Muriel Lake Winter 2019/20 Dissolved Oxygen Summary

Introduction

Muriel Lake has lost almost 60% of its water volume, limiting its ability as a recreational lake. The dropping water level prevents the proper use of power boats and swimming is unpleasant due to the muddy bottom (Save Muriel Lake 2016). The most significant impact of the dropping water levels is the loss of sport and game fishing as a result of winter kills from low oxygen levels in Muriel Lake. However, with the increased precipitation over the past couple of years the lake levels of Muriel have reached 556 meters above sea level for the first time since 2008 (Save Muriel Lake 2019).

A dedicated water stewardship group, Muriel Lake Basin Management Society (MLBMS), has taken it upon themselves to address Muriel Lake's water levels, water quality, and diminishing fish spawning habitat. Along with increasing community awareness, MLBMS has recently contributed to collecting citizen science to fill in the data gaps of Muriel Lake's winter dissolved oxygen levels. As Muriel Lake is within the Beaver River Watershed, the Watershed Planning and Advisory Group (WPAC) of LICA – *Environmental Stewards* has lent its equipment to MLBMS for their citizen science project.

The MLBMS has collected winter dissolved oxygen (DO) previously in 2018-2019 during the winter months. This is the second year of data collection for winter DO levels within Muriel Lake. These results show a slight increase in DO levels from 2018-2019 and a decrease in conductivity, total dissolved solids, and pH. Measurements of winter DO levels should be repeated next year to determine if Muriel Lake is continuing to improve from year to year.

Why Measure Dissolved Oxygen?

Dissolved oxygen (DO) is very important to measure because oxygen is needed to sustain life within a body of water. When looking at DO in parts per million (ppm) a healthy level is 8 ppm, at this level there should be an abundant level of life and high diversity. With a lower DO of 4 ppm, there is a moderate amount of life and less diversity. Readings of 3 ppm or less means the body of water is unable to support life

and is highly susceptible to disease and toxins (Alberta Lake Management Society 2002).

DO can be added to a body of water in several ways. Most oxygen is added by diffusion from the atmosphere (Oram 2014). Cooler waters can hold more DO, so shaded banks can help keep temperatures down and oxygen in. Oxygen is also added to water by photosynthesis, just like on land. Aquatic plants take in CO_2 from the surrounding environment and release O_2 as a byproduct of photosynthesis (Fondriest Environmental, Inc. 2013). Therefore, by adding more plant life along the riparian area, the shoreline area where water meets the land, more oxygen can be added to the water. DO levels can also be affected by salinity, the higher the salinity the less oxygen the water can hold (Fondriest Environmental, Inc. 2013). Another benefit of the riparian area is to help stabilize the shoreline through the root systems of riparian plants and prevents sediments from washing into the body of water.

Another very important way DO is added is by being physically mixed into the water with help from winds, streams, waterfalls, and fountains. With this movement it takes oxygen from the air around us and mixes it in with the water (Alberta Lake Management Society 2002). Once the lake freezes over, no new oxygen can be mixed into the lake and life must support itself from the oxygen which was dissolved in the water during the summer months (Fafard 2018). If not enough oxygen is available to sustain life it creates a “dead zone” and results in winter fish kills (Dybas 2005).

With the increased water levels in Muriel Lake over the past two years residents were curious to see if the winter oxygen levels were sufficient to support fish life once again. This summary report shares the data collected by MLBMS during the 2019 - 2020 winter season to determine the dissolved oxygen levels in the lake during the winter months and compares it to the 2018-2019 winter results.

Procedure

The data was collected using a YSI Professional Plus probe which measures temperature, dissolved oxygen, pH, conductivity, and total dissolved solids (TDS). The YSI probe was calibrated as needed. The MLBMS tested the water at the deepest known part of Muriel Lake, 4.5 meters, which is located at N 54° 07’ 23.1”, W -110° 38’ 45.4”. This location was marked with a stake to ensure consistency of the sampling location. The water was tested once in December, January, February, and March for a total of four samples during mid-month, aside from March which was sampled earlier for safety reasons. The water was measured in the water column at 0.5-meter intervals until it reached the bottom of the lake. The weather conditions were noted on the

datasheet to include the air temperature, wind speed, and direction, as well as percent of cloud cover. The ice thickness and the deepest measurement were also recorded.

