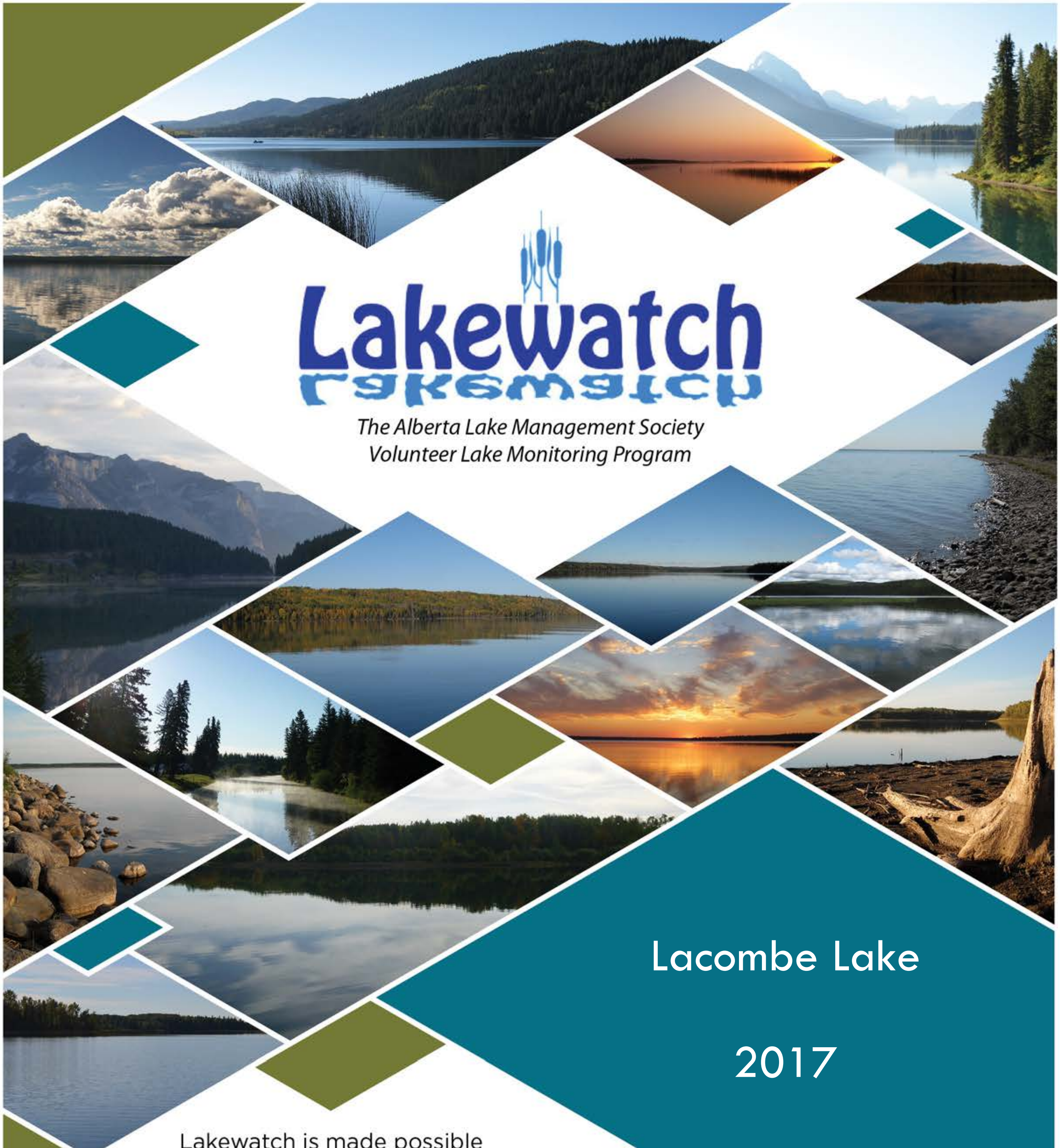

Lakewatch

The Alberta Lake Management Society
Volunteer Lake Monitoring Program

Lacombe Lake

2017

Lakewatch is made possible with support from:

Cargill Helping the world thrive · Jackfish Lake · Pigeon Lake Watershed Association · LICA Lakeland Industry & Community Association · Red Deer River Watershed Alliance · Beaver River Watershed Alliance · Alberta Environment and Parks

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEWATCH PROGRAM

LakeWatch has several important objectives, one of which is to collect and interpret water quality data on Alberta Lakes. Equally important is educating lake users about their aquatic environment, encouraging public involvement in lake management, and facilitating cooperation and partnerships between government, industry, the scientific community and lake users. LakeWatch Reports are designed to summarize basic lake data in understandable terms for a lay audience and are not meant to be a complete synopsis of information about specific lakes. Additional information is available for many lakes that have been included in LakeWatch and readers requiring more information are encouraged to seek those sources.

ALMS would like to thank all who express interest in Alberta's aquatic environments and particularly those who have participated in the LakeWatch program. These people prove that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment.

ALMS is happy to discuss the results of this report with our stakeholders. If you would like information or a public presentation, contact us at info@alms.ca.

