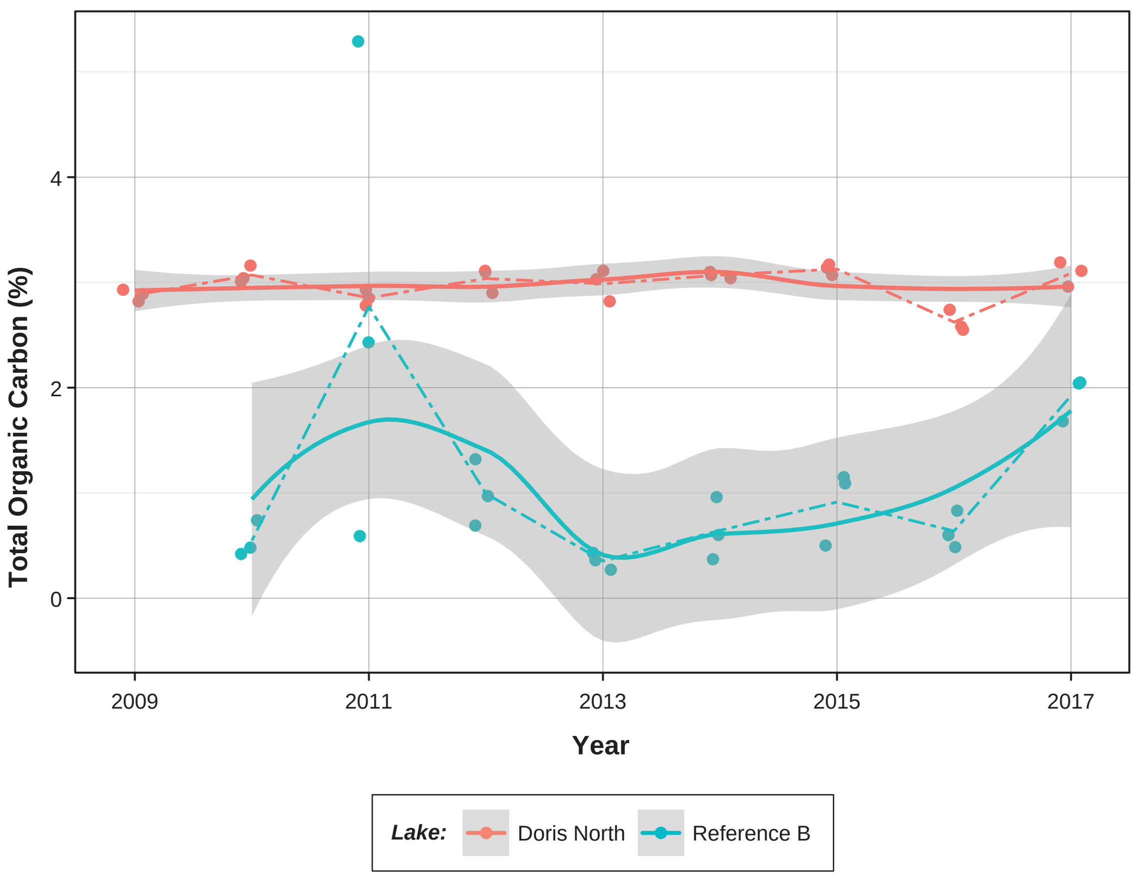
Figure 3.4-1

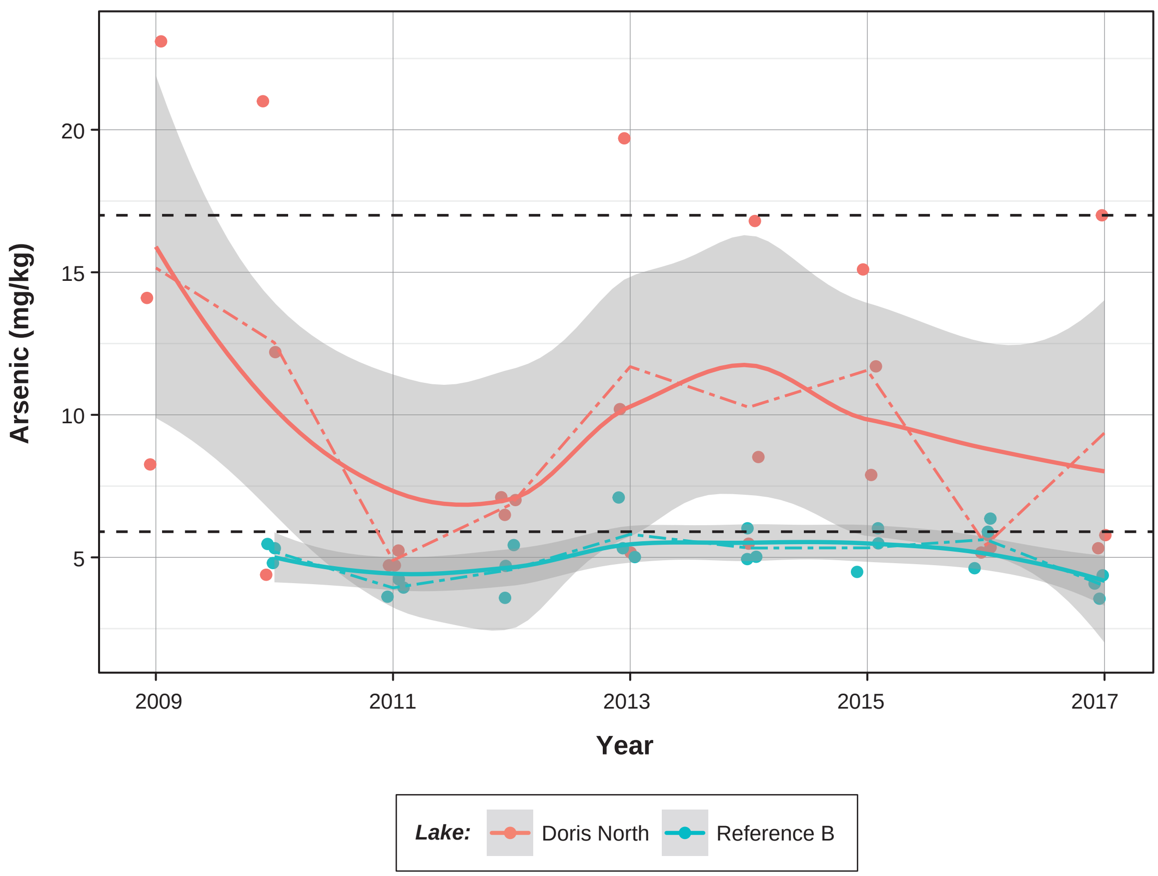
Total Organic Carbon Content in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

Figure 3.4-2

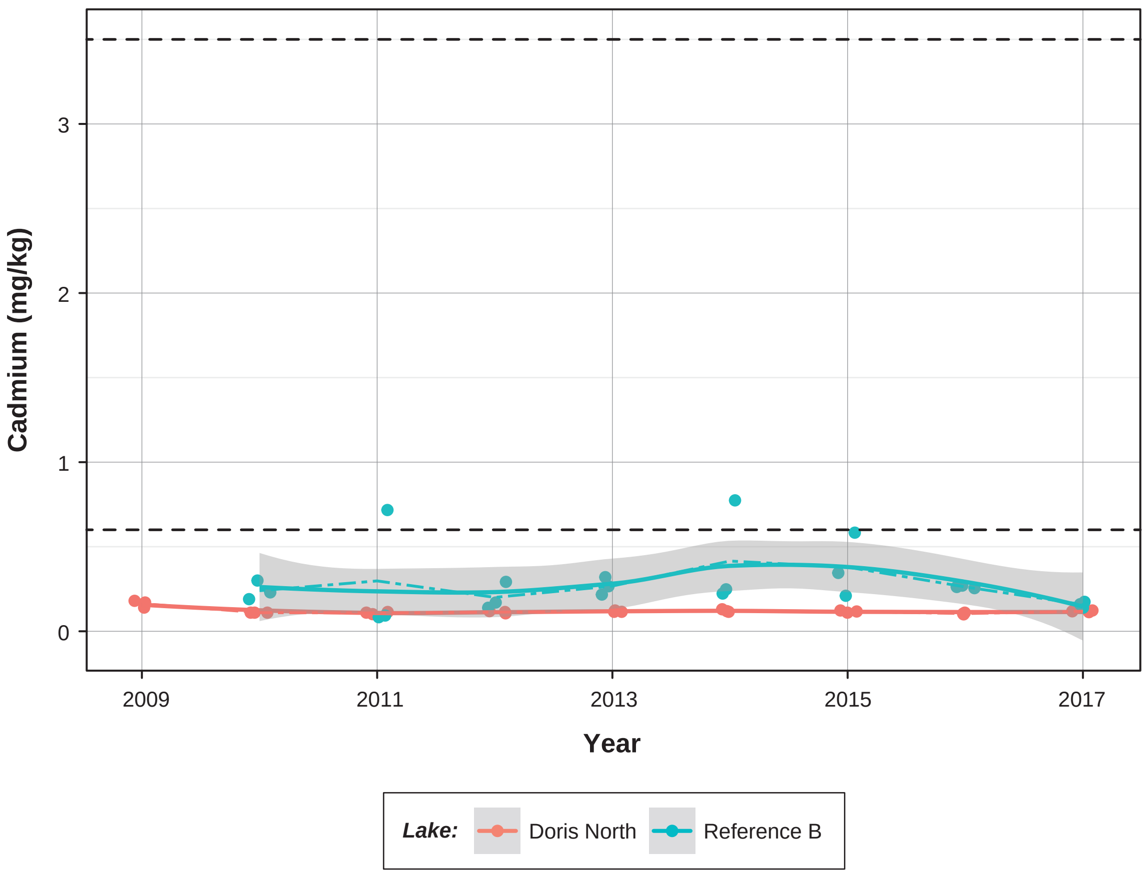
Arsenic Concentrations in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

Figure 3.4-3

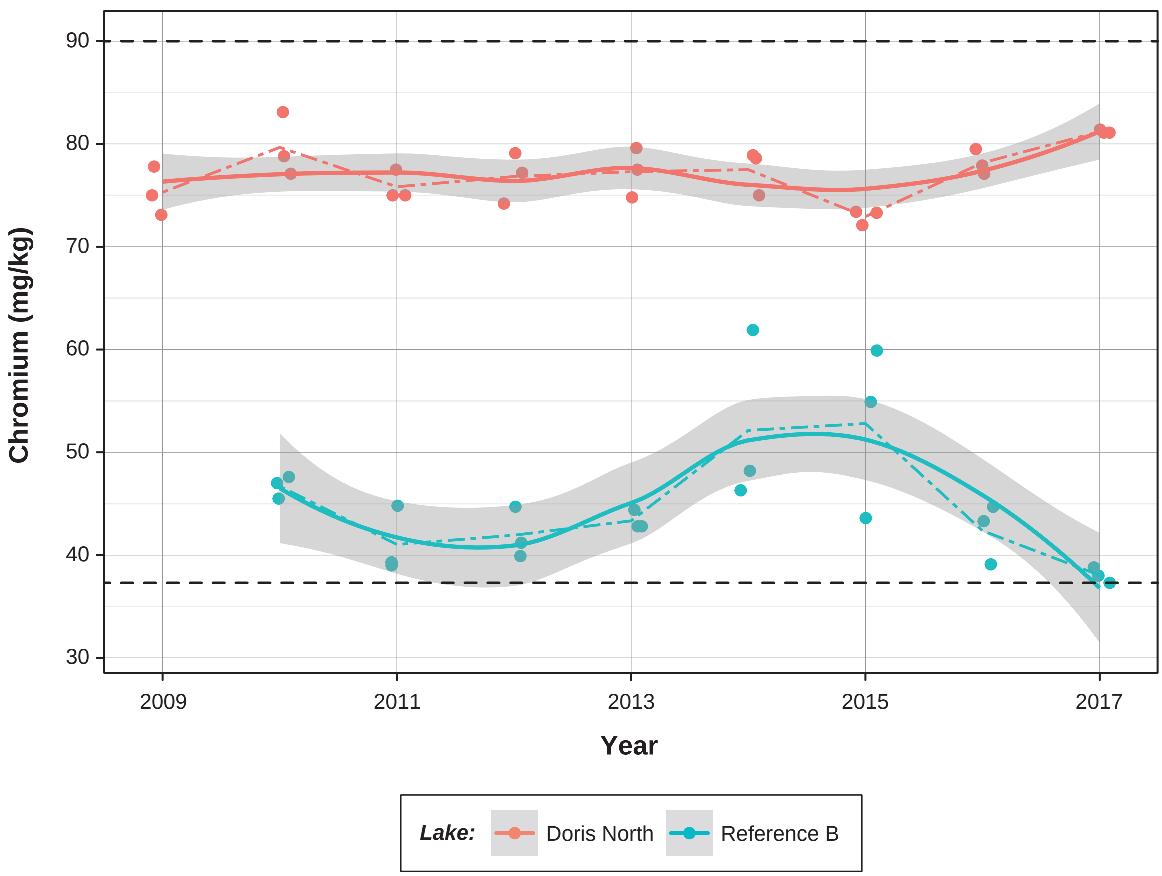
Cadmium Concentrations in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG) for cadmium (0.6 mg/kg) and the probable effects level (PEL) for cadmium (3.5 mg/kg).

Figure 3.4-4

Chromium Concentrations in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG)
for chromium (37.3 mg/kg) and the probable effects level (PEL) for chromium (90 mg/kg).

3.4.5 Copper

Sediment copper concentrations in Doris Lake North changed little over time, though concentrations were slightly higher during the baseline year (2009) compared to other years (Figure 3.4-5). The statistical analysis showed that that the copper trend over time was not significantly different from a slope of zero ($p = 0.0639$). Mean copper concentrations from 2009 to 2017 were consistently above the CCME ISQG of 35.7 mg/kg but well below the PEL of 197 mg/kg (Figure 3.4-5). Although copper concentrations in Doris Lake North sediments were higher than 75% of the ISQG guideline, the low action level was not triggered because there was no apparent Project-related change in copper concentrations.

3.4.6 Lead

In Doris Lake North sediments, the mean lead concentration of 14.4 mg/kg in 2009 was relatively high compared to other years; mean concentrations ranged between 10.0 and 11.9 mg/kg from 2010 to 2017 (Figure 3.4-6). The trend in lead concentrations over time in Doris Lake North sediments was significantly different from a slope of zero ($p = 0.0008$) and from the Reference Lake B trend ($p < 0.0001$); however, the overall trend in Doris Lake North was a decrease in lead concentrations, which is not of environmental concern. Thus, there was no apparent adverse effect of Project activities on lead concentrations in the sediments of Doris Lake North. All lead concentrations remained well below the CCME ISQG of 35 mg/kg, the PEL of 91.3 mg/kg, and the low action level thresholds of 75% of the ISQG and PEL guidelines (Figure 3.4-6).

3.4.7 Mercury

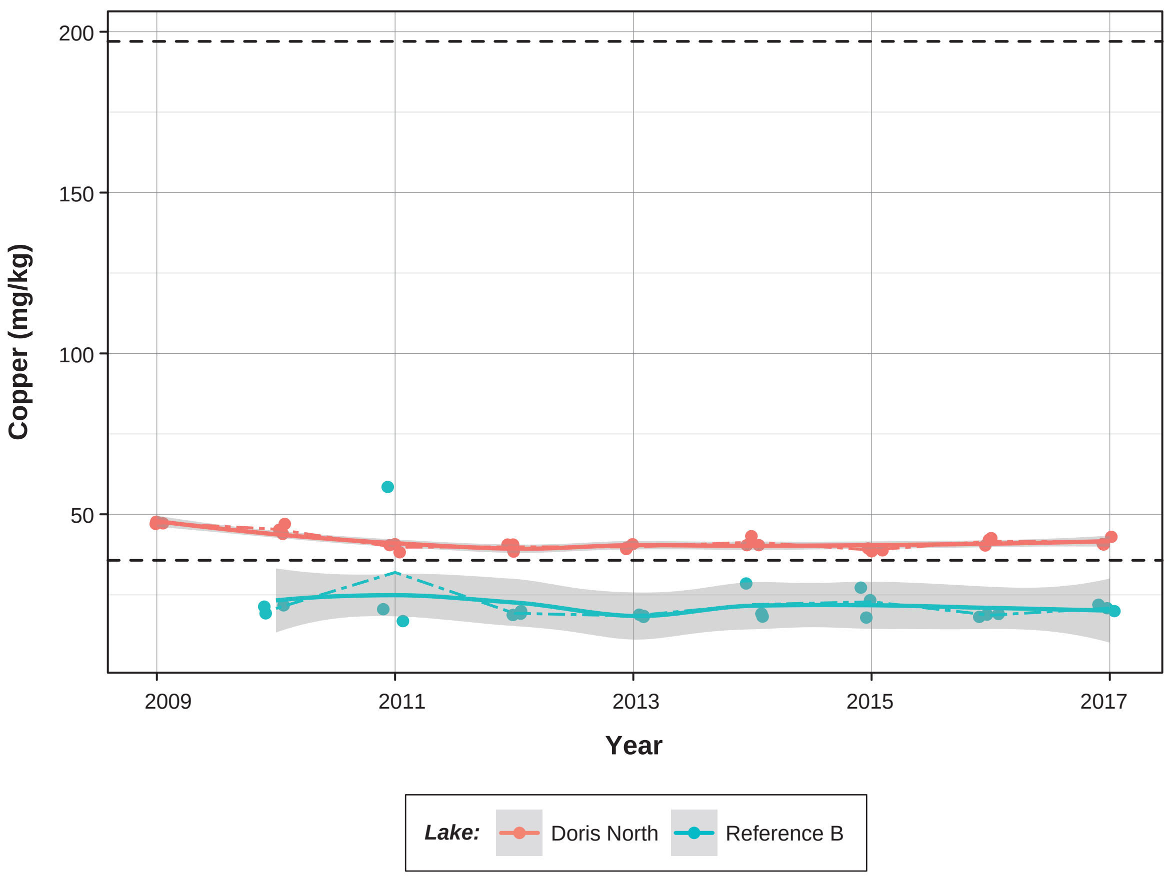
Mercury concentrations in Doris Lake North sediments decreased slightly between 2009 and 2012, and then increased slightly from 2012 to 2017 (Figure 3.4-7). The net effect of these slight changes was negligible, as the mean concentration of 0.0670 mg/kg in 2009 was similar to the 2017 mean of 0.0662 mg/kg. The statistical analysis showed that the sediment mercury trend over time in Doris Lake North was significantly different from a slope of zero ($p = 0.0316$) and significantly different from the trend in Reference Lake B ($p = 0.0363$). However, there was no evidence of an adverse effect of Project activities on sediment mercury concentrations in Doris Lake North since there was no overall change from baseline to current conditions. All sediment mercury concentrations also remained below the CCME ISQG of 0.170 mg/kg, the PEL of 0.486 mg/kg, and the low action level thresholds of 75% of the ISQG and PEL guidelines (Figure 3.4-7).

3.4.8 Zinc

Sediment zinc concentrations were similar over time in Doris Lake North (Figure 3.4-8), and the statistical analysis confirmed that the temporal trend in zinc concentrations was not significantly different from a slope of zero ($p = 0.9499$). Thus, Project activities had no apparent adverse effect on zinc concentrations in the Doris Lake North sediments. Sediment zinc concentrations in Doris Lake North remained below the CCME ISQG of 123 mg/kg and the PEL of 315 mg/kg (Figure 3.4-8), but were higher than the low action threshold of 75% of the ISQG. Despite this low action level threshold exceedance, the low action level was not triggered because there was no evidence of a change in sediment zinc concentrations over time in Doris Lake North.

Figure 3.4-5

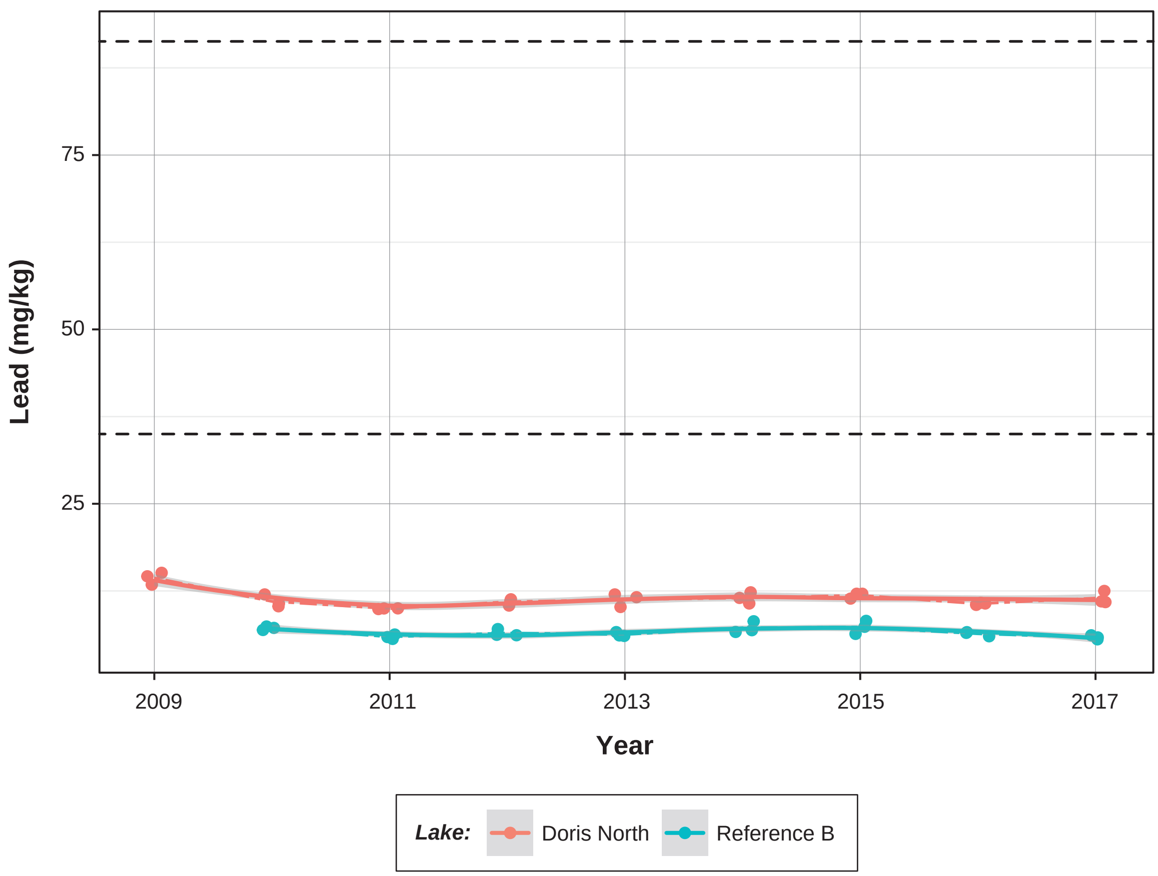
Copper Concentrations in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG) for copper (35.7 mg/kg) and the probable effects level (PEL) for copper (197 mg/kg).

Figure 3.4-6

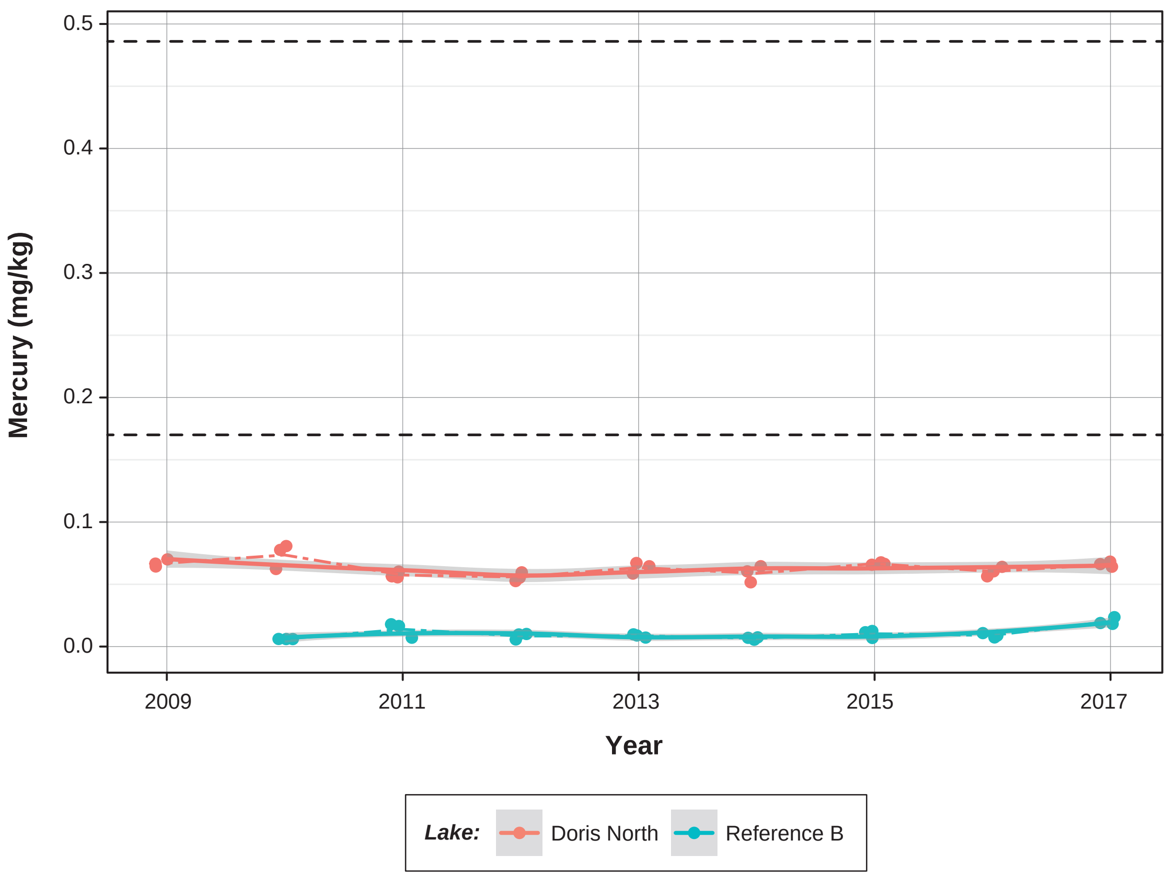
Lead Concentrations in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG)
for lead (35.0 mg/kg) and the probable effects level (PEL) for lead (91.3 mg/kg).

Figure 3.4-7

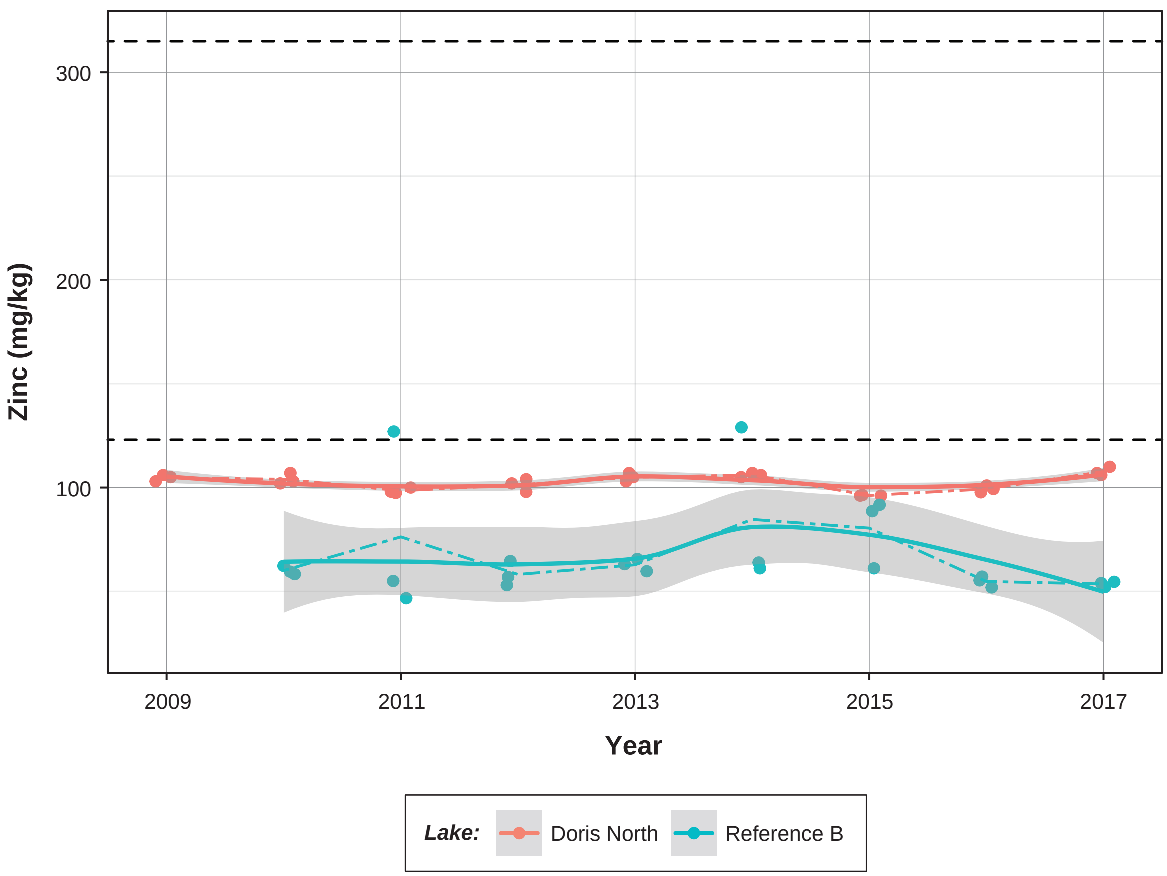
Mercury Concentrations in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG)
for mercury (0.170 mg/kg) and the probable effects level (PEL) for mercury (0.486 mg/kg).

Figure 3.4-8

Zinc Concentrations in Lake Sediments, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG)
for zinc (123 mg/kg) and the probable effects level (PEL) for zinc (315 mg/kg).

3.5 PHYTOPLANKTON

Phytoplankton biomass (as estimated by chlorophyll *a* concentration) samples were collected from one exposure lake site (Doris Lake North) and one reference lake site (Reference Lake B) in August 2017 to assess potential changes in primary producers due to overall changes in water quality. Statistical and graphical analyses were used to determine if there were changes in phytoplankton biomass over time compared to baseline conditions. Biomass trends were also compared between the exposure and reference site to determine whether a low action level was triggered according to the Response Framework.

Raw biomass data collected in 2017 are presented in Appendix A, and all statistical analysis results are presented in Appendix B.

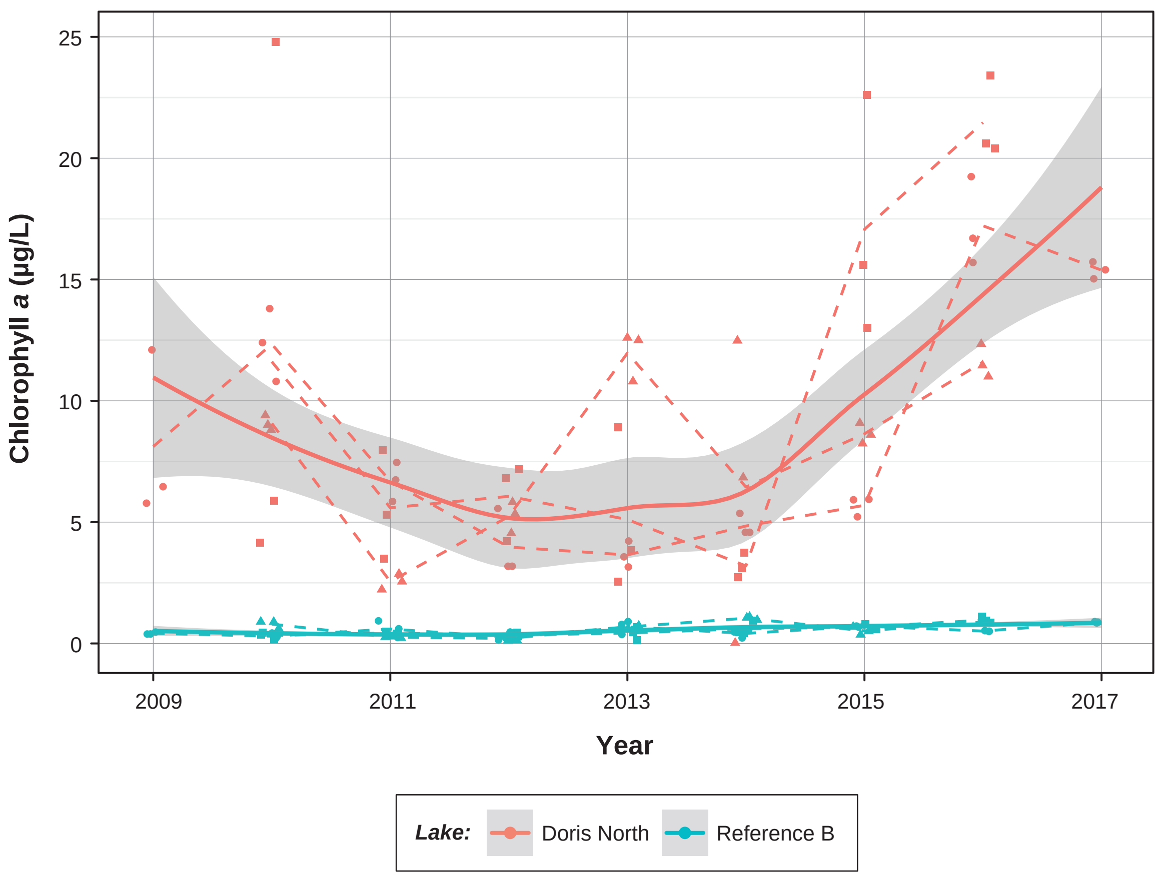
3.5.1 Phytoplankton Biomass as Chlorophyll *a*

Chlorophyll *a* concentrations were markedly higher in Doris Lake North than in Reference Lake B between 2009 and 2017 (Figure 3.5-1). Within Doris Lake North, concentrations were inter- and intra-annually variable, and there was also high variability among replicates. Chlorophyll *a* concentrations tended to increase over time in Doris Lake North, and this trend was significantly different from a slope of zero ($p < 0.0001$). However, the trends between Doris Lake North and Reference Lake B were not significantly different ($p = 0.0658$), indicating that parallel changes occurred in the exposure and reference sites and that the changes were likely unrelated to the Project. Because trends between Doris Lake north and Reference Lake B were not significantly different, the low action level was not triggered.

Between 2009 and 2017, mean monthly chlorophyll *a* concentrations in Doris Lake North ranged from a minimum of 2.5 µg chl a/L (July 2011) to a maximum of 21.5 µg chl a/L (September 2016), while mean annual chlorophyll a concentrations ranged from 4.8 µg chl a/L (2014) to 16.8 µg chl a/L (2016). In 2017, chlorophyll samples were collected only during August, and the mean concentration was 15.4 µg chl a/L (Figure 3.5-1; Appendix A). According to a widely used trophic classification system developed by Vollenweider and Kerekes (1982) and cited in Environment Canada's *Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems* (2004; Table 3.5-1), this range of chlorophyll *a* concentrations corresponds well with the range of mean and maximum chlorophyll *a* concentrations expected for a meso-eutrophic lake such as Doris Lake (average total phosphorus concentration of 0.026 mg/L from 2004 to 2017; see Section 3.3.9 and Figure 3.3-9). In Reference Lake B, monthly and annual mean chlorophyll *a* concentrations have never exceeded 1 µg chl a/L, which corresponds well with what would be expected for a borderline ultra-oligotrophic/oligo-mesotrophic lake (average total phosphorus concentration of 0.004 mg/L from 2009 to 2017; Figure 3.3-9; Table 3.5-1). Chlorophyll *a* concentrations in both study lakes were consistent with what would be expected based on total phosphorus concentrations in those lakes, and the parallel trends in chlorophyll *a* concentrations over time between lake sites suggest that the apparent increase in Doris Lake North was not Project related.

Figure 3.5-1

Phytoplankton Biomass (as Chlorophyll *a*) in Lakes, Doris Project, 2009 to 2017



Notes: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

Table 3.5-1. Trophic Classification of Lakes, with Corresponding Total Phosphorus and Chlorophyll *a* Concentrations

Trophic Level	Total Phosphorus (mg/L)		Mean Chlorophyll *a* (µg/L)	Max Chlorophyll *a* (µg/L)
Source:	Wetzel (2001)	Vollenweider and Kerekes (1982)	Vollenweider and Kerekes (1982)	
Ultra-oligotrophic	< 0.005	< 0.004	< 1	< 2.5
Oligo-mesotrophic	0.005 to 0.010	0.004 to 0.010	< 2.5	< 8
Meso-eutrophic	0.010 to 0.030	0.010 to 0.035	2.5 to 8.0	8.0 to 25
Eutrophic	0.030 to 0.100	0.035 to 0.100	8.0 to 25	27 to 75
Hypereutrophic	< 0.100	< 0.100	> 25	> 75

Source: Environment Canada (2004)

3.6 BENTHIC INVERTEBRATES

Benthic invertebrate (benthos) samples were collected from one exposure lake site (Doris Lake North) and one reference lake site (Reference Lake B) in August 2017, and the data gathered were used to calculate benthos density, taxa richness, Simpson's diversity index (which incorporates taxa richness and evenness) and the Bray-Curtis index (a measure of similarity between sites). The level of taxonomic resolution used to calculate community descriptors was family level, as recommended by Environment Canada's *Metal Mining Technical Guidance for Environmental Effects Monitoring* (2012).

Benthos data have been collected since 1996 in the Project area (Figure 2.2-6). Prior to 2010, historical benthos sampling consisted of collecting one to five replicates per site with no composite sampling. The 2010 to 2017 sampling procedure required the pooling of three subsamples per replicate, and the collection of five replicates per site. Because the pooling of subsamples for each replicate affects sample variability, as well as various diversity components (e.g., richness and diversity), baseline (1995 to 2009) benthos data were not considered comparable to data collected from 2010 to 2017.

Statistical and graphical analyses were used to determine if there were changes in benthos community descriptors over time from 2010 to 2017. Trends were also compared between the exposure and reference site to determine whether a low action level was triggered according to the Response Framework. Raw benthos data collected in 2017 and calculated summary statistics for the various benthic community metrics are presented in Appendix A, and all statistical analysis results are presented in Appendix B.

3.6.1 Density

Benthos density increased over time in Doris Lake North from a mean of 2,083 organisms/m^2 in 2010 to 5,079 organisms/m^2 in 2017 (Figure 3.6-1). This trend was significantly different from a slope of zero ($p < 0.0001$) and from the Reference Lake B trend ($p < 0.0001$), which was variable over time. This suggests that Project may have had a potential effect on benthos density in Doris Lake North. However, the inter-annual variability and among-replicate variability was high, complicating the interpretation of results. The benthos density in five replicate samples collected in Reference Lake B in 2010 ranged from 1,348 to 6,133 organisms/m^2, which spans a wider range than the observed increase in density over time in Doris Lake North, and illustrates the potential heterogeneity in benthos density that can exist even within a relatively small sampling area. Also, the benthos density of 5,079 organisms/m^2 in Doris Lake North in 2017 is within the range of densities previously recorded in Reference Lake B (e.g., in 2010 and 2013) and lower than typical densities found in other lakes in the region (e.g., Little Roberts Lake and Reference Lake D; ERM 2017), and is therefore not an unusually high density. Given the higher productivity of Doris Lake and it's classification as mesotrophic to eutrophic compared to the ultra-oligotrophic/oligo-mesotrophic Reference Lake B (see Sections 3.3.9 and 3.5.1), it would be reasonable to expect that benthos density would naturally be higher in Doris Lake North than in Reference Lake B, since lake productivity and nutrient loading are typically related to elevated abundance of benthic invertebrates (e.g., Nalepa, Lang, and Fanslow 2000).

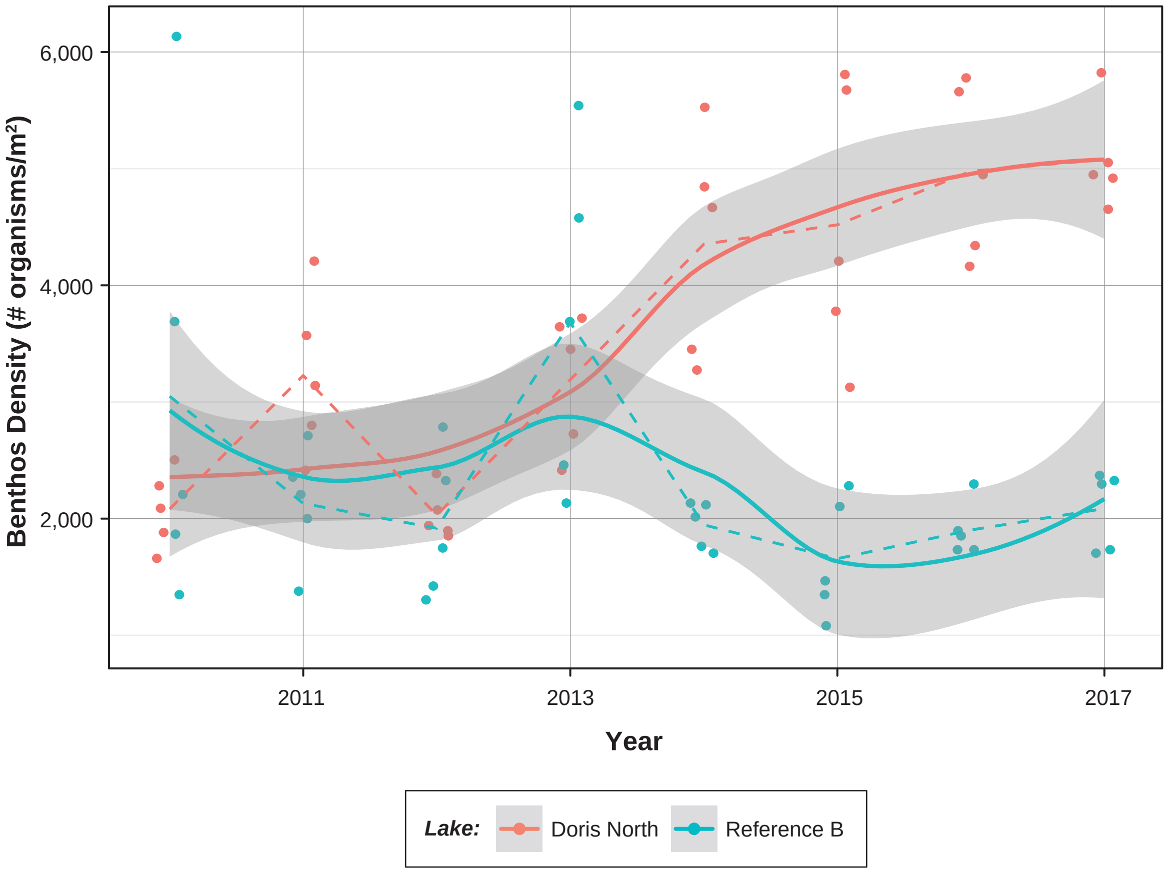
Although the conclusion of a potential mine effect on benthos density is complicated by the natural heterogeneity observed among replicates and among years and by the differences in trophic classification of the study lakes, the graphical and statistical analyses do suggest that a differential change may be occurring in Doris Lake North that is not paralleled in Reference Lake B, as densities were similar between the lakes from 2010 to 2013, and seem to have diverged since 2014 (Figure 3.6-1). Most monitoring programs that have studied the effects of mine discharges on freshwater benthic invertebrates communities have reported declines in benthos density as a result of the toxic effects of metals in effluents (see AETE Program (1999) for a review). In contrast, the opposite effect (an increase in density) is seen in Doris Lake North (although this lake does not receive mine effluent, and is assessed because it may be affected by non-point sources inputs such as run-off or dust). A toxic effect is of greater concern for fish populations and ecosystem health than a stimulatory effect, as a toxic effect could result in the exceedance of the "significance threshold" described in the AEMP Plan as "*the water of Doris Lake is not safe for fish and aquatic organisms that support the aquatic ecosystem and the growth of fish*" (TMAC 2016).

The stimulation of benthos density is not as great of a concern as a toxic effect would be since there is no risk of unsafe water for fish and aquatic organisms; however, the cause(s) of this change should be investigated to determine how Project activities could be affecting the benthic invertebrate assemblage, and to mitigate further environmental change. The most obvious explanation for increased benthos density would be increased nutrient loading causing increased availability of food for benthos; however, there were no apparent Project-related increases in water column nutrient concentrations (i.e., ammonia [Section 3.3.6], nitrate [Section 3.3.7], and total phosphorus [Section 3.3.8]), nor to any indicators of enhanced productivity such as sediment total organic carbon content (Section 3.4.1) and chlorophyll a concentrations (Section 3.5.1). Another possible explanation for increased benthos density would be lower predation by fish caused by a either a decline in fish populations or a taxa shift within the benthos community to less favorable prey types. Fish are not monitored as part of the AEMP, and there is no reason to expect that there would be a decline in predation pressure or a shift to less palatable benthos species due to Project activities as no Project effects were detected on water column nutrient concentrations and other productivity indicators. The cause of this density increase is therefore unknown, and should be further investigated.

The low action level for benthos density has been triggered because of the identification of a statistically significant change in Doris Lake between 2010 and 2017 that was not simultaneously observed at the reference site (see Section 2.2.3.3). An Aquatic Response Plan for Benthos Density has been submitted as part of this AEMP report (Appendix C).

Figure 3.6-1

Benthos Density in Lakes, Doris Project, 2010 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

3.6.2 Family Richness

Benthos family richness in Doris Lake North was generally similar from 2010 to 2017 (Figure 3.6-2), and there was no significant difference between the trend in richness over time and a slope of zero ($p = 0.78$). Therefore, there was no evidence of a Project effect on benthos family richness despite the finding of increasing benthos density in Doris Lake North. The low action level for family richness was not triggered.

3.6.3 Family Diversity

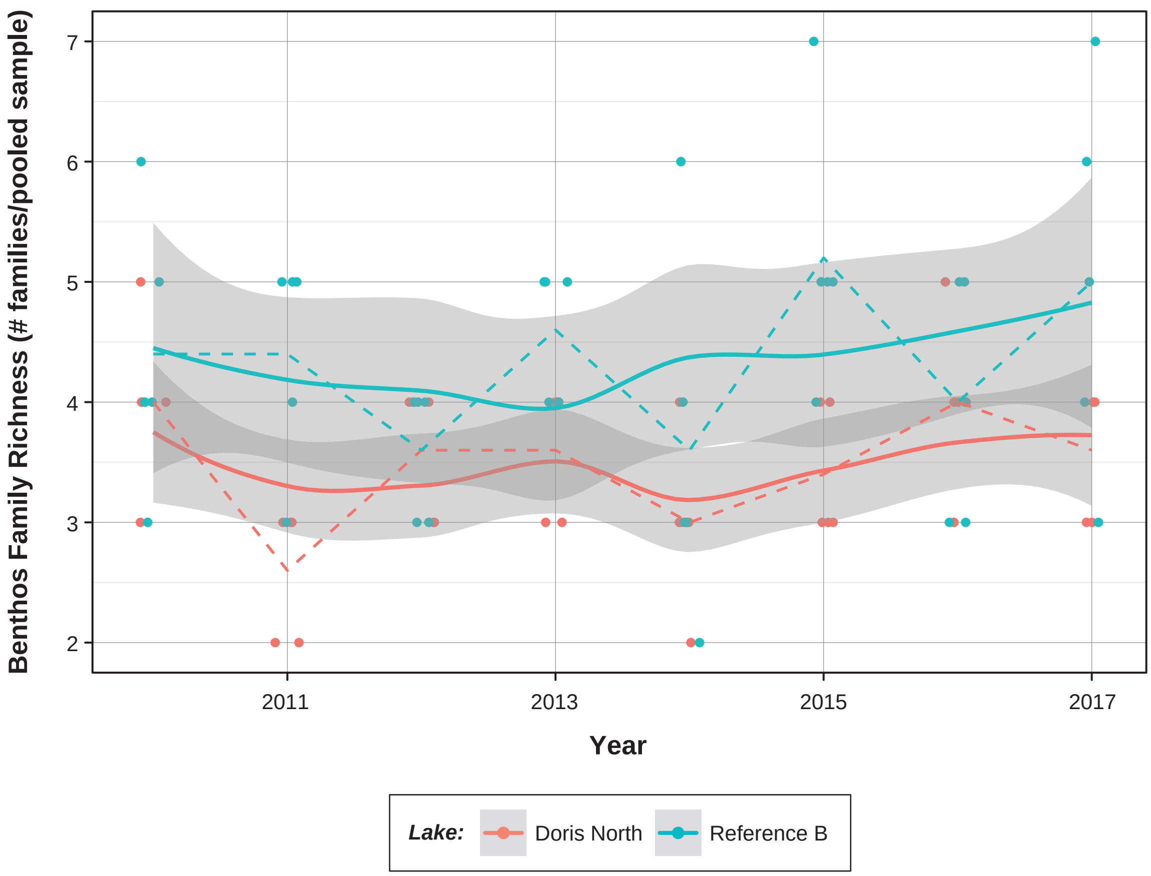
Benthos family diversity (as estimated using the Simpson's Diversity index) in Doris Lake North was variable over time from 2010 to 2017 (Figure 3.6-3). The trend in Doris Lake North was significantly different from both a slope of zero ($p < 0.0001$) and the trend in Reference Lake B ($p = 0.0005$). However, there was minimal change in diversity over time, as the 2017 mean Simpson's diversity index (0.27) was similar to the mean diversity index calculated in 2010 (0.33) and the diversity trend over time seemed to vary about the overall mean diversity of 0.26 calculated for the entire dataset (2010 to 2017). Therefore, there was no apparent adverse effect of Project activities on benthos family diversity and the low action level for family diversity was not triggered.

3.6.4 Bray-Curtis Index

The Bray-Curtis index appeared to increase over time in Doris Lake North, which would indicate increasing dissimilarity between Doris Lake North benthos assemblage and the median reference site community composition (Figure 3.6-4). However, the apparent increase was likely an artifact of the local regression (LOESS) smoothing curve drawn through the data (Figure 3.6-4) as there was no significant difference between the trend in the Bray-Curtis index trend over time in Doris Lake North and a slope of zero ($p = 0.1174$), and the Bray-Curtis index was similar over most years of monitoring (e.g., 2011, 2014, 2015, 2016, 2017). Overall, there was no clear evidence of an adverse Project-related change in the Bray-Curtis index over time and the low action level for the Bray-Curtis index was not triggered.

Figure 3.6-2

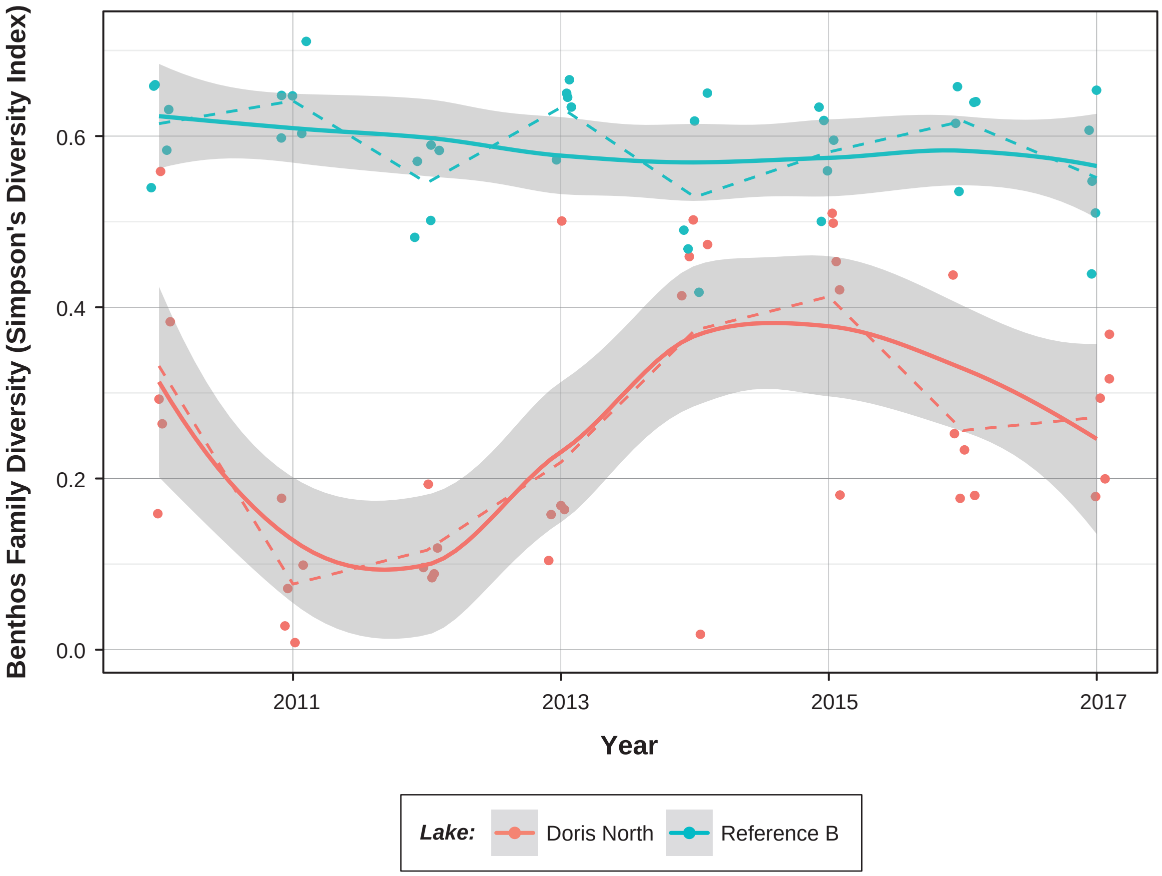
Benthos Richness in Lakes, Doris Project, 2010 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

Figure 3.6-3

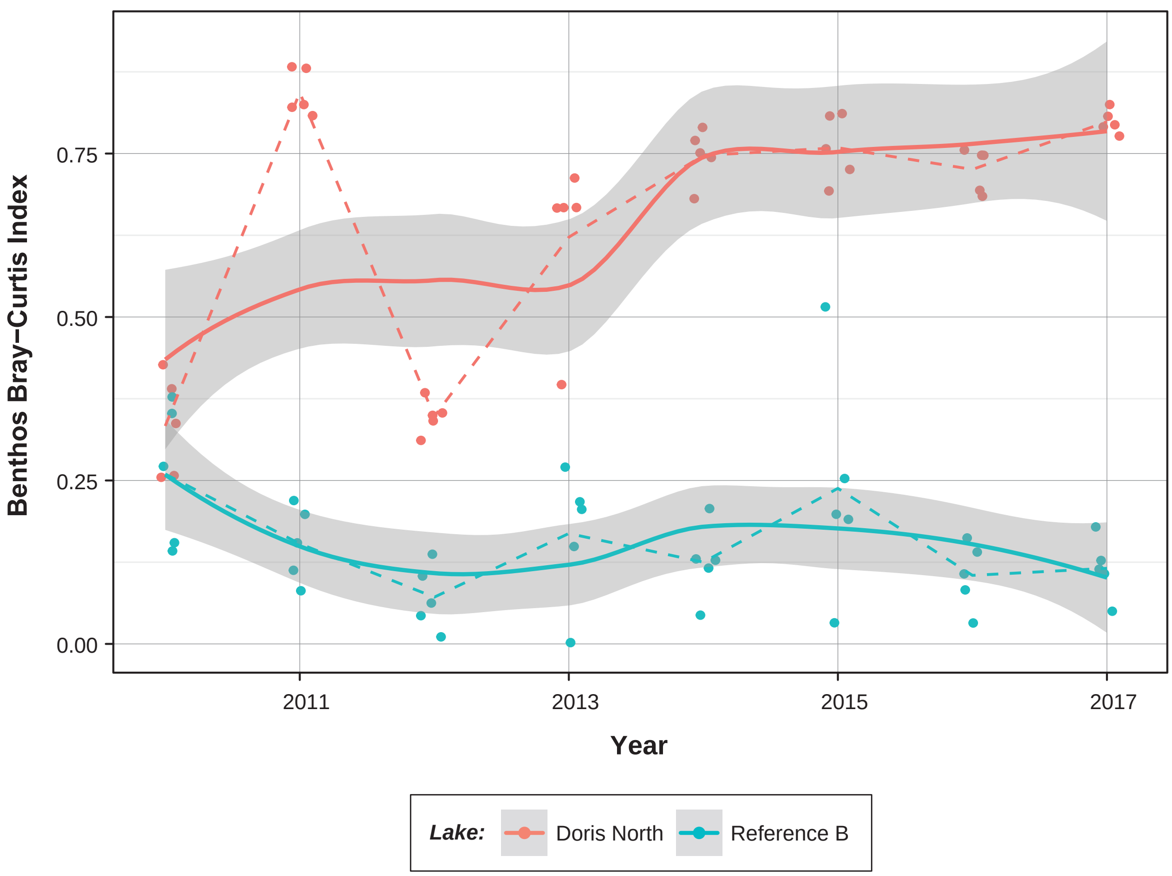
Benthos Diversity in Lakes, Doris Project, 2010 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

Figure 3.6-4

Benthos Bray-Curtis Index for Doris Lake North Relative to Reference Lake B, Doris Project, 2010 to 2017



Notes: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

4. SUMMARY OF EFFECTS ANALYSIS

In 2017, physical profiles, water and sediment samples, and biological samples were collected from one exposure lake site (Doris Lake North) and one reference lake site (Reference Lake B) to evaluate the potential for Project-related effects to the following components of the freshwater environment:

- under-ice water level in Doris Lake;
- dissolved oxygen concentration and water temperature;
- water quality;
- sediment quality;
- phytoplankton biomass; and
- benthic invertebrate community.

Physical, chemical, and biological data from 2017 (the first year of operations with ongoing construction activities) were evaluated against historical data collected during baseline years (pre-2010) and the construction phase (2010 to 2016). The evaluation of effects were based on graphical and statistical analyses of trends over time both within Doris Lake and between Doris Lake and Reference Lake B, comparisons to baseline conditions, comparisons to benchmarks based on CCME water and sediment quality guidelines for the protection of aquatic life (CCME 2018b, 2018a), and professional judgement. Table 4-1 presents an overview of the conclusions of the effects analysis.

No adverse Project-related effects to under-ice water level, under-ice dissolved oxygen concentrations, water temperature, sediment quality, and phytoplankton biomass were detected in Doris Lake North (Table 4-1).

Out of the 25 evaluated water quality variables, there was some evidence for a Project-related increase in the concentrations of two variables in Doris Lake North: total suspended solids (TSS) and total molybdenum (Table 4-1). The increase in TSS was driven mainly by one sample, so continued monitoring will help to confirm this finding. For both TSS and molybdenum, the observed increases over time were generally low in magnitude, and with the exception of the single unusually high TSS concentration, concentrations remained below CCME guidelines and low-action level thresholds, thus low action level responses were not triggered.

Benthic invertebrate density increased over time in Doris Lake North, and a similar trend was not seen at the reference site; therefore, a low action level response was triggered for benthos density. No other benthos community metrics (richness, Simpson's diversity index, Bray-Curtis index) were affected by Project activities (Table 4-1). An Aquatic Response Plan for Benthos Density has been submitted as part of this AEMP report (Appendix C).

