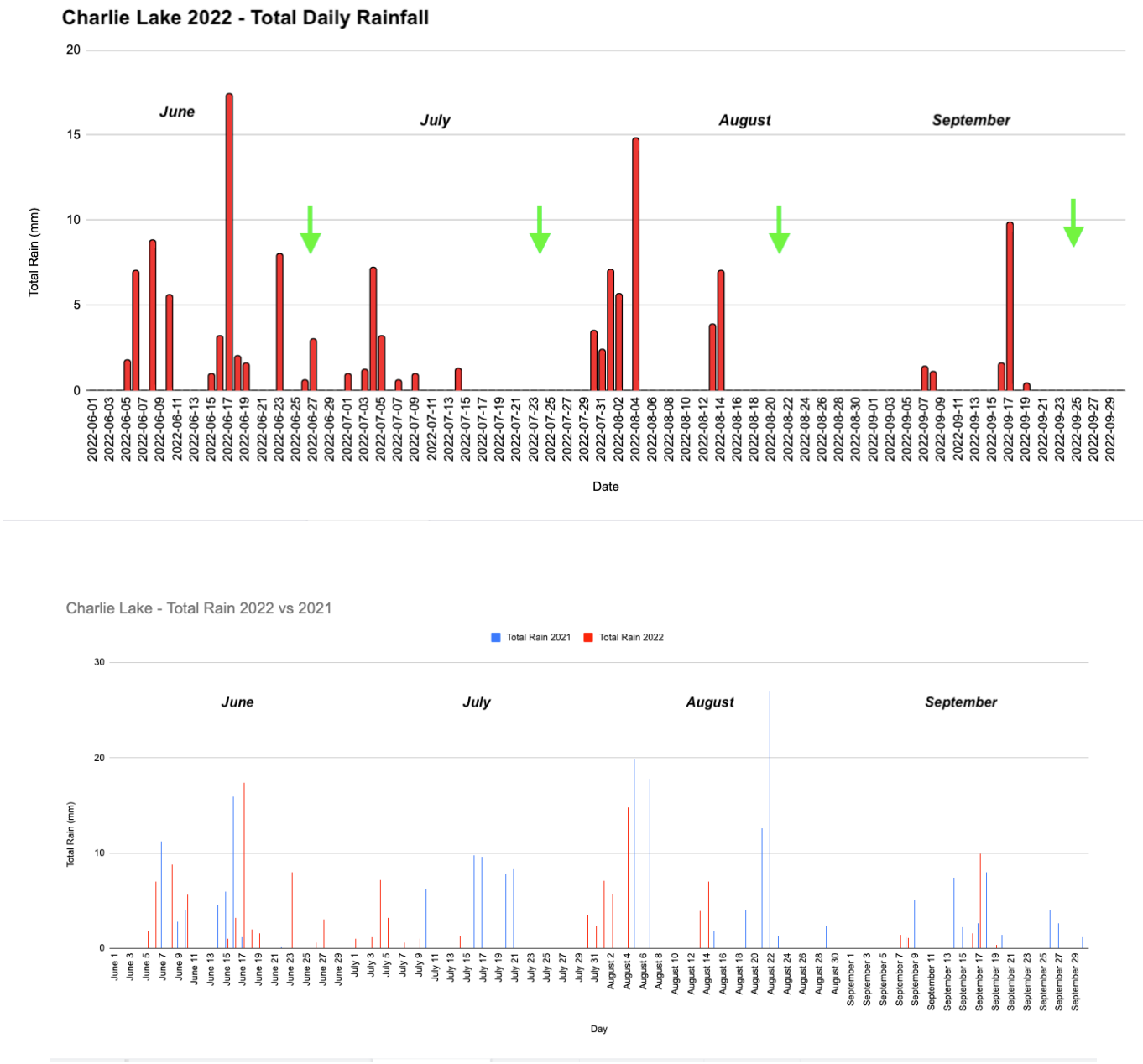


Figure 12- Total Rain (2022) and Combined Total Rain (2021 vs 22)

Rainfall in 2022 was considerably less than in 2021 (134 vs 215 mm). Less nutrient input from less runoff due to lower rainfall may be a greater factor than the increase in sunnier days for the growth of cyanobacteria.

8. Acknowledgements

The Charlie Lake Conservation Society is grateful for the support of the Peace River Regional District over the years and also for funding this study.

Thanks to the Charlie Lake Conservation Society volunteers, Glynnis Maundrell and Bruce Kosugi.

Thank you to Rick Nordin and the British Columbia Lake Stewardship Society for continued support and review of this report.