ACKNOWLEDGEMENTS

We would like to extend a special thanks to Alberta Environment and Parks for the time and energy put into sampling Lacombe Lake in 2017. This report was prepared by Laura Redmond and Bradley Peter. The Beaver River Watershed, the Lakeland Industry and Community Association, Environment Canada, and Alberta Environment and Parks are major sponsors of the LakeWatch program.

LACOMBE LAKE

Lacombe Lake is a pothole lake found in Lacombe County in central Alberta. It is located 5 km north of the town of Blackfalds and 15 km north of Red Deer. There are no public campgrounds around the lake as most of the land is private farms and homesteads as well as public land and reserves. It is thought that the lake was once called Jackfish Lake due to the northern pike found in the lake, though in 1975 the name was changed to Lacombe Lake. The Lacombe Lake area is part of the Treaty 6 Nations and was an area where the Samson and Erminskin Cree Nations hunted and travelled. Permanent camps were traditionally located in wooded areas as well as along rivers, and a known trade existed just south of Gull Lake.

The lake is long and narrow, with a length of about 3 km, a maximum depth of ~3.0 m, and a maximum width of about 500 m. Lacombe Lake has numerous bays and points which give it a distinct shape. It is not known to be a popular fishing destination but the lake is used for non-motorized recreational water sports such as rowing as well as swimming. Lacombe Lake is found in the Aspen Parkland ecoregion of Alberta, much of which is now farmland with other foliage such as trembling aspen, oak, mixed tall shrubs, and intermittent fescue grasslands[1].

Anto Davis sampling Lacombe Lake in 2016.

Known sportfish species at Lacombe Lake are the northern pike, though angling websites state that other species may include walleye, burbot, whitefish, rainbow trout, brown trout, and brook trout[2]. Lacombe Lake has a large population of macrophytes, including yellow pond lily, various pondweeds, chara, cattail, bulrushes, and bladderwort. Due to its small size, dense macrophytes, and limited recreational activity, waterfowl are known to frequent the lake. Known species include the mallard, common grebe, goldeneye, scaup, and ruddy duck[2]. Larger vertebrates that are found around the lake are deer, muskrat, lynx, and beavers. In the 1960s, the Prairie Farm Rehabilitation Association constructed a weir on Whelp Creek to control and direct the flow into the north end of Lacombe Lake during periods of high flow.

In the years previous to 2008, residents observed deteriorations in water quality as well as dense macrophyte growth. The diversion of Whelp Creek was stopped and Golder Associates Ltd. assessed the water quality of Lacombe Lake over a period of 4 years.

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[1] Ecoregions of Canada. (1995). Available at: http://ecozones.ca/English/region/156.html

[2] http://www.hookandbullet.com/fishing-lacombe-lake-blackfalds-ab/ 2015

METHODS

Profiles: Profile data is measured at the deepest spot in the main basin of the lake. At the profile site, temperature, dissolved oxygen, pH, conductivity and redox potential are measured at 0.5- 1.0 m intervals. Additionally, Secchi depth is measured at the profile site and used to calculate the euphotic zone. On one visit per season, metals are collected at the profile site by hand grab from the surface and at some lakes, 1 m off bottom using a Kemmerer.

Composite samples: At 10-sites across the lake, water is collected from the euphotic zone and combined across sites into one composite sample. This water is collected for analysis of water chemistry, chlorophyll-a, nutrients and microcystin. Quality control (QC) data for total phosphorus was taken as a duplicate true split on one sampling date. ALMS uses the following accredited labs for analysis: Routine water chemistry and nutrients are analyzed by Maxxam Analytics, chlorophyll-*a* and metals are analyzed by Alberta Innovates Technology Futures (AITF), and microcystin is analyzed by the Alberta Centre for Toxicology (ACTF). In lakes where mercury samples are taken, they are analyzed by the Biogeochemical Analytical Service Laboratory (BASL).

Invasive Species: Monitoring for invasive quagga and zebra mussels involved two components: monitoring for juvenile mussel veligers using a 63 µm plankton net at three sample sites and monitoring for attached adult mussels using substrates installed at each lake.

Data Storage and Analysis: Data is stored in the Water Data System (WDS), a module of the Environmental Management System (EMS) run by Alberta Environment and Parks (AEP). Data goes through a complete validation process by ALMS and AEP. Users should use caution when comparing historical data, as sampling and laboratory techniques have changed over time (e.g. detection limits). For more information on data storage, see AEP Surface Water Quality Data Reports at aep.alberta.ca/water.

Data analysis is done using the program R.[1] Data is reconfigured using packages tidyr [2] and dplyr [3] and figures are produced using the package ggplot2 [4]. Trophic status for each lake is classified based on lake water characteristics using values from Nurnberg (1996)[5]. The Canadian Council for Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life are used to compare heavy metals and dissolved oxygen measurements. Pearson's Correlation tests are used to examine relationships between TP, chlorophyll-*a,* TKN and Secchi depth, providing a correlation coefficient (r) to show the strength (0-1) and a p-value to assess significance of the relationship.

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[1] R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[2] Wickman, H. and Henry, L. (2017). tidyr: Easily Tidy Data with 'spread ( )' and 'gather ( )' Functions. R package version 0.7.2. https://CRAN.R-project.org/package=tidyr.