Table 4-1. Summary of Evaluation of Effects for Doris Lake North, Doris Project, 2017

Variable	Method of Evaluation[a]	Statistical Analysis: Linear Mixed Model or Tobit Regression				Graphical Analysis/Interpretation		Conclusion of Effect[a]		Low Action Level Triggered?	
		Under-ice		Open-water		Evidence of an adverse[c] change?					
		Different from slope 0?[b]	Different from Reference Lake B slope?[b]	Different from slope 0?[b]	Different from Reference Lake B slope?[b]	Under-ice	Open-water	Under-ice	Open-water	Under-ice	Open-water
Water Level and Ice Thickness											
Winter drawdown and ice thickness	CB	-	-	-	-	No	-	No effect	-	No	-
Physical Limnology											
Under-ice dissolved oxygen	GA, CB	-	-	-	-	No	-	No effect	-	No	-
Temperature	GA, CB	-	-	-	-	No	No	No effect	No effect	No	No
Water Quality											
pH	GA, SA, CB	**Yes**	No	**Yes**	No	No	No	No effect	No effect	No	No
Total Suspended Solids	GA, SA, CB	**Yes**	◆	No	☐	**Yes**	No	Possible mine effect	No effect	No	No
Turbidity	GA, SA, CB	**Yes**	No	No	☐	No	No	No effect	No effect	No	No
Chloride	GA, SA, CB	**Yes**	**Yes**	**Yes**	No	No	No	No effect	No effect	No	No
Fluoride	GA, SA, CB	No	☐	No	☐	No	No	No effect	No effect	No	No
Total Ammonia (as N)	GA, SA, CB	**Yes**	No	◆	◆	No	No	No effect	No effect	No	No
Nitrate (as N)	GA, SA, CB	**Yes**	**Yes**	◆	◆	No	No	No effect	No effect	No	No
Nitrite (as N)	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Total Phosphorus	GA, SA, CB	No	☐	No	☐	No	No	No effect	No effect	No	No
Total Aluminum	GA, SA, CB	No	☐	No	☐	No	No	No effect	No effect	No	No
Total Arsenic	GA, SA, CB	**Yes**	**Yes**	**Yes**	No	No	No	No effect	No effect	No	No
Total Boron	GA, SA, CB	**Yes**	**Yes**	**Yes**	No	No	No	No effect	No effect	No	No
Total Cadmium	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Total Chromium	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Total Copper	GA, SA, CB	No	☐	No	☐	No	No	No effect	No effect	No	No
Total Iron	GA, SA, CB	No	☐	No	☐	No	No	No effect	No effect	No	No
Total Lead	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Total Mercury	GA, SA, CB	No	☐	No	☐	No	No	No effect	No effect	No	No
Total Molybdenum	GA, SA, CB	**Yes**	◆	**Yes**	◆	**Yes**	**Yes**	Possible mine effect	Possible mine effect	No	No
Total Nickel	GA, SA, CB	No	☐	No	☐	No	No	No effect	No effect	No	No
Total Selenium	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Total Silver	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Total Thallium	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Total Uranium	GA, SA, CB	**Yes**	No	**Yes**	No	No	No	No effect	No effect	No	No
Total Zinc	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Sediment Quality											
Total Organic Carbon	GA, SA, CB	-	-	No	☐	-	No	-	No effect	-	No
Arsenic	GA, SA, CB	-	-	**Yes**	No	-	No	-	No effect	-	No
Cadmium	GA, SA, CB	-	-	No	☐	-	No	-	No effect	-	No
Chromium	GA, SA, CB	-	-	No	☐	-	No	-	No effect	-	No
Copper	GA, SA, CB	-	-	No	☐	-	No	-	No effect	-	No
Lead	GA, SA, CB	-	-	**Yes**	**Yes**	-	No	-	No effect	-	No
Mercury	GA, SA, CB	-	-	**Yes**	**Yes**	-	No	-	No effect	-	No
Zinc	GA, SA, CB	-	-	No	☐	-	No	-	No effect	-	No
Phytoplankton											
Biomass	GA, SA, CB	-	-	**Yes**	No	-	No	-	No effect	-	No
Benthic Invertebrates								-			
Total Density	GA, SA, CB	-	-	**Yes**	**Yes**	-	**Yes**	-	Possible mine effect	-	**Yes**
Family Richness	GA, SA, CB	-	-	No	☐	-	No	-	No effect	-	No
Simpson's Diversity Index	GA, SA, CB	-	-	**Yes**	**Yes**	-	No	-	No effect	-	No
Bray-Curtis Index	GA, SA, CB	-	-	No	☐	-	No	-	No effect	-	No

Notes:

[a] *GA = Graphical Analysis, SA = Satistical Analysis, CB = Comparison to Benchmark*

[b] *Statistically significant difference at $p<0.05$.*

[a] *Conclusion of effect is based on graphical analysis, statistical analyses, and professional judgment.*

[c] *For water temperature and pH, sediment total organic carbon, phytoplankton biomass, and benthos density, a change in any direction is considered to be an adverse effect. For winter dissolved oxygen concentrations and benthos family*

Diamond (◆) indicates that statistical analysis was not possible because of the high proportion of censored data.

Square (☐) indicates that the statistical comparison to Reference Lake B is not reported because the first step of the statistical analysis indicated no significant difference from a slope of zero.

Dash (-) indicates that the effect was not evaluated using that particular assessement method or for a particular season.

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Appendix A

2017 Data Report

Appendix A. 2017 Data Report

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXES

APPENDIX A. 2017 DATA REPORT

This report presents the sampling methodology, the raw data, and summary graphs and tables of the results of the 2017 Aquatic Effects Monitoring Program (AEMP) for the Doris Gold Mine Project. The 2017 AEMP included the following: measurements of water level in Doris Lake, ice thickness, Secchi depth, physical profiles of temperature and dissolved oxygen, water quality, sediment quality, phytoplankton biomass, and benthic invertebrate (benthos) taxonomy and density in Doris Lake and Reference Lake B. The evaluation of effects is provided in the main body of the report.

A.1 SAMPLING METHODOLOGY AND DATA ANALYSIS

A.1.1 Sampling Locations

Figure A.1-1 provides an overview of sampling sites included in the 2017 AEMP and Figures A.1-2 and A.1-3 show detailed maps of Doris Lake and Reference Lake B sampling sites, including sampling details and bathymetric contours.

Figure A.1-1

AEMP Sampling Locations, Doris Project, 2017

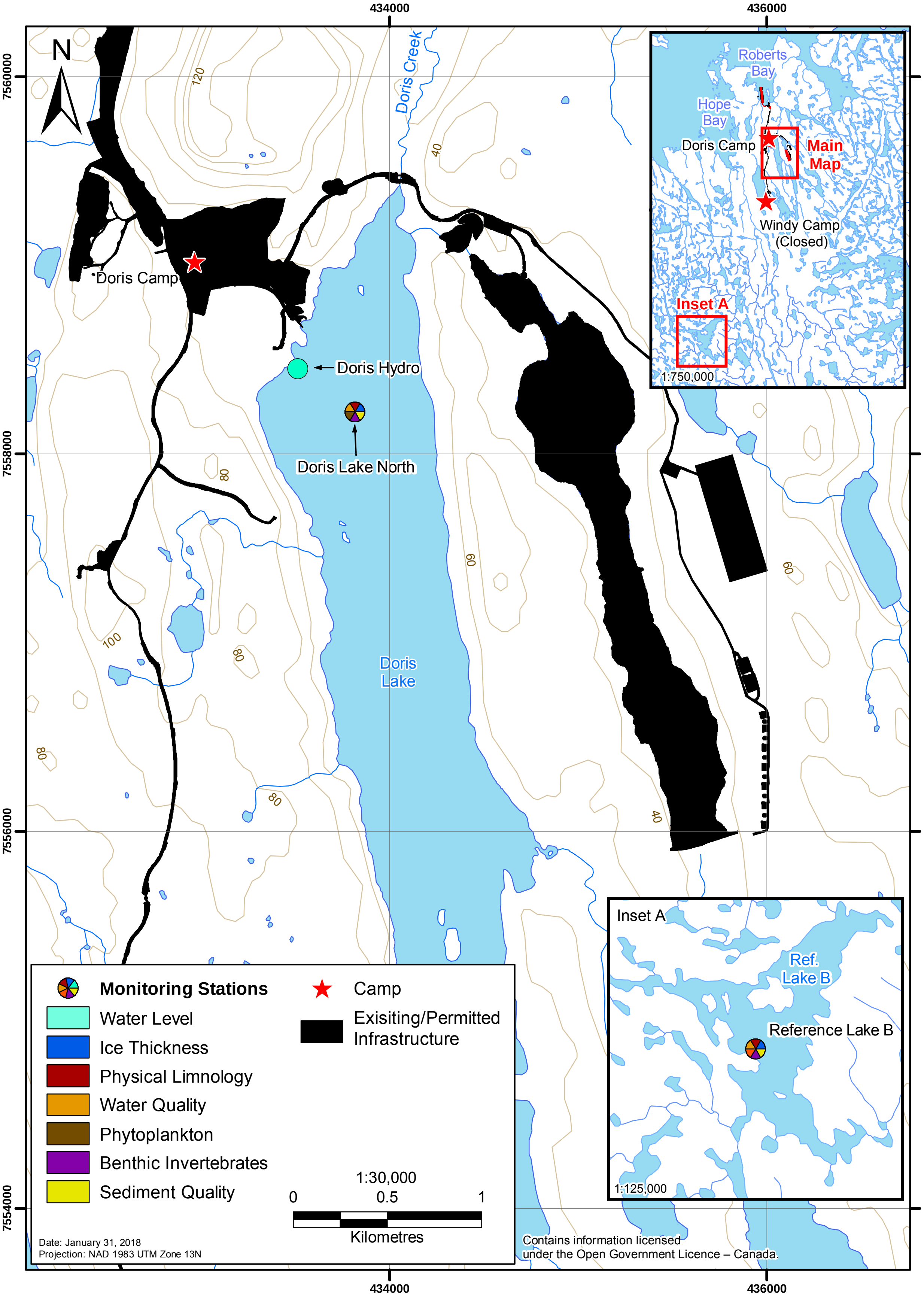
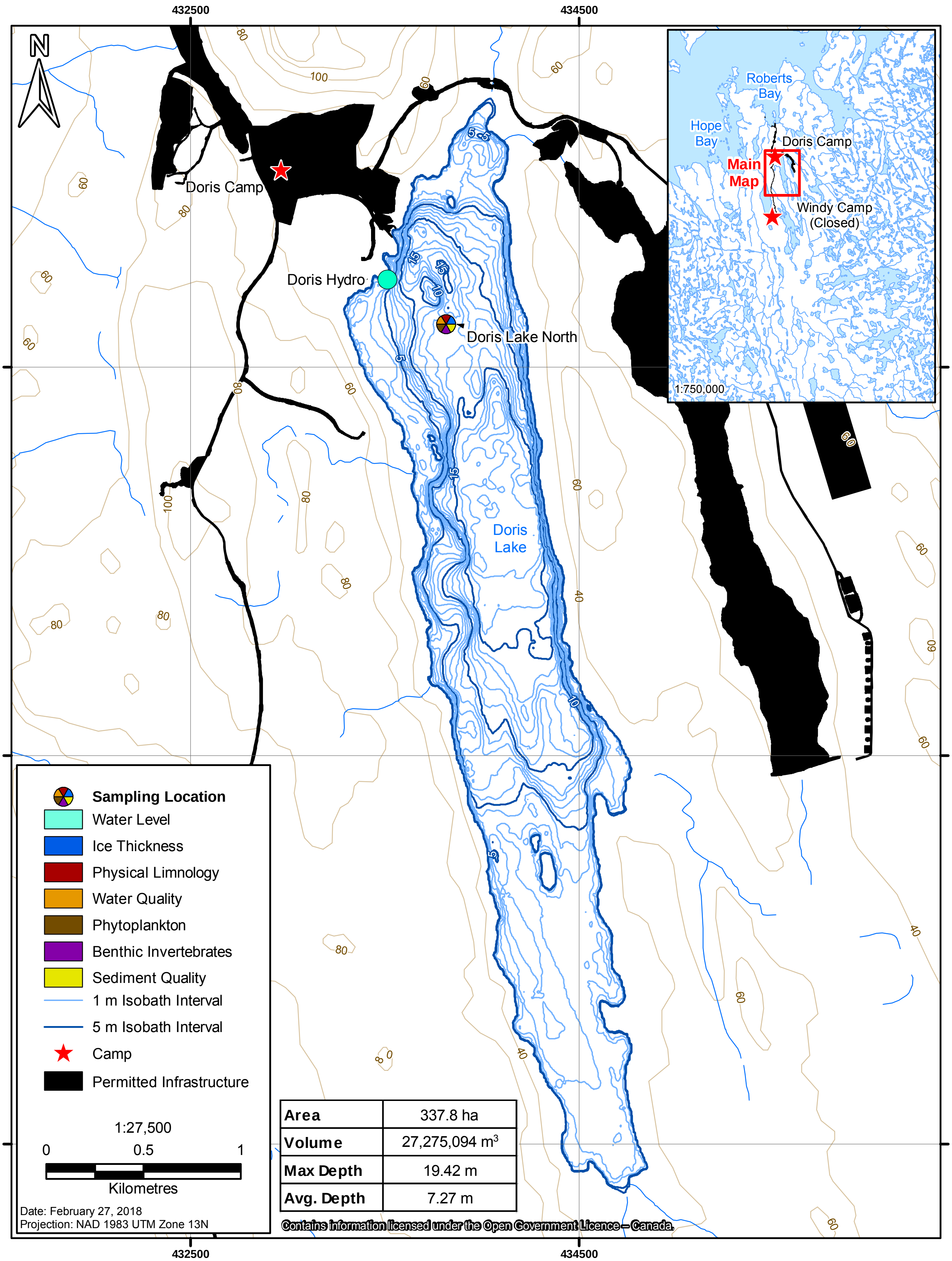


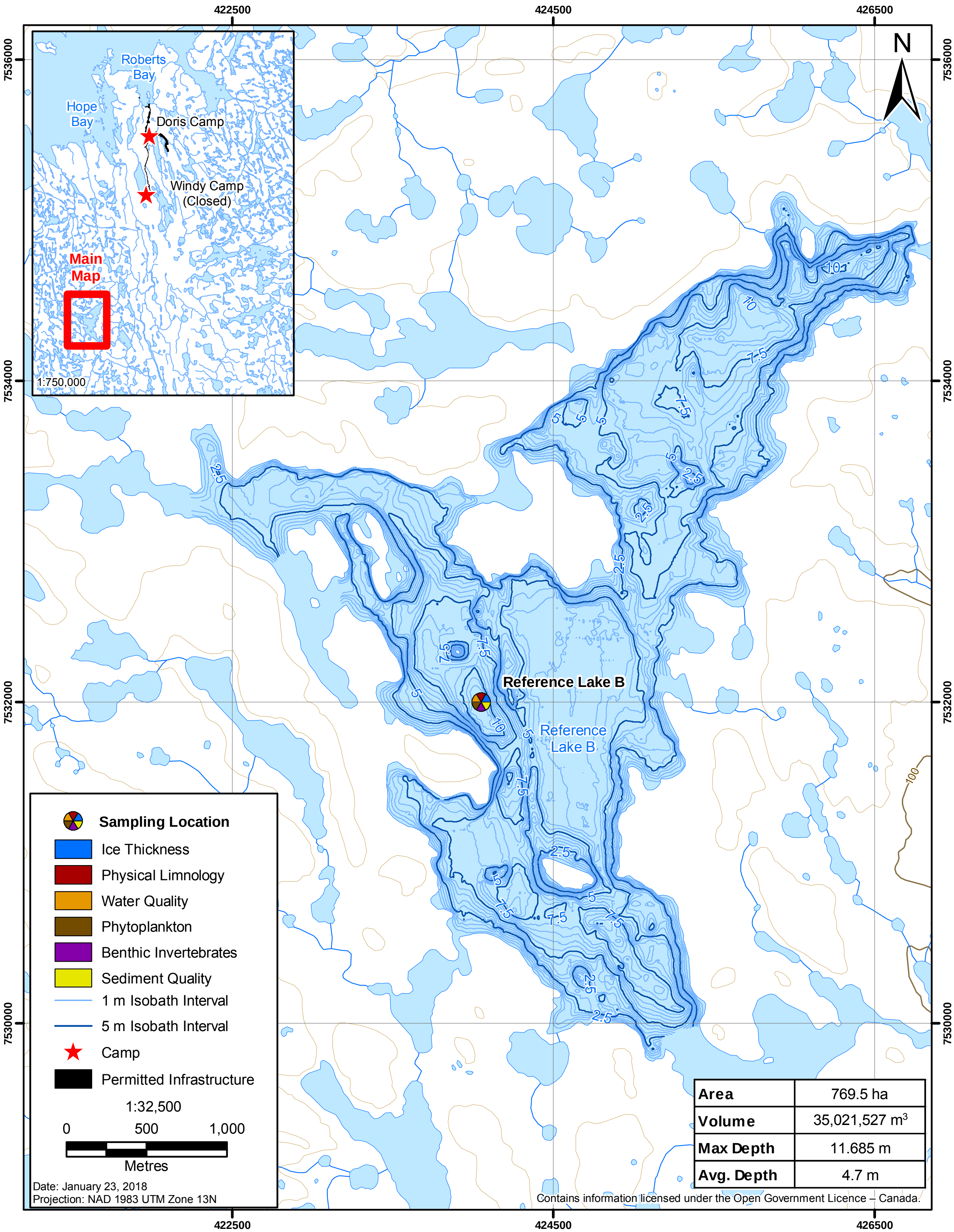
Figure A.1-2
Doris Lake Sampling Location, Doris Project, 2017



Area	337.8 ha
Volume	27,275,094 m^3
Max Depth	19.42 m
Avg. Depth	7.27 m

Figure A.1-3

Reference Lake B Sampling Location, Doris Project, 2017



A.1.2 Sampling Program Summary

Table A.1-1 presents a summary of the AEMP components and methods, including: the variables assessed, the within-year sampling frequency, sampling replication, sampling dates, and the sampling devices used.

Table A.1-1. Sampling Program Summary, Doris Project, 2017

Monitoring Variable	Sampling Frequency	Sample Replication and Depths	Sampling Dates / Timing	Sampling Device
Water Level				
	continuous	n=1 @ Doris Hydro Station	Every 10 minutes (since January 1, 2016)	Transducer/data logger (monthly download)
Ice Thickness				
Ice thickness measurement at time of under-ice sampling	1× per year	n = 1 measurement/site	April	Manual measurement
Physical Limnology				
Secchi depth; dissolved oxygen, temperature, and conductivity profiles	4× per year	n = 1 profile/site throughout water column	April (profiles only), July, August, September	Secchi disk, multi-parameter probe with optical dissolved oxygen sensor
Water Quality				
Physical parameters, nutrients, total metals	4× per year	n = 1 sample/site @ 1 m below the surface and 2 m above water-sediment interface + 20% replication	April, July, August, September	Niskin or GO-FLO sampling bottle
Sediment Quality				
Particle size, metals	1× every 3 years	n = 3/site	August	Ekman grab
Phytoplankton				
Biomass (chlorophyll *a*)	1× per year	n = 3/site @ 1 m below the surface	August	GO-FLO sampling bottle
Benthic Invertebrates				
Density and taxonomy	1× every 3 years	n = 5/site (3 composite subsamples/replicate)	August	Ekman grab, 500 µm sieve

A.1.3 Water Level and Ice Thickness

Doris Lake water levels are monitored continuously at the Doris Lake Hydrometric Station (Figure A.1-2) to detect the minimum winter surface water level, or the maximum winter water-level drawdown. A pressure transducer paired with a data logger is deployed at a depth of approximately 5 m to avoid potential ice-damage and allow continuous data collection throughout the year. Data are recorded in 10-minute intervals and are downloaded monthly for data processing to a daily mean water level and for data storage. Maximum winter water-level drawdown was calculated as the difference between fall water levels during spawning season and the minimum winter water level. Fall water levels are the mean daily surface water level for the last three weeks of September, which is when fall spawning species of fish (Lake Trout, Round Whitefish, Cisco) are likely to spawn, depositing eggs along littoral habitats.

Ice thickness was measured on April 27, 2017 at the same time as the under-ice AEMP sampling. A 25 cm diameter hole was drilled through the ice using a motorized auger; the ice thickness was then measured using a metered rod. The maximum extent of ice is calculated as the sum of the calculated maximum winter water-level drawdown and the maximum ice thickness, as measured in April. This annual value is compared to the approved benchmark of -2.74 m, the predicted maximum ice penetration depth, to mitigate impacts on fish spawning habitat and populations in Doris Lake (TMAC 2015, 2016).

A.1.3.1 Quality Assurance and Quality Control

The collection and analysis of water level data at the Doris Lake Hydrometric Station follow accepted water level surveying procedures as outlined in ERM Rescan (2014) and use stable benchmarks (i.e. bedrock) for calibration.

In addition, field crews are trained to ensure consistent methods and thus reliable results for ice thickness measurements, ensuring comparability of data across years.

A.1.4 Physical Limnology

<u>Under-Ice Season</u>

During the under-ice season (April), the underlying lake water at the sampling sites was accessed by drilling a 25 cm diameter hole through the ice using a motorized auger. The ice thickness was then recorded and the lake bottom depth measured using a depth sounder. Water column profiling and water quality sampling depths were calculated based on bottom depth.

Temperature, dissolved oxygen (DO), and conductivity measurements were collected using a YSI EXO multi-parameter probe equipped with an optical DO sensor. For ease of presentation, continuous data that were internally logged by the probe were post-processed by binning data into 0.2 m depth classes, and calculating the mean for each depth class. The profiles extended from the surface to approximately 1 m above the sediment surface to reduce suspension of bottom sediments.

Open-Water Season

Summer temperature and DO profiles were measured at the same sites as in winter, and were collected from aluminum boats. Profiles were collected using a RBR Ltd. XR-620 CTD (conductivity, temperature, depth) sonde equipped with a Rinko optical DO sensor (with internally logged data post-processed by binning data into 0.2 m depth classes), except at Reference Lake B in July where a YSI ProODO sonde equipped with an optical DO sensor was used and data were recorded manually at 1 m intervals as the probe was lowered into the water.

In addition, the euphotic zone was calculated by estimating light attenuation in each lake using a Secchi disk. Light attenuation measurements were collected at each site by lowering the 20 cm black and white Secchi disk on a metred line through the water column on the shaded side of the boat until it disappeared from sight. The depth of disappearance was first recorded to the nearest 0.1 m before the disk was then slowly raised until it once again became visible and this depth was recorded. These depths were averaged as the Secchi depth (D_s). The 1% euphotic zone depth ($Z_{1\%}$) was computed by first calculating the light extinction coefficient (k) from D_s, and then calculating the euphotic zone depth based on the appropriate light extinction coefficient. The 1% euphotic zone depth is the depth of the water column to which 1% of the surface irradiance reaches. It represents the depth at which the integrated gross water column photosynthetic production is equivalent to the integrated gross water column respiration; thus, there is net photosynthesis above this depth. The 1% euphotic zone depth is often referred to as the compensation depth, and is calculated as follows (Parsons, Takahashi, and Hargrave 1984):

Light extinction coefficient: $k\ (m^{-1}) = 1.7/D_s$

Euphotic Depth (1%): $Z_{1\%}\ (m) = 4.6/k$

A.1.5 Water Quality

Water quality samples were collected at both lake sites during the under-ice season in April, and then open-water season in July, August, and September 2017. Whenever possible, samples at a specific site were collected at least one month apart. The sampling dates and depths for all sites are presented in Table A.1-2 and the analyzed variables are presented in Table A.1-3. Sampling locations are presented in Figure A.1-1.

In April, the underlying water was accessed through a hole in the ice following the water column profiles. An adapted 2.5 L Niskin bottle was used to collect water during winter sampling. This bottle was designed to "trip" and collect discrete samples during freezing temperatures. To avoid metal contamination, the tripping mechanism used acid-cleaned silicone tubing within the interior of the bottle. A dual rope system was used to trigger the bottle to close and to ensure the collection of discrete samples.

During open-water season sampling, water samples were collected using an acid-washed, Teflon-lined 5 L GO-FLO sampling bottle except in Reference Lake B where an acid-cleaned Niskin, as described above, was used. The GO-FLO was securely attached to a metred line and lowered to the appropriate sampling depth. It was then triggered to close using a Teflon-coated brass messenger and brought aboard the boat for distribution of the collected water into sample containers.

Samples for the various water quality components (e.g., physical variables, anions and nutrients, and total metals) were drawn from the sampling bottle, with care being taken not to bring the bottle or cap into contact with the plastic spigot or other possible sources of contamination. The appropriate preservatives provided by ALS were added to the bottles in the field after sample collection.

All samples were kept cold and in the dark while in the field and were refrigerated at Doris Camp prior to first available transport off-site. Samples were sent to ALS in Yellowknife and subsequently transferred to ALS Burnaby for analysis. The variables analyzed and their realized detection limits are summarized in Table A.1-3. Realized detection limits were occasionally higher than the theoretical detection limits in freshwater samples due to interference from other variables.

Table A.1-2. Physical Limnology and Water Quality Sampling Dates and Depths, Doris Project, 2017

Site	Sampling Date	Water Quality Sampling Depth(s) (m)	Physical Limnology Sampling Depths
Doris Lake North	27-Apr-17	2.5, 11.0	Throughout water column
	8-Jul-17	1.0, 12.0	Throughout water column
	17-Aug-17	1.0, 11.0	Throughout water column
	12-Sep-17	1.0, 11.0	Throughout water column
Reference Lake B	26-Apr-17	2.5, 8.5	Throughout water column
	17-Jul-17	1.0, 8.5	Throughout water column
	21-Aug-17	1.0, 8.0	Throughout water column
	12-Sep-17	1.0, 8.0	Throughout water column

Note: April sample depths are recorded as depths below the water surface and are equal to approximately 0.25-1 m below the bottom of the ice.

Table A.1-3. Water Quality Variables and Realized Detection Limits, Doris Project, 2017

Variable	Units	Realized Detection Limits	Variable	Units	Realized Detection Limits
Physical Tests			**Total Metals** *(cont'd)*		
Conductivity	uS/cm	2.0	Gallium (Ga)-Total	mg/L	0.000050
Hardness (as $CaCO_3$)	mg/L	0.50	Iron (Fe)-Total	mg/L	0.030
pH	pH	0.10	Lead (Pb)-Total	mg/L	0.000050
Total Suspended Solids	mg/L	1.0 - 2.0	Lithium (Li)-Total	mg/L	0.00040
Turbidity	NTU	0.10	Magnesium (Mg)-Total	mg/L	0.10
Anions and Nutrients			Manganese (Mn)-Total	mg/L	0.00020
Alkalinity, Total (as $CaCO_3$)	mg/L	1.0	Mercury (Hg)-Total	ug/L	0.00050
Ammonia, Total (as N)	mg/L	0.0050	Molybdenum (Mo)-Total	mg/L	0.000050
Bromide (Br)	mg/L	0.050	Nickel (Ni)-Total	mg/L	0.00020
Chloride (Cl)	mg/L	0.50	Phosphorus (P)-Total	mg/L	0.30
Fluoride (F)	mg/L	0.020	Potassium (K)-Total	mg/L	2.0
Nitrate (as N)	mg/L	0.0050	Rhenium (Re)-Total	mg/L	0.0000050
Nitrite (as N)	mg/L	0.0010	Rubidium (Rb)-Total	mg/L	0.000020
Orthophosphate (as P)	mg/L	0.0010	Selenium (Se)-Total	mg/L	0.00020
Total Phosphorus	mg/L	0.0020	Silicon (Si)-Total	mg/L	0.10
Sulfate (SO_4)	mg/L	0.30	Silver (Ag)-Total	mg/L	0.0000050
Total Metals			Sodium (Na)-Total	mg/L	2.0
Aluminum (Al)-Total	mg/L	0.0030	Strontium (Sr)-Total	mg/L	0.00020
Antimony (Sb)-Total	mg/L	0.000030	Tellurium (Te)-Total	mg/L	0.000010
Arsenic (As)-Total	mg/L	0.00005 - 0.00040	Thallium (Tl)-Total	mg/L	0.0000050
Barium (Ba)-Total	mg/L	0.00010	Thorium (Th)-Total	mg/L	0.0000050
Beryllium (Be)-Total	mg/L	0.0000050	Tin (Sn)-Total	mg/L	0.00020
Bismuth (Bi)-Total	mg/L	0.000050	Titanium (Ti)-Total	mg/L	0.00020
Boron (B)-Total	mg/L	0.010	Tungsten (W)-Total	mg/L	0.000010
Cadmium (Cd)-Total	mg/L	0.0000050	Uranium (U)-Total	mg/L	0.0000020
Calcium (Ca)-Total	mg/L	0.050	Vanadium (V)-Total	mg/L	0.000050
Cesium (Cs)-Total	mg/L	0.0000050	Yttrium (Y)-Total	mg/L	0.0000050
Chromium (Cr)-Total	mg/L	0.00050	Zinc (Zn)-Total	mg/L	0.0030
Cobalt (Co)-Total	mg/L	0.000050	Zirconium (Zr)-Total	mg/L	0.000050
Copper (Cu)-Total	mg/L	0.00050			

A.1.5.1 Quality Assurance and Quality Control

The quality assurance and quality control (QA/QC) program for water quality sampling included the collection of replicates to account for within-site variability (~20% of total samples) and the use of chain of custody forms to track samples. A set of travel, field, and equipment blanks were also collected/processed during each trip (~20% of total samples) and submitted with the water samples as part of the QA/QC program. These blanks were used to identify potential sources of contamination to the field samples.

A.1.6 Sediment Quality

Sediment quality samples were collected at both lake sites during the open-water season in August 2017. This sampling coincided with benthic invertebrate sampling. Sampling dates and depths for all sites are presented in Table A.1-4 and the analyzed variables are presented in Table A.1-5. Sampling locations are presented in Figure A.1-1.

Coinciding with the physical limnology and water quality sampling, lake sediments were collected from the deepest section of the lake using an Ekman grab sampler with the three replicates collected approximately 5 to 20 m apart. Sampling depths are provided in Table A.1-4. The Ekman was carefully set open, lowered gradually onto the sediment surface using a metred cable line, and triggered to close with a messenger. The sample was carefully raised and inspected to ensure the collection of an intact, undisturbed sample. Each sediment sample was carefully transferred onto a tray, and the top 2 to 3 cm of sediment was homogenized in a plastic bowl using a plastic spoon and placed into two Whirl-Pak bags: one for particle size, and one for sediment chemistry. Samples were refrigerated (in darkness) until they were shipped to ALS Yellowknife and subsequently transferred to ALS Burnaby for analysis. The sediment quality variables that were analyzed and their corresponding detection limits are presented in Table A.1-5.

A.1.6.1 Quality Assurance and Quality Control

The QA/QC program for sediment quality sampling included the collection of replicates to account for within-site variability and the use of chain of custody forms to track samples.

Table A.1-4. Sediment Quality and Benthic Invertebrate Sampling Dates and Depths, Doris Project, 2017

Site	Sampling Date	Average Depth (m)
Doris Lake North	17-Aug-17	10.4
Reference Lake B	21-Aug-17	10.1

Table A.1-5. Sediment Quality Variables and Realized Detection Limits, Doris Project, August 2017

Variable	Units	Realized Detection Limit	Variable	Units	Realized Detection Limit
Physical Tests			**Metals** *(cont'd)*		
Moisture	%	0.25	Cadmium (Cd)	mg/kg	0.050
pH (1:2 soil:water)	pH	0.10	Calcium (Ca)	mg/kg	50
Particle Size			Chromium (Cr)	mg/kg	0.50
% Gravel (>2mm)	%	1.0	Cobalt (Co)	mg/kg	0.10
% Sand (2.0mm - 0.063mm)	%	1.0	Copper (Cu)	mg/kg	0.50
% Silt (0.063mm - 4um)	%	1.0	Iron (Fe)	mg/kg	50
% Clay (<4um)	%	1.0	Lead (Pb)	mg/kg	0.50
Texture	-	-	Lithium (Li)	mg/kg	2.0
Anions and Nutrients			Magnesium (Mg)	mg/kg	20
Total Nitrogen by LECO	%	0.020	Manganese (Mn)	mg/kg	1.0
Organic / Inorganic Carbon (Soil)			Mercury (Hg)	mg/kg	0.0050
Total Organic Carbon	%	0.05 - 0.075	Molybdenum (Mo)	mg/kg	0.10
Plant Available Nutrients			Nickel (Ni)	mg/kg	0.50
Available Ammonium-N	mg/kg	1.0 - 5.0	Phosphorus (P)	mg/kg	50
Nitrate+Nitrite-N	mg/kg	2.0	Potassium (K)	mg/kg	100
Nitrate-N	mg/kg	2.0	Selenium (Se)	mg/kg	0.20
Nitrite-N	mg/kg	0.40	Silver (Ag)	mg/kg	0.10
Available Phosphate-P	mg/kg	2.0	Sodium (Na)	mg/kg	50
Metals			Strontium (Sr)	mg/kg	0.50
Aluminum (Al)	mg/kg	50	Sulfur (S)-Total	mg/kg	500
Antimony (Sb)	mg/kg	0.10	Thallium (Tl)	mg/kg	0.050
Arsenic (As)	mg/kg	0.10	Tin (Sn)	mg/kg	2.0
Barium (Ba)	mg/kg	0.50	Titanium (Ti)	mg/kg	1.0
Beryllium (Be)	mg/kg	0.10	Uranium (U)	mg/kg	0.050
Bismuth (Bi)	mg/kg	0.20	Vanadium (V)	mg/kg	0.20
Boron (B)	mg/kg	5.0	Zinc (Zn)	mg/kg	2.0

A.1.7 Phytoplankton

Phytoplankton biomass (as chlorophyll *a*) samples were collected to assess potential changes in their standing stocks due to eutrophication (i.e., excess nutrients) or toxicity (i.e., presence of deleterious substances). Phytoplankton biomass samples were collected at each lake site during the open-water season (August 17 to 21, 2017).

Phytoplankton biomass samples were collected in triplicate in opaque, clean, 1 L sample bottles that were thoroughly rinsed with surface water at each site. Samples were collected at approximately 1 m depth using a 5 L GO-FLO water sampler. For each phytoplankton sample, the water sampler was lowered to the appropriate depth using a metred cable line and triggered to close with a messenger. Once retrieved, a subsample was drawn for a chlorophyll *a* sample.

The samples were kept cold and dark and transported to Doris Camp, where the samples were filtered using gentle vacuum filtration (hand pump). The samples were filtered onto 47-mm diameter, 0.45-µm pore size nitrocellulose membrane filters, folded carefully in half, and placed into a black plastic tube to prevent light penetration. A label was attached to the tube indicating sampling information. The filters were kept frozen and sent to ALS Yellowknife and subsequently transferred to ALS Burnaby for analysis.

A.1.7.1 Quality Assurance and Quality Control

The QA/QC program for phytoplankton biomass sampling included the collection of replicates to account for within-site variability and the use of chain of custody forms to track samples.

A.1.8 Benthic Invertebrates

Benthic invertebrate (benthos) samples were collected during the open-water season in August 2017. This coincided with the sediment quality sampling. Sampling dates and depths for all sites are presented in Table A.1-4 and sampling locations are indicated in Figure A.1-1.

Three separate subsamples were collected and pooled for each replicate sample; five replicates were collected at each site. Samples were obtained in the deepest section of the lake using an Ekman grab sampler (surface sampling area of 0.0225 m^2), with replicates collected approximately 5 to 20 m apart. The Ekman was carefully set open, lowered gradually onto soft sediment using a metred cable line, and triggered to close with a messenger. Average sampling depths are provided in Table A.1-4.

At the surface, each sediment sample was transferred into a 500 µm sieve bucket and rinsed with site-specific lake water until free of sediments. The material retained within the sieve was then placed into a labelled plastic jar and preserved with buffered formalin to a final concentration of 10%. Benthos samples were sent to Dr. Jack Zloty (Summerland, BC) for enumeration and identification.

Benthos counts were normalized to three times the surface area of the Ekman sampler (i.e., 3 × 0.0225 m^2) to determine the benthos density in units of organisms/m^2 (because each replicate consisted of three pooled Ekman samples). Raw benthic invertebrate counts were pre-processed to exclude a number of organisms: cladocerans and cyclopoid and calanoid copepods were excluded as these groups are generally planktonic, nematodes were excluded as they are typically considered to be meiofauna (invertebrates ranging in size between 63 µm and 500 µm) and are not adequately sampled using a 500-µm sieve bucket, immature or damaged organisms that were not identifiable to the family level were excluded, and terrestrial organisms were excluded. Organisms belonging to the groups Ostracoda and Microturbellaria were not identifiable to the family level but were included in the community metrics at the next lowest taxonomic category. Community descriptors, Bray-Curtis dissimilarity distances, and summary statistics were calculated from the benthos counts. Several community descriptors were calculated from the taxonomic results, including benthos density, family richness, Simpson's Diversity index, and the Bray-Curtis Index; these are described below.

Family richness was calculated as the total number of benthic invertebrate families present in each replicate sample.

The Simpson's Diversity Index (D) was calculated as:

$$\text{Simpson Diversity Index (D)} = 1 - \sum_{i=1}^{F} p_i^2$$

where F was the number of families present (i.e., family richness), and p_i was the relative abundance of each family calculated as n_i/N, where n_i is the number of individuals in family i, and N was the total number of individuals.

A complete dissimilarity matrix was also generated that included pairwise comparisons of all samples using the Bray-Curtis Index. The Bray-Curtis Index compares the community composition within a benthos sample to the median reference community composition (Environment Canada 2012). This reference composition is generated from the median abundance of each represented family from all of the reference site replicates (in this case, replicates collected at Reference Lake B). Since the median reference composition is generated from the combined reference site replicates, the comparison of a single reference site replicate community to the median reference community composition will produce a dissimilarity value (although generally a much lower value than exposure sites). Because the Bray-Curtis Index measures the percent difference between sites, the greater the dissimilarity value between a site and the median reference community, the more dissimilar those benthos communities are. The Bray-Curtis Index ranges from 0 to 1, with 1 representing completely dissimilar communities, and 0 representing identical communities. This index is calculated as:

$$\text{Bray-Curtis Index (BC)} = \sum_{i=1}^{n} |y_{i1} - y_{i2}| \ / \ \sum_{i=1}^{n} (y_{i1} + y_{i2})$$

where BC is the Bray-Curtis distance between sites 1 and 2, n is the total number of families present at the two sites, y_{i1} is the count for family i at site 1, and y_{i2} is the count for family i at site 2.

Standard summary statistics (minimum, maximum, median, mean, standard deviation, and standard error) were calculated for all 2017 benthic invertebrate endpoints described above.

A.1.8.1 Quality Assurance and Quality Control

The QA/QC program for benthos sampling included the collection of replicates to account for within-site variability and the use of chain of custody forms to track samples.

A re-sorting of randomly selected sample residues was conducted by taxonomists on a minimum of 10% of the benthos samples to determine the level of sorting efficiency. The criterion for an acceptable sorting was that more than 95% of the total number of organisms was recovered during the initial sort. The number of organisms initially recovered from the sample was expressed as a percentage of the total number after the re-sort (total of initial and re-sort count). Any sample not meeting the 95% removal criterion was re-sorted a third time.

A.2 2017 WATER LEVEL AND ICE THICKNESS

The following section presents the water level and ice thickness data for 2017. Ice thickness measurements and calculated values for maximum winter water-level drawdown and the maximum ice penetration depth for Doris Lake are presented in Table A.2-1. The daily mean water levels from Doris Hydro Station for September 2016 to June 2017 are presented in Annex A.2-1.

Table A.2-1. Ice Thickness Measurements and Winter Drawdown in Doris Lake, Doris Project, 2017

Lake	Measured Ice Thickness (m)	Fall Lake Surface Level (m)	Winter Minimum Lake Surface Level (m)	Maximum Ice Extent (m)
Doris	1.36 (April 27, 2017)	21.85	21.76	-1.45
Reference B	1.18 (April 26, 2017)	-	-	-

Annex A.2-1. Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2017

September 2016	
Date	**Surface Elevation (m)**
1-Sep-2016	21.85
2-Sep-2016	21.847
3-Sep-2016	21.843
4-Sep-2016	21.846
5-Sep-2016	21.843
6-Sep-2016	21.843
7-Sep-2016	21.841
8-Sep-2016	21.841
9-Sep-2016	21.846
10-Sep-2016	21.847
11-Sep-2016	21.845
12-Sep-2016	21.844
13-Sep-2016	21.852
14-Sep-2016	21.853
15-Sep-2016	21.853
16-Sep-2016	21.856
17-Sep-2016	21.855
18-Sep-2016	21.846
19-Sep-2016	21.845
20-Sep-2016	21.836
21-Sep-2016	21.833
22-Sep-2016	21.831
23-Sep-2016	21.836
24-Sep-2016	21.834
25-Sep-2016	21.829
26-Sep-2016	21.827
27-Sep-2016	21.841
28-Sep-2016	21.853
29-Sep-2016	21.864
30-Sep-2016	21.869

Note:

Highlighted dates represent water levels used to calculate mean fall water level. The mean water level is then used to calculate the maximum winter drawdown amplitude.

October 2016	
Date	**Surface Elevation (m)**
1-Oct-2016	21.873
2-Oct-2016	21.877
3-Oct-2016	21.879
4-Oct-2016	21.88
5-Oct-2016	21.883
6-Oct-2016	21.882
7-Oct-2016	21.882
8-Oct-2016	21.88
9-Oct-2016	21.877
10-Oct-2016	21.871
11-Oct-2016	21.866
12-Oct-2016	21.868
13-Oct-2016	21.868
14-Oct-2016	21.865
15-Oct-2016	21.863
16-Oct-2016	21.855
17-Oct-2016	21.848
18-Oct-2016	21.844
19-Oct-2016	21.841
20-Oct-2016	21.834
21-Oct-2016	21.829
22-Oct-2016	21.824
23-Oct-2016	21.819
24-Oct-2016	21.814
25-Oct-2016	21.808
26-Oct-2016	21.803
27-Oct-2016	21.801
28-Oct-2016	21.798
29-Oct-2016	21.796
30-Oct-2016	21.792
31-Oct-2016	21.788

Annex A.2-1. Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2017

November 2016	
Date	Surface Elevation (m)
1-Nov-2016	21.782
2-Nov-2016	21.779
3-Nov-2016	21.778
4-Nov-2016	21.776
5-Nov-2016	21.773
6-Nov-2016	21.769
7-Nov-2016	21.767
8-Nov-2016	21.766
9-Nov-2016	21.765
10-Nov-2016	21.765
11-Nov-2016	21.767
12-Nov-2016	21.766
13-Nov-2016	21.764
14-Nov-2016	21.767
15-Nov-2016	21.765
16-Nov-2016	21.766
17-Nov-2016	21.768
18-Nov-2016	21.77
19-Nov-2016	21.767
20-Nov-2016	21.765
21-Nov-2016	21.765
22-Nov-2016	21.766
23-Nov-2016	21.765
24-Nov-2016	21.766
25-Nov-2016	21.768
26-Nov-2016	21.77
27-Nov-2016	21.774
28-Nov-2016	21.778
29-Nov-2016	21.779
30-Nov-2016	21.781

Note:
Highlighted value indicates minimum winter surface water level.

December 2016	
Date	Surface Elevation (m)
1-Dec-2016	21.787
2-Dec-2016	21.791
3-Dec-2016	21.792
4-Dec-2016	21.794
5-Dec-2016	21.799
6-Dec-2016	21.801
7-Dec-2016	21.804
8-Dec-2016	21.807
9-Dec-2016	21.803
10-Dec-2016	21.797
11-Dec-2016	21.8
12-Dec-2016	21.8
13-Dec-2016	21.8
14-Dec-2016	21.801
15-Dec-2016	21.803
16-Dec-2016	21.802
17-Dec-2016	21.802
18-Dec-2016	21.803
19-Dec-2016	21.801
20-Dec-2016	21.803
21-Dec-2016	21.803
22-Dec-2016	21.802
23-Dec-2016	21.803
24-Dec-2016	21.802
25-Dec-2016	21.803
26-Dec-2016	21.801
27-Dec-2016	21.803
28-Dec-2016	21.804
29-Dec-2016	21.805
30-Dec-2016	21.8
31-Dec-2016	21.803

Annex A.2-1. Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2017

January 2017	
Date	**Surface Elevation (m)**
1-Jan-2017	21.795
2-Jan-2017	21.792
3-Jan-2017	21.785
4-Jan-2017	21.783
5-Jan-2017	21.795
6-Jan-2017	21.803
7-Jan-2017	21.806
8-Jan-2017	21.811
9-Jan-2017	21.818
10-Jan-2017	21.81
11-Jan-2017	21.826
12-Jan-2017	21.832
13-Jan-2017	21.825
14-Jan-2017	21.828
15-Jan-2017	21.833
16-Jan-2017	21.797
17-Jan-2017	21.819
18-Jan-2017	21.814
19-Jan-2017	21.819
20-Jan-2017	21.802
21-Jan-2017	21.8
22-Jan-2017	21.803
23-Jan-2017	21.803
24-Jan-2017	21.801
25-Jan-2017	21.799
26-Jan-2017	21.803
27-Jan-2017	21.81
28-Jan-2017	21.819
29-Jan-2017	21.829
30-Jan-2017	21.821
31-Jan-2017	21.815

February 2017	
Date	**Surface Elevation (m)**
1-Feb-2017	21.809
2-Feb-2017	21.804
3-Feb-2017	21.805
4-Feb-2017	21.815
5-Feb-2017	21.818
6-Feb-2017	21.812
7-Feb-2017	21.816
8-Feb-2017	21.821
9-Feb-2017	21.819
10-Feb-2017	21.832
11-Feb-2017	21.845
12-Feb-2017	21.862
13-Feb-2017	21.859
14-Feb-2017	21.839
15-Feb-2017	21.816
16-Feb-2017	21.821
17-Feb-2017	21.823
18-Feb-2017	21.828
19-Feb-2017	21.837
20-Feb-2017	21.845
21-Feb-2017	21.844
22-Feb-2017	21.832
23-Feb-2017	21.828
24-Feb-2017	21.838
25-Feb-2017	21.848
26-Feb-2017	21.853
27-Feb-2017	21.856
28-Feb-2017	21.85

Annex A.2-1. Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2017

March 2017	
Date	**Surface Elevation (m)**
1-Mar-2017	21.851
2-Mar-2017	21.834
3-Mar-2017	21.832
4-Mar-2017	21.839
5-Mar-2017	21.851
6-Mar-2017	21.852
7-Mar-2017	21.853
8-Mar-2017	21.869
9-Mar-2017	21.849
10-Mar-2017	21.832
11-Mar-2017	21.822
12-Mar-2017	21.819
13-Mar-2017	21.814
14-Mar-2017	21.82
15-Mar-2017	21.825
16-Mar-2017	21.839
17-Mar-2017	21.833
18-Mar-2017	21.828
19-Mar-2017	21.841
20-Mar-2017	21.837
21-Mar-2017	21.836
22-Mar-2017	21.835
23-Mar-2017	21.838
24-Mar-2017	21.836
25-Mar-2017	21.836
26-Mar-2017	21.832
27-Mar-2017	21.835
28-Mar-2017	21.837
29-Mar-2017	21.847
30-Mar-2017	21.851
31-Mar-2017	21.834

April 2017	
Date	**Surface Elevation (m)**
1-Apr-2017	21.827
2-Apr-2017	21.834
3-Apr-2017	21.835
4-Apr-2017	21.837
5-Apr-2017	21.841
6-Apr-2017	21.851
7-Apr-2017	21.856
8-Apr-2017	21.851
9-Apr-2017	21.84
10-Apr-2017	21.844
11-Apr-2017	21.845
12-Apr-2017	21.843
13-Apr-2017	21.846
14-Apr-2017	21.851
15-Apr-2017	21.857
16-Apr-2017	21.858
17-Apr-2017	21.853
18-Apr-2017	21.847
19-Apr-2017	21.852
20-Apr-2017	21.862
21-Apr-2017	21.86
22-Apr-2017	21.859
23-Apr-2017	21.864
24-Apr-2017	21.859
25-Apr-2017	21.847
26-Apr-2017	21.853
27-Apr-2017	21.857
28-Apr-2017	21.861
29-Apr-2017	21.86
30-Apr-2017	21.856

Annex A.2-1. Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2017

May 2017	
Date	**Surface Elevation (m)**
1-May-2017	21.845
2-May-2017	21.846
3-May-2017	21.847
4-May-2017	21.845
5-May-2017	21.846
6-May-2017	21.847
7-May-2017	21.85
8-May-2017	21.856
9-May-2017	21.859
10-May-2017	21.86
11-May-2017	21.858
12-May-2017	21.857
13-May-2017	21.857
14-May-2017	21.858
15-May-2017	21.858
16-May-2017	21.857
17-May-2017	21.857
18-May-2017	21.858
19-May-2017	21.858
20-May-2017	21.857
21-May-2017	21.857
22-May-2017	21.863
23-May-2017	21.887
24-May-2017	21.922
25-May-2017	21.948
26-May-2017	21.98
27-May-2017	22.051
28-May-2017	22.186
29-May-2017	22.307
30-May-2017	22.362
31-May-2017	22.375

June 2017	
Date	**Surface Elevation (m)**
1-Jun-2017	22.385
2-Jun-2017	22.396
3-Jun-2017	22.407
4-Jun-2017	22.4
5-Jun-2017	22.379
6-Jun-2017	22.355
7-Jun-2017	22.338
8-Jun-2017	22.323
9-Jun-2017	22.308
10-Jun-2017	22.293
11-Jun-2017	22.278
12-Jun-2017	22.266
13-Jun-2017	22.25
14-Jun-2017	22.238
15-Jun-2017	22.224
16-Jun-2017	22.211
17-Jun-2017	22.201
18-Jun-2017	22.194
19-Jun-2017	22.187
20-Jun-2017	22.177
21-Jun-2017	22.167
22-Jun-2017	22.157
23-Jun-2017	22.147
24-Jun-2017	22.138
25-Jun-2017	22.131
26-Jun-2017	22.123
27-Jun-2017	22.114
28-Jun-2017	22.103
29-Jun-2017	22.092
30-Jun-2017	22.08

Note:
Highlighted value indicates freshet (maximum surface water level).

A.3 2017 PHYSICAL LIMNOLOGY

The following section presents the Secchi depth data and the physical profiles collected from April to September 2017 at Doris Lake and Reference Lake B.

Secchi depths and calculated euphotic zone depths (1% light level) are shown in Table A.3-1. Figures A.3-1 and A.3-2 show the temperature and DO profiles collected at lake sites from April to September 2017; Annex A.3-1 provides the profile temperature, DO, and conductivity data in tabular form.

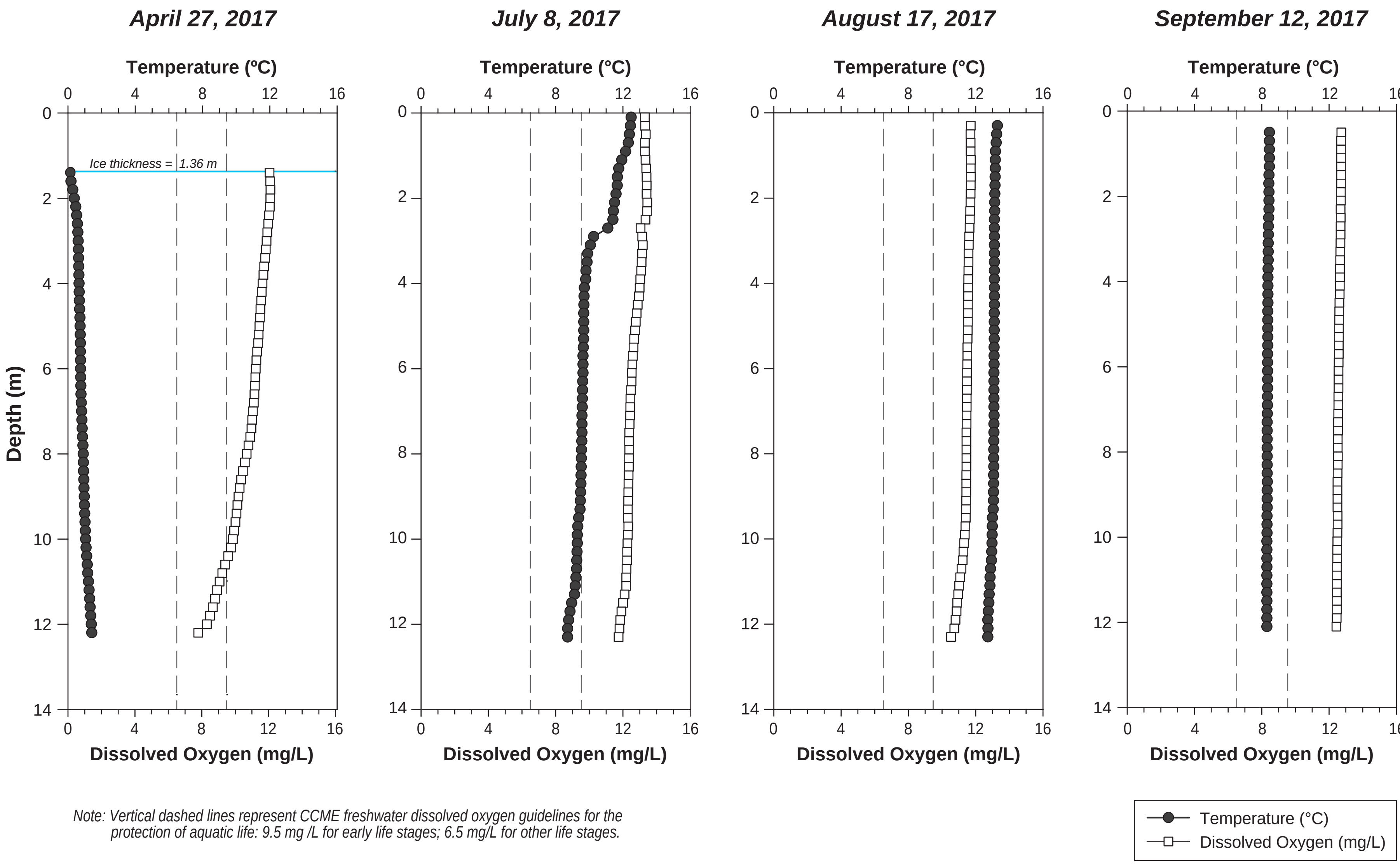
Table A.3-1. Lake Secchi Depths and Euphotic Zone Depths, Doris Project, 2017

Lake Site	Sampling Date	Secchi Depth (Ds) (m)	Euphotic Zone Depth 1% Light Level (m)
Doris Lake North	July 8, 2017	1.3	3.5
	August 17, 2017	1.3	3.5
	September 12, 2017	1.0	2.6
Reference Lake B	July 17, 2017	5.4	14.6*
	August 21, 2017	7.6	20.6*
	September 12, 2017	6.5	17.6*

*Notes: * indicates that the euphotic zone extended to the bottom of the water column.*

Figure A.3-1

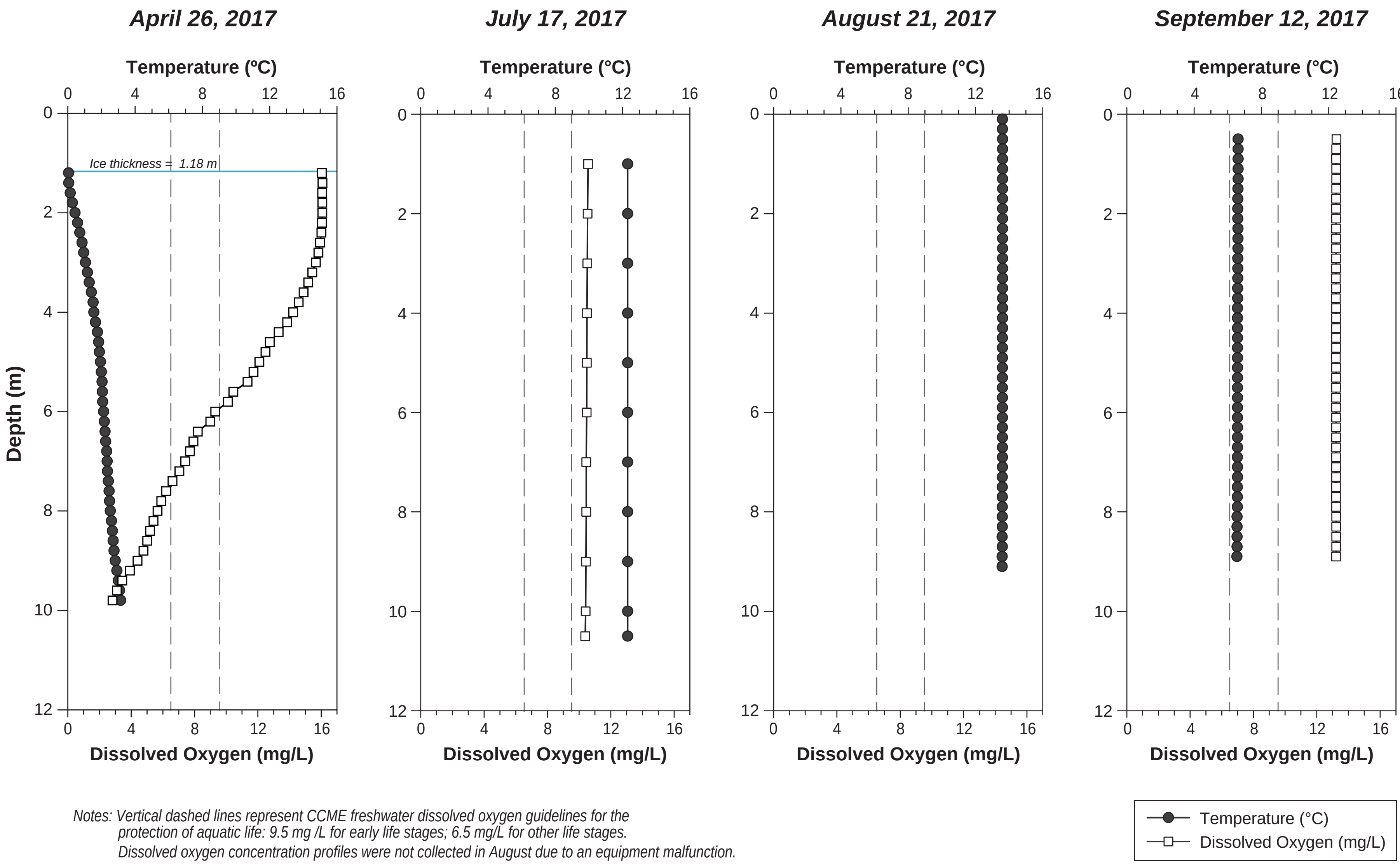
Temperature and Dissolved Oxygen Profiles in Doris Lake North, Doris Project, 2017



Note: Vertical dashed lines represent CCME freshwater dissolved oxygen guidelines for the protection of aquatic life: 9.5 mg /L for early life stages; 6.5 mg/L for other life stages.

Figure A.3-2

Temperature and Dissolved Oxygen Profiles in Reference Lake B, Doris Project, 2017



Notes: Vertical dashed lines represent CCME freshwater dissolved oxygen guidelines for the protection of aquatic life: 9.5 mg /L for early life stages; 6.5 mg/L for other life stages.
Dissolved oxygen concentration profiles were not collected in August due to an equipment malfunction.

