Charlie Lake Conservation Society
British Columbia

Eutrophication Analysis for Recreation Opportunities

Cyanobacteria/Blue Green Algae Survey of Charlie Lake 2021 Results

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Introduction

There are growing complaints, health and safety concerns about algae blooms in Charlie Lake along with suspected impacts of climate change on lakes globally (Harmful Algal Blooms, HABs). This had prompted the need for more information on the nature of algae growth, particularly blue-green algae also known as cyanobacteria. Note that cyanobacteria are actually photosynthetic bacteria – which are quite different than most of the organisms that are normally described as “algae”. Algae are considered to be simple aquatic plants, also photosynthetic but unlike cyanobacteria contain a nucleus.

From a report prepared by the BC Lake Stewardship Society and the BC Ministry Environment and Climate Change Strategy the following excerpt describes Charlie Lake as ...“one of the most eutrophic freshwater lakes in British Columbia (Reavie et al, 1995). This high productivity promotes algae blooms and aquatic plants which impact recreation activities and aesthetics. Water quality assessments of the lake have shown that dense blue-green algae blooms have occurred consistently over the last four decades of record (Heslop, 2017)”.



Figure 1 - Dissolved oxygen measurement within a localized bloom at the south end of Charlie Lake

“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 to 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. Cyanobacterial blooms have also been identified as responsible for skin rashes and allergic reactions after water based recreational activities.

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, providing funding for dissolved oxygen testing equipment and lab analysis.

Conclusions and Recommendations

Algal blooms did appear for limited periods of time in localized areas on Charlie Lake particularly in July-September. The predominant genus was *Aphanizomenon*. Other cyanobacteria genera, such as *Anabaena, Gloeotrichia* and *Lyngbya* were also detected.

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.

This algal sampling represents one season of cyanobacteria and microcystin characterization and quantification. Different/changing weather and waterconditions during future growing season may indicate different harmful algal bloom properties around Charlie Lake.

Additional growing season testing in future years is recommended. When lab capabilities allow, additional potential cyanobacteria toxins, such as anatoxins, saxitoxins and cylindrospermopsin, should be included in future testing.

An appropriate monitoring program, in areas of higher recreational use, could reduce the potential risk of user exposure to harmful algal blooms during the bathing 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.

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.

Sampling

3 sites were selected (figure 4) 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)

One additional site was visited for observations only (Site #4, Montney/ Centennial Park).



Figure 2 - Measurements being recorded at Site 1, approx.100 m offshore

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 - 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 methodology) 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.

Overall Observations

Cyanobacteria was evident in all samples from June to September (figure 5). The predominant genus was *Aphanizomenon*. Other cyanobacteria genera, such as *Anabaena, Gloeotrichia* and *Lyngbya* were also detected in a variety of small to large amounts over the season (Appendix III – Observations and lab results). Blooms appeared in limited localized areas on the lake in early August and in late September, but much of the lake did not experience full bloom conditions for the growing season (Appendix I - Photos of Water Samples Showing Various Levels of Algae).

Cyanobacteria growth was influenced by warm temperatures and sun, particularly as cell counts increased rapidly through hot weather in June and July (figures 5,9).



Figure 3 - Water sample with large cyanobacteria cell count but not considered a bloom.

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) (figure 10).

Rainfall did not seem to have a direct impact on cyanobacteria growth (figure 11).

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 early August and late September.

Microcystin toxins (figure 7) were well below recreational water limits throughout the sampling period.

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).

Site 4 – Montney/Centennial Park, although included in the lab testing, tended to be less affected by impacts of algal growth compared to other areas of the lake based on visual observations.

Observations by Sampling Period

June sampling (no blooms)
Overall cyanobacteria levels varied (small to moderate) in late June with the predominant genus being *Aphanizomenon* and *Anabaena*. A wide variety of cyanobacteria genera were detected.
Cyanobacteria cell counts varied from 2,470 to 25,700 counts/mL, chlorophyll *a* ranged from 2.6 to 13.1 ug/L.
Microcystin was below detection limits in all areas.

Early August sampling (blooms at south end)
Overall cyanobacteria levels showed a significant increase over June (large to massive) with the predominant genus being *Aphanizomenon*. A wide variety of cyanobacteria genera were detected.
Cyanobacteria cell counts varied from 331,000 to 3,730,000 counts/mL, chlorophyll *a* ranged from 305 to 14,000 µg/L.
Microcystin ranged from below detection limits at site #1 (Bruce's place) to 1.56 µg/L at site #2 (South end).

Late August sampling (no blooms)
Overall cyanobacteria levels showed a significant decrease over early August, almost comparable to June, with the predominant genus being *Aphanizomenon*. A wide variety of cyanobacteria and algae genera were detected.
Cyanobacteria cell counts varied from 1,810-38,4000 counts/mL (below recreational water count limits), chlorophyll A ranged from1.93 to 15.1 µg/L (no concerns to some algae scum and discolouration issues)
Microcystin was below detection limits at all sites.

Late September sampling (blooms at Beatton)
Overall cyanobacteria levels showed a significant increase over late August (moderate to massive), comparable to early August but with the bloom appearing in a different sampling site, with the predominant genus being *Aphanizomenon*. A wide variety of cyanobacteria and algae genera were detected.
Cyanobacteria cell counts varied from 9,800 to 17,900,000 counts/mL, chlorophyll A ranged from 2.3 to 19,700 ug/L.
Microcystin ranged from below detection limits at site #1 (Bruce's place) and site #2 (South end) to 1.62 µg/L at site #2 (Beatton).

