2009 LakeWatch Report

Completed with support from:

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Water is integral to supporting and maintaining life on this planet as it moderates the climate, creates growth and shapes the living substance of all of Earth's creatures. It is the tide of life itself, the sacred source.

David Suzuki(1997) The Sacred Balance

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.

Acknowledgements

The Lakewatch program is made possible through the dedication of its volunteers and Lakwatch Chairs, Al Sosiak and Ron Zurawell. We would like to thank Scott Lineker and Bob Lineker for their efforts in collecting data in 2009. We would also like to thank Noemie Jenni and Cristen Symes who were summer interns with ALMS in 2009. Project Technical Coordinator, Jill Anderson was instrumental in planning and organizing the field program. Technologists, Shelley Manchur, Mike Bilyk, Brian Jackson and John Willis were involved in the logistics planning and training aspects of the program. Doreen LeClair and Chris Rickard were responsible for data management. Théo Charette (ALMS President) and Jill Anderson (Program Manager) were responsible for program administration and planning. Francine Forrest, Jean-Francois Bouffard, and Théo Charette helped prepare the original reports, which were updated by Sarah Lord for 2009. Alberta Environment and the Beaver River Watershed Alliance (BRWA) were major sponsors of the Lakewatch program.

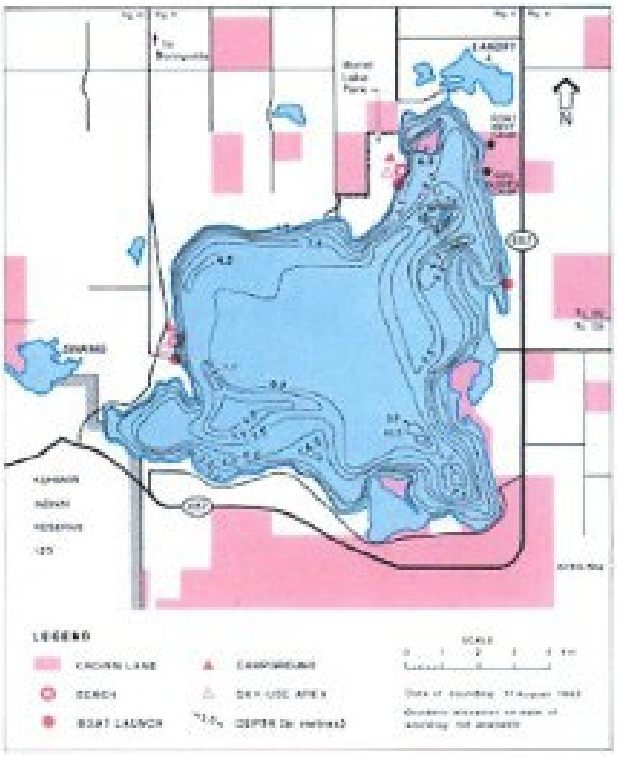


Figure 1 – Bathymetry of Muriel Lake from Mitchell and Prepas 1990.

Muriel Lake:

Muriel Lake (Figure 1) is located 13 km south of the town of Bonnyville and 250 km northeast of Edmonton. Muriel Lake is a large (64.1 km^2) but relatively shallow (mean and maximum deph 6.6 and 10.7 n, respectively) water body. The shoreline consists primarily of steep rocky slopes, but there are also several attractive sandy beaches.

The first non-native establishment in the area was a fur-trading post in 1781 by the North West Company near the present-day hamlet of Beaver Crossing, about 35 km northeast of Muriel Lake. The first settlers came to the Bonnyville area in 1907, and established an economy based on the timber industry. Two sawmills were located at Muriel Lake, one at the northeastern tip and the other on the large island/peninsula on the eastern shore. In the 1920's a large fire forced the economic base to switch to agriculture.