[3] Wickman, H., Francois, R., Henry, L. and Muller, K. (2017). dplyr: A Grammar of Data Manipulation. R package version 0.7.4. http://CRAN.R-project.org/package=dplyr.

[4] Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

[5] Nurnberg, G.K. (1996). Trophic state of clear and colored, soft- and hardwater lakes with special consideration of nutrients, anoxia, phytoplankton and fish. Lake and Reservoir Management 12: 432-447.

BEFORE READING THIS REPORT, CHECK OUT A BRIEF INTRODUCTION TO LIMNOLOGY AT ALMS.CA/REPORTS

WATER CHEMISTRY

ALMS measures a suite of water chemistry parameters. Phosphorus, nitrogen, and chlorophyll-a are important because they are indicators of eutrophication, or excess nutrients, which can lead to harmful algal/cyanobacteria blooms. One direct measure of harmful cyanobacteria blooms are Microcystins, a common group of toxins produced by cyanobacteria. See Table 2 for a complete list of parameters.

The average total phosphorus (TP) concentration for Lacombe Lake was 26.3 µg/L (Table 2), falling into the mesotrophic, or moderately productive trophic classification. TP remained relatively stable over the sampling period, peaking on July 17 (Figure 1). In the late 2000's, Lacombe Lake phosphorus was nearly 10 times higher than the 2017 average, potentially reflecting the impact of the Whelp Creek diversion.

Average chlorophyll-*a* concentrations in 2017 was 15.0 µg/L (Table 2), putting Lacombe Lake into the eutrophic or productive classification. This is the highest measured average since chlorophyll-*a* monitoring began in 2014. Chlorophyll-*a* concentrations varied over the course of the season (Figure 1).

Finally, average TKN concentration was 1.3 mg/L (Table 2), and concentrations varied throughout the summer, peaking at 1.4 mg/L on August 9 (Figure 1).

Average pH was measured as 8.53 in 2017, buffered by moderate alkalinity (220 mg/L $CaCO_3$) and bicarbonate (255 mg/L HCO_3). Sodium and magnesium were the dominant ions contributing to a moderate conductivity of 515 µS/cm (Table 2).

METALS

Samples were analyzed for metals (Table 3). In total, 27 metals were sampled for. It should be noted that many metals are naturally present in aquatic environments due to the weathering of rocks and may only become toxic at higher levels.

Metals as well as dissolved and total mercury were measured on August 9 at Lacombe Lake at the surface and 1 m off bottom and all measured values fell within their respective guidelines (Table 3).

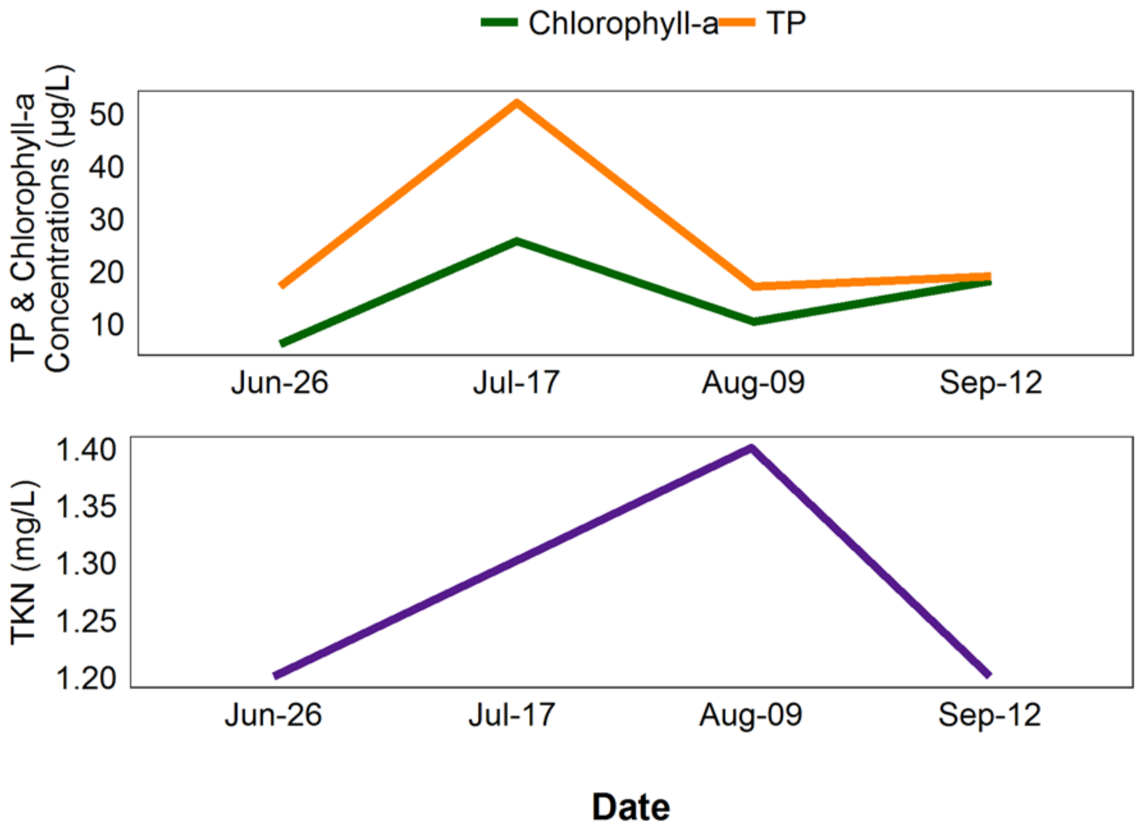

Figure 1- Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), and Chlorophyll-*a* concentrations measured four times over the course of the summer at Lacombe Lake.