Annex A.3-1. Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2017

Doris Lake North				
April 27, 2017				
Ice Thickness = 1.36 m				
Sonde used: YSI EXO				
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
1.4	0.15	12.1	82.9	167
1.6	0.18	12.1	83.2	167
1.8	0.28	12.1	83.5	167
2.0	0.37	12.1	83.6	166
2.2	0.45	12.1	83.6	166
2.4	0.51	12.0	83.4	166
2.6	0.55	12.0	83.2	166
2.8	0.58	11.9	82.9	165
3.0	0.60	11.9	82.6	165
3.2	0.61	11.8	82.4	165
3.4	0.63	11.8	82.1	165
3.6	0.64	11.7	81.7	165
3.8	0.65	11.7	81.4	165
4.0	0.65	11.6	81.1	165
4.2	0.66	11.6	80.8	165
4.4	0.67	11.5	80.6	165
4.6	0.69	11.5	80.3	165
4.8	0.70	11.5	80.1	165
5.0	0.72	11.4	79.9	165
5.2	0.72	11.4	79.7	165
5.4	0.73	11.4	79.4	165
5.6	0.74	11.3	79.0	165
5.8	0.74	11.3	78.8	165
6.0	0.74	11.2	78.5	165
6.2	0.75	11.2	78.3	165
6.4	0.76	11.2	78.2	165
6.6	0.77	11.1	78.0	165
6.8	0.78	11.1	77.7	166
7.0	0.81	11.1	77.4	166
7.2	0.82	11.0	77.1	165
7.4	0.84	11.0	76.8	165
7.6	0.86	10.9	76.4	165
7.8	0.89	10.8	75.7	165
8.0	0.90	10.7	75.1	165
8.2	0.92	10.6	74.3	165
8.4	0.92	10.5	73.5	165
8.6	0.93	10.4	72.8	166
8.8	0.95	10.3	72.1	166
9.0	0.96	10.2	71.7	166
9.2	0.97	10.1	71.3	166
9.4	0.99	10.1	70.9	167
9.6	1.01	10.0	70.5	167
9.8	1.03	9.94	70.00	167
10.0	1.05	9.87	69.50	167
10.2	1.07	9.74	68.73	167
10.4	1.10	9.58	67.60	167
10.6	1.14	9.40	66.40	167
10.8	1.17	9.23	65.27	167
11.0	1.21	9.06	64.17	167
11.2	1.25	8.91	63.17	167
11.4	1.28	8.79	62.35	167
11.6	1.31	8.66	61.50	167
11.8	1.35	8.50	60.40	167
12.0	1.38	8.31	59.07	167
12.2	1.41	7.79	55.43	168

Doris Lake North				
July 8, 2017				
Secchi Depth = 1.3 m				
Sonde used: RBR CTD				
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
0.1	12.5	13.3	125.1	247
0.3	12.4	13.3	125.1	247
0.5	12.4	13.4	125.4	247
0.7	12.3	13.3	124.6	247
0.9	12.2	13.3	124.2	246
1.1	11.9	13.3	123.9	247
1.3	11.8	13.4	123.8	247
1.5	11.7	13.4	123.7	247
1.7	11.7	13.4	123.8	247
1.9	11.6	13.4	123.6	246
2.1	11.5	13.4	123.6	247
2.3	11.4	13.4	123.3	247
2.5	11.4	13.3	122.4	246
2.7	11.1	13.0	118.9	243
2.9	10.3	13.1	117.5	248
3.1	10.1	13.2	117.2	248
3.3	9.89	13.1	116.4	248
3.5	9.86	13.1	116.1	249
3.7	9.80	13.1	115.6	249
3.9	9.78	13.0	115.1	249
4.1	9.70	13.0	114.6	249
4.3	9.68	12.9	114.2	249
4.5	9.68	12.9	113.5	249
4.7	9.67	12.8	113.0	249
4.9	9.67	12.8	112.5	249
5.1	9.66	12.7	112.0	248
5.3	9.65	12.7	111.5	249
5.5	9.64	12.6	111.2	249
5.7	9.62	12.6	110.9	249
5.9	9.62	12.6	110.6	249
6.1	9.62	12.5	110.2	249
6.3	9.61	12.5	110.1	249
6.5	9.59	12.5	109.8	248
6.7	9.59	12.4	109.4	249
6.9	9.58	12.4	109.3	249
7.1	9.56	12.4	109.2	249
7.3	9.56	12.4	108.9	249
7.5	9.56	12.4	108.7	249
7.7	9.55	12.4	108.6	249
7.9	9.54	12.4	108.7	249
8.1	9.53	12.4	108.6	249
8.3	9.51	12.3	108.4	249
8.5	9.51	12.3	108.3	249
8.7	9.50	12.3	108.2	249
8.9	9.48	12.3	108.1	249
9.1	9.46	12.3	108.0	249
9.3	9.44	12.3	107.8	248
9.5	9.37	12.3	107.5	249
9.7	9.31	12.3	107.7	250
9.9	9.28	12.3	107.4	249
10.1	9.28	12.3	107.1	249
10.3	9.27	12.2	106.9	249
10.5	9.25	12.2	106.8	249
10.7	9.24	12.2	106.5	249
10.9	9.21	12.2	106.3	249
11.1	9.16	12.2	106.1	249
11.3	9.12	12.1	105.2	249
11.5	8.95	12.0	104.0	250
11.7	8.85	11.9	102.9	250
11.9	8.77	11.8	102.1	251
12.1	8.71	11.8	101.6	250
12.3	8.70	11.7	101.1	251

Annex A.3-1. Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2017

Doris Lake North				
August 17, 2017				
Secchi Depth = 1.3 m				
Sonde used: RBR CTD				
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
0.3	13.3	11.7	112	251
0.5	13.2	11.7	112	251
0.7	13.2	11.7	112	250
0.9	13.2	11.7	112	250
1.1	13.2	11.7	112	251
1.3	13.2	11.7	112	250
1.5	13.2	11.7	112	251
1.7	13.1	11.7	112	251
1.9	13.1	11.7	112	251
2.1	13.1	11.7	112	251
2.3	13.1	11.7	111	250
2.5	13.1	11.7	111	251
2.7	13.1	11.6	111	250
2.9	13.1	11.6	111	250
3.1	13.1	11.6	111	251
3.3	13.1	11.6	111	251
3.5	13.1	11.6	110	251
3.7	13.1	11.6	110	251
3.9	13.1	11.6	110	250
4.1	13.1	11.6	110	250
4.3	13.1	11.6	110	251
4.5	13.1	11.5	110	251
4.7	13.1	11.5	110	251
4.9	13.1	11.5	110	251
5.1	13.1	11.5	110	251
5.3	13.1	11.5	110	250
5.5	13.1	11.5	110	251
5.7	13.1	11.5	110	251
5.9	13.1	11.5	110	251
6.1	13.1	11.5	110	250
6.3	13.1	11.5	110	251
6.5	13.1	11.5	109	250
6.7	13.1	11.5	109	251
6.9	13.1	11.5	109	251
7.1	13.1	11.5	109	251
7.3	13.1	11.5	109	251
7.5	13.1	11.5	109	251
7.7	13.1	11.5	109	250
7.9	13.1	11.4	109	251
8.1	13.1	11.5	109	251
8.3	13.1	11.4	109	251
8.5	13.1	11.4	109	251
8.7	13.1	11.4	109	251
8.9	13.1	11.4	109	251
9.1	13.1	11.4	109	251
9.3	13.0	11.4	109	251
9.5	13.0	11.4	109	251
9.7	13.0	11.4	108	251
9.9	13.0	11.4	108	251
10.1	13.0	11.3	108	250
10.3	13.0	11.3	107	250
10.5	12.9	11.2	107	251
10.7	12.9	11.2	106	251
10.9	12.9	11.1	105	251
11.1	12.8	11.0	105	251
11.3	12.8	11.0	104	251
11.5	12.8	10.9	103	250
11.7	12.8	10.9	103	251
11.9	12.7	10.8	102	251
12.1	12.7	10.7	102	250
12.3	12.7	10.5	100	251

Doris Lake North				
September 12, 2017				
Secchi Depth = 1.0 m				
Sonde used: RBR CTD				
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
0.5	8.45	12.7	109	255
0.7	8.46	12.7	109	256
0.9	8.46	12.7	109	256
1.1	8.46	12.7	109	256
1.3	8.46	12.7	109	255
1.5	8.43	12.7	109	256
1.7	8.42	12.7	109	256
1.9	8.43	12.7	109	256
2.1	8.43	12.7	109	256
2.3	8.44	12.7	109	256
2.5	8.41	12.7	109	255
2.7	8.39	12.7	108	256
2.9	8.39	12.7	108	256
3.1	8.39	12.7	108	256
3.3	8.38	12.7	108	256
3.5	8.38	12.7	108	256
3.7	8.38	12.7	108	256
3.9	8.37	12.6	108	255
4.1	8.37	12.6	108	255
4.3	8.37	12.6	108	256
4.5	8.37	12.6	108	256
4.7	8.36	12.6	108	256
4.9	8.36	12.6	108	256
5.1	8.36	12.6	108	255
5.3	8.36	12.6	108	255
5.5	8.36	12.6	107	256
5.7	8.35	12.6	107	256
5.9	8.35	12.6	107	256
6.1	8.35	12.6	107	256
6.3	8.35	12.6	107	256
6.5	8.35	12.6	107	256
6.7	8.34	12.6	107	256
6.9	8.34	12.6	107	255
7.1	8.33	12.5	107	256
7.3	8.33	12.5	107	255
7.5	8.32	12.5	107	256
7.7	8.32	12.5	107	256
7.9	8.32	12.5	107	257
8.1	8.32	12.5	107	256
8.3	8.32	12.5	107	256
8.5	8.33	12.5	107	256
8.7	8.33	12.5	107	256
8.9	8.33	12.5	107	256
9.1	8.32	12.5	107	257
9.3	8.32	12.5	107	256
9.5	8.31	12.5	107	256
9.7	8.31	12.5	107	256
9.9	8.32	12.5	107	256
10.1	8.31	12.5	107	256
10.3	8.31	12.5	107	256
10.5	8.30	12.5	106	256
10.7	8.31	12.5	106	256
10.9	8.31	12.5	106	256
11.1	8.31	12.5	106	256
11.3	8.30	12.5	106	255
11.5	8.30	12.5	106	256
11.7	8.30	12.5	106	256
11.9	8.30	12.5	106	256
12.1	8.31	12.4	106	256

Annex A.3-1. Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2017

Reference Lake B				
April 26, 2017				
Ice Thickness = 1.18 m				
Sonde used: YSI EXO				
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
1.2	0.04	16.0	109.8	37.2
1.4	0.05	16.1	110.2	37.5
1.6	0.14	16.1	110.3	37.3
1.8	0.26	16.1	110.7	37.2
2.0	0.42	16.1	111.1	37.0
2.2	0.57	16.1	111.5	36.8
2.4	0.71	16.0	111.6	36.4
2.6	0.84	15.9	111.5	36.0
2.8	0.94	15.8	111.0	35.6
3.0	1.05	15.7	110.3	35.4
3.2	1.16	15.4	109.0	35.5
3.4	1.26	15.2	107.6	35.5
3.6	1.39	14.9	105.8	35.7
3.8	1.50	14.6	103.9	36.0
4.0	1.54	14.2	101.6	36.3
4.2	1.64	13.9	99.1	36.5
4.4	1.76	13.3	95.5	36.4
4.6	1.83	12.8	91.8	36.0
4.8	1.87	12.5	89.9	36.1
5.0	1.94	12.1	87.3	36.4
5.2	1.99	11.7	84.8	36.4
5.4	2.03	11.4	82.1	36.5
5.6	2.05	10.4	75.6	36.8
5.8	2.07	10.1	73.2	37.6
6.0	2.12	9.3	67.5	38.0
6.2	2.16	9.0	65.3	37.9
6.4	2.21	8.2	59.7	38.1
6.6	2.25	7.9	57.7	38.3
6.8	2.30	7.7	56.3	38.2
7.0	2.33	7.4	54.1	38.0
7.2	2.35	7.0	51.4	38.9
7.4	2.40	6.6	48.2	40.2
7.6	2.45	6.2	45.4	40.3
7.8	2.48	5.9	43.3	40.2
8.0	2.52	5.7	41.5	40.1
8.2	2.59	5.4	39.7	40.1
8.4	2.65	5.2	38.2	40.0
8.6	2.69	5.0	36.9	39.8
8.8	2.74	4.8	35.2	39.6
9.0	2.81	4.4	32.5	39.3
9.2	2.91	3.9	29.0	39.3
9.4	3.00	3.4	25.5	39.2
9.6	3.07	3.1	23.0	39.5
9.8	3.14	2.8	21.0	41.4

Reference Lake B		
July 17, 2017		
Secchi Depth = 5.4 m		
Sonde used: YSI ProODO		
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)
1	12.3	10.56
2	12.3	10.54
3	12.3	10.52
4	12.3	10.50
5	12.3	10.49
6	12.3	10.48
7	12.3	10.45
8	12.3	10.45
9	12.3	10.43
10	12.3	10.41
10.5	12.3	10.38

Note: Dissolved oxygen saturation and conductivity data were not recorded.

Annex A.3-1. Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2017

Reference Lake B	
August 21, 2017	
Secchi Depth = 7.6 m	
Sonde used: RBR CTD	
Depth (m)	Temperature (°C)
0.1	13.6
0.3	13.6
0.5	13.6
0.7	13.6
0.9	13.6
1.1	13.6
1.3	13.6
1.5	13.6
1.7	13.6
1.9	13.6
2.1	13.6
2.3	13.6
2.5	13.6
2.7	13.6
2.9	13.6
3.1	13.6
3.3	13.6
3.5	13.6
3.7	13.6
3.9	13.6
4.1	13.6
4.3	13.6
4.5	13.6
4.7	13.6
4.9	13.6
5.1	13.6
5.3	13.6
5.5	13.6
5.7	13.6
5.9	13.6
6.1	13.6
6.3	13.6
6.5	13.6
6.7	13.6
6.9	13.6
7.1	13.6
7.3	13.6
7.5	13.6
7.7	13.6
7.9	13.6
8.1	13.6
8.3	13.6
8.5	13.6
8.7	13.6
8.9	13.6
9.1	13.6

Note: Oxygen and conductivity profiles were not collected due to an equipment malfunction.

Reference Lake B				
September 12, 2017				
Secchi Depth = 6.5 m				
Sonde used: RBR CTD				
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
0.5	6.62	13.2	108.3	59.5
0.7	6.62	13.2	108.2	60.0
0.9	6.62	13.2	108.1	59.1
1.1	6.62	13.2	108.2	59.9
1.3	6.62	13.2	108.2	59.3
1.5	6.61	13.2	108.1	59.4
1.7	6.60	13.2	108.1	58.8
1.9	6.60	13.2	108.0	59.0
2.1	6.60	13.2	108.1	59.1
2.3	6.61	13.2	108.1	59.3
2.5	6.61	13.2	108.1	59.3
2.7	6.61	13.2	108.0	59.4
2.9	6.60	13.2	108.0	59.7
3.1	6.60	13.2	108.0	60.1
3.3	6.60	13.2	108.0	59.1
3.5	6.59	13.2	108.0	59.1
3.7	6.59	13.2	108.0	59.3
3.9	6.59	13.2	108.0	59.4
4.1	6.58	13.2	108.0	59.3
4.3	6.58	13.2	108.0	59.2
4.5	6.58	13.2	108.0	59.8
4.7	6.58	13.2	108.0	58.9
4.9	6.58	13.2	107.9	59.5
5.1	6.58	13.2	108.0	59.2
5.3	6.58	13.2	108.0	59.5
5.5	6.58	13.2	108.0	59.4
5.7	6.58	13.2	108.0	59.4
5.9	6.58	13.2	108.0	59.3
6.1	6.58	13.2	108.0	59.1
6.3	6.58	13.2	108.0	59.8
6.5	6.58	13.2	108.0	59.7
6.7	6.58	13.2	108.0	59.0
6.9	6.58	13.2	108.0	59.4
7.1	6.58	13.2	108.0	59.7
7.3	6.58	13.2	108.0	60.0
7.5	6.57	13.2	107.9	59.5
7.7	6.58	13.2	108.0	58.8
7.9	6.58	13.2	108.0	59.5
8.1	6.56	13.2	108.0	59.4
8.3	6.56	13.2	108.0	59.3
8.5	6.56	13.2	108.0	58.6
8.7	6.56	13.2	108.0	59.1
8.9	6.54	13.2	107.9	59.2

A.4 2017 WATER QUALITY

The following sections present the water quality data collected from April to September 2017 from the AEMP sites, as well as the QA/QC water quality data. Only the variables that were subjected to an evaluation of effects (see main body of the report) are shown graphically. All water quality variables were screened against CCME water quality guidelines for the protection of aquatic life (CCME 2018b). CCME guidelines are included in all graphs and annexes.

Lake water quality data were collected at the monitoring site from the surface (1 m) and ~2 m from the bottom in both Doris Lake and Reference Lake B. Samples were collected in April (under-ice sampling) and monthly from July to September 2017. Figures A.4-1 to A.4-7 show seasonal trends for each evaluated water quality variable. Annex A.4-1 presents the full 2017 lake water quality dataset.

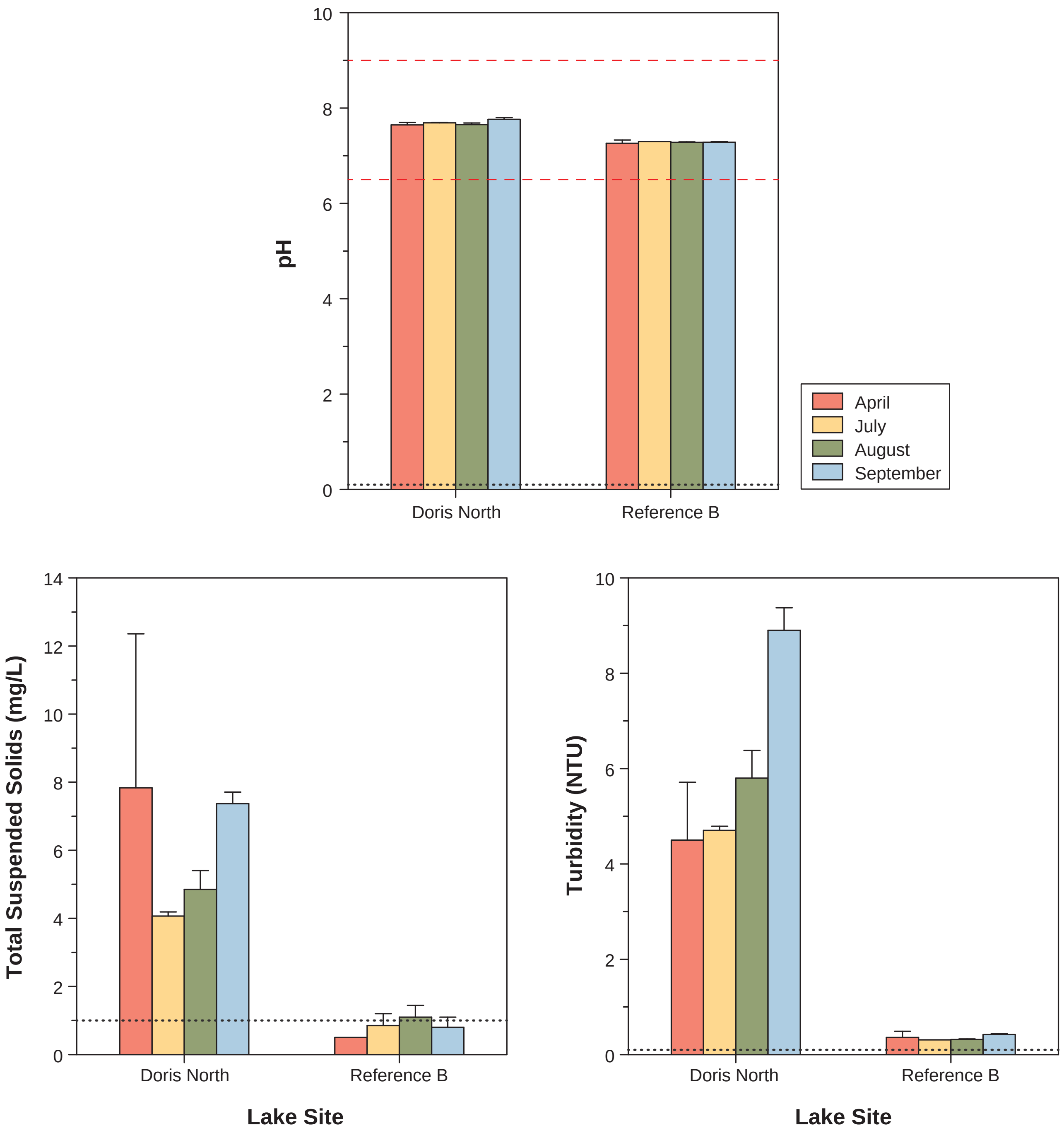
A.4.1 Quality Assurance/Quality Control (QA/QC) Data

Within-site variability was accounted for by collecting field replicates, which made up 20% of total samples. Replicate results are presented in the water quality dataset (Annex A.4.-1).

Annex A.4-2 presents the results of the QA/QC blank data (equipment, field, and travel blanks) collected to identify possible sources of contamination to water quality samples. QA/QC data collected for each sampling event represented a minimum of 20% of the samples collected. A subset of blanks contained values above detection limits for select nutrients and metals; however, there was no obvious contamination of water quality samples that can be attributed to sampling equipment, sample collection, or sample transportation.

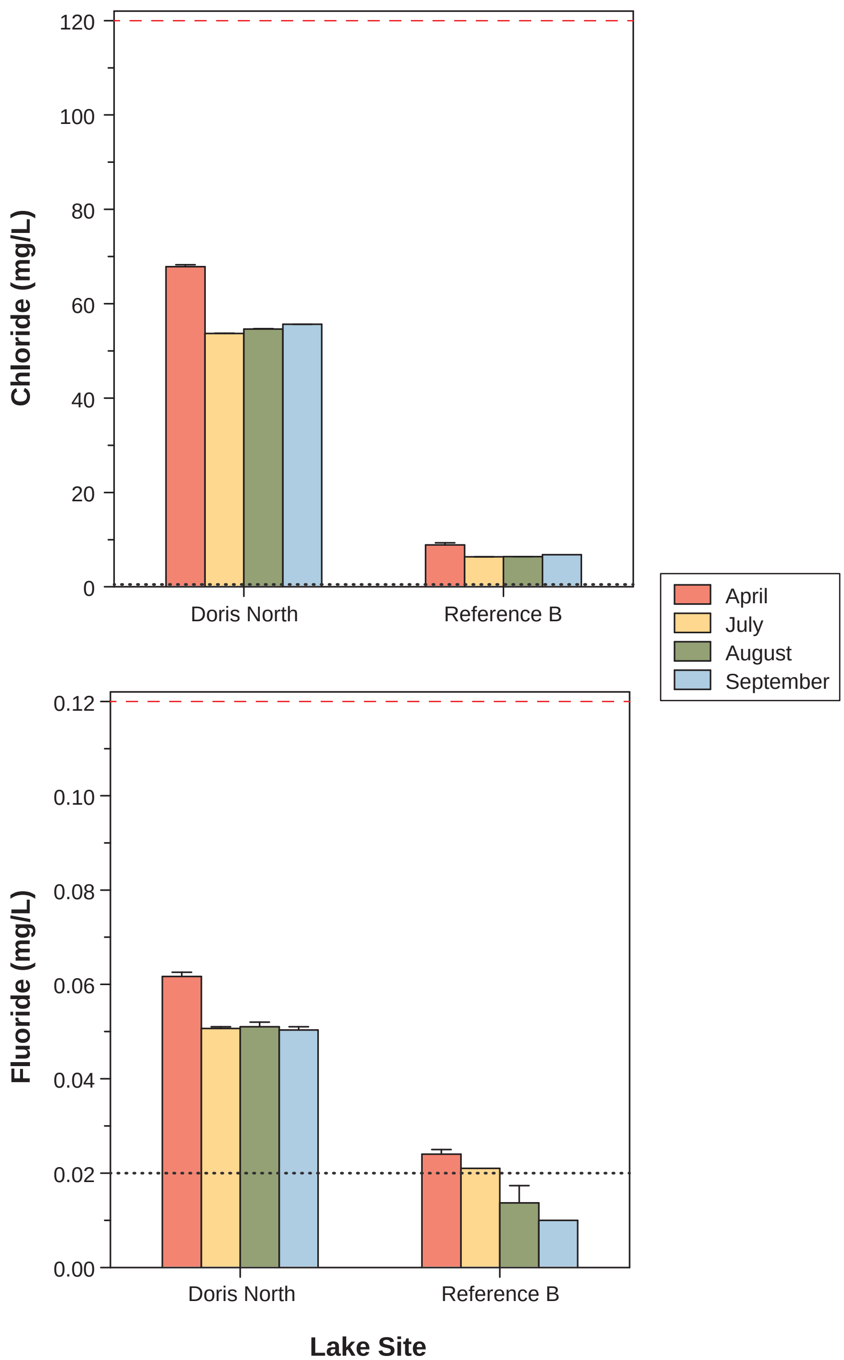
Figure A.4-1

pH, Total Suspended Solids, and Turbidity in Lakes, Doris Project, 2017



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guideline pH range (6.5–9.0).
The CCME guidelines for total suspended solids and turbidity are dependent upon background levels.

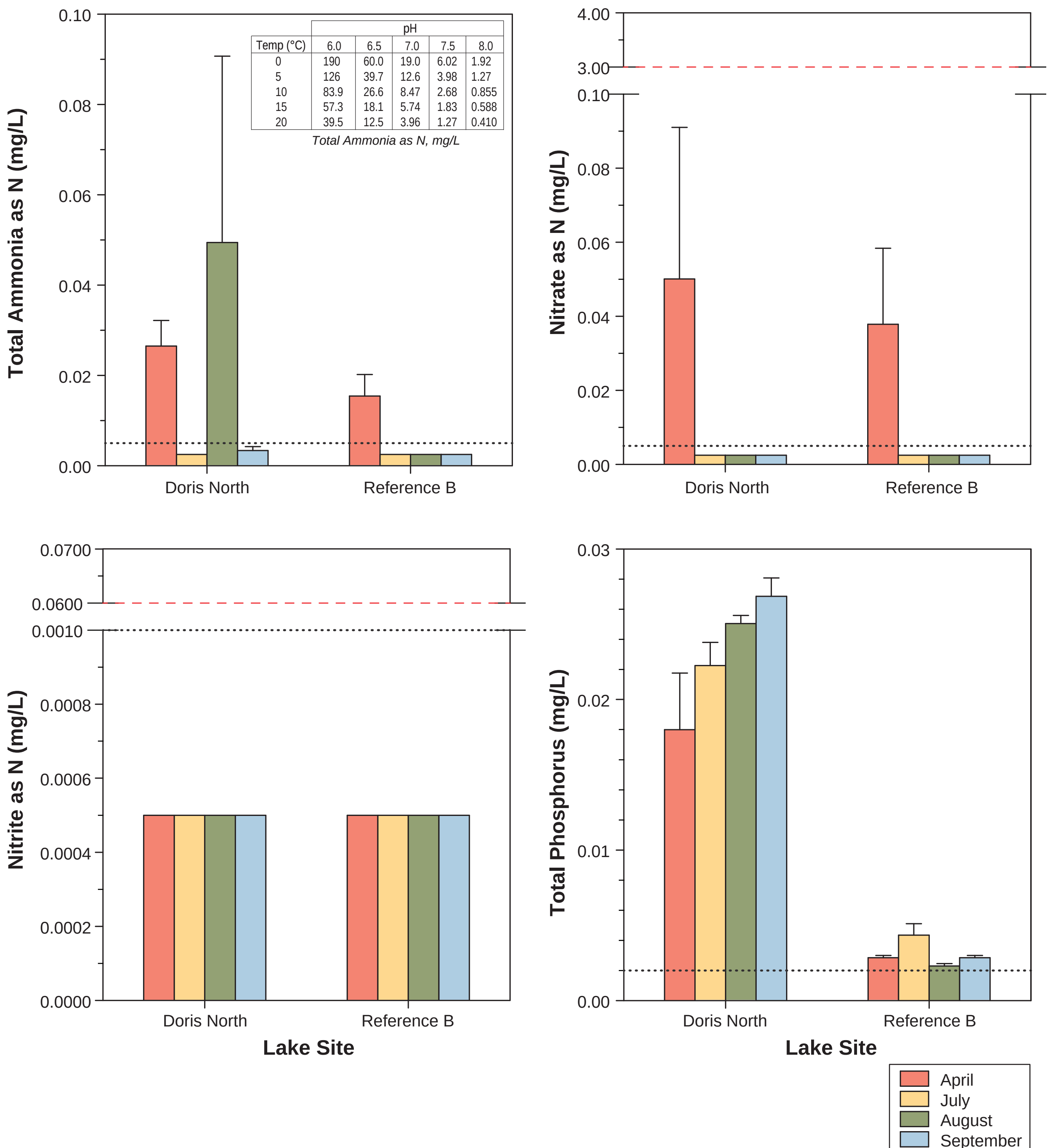
Chloride and Fluoride Concentrations in Lakes, Doris Project, 2017



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent CCME long-term guidelines for chloride (120 mg/L) and fluoride (0.12 mg.L).

Figure A.4-3

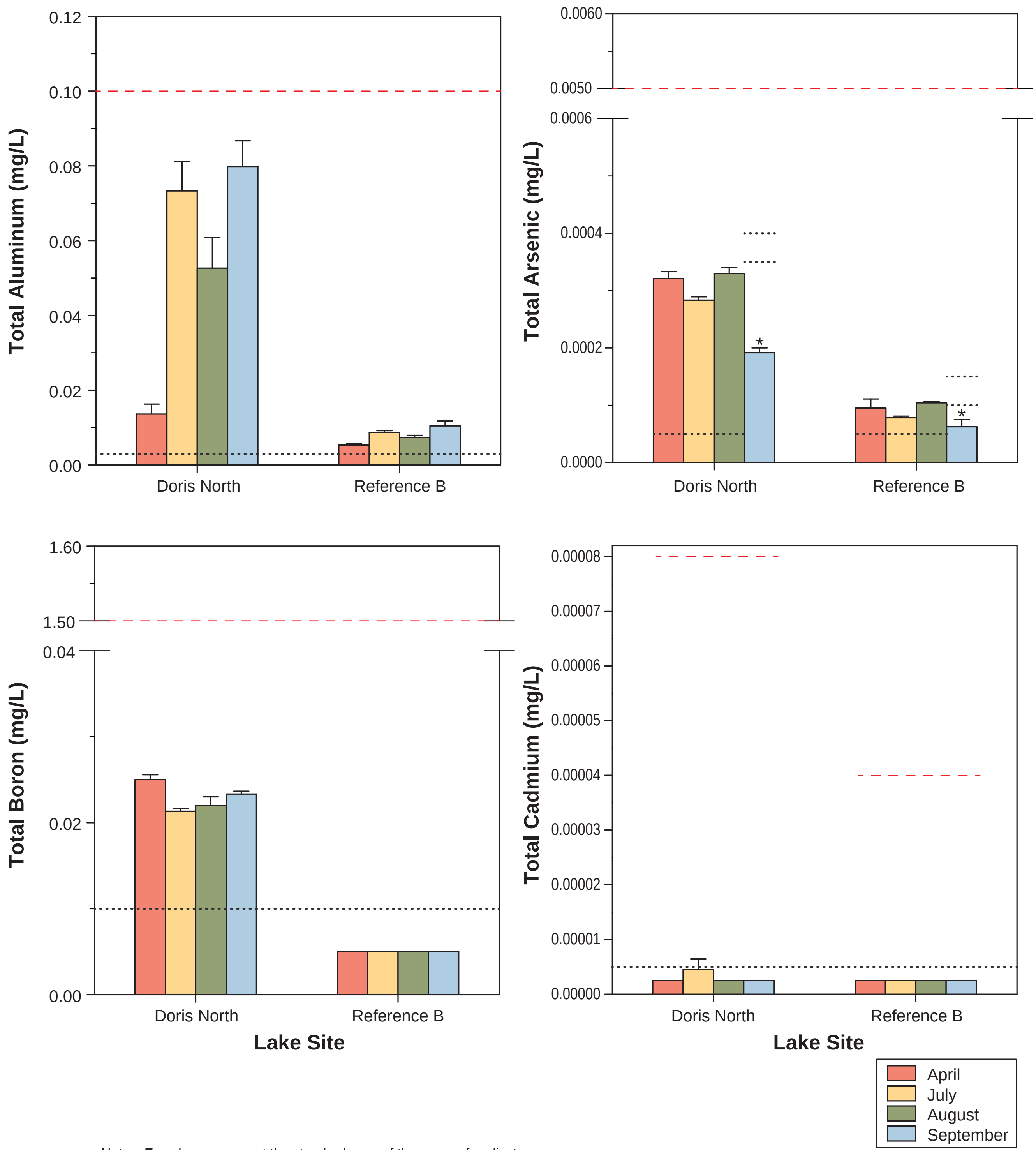
Ammonia, Nitrate, Nitrite, and Phosphorus Concentrations in Lakes, Doris Project, 2017



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Inset table shows the pH- and temperature-dependent CCME guideline for total ammonia as N.
Red dashed lines represent the CCME guidelines for nitrate as N (3.0 mg/L; long-term concentration) and nitrite as N (0.06 mg/L).

Figure A.4-4

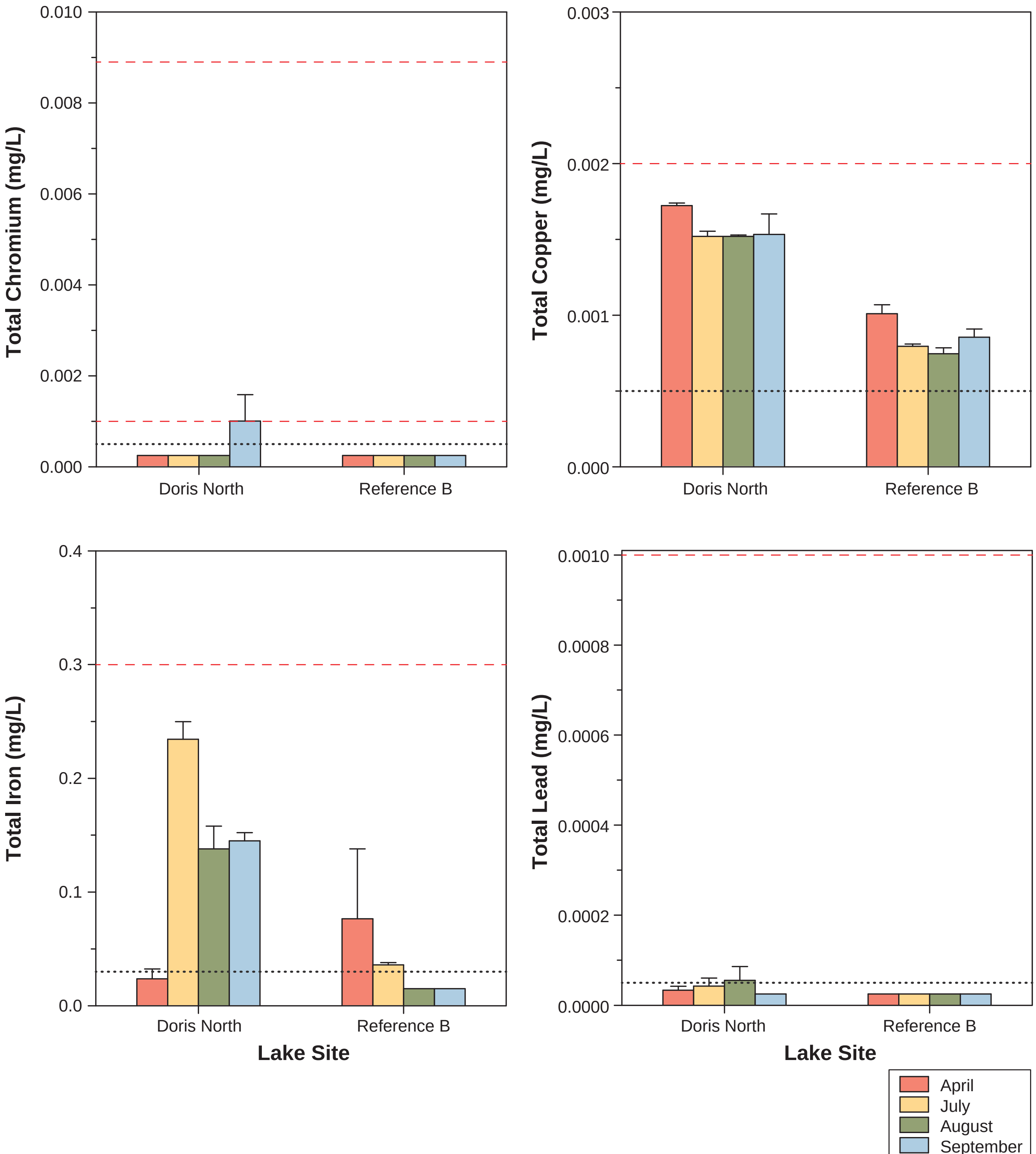
Aluminum, Arsenic, Boron, and Cadmium Concentrations in Lakes, Doris Project, 2017



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
** All arsenic concentrations measured in September at both sites were below applicable detection limits.*
Red dashed lines represent the pH-dependent CCME guideline for aluminum (0.1 mg/L at pH ≥ 6.5; pH was greater than 6.5 in all lake samples), the CCME guidelines for arsenic (0.005 mg/L) and boron (1.5 mg/L; long-term concentration), and the hardness-dependent minimum CCME guidelines for cadmium (0.00008 mg/L for Doris Lake North; 0.00004 mg/L for Reference Lake B).

Figure A.4-5

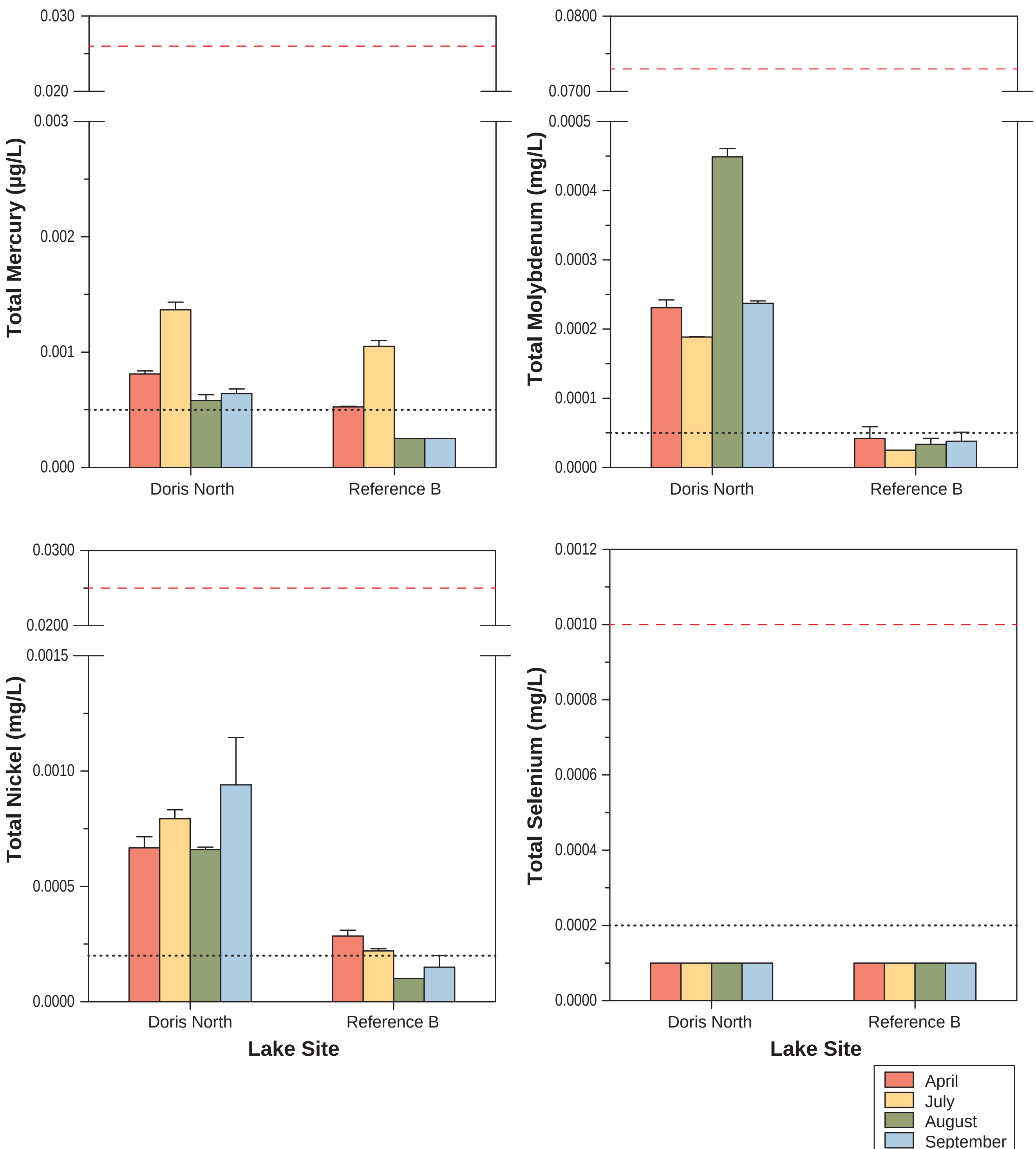
Chromium, Copper, Iron, and Lead Concentrations in Lakes, Doris Project, 2017



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guidelines for trivalent chromium (0.0089 mg/L), hexavalent chromium (0.001 mg/L), and iron (0.3 mg/L), and the hardness-dependent CCME guidelines for copper (0.002 mg/L for hardness of 0 to 82 mg/L as $CaCO_3$) and lead (0.001 mg/L for hardness of 0 to 60 mg/L as $CaCO_3$).

Figure A.4-6

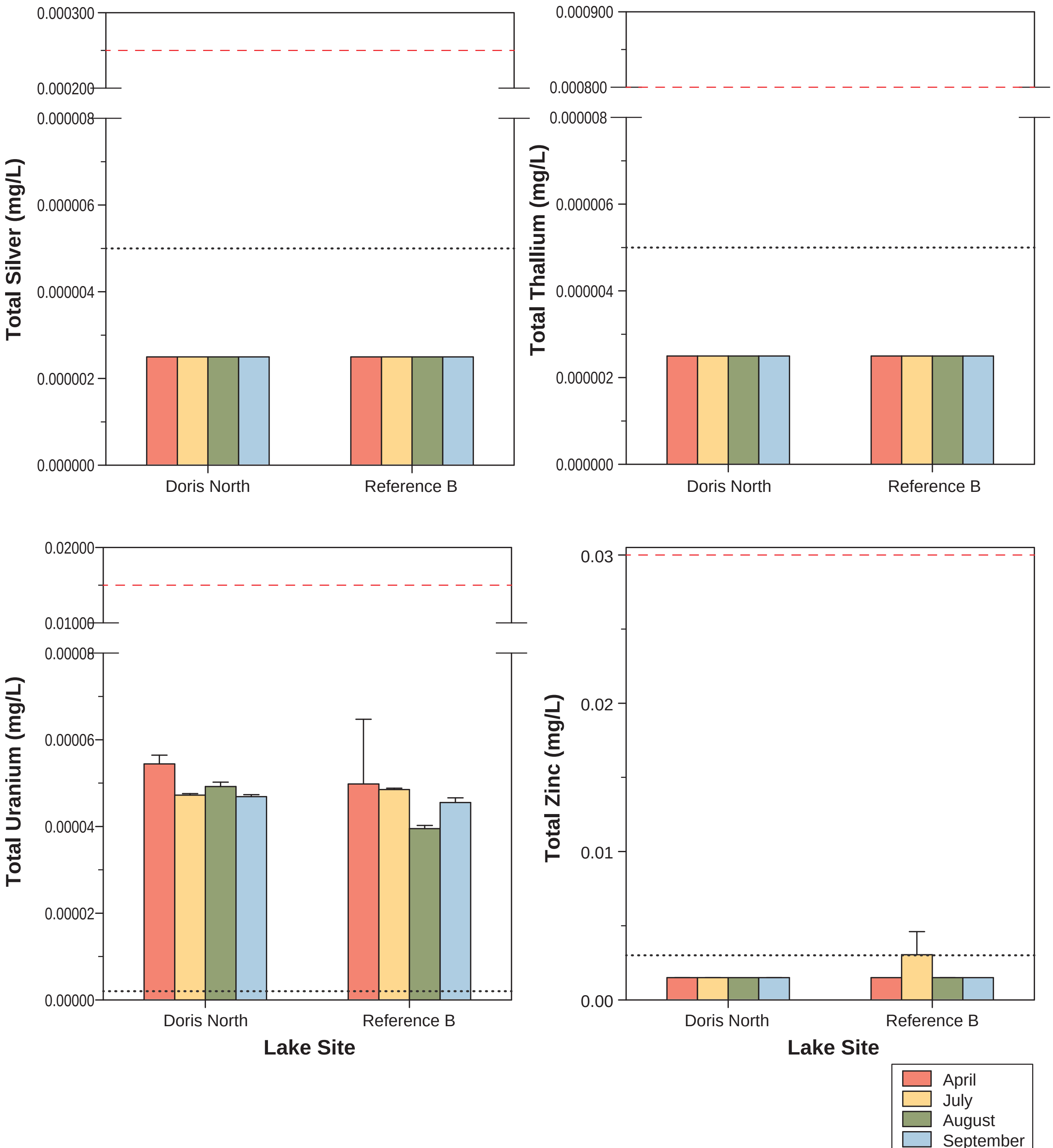
Mercury, Molybdenum, Nickel, and Selenium in Lakes, Doris Project, 2017



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guidelines for mercury (0.026µg/L) and selenium (0.001 mg/L), the interim CCME guideline for molybdenum (0.073 mg/L), and the hardness-dependent CCME guideline for nickel (0.025 mg/L for hardness of 0 to 60 mg/L as $CaCO_3$).

Figure A.4-7

Silver, Thallium, Uranium, and Zinc Concentrations in Lakes, Doris Project, 2017



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guidelines for silver (0.00025 mg/L; long-term concentration), thallium (0.0008 mg/L), uranium (0.015 mg/L; long-term concentration), and zinc (0.03 mg/L).

Annex A.4-1. Lake Water Quality Data, Doris Project, 2017

Site ID:				Doris North			Reference B		Doris North			Reference B	
Replicate:				1	2	1	1	1	1	2	1	1	1
Depth Sampled (m):				2.5	2.5	11	2.5	8.5	1	1	12	1	8.5
Date Sampled:		CCME Guideline for the Protection	Realized Detection	27-Apr-2017	27-Apr-2017	27-Apr-2017	26-Apr-2017	26-Apr-2017	8-Jul-2017	8-Jul-2017	8-Jul-2017	17-Jul-2017	17-Jul-2017
ALS Sample ID:	Units	of Aquatic life[a]	Limit	L1918949-3	L1918949-7	L1918949-4	L1918949-8	L1918949-9	L1957154-2	L1957154-3	L1957154-1	L1960769-1	L1960769-2
Physical Tests													
Conductivity	uS/cm		2.0	307	301	298	72.1	68.2	233	232	234	49.4	48.9
Hardness (as $CaCO_3$)	mg/L		0.50	54.7	55.5	57.6	21	19.2	43.5	43.4	44.6	14.2	14.1
pH	pH	6.5 to 9.0	0.10	7.68	7.72	7.55	7.33	7.19	7.69	7.71	7.68	7.30	7.30
Total Suspended Solids	mg/L	dependent on background levels	1.0 - 2.0	4.4	16.8	2.3	<1.0	<1.0	4.0	4.3	3.9	<1.0	1.2
Turbidity	NTU	dependent on background levels	0.10	5.66	5.76	2.07	0.23	0.49	4.61	4.63	4.87	0.31	0.31
Anions and Nutrients													
Alkalinity, Total (as $CaCO_3$)	mg/L		1.0	34.6	35.2	33.8	16.3	16.0	28.4	28.5	28.8	11.1	10.9
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005 - 0.015	0.0332	0.0311	0.0152	0.0202	0.0107	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.050	0.221	0.225	0.224	<0.050	<0.050	0.178	0.178	0.180	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.50	68.2	68.3	67.0	9.35	8.39	53.7	53.6	53.8	6.35	6.36
Fluoride (F)	mg/L	0.12[b]	0.020	0.062	0.063	0.060	0.025	0.023	0.051	0.051	0.050	0.021	0.021
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.0050	0.0095	0.0088	0.132	0.0173	0.0584	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	mg/L	Trigger ranges from guidance framework[c]	0.0020	0.0212	0.0223	0.0105	0.0027	0.0030	0.0195	0.0248	0.0225	0.0036	0.0051
Sulphate (SO_4)	mg/L		0.30	3.05	3.06	2.93	2.28	2.11	2.41	2.41	2.43	1.53	1.53
Total Metals													
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0103	0.0117	0.0189	0.0050	0.0057	0.0640	0.0668	0.0891	0.0083	0.0092
Antimony (Sb)	mg/L		0.000030	<0.000030	<0.000030	0.000036	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030
Arsenic (As)	mg/L	0.005	0.00005 - 0.00040	0.000321	0.000342	0.000300	0.000111	0.000079	0.000292	0.000272	0.000286	0.000075	0.000081
Barium (Ba)	mg/L		0.00010	0.00273	0.00272	0.00311	0.00235	0.00276	0.00346	0.00335	0.00340	0.00163	0.00165
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.010	0.026	0.024	0.025	<0.010	<0.010	0.022	0.021	0.021	<0.010	<0.010
Cadmium (Cd)	mg/L	short-term: 0.00027 - 0.00120; long-term: 0.00004 - 0.00010[d]	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000084	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	9.87	10.0	11.3	5.12	4.74	7.56	7.52	7.72	3.45	3.41
Cesium (Cs)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089[b]	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000151	<0.000050	<0.000050	0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002[e]	0.00050	0.00173	0.00175	0.00169	0.00107	0.00095	0.00152	0.00158	0.00146	0.00081	0.00078
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	<0.030	<0.030	0.041	<0.030	0.138	0.216	0.222	0.265	0.034	0.038
Lead (Pb)	mg/L	0.001[f]	0.000050	0.000051	<0.000050	<0.000050	<0.000050	<0.000050	0.000078	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00040	0.00406	0.00409	0.00393	0.00072	0.00061	0.00346	0.00353	0.00355	0.00042	0.00042
Magnesium (Mg)	mg/L		0.10	7.30	7.40	7.10	1.98	1.79	5.97	5.99	6.14	1.36	1.35
Manganese (Mn)	mg/L		0.00020	0.00282	0.00282	0.0292	0.00100	0.0567	0.0235	0.0244	0.0361	0.00208	0.00207
Mercury (Hg)	μg/L	Inorganic Hg: 0.026	0.00050	0.00086	0.00077	0.00080	0.00052	0.00053	0.00130	0.00150	0.00130	0.00110	0.00100
Molybdenum (Mo)	mg/L	0.073[b]	0.000050	0.000238	0.000246	0.000209	0.000059	<0.000050	0.000188	0.000189	0.000189	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.025[g]	0.00020	0.00072	0.00071	0.00057	0.00026	0.00031	0.00076	0.00087	0.00075	0.00021	0.00023
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.4	2.5	2.3	<2.0	<2.0	2.4	2.4	2.5	<2.0	<2.0
Rhenium (Re)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00170	0.00171	0.00165	0.00119	0.00106	0.00155	0.00155	0.00157	0.000842	0.000815
Selenium (Se)	mg/L	0.001	0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.10	1.86	1.85	2.05	0.23	0.74	1.64	1.67	1.76	0.17	0.17

Annex A.4-1. Lake Water Quality Data, Doris Project, 2017

Site ID:				Doris North			Reference B		Doris North			Reference B	
Replicate:				**1**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**
Depth Sampled (m):				**2.5**	**2.5**	**11**	**2.5**	**8.5**	**1**	**1**	**12**	**1**	**8.5**
Date Sampled:				**27-Apr-2017**	**27-Apr-2017**	**27-Apr-2017**	**26-Apr-2017**	**26-Apr-2017**	**8-Jul-2017**	**8-Jul-2017**	**8-Jul-2017**	**17-Jul-2017**	**17-Jul-2017**
ALS Sample ID:	**Units**	**CCME Guideline for the Protection of Aquatic life[a]**	**Realized Detection Limit**	**L1918949-3**	**L1918949-7**	**L1918949-4**	**L1918949-8**	**L1918949-9**	**L1957154-2**	**L1957154-3**	**L1957154-1**	**L1960769-1**	**L1960769-2**
Silver (Ag)	mg/L	long-term : 0.00025	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	36.2	36.4	35.3	5.5	4.7	31.2	28.9	29.5	3.9	3.9
Strontium (Sr)	mg/L		0.00020	0.0492	0.0512	0.0495	0.0256	0.0250	0.0353	0.0358	0.0350	0.0153	0.0150
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)	mg/L		0.0000050	0.0000116	0.0000135	0.0000133	0.0000087	0.0000057	0.0000370	0.0000379	0.0000410	<0.0000050	0.0000052
Tin (Sn)	mg/L		0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	<0.00020	<0.00020	0.00025	<0.00020	<0.00020	0.00164	0.00169	0.00226	<0.00020	0.00024
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000011	0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000559	0.0000569	0.0000505	0.0000647	0.0000349	0.0000468	0.0000479	0.0000470	0.0000482	0.0000488
Vanadium (V)	mg/L		0.000050	0.000101	0.000101	0.000093	<0.000050	<0.000050	0.000181	0.000191	0.000213	<0.000050	<0.000050
Yttrium (Y)	mg/L		0.0000050	0.0000255	0.0000254	0.0000346	0.0000161	0.0000192	0.0000458	0.0000463	0.0000496	0.0000131	0.0000123
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0046	<0.0030
Zirconium (Zr)	mg/L		0.000050	0.000050	0.000054	0.00120	<0.000050	<0.000050	0.000087	0.000083	0.000808	<0.000050	<0.000050

Notes:

April sampling depths are depths below the water surface and are equal to approximately 0.25-1 m below ice.

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

[a] *Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, Accessed 2017.*

[b] *Interim guideline.*

[c] *Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.*

[d] *Cadmium guideline is hardness dependent (hardness as $CaCO_3$).For the short-term benchmark, when the water hardness is 0-5.3 mg/L, the CWQG is 0.00011 mg/L. At hardness ≥ 5.3 to ≤ 360 mg/L, the CWQG is calculated using this equation:*
*CWQG (mg/L) = 0.001*10{1.016(log[hardness]) – 1.71 }. At hardness > 360 mg/L, the CWQG is 0.0077 mg/L. For long term, when the water hardness is <17 mg/L, the CWQG is 0.00004 mg/L. At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated using this equation:*
CWQG (mg/L) = $0.001 \times 10^{\{0.83(\log[hardness]) - 2.46\}}$. At hardness > 280 mg/L, the CWQG is 0.00037 mg/L.

[e] *Copper guideline is hardness dependent (hardness as $CaCO_3$). When the water hardness is <82 mg/L, the CWQG is 0.002 mg/L. At hardness ≥82 to ≤180 mg/L the CWQG is calculated using this equation:*
CWQG (mg/L) = $0.0002 \times e^{\{0.8545[\ln(hardness)]-1.465\}}$. At hardness >180 mg/L, the CWQG is 0.004 mg/L. If the hardness is unknown, the CWQG is 0.002 mg/L.

[f] *Lead guideline is hardness dependent (hardness as $CaCO_3$). When the hardness is 0 to ≤ 60 mg/L, the CWQG is 0.001 mg/L. At hardness >60 to ≤ 180 mg/L the CWQG is calculated using this equation:*
CWQG (mg/L)= $0.001 \times e^{\{1.273[\ln(hardness)]-4.705\}}$. At hardness >180 mg/L, the CWQG is 0.007 mg/L. If the hardness is unknown, the CWQG is 0.001 mg/L.

[g] *Nickel guideline is hardness dependent (hardness as $CaCO_3$). When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 0.025 mg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated using this equation:*
CWQG (mg/L) = $0.001 \times e^{\{0.76[\ln(hardness)]+1.06\}}$. At hardness >180 mg/L, the CWQG is 0.150 mg/L. If the hardness is unknown, the CWQG is 0.025 mg/L.

Annex A.4-1. Lake Water Quality Data, Doris Project, 2017

Site ID:				Doris North		Reference B			Doris North			Reference B	
Replicate:				1	1	1	1	2	1	1	2	1	1
Depth Sampled (m):				1	11	1	8	8	1	11	11	1	8
Date Sampled:		CCME Guideline for the Protection	Realized Detection	17-Aug-2017	17-Aug-2017	21-Aug-2017	21-Aug-2017	21-Aug-2017	12-Sep-2017	12-Sep-2017	12-Sep-2017	12-Sep-2017	12-Sep-2017
ALS Sample ID:	Units	of Aquatic life[a]	Limit	L1977612-1	L1977612-2	L1979265-1	L1979265-2	L1979265-3	L1992296-2	L1992296-3	L1992296-4	L1992296-5	L1992296-6
Physical Tests													
Conductivity	uS/cm		2.0	261	253	48.0	48.9	48.4	256	248	252	52.4	51.2
Hardness (as $CaCO_3$)	mg/L		0.50	43.1	43.6	13.8	13.5	13.9	44.8	45	46.4	14.6	14.7
pH	pH	6.5 to 9.0	0.10	7.62	7.69	7.26	7.30	7.28	7.69	7.83	7.77	7.30	7.27
Total Suspended Solids	mg/L	dependent on background levels	1.0 - 2.0	4.3	5.4	<1.0	1.1	1.7	6.7	7.6	7.8	<1.0	1.1
Turbidity	NTU	dependent on background levels	0.10	5.22	6.38	0.31	0.30	0.34	8.26	9.83	8.61	0.44	0.40
Anions and Nutrients													
Alkalinity, Total (as $CaCO_3$)	mg/L		1.0	29.0	29.1	11.7	11.5	12.0	30.5	30.0	30.4	12.4	11.9
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005 - 0.015	0.0907	0.0082	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0051	<0.0050	<0.0050
Bromide (Br)	mg/L		0.050	0.178	0.183	<0.050	<0.050	<0.050	0.196	0.193	0.201	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.50	54.6	54.7	6.41	6.38	6.37	55.7	55.6	55.6	6.80	6.80
Fluoride (F)	mg/L	0.12[b]	0.020	0.050	0.052	<0.020	<0.020	0.021	0.049	0.051	0.051	<0.020	<0.020
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	mg/L	Trigger ranges from guidance framework[c]	0.0020	0.0245	0.0256	0.0020	0.0024	0.0025	0.0266	0.0291	0.0249	0.0030	0.0027
Sulphate (SO_4)	mg/L		0.30	2.54	2.52	1.57	1.56	1.56	2.52	2.52	2.51	1.62	1.62
Total Metals													
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0445	0.0608	0.0063	0.0084	0.0073	0.0666	0.0898	0.0830	0.0091	0.0118
Antimony (Sb)	mg/L		0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030
Arsenic (As)	mg/L	0.005	0.00005 - 0.00040	0.000319	0.000340	0.000108	0.000102	0.000103	<0.00035	<0.00040	<0.00040	<0.00015	<0.00010
Barium (Ba)	mg/L		0.00010	0.00313	0.00283	0.00144	0.00146	0.00140	0.00285	0.00295	0.00295	0.00146	0.00154
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.010	0.023	0.021	<0.010	<0.010	<0.010	0.024	0.023	0.023	<0.010	<0.010
Cadmium (Cd)	mg/L	short-term: 0.00027 - 0.00120; long-term: 0.00004 - 0.00010[d]	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	7.70	7.80	3.33	3.28	3.36	8.06	8.08	8.34	3.54	3.57
Cesium (Cs)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089[b]	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00062	0.00215	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	<0.000050	0.000054	<0.000050	<0.000050	<0.000050	0.000064	0.000051	0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002[e]	0.00050	0.00153	0.00151	0.00077	0.00080	0.00067	0.00179	0.00148	0.00133	0.00091	0.00080
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	0.118	0.158	<0.030	<0.030	<0.030	0.133	0.144	0.158	<0.030	<0.030
Lead (Pb)	mg/L	0.001[f]	0.000050	<0.000050	0.000086	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00040	0.00369	0.00346	0.00067	0.00071	0.00061	0.00376	0.00380	0.00374	0.00053	0.00051
Magnesium (Mg)	mg/L		0.10	5.80	5.86	1.32	1.29	1.33	6.00	6.03	6.21	1.39	1.41
Manganese (Mn)	mg/L		0.00020	0.0292	0.0386	0.00148	0.00165	0.00157	0.0264	0.0277	0.0276	0.00176	0.00202
Mercury (Hg)	µg/L	Inorganic Hg: 0.026	0.00050	0.00053	0.00063	<0.00050	<0.00050	<0.00050	0.00072	0.00061	0.00059	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.073[b]	0.000050	0.000437	0.000461	0.000051	<0.000050	<0.000050	0.000243	0.000238	0.000231	0.000051	<0.000050
Nickel (Ni)	mg/L	0.025[g]	0.00020	0.00065	0.00067	<0.00020	<0.00020	<0.00020	0.00134	0.00082	0.00066	0.00020	<0.00020
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.0	2.1	<2.0	<2.0	<2.0	2.1	2.1	2.1	<2.0	<2.0
Rhenium (Re)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00155	0.00134	0.000864	0.000869	0.000887	0.00155	0.00157	0.00160	0.000846	0.000882
Selenium (Se)	mg/L	0.001	0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.10	1.55	1.61	0.15	0.15	0.15	1.67	1.68	1.73	0.16	0.16

Annex A.4-1. Lake Water Quality Data, Doris Project, 2017

Site ID:				Doris North		Reference B			Doris North			Reference B	
Replicate:				**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**1**
Depth Sampled (m):				**1**	**11**	**1**	**8**	**8**	**1**	**11**	**11**	**1**	**8**
Date Sampled:		**CCME Guideline for the Protection**	**Realized Detection**	**17-Aug-2017**	**17-Aug-2017**	**21-Aug-2017**	**21-Aug-2017**	**21-Aug-2017**	**12-Sep-2017**	**12-Sep-2017**	**12-Sep-2017**	**12-Sep-2017**	**12-Sep-2017**
ALS Sample ID:	**Units**	**of Aquatic life[a]**	**Limit**	**L1977612-1**	**L1977612-2**	**L1979265-1**	**L1979265-2**	**L1979265-3**	**L1992296-2**	**L1992296-3**	**L1992296-4**	**L1992296-5**	**L1992296-6**
Silver (Ag)	mg/L	long-term : 0.00025	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	28.7	29.0	3.8	3.8	3.9	28.7	28.8	29.7	3.8	3.9
Strontium (Sr)	mg/L		0.00020	0.0382	0.0354	0.0168	0.0166	0.0169	0.0371	0.0380	0.0380	0.0165	0.0176
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)	mg/L		0.0000050	0.0000158	0.0000198	<0.0000050	<0.0000050	<0.0000050	0.0000174	0.0000217	0.0000226	0.0000079	<0.0000050
Tin (Sn)	mg/L		0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	0.00131	0.00201	<0.00020	0.00020	<0.00020	0.00202	0.00228	0.00243	<0.00020	0.00030
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000012	0.000015	0.000012	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000502	0.0000482	0.0000381	0.0000405	0.0000399	0.0000460	0.0000471	0.0000475	0.0000444	0.0000466
Vanadium (V)	mg/L		0.000050	0.000201	0.000242	<0.000050	<0.000050	<0.000050	0.000231	0.000233	0.000225	<0.000050	<0.000050
Yttrium (Y)	mg/L		0.0000050	0.0000276	0.0000274	0.0000084	0.0000081	0.0000076	0.0000274	0.0000283	0.0000293	0.0000087	0.0000094
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.000050	0.000061	0.000069	<0.000050	<0.000050	<0.000050	0.000051	0.000056	0.000057	<0.000050	<0.000050

Notes:

April sampling depths are depths below the water surface and are equal to approximately 0.25-1 m below ice.