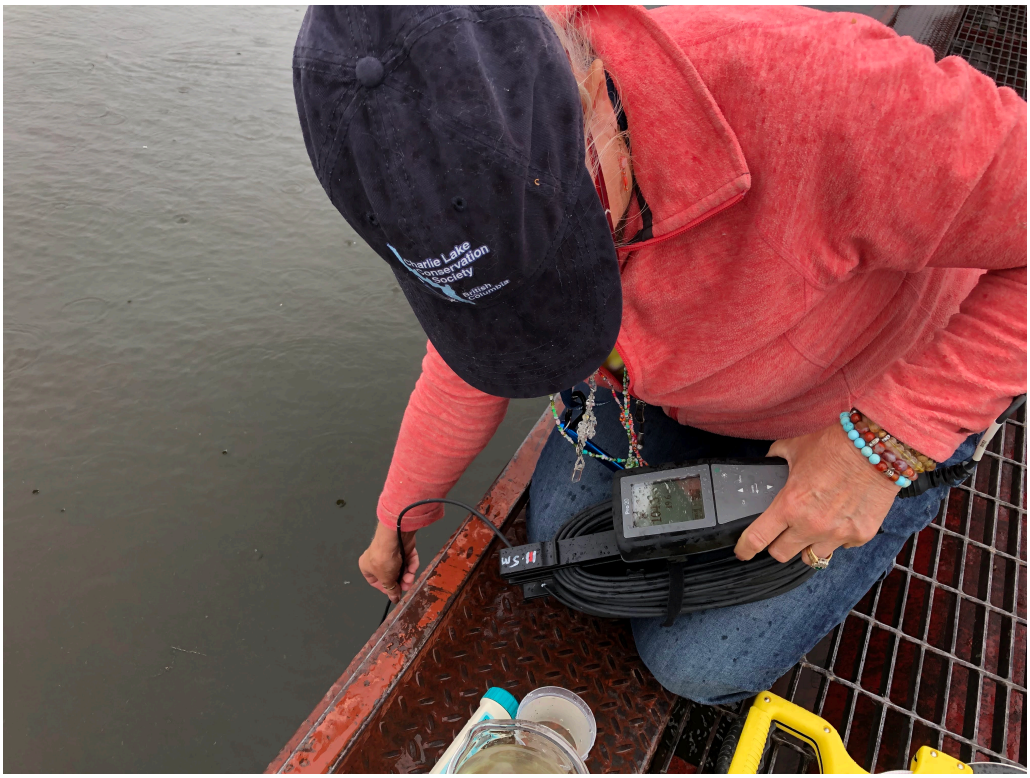


Figure 13 - Measuring Dissolved Oxygen and Water Temperature

9. References

BC Lake Stewardship and Monitoring Program Charlie Lake 2003-2005 & 2016-2018, BCLSS and the BC Ministry of Environment and Climate Change Strategy, 2020
https://www.bclss.org/document-library

Cyanobacteria Blooms (Blue-green Algae), HealthLinkBC File Number: 47, Northern Health website, 2021
https://www.healthlinkbc.ca/healthlinkbc-files/blue-green-algae

Dissolved Oxygen in Water, Water Research Centre, 2021
https://www.knowyourh2o.com/outdoor-4/dissolved-oxygen-in-water

Ecosystem and Lake Productivity by Chlorophyll Analysis, Water Research Centre, 2021
https://www.knowyourh2o.com/outdoor-4/ecosystem-and-lake-productivity-by-chlorophyll-analysis

Eutrophication Analysis for Recreation Opportunities Cyanobacteria/Blue Green Algae Survey of Charlie Lake, 2021*, Charlie Lake Conservation Society, 2022*

Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Cyanobacterial Toxins, Health Canada, 2021
https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-cyanobacterial-toxins-document.html#11_0_Rationale_for_guideline

Guidelines for Canadian Recreational Water Quality: Third Edition, Health Canada, 2012
https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-recreational-water-quality-third-edition.html

Harmful Algal Bloom Water Quality | Everything You Need To Know
S.Smith, YSI website, September 2016
https://www.ysi.com/ysi-blog/water-blogged-blog/2016/09/harmful-algal-blooms-everything-you-need-to-know

Learn about Cyanobacteria and Cyanotoxins, EPA website, 2021
https://www.epa.gov/cyanohabs/learn-about-cyanobacteria-and-cyanotoxins