Figures



Figure 4 - Sampling Sites

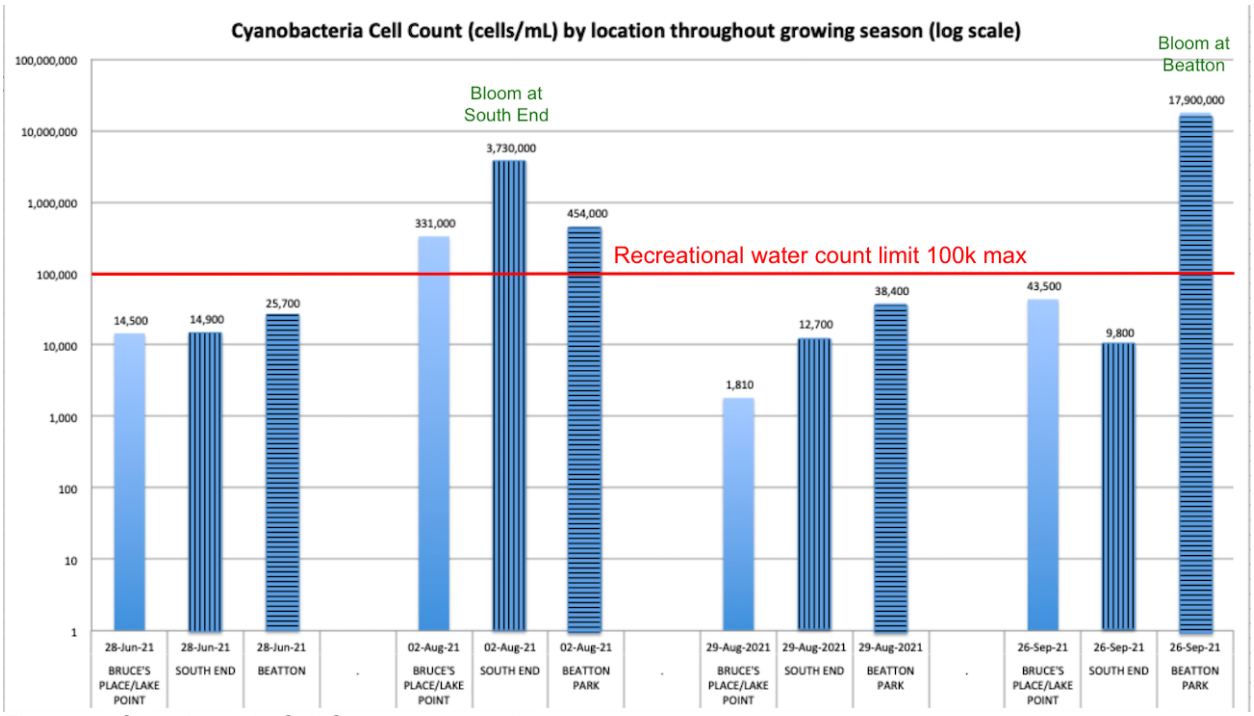


Figure 5 - Cyanobacteria Cell Counts measured

Cell counts exceeded limits during early August at all sampling sites with blooms appearing in limited localized areas starting in early August and appeared again in September.

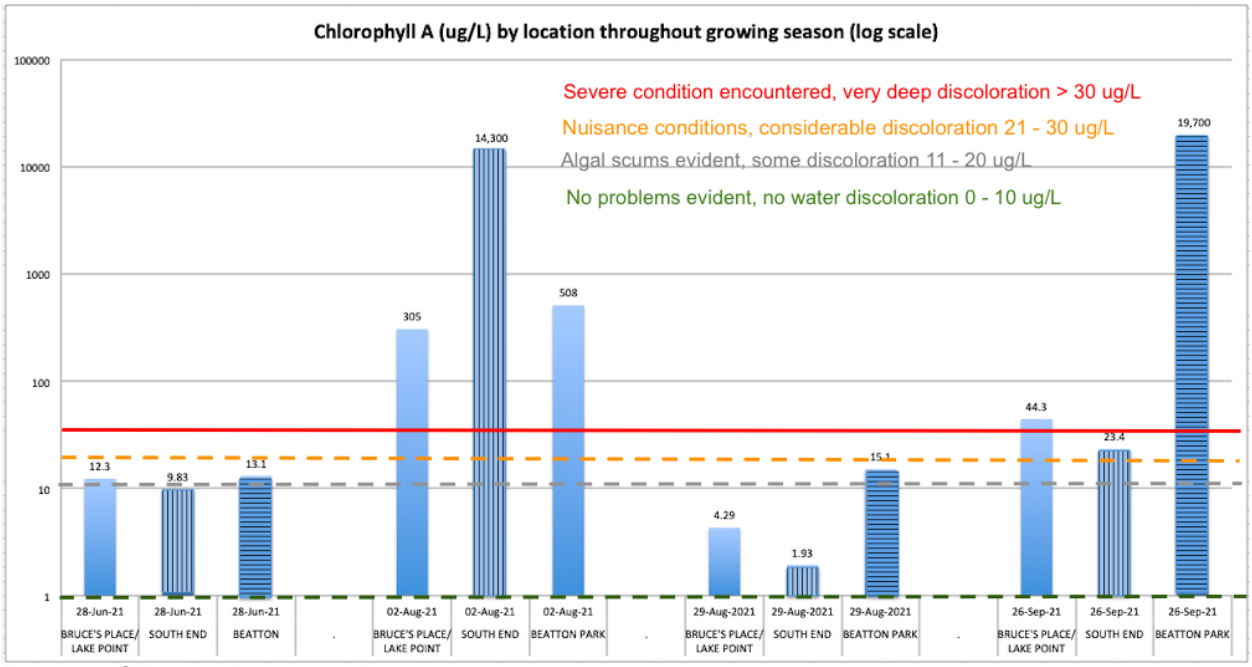


Figure 6 - Chlorophyll a measured

Most readings indicate that conditions were right for algae scums and discolouration and favourable for nuisance/severe conditions in early August and late September.