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

[a] *Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, Accessed 2017.*

[b] *Interim guideline.*

[c] *Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.*

[d] *Cadmium guideline is hardness dependent (hardness as $CaCO_3$).For the short-term benchmark, when the water hardness is 0-5.3 mg/L, the CWQG is 0.00011 mg/L. At hardness ≥ 5.3 to ≤ 360 mg/L, the CWQG is calculated using this equation:*
*CWQG (mg/L) = 0.001*10{1.016(log[hardness]) – 1.71 }. At hardness > 360 mg/L, the CWQG is 0.0077 mg/L. For long term, when the water hardness is <17 mg/L, the CWQG is 0.00004 mg/L. At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated using this equation:*
CWQG (mg/L) = $0.001*10^{\{0.83(\log[hardness]) - 2.46\}}$. At hardness > 280 mg/L, the CWQG is 0.00037 mg/L.

[e] *Copper guideline is hardness dependent (hardness as $CaCO_3$). When the water hardness is <82 mg/L, the CWQG is 0.002 mg/L. At hardness ≥82 to ≤180 mg/L the CWQG is calculated using this equation:*
CWQG (mg/L) = $0.0002 * e^{\{0.8545[\ln(hardness)]-1.465\}}$. At hardness >180 mg/L, the CWQG is 0.004 mg/L. If the hardness is unknown, the CWQG is 0.002 mg/L.

[f] *Lead guideline is hardness dependent (hardness as $CaCO_3$). When the hardness is 0 to ≤ 60 mg/L, the CWQG is 0.001 mg/L. At hardness >60 to ≤ 180 mg/L the CWQG is calculated using this equation:*
CWQG (mg/L)= $0.001*e^{\{1.273[\ln(hardness)]-4.705\}}$. At hardness >180 mg/L, the CWQG is 0.007 mg/L. If the hardness is unknown, the CWQG is 0.001 mg/L.

[g] *Nickel guideline is hardness dependent (hardness as $CaCO_3$). When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 0.025 mg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated using this equation:*
CWQG (mg/L) = $0.001*e^{\{0.76[\ln(hardness)]+1.06\}}$. At hardness >180 mg/L, the CWQG is 0.150 mg/L. If the hardness is unknown, the CWQG is 0.025 mg/L.

Annex A.4-2. QA/QC Blank Data for Water Quality Sampling, Doris Project, 2017

Blank Type:		Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Travel Blank	Travel Blank	Field Blank	Equipment Blank	Field Blank	Travel Blank
Date Sampled:		**22-Apr-2017**	**27-Apr-2017**	**27-Apr-2017**	**7-Jul-2017**	**16-Jul-2017**	**17-Jul-2017**	**17-Jul-2017**	**16-Aug-2017**	**17-Aug-2017**	**19-Aug-2017**	**19-Aug-2017**	**12-Sep-2017**	**12-Sep-2017**	**12-Sep-2017**
ALS Sample ID:	**Units**	**L1920252-10**	**L1918949-5**	**L1918949-6**	**L1957154-4**	**L1960769-3**	**L1960769-4**	**L1960769-5**	**L1977620-3**	**L1977612-3**	**L1979286-5**	**L1979286-6**	**L1992296-1**	**L1992296-7**	**L1992296-8**
Physical Tests															
Conductivity	uS/cm	<2.0	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (as $CaCO_3$)	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
pH	pH	5.30	5.41	5.34	5.32	5.31	5.26	5.39	5.26	5.32	5.38	5.35	5.29	5.39	5.39
Total Suspended Solids	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turbidity	NTU	<0.10	<0.10	<0.10	**0.15**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Anions and Nutrients															
Alkalinity, Total (as $CaCO_3$)	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia, Total (as N)	mg/L	<0.0050	<0.0050	**0.0076**	<0.0050	<0.0050	<0.0050	**0.0220**	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.015
Bromide (Br)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chloride (Cl)	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (as N)	mg/L	**0.0103**	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)-Total	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Sulphate (SO_4)	mg/L	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Metals															
Aluminum (Al)-Total	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	**0.0036**	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Antimony (Sb)-Total	mg/L	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030
Arsenic (As)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00010	<0.00015	<0.00010
Barium (Ba)-Total	mg/L	<0.00010	<0.00010	<0.00010	**0.00011**	<0.00010	<0.00010	<0.00010	**0.00013**	<0.00010	<0.00010	<0.00010	**0.00044**	<0.00010	<0.00010
Beryllium (Be)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)-Total	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cesium (Cs)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)-Total	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Total	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Gallium (Ga)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)-Total	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040
Magnesium (Mg)-Total	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese (Mn)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Mercury (Hg)-Total	ug/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Nickel (Ni)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Phosphorus (P)-Total	mg/L	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)-Total	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)-Total	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Selenium (Se)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)-Total	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silver (Ag)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)-Total	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Strontium (Sr)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tellurium (Te)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010

Annex A.4-2. QA/QC Blank Data for Water Quality Sampling, Doris Project, 2017

Blank Type:		**Equipment Blank**	**Field Blank**	**Travel Blank**	**Equipment Blank**	**Equipment Blank**	**Field Blank**	**Travel Blank**	**Equipment Blank**	**Travel Blank**	**Travel Blank**	**Field Blank**	**Equipment Blank**	**Field Blank**	**Travel Blank**
Date Sampled:		**22-Apr-2017**	**27-Apr-2017**	**27-Apr-2017**	**7-Jul-2017**	**16-Jul-2017**	**17-Jul-2017**	**17-Jul-2017**	**16-Aug-2017**	**17-Aug-2017**	**19-Aug-2017**	**19-Aug-2017**	**12-Sep-2017**	**12-Sep-2017**	**12-Sep-2017**
ALS Sample ID:	**Units**	**L1920252-10**	**L1918949-5**	**L1918949-6**	**L1957154-4**	**L1960769-3**	**L1960769-4**	**L1960769-5**	**L1977620-3**	**L1977612-3**	**L1979286-5**	**L1979286-6**	**L1992296-1**	**L1992296-7**	**L1992296-8**
Thallium (Tl)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Tin (Sn)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	**0.00023**	<0.00020	<0.00020
Tungsten (W)-Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)-Total	mg/L	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Vanadium (V)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Yttrium (Y)-Total	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Zinc (Zn)-Total	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)-Total	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050

Notes:

Bold and highlighted values represent concentrations that are higher than analytical detection limits.

"-" *indicates paramerter not analyzed*

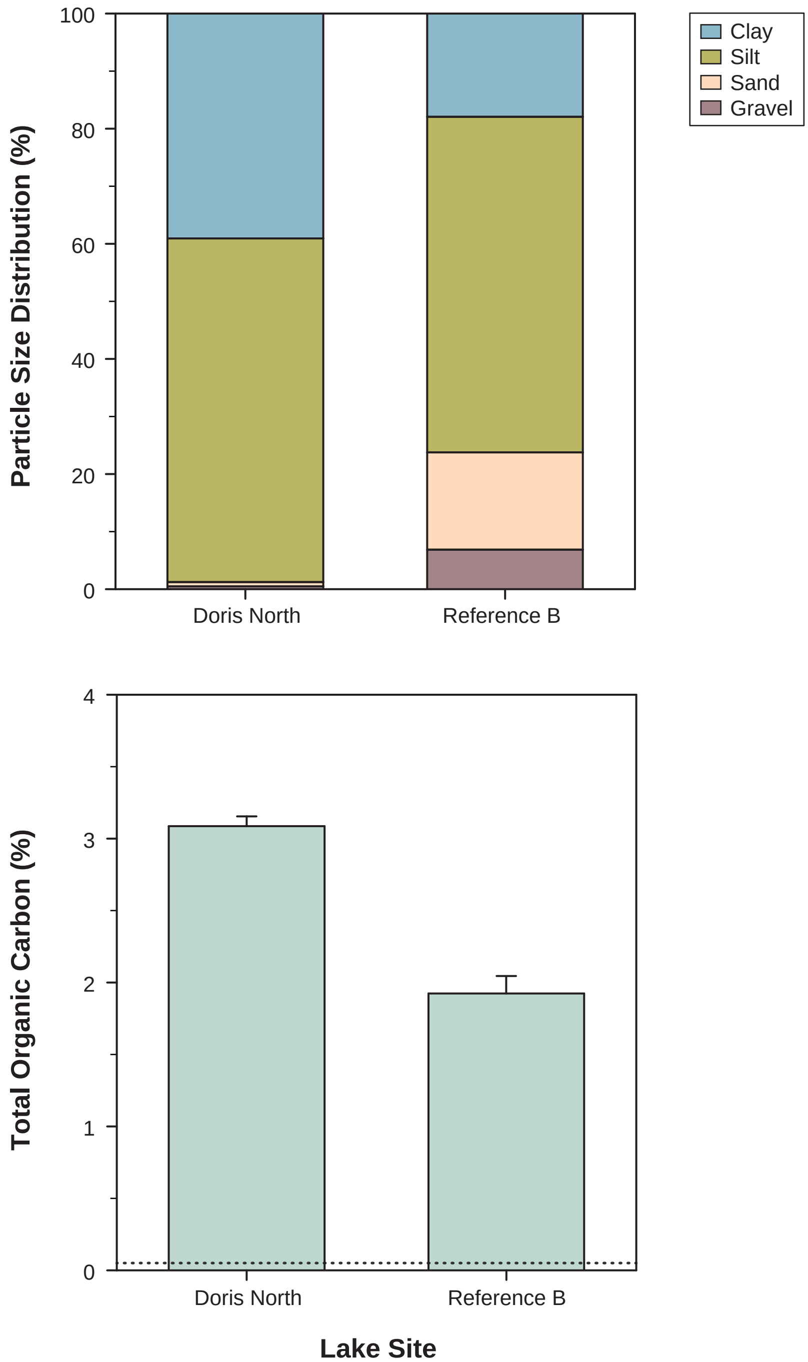
A.5 2017 SEDIMENT QUALITY

The following section presents the sediment quality data collected in August 2017 from the AEMP sites. Only the variables that were subjected to an evaluation of effects (see main body of report) are shown graphically. All sediment quality variables were screened against CCME sediment quality guidelines for the protection of aquatic life (CCME 2018a). CCME guidelines for sediments include interim sediment quality guidelines (ISQGs) and probable effects levels (PELs). The more conservative ISQGs are levels below which adverse biological effects are rarely observed. The higher PELs correspond to concentrations above which negative effects would be expected. CCME guidelines are included in all graphs and annexes.

Figures A.5-1 to A.5-3 show evaluated sediment quality variable concentrations in the AEMP lakes. Annex A.5-1 presents the full lake sediment quality dataset.

Figure A.5-1

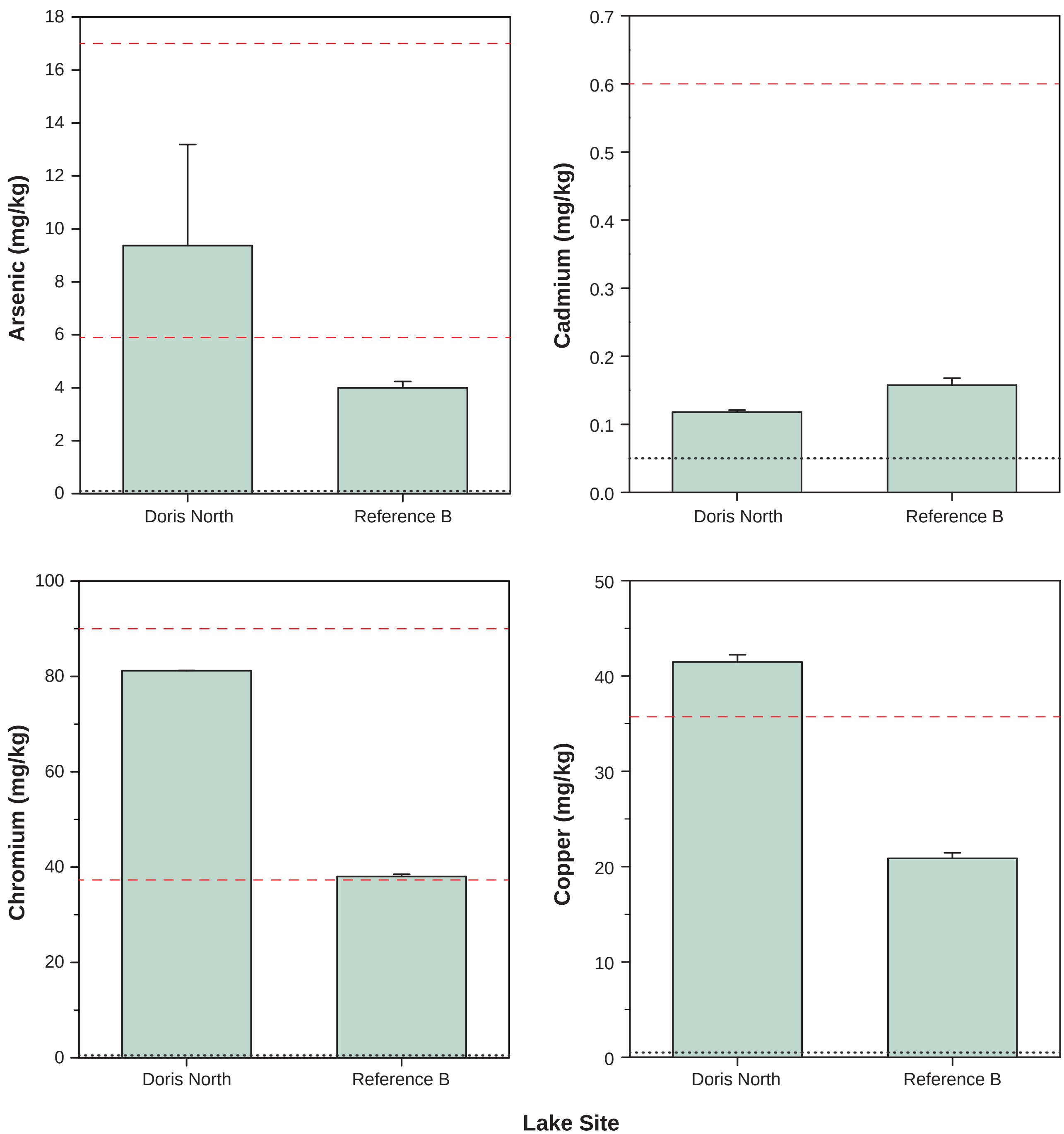
Particle Size Distribution and Total Organic Carbon Content in Lake Sediments, Doris Project, August 2017



Notes: Error bars represent the standard error of the mean of replicates.
Stacked bars represent the mean of replicate samples.
Dotted line represents the analytical detection limit.

Figure A.5-2

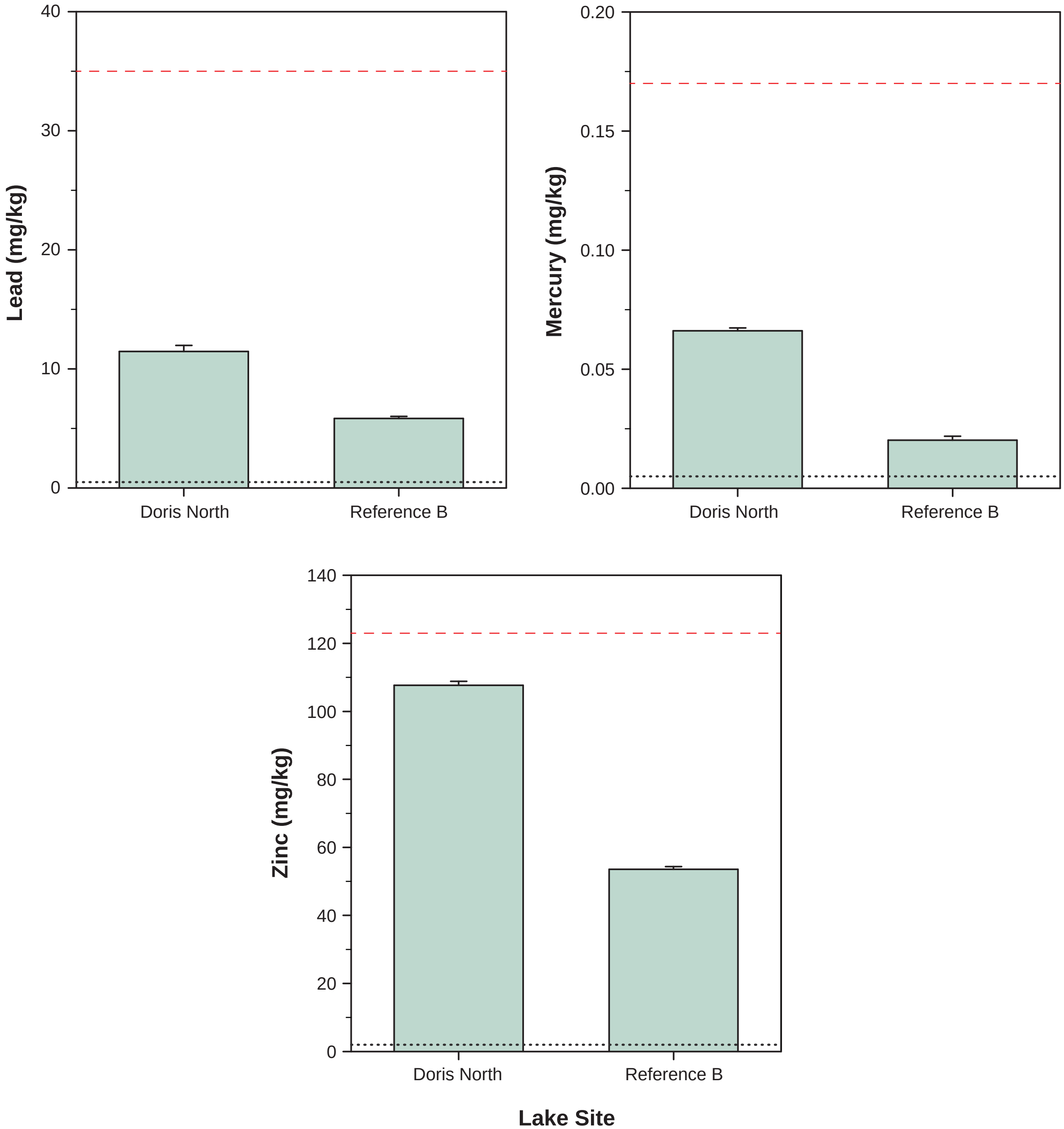
Arsenic, Cadmium, Chromium, and Copper Concentrations in Lake Sediments, Doris Project, August 2017



Notes: Error bars represent the standard error of the mean of replicates.
Dotted lines represent the analytical detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for arsenic (5.9 mg/kg), cadmium (0.6 mg/kg), chromium (37.3 mg/kg), and copper (35.7 mg/kg) and the probable effects levels (PELs) for arsenic (17 mg/kg) and chromium (90 mg/kg); the PELs for cadmium (3.5 mg/kg) and copper (197 mg/kg) are not shown.

Figure A.5-3

Lead, Mercury, and Zinc Concentrations in Lake Sediments, Doris Project, August 2017



Notes: Error bars represent the standard error of the mean of replicates.
Dotted lines represent the analytical detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for lead (35 mg/kg), mercury (0.170 mg/kg), and zinc (123 mg/kg); probable effects levels (PELs) for lead (91.3 mg/kg), mercury (0.486 mg/kg), and zinc (315 mg/kg) are not shown.

Annex A.5-1. Lake Sediment Quality Data, Doris Project, 2017

Site ID:		CCME Guidelines for the Protection of Aquatic Life[a]			Doris North			Reference B		
Date Sampled:					17-Aug-2017	17-Aug-2017	17-Aug-2017	21-Aug-2017	21-Aug-2017	21-Aug-2017
Replicate:				Realized Detection Limit	1	2	3	1	2	3
Depth Sampled (m):					13.5	13.8	13.6	10.4	10.4	10.3
ALS Sample ID:	Unit	ISQG[b]	PEL[c]		L1979954-1	L1979954-2	L1979954-3	L1979954-4	L1979954-5	L1979954-6
Physical Tests										
Moisture	%			0.25	75.7	75.1	77.8	80.9	76.7	67.4
pH (1:2 soil:water)	pH			0.10	5.93	5.91	6.06	6.16	5.83	6.17
Particle Size										
% Gravel (>2mm)	%			1.0	<1.0	<1.0	<1.0	4.4	5.7	10.5
% Sand (2.0mm - 0.063mm)	%			1.0	1.2	<1.0	<1.0	17.9	15.5	17.4
% Silt (0.063mm - 4um)	%			1.0	62.6	59.1	57.5	59.3	60.7	54.9
% Clay (<4um)	%			1.0	36.2	40.1	41.7	18.5	18.1	17.3
Texture	-			-	Silty clay loam	Silty clay loam	Silty clay loam	Silt loam	Silt loam	Silt loam
Anions and Nutrients										
Total Nitrogen by LECO	%			0.020	0.426	0.413	0.427	0.229	0.227	0.189
Organic / Inorganic Carbon										
Total Organic Carbon	%			0.050 - 0.075	3.19	2.96	3.11	2.04	2.05	1.68
Plant Available Nutrients										
Available Ammonium-N	mg/kg			1.0 - 5.0	23.8	19.8	18.2	5.1	7.0	5.2
Nitrate+Nitrite-N	mg/kg			2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nitrate-N	mg/kg			2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nitrite-N	mg/kg			0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Available Phosphate-P	mg/kg			2.0	<2.0	<2.0	<2.0	3.3	<2.0	2.6
Metals										
Aluminum (Al)	mg/kg			50	28700	28700	28600	14500	14000	13500
Antimony (Sb)	mg/kg			0.10	0.11	<0.10	<0.10	0.15	0.16	0.14
Arsenic (As)	mg/kg	5.9	17	0.10	17.0	5.32	5.78	3.55	4.08	4.37
Barium (Ba)	mg/kg			0.50	163	149	151	69.7	67.1	65.9
Beryllium (Be)	mg/kg			0.10	0.99	0.94	0.94	0.50	0.49	0.48
Bismuth (Bi)	mg/kg			0.20	0.28	0.25	0.25	<0.20	<0.20	<0.20
Boron (B)	mg/kg			5.0	20.0	19.9	20.8	11.4	10.9	10.5
Cadmium (Cd)	mg/kg	0.6	3.5	0.050	0.123	0.118	0.113	0.160	0.174	0.139
Calcium (Ca)	mg/kg			50	6450	6290	6360	3580	3460	3340
Chromium (Cr)	mg/kg	37.3	90	0.50	81.1	81.1	81.4	38.8	38.0	37.3
Cobalt (Co)	mg/kg			0.10	17.1	15.7	15.4	11.0	11.2	12.1
Copper (Cu)	mg/kg	35.7	197	0.50	43.0	40.8	40.6	21.9	20.8	19.9
Iron (Fe)	mg/kg			50	63200	42700	44100	33700	34100	35500
Lead (Pb)	mg/kg	35	91.3	0.50	12.5	11.0	10.9	6.14	5.84	5.56
Lithium (Li)	mg/kg			2.0	47.6	48.5	48.5	23.3	22.4	21.9
Magnesium (Mg)	mg/kg			20	16500	16800	16900	7430	7140	6970
Manganese (Mn)	mg/kg			1.0	1010	586	654	340	224	307
Mercury (Hg)	mg/kg	0.17	0.486	0.0050	0.0662	0.0641	0.0682	0.0236	0.0189	0.0182
Molybdenum (Mo)	mg/kg			0.10	1.50	1.19	0.95	1.62	2.18	1.99
Nickel (Ni)	mg/kg			0.50	50.4	48.1	48.3	19.5	19.8	20.1
Phosphorus (P)	mg/kg			50	1610	1000	1040	686	700	735
Potassium (K)	mg/kg			100	6590	6810	6870	2980	2960	2950
Selenium (Se)	mg/kg			0.20	0.38	0.32	0.30	0.36	0.31	0.36
Silver (Ag)	mg/kg			0.10	0.27	0.22	0.26	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg			50	1580	1520	1570	396	388	385
Strontium (Sr)	mg/kg			0.50	44.1	41.6	42.4	25.5	24.6	24.2
Sulfur (S)-Total	mg/kg			500	1600	1400	1300	1300	1300	1200
Thallium (Tl)	mg/kg			0.050	0.312	0.315	0.314	0.168	0.180	0.182
Tin (Sn)	mg/kg			2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	mg/kg			1.0	1680	1690	1700	913	903	870
Uranium (U)	mg/kg			0.050	2.65	2.26	2.28	2.32	2.17	2.09
Vanadium (V)	mg/kg			0.20	92.4	84.4	83.2	43.0	44.0	42.3
Zinc (Zn)	mg/kg	123	315	2.0	110	107	106	54.6	54.0	52.1

Notes:

Shaded cells indicate values that exceed CCME guidelines (light grey ISQG, dark grey PEL).

[a] *Canadian sediment quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, Accessed 2017.*

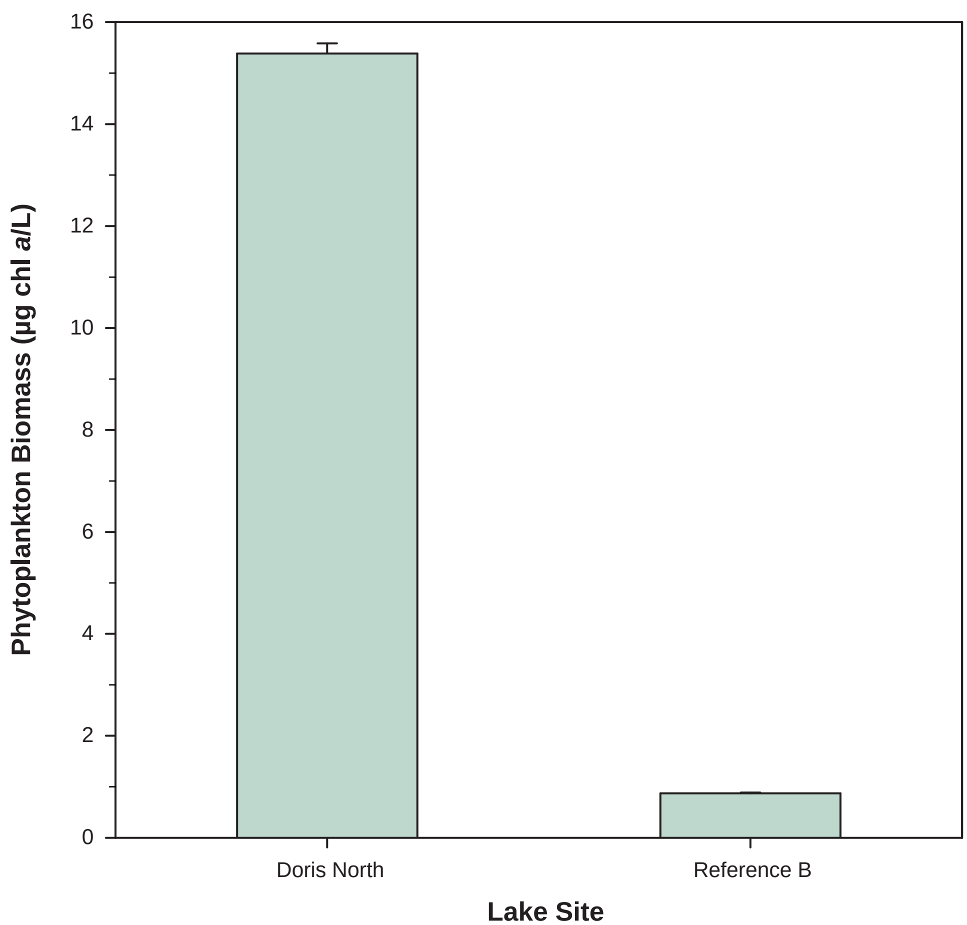
[b] *ISQG = Interim Sediment Quality Guideline*

[c] *PEL = Probable Effects Level*

A.6 2017 PRIMARY PRODUCERS

The following sections present the phytoplankton biomass (chlorophyll *a*) data collected in August 2017 at the AEMP lake sites. Figure A.6-1 shows the average phytoplankton biomass measured in Doris Lake and Reference Lake B. Annex A.6-1 presents the full phytoplankton biomass dataset.

Lake Phytoplankton Biomass (as Chlorophyll *a*), Doris Project, August 2017



Notes: Error bars represent the standard error of the mean of replicates.
The analytical detection limit for chlorophyll a was 0.01 or 0.02 µg; all chlorophyll a concentrations were higher than detection limits.

Annex A.6-1. Lake Phytoplankton Biomass Data, Doris Project, 2017

Lake Site	Replicate #	Date Sampled	Depth Sampled (m)	ALS Sample ID	Phytoplankton Biomass (μg chl *a*/L)	Mean	SE
Doris North	1	17-Aug-2017	1	L1979275-1	15.03	15.38	0.201
Doris North	2	17-Aug-2017	1	L1979275-2	15.40		
Doris North	3	17-Aug-2017	1	L1979275-3	15.73		
Reference B	1	21-Aug-2017	1	L1979275-4	0.897	0.87	0.015
Reference B	2	21-Aug-2017	1	L1979275-5	0.844		
Reference B	3	21-Aug-2017	1	L1979275-6	0.877		

Notes:
SE = standard error of the mean

A.7 2017 BENTHIC INVERTEBRATES

The following sections present the benthic invertebrate taxonomy data collected in August 2017 from the AEMP sites. Benthos data were used to calculate several community descriptors including: total density, taxa richness, diversity, and the Bray-Curtis Index. Details of these calculations are provided in Section A.1-8.

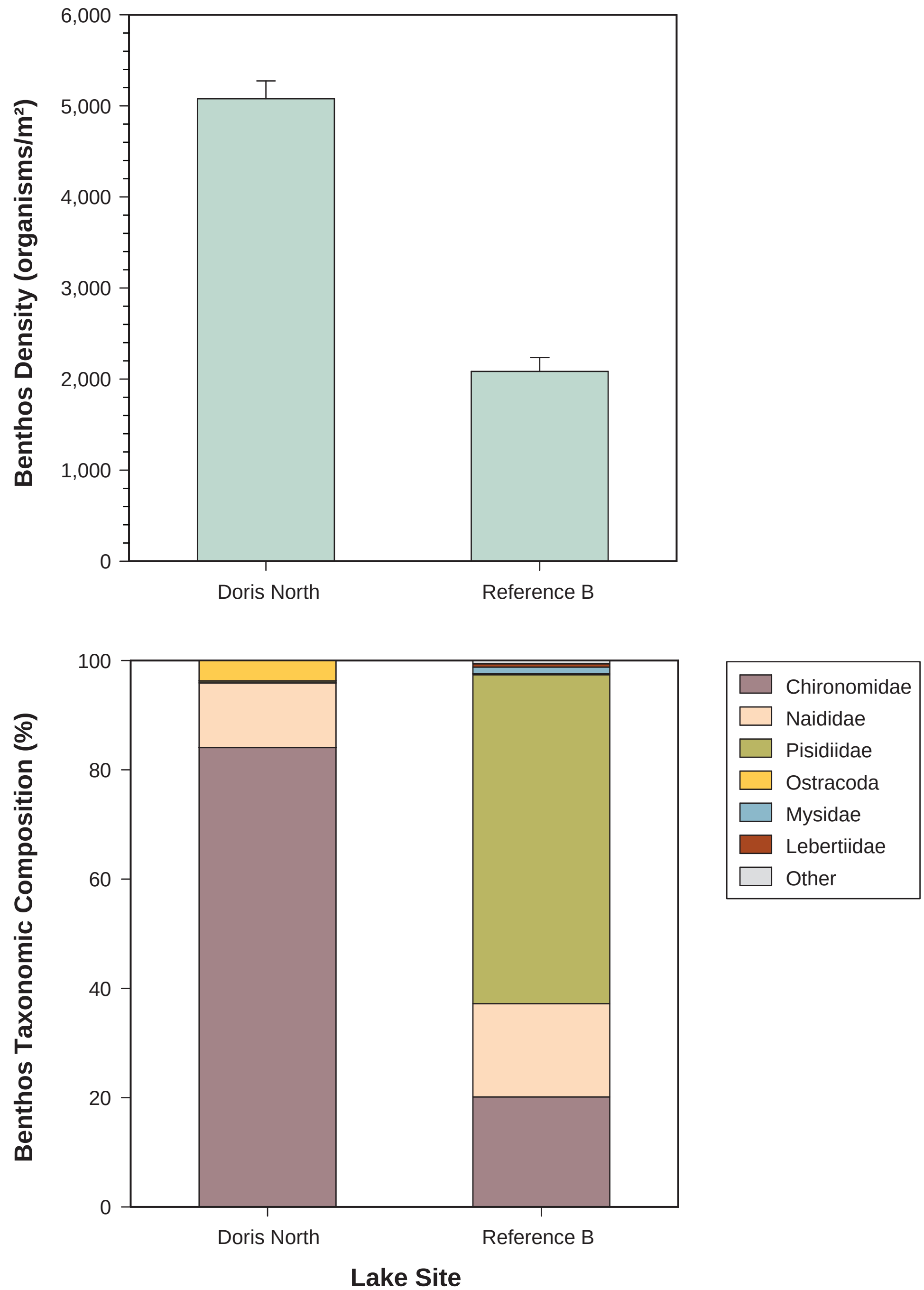
Figure A.7-1 presents the average density and taxonomic composition of the lake benthos communities. Figure A.7-2 presents the average family richness, Simpson's Diversity Index, and Bray-Curtis Index. Annex A.7-1 provides the full lake benthos taxonomy dataset, and Annex A.7-2 presents the summary statistics calculated for the community descriptors.

A.7.1 Quality Assurance/Quality Control (QA/QC) Data

A re-sorting of randomly selected sample residues was conducted by taxonomists on 10% of the benthos samples (i.e., 1 of 10 samples) to determine the level of sorting efficiency. The 95% minimum sorting efficiency was attained. Results of this QA/QC procedure are provided in Annex A.7-3.

Figure A.7-1

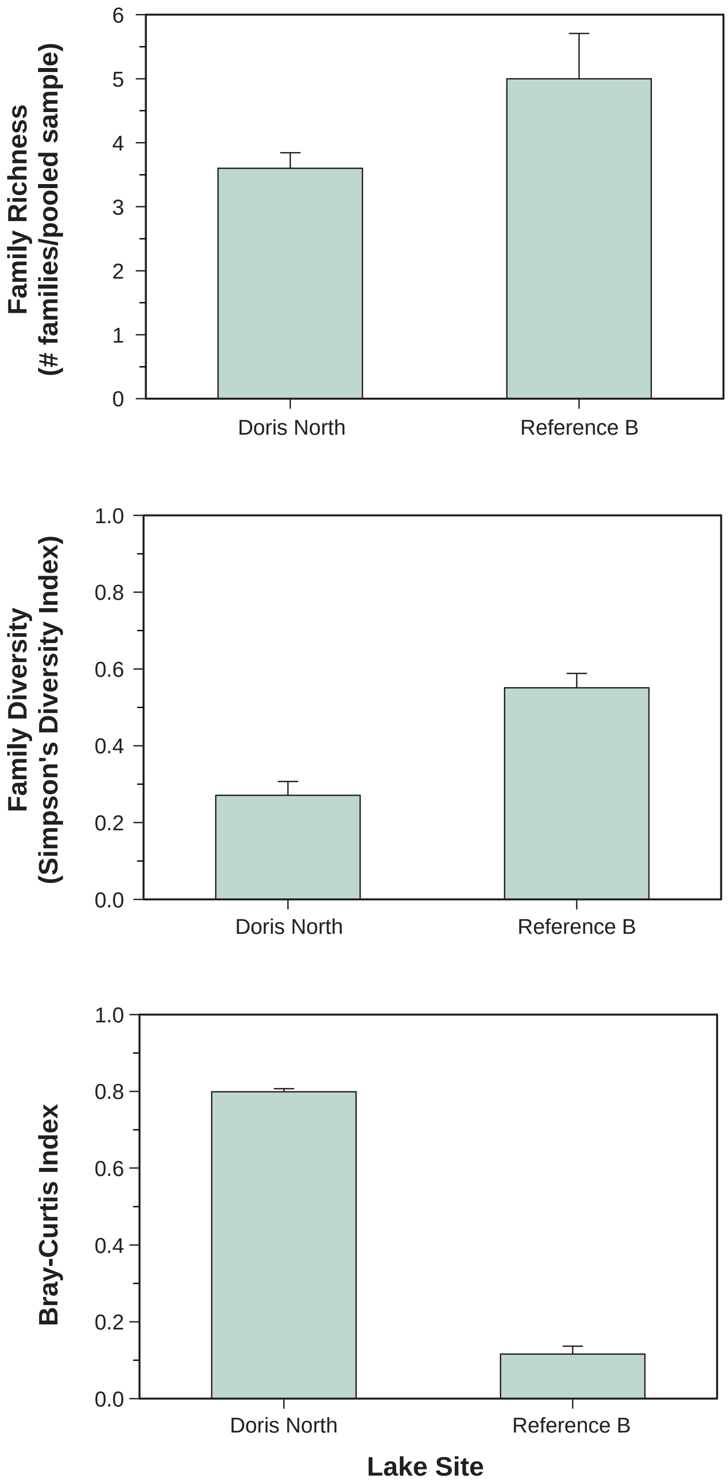
Lake Benthos Density and Taxonomic Composition, Doris Project, August 2017



Notes: Error bars represent the standard error of the mean of replicates.
Stacked bars represent the mean of replicate samples.

Figure A.7-2

Lake Benthos Richness, Diversity, and Bray-Curtis Index, Doris Project, August 2017



Note: Error bars represent the standard error of the mean of replicates.

Annex A.7-1. Lake Benthos Taxonomy Data, Doris Project, 2017

					Doris Lake North					Reference Lake B				
				Sampling Date:	17-Aug-17					21-Aug-17				
				Sampling Depth:	13.5	13.8	13.6	13.8	13.6	10.4	10.4	10.3	-	10.4
Major Group	**Family**	**Subfamily**	**Tribe**	**Genus**	**Rep-1**	**Rep-2**	**Rep-3**	**Rep-4**	**Rep-5**	**Rep-1**	**Rep-2**	**Rep-3**	**Rep-4**	**Rep-5**
Microturbellaria	-	-	-	-								1		
Nematoda*	-	-	-	-						44	37	76	59	40
Oligochaeta - cocoon*	-	-	-		20	12	5	3	3					
Oligochaeta	Lumbriculidae	-	-	-										2
	Naididae	Tubificinae	-	-	56	57	19	63	12	48	21	16	21	15
Pelecypoda	Pisidiidae	-	-	(i/d)			2			31	34	23	35	58
		-	-	*Sphaerium*						2	2		5	
		-	-	*Pisidium*			1	2	1	41	40	41	54	58
Hydracarina	-	-	-	(i/d)*								1	1	1
	Lebertiidae	-	-	*Lebertia*						2		2		
Copepoda - Calanoida*	-	-	-	-	2	2		1	3	1				
Ostracoda	-	-	-	-	3	8	12	23	19	1				1
Cladocera*	Bosminidae	-	-	*Bosmina*						1				
	Daphnidae	-	-	*Daphnia*							1			
Malacostraca	Mysidae	-	-	*Mysis relicta*						5	2	1		
Trichoptera	Limnephilidae	-	-	(i/d)								1		
Diptera	Chironomidae	-	-	(pupa)	1			2	1					
		Tanypodinae	Procladiini	*Procladius*	1			1		3	1		5	3
		Diamesinae	Protanypini	*Protanypus*						8	4	3		2
		Prodiamesinae		*Monodiamesa*										2
		Orthocladiinae	Orthocladiini	*Abyskomyia*						1		1		2
				Heterotrissocladius										1
				Paracladius						1				
				Zalutschia						6	5	10	23	16
		Chironominae	Chironomini	*Chironomus*	273	276	280	302	299					
			Tanytarsini	*Corynocera*							2	1	1	
				Micropsectra						8	4	14	6	
				Paratanytarsus								1	1	
				Tanytarsus								2	4	
				Total	***356***	***355***	***319***	***397***	***338***	***203***	***153***	***194***	***215***	***201***

Notes:

i/d = immature or damaged

** Taxa marked with an asterisk were excluded from total counts and from all benthos analyses:*

Calanoid and cyclopoid copepods and cladocerans were excluded because they are generally planktonic.

Nematodes were excluded because they are meiofauna and are not adequately sampled using a 500 um sieve bucket.

Immature (e.g., oligochaete cocoons) or damaged organisms that were not identiable to the family level were excluded from analyses.

Individuals within the major groups Ostracoda were not identifiable to family, so they are included at the next lowest taxonomic category (class).

The total number of individuals was divided by 3 times the surface are of the Ekman sampler (i.e., 3 x 0.0225 m^2) to determine the benthos density in units of organisms/m^2 (because each replicate consisted of 3 pooled Ekman grabs).

Annex A.7-2. Lake Benthos Summary Statistics, Doris Project, 2017

	Doris Lake North					
	Min	Max	Median	Mean	SD	SE
Density (#/m²)	4,652	5,822	4,948	5,079	441	197
Family Richness	3	4	4	3.6	0.5	0.2
Simpson's Diversity Index	0.18	0.37	0.29	0.27	0.08	0.04
Bray-Curtis Index	0.78	0.82	0.79	0.80	0.02	0.01

	Reference Lake B					
	Min	Max	Median	Mean	SD	SE
Density (#/m²)	1,704	2,370	2,296	2,086	337	151
Family Richness	3	7	5	5.0	1.6	0.7
Simpson's Diversity Index	0.44	0.65	0.55	0.55	0.08	0.04
Bray-Curtis Index	0.050	0.18	0.11	0.12	0.05	0.02

Notes:
SD – Standard deviation of the mean
SE – Standard error of the means

Annex A.7-3. Results of Benthos QA/QC Sorting Efficiencies, Doris Project, 2017

Sample ID	# from First Sort	1st QAQC Re-sort # Found	Initial Sort Efficiency (%)	Re-sort Required?	2nd QAQC Re-sort # Found	Final Efficiency (%)
Doris Lake North, rep 1	356	5	98.6	No	-	98.6

Notes:
If the efficiency is 95% or better nothing further is done and the QA/QC invertebrates are not added to the data.
If the efficiency is less than 95%, the QA/QC invertebrates are added to the sample, it is re-sorted, and a second 20% QA/QC is performed.
*% Sorting Efficiency = [1- {# in QA/QC re-sort/(# sorted originally + # in QA/QC re-sort)}]*100*

REFERENCES

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Appendix B

2017 Evaluation of Effects Supporting Information

APPENDIX B. 2017 EVALUATION OF EFFECTS SUPPORTING INFORMATION

TABLE OF CONTENTS

LIST OF TABLES

B.1 HISTORICAL DATA SELECTION RATIONALE FOR EVALUATION OF EFFECTS

The tables presented in this section present a summary of the water quality, sediment quality, primary producer biomass data, and benthic invertebrate data collected at the AEMP lake sites, as well as the rationale for the inclusion or exclusion of certain baseline data from the 2017 evaluation of effects.

B.1.1 Water Quality

Table B.1-1 presents a summary of the historical water quality data collected at AEMP lake sites, and the rationale for the inclusion or exclusion of certain historical data from the 2017 evaluation of effects. The selection of historical data to include in the water quality evaluation of effects was mainly based on similarity of historical sampling locations to 2017 sampling locations, methodology, and sampling depth.

B.1.2 Sediment Quality

Table B.1-2 presents a summary of the historical sediment quality data collected at AEMP lake sites, and the rationale for the inclusion or exclusion of certain historical data from the 2017 evaluation of effects. The selection of historical data to include in the sediment quality evaluation of effects was mainly based on the comparability of the depth strata sampled between historical and 2017 samples, the proximity of historical sampling sites to the 2017 sites, and the similarity of sampling techniques.

B.1.3 Phytoplankton

Table B.1-3 presents a summary of the historical phytoplankton biomass (as chlorophyll *a*) data collected at AEMP lake sites, and the rationale for the inclusion or exclusion of certain historical data from the 2017 evaluation of effects. The main criteria for the selection of historical phytoplankton and biomass data for inclusion in the evaluation of effect were the proximity of historical sampling sites to 2017 AEMP sampling sites, and the comparability of sampling methodologies.

B.1.4 Benthic Invertebrates

Table B.1-4 presents a summary of the historical benthic invertebrate data collected at AEMP lake sites, and the rationale for the inclusion or exclusion of certain historical data from the 2017 evaluation of effects. The selection of historical data to include in the benthos evaluation of effects was mainly based on the comparability of the depth strata sampled between historical and 2017 samples, the proximity of historical sampling sites to the 2017 sites, and the similarity of sampling techniques (e.g., single grab samples vs. composite samples).

Table B.1-1. Historical Data Selection Rationale for Water Quality Evaluation of Effects, Doris Project, 2017

Sampling Sites	Years Sampled	Months Sampled	Data Included in Graphs and Statistical Analyses	Data Excluded from Graphs and Statistical Analyses	Rationale for Exclusion
Doris Lake	1995	May, June, July, August	None	All	High analytical detection limits for many parameters (e.g., As, Cd, Cr, Co, Pb, ammonia) compared to modern analytical methods. Some samples were shoreline grabs, which are not comparable to samples collected from a boat over deep areas of the lake.
	1996	April, August	None	All	Samples were collected from a sampling location further south than current AEMP site.
	1997	April, July, August	None	All	Samples were collected from a sampling location further south than current AEMP site.
	1998	April			
	2000	July, August	None	All	Samples were collected from a sampling location further south than current AEMP site.
	2003	July, August, September	All	None	
	2004	June, July, August, September	All	None	
	2005	July, August, September	All	None	
	2006 to 2008	May, July, August, September	All	None	
	2009	April, August	All	None	
	2010 to 2016	April, July, August, September	All	None	
Reference Lake B	2009	May, August	All	None	
	2010 to 2016	April, July, August, September	All	None	

Table B.1-2. Historical Data Selection Rationale for Sediment Quality Evaluation of Effects, Doris Project, 2017

Sampling Sites	Years Sampled	Month Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Doris Lake	1996	August	None	All	Samples were collected from a sampling location further south than current AEMP site. Samples were divided into depth horizons (0 to 1 cm and 2 to 3 cm)
	1997	July	None	All	Samples were collected from a sampling location further south than current AEMP site.
	2009	August	Included deep site.	Excluded shallow site.	Shallow site not comparable with deep 2010 to 2017 sampling site.
	2010 to 2016	August	All	None	
Reference Lake B	2009	August	None	All	Shallow/mid depth sites and located at opposite end of lake relative to deep 2010 to 2017 sampling site.
	2010	August	Included deep site.	Excluded shallow site.	Shallow site not comparable with deep 2010 to 2017 sampling site.
	2011 to 2016	August	All	None	

Table B.1-3. Historical Data Selection Rationale for Phytoplankton Biomass (as Chlorophyll *a*) Evaluation of Effects, Doris Project, 2017

Sampling Sites	Years Sampled	Months Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Doris Lake	1997	July	None	All	Samples were collected from a sampling location further south than current AEMP site.
	2000	July	None	All	Samples were collected from a sampling location further south than current AEMP site.
	2003	July, August, September	None	All	Each sample consisted of a composite of 5 subsamples collected throughout the euphotic zone (not comparable to discrete surface samples collected in 2017).
	2006	September	None	All	Phytoplankton biomass sampling method not described in report.
	2007 and 2008	July, August, September	None	All	Phytoplankton biomass samples were collected using an integrated tube sampler deployed throughout the euphotic zone (not comparable to discrete surface samples collected in 2017).
	2009	April, August	August data	April data	Only open-water season chlorophyll *a* data are collected according to the 2016 Doris Aquatic Effects Monitoring Plan, so only historical data collected in open-water season are included in the evaluation of effects.
	2010 to 2016	April, July, August, September	July, August, September data	April data	Only open-water season chlorophyll *a* data are collected according to the 2016 Doris Aquatic Effects Monitoring Plan, so only historical data collected in open-water season are included in the evaluation of effects.
Reference Lake B	2009	August	All	None	
	2010 to 2016	April, July, August, September	July, August, September data	April data	Only open-water season chlorophyll a data are collected according to the 2016 Doris Aquatic Effects Monitoring Plan, so only historical data collected in open-water season are included in the evaluation of effects.

Table B.1-4. Historical Data Selection Rationale for Benthic Invertebrate Evaluation of Effects, Doris Project, 2017

Sampling Sites	Years Sampled	Months Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Doris Lake	1996	August	None	All	Samples were collected from a sampling location further south than current AEMP site. Samples consisted of single grabs rather than composite samples.
	1997	July, August	None	All	Samples were collected from a sampling location further south than current AEMP site or from a shallow site not comparable to deep AEMP site. Samples consisted of single grabs rather than composite samples.
	2000	July	None	All	Samples were collected from location roughly in the middle of Doris Lake rather than at the northern end. Samples consisted of single grabs rather than composite samples.
	2009	August	None	All	Samples consisted of single grabs rather than composite samples.
	2010 to 2016	August	All	None	
Reference Lake B	2009	August	None	All	Samples were collected from mid-depth and shallow-depth sites (not comparable to deep site) and from a different location in the lake compared to the current location. Samples consisted of single grabs rather than composite samples.
	2010 to 2016	August	All	None	

B.2 STATISTICAL METHODOLOGY FOR WATER AND SEDIMENT QUALITY, PHYTOPLANKTON, AND BENTHOS EVALUATION OF EFFECTS

B.2.1 General Statistical Methodology

Previous years' analyses employed a before-after control-impact (BACI) design to assess the change in mean variable values between two periods defined as "before" and "after". The before period included data prior to 2010 (before initiation of construction) and the after period included data from the current assessment year. Any data between 2010 and the previous assessment year (inclusive) were removed from the analysis. The BACI approach is appropriate when limited data is available to assess long term time trends. However, the amount of information lost increases as more data gets collected since only data in the current assessment are included in the after period of the analysis. In the 2017 assessment year, 8 to 14 years of data have been collected and provides adequate information to estimate long term time trends. The advantage of trend analysis over BACI approach is that all the collected data would be utilized to estimate the effects of interest and inter-annual patterns over time can be better captured.

Regression models were used to assess data from Doris Lake North and examine any time trends over the monitoring period (2003 to 2017). Hypothesis tests were conducted to assess time trends for particular water, sediment, or biology variables in Doris Lake North. If there was a significant change over time, the time trend in Doris Lake North was compared to Reference Lake B. All the observed and fitted data were presented graphically to support the interpretation of results. Sections B.2.2 to B.2.5 describe modifications to the general methodology for specific variables.

B.2.1.1 Non-detects

Observations below the analytical detection limit were substituted by half the detection limit. If all data in the current assessment year (2017) were below the detection limit, no regression analysis was performed for that variable. If a large amount of data (> 60%) from a lake were below the detection limit, the lake was removed from the analyses and inference was based on plots of the observed data. In cases where the reference lake was removed, it was not possible to make comparisons with the monitored lake and inference was based on plots of the observed data.

Linear mixed effects (LME) regression or Tobit regression analysis was used to test whether or not there was evidence of time trend at each monitored lake. Tobit regression was used when a moderate amount of data (between 10 and 60%), from a given lake, were below the detection limit.

B.2.1.2 Linear Mixed Effects (LME) Regression

Model Form

Let y denote a water, sediment, or biological variable of interest, and $y_i(x)$ be an observation from lake i in year x. The model fitted to the data have the basic regression model form:

$$y = \text{Lake} + s(\text{Year}) + \text{Lake}*s(\text{Year}),$$

where the mean level of a variable is modelled with separate intercepts and time effects, s(Year), in each lake. Separate intercepts allowed for differences in the initial values of the variable between lakes. Time effects were modelled using natural cubic regression splines to allow for non-linearity. Cubic regression splines are piecewise cubic polynomials joined together at points, called knots, often chosen at quantile points, and continuous up to the second derivative at each knot. Natural cubic splines have the additional constraint that the spline is linear beyond the boundaries of the data. The advantage of using regression splines over linear and quadratic effects is improved flexibility in capturing fluctuations in the data where a quadratic relationship appears inadequate. Regression splines are an extension of linear and quadratic effects where instead of representing an effect x with x and x^2, functions of x, called basis functions, are used.

Mathematically, the regression model can be written as:

$$E[y_i(x)] = \beta_{0i} + \sum_{n=1}^{K} \beta_{ki} h_k(x),$$

where:

- $E[y_i(x)]$ represents the expected mean value of the variable in lake i in year x,
- β_{0i} represents the intercept for lake i,
- β_{ki} represents the basis coefficients for lake i, and
- $\{h_k\}$ are known functions called basis functions.

The regression model is linear in the new variables, $h_k(x)$, and usual LME or Tobit approaches for model fitting and inference may be used. The splines are represented as linear combinations of basis functions evaluated at x and the number of basis functions is dependent on the number of knots (K) chosen. As only 8 to 14 years of data are available, the number of knots chosen was 4 and 5 for variables with less than 10 years of data and more than 10 years of data, respectively. Plots of the fitted curves were used to assess the adequacy of the number of knots and to avoid over- or under-fitting the data.

Pseudoreplication

All observations from the same lake in the same year (as well as the same depth and same season, if applicable) were averaged to obtain single observation. Since comparisons were made across years and across lakes, averaging the data within one lake (as well as season and depth, if applicable) had little effect on the tests of interest.

Random Variation

Random sources of variation can affect variable measurements. Potential sources of variability include environmental factors affecting all lakes equally in a given year, sampling variation that affects samples taken from a lake in a single year, and true measurement errors from laboratory analysis. The main sources of variation can be broken down into two components: yearly effects that affect the measurements in all lakes and effects that affect each lake individually. Random effects are included in the LME model to account for these sources of variation. The final model of the average variable value observed in lake i in year x becomes:

*y = Lake + s(Year) + Lake*s(Year) + Year-R + Error-R,*

or mathematically:

$$y_i(x) = \beta_{0i} + \sum_{k=1}^{K} \beta_{ki} h_k(x) + \varepsilon_x + \varepsilon_{ix} ,$$

where ε_x and ε_{ix} represent random variables that affect all lakes identically in year x, and those that only affects lake i, respectively. These random variables are assumed to follow normal distributions with zero mean and variance σ_x^2 and σ_{ix}^2, respectively.

Assessing Model Fit and Outliers

The goodness-of-fit of the regression models was examined through plots of the residuals. Let $\widehat{y_i}(x)$ denote the fitted value for lake *i* in year x, defined as:

$$\widehat{y_i}(x) = \hat{\beta}_{0i} + \sum_{k=1}^{K} \hat{\beta}_{ki} h_k(x) + \varepsilon_x + \varepsilon_{ix} ,$$

The residual for each observation, denoted e_{ix}, is the difference between the fitted and observed values:

$$e_{ix} = y_i(x) - \widehat{y_i}(x).$$

The residuals estimate the true error or unexplained variation for lake *i* in year *x*. The key assumption is that the true errors are normally distributed with equal variance. That is, the residuals are normally distributed and their variance does not depend on either lake or year. Normal quantile-quantile (Q-Q) plots were used to assess the distribution of residuals for each fitted model. Plots of the residuals by year and against the fitted values were used to assess homogeneity of variance over time and across values of the variable. A common deviation from this assumption is that variance increases as the value of the variable increases since values tend to vary more at larger scales. A natural logarithm transformation was often required to stabilize variance and meet the assumption of approximately normally distributed residuals. Standardized residuals greater than three were identified as outliers and flagged to caution interpretation of results, but not removed from the analysis.

B.2.1.3 Tobit Regression

Model Form

All water quality variables have detection limits below which the laboratory analyses cannot make an accurate measurement. Thus, for some water quality variables the observed value was below the detection limit and only an upper bound could be determined. Often values under detection limit are replaced with half the upper bound and statistical analyses are performed as if the value is actually observed. Results from this type of analysis can be misleading, particularly when the detection limits are not consistent from year to year. For example, if all observations for a given variable in one lake have been below the detection limit in every year but the detection limit for that variable has consistently decreased (perhaps due to improving technology), then the imputed observations will appear to decrease over time. In reality, there is no information to conclude if the value is increasing, decreasing or remaining constant. Further, replacing these values with half of the detection limit ignores any uncertainty in these observations and the analysis will tend to underestimate the standard deviation (SD) of the variables.

A better approach is to use Tobit regression, which properly accounts for the censoring below the detection limit. In a maximum likelihood analysis of a standard regression model (as above) the likelihood contribution of a single observation y given the covariates $x_1, \ldots, x_p$ and a single error term $\varepsilon \sim N(0, \sigma^2)$ is:

$$L(y) = \left(2\pi\sigma^2\right)^{-1/2} \exp\left(\frac{-1}{2\sigma^2}\left(y - \sum_{i=1}^{p} \beta_i x_i\right)^2\right),$$

which is simply a normal probability density function of an observation, y, with mean $\sum \beta_i x_i$ and variance σ^2 . Now consider the case where y is censored and is only known to lie in the interval (a,b). Tobit regression replaces the likelihood contribution with the integrated density:

(8) $$L(y) = \int_a^b \exp\left(\frac{-1}{2\sigma^2}\left(y - \sum_{i=1}^{p} \beta_i x_i\right)^2\right) dy = \Phi\left(\frac{b - \sum_{i=1}^{p} \beta_i x_i}{\sigma}\right) - \Phi\left(\frac{a - \sum_{i=1}^{p} \beta_i x_i}{\sigma}\right),$$

where $\Phi(x)$ is the standard normal cumulative distribution function. The likelihood can then be formed by multiplying the appropriate censored or uncensored contributions for each observation and maximum likelihood inference can be conducted to compute variable estimates and their standard errors, and perform hypothesis tests (Tobin 1958).

Pseudoreplication

The same concern with pseudoreplication in the LME regression models exists in the Tobit regression. However, when values were censored it was not possible to average the observations in each lake to obtain a single value for each year or season and a different solution was necessary. Suppose that observations $y_1, \ldots, y_{n1}$ and $y'_1, \ldots, y'_{n2}$ are available from a given lake in a given year where each y_i is known exactly and each y'_i is censored so that y'_i belongs to the interval (a_i, b_i). Given these observations, the sample average, $\bar{y}$, was bounded such that:

(9) $$a = \frac{\sum_{i=1}^{n_1} y_i + \sum_{i=1}^{n_2} a_i}{n_1 + n_2} < \bar{y} < \frac{\sum_{i=1}^{n_1} y_i + \sum_{i=1}^{n_2} b_i}{n_1 + n_2} = b,$$

and Tobit regression was performed with (a, b) as the censoring interval for the sample mean. If all measurements are known exactly, then $n_2 = 0$ and $a = b = \bar{y}$.

B.2.1.4 Hypothesis Testing

Once the regression models were fit, hypothesis tests were performed to determine if there was evidence that the mean variable values in the monitored lake (*M*) had changed over time. If there was no evidence of change over time, differences were attributed to random variation. If there was evidence of change over time, the time trend at the monitored lake was compared to the reference lake (*R*) to determine if there was a parallel trend over time at the monitored and reference lakes.

Test 1: Comparison within Monitored Lake

The fitted pattern of means in the monitored lake were compared to a constant value to determine if there was evidence suggesting the mean value of the variable had changed over time.

The hypothesis of this test was:

H_0: $\beta_{kM} = 0$ for $k = 1 \ldots K$.

H_a: $\beta_{kM} \neq 0$ for at least one $k = 1 \ldots K$.

Rejection of the null hypothesis provides evidence that the mean variable value in the monitored lake had changed over time and analysis proceeded with Test 2. If the reference lake was removed from the analysis then plots of the fitted and observed values were used to identify the changes.