Much of the watershed is occupied by Kehiwin Indian Reserve No. 123, which is located on 8200 ha of land southwest of the lake. There are several subdivisions around the lake shore, mostly on the south and east sides of the lake. The largest recreational facility on Muriel Lake, is Muriel Lake Park, which is operated by the Municipal District of Bonnyville. Muriel Lake is managed for domestic, sport and commercial fisheries. Northern pike, yellow perch, lake whitefish, and walleye are the sport fish found in the lake. Lake whitefish were stocked in 1937 and walleye are stocked periodically. The primary commercial species in lake whitefish, which constitutes about 95% of the total catch.

Muriel Lake is mesotrophic, with a moderate supply of nutrients and relatively low concentration of algae, and mixes periodically throughout the summer. Phytoplankton succession during the summer goes form golden-brown algae (*Dinobryon* spp.) in May, to diatoms (*Fragilaria crontonensis*) and dinoflagellates (*Ceratium hirendinella*) in June, and diatoms (*Fragilaria crotonensis*), blue-green algae, and green algae (*Closterium* spp.) in late summer. As a result of its clear water, aquatic plants can grow to a depth of 7 m in Muriel Lake and the littoral zone can cover almost 50% of the lake's area. Emergent vegetation is largely restricted to areas sheltered from the wind. The northwest shore, although somewhat protected, has no emergent stands because of its rocky or sandy substrate. The dominant emergent species in 1978 were common great bulrush (*Scirpus validus*), and common cattail (*Typha latifolia*) and sedges (*Carex* spp.) closer to shore. The dominant submergent species was a large-sheath pondweed (*Potamodeton vaginatus*).

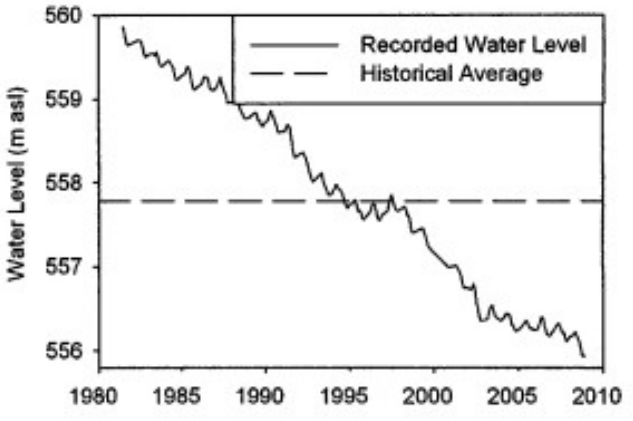


Figure 2. Historical water levels (m asl) in Muriel Lake, Alberta 1980 – 2009.

Results:

Water Level:

Water levels in Muriel Lake have declined steadily since 1981 (Figure 2), at which time the maximum lake elevation was recorded as 555.9 m asl. Water level has since declined by 3.92 m to its current elevation of 555.9 m asl, the lowest level on record. In many other lakes in Alberta the wet years of 1996 and 1997 resulted in peak water levels barely registered at Muriel Lake.

Water Temperature and Dissolved Oxygen:

Water temperature and dissolved oxygen profiles in the water column can provide information on water quality and fish habitat. Please refer to the end of this report for descriptions of technical terms.

Thermal stratification in Muriel Lake was not observed during the summer of 2009 (Figure 3). Due to logistical constraints, a full depth profile for temperature and oxygen was taken only once, on 13 August. A partial profile (to 1.0 m in depth) was taken on 16 July. Surface water temperature increased from 17.6°C on 16July to 19.9°C on 13 August. There was no temperature difference between surface and below waters, indicating the lake was isothermic. Dissolved oxygen (DO) concentrations in upper layers of surface waters of Muriel Lake were ≥ 8 mg/L on both sampling dates in 2009, well within the acceptable range for surface water quality (DO ≥ 5.0 mg/L) (Figure 3). DO concentrations declined at a depth of 3.0 m in August, but bottom waters were still well oxygenated.