Monitoring for Harmful Algal Blooms: From Data to Decisions | Part 1 of 2
S.Smith, YSI website, October 2017
https://www.ysi.com/ysi-blog/water-blogged-blog/2017/10/monitoring-for-harmful-algal-blooms-from-data-to-decisions-part-1-of-2

Recommendations for Cyanobacteria and Cyanotoxin Monitoring in Recreational Waters, EPA, EPA 823-R-19-001 September 2019
https://www.epa.gov/cyanohabs/recommendations-cyanobacteria-and-cyanotoxin-monitoring-recreational-waters

Wind Roses from airports around the world - Graphics or Raw Data Tables
https://www.climate.gov/maps-data/dataset/wind-roses-airports-around-world-graphics-or-raw-data-tables

Appendix I - Photos of Water Samples Showing Various Levels of Algae



June 26 2022
Site #1, Bruce's Place/Lake Point

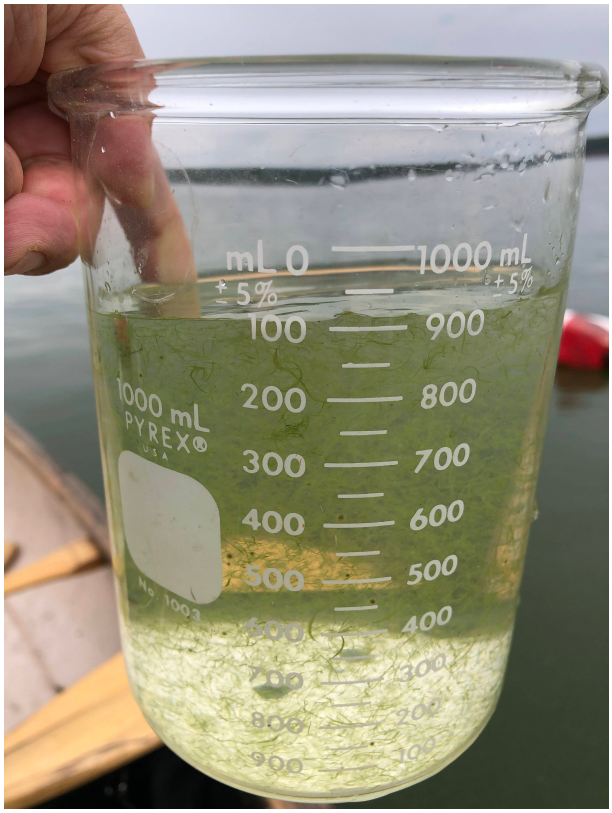
Clear with a small amount of algae filaments observed

Total cyanobacteria cell count 2,370 cells/mL (low count)

July 24 2022
Site #1, Bruce's Place/Lake Point

Lots of algae (grass-clippings like) suspended

Total cyanobacteria cell count 379,000 cells/mL (massive count) but not a full bloom where a scum layer is typically present on surface



Jul 2022
Site #2, South End

Some algae suspended

Total cyanobacteria cell count 4,290 cells/mL (moderate count)





Jul 2022
Site #3, Beatton

Some algae suspended

Total cyanobacteria cell count 40,200 cells/mL (large count)

Appendix II - Lab testing and Equipment

Lab testing (conducted by ALS Group's Environmental Division)

Water Enumeration of blue green algae cells APHA 10200 C & F
Samples are prepared by sedimentation/settling and examined using a compound phase contrast inverted microscope. Cyanobacteria (also known as blue-green algae) are identified to genus and the cells are enumerated. The total cyanobacteria count is also reported.

Water Algae Identification Microscopic Examination Standard Methods 10200, 2005
This procedure is applicable to the general identification of algae occurring in samples of fresh water. Samples are prepared using a sedimentation technique, and are then examined using a compound phase contrast inverted microscope. This test is a general screen of dominant types of algae. Dominant genera of algae are reported.

Water Chlorophyll a by fluorometry EPA 445.0 ACET
This analysis is done using procedures modified from EPA method 445.0. Chlorophyll a is determined by a 90 % acetone extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b.

Water Microcystin ENVIROLOGIX QUANTIPLATE KIT CAT. EP022HS
Total Microcystins (intraceller and extraceller) in aqueous matrices is determined by the Enzyme-Linked ImmunoSorbent Assay (ELISA) method.