WATER CLARITY AND SECCHI DEPTH

Water clarity is influenced by suspended materials, both living and dead, as well as dissolved colored compounds in the water column. During the melting of snow and ice in spring, lake water can become turbid (cloudy) from silt transported into the lake. Lake water usually clears in late spring but then becomes more turbid with increased algal growth as the summer progresses. The easiest and most widely used measure of lake water clarity is the Secchi depth. Two times the Secchi depth equals the euphotic depth – the depth to which there is enough light for photosynthesis.

The average Secchi depth of Lacombe Lake in 2017 was 1.45 m (Table 2). Secchi depth remained relatively stable but decreased slightly over the course of the sampling season (Figure 2). The decreasing water clarity could be associated with increasing algae biomass in the warmer months of the summer.

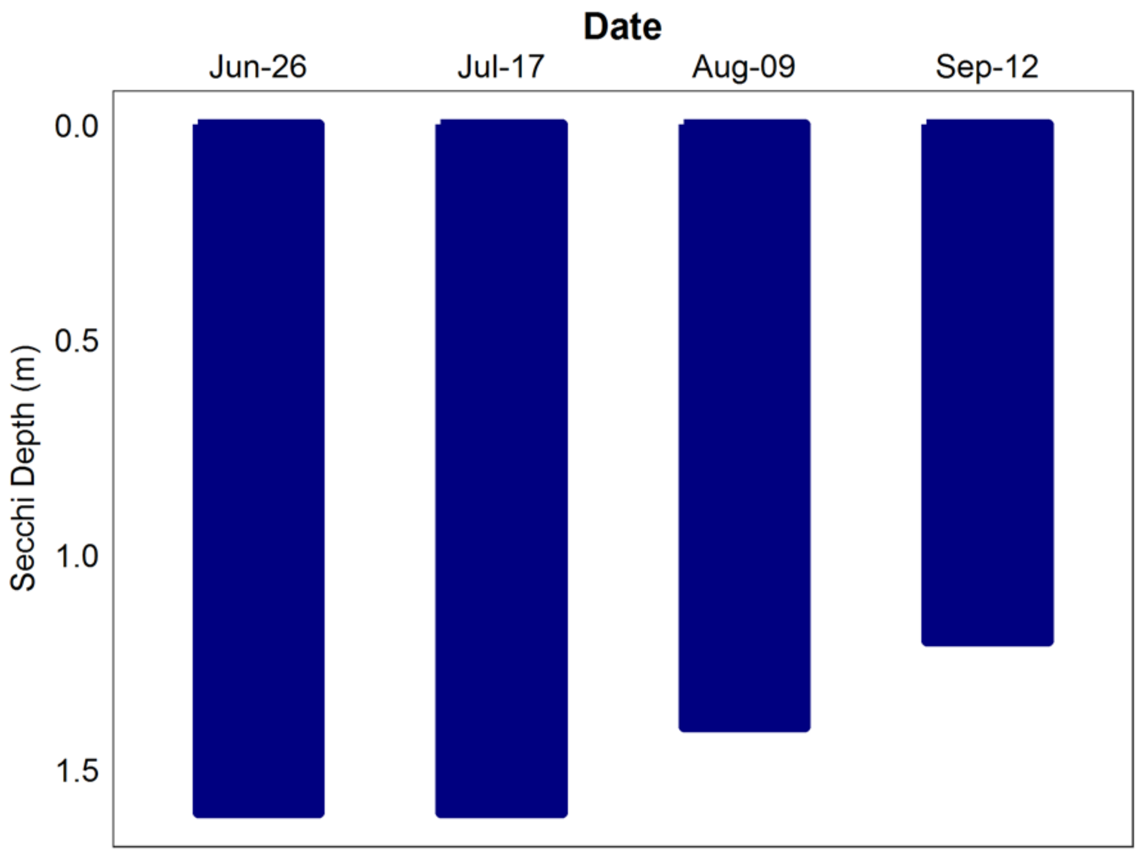

Figure 2 – Secchi depth values measured four times over the course of the summer at Lacombe Lake in 2017.

WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature and dissolved oxygen profiles in the water column can provide information on water quality and fish habitat. The depth of the thermocline is important in determining the depth to which dissolved oxygen from the surface can be mixed. Please refer to the end of this report for descriptions of technical terms.

Temperatures of Lacombe Lake varied throughout the summer, with a maximum temperature of 21.2 °C measured at the surface on July 17 (Figure 3a). The lake was well mixed for most of the summer, with weak stratification occurring on August 9.

Lacombe Lake remained well oxygenated through its water column throughout the summer, measuring above the CCME guidelines of 6.5 mg/L for the Protection of Aquatic Life (Figure 3b). During thermal stratification, oxygen levels decreased but did not reach anoxia near the bottom.