Test 2: Comparison to Reference Lake

If there was enough evidence to suggest that the variable changed across time, the fitted patterns of means in the monitored lake was compared to the reference lake.

The hypotheses of these tests were:

H_0: $\beta_{kM} = \beta_{kR}$ for $k = 1 \ldots K$.

H_a: $\beta_{kM} \neq \beta_{kR}$ for at least one $k = 1 \ldots K$.

Rejection of the null hypothesis provided evidence that the time trend in the mean variable value in the monitored lake differed from the time trend in the reference lake.

Structure of Tests

All of the hypothesis tests were performed using Wald-type chi-square tests based on the normal approximation for maximum likelihood estimation. Each null hypothesis can be written as a matrix equation with the form, $L'\beta = 0$, where L' denotes the vector of regression coefficients. The Wald theory then states that the quantity:

$$X^2 = (L'\hat{\beta})(L'\Sigma L)(\hat{\beta}'L)$$

is approximately distributed as a chi-square with degrees of freedom equal to the row rank of L, where $\hat{\beta}$ is the vector of maximum likelihood estimates and Σ is its estimated variance-covariance matrix. The p-values for the tests are computed from the upper-tail probabilities of this distribution.

Plots of Observed and Fitted Values

Plots of the observed and fitted values were used to visually assess and compare the values within and among lakes, and aid in the interpretation of the hypothesis test results. Observations below the DL were plotted at half the DL and indicated by a hollow symbol. Different symbols were used to distinguish between observed and yearly averaged values. The fitted values of the mean variable were represented with curves and error bars about the curves represent the 95% confidence intervals for the model estimates of the annual mean.

Computing

All steps of the analysis were performed using the statistical computing package R 3.4.3 (R Development Core Team 2016). The following versions of packages were used for the analyses:

- dplyr (0.7.4);
- stringr (1.2.0);
- tidyr (0.7.2);
- lubridate (1.7.1);
- ggplot2 (2.2.1);
- knitr (1.17);
- survival (2.41-3); and
- lme4 (1.1-14).

B.2.2 Water Quality

Water quality samples were collected during the under-ice (April) and open-water (July, August, and September) seasons at shallow and deep depths. Depth was included in the regression model as a fixed effect and represents the mean difference between surface and deep samples. Season was included in the regression model as an interaction term with lake and time so that separate time trends were estimated for each lake-season group. The regression model for water quality data in lake *i* season *j* was as follows:

y = Lake + Season + Depth + s(Year) + Lake*Season + Lake* Season*s(Year) + Year-R + Error-R,

or mathematically:

$$E[y_{ij}(x)] = \beta_{0ij} + \beta_1 + \sum_{k=2}^{K} \beta_{kij} h_k(x) \ ,$$

where:

- $E[y_{ij}(x)]$ represents the expected mean value of the variable in lake *i*, season *j*, in year *x;*
- β_{0ij} represents the intercept for lake *i* in season *j;*
- β_1 represents the mean difference between deep and surface samples;
- β_{kij} represents the basis coefficients for lake *i* season *j;* and
- $\{h_k\}$ are the basis functions.

B.2.2.1 Hypothesis Testing

Test 1: Comparison within Monitored Lake

For season *j* in monitored lake *M*, the hypothesis tests were:

H_0: $\beta_{kMj} = 0$ for $k = 1 \ldots K$.

H_a: $\beta_{kMj} \neq 0$ for at least one $k = 1 \ldots K$.

If there was enough evidence to suggest the variable changed across time in the monitored lake in season *j*, the time trend in the monitored lake was compared to the reference lake in season *j* using Test 2.

Test 2: Comparison against Reference Lake

The hypotheses of the tests were:

H_0: $\beta_{kMj} = \beta_{kRj}$ for $k = 1 \ldots K$.

H_a: $\beta_{kMj} \neq \beta_{kRj}$ for at least one $k = 1 \ldots K$.

Rejection of the null hypothesis provided evidence that the change over time in the mean variable value in the monitored lake differed from the time trend in the reference lake in season *j*.

B.2.3 Sediment Quality

Sediment samples were collected in one season at one depth, hence the model form and hypothesis testing procedure follows that outlined in section B.2.1.

B.2.4 Phytoplankton

Phytoplankton biomass data were collected in July, August, and September. Sampling month was included in the regression model as a fixed effect and represented the mean difference between samples collected in different months, while assuming this difference was the same across lakes and time.

*y = Lake + Month + f(Year) + Lake*f(Year) + Year-R + Error-R* or mathematically:

$$E[y_i(x)] = \beta_{0i} + \alpha_m + \sum_{k=1}^{K} \beta_{ki} h_k(x) \ ,$$

where:

- $E[y_i(x)]$ represents the expected mean value of the variable in lake i in year x;
- β_{0i} represents the intercept for lake i;
- α_m represents the mean difference between month m and reference month m^*;
- β_{ki} represents the basis coefficients for lake i; and
- $\{h_k\}$ are basis functions.

All hypothesis testing procedures follow that described in section B.2.1.

B.2.5 Benthic Invertebrates

B.2.5.1 Density

Benthos density data were collected in one season at one depth, hence the model form and hypothesis testing procedure followed that outlined in Section B.2.1.

B.2.5.2 Family Richness

Family richness is the number of distinct species families collected in a sample. A generalized linear mixed effects model (GLMM) was used to model family richness. Generalized linear mixed effects models are an extension of LME where the response, given the covariates, may follow one of several distributions. Count data are often fit using a Poisson distribution, as done here. In a GLMM, instead of modelling the response directly, a link function, in this case, the “log link” (natural logarithm) relates the mean of the response to the linear predictor.

Let $y_i(x)$ be the family richness count for lake i in year x, then $y_i(x)$ is assumed to follow a Poisson distribution with mean $\mu_i(x)$. The model is written as:

$$\log(\mu_i(x)) = \beta_{0i} + \beta_{1i}x + \varepsilon_x,$$

where,

- $\mu_i(x) = E[y_i(x)]$ represents the expected mean value of the variable in lake i in year x;
- β_{1i} represents the time effect in lake i; and
- ε_x is the random effect that affects all lakes identically in year x, and is assumed to follow a normal distribution with variance σ_x^2.

Hypothesis Testing

Test 1: Comparison within Monitored Lake

The hypothesis of this test was:

$H_0: \beta_{1M} = 0$

$H_a: \beta_{1M} \neq 0$

If there was enough evidence to suggest that the variable values changed across time in lake M, the fitted pattern of means in that monitored lake was compared to the reference lake.

Test 2: Comparison against Reference Lake

The hypotheses of this test was:

$H_0: \beta_{1M} = \beta_{1R}$

$H_a: \beta_{1M} \neq \beta_{1R}$

Rejection of the null hypothesis provided evidence that the change over time in the mean variable value in the monitored lake differed from the time trend in the reference lake.

B.2.5.3 Family Diversity and Bray-Curtis Index

Benthos family diversity and Bray-Curtis index data were collected in one season at one depth, hence the model form and hypothesis testing procedure followed that outlined in section B.2.1. However, instead of modelling the natural log of the variable value, logit transformations were employed as the data were constrained to lie between 0 and 1. The logit transformation maps data in the interval [0, 1] to the real line so that predicted values are restricted to fall in the interval [0, 1].

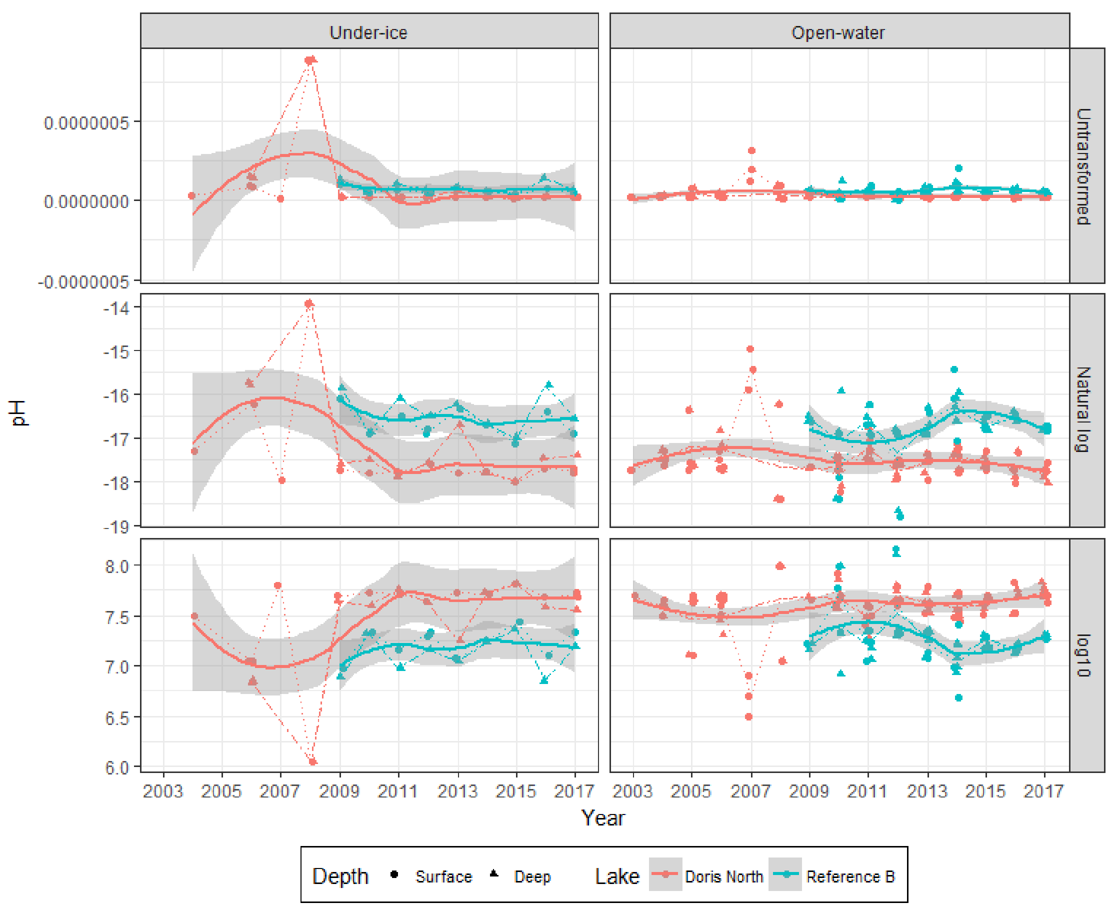
B.3 Statistical Results for Water and Sediment Quality, Phytoplankton, and Benthos Evaluation of Effects

B.3.1 Water Quality

B.3.1.1 Analysis of pH

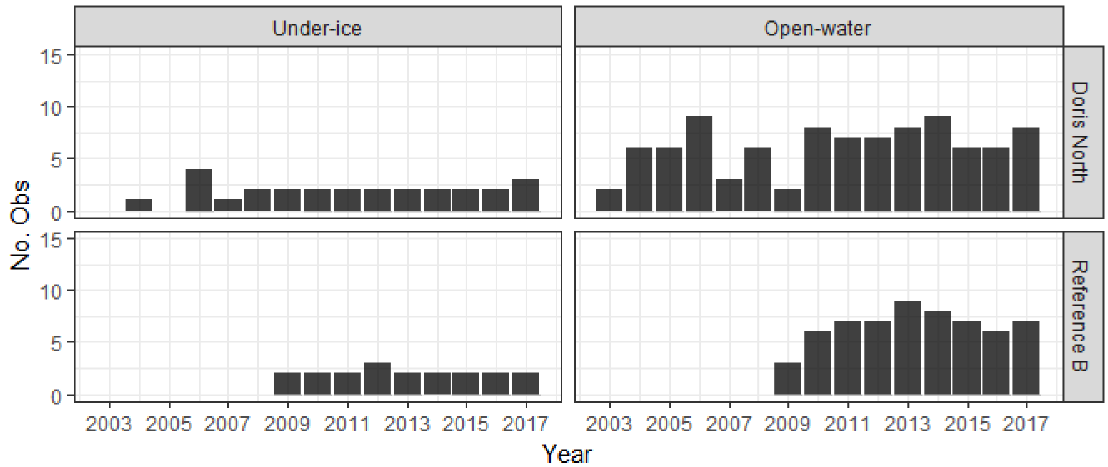
<u>Observed Data</u>

The following plots show all the observed data on the untransformed, natural log scale, and log (base 10) scale. For analysis of untransformed and natural log transformed pH, pH values were first converted to the concentration of hydrogen ions ([H+] = 10^{-pH}). For the log (base 10) transformation, raw pH values are presented, since pH = -log10[H+]. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

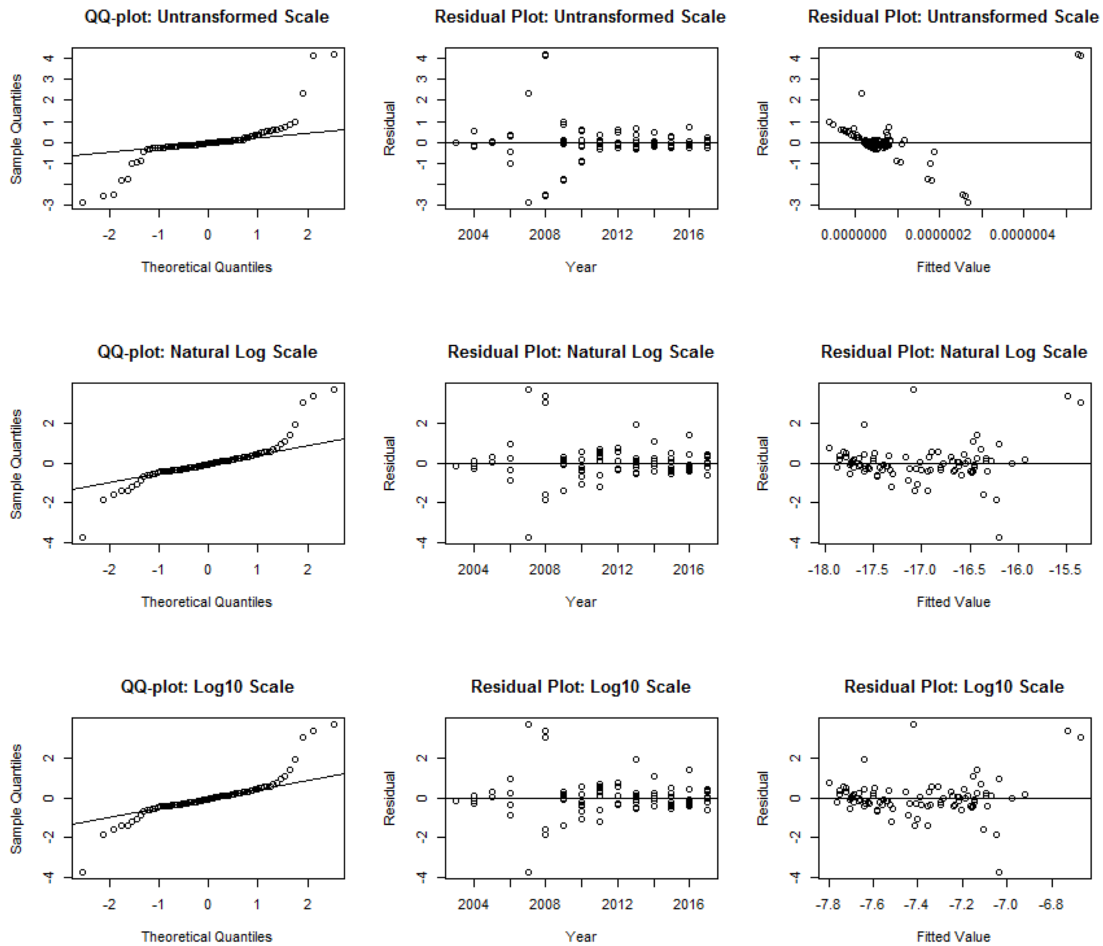
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	27	0	0	0.0000000
Doris North	Open-water	93	0	0	0.0000000
Reference B	Under-ice	19	0	0	0.0000001
Reference B	Open-water	60	0	0	0.0000001

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
16	Doris North	2008	Under-ice	Deep	0.0000009	0.0000005	4.104668
17	Doris North	2008	Under-ice	Surface	0.0000009	0.0000005	4.188529

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
13	Doris North	2007	Under-ice	Surface	0.0000000	-16.19501	-3.758623
15	Doris North	2007	Open-water	Surface	0.0000002	-17.08949	3.687291
16	Doris North	2008	Under-ice	Deep	0.0000009	-15.35562	3.034286
17	Doris North	2008	Under-ice	Surface	0.0000009	-15.49660	3.334473

Outliers on log10 scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
13	Doris North	2007	Under-ice	Surface	0.0000000	-7.033404	-3.758623
15	Doris North	2007	Open-water	Surface	0.0000002	-7.421873	3.687291
16	Doris North	2008	Under-ice	Deep	0.0000009	-6.668862	3.034286
17	Doris North	2008	Under-ice	Surface	0.0000009	-6.730087	3.334473

The log10 data meets residual assumptions better than the untransformed data. Analysis proceeds with log10 data since pH is in log base 10 units.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	24.108	4	0.0001
Compare to Reference B	2.054	4	0.7258

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

Open-Water

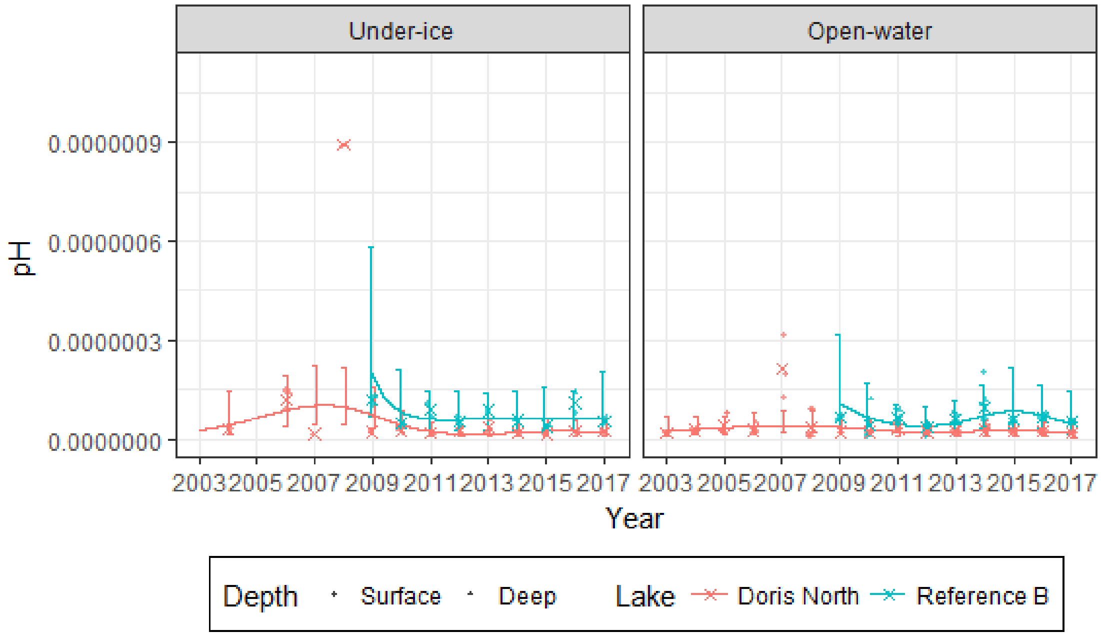
Analysis	Chi.sq	DF	P.value
Compare to slope 0	9.852	4	0.0430
Compare to Reference B	2.282	4	0.6841

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

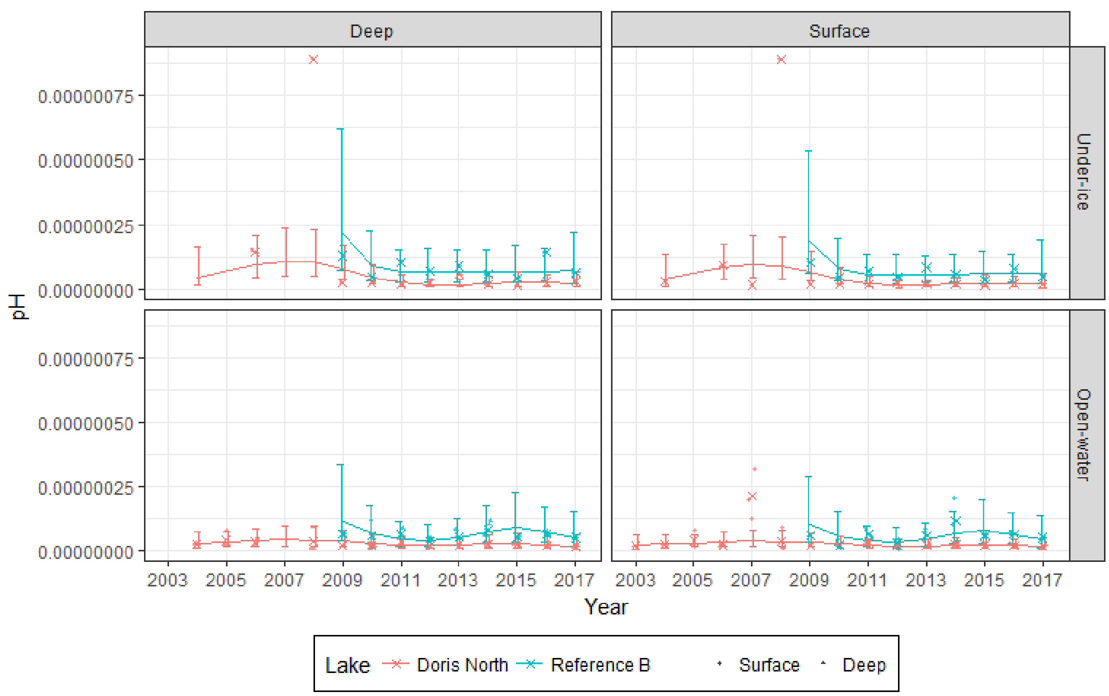
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



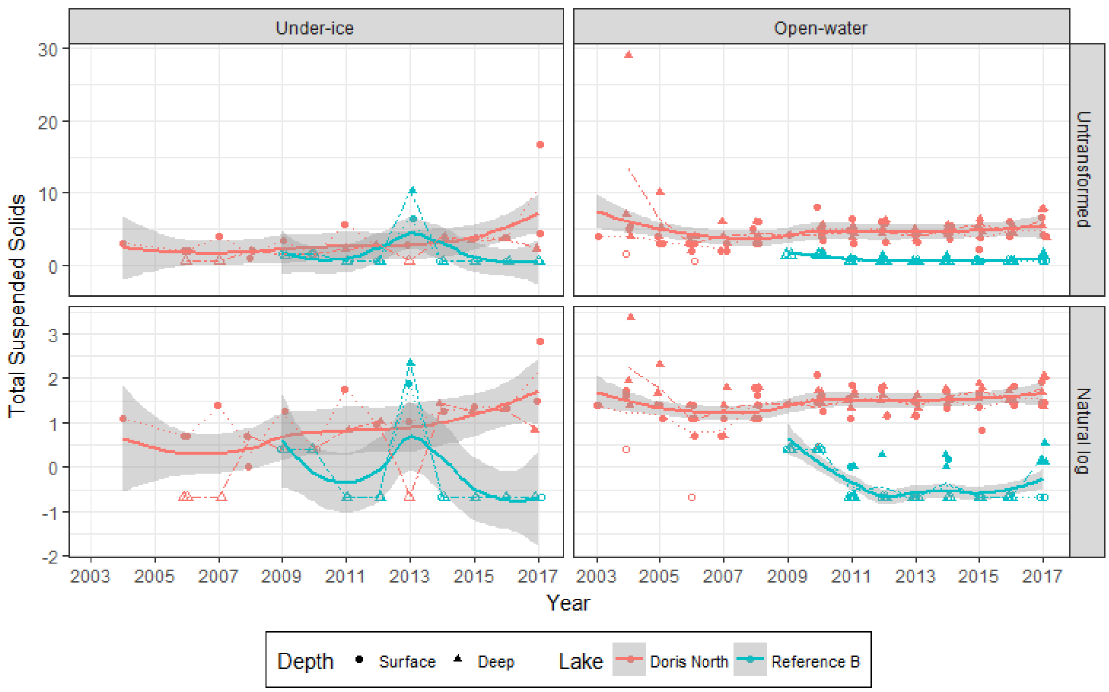
Plot of observed and fitted data separated by depth:



B.3.1.2 Analysis of Total Suspended Solids

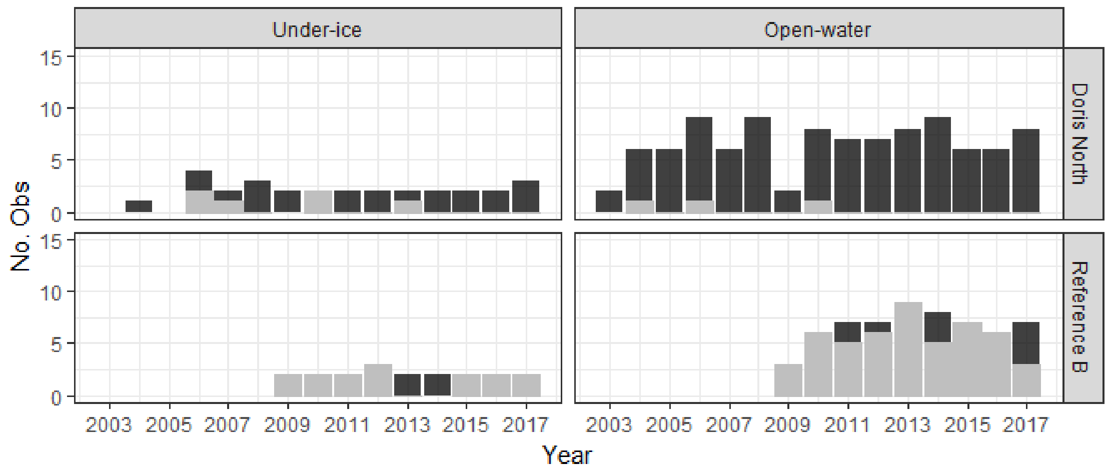
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



<u>Censored Values and Sample Sizes</u>

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

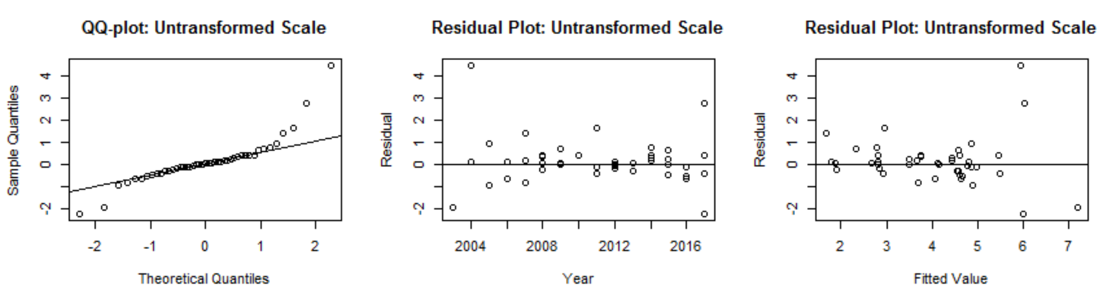
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	29	7	0.24	3.0
Doris North	Open-water	99	3	0.03	4.3
Reference B	Under-ice	19	17	0.89	1.0
Reference B	Open-water	60	50	0.83	1.0

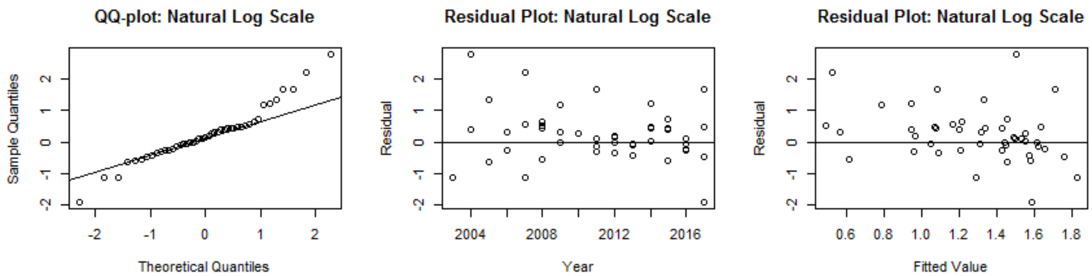
More than 60% of data under detection limit for Reference B. Reference B removed from the analyses.

Linear mixed model regression cannot be performed when only one site remains in the analysis. Proceeding with Tobit regression for the remainder of the analyses. Results for LME and Tobit are comparable when all or most of the data is above detection limit.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
4	Doris North	2004	Open-water	Deep	13.33333	5.958239	4.438741

Outliers on natural log scale:

None.

The natural log-transformed data better meets the residual assumptions. Analysis proceeds with natural log-transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	16.964	4	0.0020

Doris Lake North appears to show significant deviation from no trend.

Open-Water

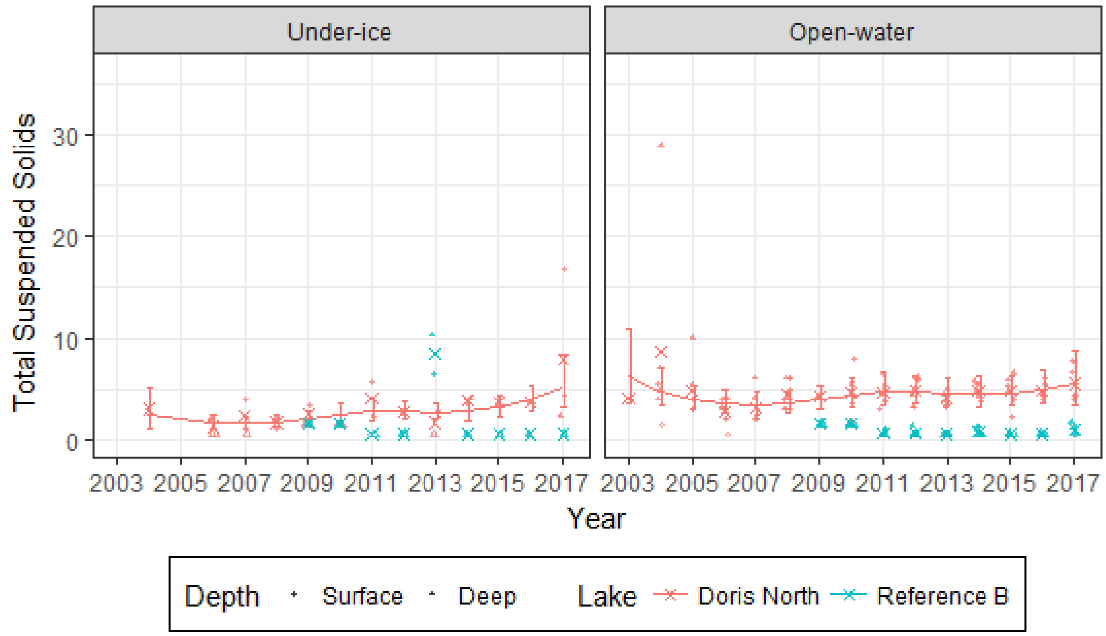
Analysis	Chi.sq	DF	P.value
Compare to slope 0	3.465	4	0.4833

Doris Lake North did not exhibit significant deviation from no trend.

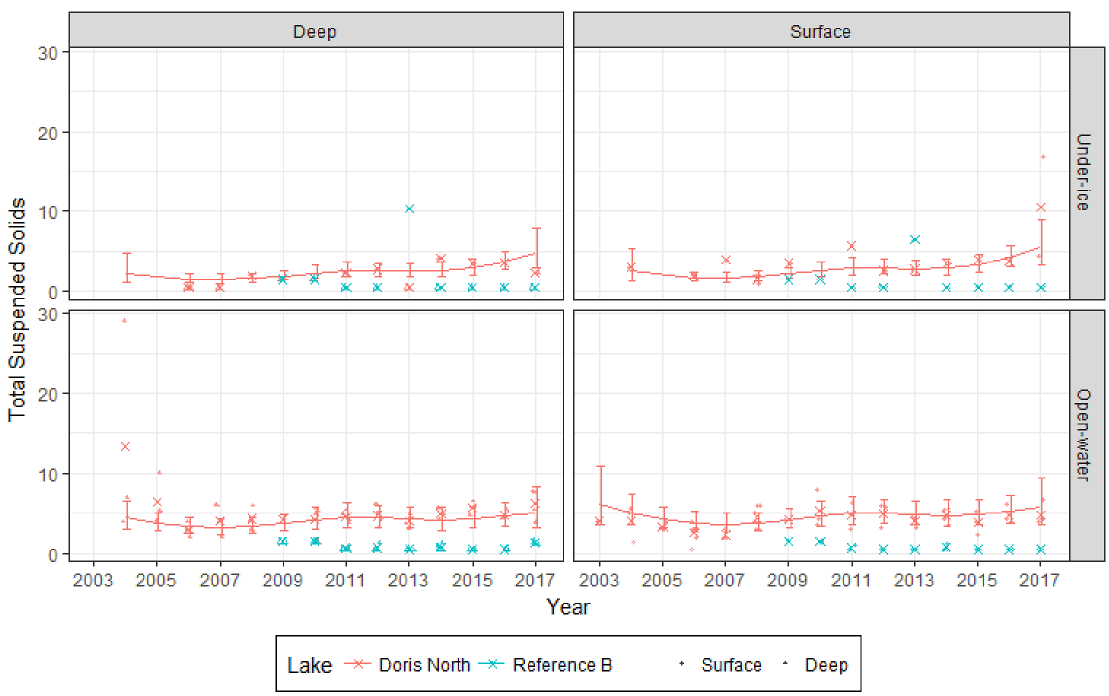
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



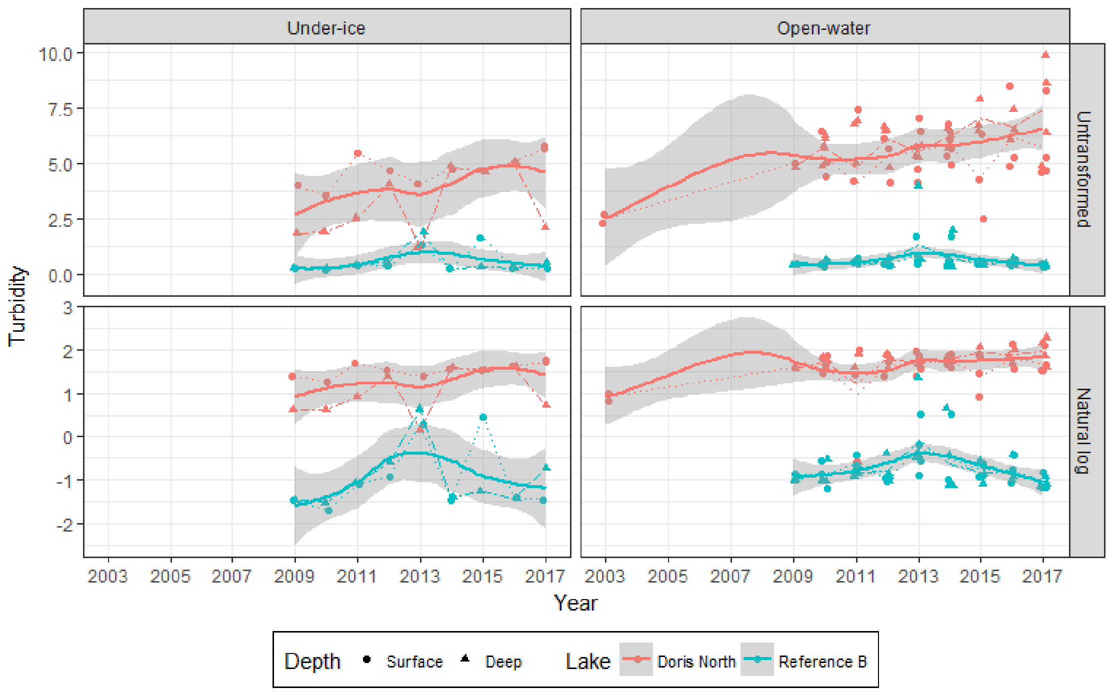
Plot of observed and fitted data separated by depth:



B.3.1.3 Analysis of Turbidity

Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

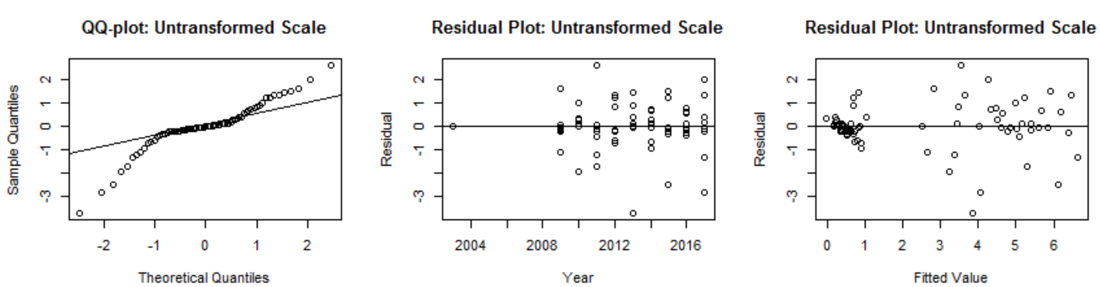
The sample sizes and median values per lake and season are summarized in the table below.

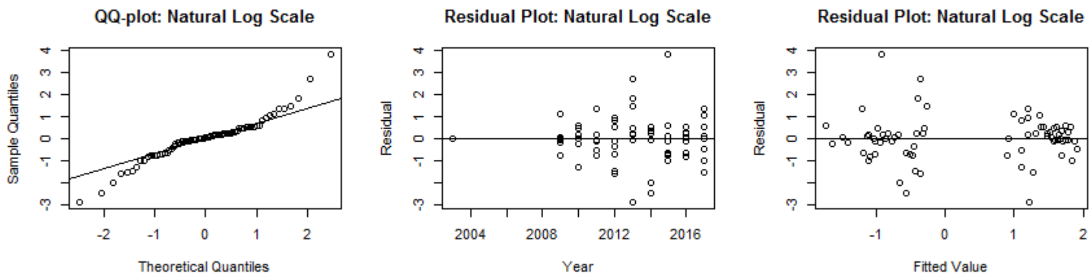
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	19	0	0	4.59
Doris North	Open-water	63	0	0	5.69
Reference B	Under-ice	19	0	0	0.28
Reference B	Open-water	60	0	0	0.42

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

<u>Initial Model Fit</u>

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
36	Doris North	2013	Under-ice	Deep	1.18	3.839345	-3.736396

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
81	Reference B	2015	Under-ice	Surface	1.59	-0.9259123	3.834305

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	13.443	4	0.0093
Compare to Reference B	5.631	4	0.2284

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

Open-Water

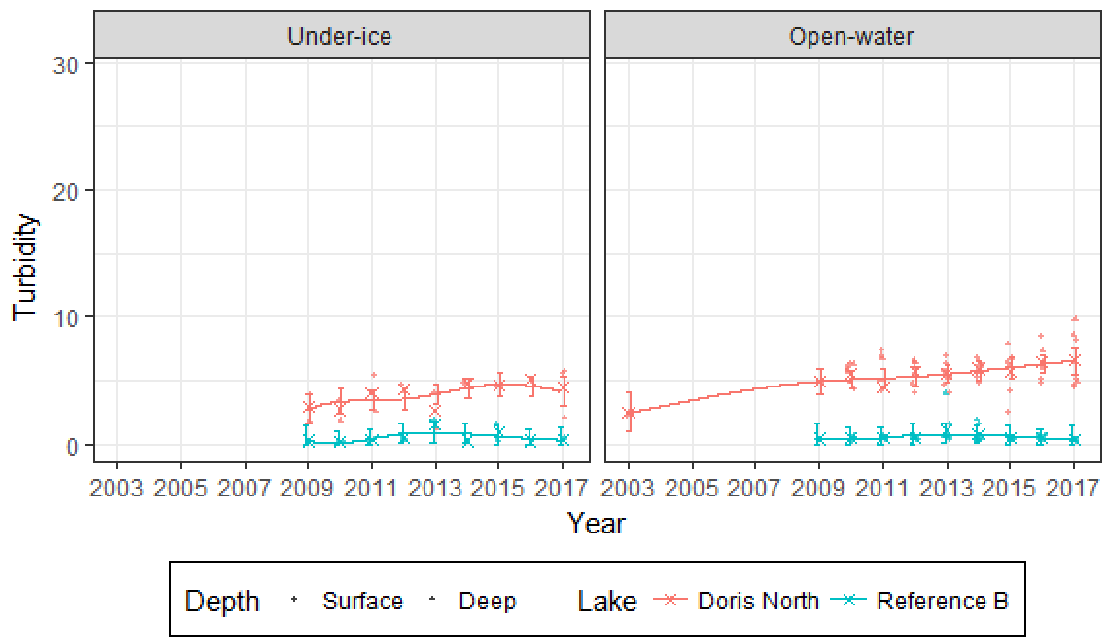
Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.171	4	0.7044

Doris Lake North did not exhibit significant deviation from no trend.

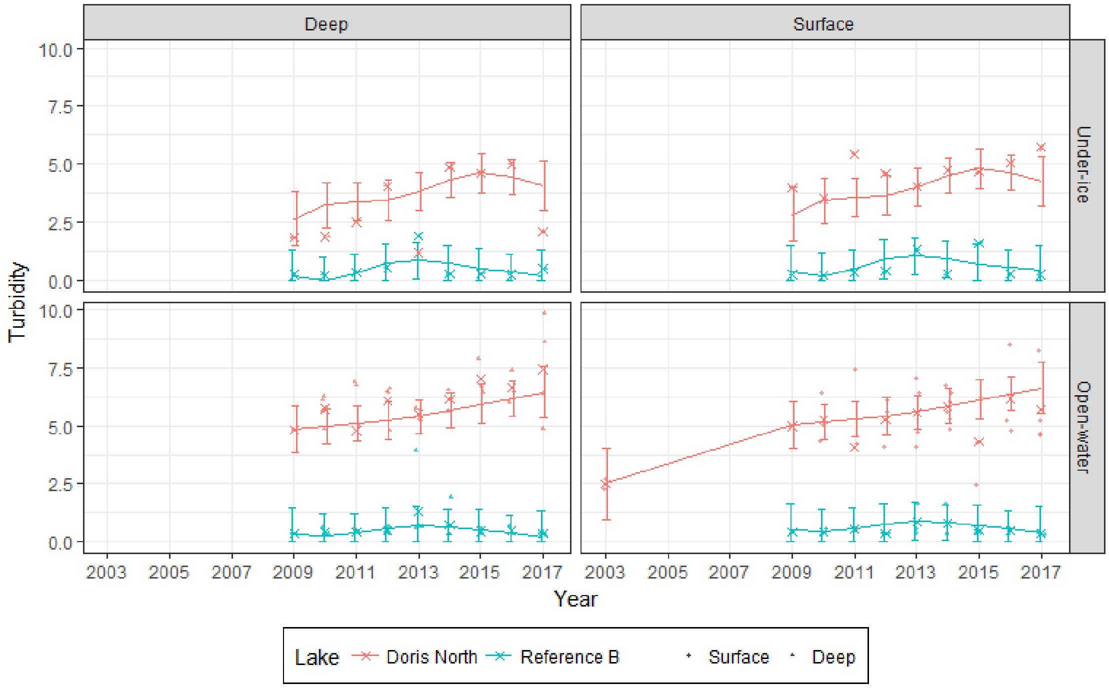
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



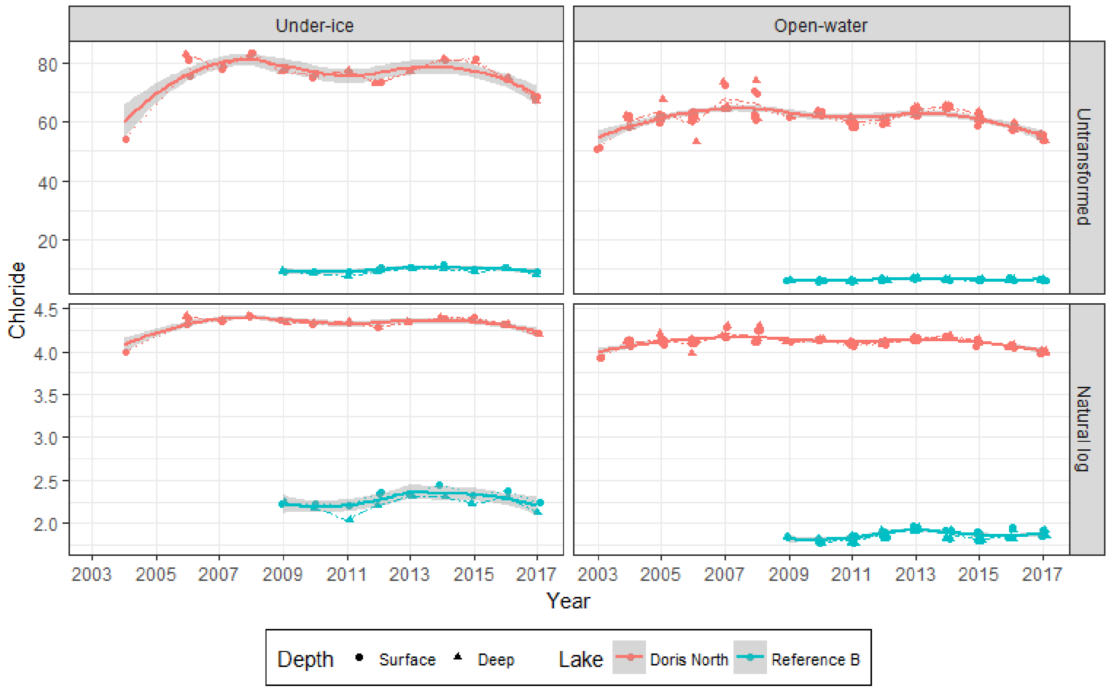
Plot of observed and fitted data separated by depth:



B.3.1.4 Analysis of Chloride

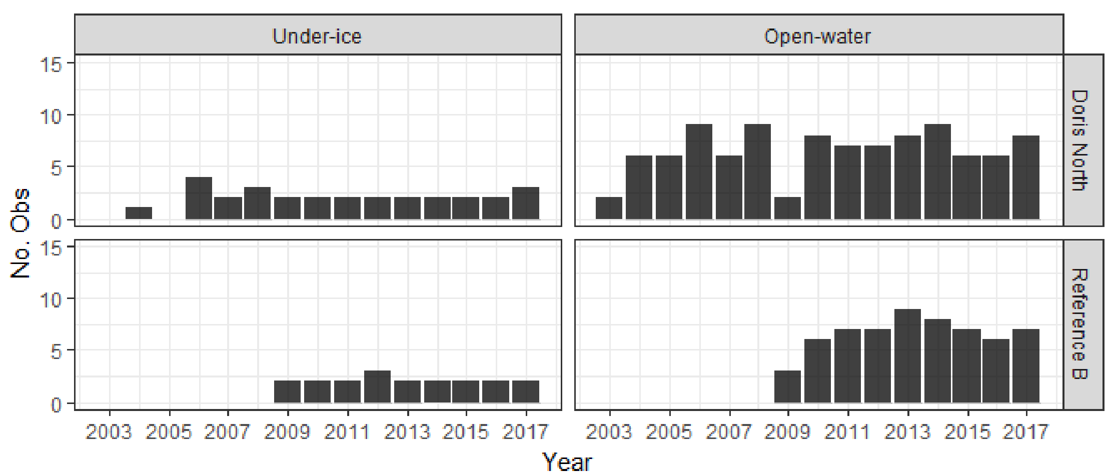
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

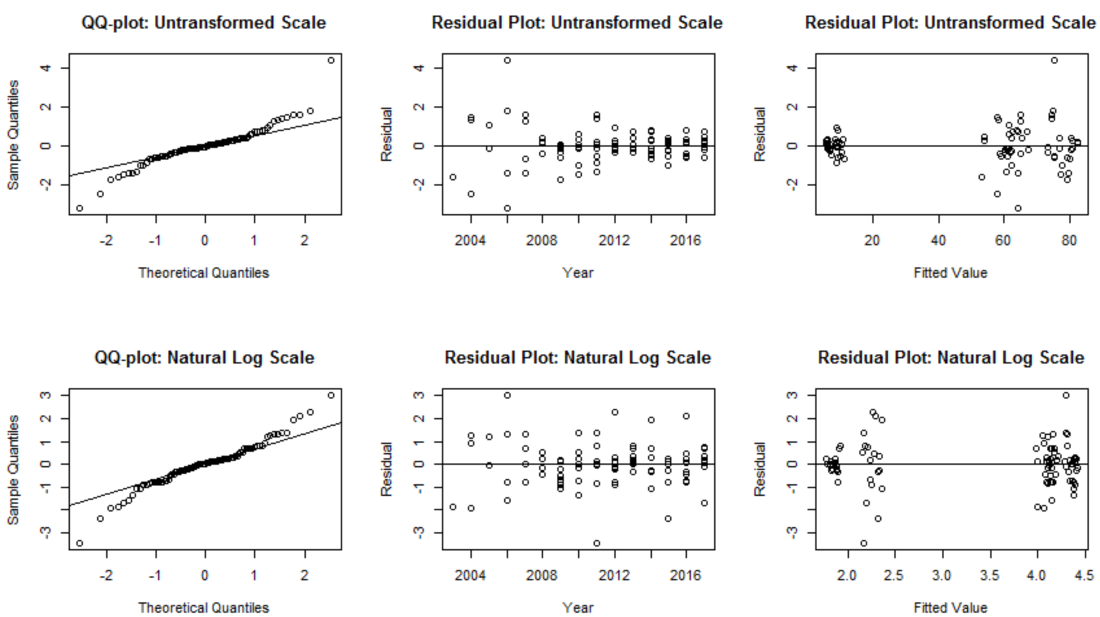
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	29	0	0	77.300
Doris North	Open-water	99	0	0	61.800
Reference B	Under-ice	19	0	0	9.390
Reference B	Open-water	60	0	0	6.355

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
8	Doris North	2006	Under-ice	Deep	82.35	75.30726	4.385172
10	Doris North	2006	Open-water	Deep	59.20	64.36257	-3.214480

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
8	Doris North	2006	Under-ice	Deep	82.35	4.292465	3.025310
64	Reference B	2011	Under-ice	Deep	7.66	2.172160	-3.475491

The natural log transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data.

Test Results for Monitored Lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	88.668	4	0.0000
Compare to Reference B	30.747	4	0.0000

Doris Lake North appears to show significant deviation from no trend. Doris Lake North appears to show significant deviation from the trend of Reference B lake.

Open-Water

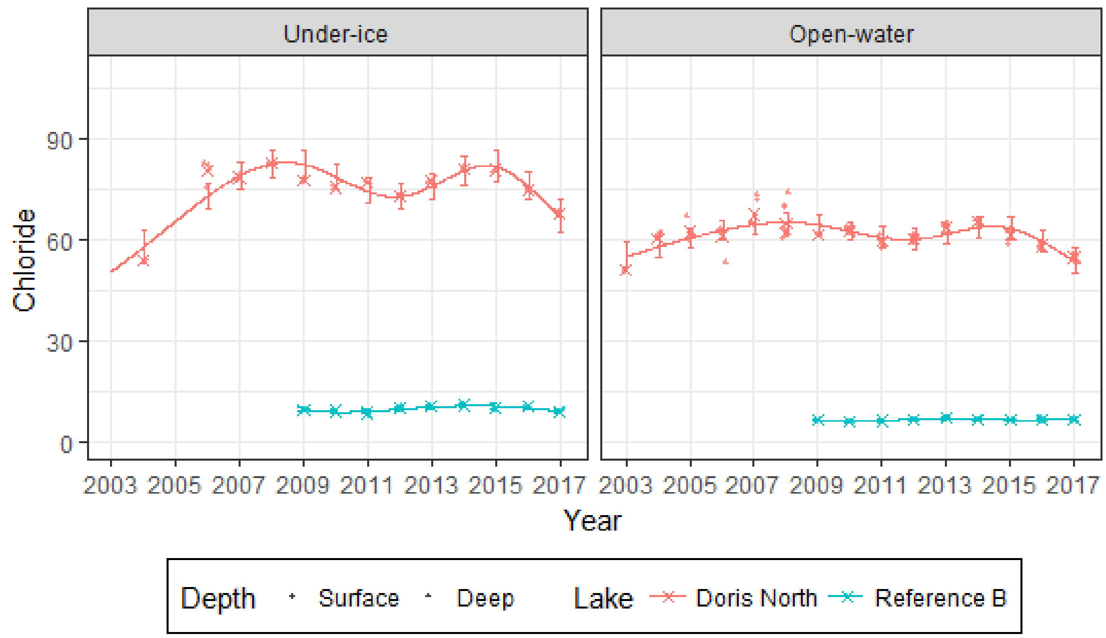
Analysis	Chi.sq	DF	P.value
Compare to slope 0	30.486	4	0.0000
Compare to Reference B	4.497	4	0.3429

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

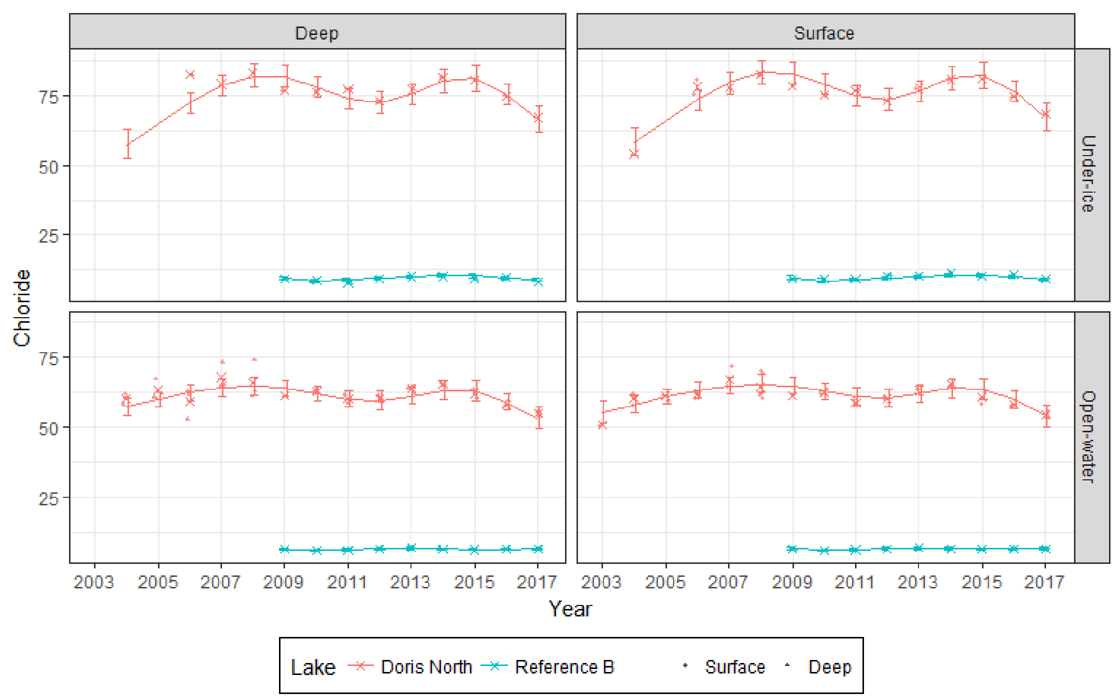
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



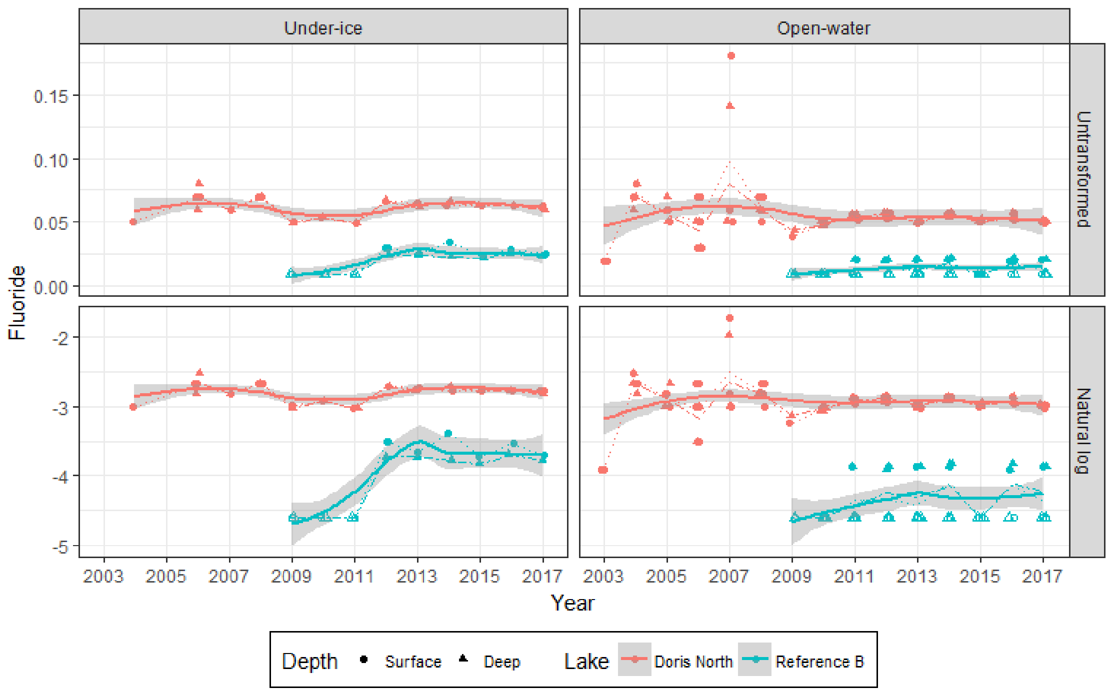
Plot of observed and fitted data separated by depth:



B.3.1.5 Analysis of Fluoride

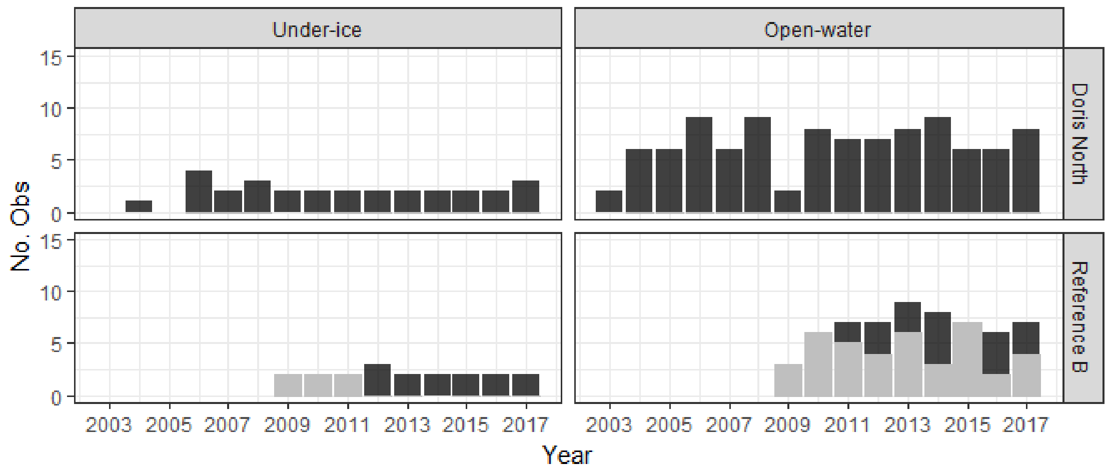
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

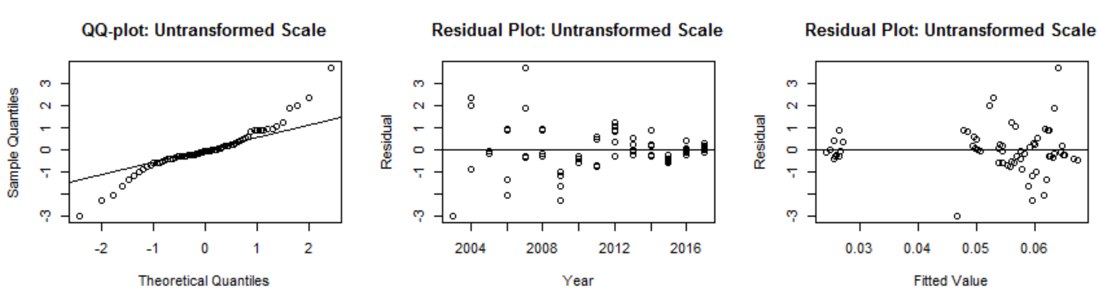
The sample sizes and median values per lake and season are summarized in the table below.