Field equipment

Dissolved Oxygen Meter YSI Pro20, temperature and dissolved oxygen measurement with Galvanic DO Sensor, 20 m cable

Secchi Disk, 8-inch diameter

Appendix III – Sampling Observations and Lab Results

June 26 2022 Sampling Observations

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON	Duplicate (Beatton)
	Date Sampled		26-Jun-22	26-Jun-22	26-Jun-22	26-Jun-22
	Time Sampled		20:00	18:30	19:00	19:00
Sky conditions			cloudy	rainy	cloudy	cloudy
Wind Conditions			calm	light breeze (N)	light breeze (N)	light breeze (N)
Water conditions			slight ripple	ripples	slight ripple	slight ripple
Water Temp @ 0.3m (deg C)			19.3	18.7	16.9	16.9
Dissolved Oxygen @ 0.3m (mg/L)			8.4	8.4	7.1	7.1
Water Temp @ 2m (deg C)			19.3			
Dissolved Oxygen @ 2m (mg/L)			8.7			
Observations			clear with some algae filaments	slightly cloudy, no algae visible, pollen on surface	clear, no algae visible, no pollen visible	clear, no algae visible, no pollen visible

June 26, 2022 – Lab results

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON	Duplicate (Beatton)
	Date Sampled		26-Jun-22	26-Jun-22	26-Jun-22	26-Jun-22
	Time Sampled		20:00	18:30	19:00	19:00
Taxonomy (Water)						
Achnanthes (Bacillariophyceae)	1.0	-		Small amount		
Amphora (Bacillariophyceae)	1.0	-		Small amount		
Anabaena (Cyanophyceae)	1	cells/mL	Small amount	Small amount		Small amount
Anabaena (Cyanophyceae)	1.0	-	69	20		2
Aphanizomenon (Cyanophyceae)	1	-	Small amount	Small amount	Small amount	Small amount
Aphanizomenon (Cyanophyceae)	1	cells/mL	2,200	196	24	18
Asterionella (Fragilariophyceae)	1	cells/mL	Small amount	Small amount	Small amount	Small amount
Total cyanobacterial cell count			**2,370**	**415**	**24**	**30**
Plant Pigments (Water)						
Chlorophyll a	0.10	ug/L	7.70	5.79	2.16	1.97
Organic Parameters (Water)						
Microcystin	0.20	ug/L	<0.20	<0.20	<0.20	<0.20

June 26, 2022 – Lab results (continued)

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON	Duplicate (Beatton)
	Date Sampled		26-Jun-22	26-Jun-22	26-Jun-22	26-Jun-22
	Time Sampled		20:00	18:30	19:00	19:00
Unidentified filamentous blue-green	1	cells/mL	24	127		
Amphora (Bacillariophyceae)	1.0	-				
Botryococcus (Chlorophyceae)	1.0	-				
Ceratium (Dinophyceae)	1.0	-				
Closterium (Chlorophyceae)	1.0	-		Small amount		
Cocconeis (Bacillariophyceae)	1.0	-		Small amount		
Cryptomonas (Cryptophyceae)	1.0	-	Small amount	Small amount	Small amount	Small amount
Cyclotella (Coscinodiscophyceae)	1.0	-		Small amount		
Cymbella (Bacillariophyceae)	1.0	-		Small amount		
Euglena (Euglenophyceae)	1.0	-				
Eunotia (Bacillariophyceae)	1.0	-	Small amount		Small amount	Small amount
Fragilaria (Fragilariophyceae)	1.0	-		Small amount		
Gomphosphaeria (Cyanophyceae)	1.0	-				Small amount
Gomphosphaeria (Cyanophyceae)	1	cells/mL				10
Gyrosigma (Bacillariophyceae)	1.0	-				
Lyngbya (Cyanophyceae)	1.0	-				
Lyngbya (Cyanophyceae)	1	cells/mL				
Mallomonas (Chrysophyceae)	1.0	-	Small amount	Small amount		Small amount
Melosira (Coscinodiscophyceae)	1.0	-		Small amount	Small amount	
Microcystis (Cyanophyceae)	1.0	-				
Microcystis (Cyanophyceae)	1.0	cells/mL				
Navicula (Bacillariophyceae)	1.0	-		Small amount	Small amount	
Nitzschia (Bacillariophyceae)	1.0	-	Small amount	Small amount		
Oscillatoria (Cyanophyceae)	1.0	-	Small amount			
Oscillatoria (Cyanophyceae)	1	cells/mL	1			
Other	1.0	-	Moderate amount	Small amount		
Pediastrum (Chlorophyceae)	1.0					
Planktolyngbya (Cyanophyceae)	1.0	-		Small amount		
Planktolyngbya (Cyanophyceae)	1	cells/mL		50		
Planktosphaeria (Chlorophyceae)	1.0	-		Small amount	Small amount	
Pseudanabaena (Cyanophyceae)	1.0	-	Small amount	Small amount		
Pseudanabaena (Cyanophyceae)	1	cells/mL	78	10		
Rhoicosphenia (Bacillariophyceae)	1.0	-		Small amount		
Schroederia (Chlorophyceae)	1.0	-	Moderate amount	Moderate amount	Moderate amount	Moderate amount
Small Chrysophytes (Chrysophyceae)	1.0	-				
Spirulina (Cyanophyceae)	1.0	-		Small amount		
Spirulina (Cyanophyceae)	1	cells/mL		12		
Stephanodiscus (Coscinodiscophyceae)	1.0	-				
Surirella (Bacillariophyceae)	1.0					
Synedra (Fragilariophyceae)	1.0	-	Small amount	Small amount		
Tabellaria (Fragilariophyceae)	1.0	-				
Trachelomonas (Euglenophyceae)	1.0	-			Small amount	
Unidentified	1.0	-	Small amount	Small amount		Small amount
Woronichinia (Cyanophyceae)	1	cells/mL				