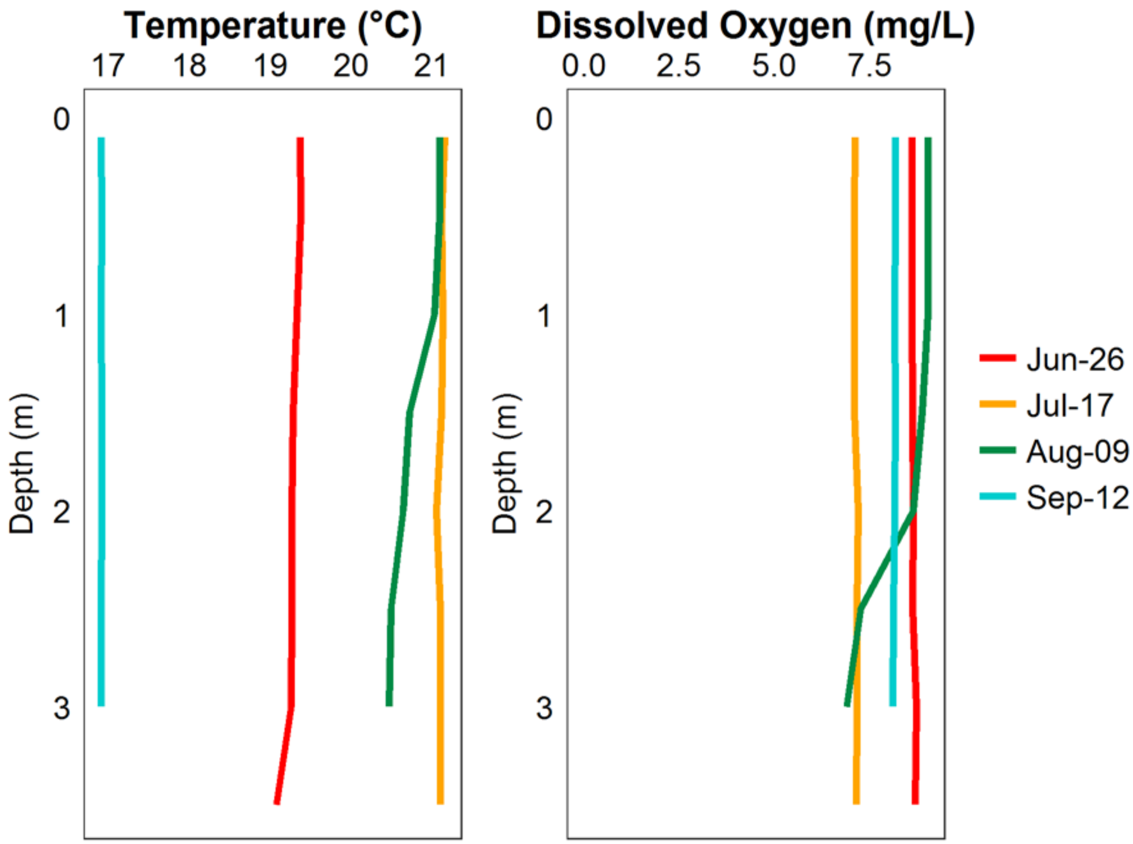

Figure 3 – a) Temperature (°C) and b) dissolved oxygen (mg/L) profiles for Lacombe Lake measured four times over the course of the summer of 2017.

MICROCYSTIN

Microcystins are toxins produced by cyanobacteria (blue-green algae) which, when ingested, can cause severe liver damage. Microcystins are produced by many species of cyanobacteria which are common to Alberta's Lakes, and are thought to be the one of the most common cyanobacteria toxins. In Alberta, recreational guidelines for microcystin are set at 20 μg/L. Blue-green algae advisories are managed by Alberta Health Services. Recreating in algal blooms, even if microcystin concentrations are not above guidelines, is not recommended.

Microcystin levels in Lacombe Lake fell below the recreational guideline for the entire sampling period of 2017 (Table 1).

Table 1: Microcystin concentrations measured four times at Lacombe Lake in 2017.

Date	**Microcystin Concentration (μg/L)**
26-Jun-17	0.22
17-Jul-17	0.55
9-Aug-17	1.40
12-Sep-17	3.45
Average	1.41

INVASIVE SPECIES MONITORING

Dreissenid mussels pose a significant concern for Alberta because they impair the function of water conveyance infrastructure and adversely impact the aquatic environment. These invasive mussels have been linked to creating toxic algae blooms, decreasing the amount of nutrients needed for fish and other native species, and causing millions of dollars in annual costs for repair and maintenance of water-operated infrastructure and facilities.

Monitoring involved two components: monitoring for juvenile mussel veligers using a plankton net and monitoring for attached adult mussels using substrates installed in each lake. No mussels have been detected in Lacombe Lake.

WATER LEVELS

There are many factors influencing water quantity. Some of these factors include the size of the lake's drainage basin, precipitation, evaporation, water consumption, ground water influences, and the efficiency of the outlet channel structure at removing water from the lake. Requests for water quantity monitoring should go through Alberta Environment and Parks Monitoring and Science division.