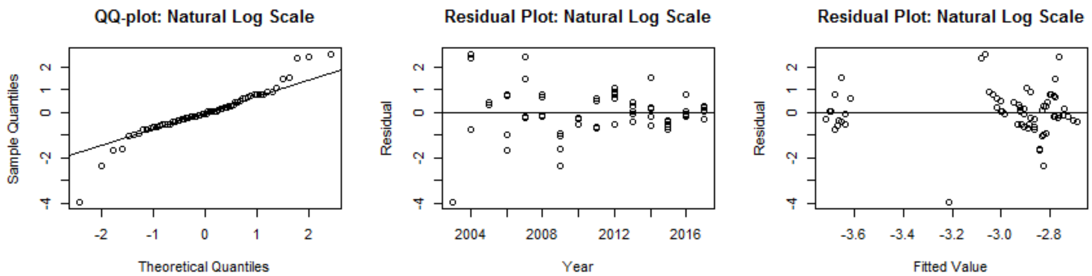
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	29	0	0.00	0.063
Doris North	Open-water	99	0	0.00	0.052
Reference B	Under-ice	19	6	0.32	0.024
Reference B	Open-water	60	40	0.67	0.020

Reference B Open-water exhibited more than 60% data under detection limit, and was removed from the analysis. Though only 32% of data in Reference B Under-ice was under detection limit, inclusion of Reference B 2009 - 2011 data lead to unstable results. Hence, Reference B Under-ice 2009 - 2011 data from was removed from the analysis, and 2012-2017 data were kept in the analysis.

<u>Initial Model Fit</u>

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
15	Doris North	2007	Open-water	Surface	0.0966667	0.0639102	3.677752

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2003	Open-water	Surface	0.02	-3.212793	-3.988337

The natural log transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.968	4	0.5632

Doris Lake North did not exhibit significant deviation from no trend.

Open-Water

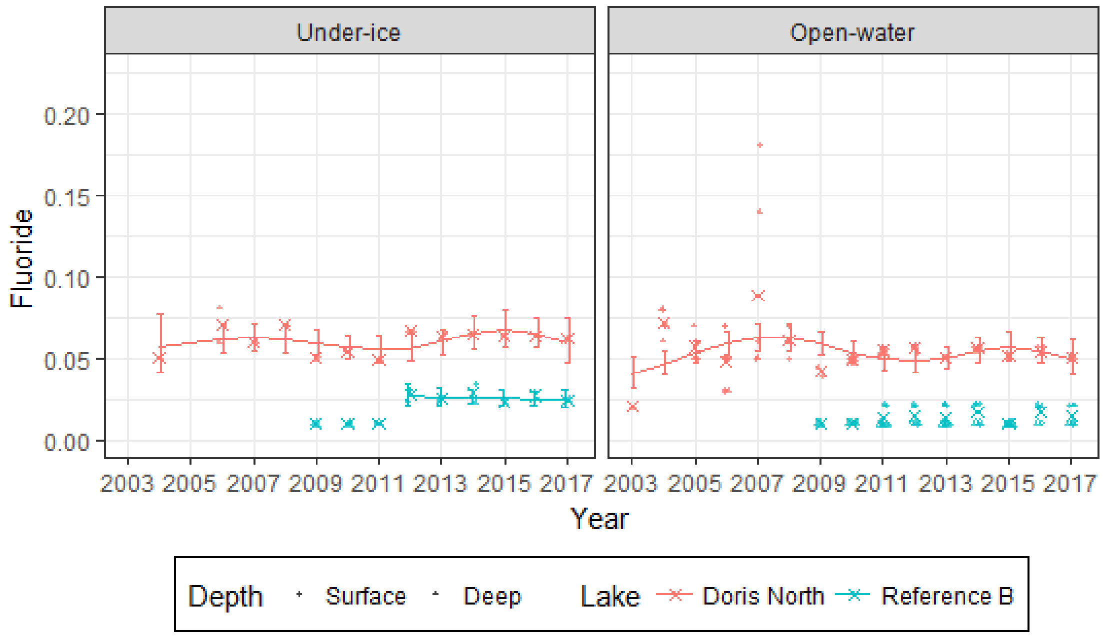
Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.675	4	0.6136

Doris Lake North did not exhibit significant deviation from no trend.

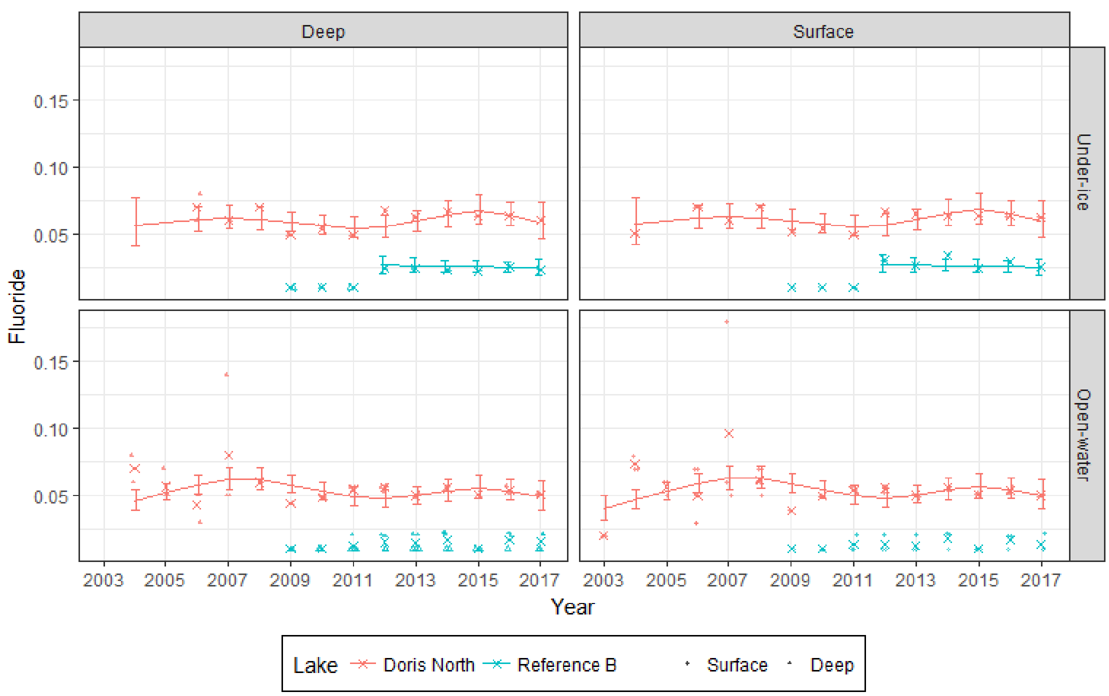
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



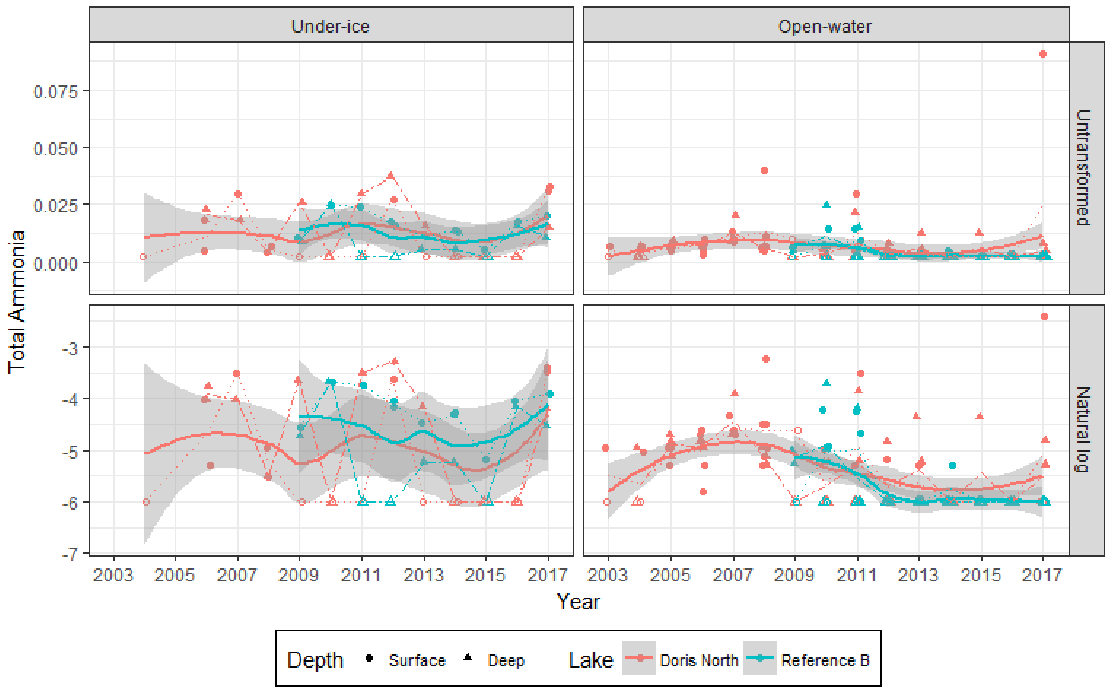
Plot of observed and fitted data separated by depth:



B.3.1.6 Analysis of Total Ammonia

<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



<u>Censored Values and Sample Sizes</u>

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

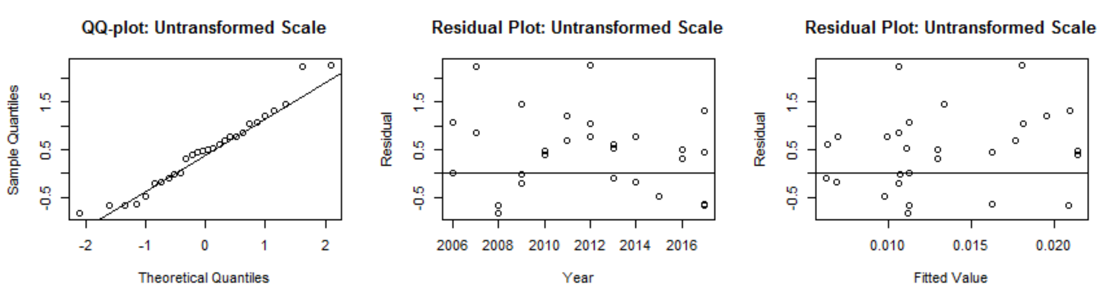
The sample sizes and median values per lake and season are summarized in the table below.

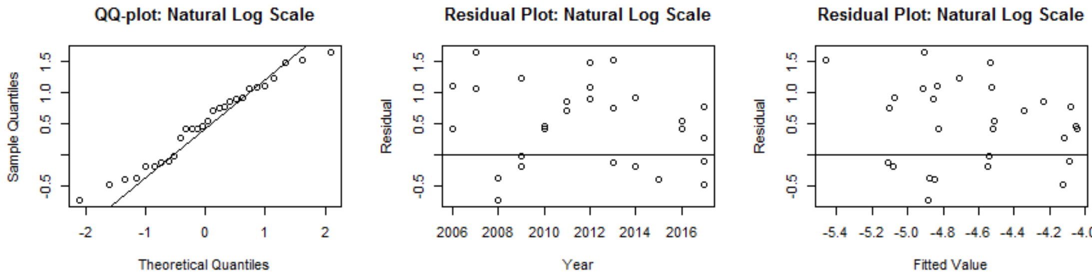
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	29	12	0.41	0.00500
Doris North	Open-water	99	49	0.49	0.00500
Reference B	Under-ice	20	3	0.15	0.01245
Reference B	Open-water	60	50	0.83	0.00500

Reference B Open-water exhibited more than 60% data under detection limit, and was removed from the analysis. Though only 49% of data in Doris North Open-water was under detection limit, inclusion of Doris North Open-water lead to unstable results. Hence Open-water data was removed from the analysis.

<u>Initial Model Fit</u>

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

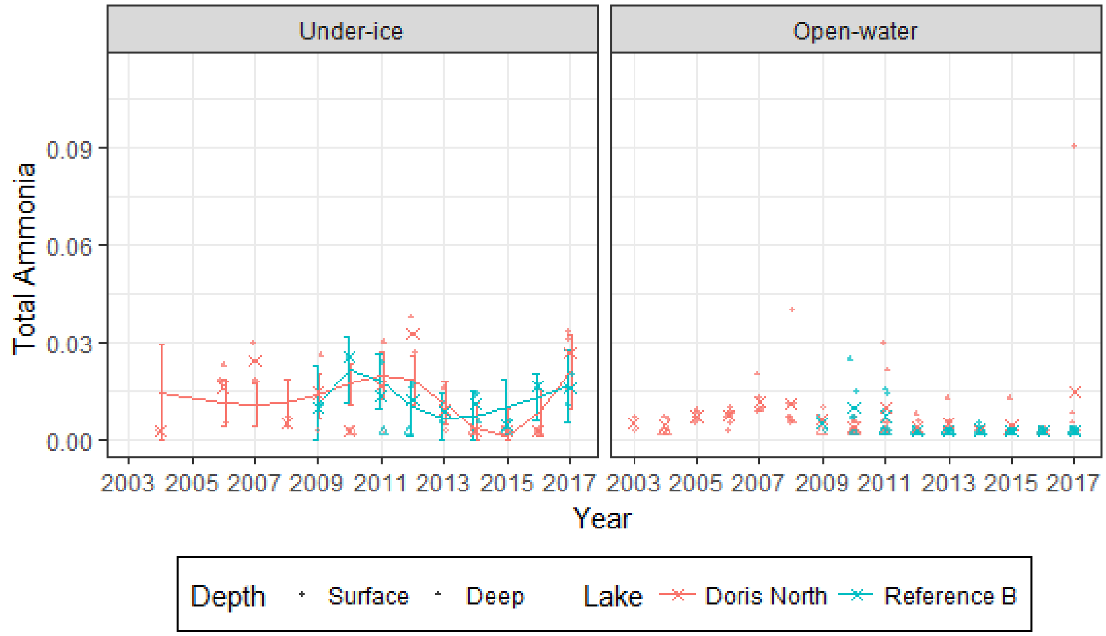
Analysis	Chi.sq	DF	P.value
Compare to slope 0	11.206	4	0.0243
Compare to Reference B	8.463	4	0.0760

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

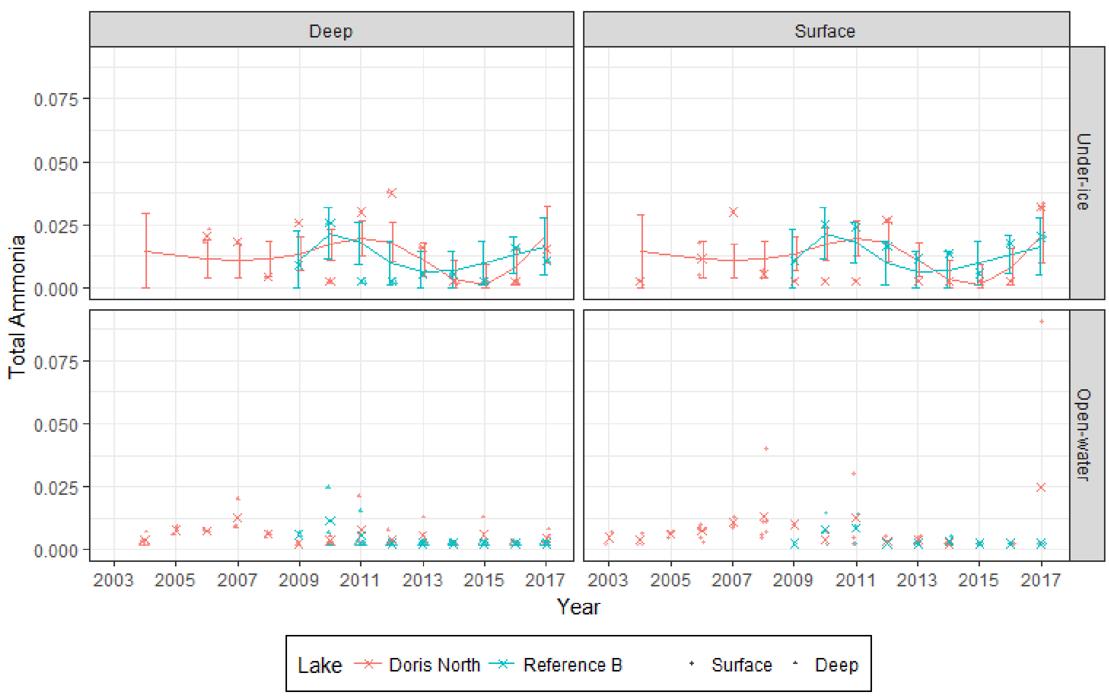
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



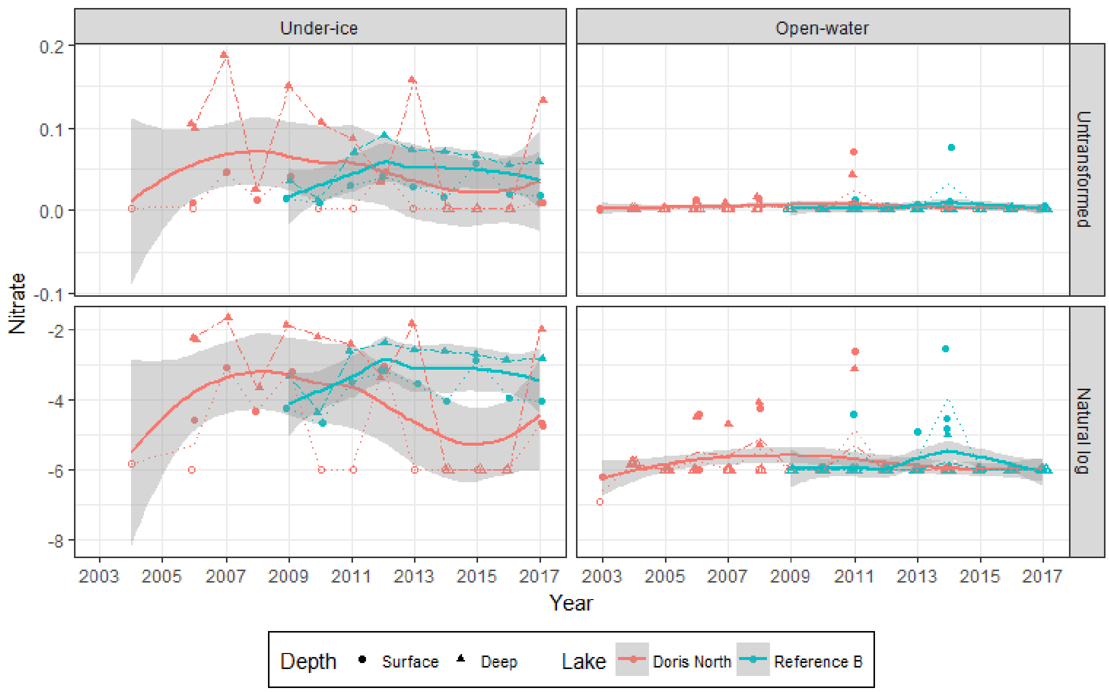
Plot of observed and fitted data separated by depth:



B.3.1.7 Analysis of Nitrate

<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



<u>Censored Values and Sample Sizes</u>

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

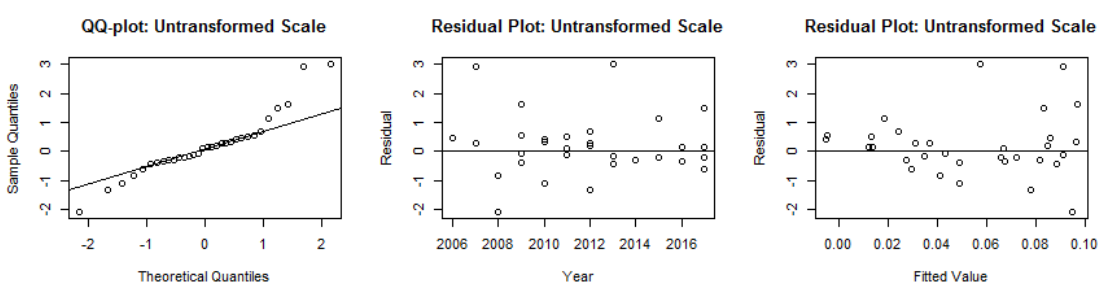
The sample sizes and median values per lake and season are summarized in the table below.

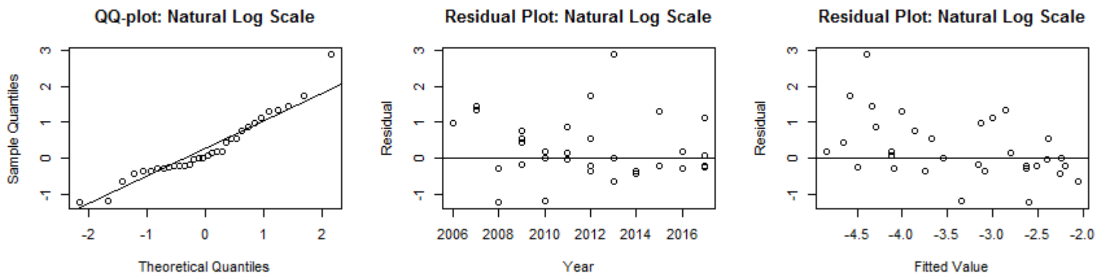
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	28	11	0.39	0.0115
Doris North	Open-water	96	87	0.91	0.0050
Reference B	Under-ice	19	0	0.00	0.0410
Reference B	Open-water	60	54	0.90	0.0050

Doris North exhibited more than 10% of data under detection limit in one (or more) of the seasons. The analysis proceeds with tobit regression. More than 60% of data under detection limit for Open-water. Data for Open-water will be removed from the analysis.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
17	Doris North	2013	Under-ice	Deep	0.157	0.0571425	3.004512

Outliers on natural log scale:

None.

The natural log-transformed data better meets the residual assumptions. Analysis proceeds with natural log-transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

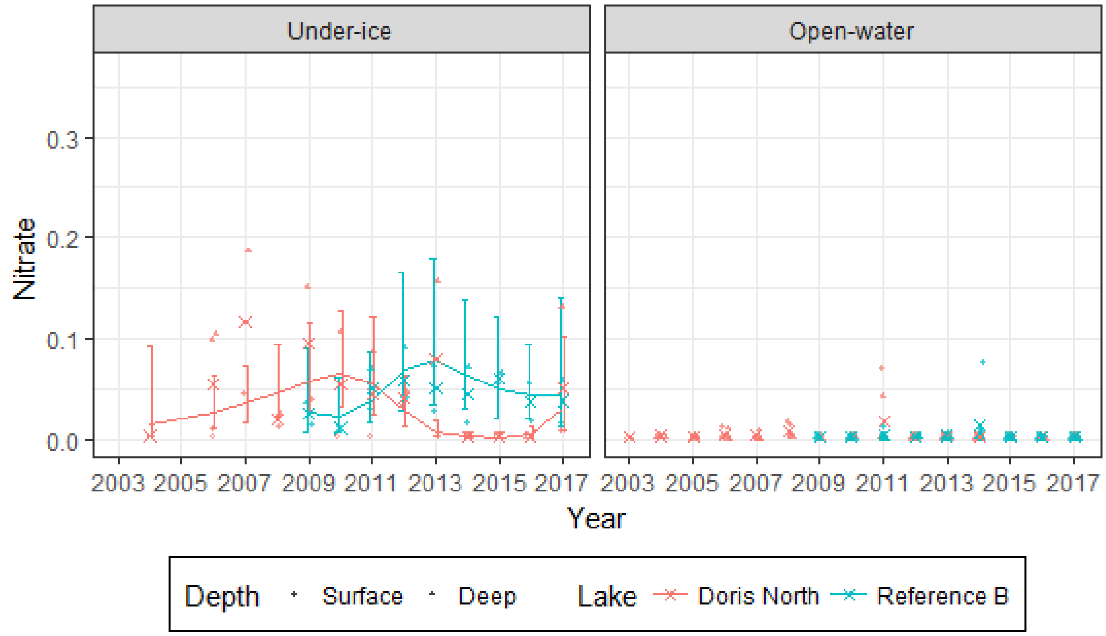
Analysis	Chi.sq	DF	P.value
Compare to slope 0	21.724	4	0.0002
Compare to Reference B	25.161	4	0.0000

Doris Lake North appears to show significant deviation from no trend. Doris Lake North appears to show significant deviation from the trend of Reference B lake.

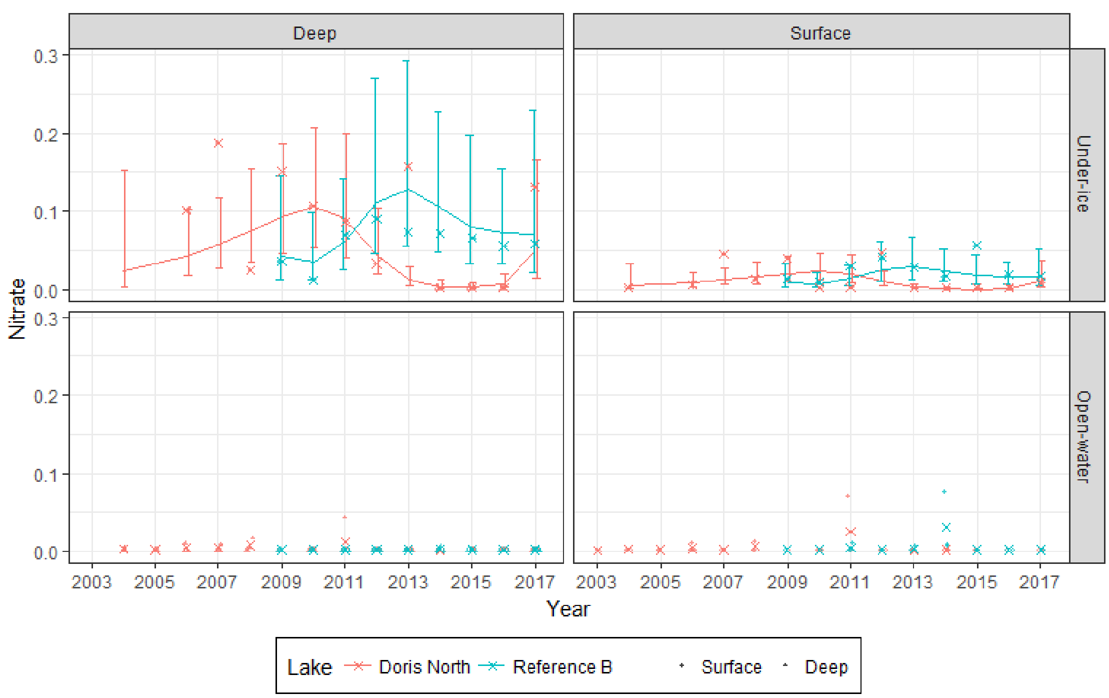
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



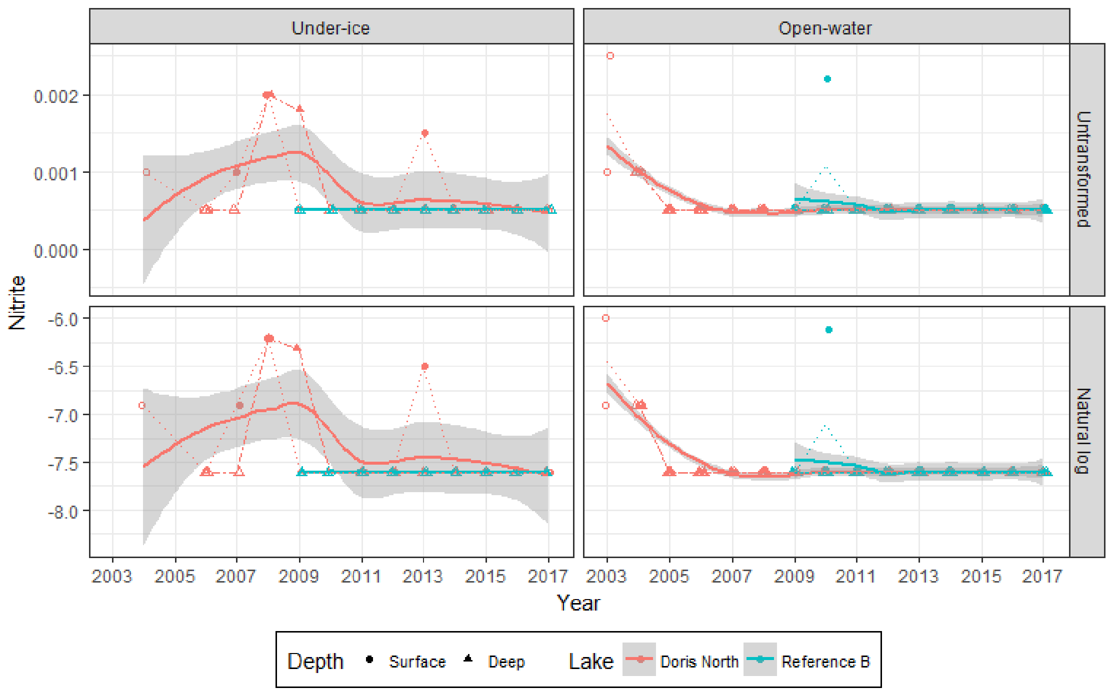
Plot of observed and fitted data separated by depth:



B.3.1.8 *Analysis of Nitrite*

Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

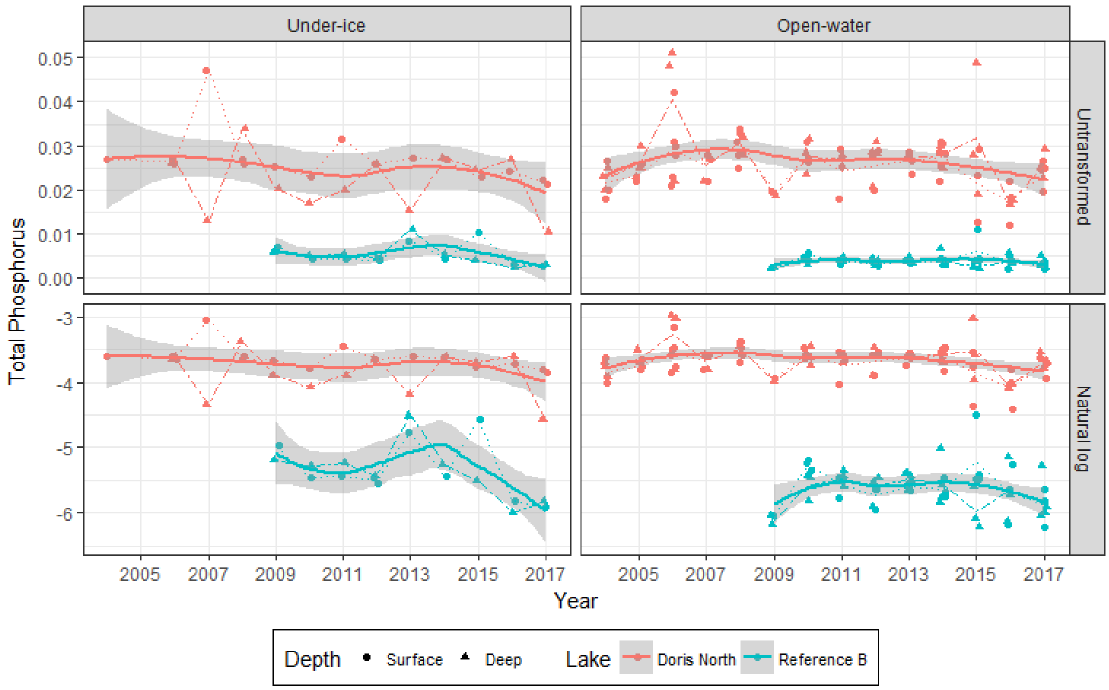
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	29	23	0.79	0.001
Doris North	Open-water	99	99	1.00	0.001
Reference B	Under-ice	19	19	1.00	0.001
Reference B	Open-water	60	59	0.98	0.001

More than 60% of data under detection limit for Doris North and Reference B. Doris North and Reference B removed from the analyses. No statistical analyses were performed.

B.3.1.9 Analysis of Total Phosphorus

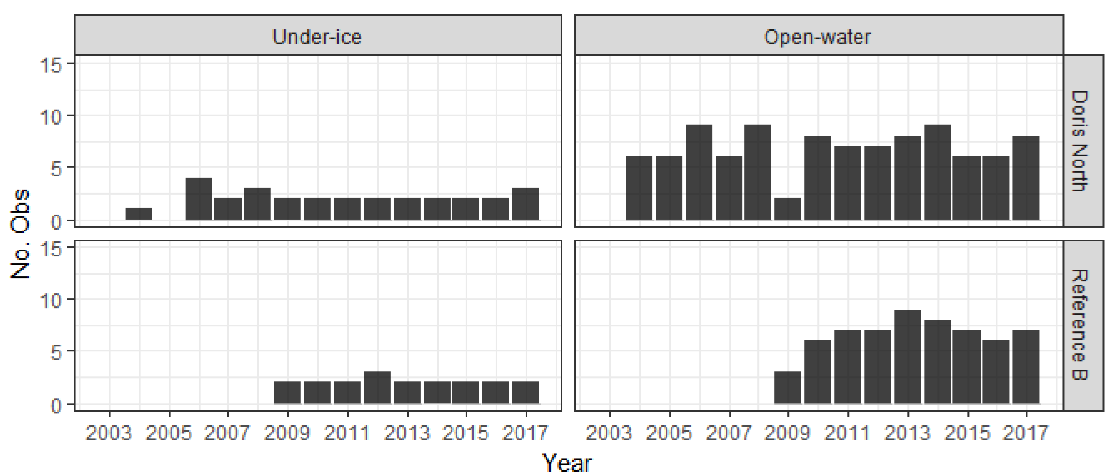
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

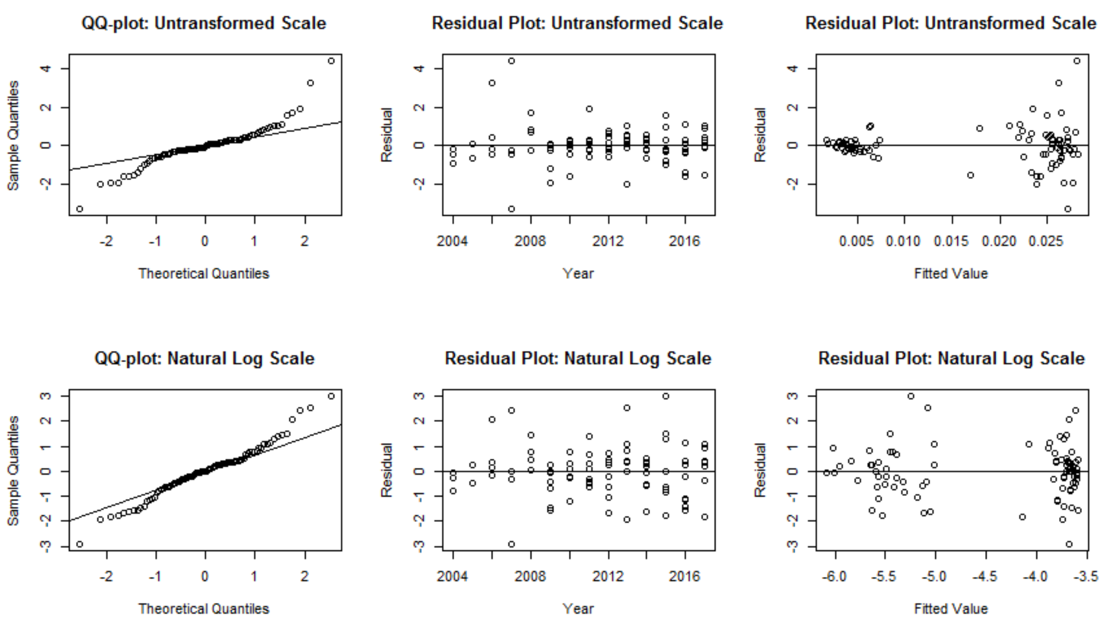
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	29	0	0	0.0260
Doris North	Open-water	97	0	0	0.0268
Reference B	Under-ice	19	0	0	0.0044
Reference B	Open-water	60	0	0	0.0037

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
10	Doris North	2006	Open-water	Deep	0.0403333	0.0262259	3.300246
12	Doris North	2007	Under-ice	Deep	0.0130000	0.0271372	-3.307200
13	Doris North	2007	Under-ice	Surface	0.0470000	0.0280962	4.422268

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
81	Reference B	2015	Under-ice	Surface	0.0104	-5.245989	3.01078

The natural log-transformed data better meets the residual assumptions. Analysis proceeds with natural log-transformed data. However, there was an outlier retained in the analysis. Results should be interpreted with caution and along with graphical results.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	7.768	4	0.1004

Doris Lake North did not exhibit significant deviation from no trend.

Open-Water

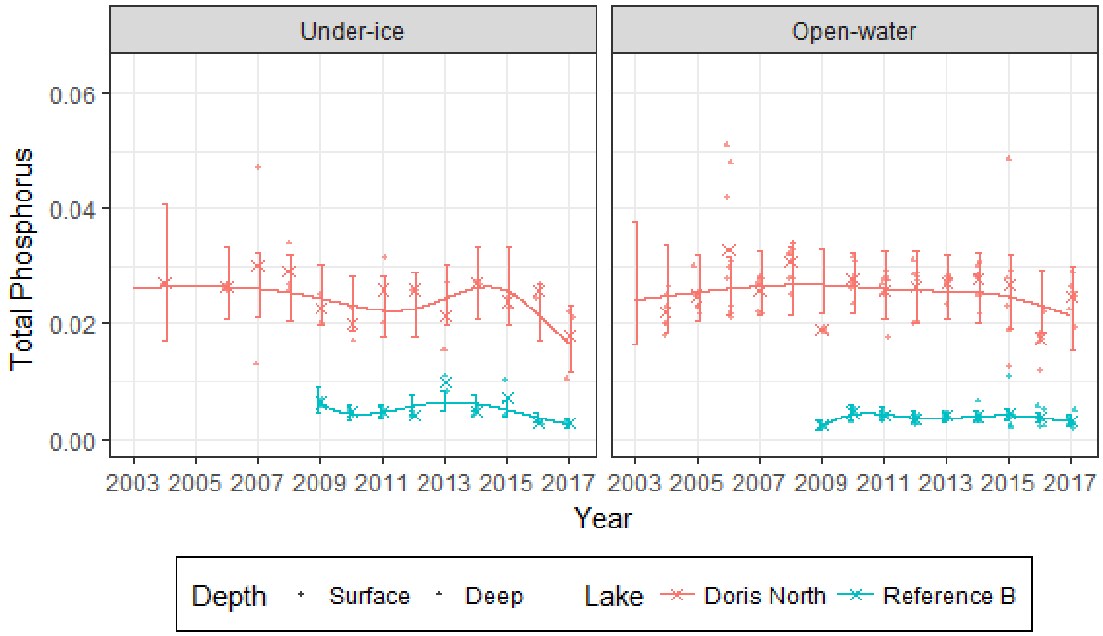
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.91	4	0.7523

Doris Lake North did not exhibit significant deviation from no trend.

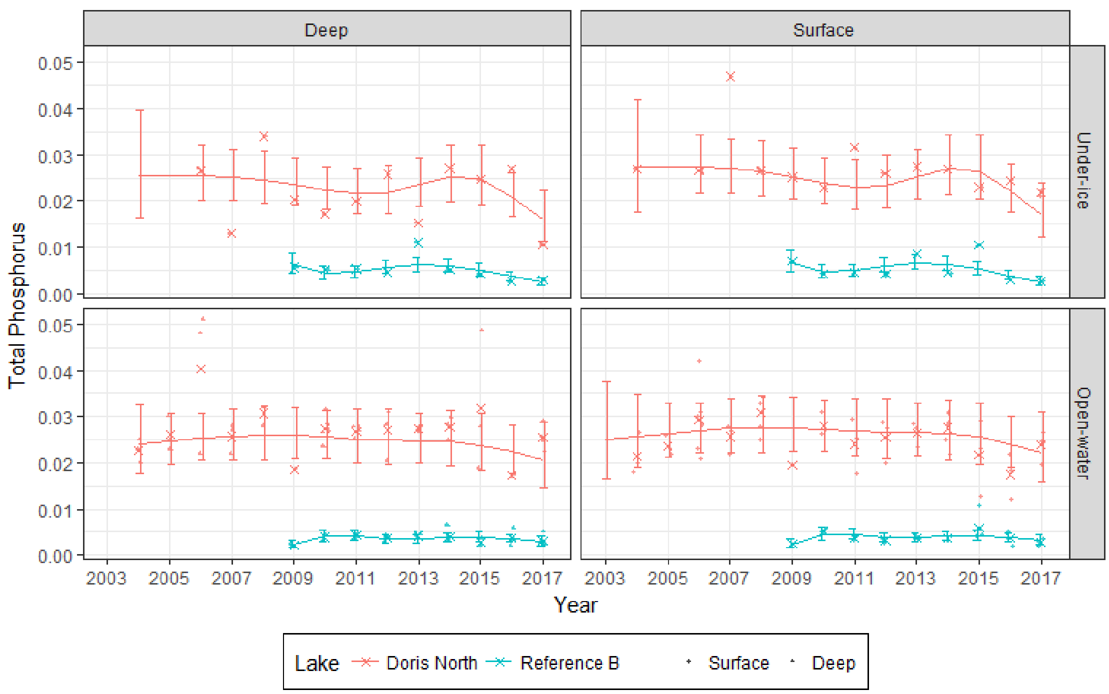
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



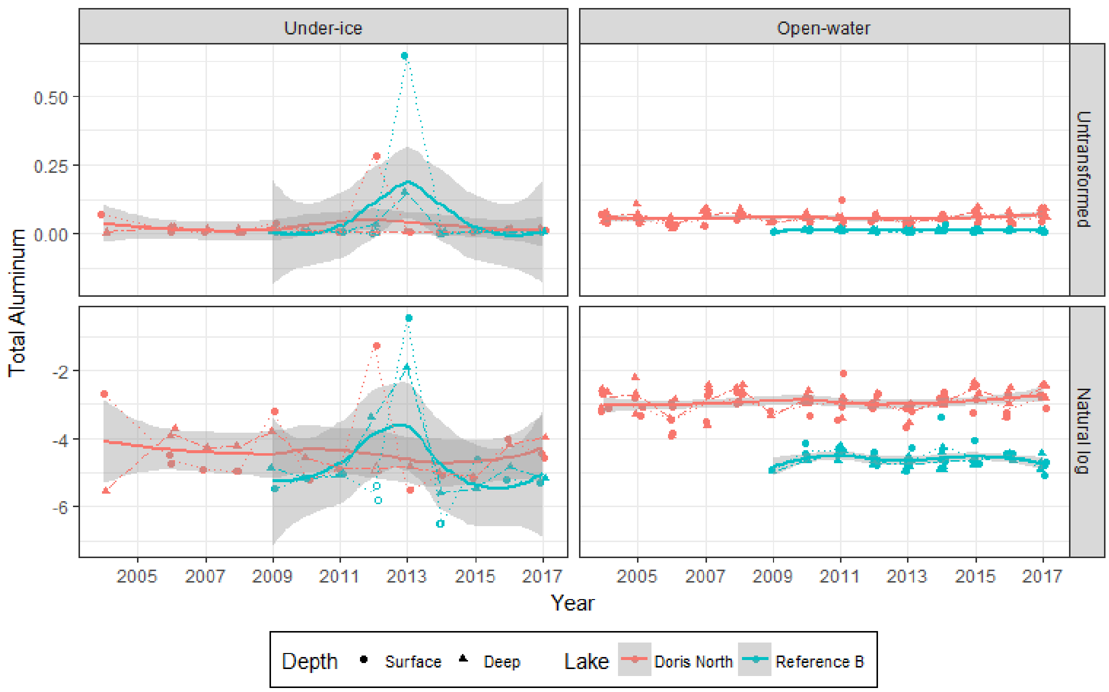
Plot of observed and fitted data separated by depth:



B.3.1.10 Analysis of Total Aluminum

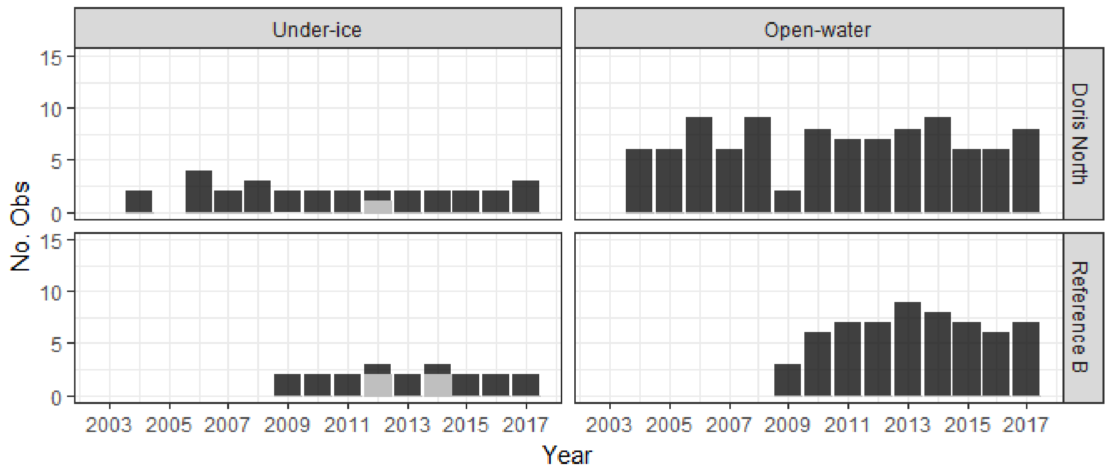
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

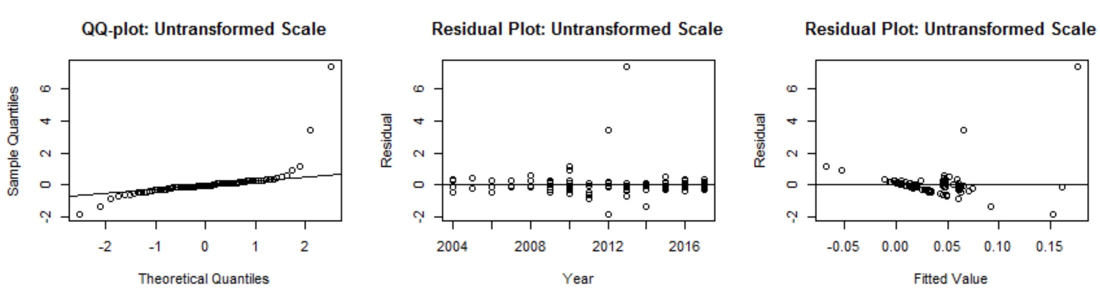
The sample sizes and median values per lake and season are summarized in the table below.

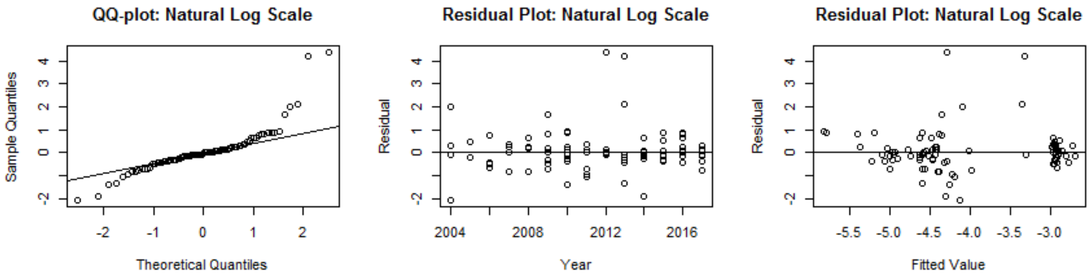
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	1	0.03	0.01040
Doris North	Open-water	97	0	0.00	0.05350
Reference B	Under-ice	20	4	0.20	0.00585
Reference B	Open-water	60	0	0.00	0.00955

Reference B exhibited more than 10% of data under detection limit in one (or more) of the seasons. The analysis proceeds with tobit regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
33	Doris North	2012	Under-ice	Surface	0.280	0.0650711	3.395444
73	Reference B	2013	Under-ice	Surface	0.644	0.1765834	7.384243

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
33	Doris North	2012	Under-ice	Surface	0.280	-4.288396	4.366394
73	Reference B	2013	Under-ice	Surface	0.644	-3.321515	4.172402

The natural log transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	4.252	4	0.3730

Doris Lake North did not exhibit significant deviation from no trend.

Open-Water

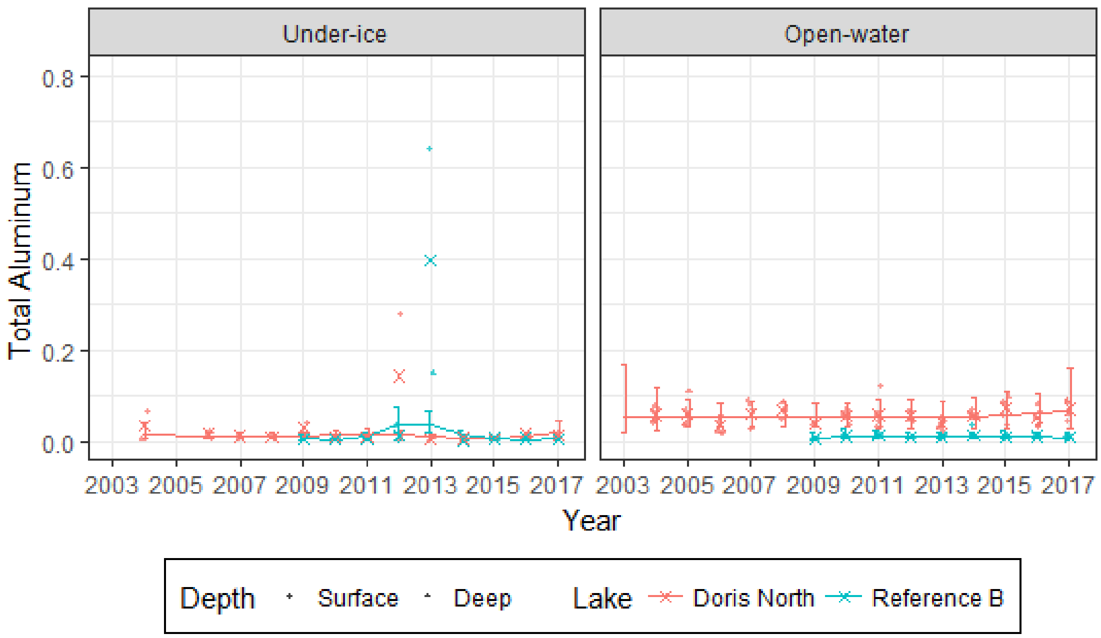
Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.265	4	0.6871

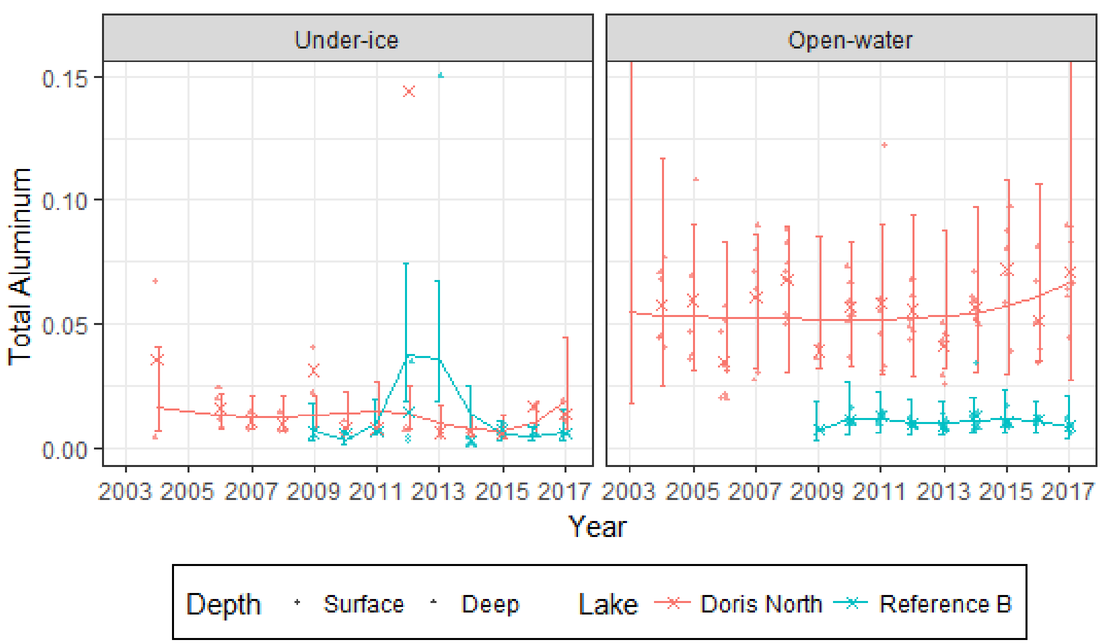
Doris Lake North did not exhibit significant deviation from no trend.

Observed Data and Fitted Values

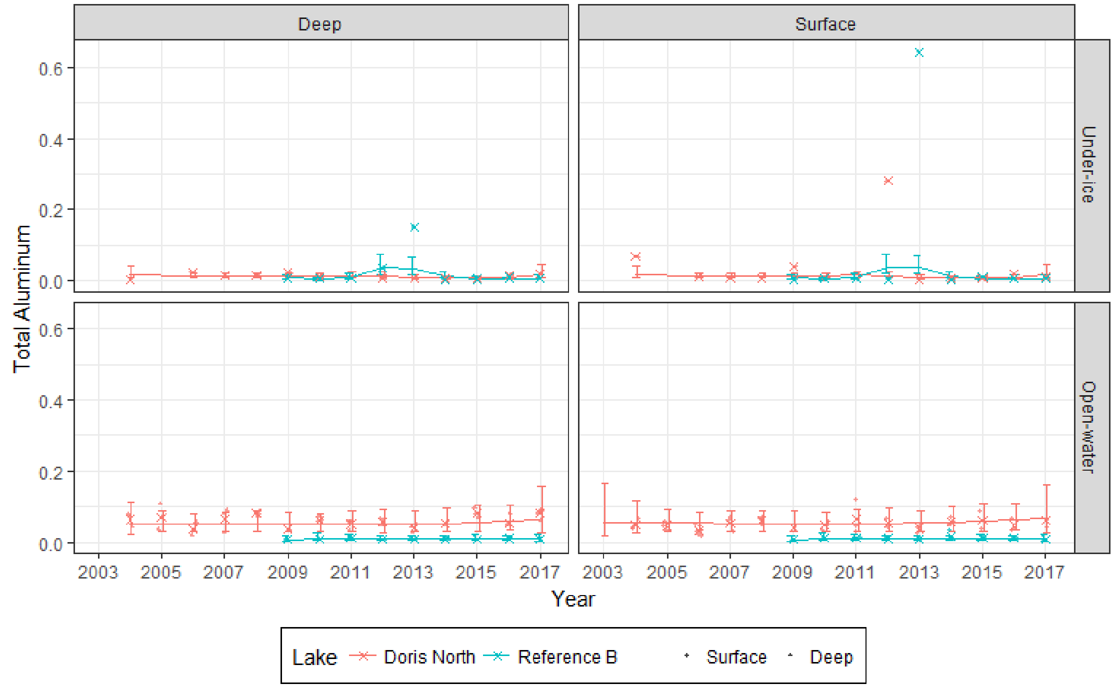
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:





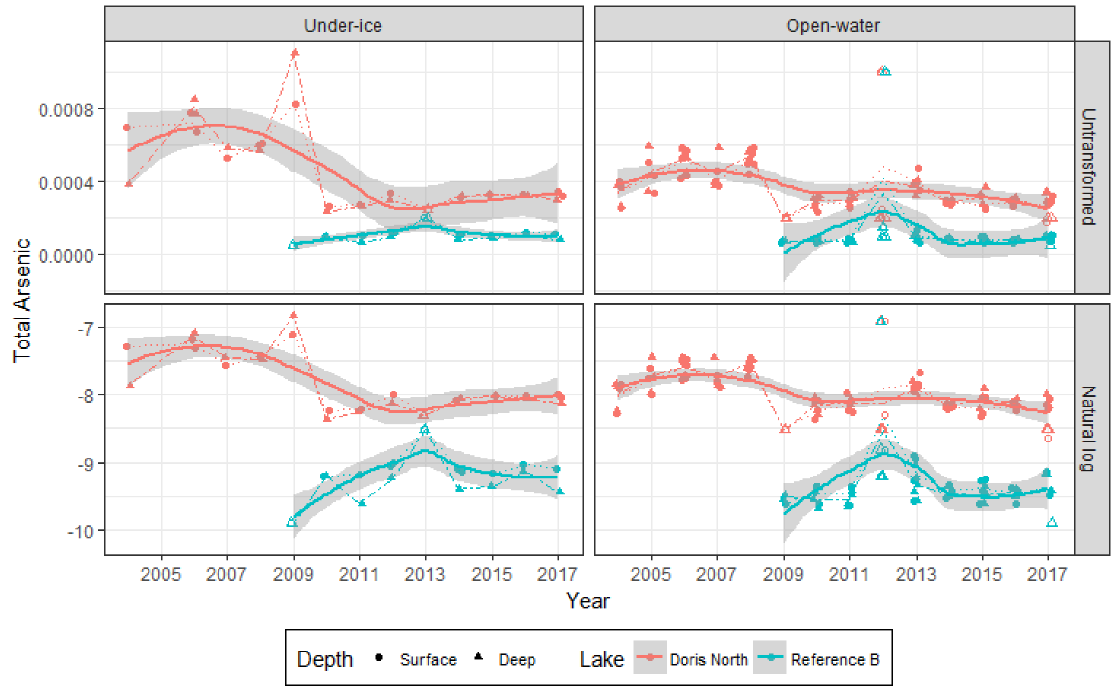
Plot of observed and fitted data separated by depth.



B.3.1.11 Analysis of Total Arsenic

<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

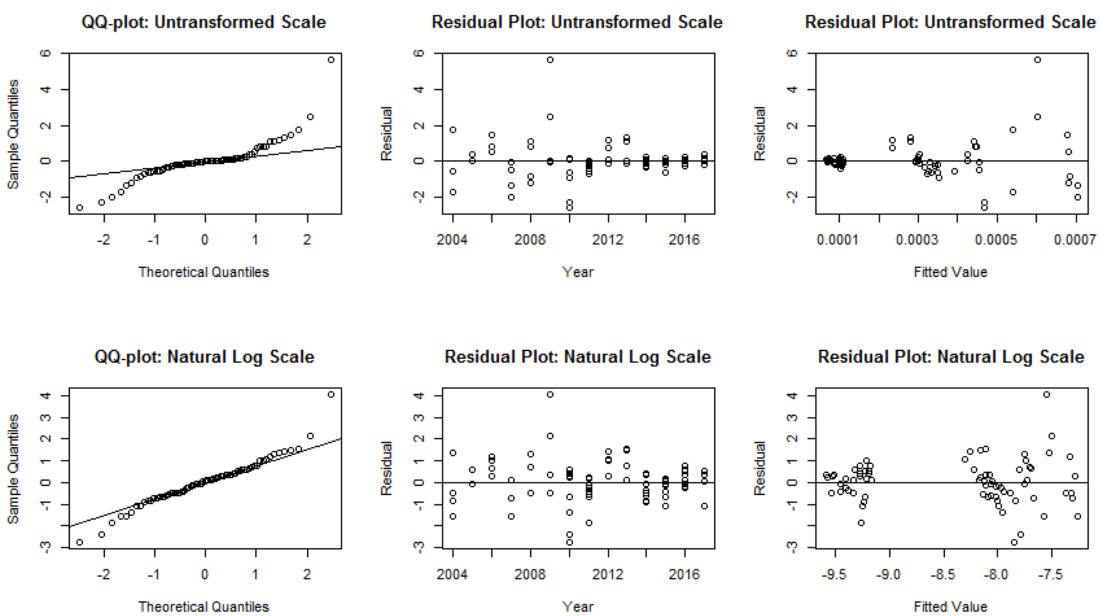
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	2	0.07	0.000363
Doris North	Open-water	97	12	0.12	0.000369
Reference B	Under-ice	20	4	0.20	0.000104
Reference B	Open-water	60	9	0.15	0.000081

Doris North and Reference B exhibited more than 10% of data under detection limit in one (or more) of the seasons. The analysis proceeds with tobit regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
20	Doris North	2009	Under-ice	Deep	0.0011	0.0006026	5.670979

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
20	Doris North	2009	Under-ice	Deep	0.0011	-7.553951	4.063235

The natural log transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	84.697	4	0.0000
Compare to Reference B	30.825	4	0.0000

Doris Lake North appears to show significant deviation from no trend. Doris Lake North appears to show significant deviation from the trend of Reference B lake.