July 24 2022 – Sampling Observations

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK	Duplicate (Beatton)
	Date Sampled		24-Jul-22	24-Jul-22	24-Jul-22	24-Jul-22
	Time Sampled		17:00	18:00	18:30	19:30
Parameter	Lowest Detection Limit	Units				
Water Depth (m)			2.3	1.1	1.6	1.6
Secchi (m)			0.5	1.1+	1.2	1.2
Air Temp (deg C)			22	22	19	19
Sky conditions			cloudy	rain	rain	rain
Wind Conditions			calm	cal	strong breeze W	strong breeze W
Water conditions			boat ripples	boat ripples	white caps	white caps
Water Temp @ 0.3m (deg C)			22	23	20.7	20.7
Dissolved Oxygen @ 0.3m (mg/L)			16.2	8.7	11.5	11.5
Water Temp @ 2m (deg C)			20			
Dissolved Oxygen @ 2m (mg/L)			9.5			
Observations			lots of algae (grass-clippings like) suspended	some algae suspended	some algae suspended	some algae suspended

July 24 2022 – – Lab Results

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK	Duplicate (Beatton)
	Date Sampled		24-Jul-22	24-Jul-22	24-Jul-22	24-Jul-22
	Time Sampled		17:00	18:00	18:30	19:30
Taxonomy (Water)						
Achnanthes (Bacillariophyceae)	1.0	-				
Amphora (Bacillariophyceae)	1.0	-				
Anabaena (Cyanophyceae)	1	cells/mL	Small amount	Small amount	Small amount	Small amount
Anabaena (Cyanophyceae)	1.0	-	217	1,090	1,050	744
Aphanizomenon (Cyanophyceae)	1	-	Massive amount	Moderate amount	Large amount	Large amount
Aphanizomenon (Cyanophyceae)	1	cells/mL	375,000	3,100	38,600	30,700
Asterionella (Fragilariophyceae)	1	cells/mL		Small amount		
Total cyanobacterial cell count			**379,000**	**4,290**	**40,200**	**31,500**
Plant Pigments (Water)						
Chlorophyll a	0.10	ug/L	362	10.2	24.4	25.3
Organic Parameters (Water)						
Microcystin	0.20	ug/L	0.29	<0.20	<0.20	<0.20

July 24 2022 – – Lab Results (continued)