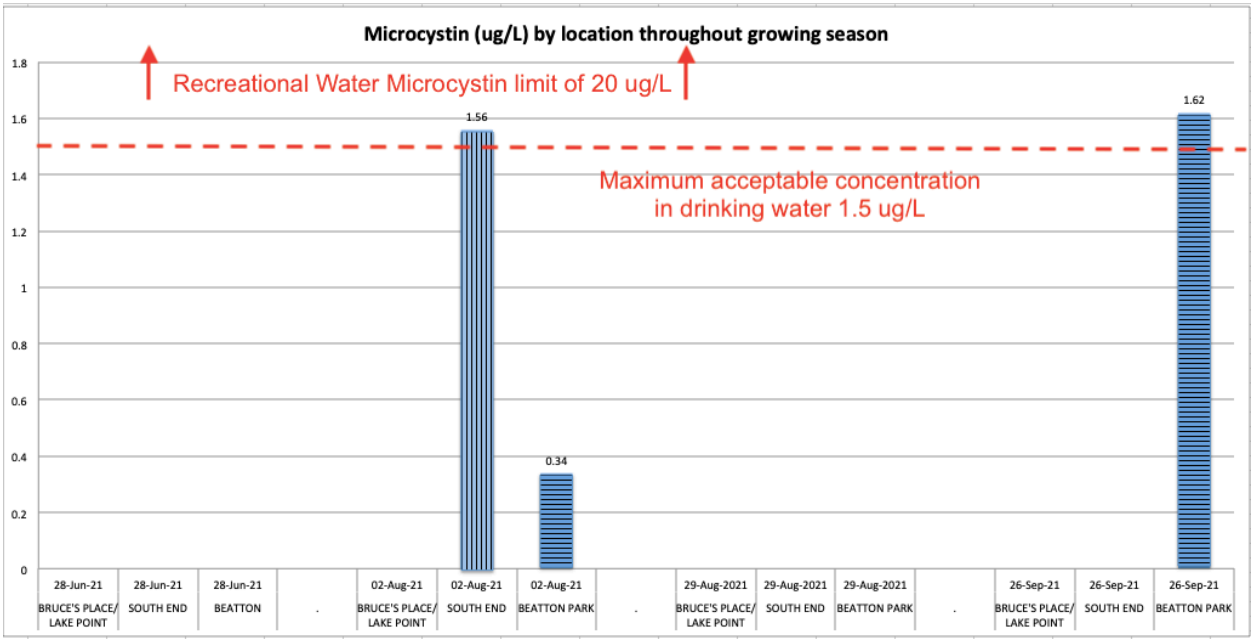


Figure 7 - Microcystin measured

Microcystin toxins were well below recreational water limits throughout the sampling period.

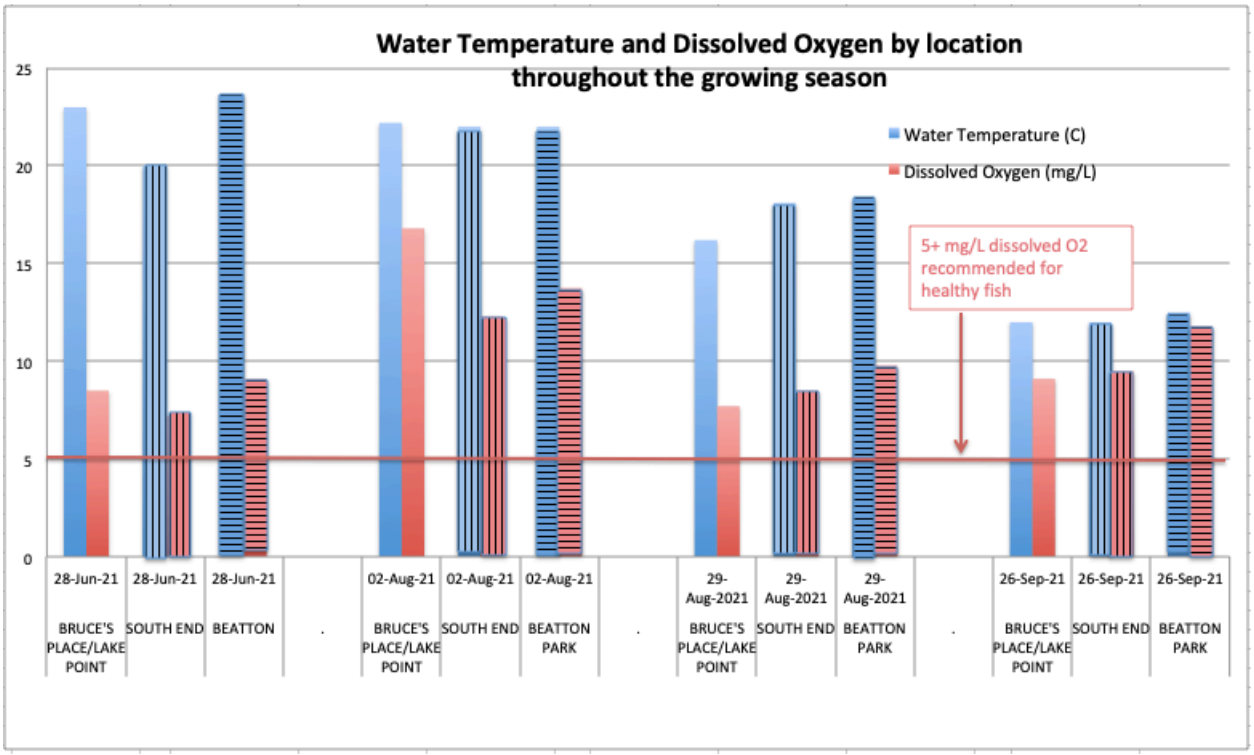


Figure 8 - dissolved oxygen measured

No harmful declines in dissolved oxygen levels were observed, including during the algal blooms in early August and late September.

Weather Patterns During 2021 Sampling Season
(Environment Canada - FSJ, BC)

(green arrows indicate sampling dates)

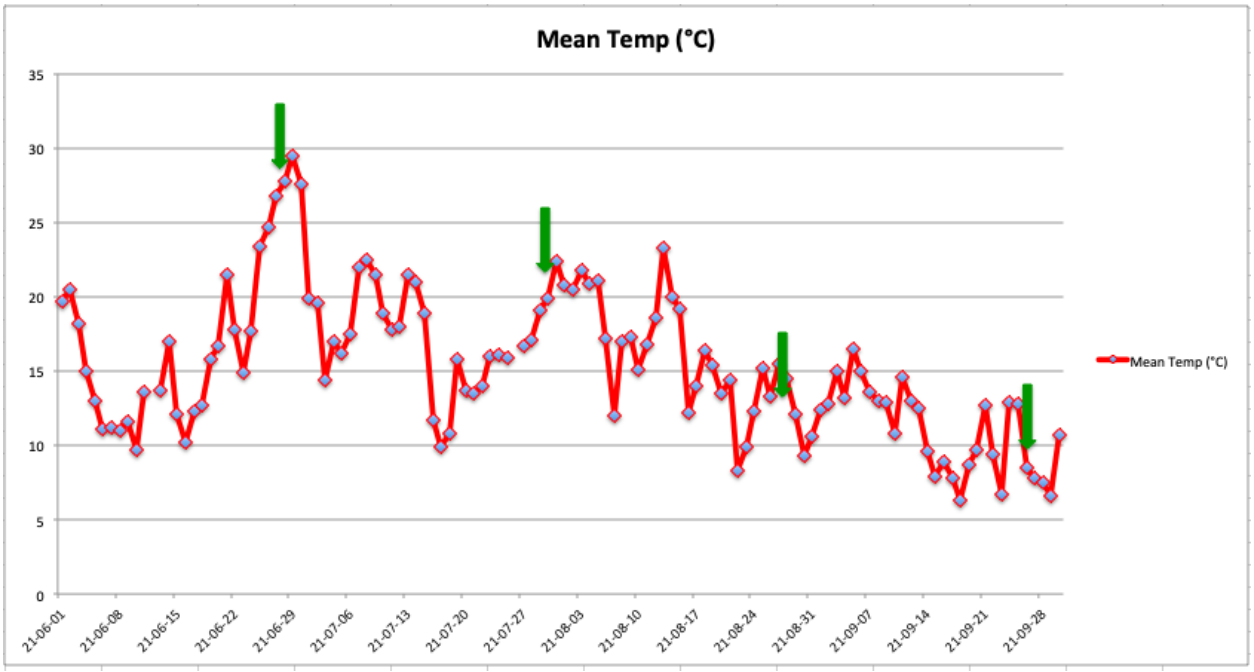


Figure 9- Mean temperature recorded

Higher temperatures through June/July promoted the initial rapid growth of cyanobacteria