2019-2020 Results

DECEMBER 2019

Depth (m)	Temperature	DO%	DO (ppm)	Conductivity (us/m)	TDS	pH
0.5	0	58.1	7.5	985	1222	8.65
1	0.6	91.7	12.87	1058	1280	8.96
1.5	1	92	12.83	1076	1287	9
2	1.4	94.6	13.53	1089	1287	9.02
2.5	1.9	94.5	12.84	1104	1280	9.03
3	2.2	96.8	13.13	1115	1280	9.03
3.5	2.7	57.4	7.02	1136	1287	9.02
4	2.4	105	14.19	1145	1313	9.05

Table 1: *December 12, 2019. The air temperature of -8 degrees Celsius, wind speed of 5 km/h from the S/SE and 100% cloud cover. Ice thickness 0.38 m. Bottom depth 4.26 m*

JANUARY 2020

Depth (m)	Temperature	DO%	DO (ppm)	Conductivity (us/m)	TDS	pH
0.5	0.1	26.4	3.8	996	1235	8.58
1	0.9	44	6.22	1063	1280	8.75
1.5	1.6	47.7	6.63	1124	1319	8.79
2	2.1	47.9	6.57	1146	1319	8.82
2.5	2.6	47.9	6.46	1163	1319	8.86
3	2.5	40.6	5.49	1167	1332	8.88
3.5	2.5	35.7	4.81	1172	1339	8.89
4	2.9	49.4	6.59	1196	1345	8.91

Table 2: *January 23, 2020. The air temperature of -8 degrees Celsius, wind speed of 8 km/h from the S/SE and 45% cloud cover. Ice thickness 0.61 m. Bottom depth 4.51 m*

FEBRUARY 2020

Depth (m)	Temperature	DO%	DO (ppm)	Conductivity (us/m)	TDS	pH
0.5	0.3	27.7	4	1064	1306	8.53
1	0.8	24.4	3.87	1072	1293	8.6
1.5	1.6	23.2	3.21	1093	1287	8.64
2	2.2	22.1	3.04	1116	1287	8.67
2.5	2.6	17	2.28	1130	1280	8.7
3	3	3.2	0.39	1148	1287	8.71
3.5	3.7	1.3	0.17	1170	1280	8.7
4	4.1	0.8	0.11	1206	1306	8.69

Table 3: *February 14, 2020. The air temperature of -3 degrees Celsius, wind speed of 3 km/h from the west and 5% cloud cover. Ice thickness 0.76 m. Bottom depth 4.4 m*

MARCH 2020

Depth (m)	Temperature	DO%	DO (ppm)	Conductivity (us/m)	TDS	pH
0.5	0.3	20.6	2.92	1056	1300	8.61
1	0.6	20	2.77	1062	1293	8.63
1.5	1.1	19	2.64	1074	1293	8.46
2	1.9	17.4	2.37	1099	1280	8.69
2.5	2.3	14.6	1.96	1117	1280	8.7
3	2.5	4.6	0.60	1132	1287	8.7
3.5	3.6	2	0.26	1176	1293	8.7
4	3.9	1.7	0.22	1194	1300	8.7
4.5	3.6	1.6	0.21	1186	1306	8.7

Table 4: *March 10, 2020. The air temperature of 0 degrees Celsius, wind speed of 16 km/h from the N/NW and 80% cloud cover. Ice thickness 0.76 m. Bottom depth 4.67 m*

Generally, the DO levels decreased at greater depths within the water column with the lowest DO values at the bottom of the lake. December showed the highest levels of DO in all layers of the water column at 14.19 ppm. The DO levels have a general trend of steadily decreasing throughout the winter months, with the lowest DO values in February at 0.11 ppm. There are sustainable levels of DO in December and January, but levels drop below the ability to support fish life in February and March. The lake depth was recorded at 4.51m in December and increased to 4.67m by March.