			SOUTH END	BEATTON PARK	Duplicate (Beatton)
	Date Sampled		24-Jul-22	24-Jul-22	24-Jul-22
	Time Sampled		18:00	18:30	19:30
Unidentified filamentous blue-green	1	cells/mL			
Amphora (Bacillariophyceae)	1.0	-			
Botryococcus (Chlorophyceae)	1.0	-			
Ceratium (Dinophyceae)	1.0	-		Small amount	Small amount
Closterium (Chlorophyceae)	1.0	-			
Cocconeis (Bacillariophyceae)	1.0	-			
Cryptomonas (Cryptophyceae)	1.0	-			
Cyclotella (Coscinodiscophyceae)	1.0	-			
Cymbella (Bacillariophyceae)	1.0	-	Small amount		
Euglena (Euglenophyceae)	1.0	-			
Eunotia (Bacillariophyceae)	1.0	-			
Fragilaria (Fragilariophyceae)	1.0	-	Small amount	Small amount	Small amount
Gomphosphaeria (Cyanophyceae)	1.0	-			
Gomphosphaeria (Cyanophyceae)	1	cells/mL			
Gyrosigma (Bacillariophyceae)	1.0	-			
Lyngbya (Cyanophyceae)	1.0	-		Small amount	
Lyngbya (Cyanophyceae)	1	cells/mL		300	
Mallomonas (Chrysophyceae)	1.0	-			
Melosira (Coscinodiscophyceae)	1.0	-		Small amount	Small amount
Microcystis (Cyanophyceae)	1.0	-	Small amount		
Microcystis (Cyanophyceae)	1.0	cells/mL	50	200	
Navicula (Bacillariophyceae)	1.0	-			
Nitzschia (Bacillariophyceae)	1.0	-	Small amount		
Oscillatoria (Cyanophyceae)	1.0	-			
Oscillatoria (Cyanophyceae)	1	cells/mL			
Other	1.0	-	Small amount		Small amount
Pediastrum (Chlorophyceae)	1.0				
Planktolyngbya (Cyanophyceae)	1.0	-			
Planktolyngbya (Cyanophyceae)	1	cells/mL			
Planktosphaeria (Chlorophyceae)	1.0	-			
Pseudanabaena (Cyanophyceae)	1.0	-			
Pseudanabaena (Cyanophyceae)	1	cells/mL			
Rhoicosphenia (Bacillariophyceae)	1.0	-			
Schroederia (Chlorophyceae)	1.0	-	Small amount		
Small Chrysophytes (Chrysophyceae)	1.0	-	Small amount		
Spirulina (Cyanophyceae)	1.0	-			
Spirulina (Cyanophyceae)	1	cells/mL			
Stephanodiscus (Coscinodiscophyceae)	1.0	-			
Surirella (Bacillariophyceae)	1.0				
Synedra (Fragilariophyceae)	1.0	-			
Tabellaria (Fragilariophyceae)	1.0	-	Small amount		
Trachelomonas (Euglenophyceae)	1.0	-	Small amount	Small amount	Small amount
Unidentified	1.0	-			
Woronichinia (Cyanophyceae)	1	cells/mL	50		50

August 21 2022 – Sampling Observations

			SOUTH END	BEATTON PARK	Duplicate (Beatton)
	Date Sampled		21-Aug-2022	21-Aug-2022	21-Aug-2022
	Time Sampled		18:00	18:30	18:00
Parameter	Lowest Detection Limit	Units			
Water Depth (m)			1	1.1	1
Secchi (m)			1+	1	1+
Air Temp (deg C)			26	26	26
Sky conditions			sunny	sunny	sunny
Wind Conditions			breeze from SE	breeze from SE	breeze from SE
Water conditions			ripple	ripple	ripple
Water Temp @ 0.3m (deg C)			22		22
Dissolved Oxygen @ 0.3m (mg/L)			8.4		8.4
Water Temp @ 2m (deg C)					
Dissolved Oxygen @ 2m (mg/L)					
Observations			some algae suspended	some algae suspended, slightly more than other areas	some algae suspended, slightly more than other areas

August 21 2022 – Lab Results

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK	Duplicate (Beatton)
	Date Sampled		21-Aug-2022	21-Aug-2022	21-Aug-2022	21-Aug-2022
	Time Sampled		16:30	18:00	18:30	18:00
Taxonomy (Water)						
Achnanthes (Bacillariophyceae)	1.0	-				
Amphora (Bacillariophyceae)	1.0	-				
Anabaena (Cyanophyceae)	1	cells/mL				80
Anabaena (Cyanophyceae)	1.0	-		Small amount		
Aphanizomenon (Cyanophyceae)	1	-	Large Amount	Moderate amount	Large amount	Large amount
Aphanizomenon (Cyanophyceae)	1	cells/mL	16,300	961	38,600	26,700
Asterionella (Fragilariophyceae)	1	cells/mL	Large Amount			
Total cyanobacterial cell count			18,200	3,850	47,900	32,400
Plant Pigments (Water)						
Chlorophyll a	0.10	ug/L	22	14	82	15
Organic Parameters (Water)						
Microcystin	0.20	ug/L	<0.20	<0.20	0	

August 21 2022 – Lab Results (continued)