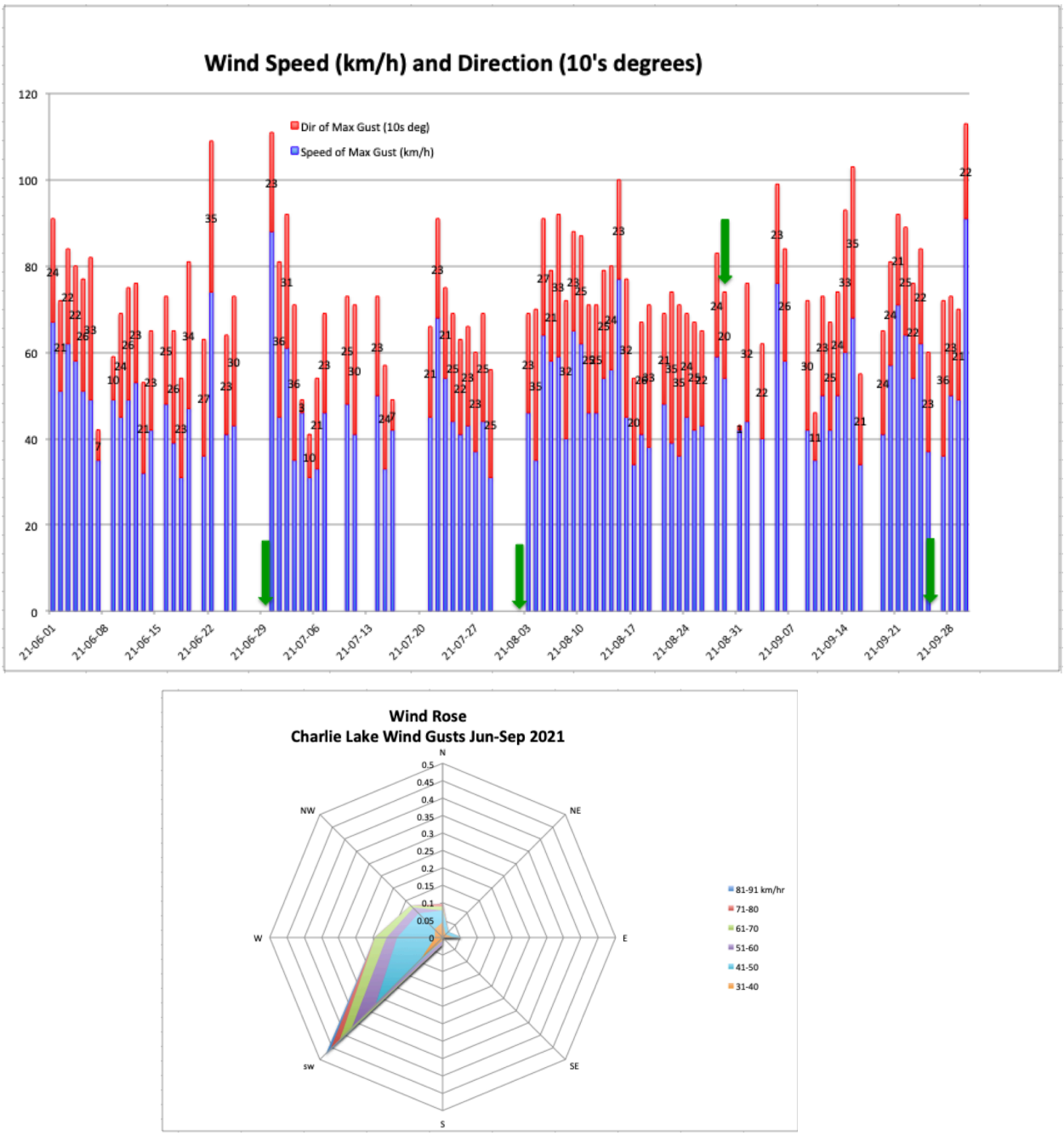


Figure 10 - Wind Speed and Direction recorded

Winds throughout the sampling period predominantly blew from the NW, W and SW.

Blooms were observed at the south end in early August following a period of stagnant wind. No blooms were observed at the sampling sites in late August, possibly due stronger winds experienced over the month since the last sampling period. Blooms were observed at Beatton Park in late September. Despite the intermittent winds prior in the month, the day of sampling was calm.