It is important to note the accuracy of the YSI probe is ± 2% of the reading or 0.2 ppm when reading in the range of 0 to 20 ppm, with the ideal functioning temperatures between -5 and 45 degrees Celsius (Xylem 2018). The YSI may malfunction if the probe hits the bottom of the lake which is a likely occurrence at the 4-meter depth in December and January.

Discussion

Winter 2019/20

It is natural to have the DO levels steadily decrease the deeper down you go in the water column, finding the lowest levels of oxygen at the bottom of a water body. The lake bottom has the least amount of interaction with the atmosphere, limiting the amount of DO. Additionally, the densest state of water is 4 degrees Celsius, which sits at the bottom of the lake and is typically the warmest water temperature during the winter, holding less oxygen than colder water (Fondriest Environmental, Inc. 2013). The surface of the water has the highest amounts of oxygen because it has the most interaction with the atmosphere and typically holds colder waters during the winter. Generally, the data collected supports this natural layering within a waterbody aside from a few outliers that have been excluded from the discussion. The DO sensors on the YSI probe were replaced after the January measurements to ensure greater accuracy in measurements.

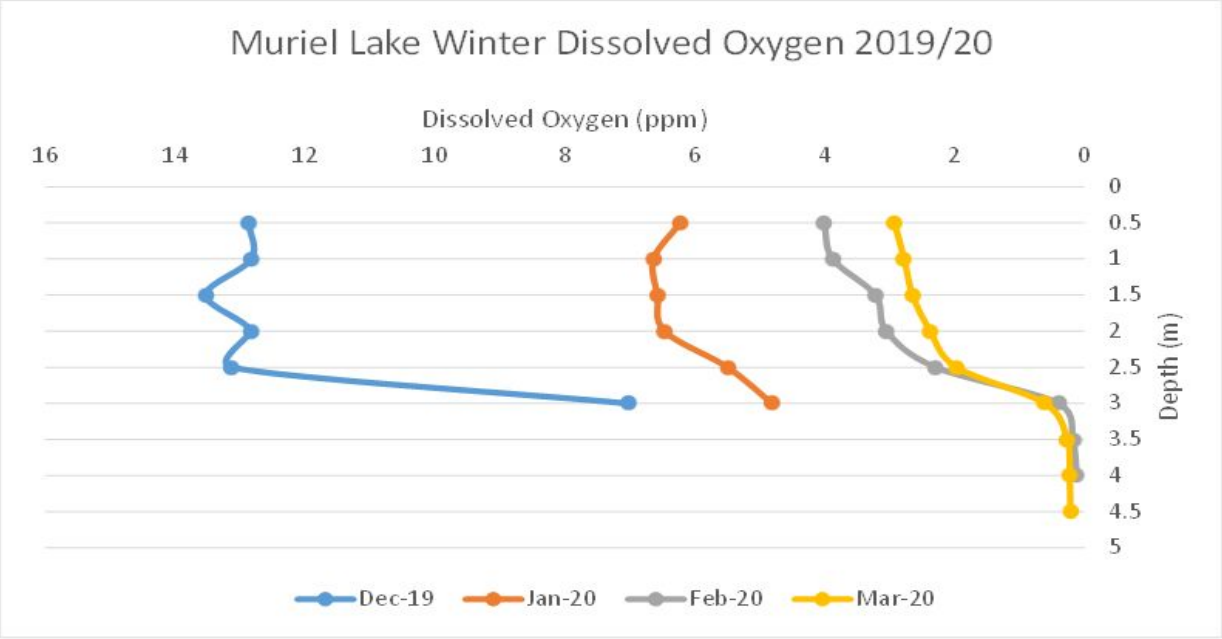

Figure 1. *DO levels in Muriel Lake in relation to the measured depth in winter 2019/20 with the outliers removed.*

The DO levels decreased throughout the winter which is a natural occurrence as the oxygen is used by other aquatic life and no new oxygen is mixed into the water. The oxygen gets mixed into a body of water during the spring, summer and fall months mainly through winds and photosynthesis. Once the ice forms on the body of water during the winter, very limited amounts of oxygen are added into the water and will continuously decrease throughout the winter as living organisms use it up. Additionally,

decaying plant matter will also remove oxygen that could be available to fish. This trend of decreasing DO can be seen in Figure 1.