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK	Duplicate (Beatton)
	Date Sampled		21-Aug-2022	21-Aug-2022	21-Aug-2022	21-Aug-2022
	Time Sampled		16:30	18:00	18:30	18:00
Unidentified filamentous blue-green	1	cells/mL				
Amphora (Bacillariophyceae)	1.0	-		Small amount		sm
Botryococcus (Chlorophyceae)	1.0	-				
Ceratium (Dinophyceae)	1.0	-	sm		sm	
Closterium (Chlorophyceae)	1.0	-		Small amount		
Cocconeis (Bacillariophyceae)	1.0	-	small amount	Small amount		sm
Cryptomonas (Cryptophyceae)	1.0	-		Small amount	sm	sm
Cyclotella (Coscinodiscophyceae)	1.0	-				
Cymbella (Bacillariophyceae)	1.0	-		Small amount		
Euglena (Euglenophyceae)	1.0	-				
Eunotia (Bacillariophyceae)	1.0	-				
Fragilaria (Fragilariophyceae)	1.0	-		Small amount	sm	sm
Gomphosphaeria (Cyanophyceae)	1.0	-				
Gomphosphaeria (Cyanophyceae)	1	cells/mL				350
Gyrosigma (Bacillariophyceae)	1.0	-		Small amount		
Lyngbya (Cyanophyceae)	1.0	-	small amount	Small amount	sm	sm
Lyngbya (Cyanophyceae)	1	cells/mL	160		2,400	350
Mallomonas (Chrysophyceae)	1.0	-		Small amount		
Melosira (Coscinodiscophyceae)	1.0	-		Small amount		sm
Microcystis (Cyanophyceae)	1.0	-		Small amount	sm	
Microcystis (Cyanophyceae)	1.0	cells/mL		1,200	1,900	
Navicula (Bacillariophyceae)	1.0	-		Small amount		sm
Nitzschia (Bacillariophyceae)	1.0	-		Small amount	sm	sm
Oscillatoria (Cyanophyceae)	1.0	-				
Oscillatoria (Cyanophyceae)	1	cells/mL				
Other	1.0	-	small amount		sm	sm
Pediastrum (Chlorophyceae)	1.0		small amount			
Planktolyngbya (Cyanophyceae)	1.0	-				
Planktolyngbya (Cyanophyceae)	1	cells/mL	260	820		
Planktosphaeria (Chlorophyceae)	1.0	-				
Pseudanabaena (Cyanophyceae)	1.0	-	small amount		Moderate amount	Moderate amount
Pseudanabaena (Cyanophyceae)	1	cells/mL	1,490	868	4,950	4,950
Rhoicosphenia (Bacillariophyceae)	1.0	-	small amount	sm		
Schroederia (Chlorophyceae)	1.0	-			sm	sm
Small Chrysophytes (Chrysophyceae)	1.0	-	small amount			
Spirulina (Cyanophyceae)	1.0	-				
Spirulina (Cyanophyceae)	1	cells/mL				
Stephanodiscus (Coscinodiscophyceae)	1.0	-	small amount	sm	sm	sm
Surirella (Bacillariophyceae)	1.0					sm
Synedra (Fragilariophyceae)	1.0	-	small amount			
Tabellaria (Fragilariophyceae)	1.0	-				
Trachelomonas (Euglenophyceae)	1.0	-	small amount	sm	sm	sm
Unidentified	1.0	-				
Woronichinia (Cyanophyceae)	1	cells/mL				

September 25 2022 – Sampling Observations

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK
	Date Sampled		25-Sep-22	25-Sep-22	25-Sep-22
	Time Sampled		1	1	1
Parameter	Lowest Detection Limit	Units			
Water Depth (m)			2	1	1
Secchi (m)			2	.85+	1.4+
Air Temp (deg C)			18	18	18
Sky conditions			overcast	overcast	sun/cloud
Wind Conditions			breeze SW	breeze SW	breeze SW
Water conditions			wavy	ripples	white caps
Water Temp @ 0.3m (deg C)			13	13	14
Dissolved Oxygen @ 0.3m (mg/L)			8	9	10
Water Temp @ 2m (deg C)			13		
Dissolved Oxygen @ 2m (mg/L)			8		
Observations			very small amount of algae (grass-like clippings)	small amount of algae (grass-like clippings)	some algae (grass-like clippings)

September 25 2022 – Lab results

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK
	Date Sampled		25-Sep-22	25-Sep-22	25-Sep-22
	Time Sampled		1	1	1
Taxonomy (Water)					
Achnanthes (Bacillariophyceae)	1.0	-			
Amphora (Bacillariophyceae)	1.0	-			
Anabaena (Cyanophyceae)	1	cells/mL			
Anabaena (Cyanophyceae)	1.0	-			
Aphanizomenon (Cyanophyceae)	1	-	Small amount	Small amount	Large amount
Aphanizomenon (Cyanophyceae)	1	cells/mL	430		22,300
Asterionella (Fragilariophyceae)	1	cells/mL			
Total cyanobacterial cell count			930	240	26,300
Plant Pigments (Water)					
Chlorophyll a	0.10	ug/L	11	8	29
Organic Parameters (Water)					
Microcystin	0.20	ug/L	<0.20	<0.20	<0.20