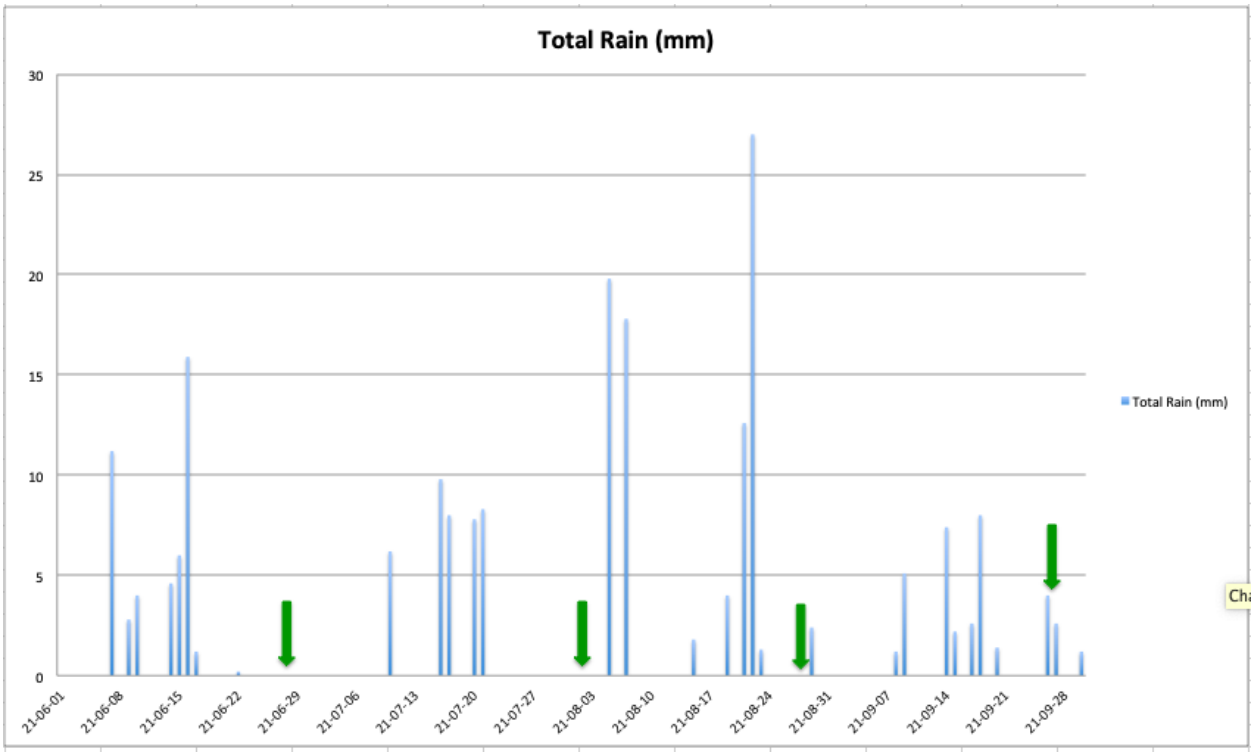


Figure 11- Total rain recorded

Rainfall did not appear to have a direct impact on cyanobacteria growth, however the extended periods of non-rain and associated sun in June/July may have contributed to the initial rapid growth of cyanobacteria.

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, Edward Stanford, Glynnis Maundrell, Jim Patterson and Bruce Kosugi. Thank you to the BC Lake Stewardship Society for ongoing support and Rick Nordin for his review.



Figure 10 - Secchi disk measurement (for water clarity)

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

Dissolve 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

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

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



Figure 11 – Moderate algal concentration

- June 28, 2021
- Site 1, Bruce's Place/Lake Point
- Light dispersal of grass clippings-like and spherical algae
- Total cyanobacteria cell count 14,500 cells/mL (moderate count)

- August 2, 2021
- Site 3 - Beatton Park
- Large flocs of algae in water
- Total cyanobacteria cell count 454,000 cells/mL (large amount, but not considered a bloom)



Figure 12 – Large algal concentration (non-bloom)

August 2, 2021

- Site 2 - South end
- Full algae bloom with thick scum on surface
- Total cyanobacteria cell count 3,730,000 cells/mL (massive count - bloom levels)



Figure 13 – Algal bloom

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



Figure 14 – Water sample kit

Appendix III – Observations and lab results

June 28, 2021 Observations

				BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON
		Date Sampled		28-Jun-21	28-Jun-21	28-Jun-21
		Time Sampled		04:00	05:15	06:55
Parameter		Lowest Detection Limit	Units			
Water Depth (m)				2.9	1	1.6
Secchi (m)				2.55		
Air Temp (deg C)				19	21	22
Sky conditions				sunny	sunny	sunny
Wind Conditions				calm	calm	calm
Water conditions				calm	calm	calm
Water Temp @ 0.3m (deg C)				23	20	23.7
Dissolved Oxygen @ 0.3m (mg/L)				8.5	7.2	9.1
Water Temp @ 2m (deg C)				23.5		
Dissolved Oxygen @ 2m (mg/L)				5.9		
Observations				Light dispersal of grass clippings-like and spherical algae	Light dispersal of grass clippings-like algae	Light dispersal of grass clippings-like and spherical algae

June 28, 2021 – Lab results

				BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON
		Date Sampled		28-Jun-21	28-Jun-21	28-Jun-21
		Time Sampled		04:00	05:15	06:55
Parameter		Lowest Detection Limit	Units			
Taxonomy (Water)						
Amphora (Bacillariophyceae)		1.0	-		Small amount	
Anabaena (Cyanophyceae)		1.0	-	Moderate amount	Small amount	Moderate amount
Anabaena (Cyanophyceae)		1	cells/mL	4,160	533	14,100
Aphanizomenon (Cyanophyceae)		1.0	-	Moderate amount	Moderate amount	Moderate amount
Aphanizomenon (Cyanophyceae)		1	cells/mL	10,300	13,900	7,520
Total cyanobacterial cell count		1	cells/mL	14,500	14,900	25,700
Botryococcus (Chlorophyceae)	algae					
Closterium (Chlorophyceae)	desmid	1.0	-			
Cocconeis (Bacillariophyceae)	diatom	1.0	-		Small amount	
Cryptomonas (Cryptophyceae)	algae	1.0	-		Small amount	Small amount
Ceratium (Dinophyceae)	diatom	1.0	-			
Cyclotella (Coscinodiscophyceae)	diatom	1.0	-		Small amount	
Cymatopleura (Bacillariophyceae)	diatom	1.0				
Cymbella (Bacillariophyceae)	diatom	1.0	-			
Eunotia (Bacillariophyceae)	diatom	1.0	-			
Fragilaria (Fragilariophyceae)	diatom	1.0	-	Small amount	Small amount	
Gloeotrichia (Cyanophyceae)	cyano	1.0	-			Small amount
Gloeotrichia (Cyanophyceae)	cyano	1	cells/mL			4,000
Gomphosphaeria (Cyanophyceae)	cyano	1.0	-			Small amount
Gomphosphaeria (Cyanophyceae)	cyano	1	cells/mL			20
Lyngbya (Cyanophyceae)	cyano	1.0	-		Small amount	Small amount
Lyngbya (Cyanophyceae)	cyano	1	cells/mL		492	72
Melosira (Coscinodiscophyceae)	diatom	1.0	-			
Microcystis (Cyanophyceae)	cyano	1.0	-			
Microcystis (Cyanophyceae)	cyano	1	cells/mL			
Navicula (Bacillariophyceae)	diatom	1.0	-		Small amount	
Nitzschia (Bacillariophyceae)	diatom	1.0	-			Small amount
Other		1.0	-			
Planktosphaeria (Chlorophyceae)	green algae	1.0	-		Small amount	Small amount
Planktolyngbya (Cyanophyceae)	cyano	1.0	-			
Pseudanabaena (Cyanophyceae)	cyano	1.0	-	Small amount		
Pseudanabaena (Cyanophyceae)	cyano	1	cells/mL	46		
Rhoicosphenia (Bacillariophyceae)	diatom	1.0				
Schroederia (Chlorophyceae)	green algae	1.0	-	Small amount	Small amount	Small amount
Stephanodiscus (Coscinodiscophyceae)	diatom	1.0	-		Small amount	
Synedra (Fragilariophyceae)	diatom	1.0	-	Small amount	Small amount	Small amount
Trachelomonas (Euglenophyceae)	euglena	1.0	-			
Woronichinia (Cyanophyceae)	cyano	1	cells/mL			
Unidentified		1.0	-	Small amount	Small amount	Small amount
Plant Pigments (Water)						
Chlorophyll a		0.1	ug/L	12.3	9.83	13.1
Organic Parameters (Water)						
Microcystin		0.2	ug/L	<0.20	<0.20	<0.20