Table 2: Average Secchi depth and water chemistry values for Lacombe Lake.

Parameter	2008	2009	2010	2011	2012	2014	2015	2016	2017
TP (µg/L)	200	233	129	45.67	82	22	19	16	26.3
TDP (µg/L)	\	\	\	\	\	5.1	6.0	2.7	4.4
Chlorophyll-*a* (µg/L)	\	\	\	\	\	7.7	7.5	8.6	15.0
Secchi depth (m)	\	\	\	\	\	1.54	1.74	1.77	1.45
TKN (mg/L)	1.1	1.9	1.9	1.6	1.3	1.3	1.4	1.3	1.3
NO_2-N and NO_3-N (µg/L)	20	35	13.2	4.5	3	5.28	2.5	2.5	/
NH_3-N (µg/L)	450	858.33	285	860	375	18.02	25	54	/
DOC (mg/L)	\	\	\	\	\	\	17	14.6	15.25
Ca (mg/L)	\	\	\	\	\	27.18	20	21	24.25
Mg (mg/L)	\	\	\	\	\	31.62	32	34	30.75
Na (mg/L)	\	\	\	\	\	34.08	33	36	32.5
K (mg/L)	\	\	\	\	\	12.63	12	12	10.75
SO_4^{2-} (mg/L)	\	\	\	\	\	14.18	16	14	13.25
Cl^- (mg/L)	\	\	\	\	\	21.45	25	25	26.75
CO_3 (mg/L)	\	\	\	\	\	8.12	14	8	6.78
HCO_3 (mg/L)	\	\	\	\	\	261	230	254	255
pH	\	\	\	\	\	8.54	8.78	8.62	8.53
Conductivity (µS/cm)	\	\	\	\	\	505.67	478	490	515
Hardness (mg/L)	\	\	\	\	\	198	182	192	185
TDS (mg/L)	\	\	\	\	\	278	266	280	278
Microcystin (µg/L)	\	\	\	\	\	0.15	0.38	0.28	1.41
Total Alkalinity (mg/L $CaCO_3$)	\	\	\	\	\	228	212	224	220

Table 3: Concentrations of metals measured in Lacombe Lake on August 9. The CCME heavy metal Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated) are presented for reference.

Metals (Total Recoverable)	**2014**	**2015**	**2016**	**2017 Top**	**2017 Bottom**	**Guidelines**
Aluminum µg/L	14	11.5667	7.2	8.7	3.4	100[a]
Antimony µg/L	0.0595	0.0643	0.057	0.06	0.065	/
Arsenic µg/L	0.9115	0.9550	0.803	0.97	1.02	5
Barium µg/L	62.25	45.67	44.5	57	57.3	/
Beryllium µg/L	0.004	0.0073	0.004	<0.003	<0.003	100[c,d]
Bismuth µg/L	0.0005	0.0302	5.00E-04	<0.003	<0.003	/
Boron µg/L	45.75	46.63	47.7	46.5	47.1	1500
Cadmium µg/L	0.0015	0.0030	0.001	<0.01	<0.01	0.26[b]
Chromium µg/L	0.175	0.180	0.04	L0.1	L0.1	/
Cobalt µg/L	0.033	0.041	0.01	0.054	0.056	1000[d]
Copper µg/L	0.3975	0.6967	0.37	0.27	0.29	4[b]
Iron µg/L	17.7	12.4	10.4	6.6	5.3	300
Lead µg/L	0.01475	0.1047	0.021	0.049	0.013	7[b]
Lithium µg/L	19.8	22.13	24.7	24.2	24.4	2500[e]
Manganese µg/L	48.1	53.2	51	56.4	58.4	200[e]
Mercury (dissolved) ng/L	/	/	/	0.28	0.29	/
Mercury (total) ng/L	/	/	/	0.72	0.67	26
Molybdenum µg/L	0.137	0.104	0.102	0.083	0.084	73[c]
Nickel µg/L	0.042	0.109	0.035	1.2	1.2	150[b]
Selenium µg/L	0.175	0.057	0.22	0.3	0.3	1
Silver µg/L	0.001	0.005	0.001	<0.001	<0.001	0.25
Strontium µg/L	199.5	139.3	131	185	184	/
Thallium µg/L	0.001575	0.0121	0.00045	<0.002	<0.002	0.8
Thorium µg/L	0.001975	0.0938	0.0035	<0.002	0.01	/
Tin µg/L	0.00775	0.0320	0.02	<0.06	<0.06	/
Titanium µg/L	0.865	0.9833	0.76	1.09	1.04	/
Uranium µg/L	0.6785	0.5223	0.524	0.477	0.476	15
Vanadium µg/L	0.185	0.1667	0.2	0.169	0.122	100[d,e]
Zinc µg/L	0.95	1.37	0.6	0.4	0.4	30

Values represent means of total recoverable metal concentrations.
[a] Based on pH ≥ 6.5
[b] Based on water hardness > 180mg/L (as CaCO3)
[c] CCME interim value.
[d] Based on CCME Guidelines for Agricultural use (Livestock Watering).
[e] Based on CCME Guidelines for Agricultural Use (Irrigation).
A forward slash (/) indicates an absence of data or guidelines.