Open-Water

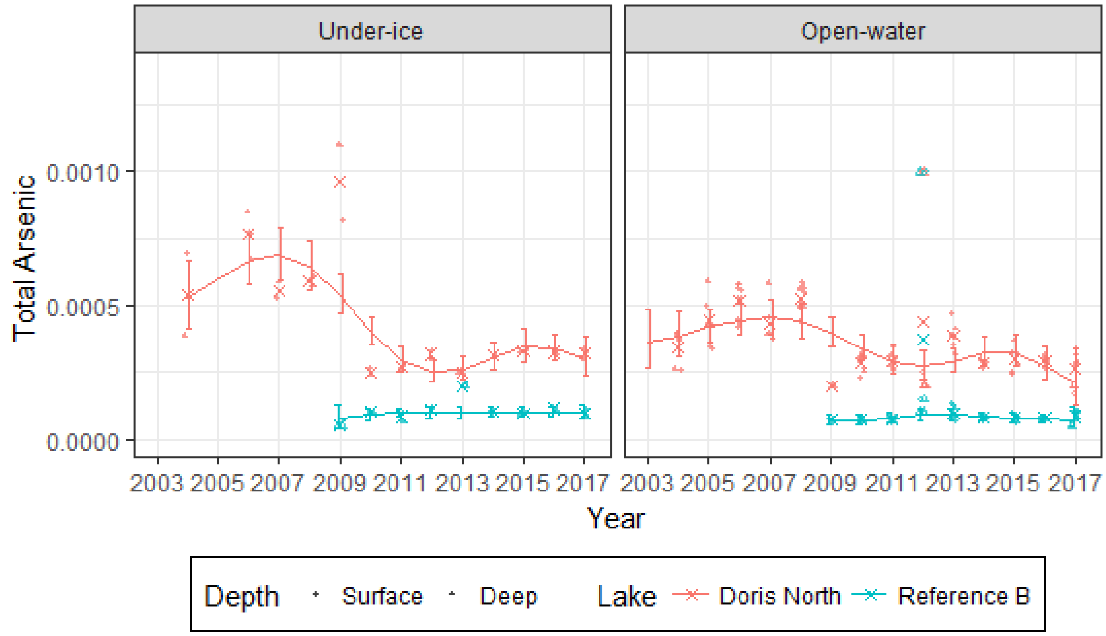
Analysis	Chi.sq	DF	P.value
Compare to slope 0	11.031	4	0.0262
Compare to Reference B	1.721	4	0.7868

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

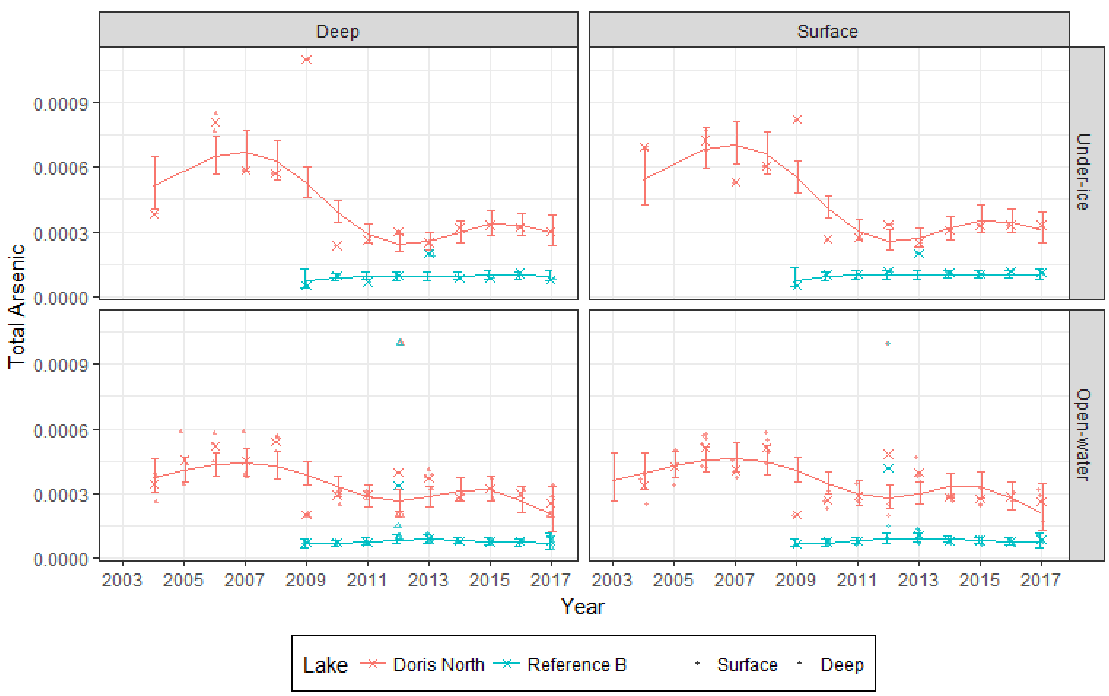
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of observed and fitted data averaged over depth:



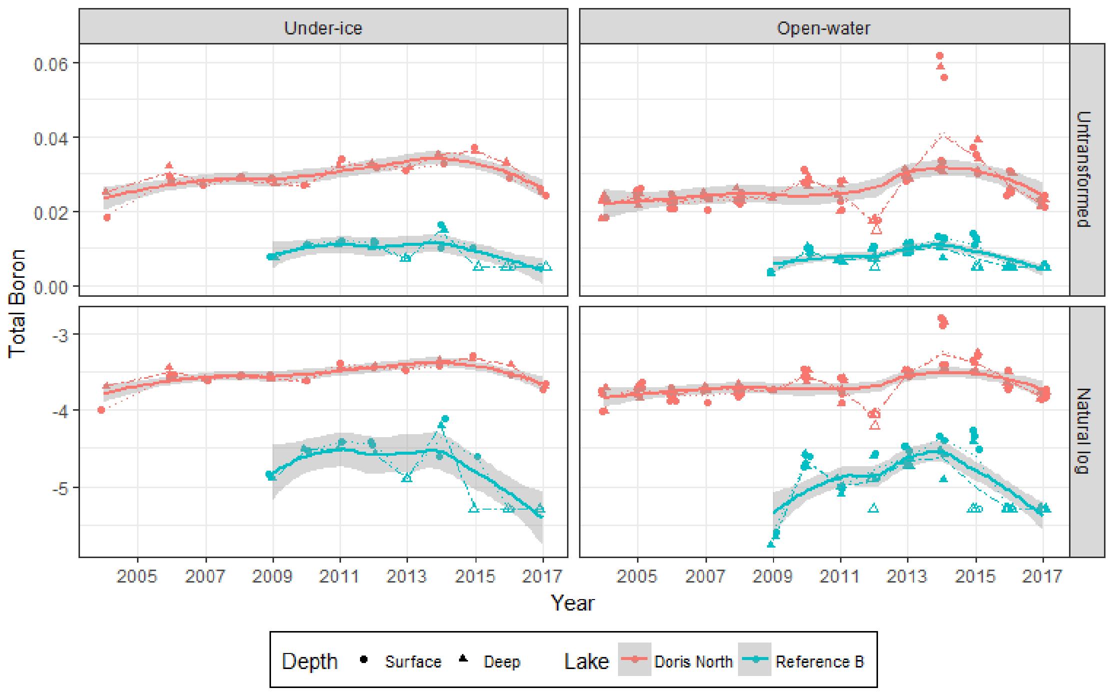
Plot of observed and fitted data separated by depth:



B.3.1.12 Analysis of Total Boron

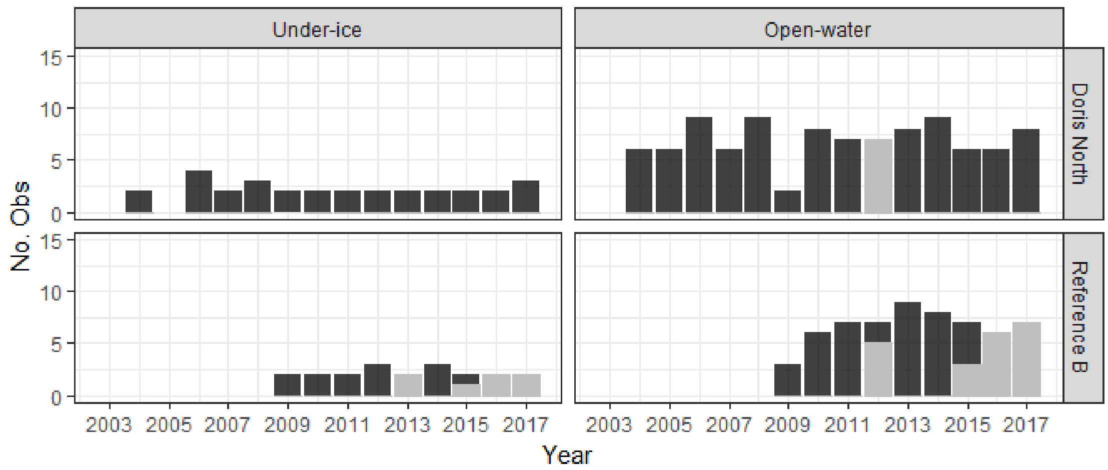
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

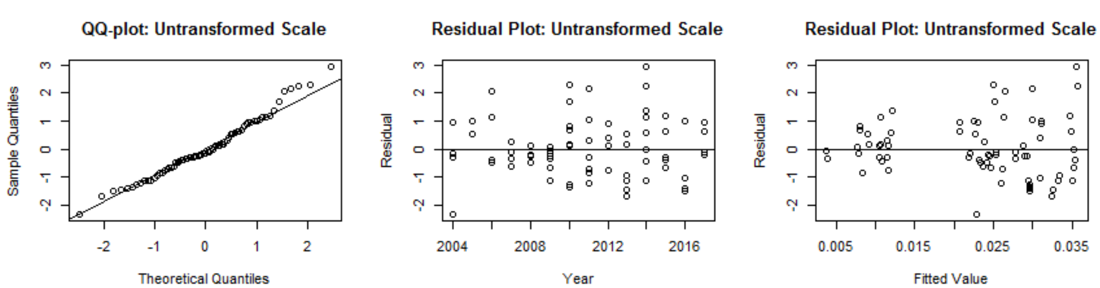
The sample sizes and median values per lake and season are summarized in the table below.

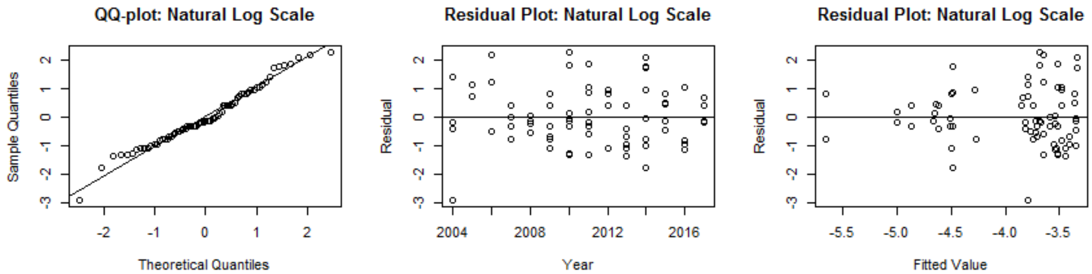
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	0	0.00	0.02900
Doris North	Open-water	97	7	0.07	0.02500
Reference B	Under-ice	20	7	0.35	0.01055
Reference B	Open-water	60	21	0.35	0.01000

Reference B exhibited more than 10% of data under detection limit in one (or more) of the seasons. The analysis proceeds with tobit regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

<u>Test Results for Monitored lake</u>

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	80.193	4	0.0000
Compare to Reference B	14.698	4	0.0054

Doris Lake North appears to show significant deviation from no trend. Doris Lake North appears to show significant deviation from the trend of Reference B lake.

Open-Water

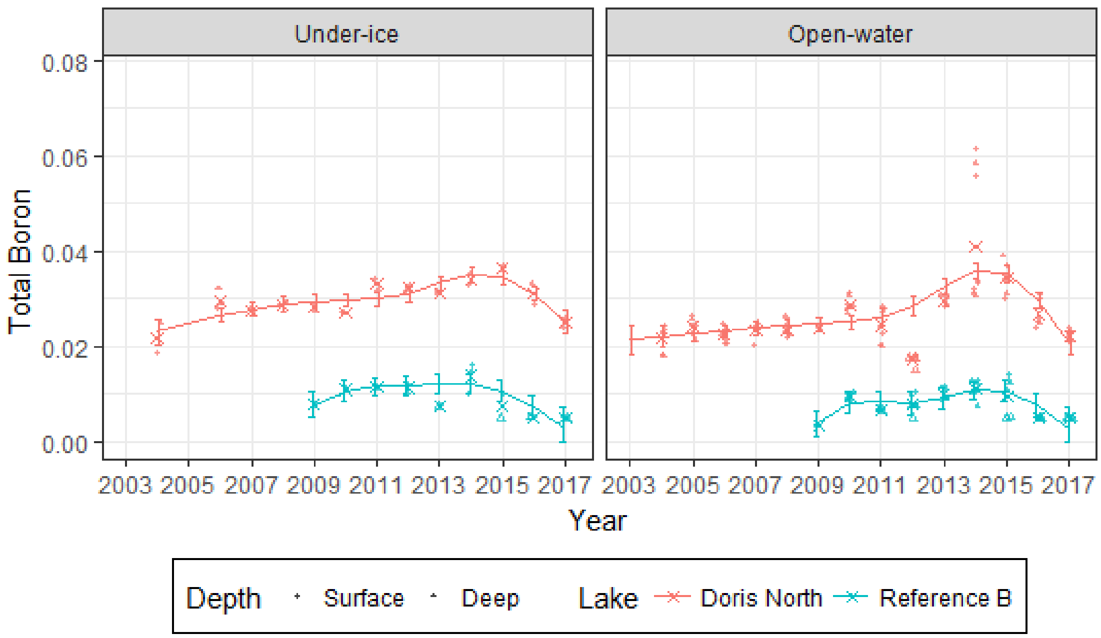
Analysis	Chi.sq	DF	P.value
Compare to slope 0	12.710	4	0.0128
Compare to Reference B	3.578	4	0.4662

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

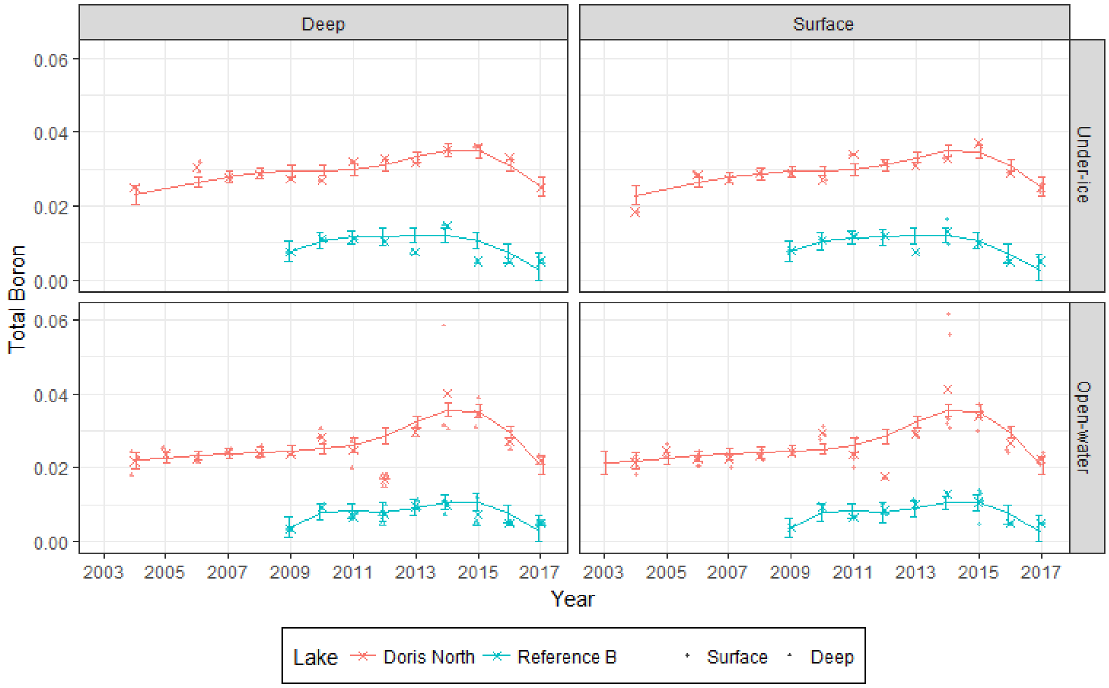
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



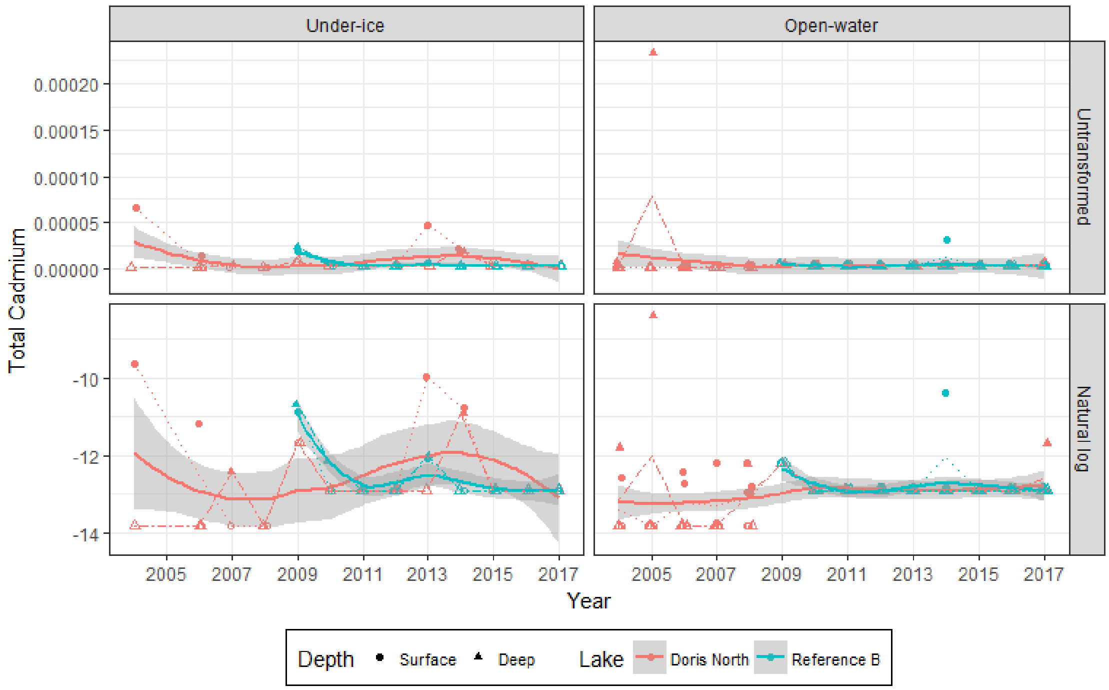
Plot of observed and fitted data separated by depth:



B.3.1.13 Analysis of Total Cadmium

<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

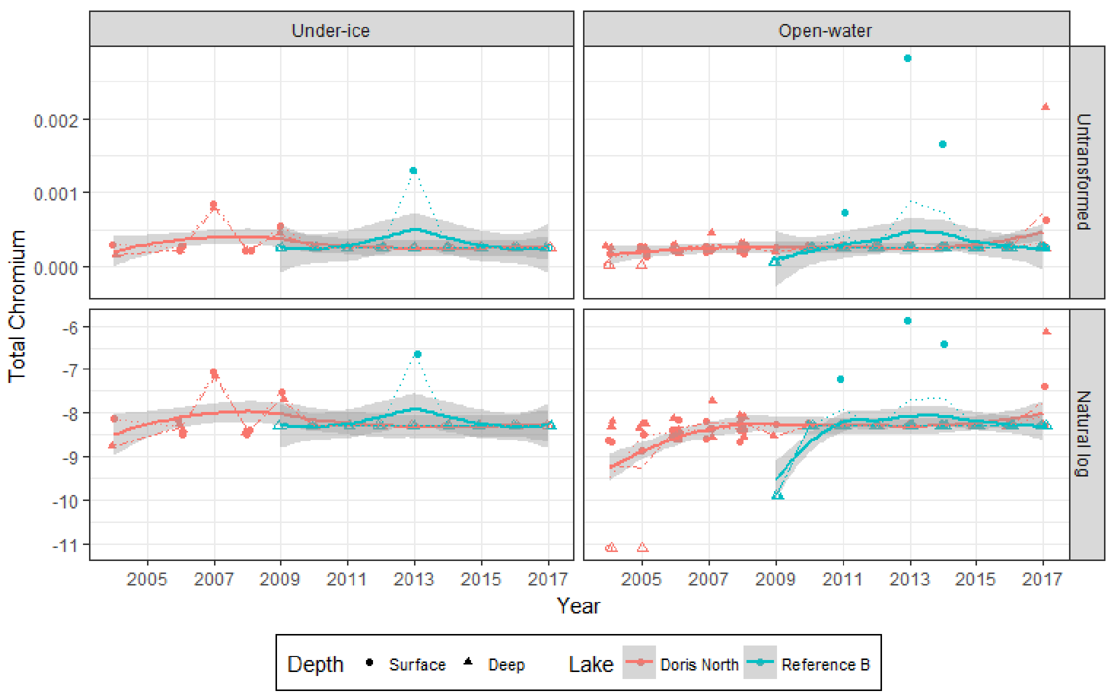
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	24	0.80	0.000005
Doris North	Open-water	97	83	0.86	0.000005
Reference B	Under-ice	20	15	0.75	0.000005
Reference B	Open-water	60	59	0.98	0.000005

More than 60% of data under detection limit for Doris North and Reference B. Doris North and Reference B removed from the analyses. No statistical analyses were performed.

B.3.1.14 Analysis of Total Chromium

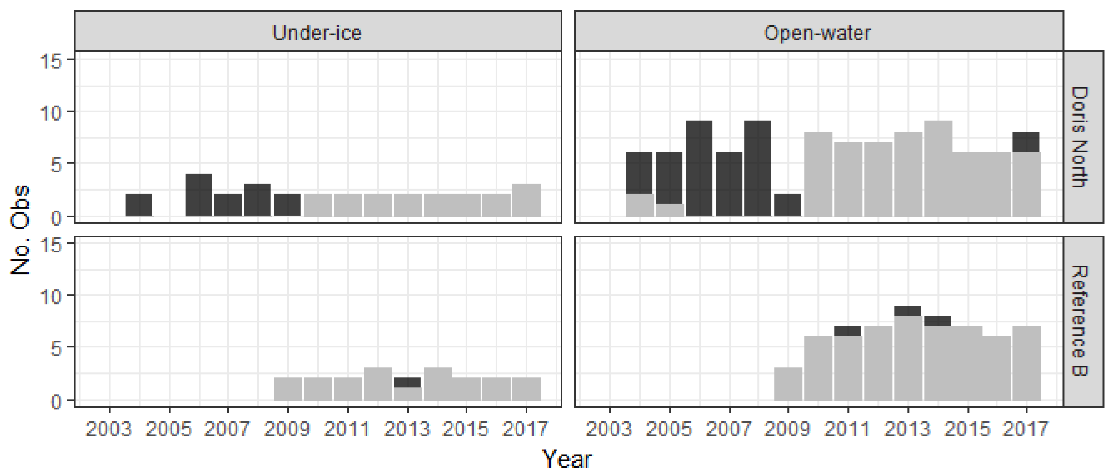
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	17	0.57	0.0005
Doris North	Open-water	97	60	0.62	0.0005
Reference B	Under-ice	20	19	0.95	0.0005
Reference B	Open-water	60	57	0.95	0.0005

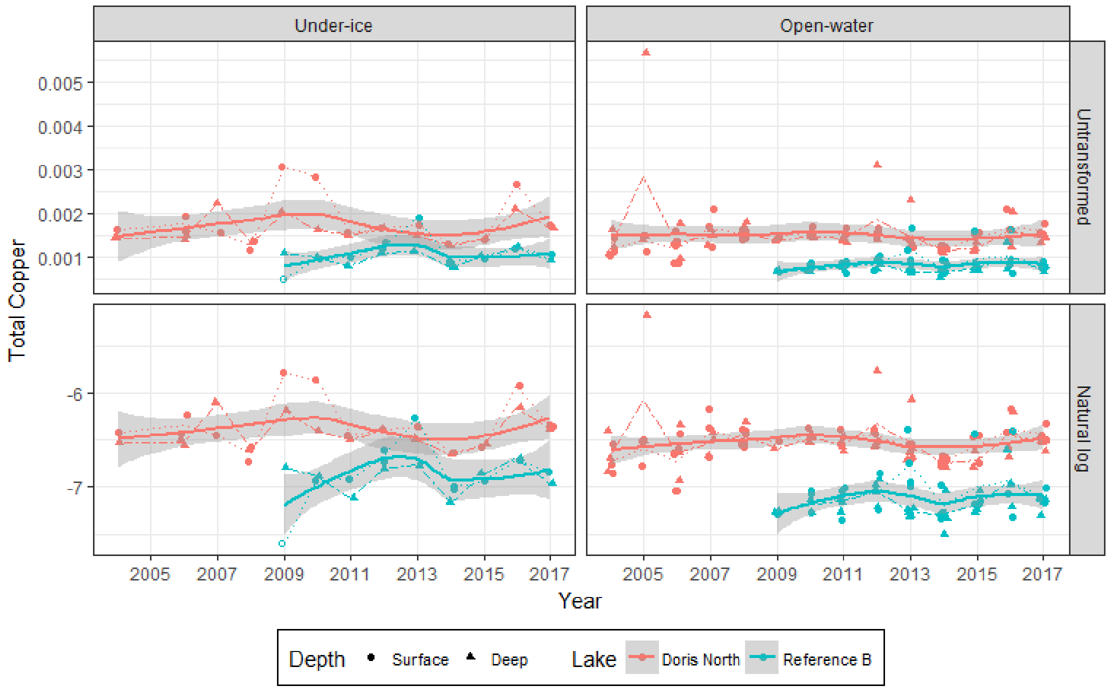
More than 60% of data under detection limit for Reference B. Reference B removed from the analyses. More than 60% of data under detection limit for Open-water. Data for Open-water will be removed from the analysis.

All data from Doris North Under-ice 2017 were censored, therefore data was removed from the analysis. All data removed from the analysis and no statistical analyses were performed.

B.3.1.15 Analysis of Total Copper

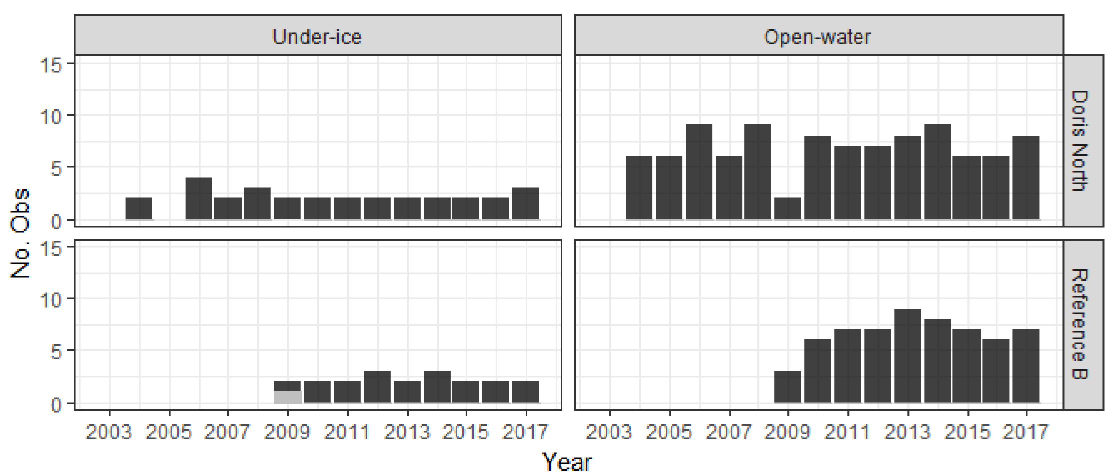
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

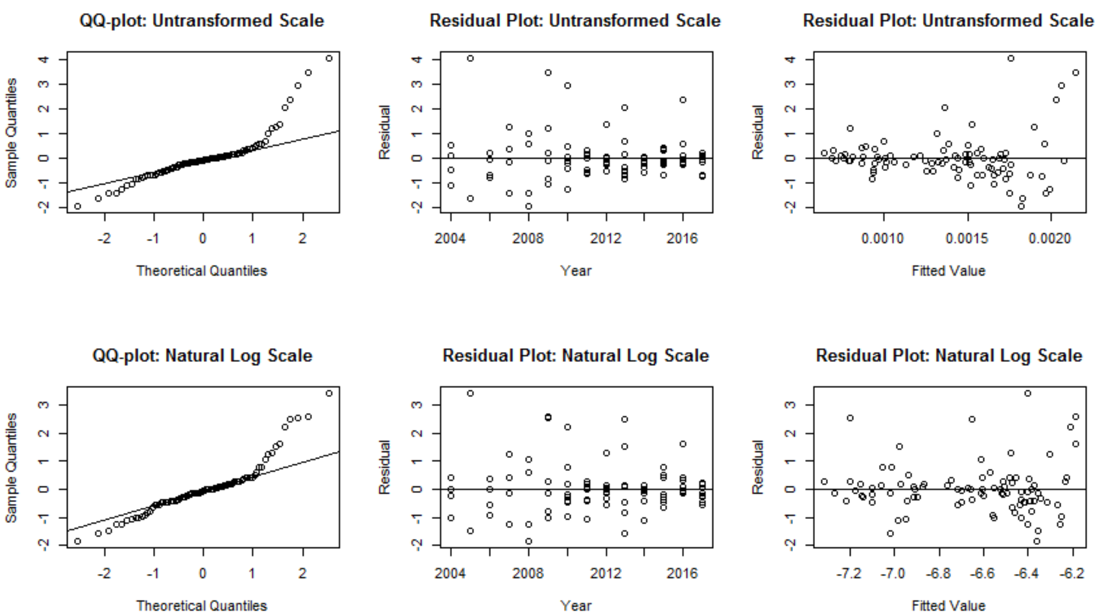
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	0	0.00	0.001620
Doris North	Open-water	97	0	0.00	0.001460
Reference B	Under-ice	20	1	0.05	0.001035
Reference B	Open-water	60	0	0.00	0.000785

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
6	Doris North	2005	Open-water	Deep	0.0028533	0.0017564	4.069884
21	Doris North	2009	Under-ice	Surface	0.0030900	0.0021445	3.508282

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
6	Doris North	2005	Open-water	Deep	0.0028533	-6.399291	3.435608

The natural log-transformed data better meets the residual assumptions. Analysis proceeds with natural log-transformed data. However, there was an outlier retained in the analysis. Results should be interpreted with caution and along with graphical results.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	4.188	4	0.3812

Doris Lake North did not exhibit significant deviation from no trend.

Open-Water

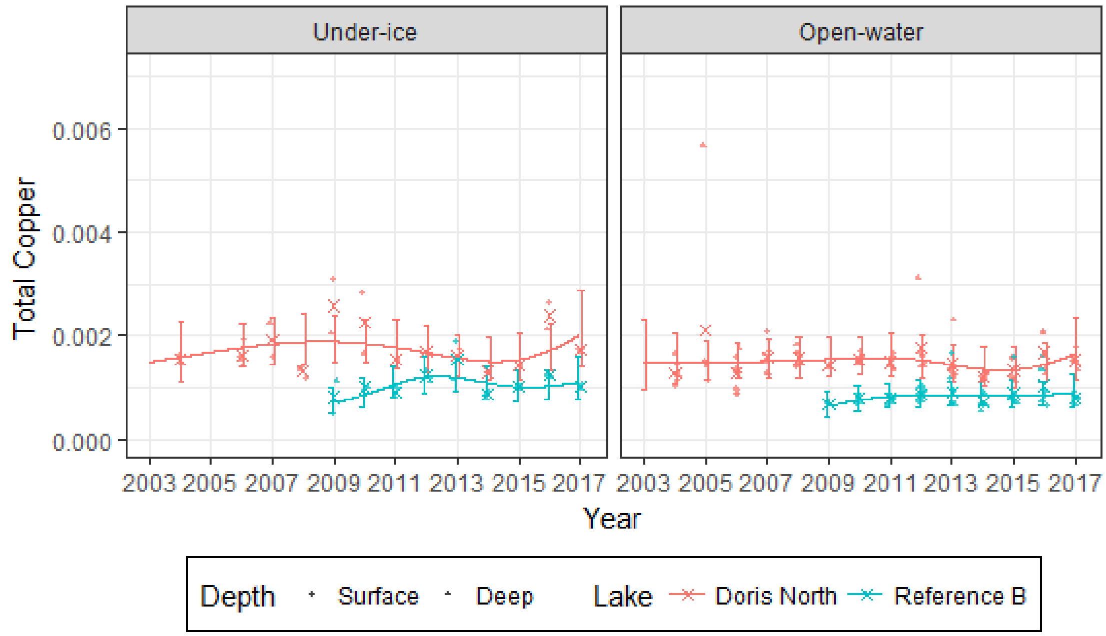
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.159	4	0.8848

Doris Lake North did not exhibit significant deviation from no trend.

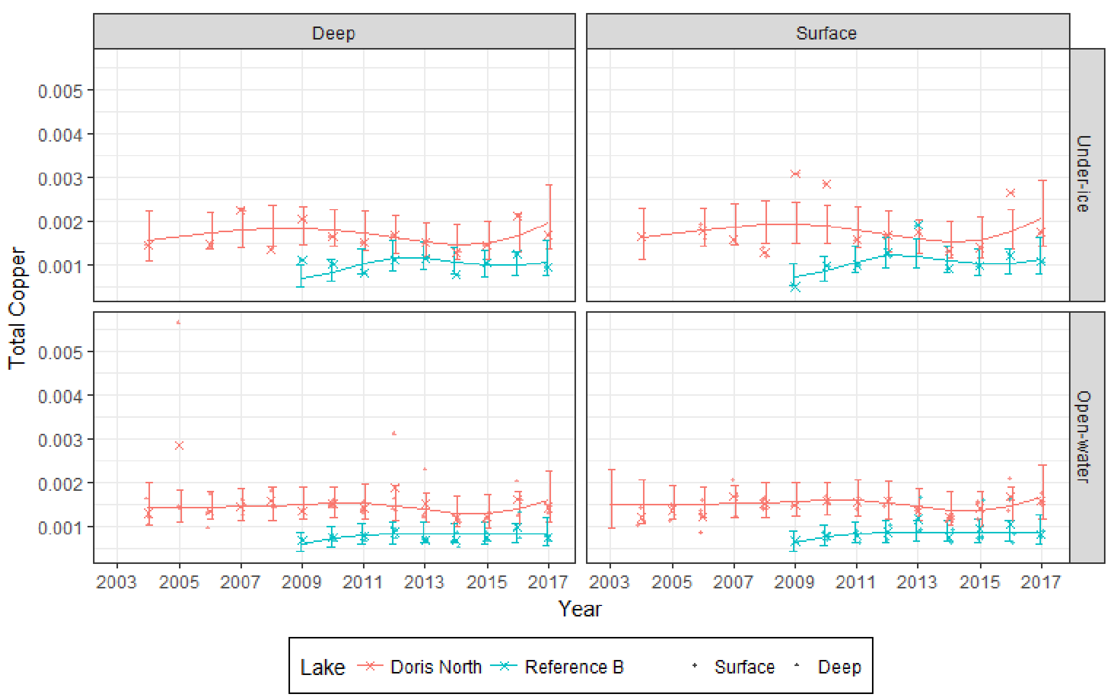
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



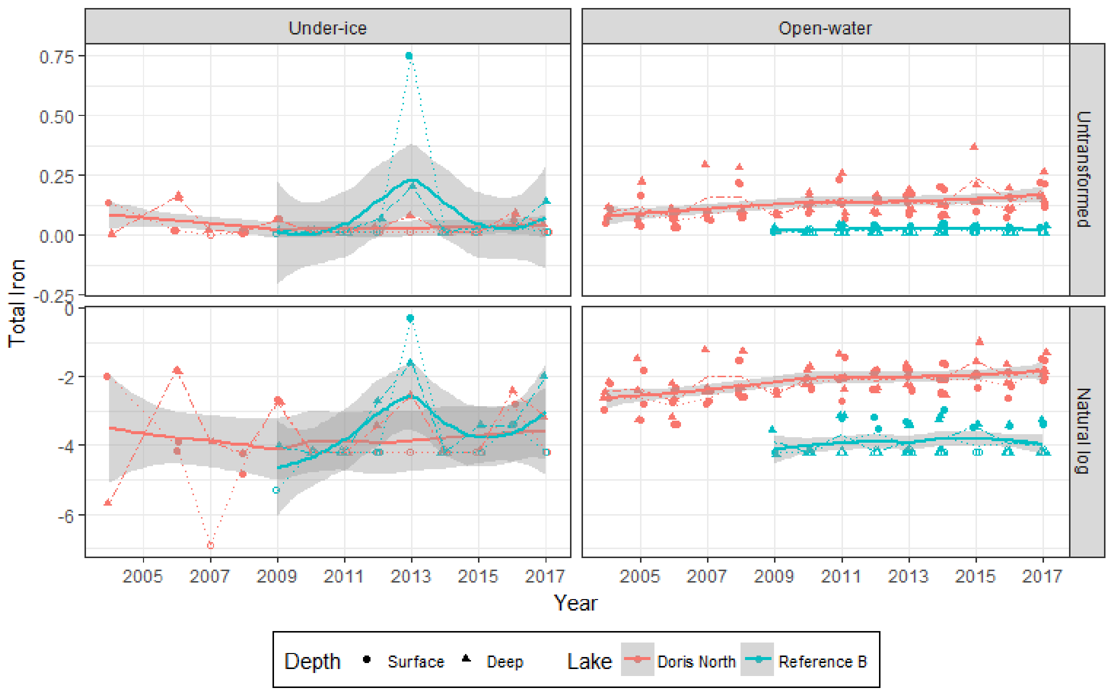
Plot of observed and fitted data separated by depth:



B.3.1.16 Analysis of Total Iron

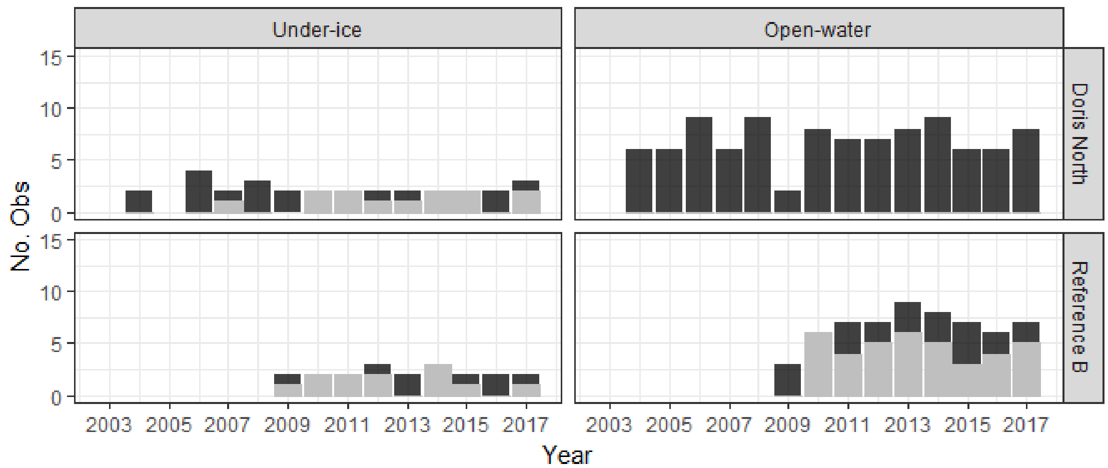
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

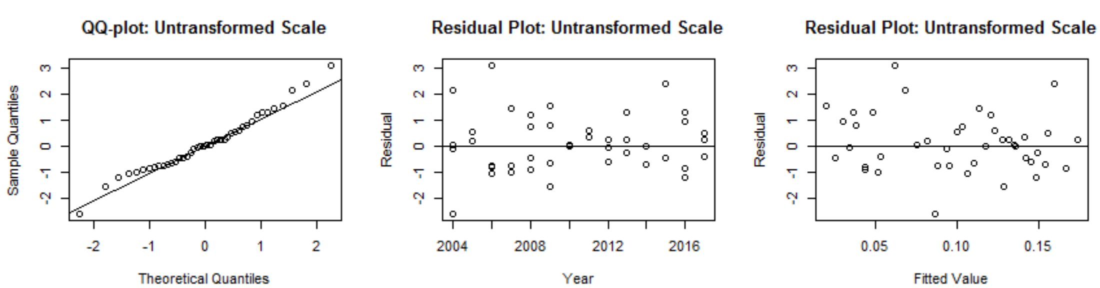
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	13	0.43	0.030
Doris North	Open-water	97	0	0.00	0.111
Reference B	Under-ice	20	12	0.60	0.030
Reference B	Open-water	60	38	0.63	0.030

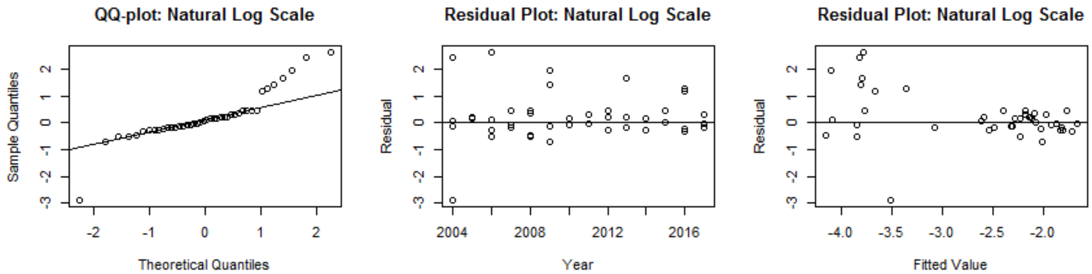
More than 60% of data under detection limit for Reference B. Reference B removed from the analyses.

Linear mixed model regression cannot be performed when only one site remains in the analysis. Proceeding with Tobit regression for the remainder of the analyses. Results for LME and Tobit are comparable when all or most of the data is above detection limit.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
8	Doris North	2006	Under-ice	Deep	0.16	0.0613768	3.083851

Outliers on natural log scale:

None.

The natural log-transformed data better meets the residual assumptions. Analysis proceeds with natural log-transformed data.

Test Results for Monitored Lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.932	4	0.7483

Doris Lake North did not exhibit significant deviation from no trend.

Open-Water

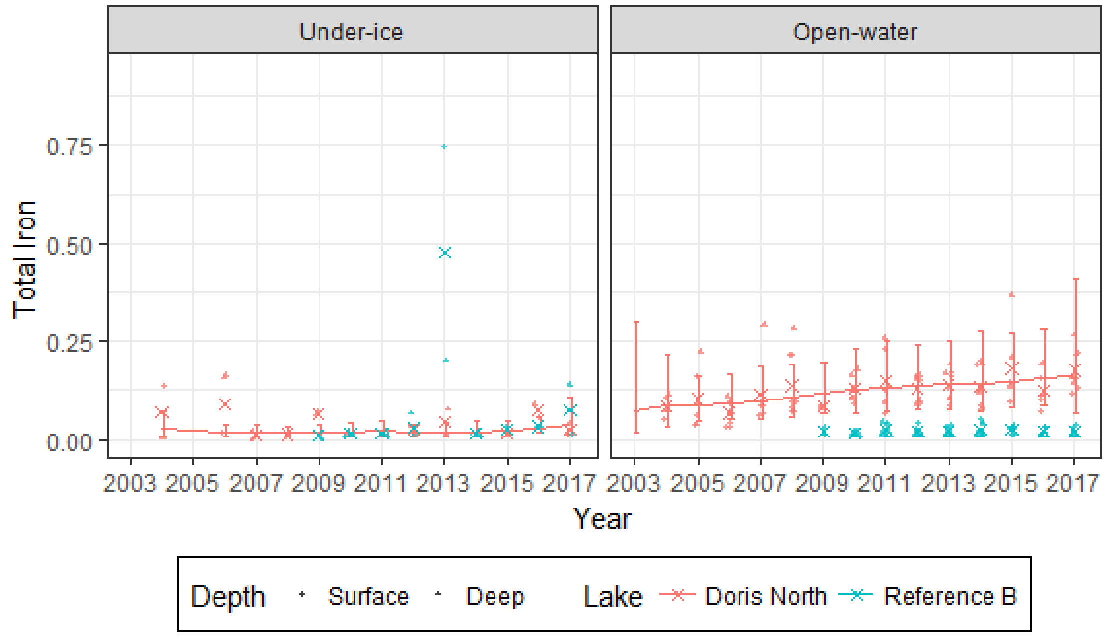
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.077	4	0.8980

Doris Lake North did not exhibit significant deviation from no trend.

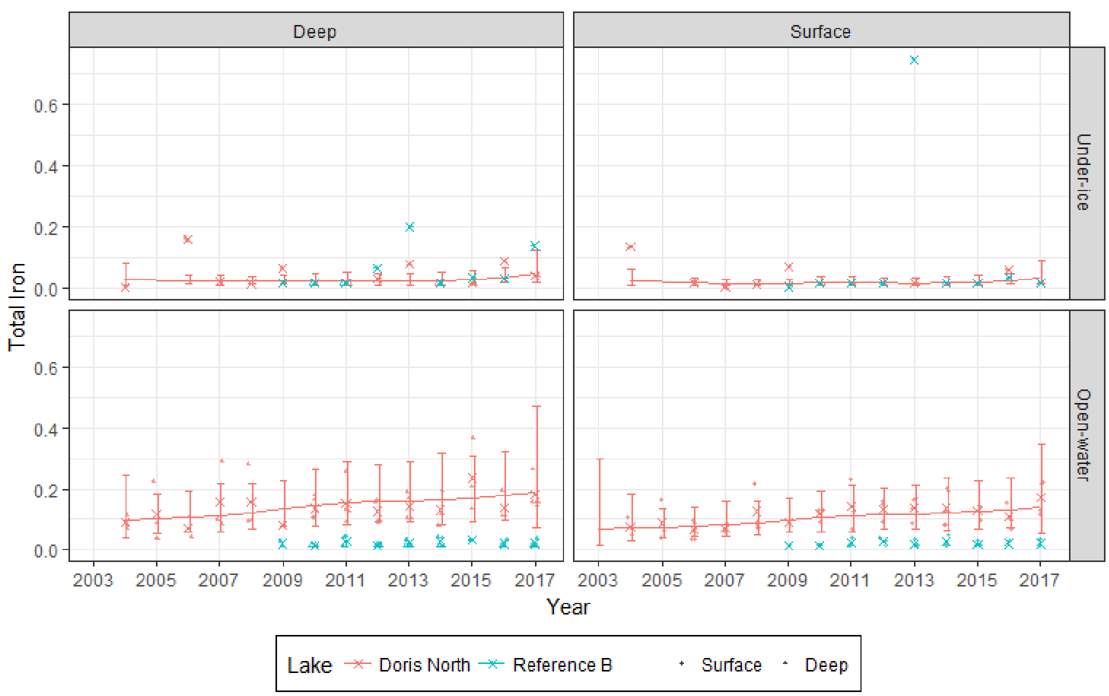
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



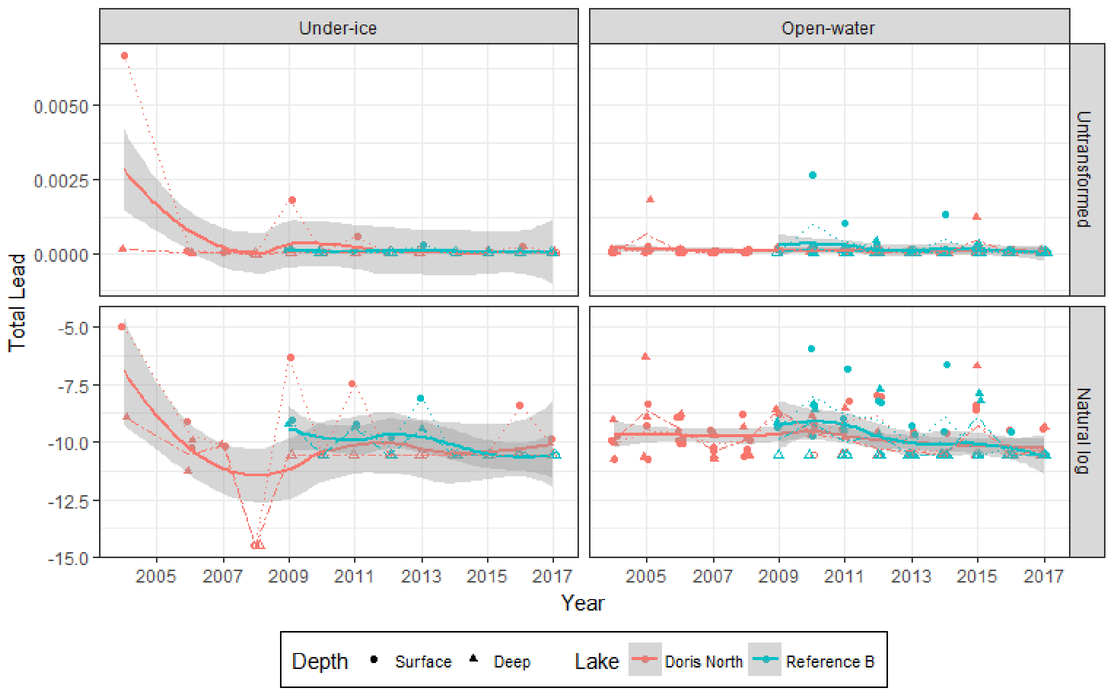
Plot of observed and fitted data separated by depth.



B.3.1.17 Analysis of Total Lead

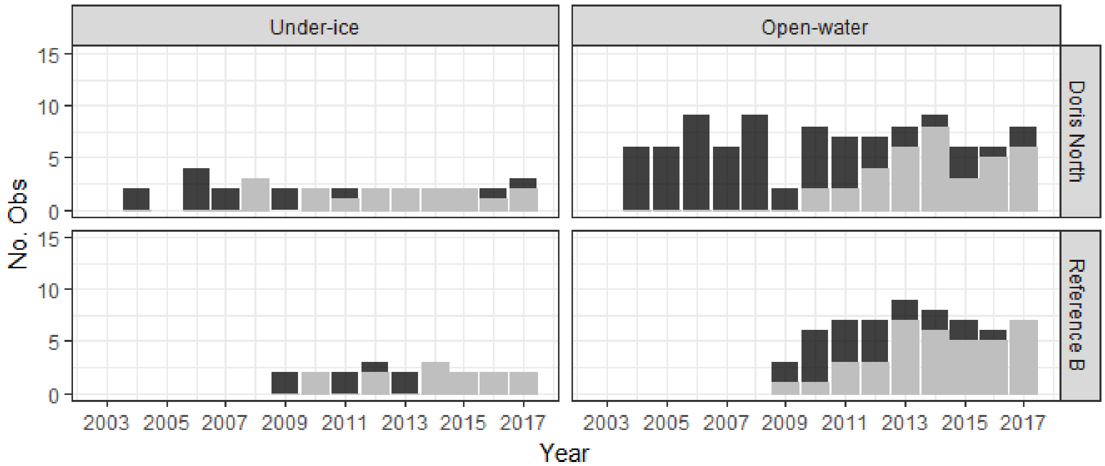
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

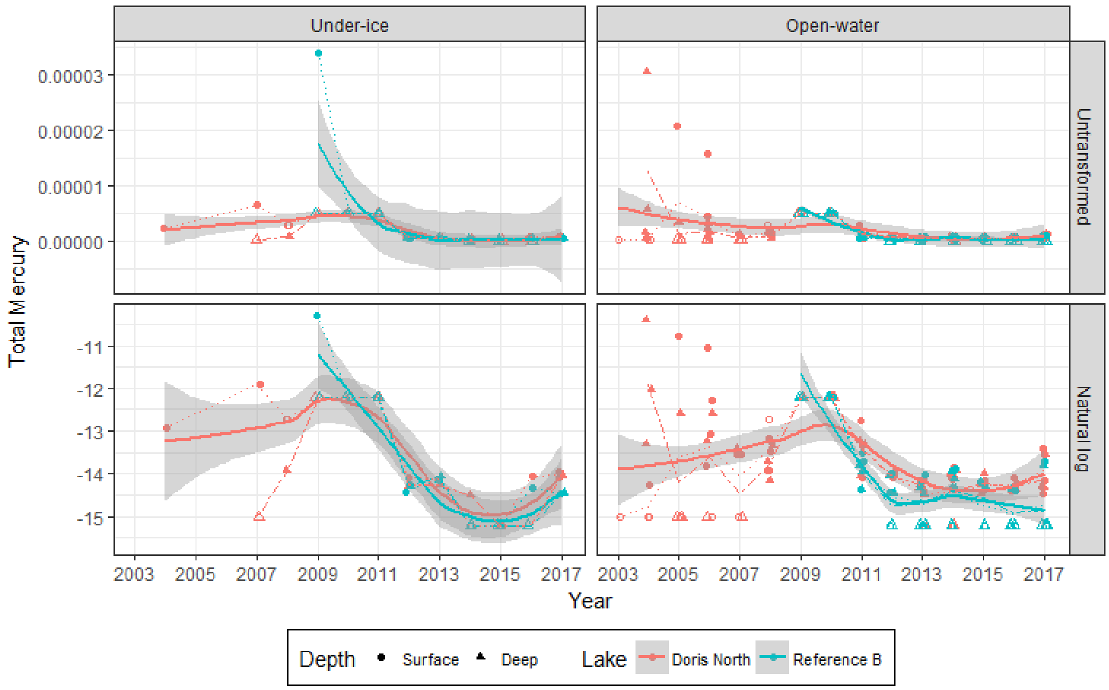
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	18	0.60	0.00005
Doris North	Open-water	97	36	0.37	0.00005
Reference B	Under-ice	20	13	0.65	0.00005
Reference B	Open-water	60	38	0.63	0.00005

More than 60% of data under detection limit for Reference B. Reference B removed from the analyses. More than 60% of data under detection limit for Under-ice. Data for Under-ice will be removed from the analysis. Though only 37% of data was under detection limit for Doris North Open-water, inclusion of Doris North Open-water lead to unstable results. Hence, no statistical analyses performed.

B.3.1.18 Analysis of Total Mercury

Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

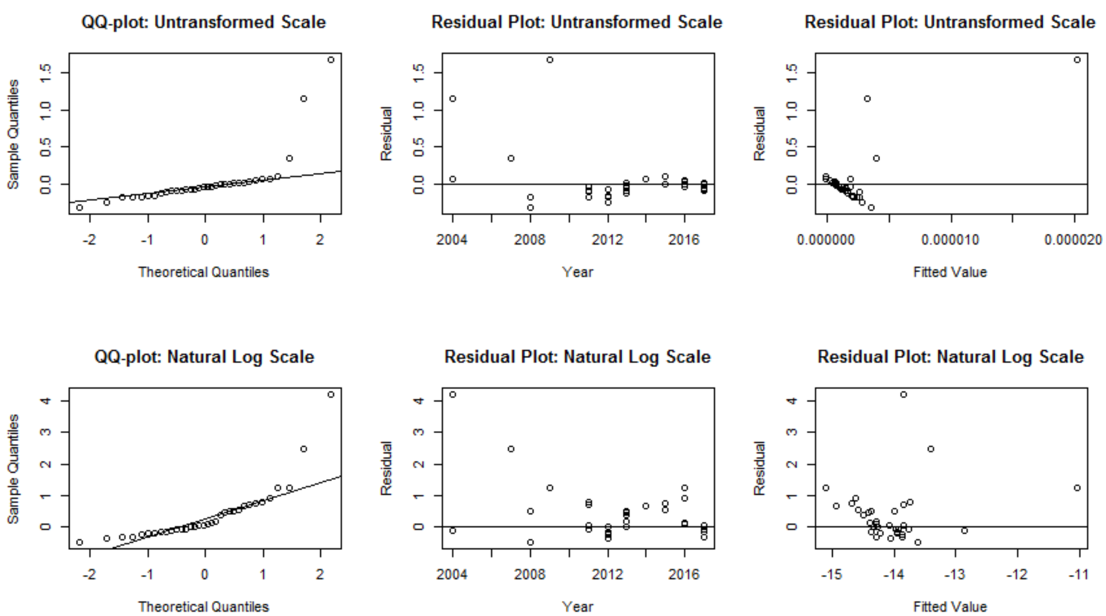
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	25	13	0.52	0.0000008
Doris North	Open-water	98	28	0.29	0.0000008
Reference B	Under-ice	20	11	0.55	0.0000006
Reference B	Open-water	60	30	0.50	0.0000006

Doris North and Reference B exhibited more than 10% of data under detection limit in one (or more) of the seasons. The analysis proceeds with tobit regression.

<u>Initial Model Fit</u>

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
4	Doris North	2004	Open-water	Deep	0.0000128	-13.8413	4.194852

There was an outlier retained in the analysis. Results should be interpreted with caution and along with graphical results. The untransformed data better meets the residual assumptions. Analysis proceeds with untransformed data.

Test Results for Monitored Lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.79	4	0.9398

Doris Lake North did not exhibit significant deviation from no trend.

Open-Water

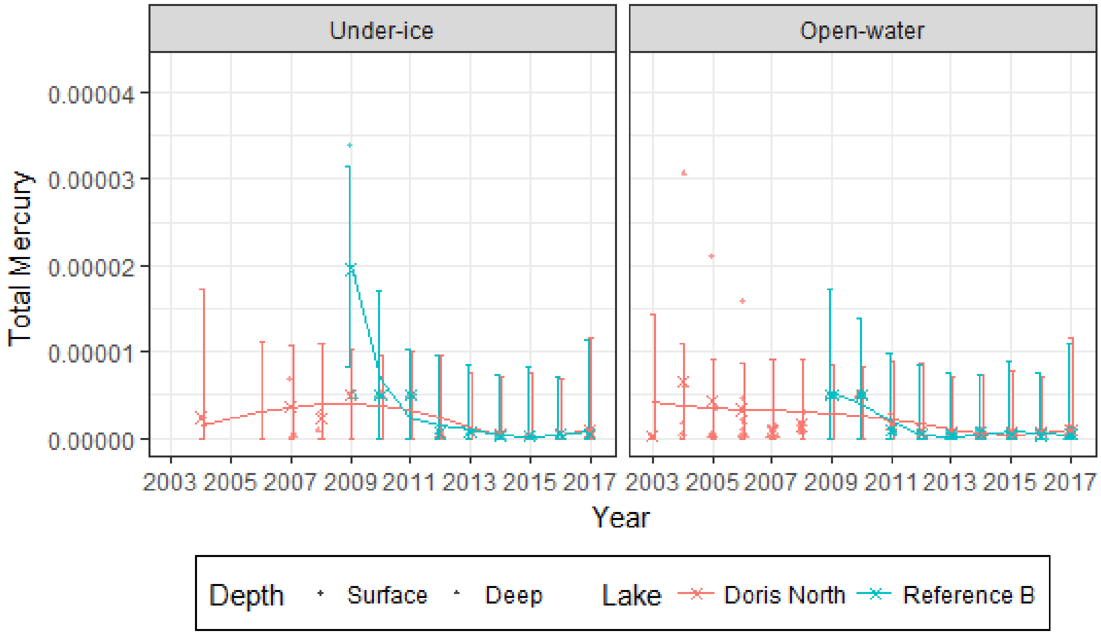
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.132	4	0.9979

Doris Lake North did not exhibit significant deviation from no trend.