August 2, 2021 – Observations

				BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK
		Date Sampled		02-Aug-21	02-Aug-21	02-Aug-21
		Time Sampled		21:00	19:00	20:14
Parameter		Lowest Detection Limit	Units			
Water Depth (m)				3.2	1	1.2
Secchi (m)				0.8		
Air Temp (deg C)				20	25	20
Sky conditions				cloudy	cloudy	cloudy
Wind Conditions				calm	calm	calm
Water conditions				calm	calm	calm
Water Temp @ 0.3m (deg C)				22.2	22	22
Dissolved Oxygen @ 0.3m (mg/L)				16.8	12.3	13.75
Water Temp @ 2m (deg C)				18.4		
Dissolved Oxygen @ 2m (mg/L)				6.2		
Observations				moderate suspension of algae in water column	Full algae bloom with thick scum on surface	Large flocs of algae in water

August 2, 2021 – Lab Results

				BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK
		Date Sampled		02-Aug-21	02-Aug-21	02-Aug-21
		Time Sampled		21:00	19:00	20:14
Parameter		Lowest Detection Limit	Units			
Taxonomy (Water)						
Amphora (Bacillariophyceae)		1.0	-			
Anabaena (Cyanophyceae)		1.0	-	Small amount	Small amount	Small amount
Anabaena (Cyanophyceae)		1	cells/mL	2,970	18,300	1,980
Aphanizomenon (Cyanophyceae)		1.0	-	Large amount	Massive amount	Large amount
Aphanizomenon (Cyanophyceae)		1	cells/mL	297,000	2,090,000	269,000
Total cyanobacterial cell count		1	cells/mL	331,000	3,730,000	454,000
Botryococcus (Chlorophyceae)	algae				Small amount	
Closterium (Chlorophyceae)	desmid	1.0	-			
Cocconeis (Bacillariophyceae)	diatom	1.0	-			
Cryptomonas (Cryptophyceae)	algae	1.0	-			
Ceratium (Dinophyceae)	diatom	1.0	-			Small amount
Cyclotella (Coscinodiscophyceae)	diatom	1.0	-		Small amount	
Cymatopleura (Bacillariophyceae)	diatom	1.0			Small amount	
Cymbella (Bacillariophyceae)	diatom	1.0	-			Small amount
Eunotia (Bacillariophyceae)	diatom	1.0	-			
Fragilaria (Fragilariophyceae)	diatom	1.0	-	Small amount	Moderate amount	
Gloeotrichia (Cyanophyceae)	cyano	1.0	-		Large amount	Moderate amount
Gloeotrichia (Cyanophyceae)	cyano	1	cells/mL		550,000	100,000
Gomphosphaeria (Cyanophyceae)	cyano	1.0	-			
Gomphosphaeria (Cyanophyceae)	cyano	1	cells/mL			
Lyngbya (Cyanophyceae)	cyano	1.0	-	Small amount	Large amount	Moderate amount
Lyngbya (Cyanophyceae)	cyano	1	cells/mL	8,700	950,000	24,900
Melosira (Coscinodiscophyceae)	diatom	1.0	-	Small amount	Small amount	Small amount
Microcystis (Cyanophyceae)	cyano	1.0	-	Small amount	Small amount	Small amount
Microcystis (Cyanophyceae)	cyano	1	cells/mL	200	16,400	5,580
Navicula (Bacillariophyceae)	diatom	1.0	-		Small amount	Small amount
Nitzschia (Bacillariophyceae)	diatom	1.0	-			
Other		1.0	-	Small amount	Moderate amount	Small amount
Planktosphaeria (Chlorophyceae)	green algae	1.0	-		Small amount	
Planktolyngbya (Cyanophyceae)	cyano	1.0	-			
Pseudanabaena (Cyanophyceae)	cyano	1.0	-	Moderate amount	Moderate amount	Moderate amount
Pseudanabaena (Cyanophyceae)	cyano	1	cells/mL	21,800	54,900	51,500
Rhoicosphenia (Bacillariophyceae)	diatom	1.0				
Schroederia (Chlorophyceae)	green algae	1.0	-			
Stephanodiscus (Coscinodiscophyceae)	diatom	1.0	-			
Synedra (Fragilariophyceae)	diatom	1.0	-	Small amount	Small amount	
Trachelomonas (Euglenophyceae)	euglena	1.0	-			
Woronichinia (Cyanophyceae)	cyano	1	cells/mL	600	52,500	1,240
Unidentified		1.0	-			
Plant Pigments (Water)						
Chlorophyll a		0.1	ug/L	305	14,300	508
Organic Parameters (Water)						
Microcystin		0.2	ug/L	<0.20	1.56	0.34

August 29, 2021 – Observations

				BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK
		Date Sampled		29-Aug-2021	29-Aug-2021	29-Aug-2021
		Time Sampled		18:15	19:00	19:25
Parameter		Lowest Detection Limit	Units			
Water Depth (m)				3.2	0.8	1.3
Secchi (m)				2.3		
Air Temp (deg C)				14	13	14
Sky conditions				sunny	sunny	sun/cloud
Wind Conditions				slight breeze	slight breeze	breezy
Water conditions				ripple	slight ripple	waves
Water Temp @ 0.3m (deg C)				16.2	18.1	18.3
Dissolved Oxygen @ 0.3m (mg/L)				7.7	8.5	9.8
Water Temp @ 2m (deg C)				18.1		
Dissolved Oxygen @ 2m (mg/L)				7.3		
Observations				some suspended algae filaments	few suspended algae filaments	suspended algae filaments