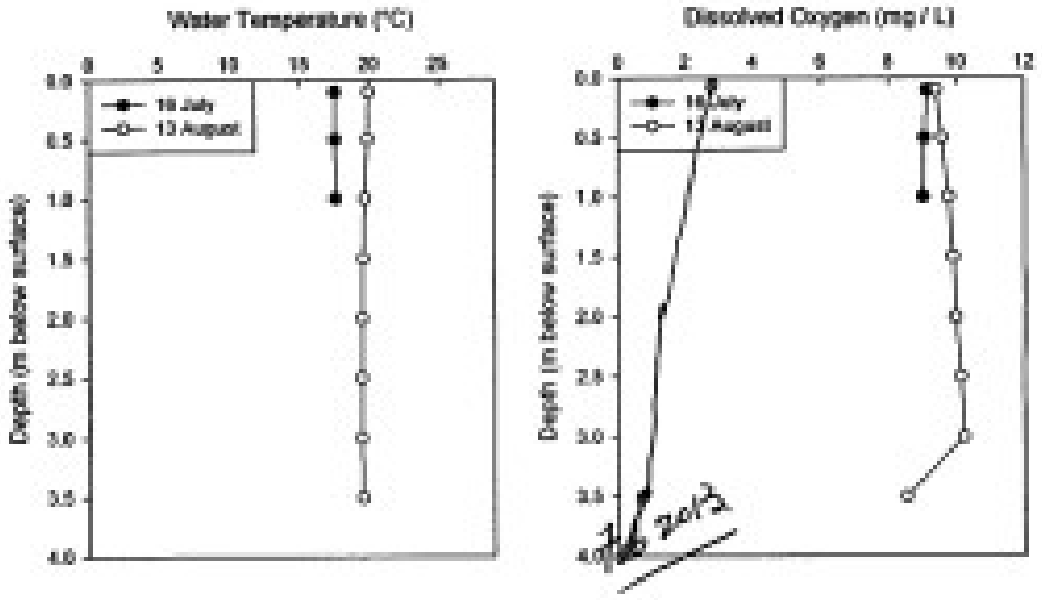


Figure 3. Water temperature (°C) and dissolved oxygen (mg/L) profiles for Muriel Lake during the summer of 2009.

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 the 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 disk depth.

Water clarity on Muriel Lake was measured three times during the summer of 2009. Muriel Lake is of average turbidity compared to other lakes in Alberta, with average Secchi depth of 1.08 m (Table 1). On 16 July, light penetrated 1.25 m or ~35% of the current total lake depth, which allowed for algal growth in th top 2.5 m of the lake. By 13 August, Secchi depth had increased slightly to 1.5 m, but water clarity declined to a seasonal minimum of 0.5 m Secchi depth on 27 August. This pattern of water clarity dynamics is typical of highly productive Alberta lakes, when algal growth during July and August causes reduced water clarity. Water clarity typically recovers in September as lower temperatures limit growth, and dying algae fall out of the water column and settle on the lakebed where they are decomposed by anaerobic bacteria.

Water Chemistry:

Based on lake water characteristics, Muriel Lake is considered eutrophic (see *A Brief Introduction to Limnology* at the end of the report). In 2009, Muriel Lake and high concentrations of total phosphorus (average TP = 64.3 µg/L), total nitrogen (average TN = 3434 µg/L) (Table 1). Total phosphorus increased over the summer, from 58 µg/L on 16 July and 13 August, to 77 µg/L on 27 August (Figure 4). Total nitrogen also increased over the summer, from 3.059 mg/L on 16 July to a seasonal maximum of 3.758 mg/L by 27 August. Cholophyll *a* (a measure of algal biomass) increased slightly from 7.49 µg/L on 13 August, and then rose sharply to 13.5 µg/L on 27 August.

During the summer 2009, Muriel Lake was well buffered from acidification with an average pH = 9.25, which is well above that of pure water (i.e., pH 7). Dominant ions include bicarbonate, sulfate, and carbonate (Table 1). Ion concentrations have increased significantly since the sampling began on Muriel Lake in 1988. This indicates a change in hydrology, potentially an increasing contribution of groundwater (which has high concentrations of ions) and a reduced contribution of surface runoff and throughflow. The reduction in water levels observed in Muriel Lake can also itself lead to a higher concentrations of ions.