September 25 2022 – Lab results (continued)

			BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK	Duplicate (not collected)
	Date Sampled		25-Sep-22	25-Sep-22	25-Sep-22	25-Sep-22
	Time Sampled		1	1	1	
Unidentified filamentous blue-green	1	cells/mL				
Amphora (Bacillariophyceae)	1.0	-				
Botryococcus (Chlorophyceae)	1.0	-			Small amount	
Ceratium (Dinophyceae)	1.0	-			Small amount	
Closterium (Chlorophyceae)	1.0	-	Small amount		Small amount	
Cocconeis (Bacillariophyceae)	1.0	-	Small amount	Small amount		
Cryptomonas (Cryptophyceae)	1.0	-	Small amount	Moderate amount	Small amount	
Cyclotella (Coscinodiscophyceae)	1.0	-	Small amount			
Cymbella (Bacillariophyceae)	1.0	-				
Euglena (Euglenophyceae)	1.0	-		Small amount		
Eunotia (Bacillariophyceae)	1.0	-				
Fragilaria (Fragilariophyceae)	1.0	-				
Gomphosphaeria (Cyanophyceae)	1.0	-	Small amount			
Gomphosphaeria (Cyanophyceae)	1	cells/mL	400			
Gyrosigma (Bacillariophyceae)	1.0	-				
Lyngbya (Cyanophyceae)	1.0	-	Small amount		Small amount	
Lyngbya (Cyanophyceae)	1	cells/mL			20	
Mallomonas (Chrysophyceae)	1.0	-				
Melosira (Coscinodiscophyceae)	1.0	-	Small amount			
Microcystis (Cyanophyceae)	1.0	-	Small amount	Small amount	Small amount	
Microcystis (Cyanophyceae)	1.0	cells/mL		200		
Navicula (Bacillariophyceae)	1.0	-	Small amount			
Nitzschia (Bacillariophyceae)	1.0	-		Small amount		
Oscillatoria (Cyanophyceae)	1.0	-				
Oscillatoria (Cyanophyceae)	1	cells/mL				
Other	1.0	-				
Pediastrum (Chlorophyceae)	1.0					
Planktolyngbya (Cyanophyceae)	1.0	-				
Planktolyngbya (Cyanophyceae)	1	cells/mL				
Planktosphaeria (Chlorophyceae)	1.0	-				
Pseudanabaena (Cyanophyceae)	1.0	-	Small amount	Small amount	Moderate amount	
Pseudanabaena (Cyanophyceae)	1	cells/mL	100	40	3,960	
Rhoicosphenia (Bacillariophyceae)	1.0	-		Small amount		
Schroederia (Chlorophyceae)	1.0	-				
Small Chrysophytes (Chrysophyceae)	1.0	-	Moderate amount		Small amount	
Spirulina (Cyanophyceae)	1.0	-				
Spirulina (Cyanophyceae)	1	cells/mL				
Stephanodiscus (Coscinodiscophyceae)	1.0	-	Small amount	Small amount	Small amount	
Surirella (Bacillariophyceae)	1.0					
Synedra (Fragilariophyceae)	1.0	-				
Tabellaria (Fragilariophyceae)	1.0	-				
Trachelomonas (Euglenophyceae)	1.0	-		Small amount		
Unidentified	1.0	-	Small amount	Small amount	Small amount	
Woronichinia (Cyanophyceae)	1	cells/mL				

Appendix IV – Guidelines and Recommended Limits

Cyanobacteria Cell Counts

Total cyanobacteria (Health Canada)	<100 000 cells/mL

Microcystin

Recreational waters (Health Canada)	<20 µg/L (expressed as microcystin-LR)
Maximum acceptable concentration in drinking water (Health Canada)	1.5 µg/L

Chlorophyll a

Reference: Water Research Center

Recreational waters	< 25 µg/L

Conditions

No problems evident, no water discoloration	0 - 10 µg/L
Algal scums evident, some discoloration	11 - 20 µg/L
Nuisance conditions, considerable discoloration	21 - 30 µg/L
Severe condition encountered, very deep discoloration	> 30 µg/L

Lake Tropic Status

Oligotrophic	< 2 µg/L
Mesotrophic	2 to 6 µg/L
Eutrophic	6 to 40 µg/L
Hypereutrophic	> 40 µg/L

Dissolved Oxygen

Reference: Water Research Centre

Recommended for healthy fish	at least 5 mg/L