August 29, 2021 – Lab Results

				BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK
		Date Sampled		29-Aug-2021	29-Aug-2021	29-Aug-2021
		Time Sampled		18:15	19:00	19:25
Parameter		Lowest Detection Limit	Units			
Taxonomy (Water)						
Amphora (Bacillariophyceae)		1.0	-			
Anabaena (Cyanophyceae)		1.0	-	Small amount		Small amount
Anabaena (Cyanophyceae)		1	cells/mL	20		62
Aphanizomenon (Cyanophyceae)		1.0	-	Small amount	Small amount	Large amount
Aphanizomenon (Cyanophyceae)		1	cells/mL	1,150	1,350	33,700
Total cyanobacterial cell count		1	cells/mL	1,810	12,700	38,400
Botryococcus (Chlorophyceae)	algae					
Closterium (Chlorophyceae)	desmid	1.0	-	Small amount		
Cocconeis (Bacillariophyceae)	diatom	1.0	-	Small amount		Small amount
Cryptomonas (Cryptophyceae)	algae	1.0	-	Small amount	Small amount	Small amount
Ceratium (Dinophyceae)	diatom	1.0	-	Small amount	Small amount	Small amount
Cyclotella (Coscinodiscophyceae)	diatom	1.0	-			
Cymatopleura (Bacillariophyceae)	diatom	1.0				
Cymbella (Bacillariophyceae)	diatom	1.0	-	Small amount		
Eunotia (Bacillariophyceae)	diatom	1.0	-			
Fragilaria (Fragilariophyceae)	diatom	1.0	-			Small amount
Gloeotrichia (Cyanophyceae)	cyano	1.0	-			
Gloeotrichia (Cyanophyceae)	cyano	1	cells/mL			
Gomphosphaeria (Cyanophyceae)	cyano	1.0	-	Small amount		
Gomphosphaeria (Cyanophyceae)	cyano	1	cells/mL			
Lyngbya (Cyanophyceae)	cyano	1.0	-	Small amount	Small amount	Small amount
Lyngbya (Cyanophyceae)	cyano	1	cells/mL	60	30	
Melosira (Coscinodiscophyceae)	diatom	1.0	-	Small amount		
Microcystis (Cyanophyceae)	cyano	1.0	-	Small amount	Small amount	Small amount
Microcystis (Cyanophyceae)	cyano	1	cells/mL		800	200
Navicula (Bacillariophyceae)	diatom	1.0	-	Small amount	Small amount	
Nitzschia (Bacillariophyceae)	diatom	1.0	-	Small amount	Small amount	
Other		1.0	-	Small amount	Small amount	Small amount
Planktosphaeria (Chlorophyceae)	green algae	1.0	-		Moderate amount	
Planktolyngbya (Cyanophyceae)	cyano	1.0	-		9,980	
Pseudanabaena (Cyanophyceae)	cyano	1.0	-	Small amount	Small amount	Moderate amount
Pseudanabaena (Cyanophyceae)	cyano	1	cells/mL	180	290	4,280
Rhoicosphenia (Bacillariophyceae)	diatom	1.0				
Schroederia (Chlorophyceae)	green algae	1.0	-	Small amount		
Stephanodiscus (Coscinodiscophyceae)	diatom	1.0	-	Small amount		
Synedra (Fragilariophyceae)	diatom	1.0	-			
Trachelomonas (Euglenophyceae)	euglena	1.0	-	Small amount	Small amount	Small amount
Woronichinia (Cyanophyceae)	cyano	1	cells/mL	400	200	200
Unidentified		1.0	-	Small amount	Small amount	Small amount
Plant Pigments (Water)						
Chlorophyll a		0.1	ug/L	4.29	1.93	15.1
Organic Parameters (Water)						
Microcystin		0.2	ug/L	<0.20	<0.20	<0.20

September 26, 2021 – Observations

		Date Sampled		26-Sep-21	26-Sep-21	26-Sep-21
		Time Sampled		14:00	14:30	18:00
Parameter		Lowest Detection Limit	Units			
Water Depth (m)				3	0.9	1.4
Secchi (m)						
Air Temp (deg C)				10	9	9
Sky conditions				overcast, mist	cloudy	cloudy
Wind Conditions				slight breeze from NE	breeze from NE	breeze from NE
Water conditions				slight ripple	slight ripple	slight ripple
Water Temp @ 0.3m (deg C)				12	12	12.5
Dissolved Oxygen @ 0.3m (mg/L)				9.1	9.5	11.8
Water Temp @ 2m (deg C)				12		
Dissolved Oxygen @ 2m (mg/L)				8.9		
Observations				some suspended algae filaments	some suspended algae filaments	Full algae bloom with substantial clumps of surface algae