Freshwater fish start to have health issues when the DO hits levels below 4 ppm. December and January had adequate levels of DO to sustain fish life in the higher reaches of the lake, however, February and March did not have any values above 4 ppm in the entire water column which would lead to winter kill (Oram 2014). In conclusion, the data collected from Muriel Lake during the 2019/20 winter continues to show it is not able to sustain fish over the winter.

Comparing Winter 2018/19 and Winter 2019/20

Parameter	Depth (m)	Dec-18	Dec-19	Jan-19	Jan-20	Feb-19	Feb-20	Mar-19	Mar-20
Dissolved Oxygen (ppm)	0.5	11.63	-	-	-	3.10	4.00	1.32	2.92
	1	10.73	12.87	7.63	6.22	0.60	3.87	0.21	2.77
	1.5	10.18	12.83	7.25	6.63	1.17	3.21	0.21	2.64
	2	9.80	13.53	7.01	6.57	1.26	3.04	0.10	2.37
	2.5	9.27	12.84	5.59	6.46	1.08	2.28	0.09	1.96
	3	7.70	13.13	2.25	5.49	0.15	0.39	0.08	0.60
	3.5	6.10	7.02	0.31	4.81	0.12	0.17	0.07	0.26
	4	1.84	-	0.15	-	0.09	0.11	0.06	0.22
	4.5			0.10				0.07	0.21
Conductivity (us/cm)		1386-1499	985-1145	2309-2605	996-1196	1253-1339	1064-1206	1625-1736	1056-1194
TSD (mg/L)		1690-1722	1222-1313	2853-2860	1235-1345	1547-1599	1280-1306	1911-2015	1280-1306
pH		9.80	9.00	9.30	8.81	9.35	8.70	8.95	8.70

Table 5. *Summary of the data collected from winter 2018/19 and winter 2019/20 (outliers removed). Range: Conductivity and TDS. Average: pH.*