The average concentrations of various metals (as total recoverable concentrations) in Muriel Lake were measured twice in the summer of 2009. All concentrations were within CCME guidelines for the Protection of Freshwater Aquatic Life except for arsenic, which was nearly double the CCME guideline (Appendix 1).

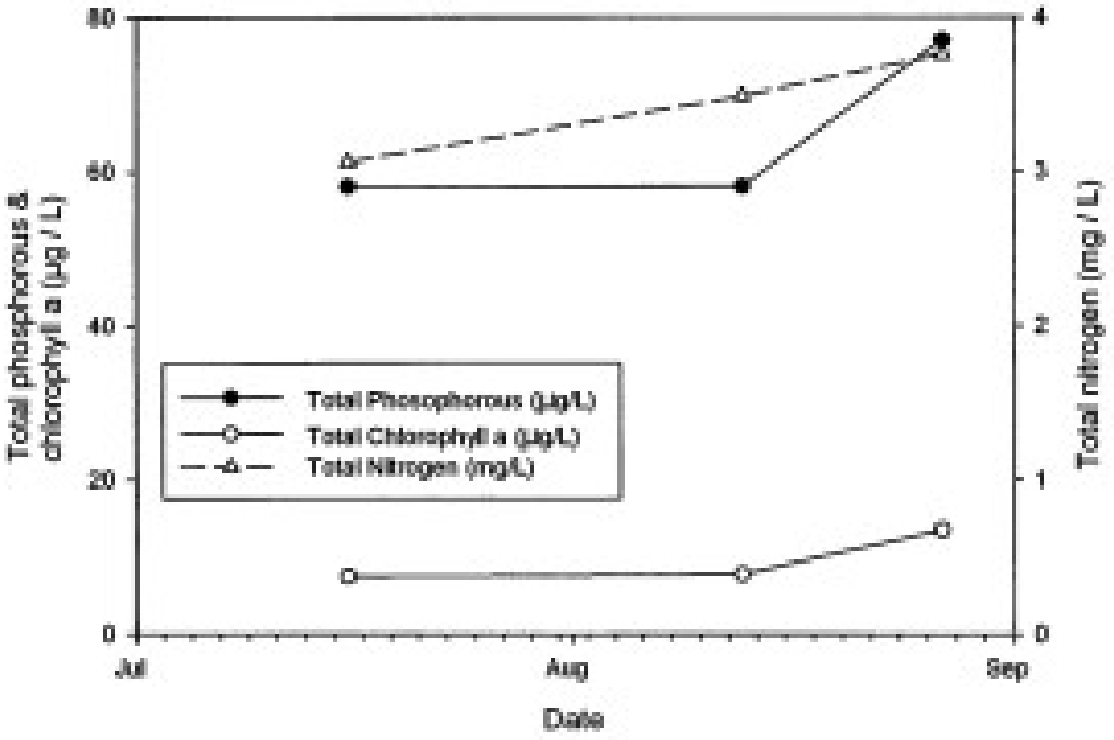


Figure 4. Total phosphorous, chlorophyll *a* (a measure of algal biomass), and total nitrogen concentrations for Muriel Lake during the summer of 2009.

Table 1. Mean water chemistry and Secchi depth values for Muriel Lake, summer 2009 compared to historical values. Data are seasonal averages, unless otherwise indicated.