Plant Monitoring

ALMS conducted a bioblitz for aquatic plants and macro-algae on August 5th as a way to identify the composition of the native plant community and to scan for the presence of invasive species. The lake's shoreline was divided into three sections, and each section was assigned sample points 150-m apart (Appendix Figure 1). At each sample point, volunteers threw a double sided rake over the side of a canoe and bagged or identified plants collected. If comfortable doing so, volunteers also identified plants which could be seen from the canoe but which were not collected with a rake throw.

Much of Lacombe Lake's shoreline is dominated by bulrushes, however these observations were not included in the data summary. In Lacombe's open-water areas the lakebed is covered in dense beds of *Chara* spp. (pers. obs.) - due to the design of the sampling program, these beds are not included in the data summary. Voucher specimens collected during the bioblitz are presented in Figure 2 of the Appendix. Moreover, dense beds of yellow water-lily prevented access to the shoreline at many sample locations.

ALMS Technician Elashia Young holding a specimen of bladderwort during the 2017 bioblitz.

Bradley Peter and Ageleky Bouzetos of ALMS sampling plants in Lacombe Lake in 2016.

In total, not including emergents such as rushes and reeds, 9 unique macrophytes were identified to species. Two additional categories, Lily spp. and Pondweed spp. were included to categorize individuals which were unidentifiable to species. In total, 108 observations were made (Table 4). Identified plants included Sago Pondweed (*Stuckenia pectinata*), Small Pondweed (*Potamogeton pusillus*), Arrowhead (*Saggitaria latifolia*), Spiral Ditchgrass (*Ruppia cirrhosa),* Northern Milfoil (*Myriophyllum sibricum),* Chara spp., Richardson's Pondweed (*Potamogeton richardsonii*), Yellow Water-lily (*Nuphar variegata*), and Bladderwort spp. (Utricularia spp.). Previous aquatic plant sampling events at Lacombe Lake have identified Fries' Pondweed (*Potamogeton friesii*), Sheathing Pondweed (*Stuckenia vaginata*)*,* and Floating-Leaf Pondweed (*Potamogeton natans*). No invasive species were detected in 2017.

Table 4 - The number of observations of each plant species during the 2018 bioblitz at Lacombe Lake.

Common Name	# Observations
Sago Pondweed	1
Small Pondweed	1
Arrowhead	1
Spiral Ditchgrass	2
Northern Milfoil	4
Lily spp.	5
Richardson's Pondweed	14
Chara	15
Yellow Water-lily	18
Bladderwort spp.	22
Pondweed spp.	25
Total Observations	**108**