September 26, 2021 – Lab results

				BRUCE'S PLACE/LAKE POINT	SOUTH END	BEATTON PARK
		Date Sampled		26-Sep-21	26-Sep-21	26-Sep-21
		Time Sampled		14:00	14:30	18:00
Parameter		Lowest Detection Limit	Units			
Taxonomy (Water)						
Amphora (Bacillariophyceae)		1.0	-			
Anabaena (Cyanophyceae)		1.0	-	Small amount	Small amount	
Anabaena (Cyanophyceae)		1	cells/mL	120	124	
Aphanizomenon (Cyanophyceae)		1.0	-	Large amount	Moderate amount	Massive amount
Aphanizomenon (Cyanophyceae)		1	cells/mL	34,700	6,700	17,600,000
Total cyanobacterial cell count		1	cells/mL	43,500	9,800	17,900,000
Botryococcus (Chlorophyceae)	algae					
Closterium (Chlorophyceae)	desmid	1.0	-			
Cocconeis (Bacillariophyceae)	diatom	1.0	-			
Cryptomonas (Cryptophyceae)	algae	1.0	-	Small amount	Moderate amount	
Ceratium (Dinophyceae)	diatom	1.0	-			
Cyclotella (Coscinodiscophyceae)	diatom	1.0	-			
Cymatopleura (Bacillariophyceae)	diatom	1.0				
Cymbella (Bacillariophyceae)	diatom	1.0	-			
Eunotia (Bacillariophyceae)	diatom	1.0	-			
Fragilaria (Fragilariophyceae)	diatom	1.0	-		Small amount	
Gloeotrichia (Cyanophyceae)	cyano	1.0	-			
Gloeotrichia (Cyanophyceae)	cyano	1	cells/mL			
Gomphosphaeria (Cyanophyceae)	cyano	1.0	-			
Gomphosphaeria (Cyanophyceae)	cyano	1	cells/mL			
Lyngbya (Cyanophyceae)	cyano	1.0	-			
Lyngbya (Cyanophyceae)	cyano	1	cells/mL			
Melosira (Coscinodiscophyceae)	diatom	1.0	-			
Microcystis (Cyanophyceae)	cyano	1.0	-	Small amount		
Microcystis (Cyanophyceae)	cyano	1	cells/mL			
Navicula (Bacillariophyceae)	diatom	1.0	-		Small amount	
Nitzschia (Bacillariophyceae)	diatom	1.0	-		Moderate amount	
Other		1.0	-			
Planktosphaeria (Chlorophyceae)	green algae	1.0	-	Small amount	Small amount	
Planktolyngbya (Cyanophyceae)	cyano	1.0	-			
Pseudanabaena (Cyanophyceae)	cyano	1.0	-	Moderate amount	Small amount	Large amount
Pseudanabaena (Cyanophyceae)	cyano	1	cells/mL	5,940	1,180	329,000
Rhoicosphenia (Bacillariophyceae)	diatom	1.0			Small amount	
Schroederia (Chlorophyceae)	green algae	1.0	-			
Stephanodiscus (Coscinodiscophyceae)	diatom	1.0	-	Small amount	Small amount	
Synedra (Fragilariophyceae)	diatom	1.0	-			
Trachelomonas (Euglenophyceae)	euglena	1.0	-	Small amount	Small amount	
Woronichinia (Cyanophyceae)	cyano	1	cells/mL	2,700	1,800	
Unidentified		1.0	-			
Plant Pigments (Water)						
Chlorophyll a		0.1	ug/L	44.3	23.4	19,700
Organic Parameters (Water)						
Microcystin		0.2	ug/L	<0.20	<0.20	1.62

Site 4 – Montney/Centennial Park - Observations

				CENTENNIAL	CENTENNIAL	CENTENNIAL	CENTENNIAL
		Date Sampled		28-Jun-21	02-Aug-21	29-Aug-21	26-Sep-21
		Time Sampled		05:15	19:45	19:53	18:30
Parameter		Lowest Detection Limit	Units				
Water Depth (m)				0.7	0.3	0.3	0.3
Secchi (m)							
Air Temp (deg C)				21	20	11	8
Sky conditions				sunny	cloudy	sun setting	cloudy/fog
Wind Conditions				calm	calm	breezy	calm
Water conditions				calm	calm	ripples	calm
Water Temp @ 0.3m (deg C)				22.8	16.9	24.8	12
Dissolved Oxygen @ 0.3m (mg/L)				8.2	11.3	10.2	6.9
Water Temp @ 2m (deg C)							
Dissolved Oxygen @ 2m (mg/L)							
Observations				Clear	Light dispersal of grass clippings-like algae	suspended algae filaments	some clumps near shore, rotting weeds close to sampling location

Site 4 – Montney/Centennial Park - Lab results (June only)

				CENTENNIAL	CENTENNIAL	CENTENNIAL	CENTENNIAL
		Date Sampled		28-Jun-21	02-Aug-21	29-Aug-21	26-Sep-21
		Time Sampled		05:15	19:45	19:53	18:30
Parameter		Lowest Detection Limit	Units				
Taxonomy (Water)							
Amphora (Bacillariophyceae)		1.0	-	Small amount			
Anabaena (Cyanophyceae)		1.0	-	Moderate amount			
Anabaena (Cyanophyceae)		1	cells/mL	2,050			
Aphanizomenon (Cyanophyceae)		1.0	-	Small amount			
Aphanizomenon (Cyanophyceae)		1	cells/mL	422			
Total cyanobacterial cell count		1	cells/mL	2,470			
Botryococcus (Chlorophyceae)	algae						
Closterium (Chlorophyceae)	desmid	1.0	-				
Cocconeis (Bacillariophyceae)	diatom	1.0	-				
Cryptomonas (Cryptophyceae)	algae	1.0	-	Small amount			
Ceratium (Dinophyceae)	diatom	1.0	-				
Cyclotella (Coscinodiscophyceae)	diatom	1.0	-				
Cymatopleura (Bacillariophyceae)	diatom	1.0					
Cymbella (Bacillariophyceae)	diatom	1.0	-	Small amount			
Eunotia (Bacillariophyceae)	diatom	1.0	-	Small amount			
Fragilaria (Fragilariophyceae)	diatom	1.0	-	Small amount			
Gloeotrichia (Cyanophyceae)	cyano	1.0	-				
Gloeotrichia (Cyanophyceae)	cyano	1	cells/mL				
Gomphosphaeria (Cyanophyceae)	cyano	1.0	-				
Gomphosphaeria (Cyanophyceae)	cyano	1	cells/mL				
Lyngbya (Cyanophyceae)	cyano	1.0	-				
Lyngbya (Cyanophyceae)	cyano	1	cells/mL				
Melosira (Coscinodiscophyceae)	diatom	1.0	-				
Microcystis (Cyanophyceae)	cyano	1.0	-				
Microcystis (Cyanophyceae)	cyano	1	cells/mL				
Navicula (Bacillariophyceae)	diatom	1.0	-				
Nitzschia (Bacillariophyceae)	diatom	1.0	-				
Other		1.0	-				
Planktosphaeria (Chlorophyceae)	green algae	1.0	-	Small amount			
Planktolyngbya (Cyanophyceae)	cyano	1.0	-				
Pseudanabaena (Cyanophyceae)	cyano	1.0	-				
Pseudanabaena (Cyanophyceae)	cyano	1	cells/mL				
Rhoicosphenia (Bacillariophyceae)	diatom	1.0					
Schroederia (Chlorophyceae)	green algae	1.0	-	Small amount			
Stephanodiscus (Coscinodiscophyceae)	diatom	1.0	-				
Synedra (Fragilariophyceae)	diatom	1.0	-				
Trachelomonas (Euglenophyceae)	euglena	1.0	-				
Woronichinia (Cyanophyceae)	cyano	1	cells/mL				
Unidentified		1.0	-	Small amount			
Plant Pigments (Water)							
Chlorophyll a		0.1	ug/L	2.6			
Organic Parameters (Water)							
Microcystin		0.2	ug/L	<0.20			

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