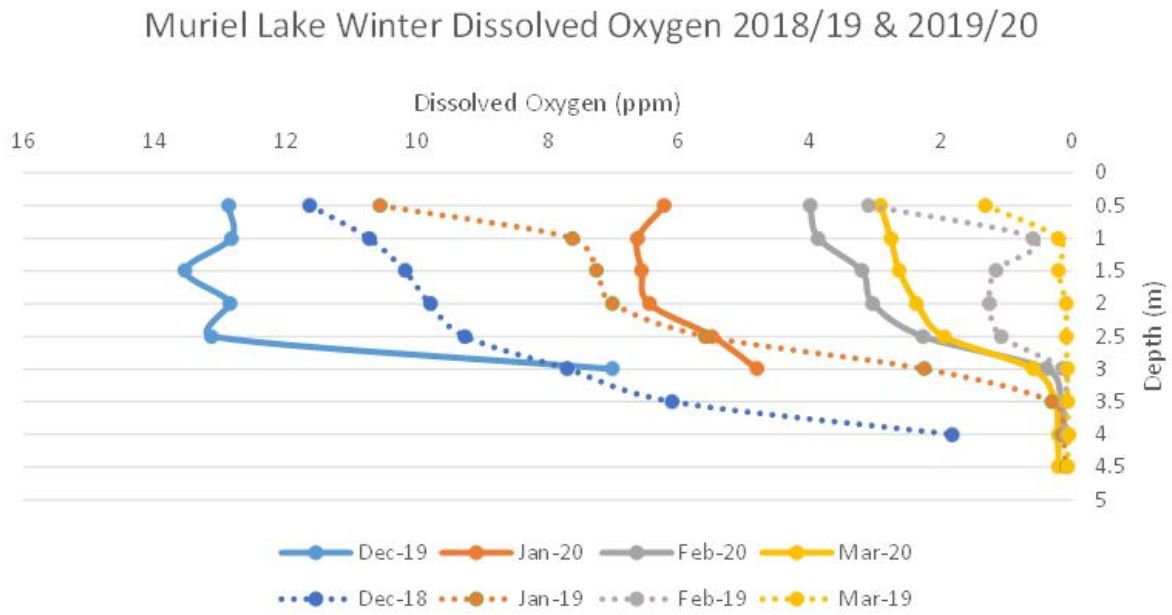

Figure 2. *DO levels in Muriel Lake in relation to the measured depth in winter 2018/19 and winter 2019/20 with the outliers removed.*

In comparison to 2018/19, this year's data showed a decrease in conductivity, TDS, and pH and an overall increase of DO. This decrease in conductivity is likely due to a decrease in salinity which allows water to hold on to more oxygen. In both years the February and March DO levels were too low in the water column to support fish life, falling below 4 ppm. This decrease in conductivity, TDS, and pH and increase in DO could result from higher amounts of rainfall in the spring and summer. The extra amounts of water entering the lake would dilute the water and therefore cause decreased conductivity and TDS levels. The change of pH could be a result of which types of runoff are entering the lake. Higher levels of water in the Muriel Lake will allow it to capture more oxygen to have available for aquatic life.

Conclusion

The data being collected by the dedicated volunteers from the MLBMS is a necessary step when improving the health of Muriel Lake. Measuring the levels of winter DO helps to determine if the efforts of the MLBMS are making an impact and aids in the development of future projects. The winter DO levels measured in 2019/2020 did not meet the requirements to sustain fish life over the winter. However, the DO levels have increased from the previous year. It is recommended that the MLBMS continues to monitor the winter DO levels of Muriel Lake to see if this upward trend continues.

Contact & Resources

To learn more about the Muriel Lake Basin Management Society and to get involved visit their website at http://www.savemuriellake.com/ and follow their Facebook Page @savemuriellake.

To read the LakeWatch Reports of the summer monitoring of Muriel Lake visit the Alberta Lake Management Society website. www.alms.ca/reports

To learn more about LICA visit our website www.lica.ca and follow us on Facebook @infoLICAonline.

If you wish to start your own citizen science project and wish to utilize equipment please contact lica2@lica.ca.

References

Alberta Lake Management Society (2002). *Alberta Water Quality Awareness Day.* Alberta Lake Management Society. Retrieved from https://alms.ca/about-awqa/

Dybas, C.L. (2005, July 01). *Dead Zones Spreading in World Oceans*. BioScience, Volume 55, Issue 7, July 2005, Pages 552–557, Retrieved from https://doi.org/10.1641/0006-3568(2005)055[0552:DZSIWO]2.0.CO;2

Fafard, P. (2018, May 16). *How and Why Lakes Stratify and Turn Over: We explain the science behind the phenomena.* ELA 5, Retrieved from https://www.iisd.org/ela/blog/commentary/lakes-stratify-turn-explain-science-behind-phenomena/

Fondriest Environmental, Inc. (2013, November 19). *Dissolved Oxygen*. Fundamentals of Environmental Measurements, Retrieved from https://www.fondriest.com/environmental-measurements/parameters/water-quality/dissolved-oxygen/

Oram, Brain. (2014). *Dissolved Oxygen in Water.* Water Research Center. [Web blog post]. Retrieved from https://www.water-research.net/index.php/dissovled-oxygen-in-water

Xylem. (2018) *Professional Plus, Multiparameter water quality instrument.* YSI Incorporated. Received from https://www.ysi.com/File%20Library/Documents/Specification%20Sheets/YSI-Professional-Plus-Spec-Sheet-Web.pdf

Save Muriel Lake. (2016, February 4). *Water Level is Not Getting Any Higher.* [Web blog post]. Retrieved from http://www.savemuriellake.com

Save Muriel Lake (2019, April 15). [Facebook post]. Retrieved from http://www.facebook.com/Savemuriellake/