APPENDIX

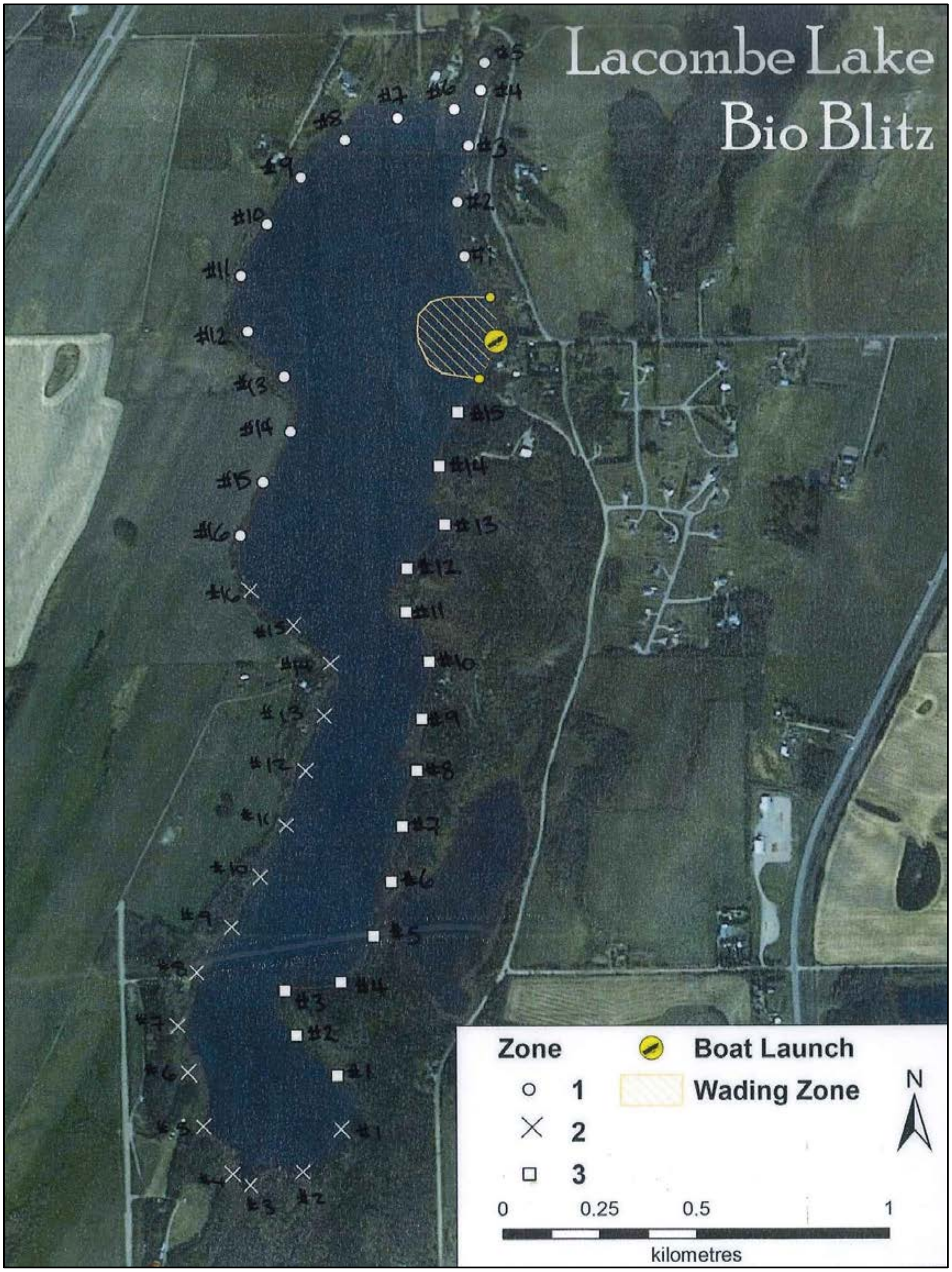

Figure 1 - Aquatic plant sample locations for the 2018 Lacombe Lake bioblitz.

Table 1 - Sample locations and plant species (common names) collected or seen at each location.

Location	Plant Species Collected (Common Names)					
Square 1	Pondweed spp.	Yellow Pond Lily				
Square 2	Pondweed spp.	Bladderwort				
Square 3	Pondweed spp.	Richardson's Pondweed				
Square 4	Yellow Pond Lily	Pondweed spp.	Chara	Bladderwort		
Square 5	Richardson's Pondweed	Bladderwort	Richardson's Pondweed	Yellow Pond Lily		
Square 6	Bladderwort	Pondweed spp.	Yellow Pond Lily			
Square 7	Richardson's Pondweed	Chara	Chara			
Square 8	Pondweed spp.	Yellow Pond Lily				
Square 9						
Square 10	Bladderwort	Lily spp.				
Square 11	Yellow Pond Lily	Bladderwort	Pondweed spp.	Richardson's Pondweed		
Square 12	Chara	Yellow Pond Lily				
Square 13	Richardson's Pondweed	Yellow Pond Lily	Bladderwort	Pondweed spp.		
Square 14						
Square 15						
Square 16						
EX 1	Bladderwort	Pondweed spp.				
EX 2	Chara					
EX 3	Chara					
EX 4	Bladderwort					
EX 5	Chara	Richardson's Pondweed	Bladderwort	Lily spp.		
EX 6	Chara					
EX 7	Chara	Yellow Pond Lily				
EX 8	Chara	Pondweed spp.				
EX 9	Spiral Ditchgrass					
EX 10	Spiral Ditchgrass					
EX 11	Bladderwort	Pondweed spp.				
EX 12	Bladderwort	Pondweed spp.				
EX 13	Bladderwort	Pondweed spp.				
EX 14						
EX 15	Chara					
EX 16	Chara					
Circle 1	Pondweed spp.	Richardson's Pondweed	Northern Milfoil	Lily spp.		
Circle 2	Richardson's Pondweed	Pondweed spp.				
Circle 3	Richardson's Pondweed	Yellow Pond Lily	Bladderwort	Lily spp.	Northern Milfoil	Pondweed spp.
Circle 4						
Circle 5						
Circle 6	Pondweed spp.					
Circle 7	Pondweed spp.	Richardson's Pondweed	Chara	Bladderwort	Small Pondweed	Lily spp.
Circle 8	Pondweed spp.	Bladderwort	Yellow Pond Lily	Richardson's Pondweed		
Circle 9	Pondweed spp.	Bladderwort	Yellow Pond Lily			
Circle 10	Chara	Yellow Pond Lily	Bladderwort			
Circle 11	Sago Pondweed	Pondweed spp.	Bladderwort	Yellow Pond Lily		
Circle 12	Pondweed spp.	Yellow Pond Lily	Northern Milfoil	Richardson's Pondweed	Bladderwort	
Circle 13	Pondweed spp.	Yellow Pond Lily				
Circle 14	Pondweed spp.	Yellow Pond Lily	Bladderwort			
Circle 15	Arrowhead	Pondweed spp.	Bladderwort	Chara	Northern Milfoil	
Circle 16	Richardson's Pondweed	Yellow Pond Lily				

Pondweed spp.
Possibly Sheathing Pondweed
Stuckenia vaginata

Richardson's Pondweed
Potamogeton richardsonii

Northern Milfoil
Myriophyllum sibiricum

Arrowhead
Saggitaria latifolia

Lily spp.
Nuphar spp.

Sago Pondweed
Stuckenia pectinata

Small Leaf Pondweed
Potamogeton pusillus

Bladderwort
Utricularia spp.

Spiral Ditchgrass
Ruppia cirrhosa

Figure 2 - Pressed voucher specimens submitted to the University of Alberta Vascular Plant Herbarium