Parameter	1968	1987	2001	2003	2006	2009
TP (µg/L)	36	42	62	48	54	64.3
TDP (µg/L)	12	16	29	18	21.5	28.7
Chlorophyll-a (µg/L)	6.7	6.7	12	9.2	8.5	9.59
Secchi disk depth (m)	2.2	1.9	0.9	1.1	1.5	1.08
TKN (µg/L)	1532	1998	1826	2470	2655	3.41
NO_{2-3} (µg/L)	<2	3	6	2.5	<5	24
NH_4 (µg/L)	21	23	<1	20	45	26
Dissolved organic C (mg/L)	-	-	-	-	-	47.1
Ca (mg/L)	11	7.5	-	5	5.6	4.74
Mg (mg/L)	98	126	-	173	164	152.7
Na (mg/L)	118	160	-	238	245	288.7
K (mg/L)	21	30	-	39	40.6	53.8
SO_4^{2-} (mg/L)	116	154	-	239	257	332.7
Cl (mg/L)	17	32	-	34	36.7	41.0
TDS (mg/L)	-	-	-	-	-	1510
pH	8.2 - 9.6	9.2	-	9.3	9.2	9.25
Conductivity (µS/cm)	1143	1354	-	1908	1925	2156
Hardness (mg/L)	-	-	-	-	-	840
HCO_3 (mg/L)	535	620	-	746	800	858
CO_3 (mg/L)	70	115	-	210	181	213
Total Alkalinity (mg/L $CaCO_3$)	556	696	-	961	957	1080

Note: TP = total phosphorous, TDP = total dissolved phosphorous, Chla = chlorophyll *a*, TKN = total Kjeldahl nitrogen, NO_{2-3} = nitrate+nitrite, NH_4 = ammonium, Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, SO_4 = sulphate, Cl = chloride, CO_3 = carbonate, HCO_3 = bicarbonate.

*Atlas of Alberta Lakes (Mitchell and Prepas, 1990).

Appendix I

Mean concentrations of metals in Muriel Lake, 2008, compared to previous years and to CCME Guidelines for the Protection of Freshwater Aquatic Life (unless otherwise indicated).

Metals (total)	2008	2009	Guidelines
ALUMINUM µg/L	31.8	30.15	100[F]
ANTIMONY µg/L	0.183	0.1825	6[F]
ARSENIC µg/L	8.54	9.21	5
BARIUM µg/L	5.13	3.109	1000[F]
BERYLLIUM µg/L	0.053	<0.053	100[CC]
BISMUTH µg/L	0.0032	0.0046	
BORON µg/L	290	325.5	5000[A,I]
CADMIUM µg/L	0.0058	0.00368	0.085[D]
CHROMIUM µg/L	0.696	0.72	
COBALT µg/L	0.33	0.0579	1000[F]
COPPER µg/L	1.87	1.435	4[E]
IRON µg/L	26.3	14.585	300
LEAD µg/L	0.0944	0.04568	7[E]
LITHIUM µg/L	132	164	2500[F]
MANGANESE µg/L	4.36	1.665	200[F]
MOLYBDENUM µg/L	1.49	1.58	73[F]
NICKEL µg/L	0.208	0.1315	150[F]
SELENIUM µg/L	1.41	0.759	1
SILVER µg/L	0.0024	0.00575	
STRONTIUM µg/L	11	9.405	
THALLIUM µg/L	0.0098	0.00168	0.8
THORIUM µg/L	0.0104	0.00725	
TIN µg/L	0.03	<0.03	
TITANIUM µg/L	2.56	2.12	
URANIUM µg/L	1.44	1.595	100[F]
VANADIUM µg/L	0.597	0.705	100[H]
ZINC µg/L	2.46	1.525	30

With the exception of fluoride (which reflects the mean concentration of dissolved fluoride only), values represent means of total recoverable metal concentrations.

[A] Based on pH ≥ 6.5; calcium ion concentration [Ca^{2+}] ≤ 4 mg/L; and dissolved organic carbon concentration [DOC] ≤ 2 mg/L.

[B] Based on water Hardness of 100 mg/L (as $CaCO_3$).

[C] Based on water Hardness > 100 mg/L (as $CaCO_3$).

[D] CCME interim value.

[E] Based of Canadian Drinking Water Quality guideline values.

[F] Based of CCME Guidelines for Agricultural Use (Livestock Watering).

[G] Based of CCME Guidelines for Agricultural Use (Irrigation).

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