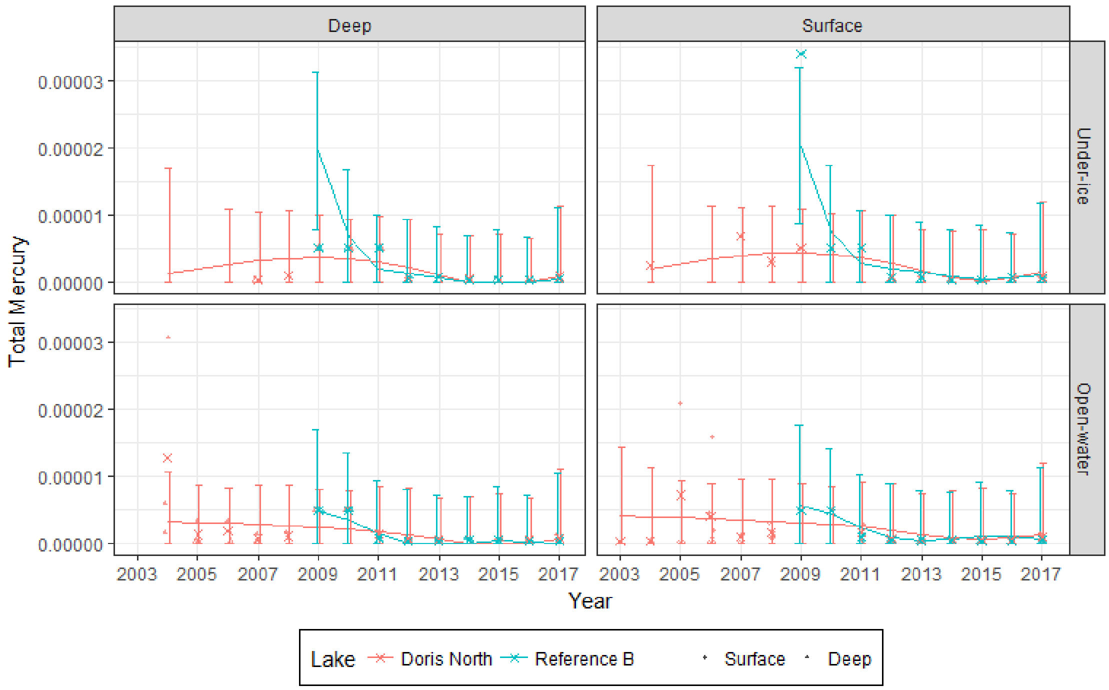
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth.



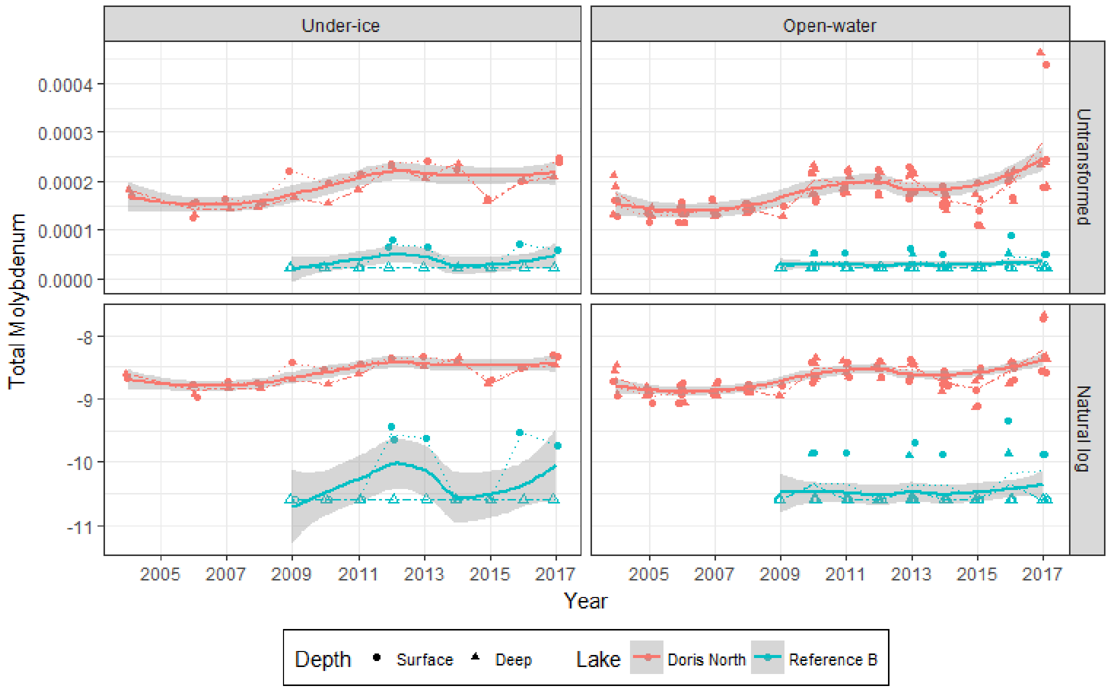
Plot of observed and fitted data separated by depth.



B.3.1.19 Analysis of Total Molybdenum

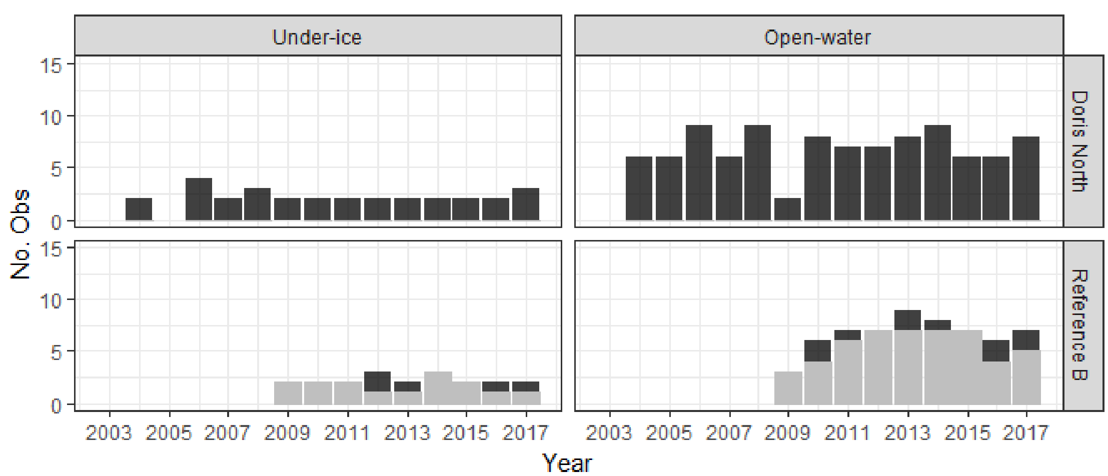
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

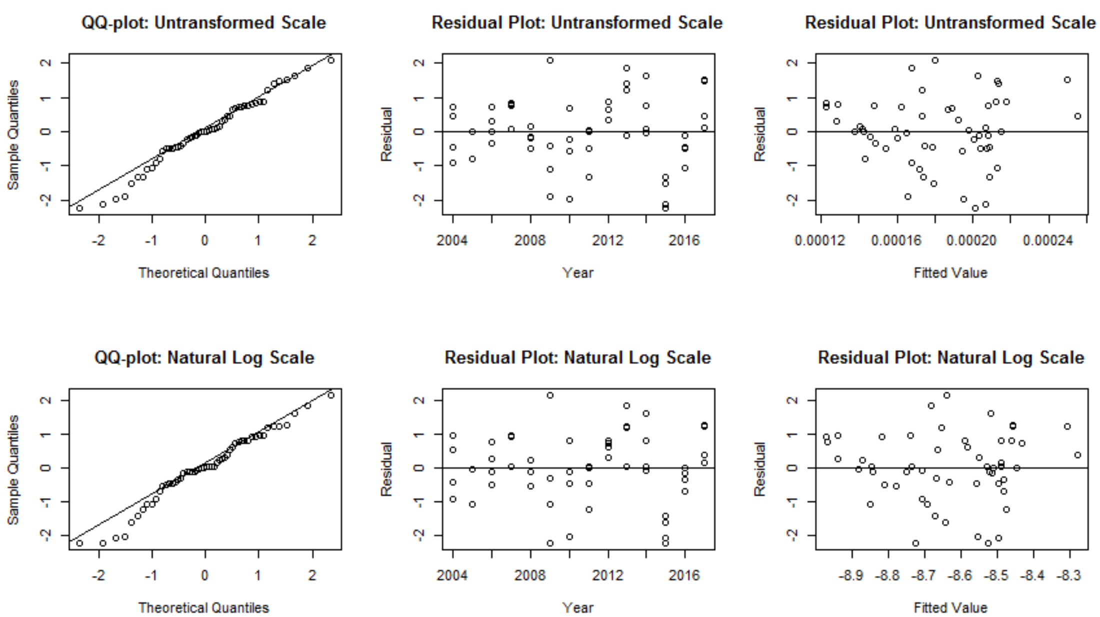
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	0	0.00	0.0001825
Doris North	Open-water	97	0	0.00	0.0001670
Reference B	Under-ice	20	15	0.75	0.0000500
Reference B	Open-water	60	50	0.83	0.0000500

More than 60% of data under detection limit for Reference B. Reference B removed from the analyses.

Linear mixed model regression cannot be performed when only one site remains in the analyis. Proceeding with Tobit regression for the remainder of the analyses. Results for LME and Tobit are comparable when all or most of the data is above detection limit.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	42.05	4	0.0000

Doris Lake North appears to show significant deviation from no trend.

Open-Water

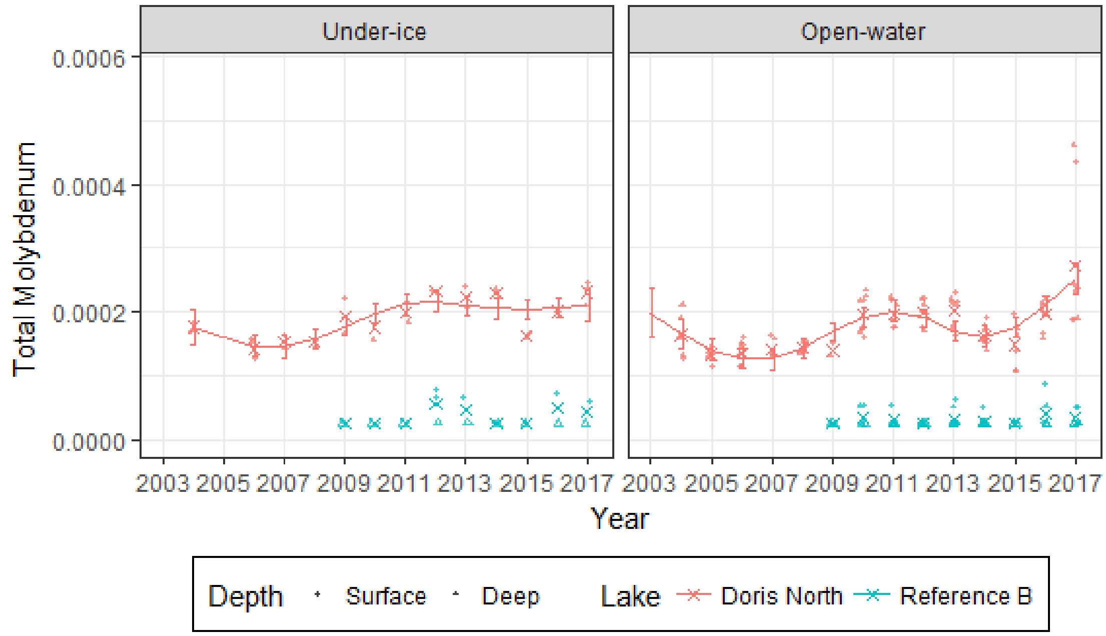
Analysis	Chi.sq	DF	P.value
Compare to slope 0	14.418	4	0.0061

Doris Lake North appears to show significant deviation from no trend.

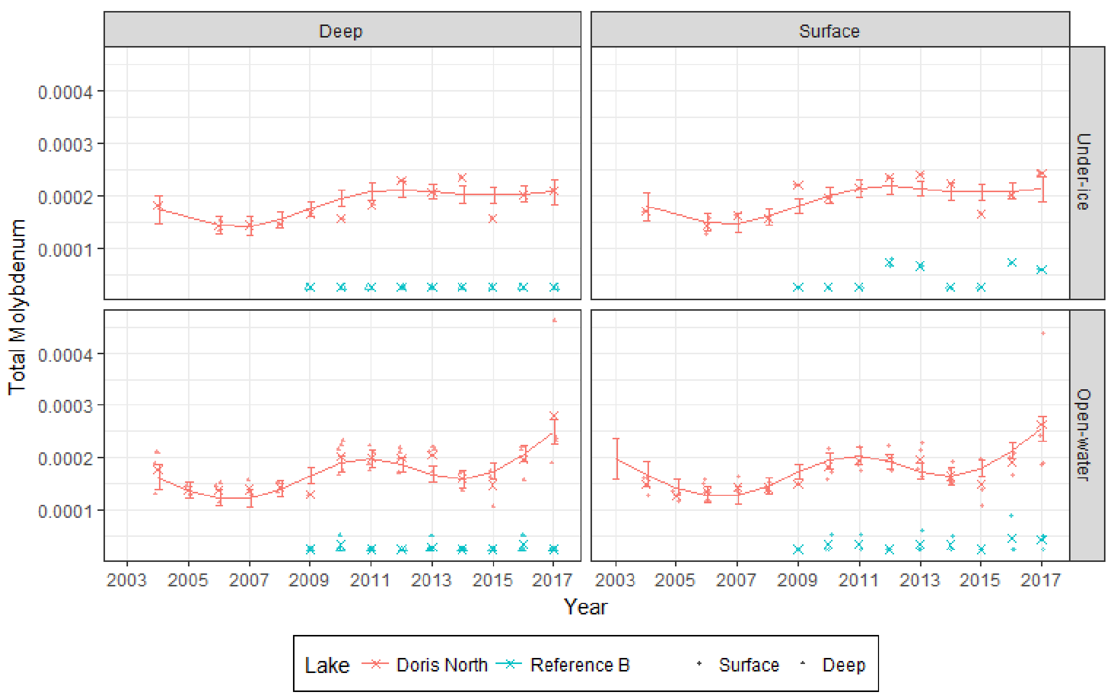
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:



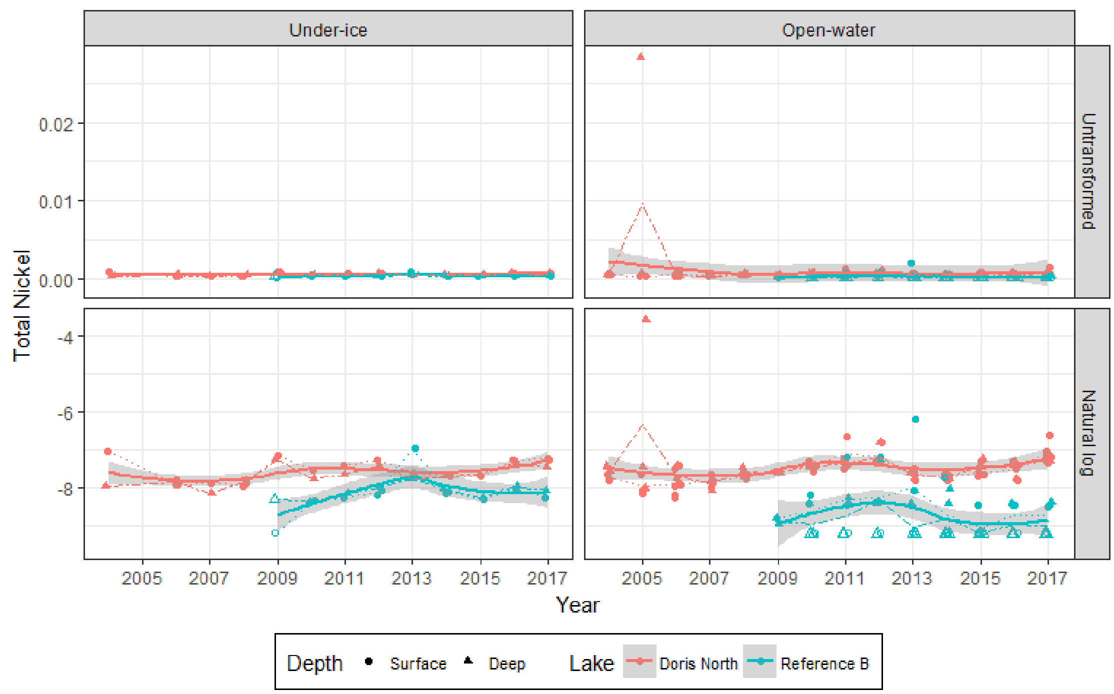
Plot of observed and fitted data separated by depth:



B.3.1.20 Analysis of Total Nickel

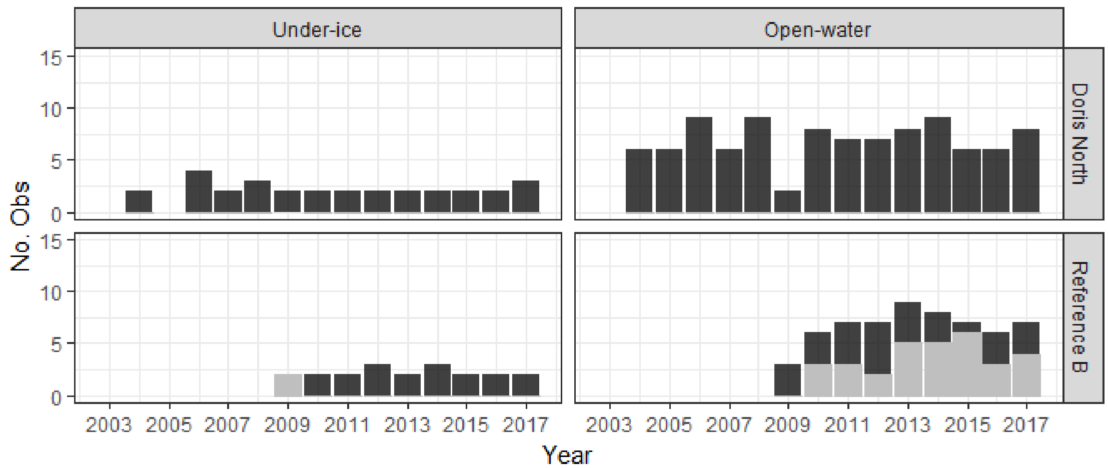
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

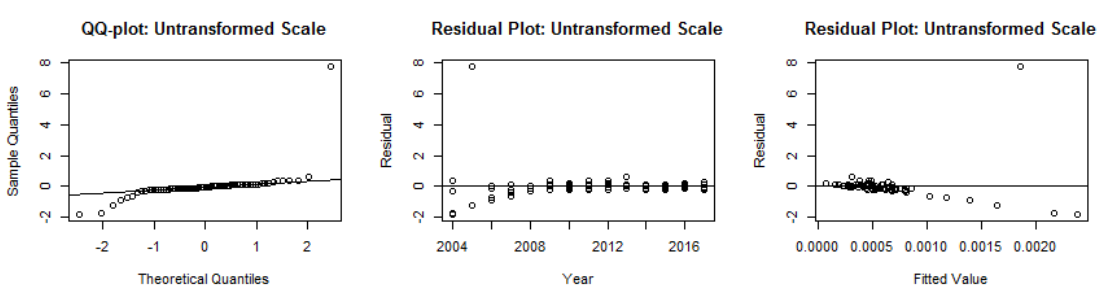
The sample sizes and median values per lake and season are summarized in the table below.

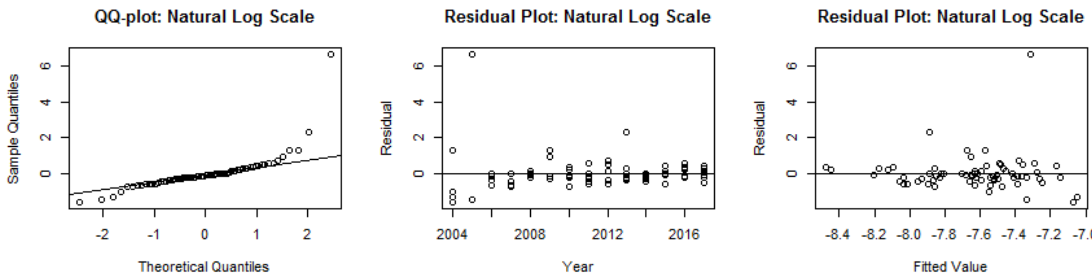
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	0	0.00	0.000470
Doris North	Open-water	97	0	0.00	0.000510
Reference B	Under-ice	20	2	0.10	0.000295
Reference B	Open-water	60	31	0.52	0.000200

Reference B exhibited more than 10% of data under detection limit in one (or more) of the seasons. The analysis proceeds with tobit regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
6	Doris North	2005	Open-water	Deep	0.0097363	0.0018602	7.74443

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
6	Doris North	2005	Open-water	Deep	0.0097363	-7.312458	6.680908

The natural log transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	4.873	4	0.3006

Doris Lake North did not exhibit significant deviation from no trend.

Open-Water

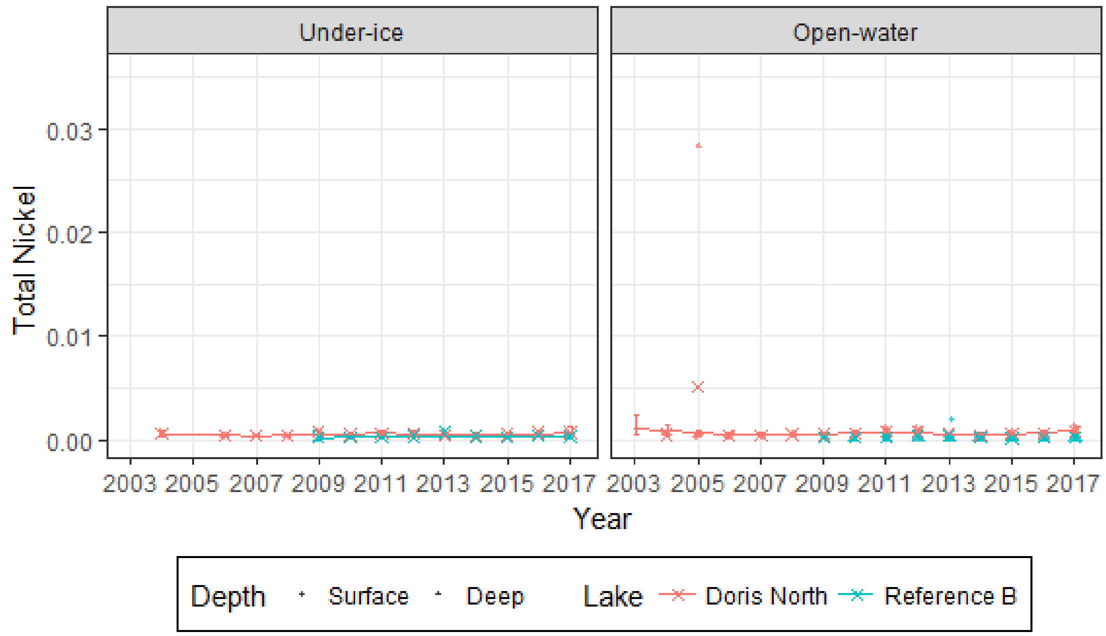
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.281	4	0.8646

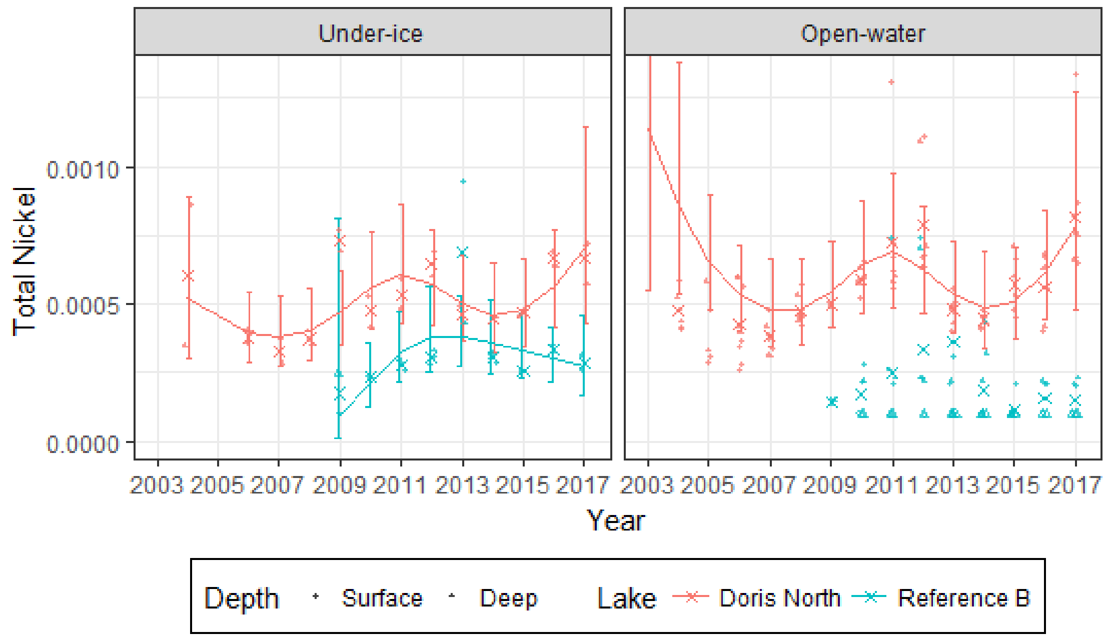
Doris Lake North did not exhibit significant deviation from no trend.

Observed Data and Fitted Values

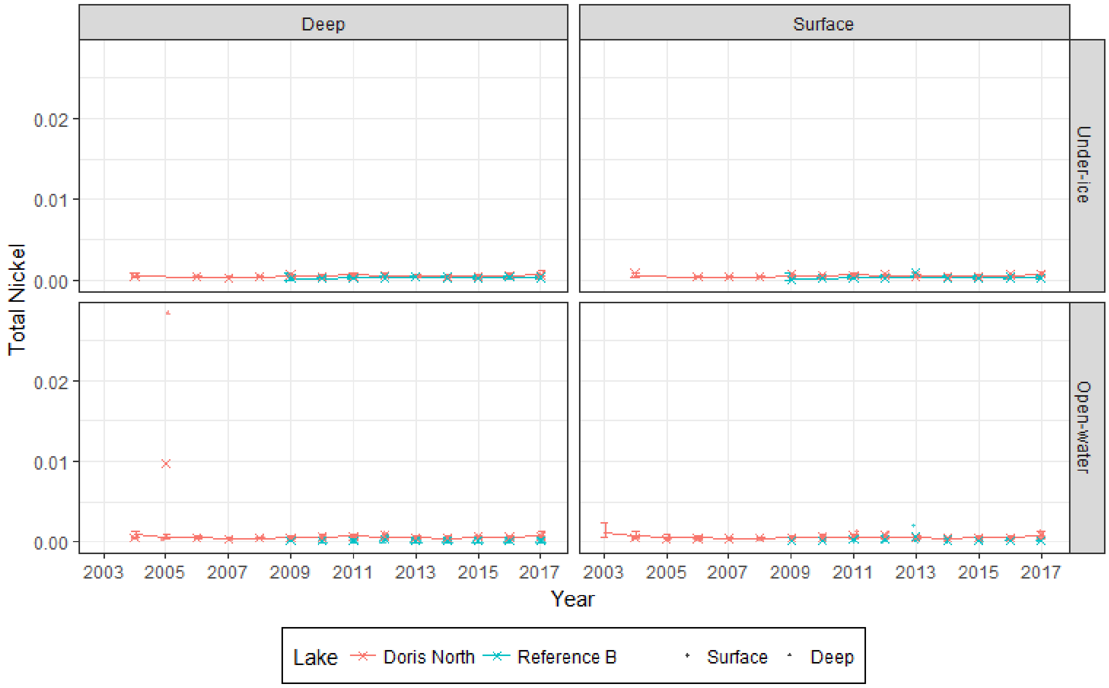
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth:





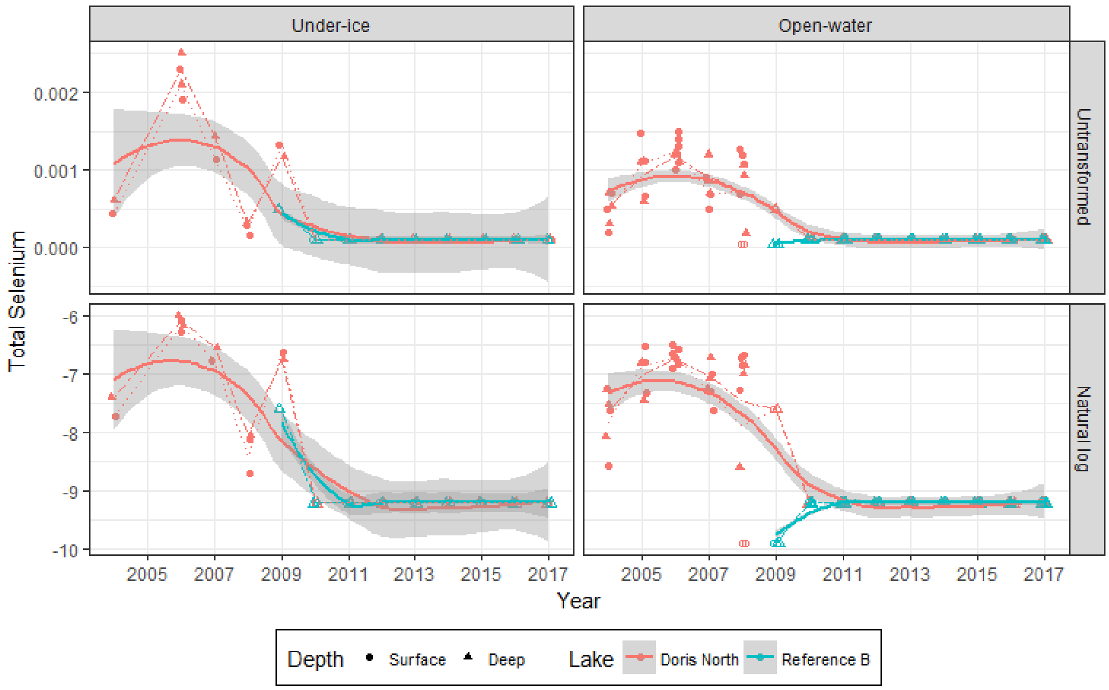
Plot of observed and fitted data separated by depth:



B.3.1.21 Analysis of Total Selenium

<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	17	0.57	0.0002
Doris North	Open-water	97	63	0.65	0.0002
Reference B	Under-ice	20	20	1.00	0.0002
Reference B	Open-water	60	60	1.00	0.0002

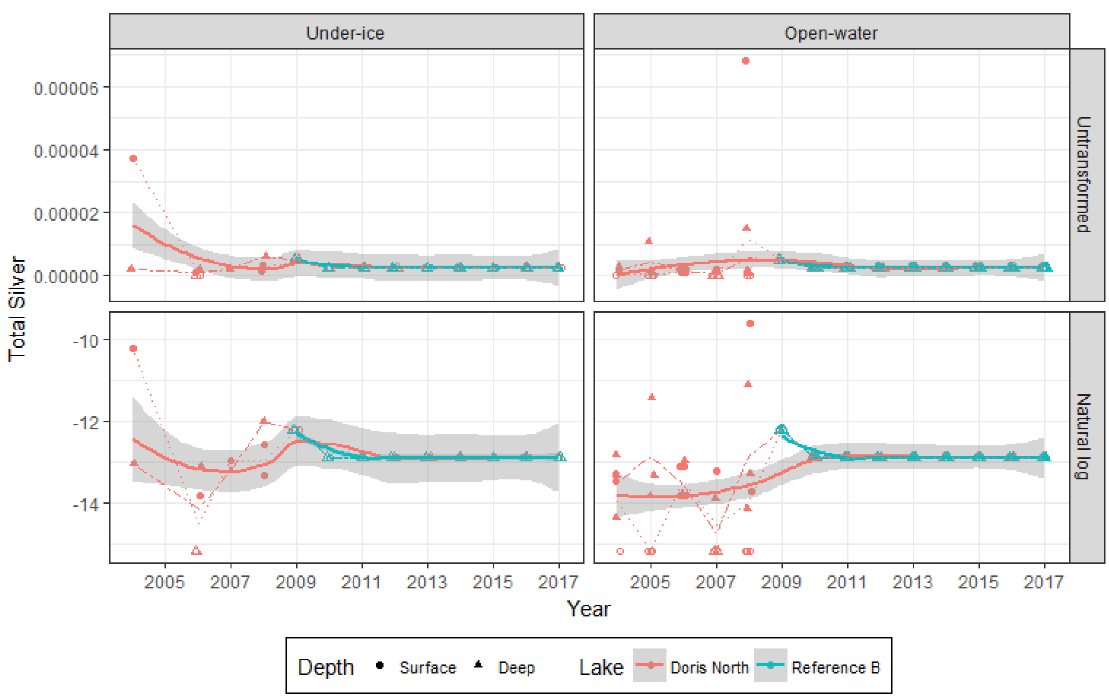
More than 60% of data under detection limit for Reference B. Reference B removed from the analyses. More than 60% of data under detection limit for Open-water. Data for Open-water will be removed from the analysis.

All data from Doris North Under-ice and Open-water 2017 were censored, therefore data was removed from the analysis. All data removed from the analysis and no statistical analyses were performed.

B.3.1.22 *Analysis of Total Silver*

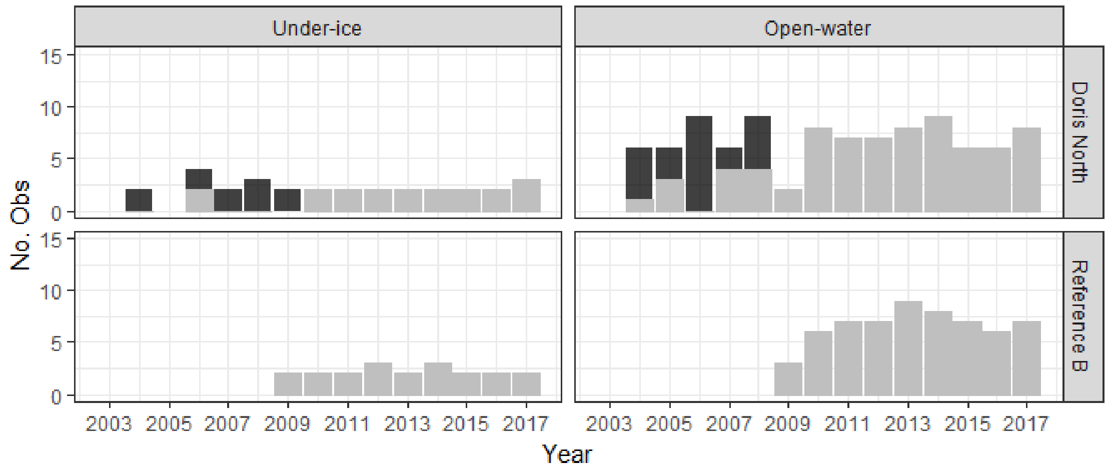
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

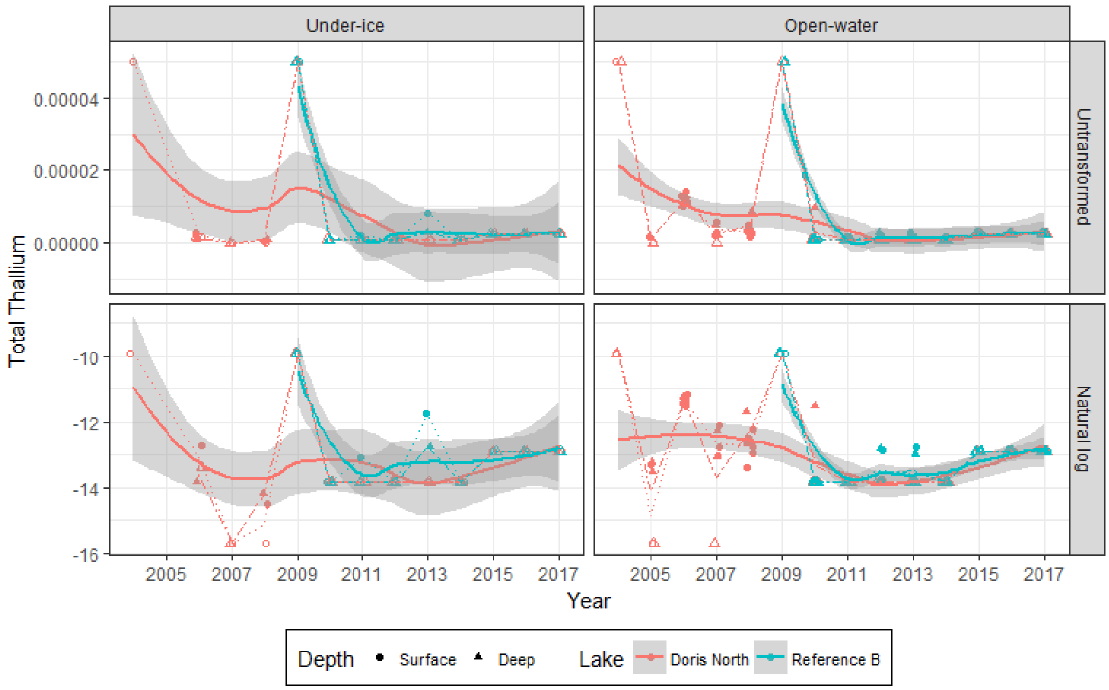
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	21	0.70	0.000005
Doris North	Open-water	97	73	0.75	0.000005
Reference B	Under-ice	20	20	1.00	0.000005
Reference B	Open-water	60	60	1.00	0.000005

More than 60% of data under detection limit for Doris North and Reference B. Doris North and Reference B removed from the analyses. No statistical analyses were performed.

B.3.1.23 Analysis of Total Thallium

Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

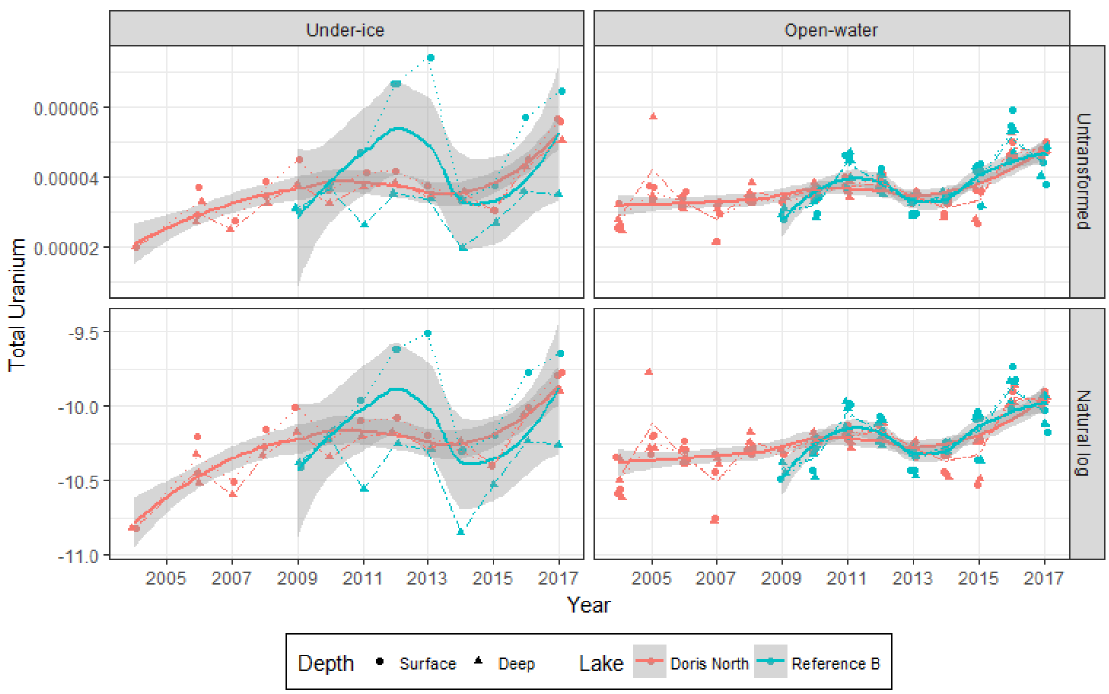
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	29	25	0.86	0.0000020
Doris North	Open-water	93	66	0.71	0.0000021
Reference B	Under-ice	20	17	0.85	0.0000024
Reference B	Open-water	60	55	0.92	0.0000020

More than 60% of data under detection limit for Doris North and Reference B. Doris North and Reference B removed from the analyses. No statistical analyses were performed.

B.3.1.24 Analysis of Total Uranium

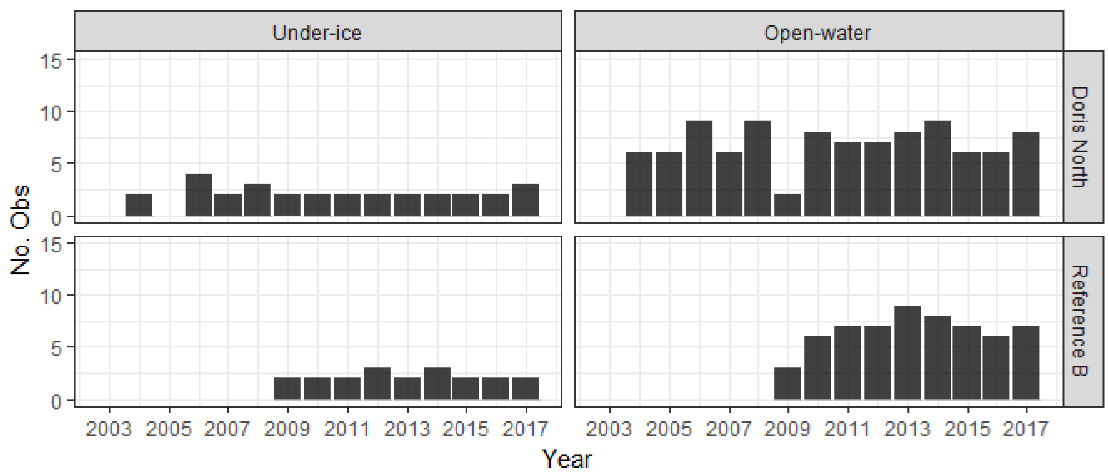
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

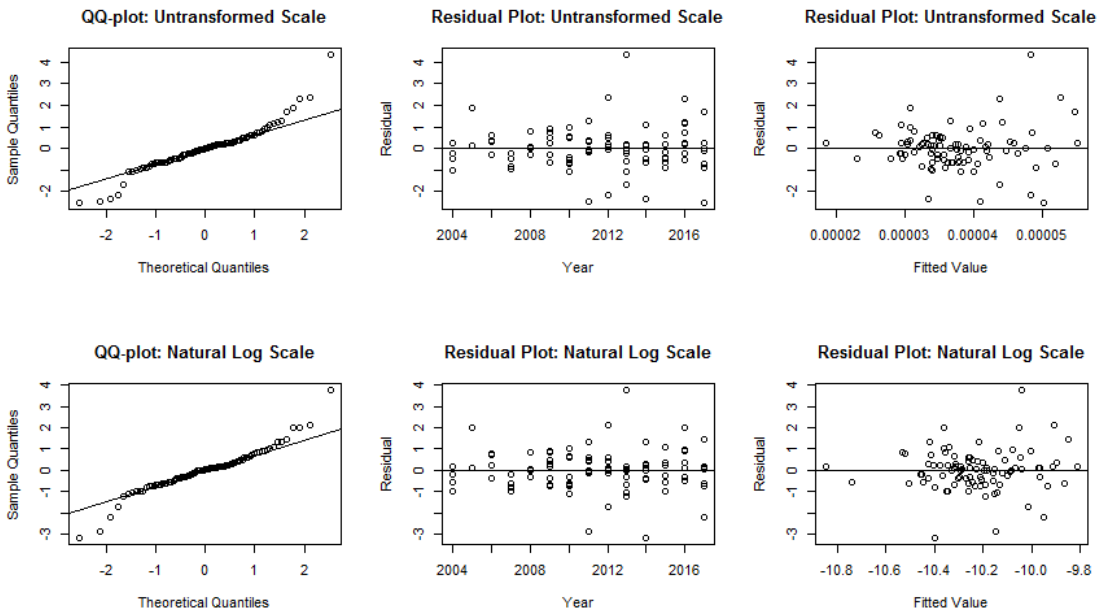
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	0	0	0.0000361
Doris North	Open-water	97	0	0	0.0000344
Reference B	Under-ice	20	0	0	0.0000356
Reference B	Open-water	60	0	0	0.0000365

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
73	Reference B	2013	Under-ice	Surface	0.0000743	0.0000482	4.329343

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
73	Reference B	2013	Under-ice	Surface	0.0000743	-10.03899	3.766321
76	Reference B	2014	Under-ice	Deep	0.0000194	-10.39875	-3.198825

The natural log-transformed data better meets the residual assumptions. Analysis proceeds with natural log-transformed data. There was an outlier retained in the analysis. Results should be interpreted with caution and along with graphical results.

Test Results for Monitored Lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Under-Ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	43.946	4	0.0000
Compare to Reference B	7.451	4	0.1139

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

Open-Water

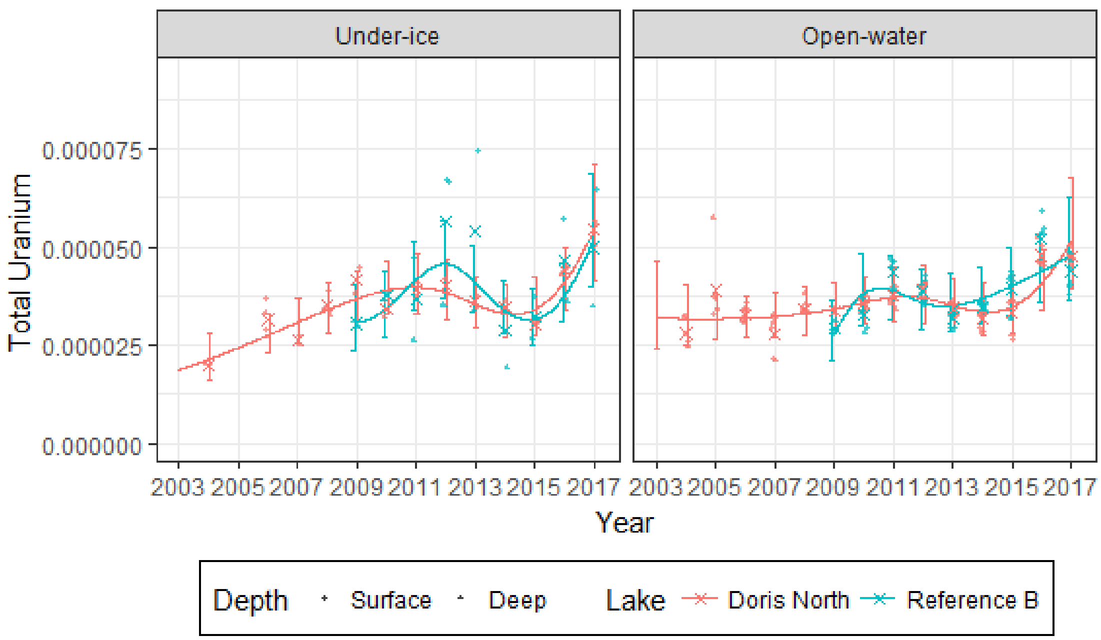
Analysis	Chi.sq	DF	P.value
Compare to slope 0	10.746	4	0.0296
Compare to Reference B	7.062	4	0.1327

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

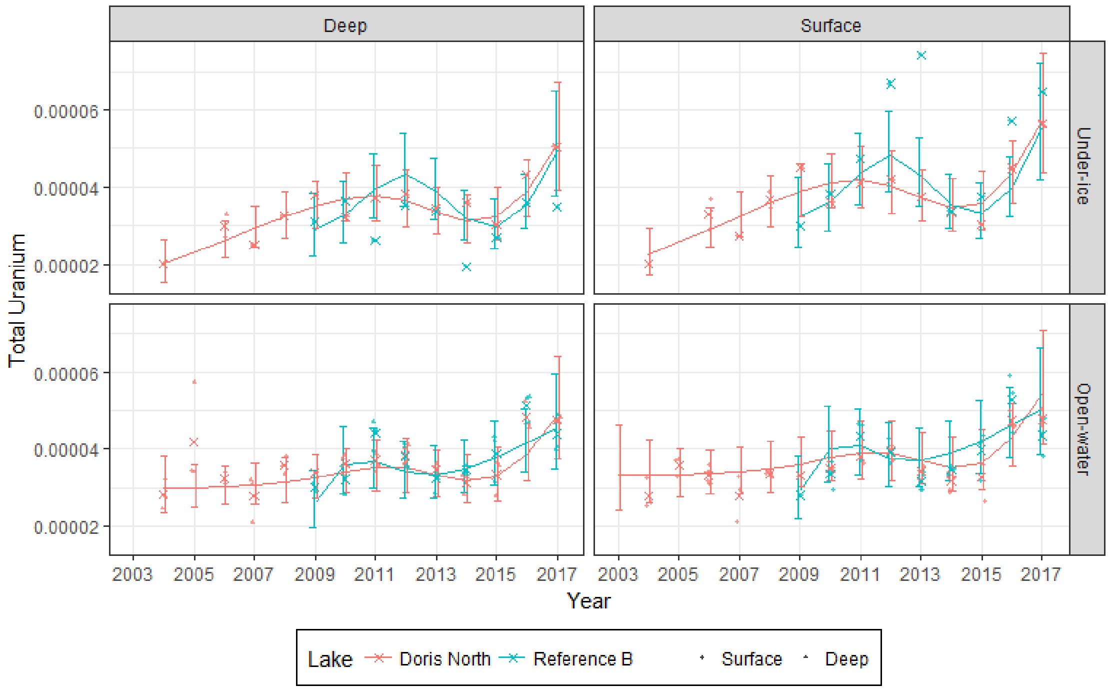
Observed Data and Fitted Values

Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed data values (x's represent annual observed means) and hollow symbols at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of Observed and fitted data averaged over depth.



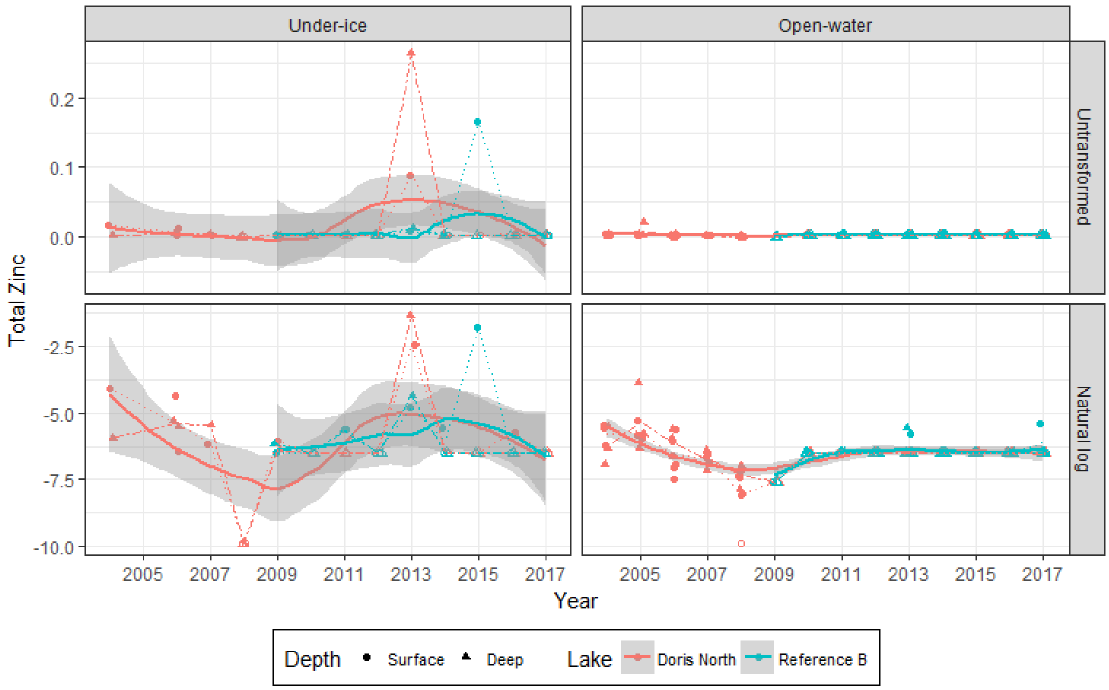
Plot of observed and fitted data separated by depth.



B.3.1.25 Analysis of Total Zinc

Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.

Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	17	0.57	0.003
Doris North	Open-water	97	62	0.64	0.003
Reference B	Under-ice	20	12	0.60	0.003
Reference B	Open-water	60	57	0.95	0.003

More than 60% of data under detection limit for Reference B. Reference B removed from the analyses. More than 60% of data under detection limit for Open-water. Data for Open-water will be removed from the analysis.

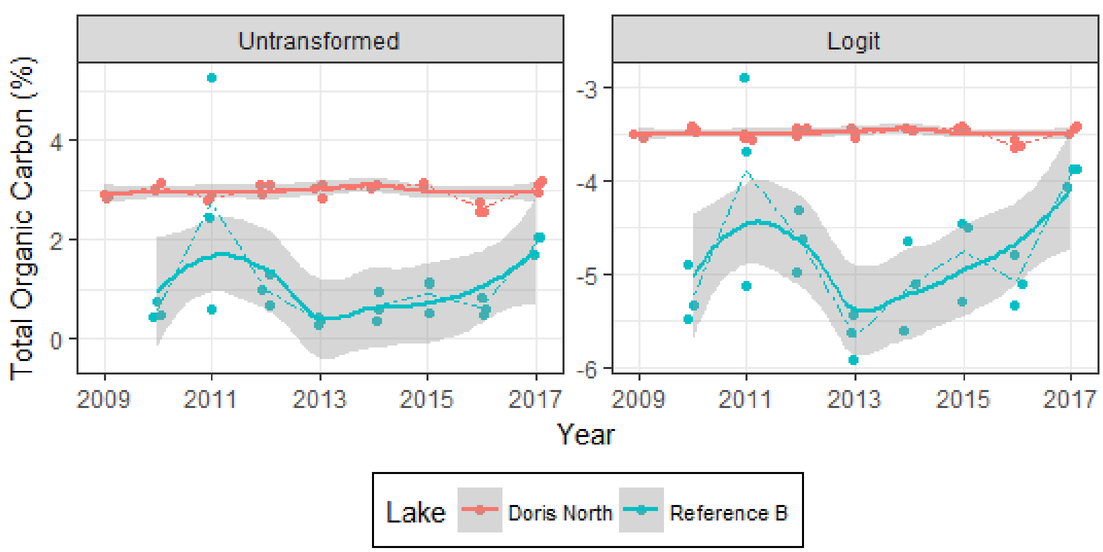
All data from Doris North Under-ice and Open-water 2017 were censored, therefore data was removed from the analysis. All data removed from the analysis and no statistical analyses were performed.

B.3.2 Sediment Quality

B.3.2.1 Analysis of Total Organic Carbon

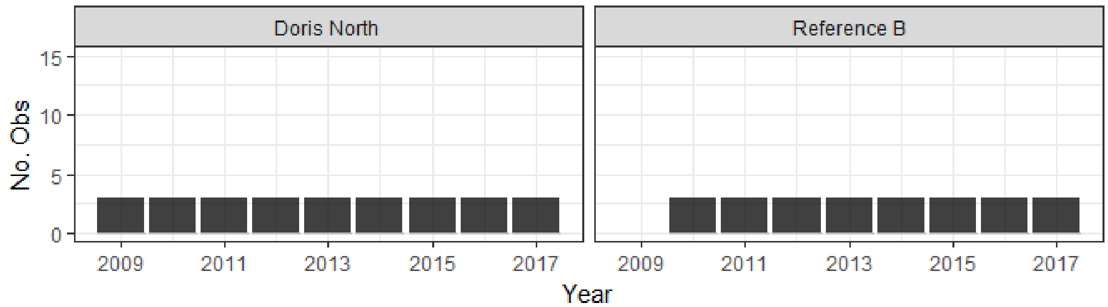
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and logit scale. The logit transformation was selected since the observed data is in the interval [0, 1]. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

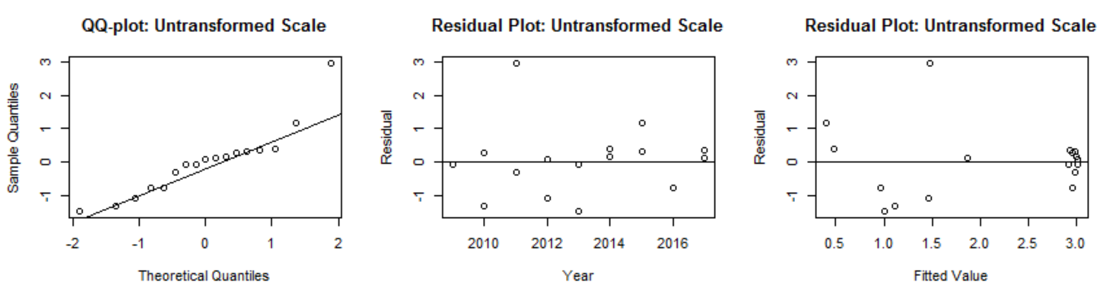
The sample sizes and median values per lake are summarized in the table below.

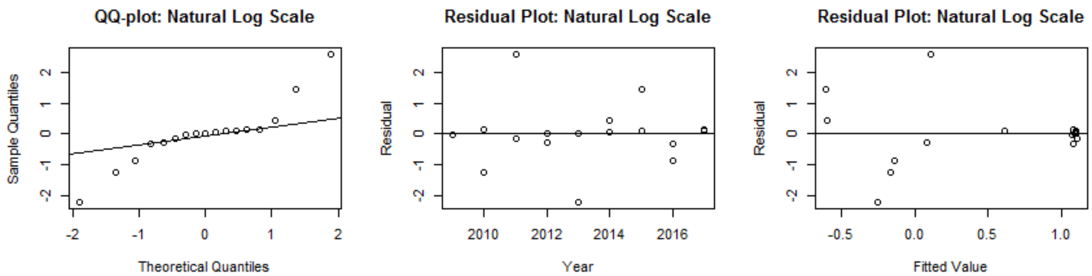
Lake	# Obs	# Under DL	% Under DL	Median
Doris North	27	0	0	3.030
Reference B	24	0	0	0.715

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.





Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed model better meets the residual assumptions. Analysis proceeds with untransformed data.

Test Results for Monitored lake

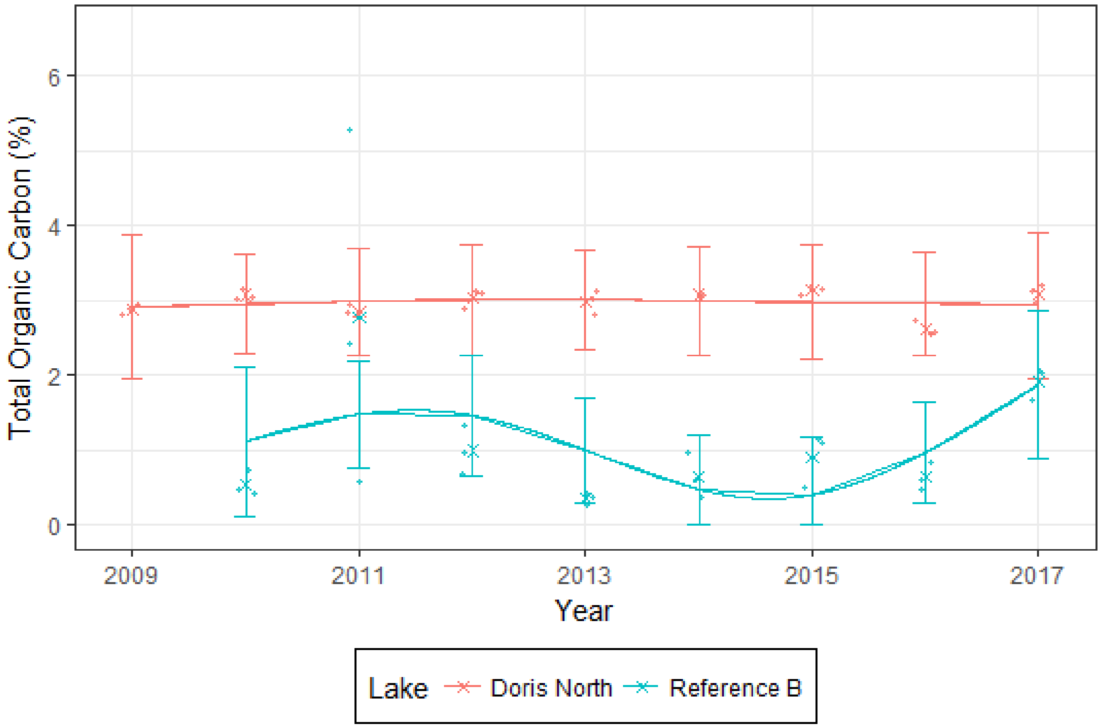
The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.048	3	0.9973

Conclusions:
Doris Lake North did not exhibit significant deviation from no trend.

Observed Data and Fitted Values

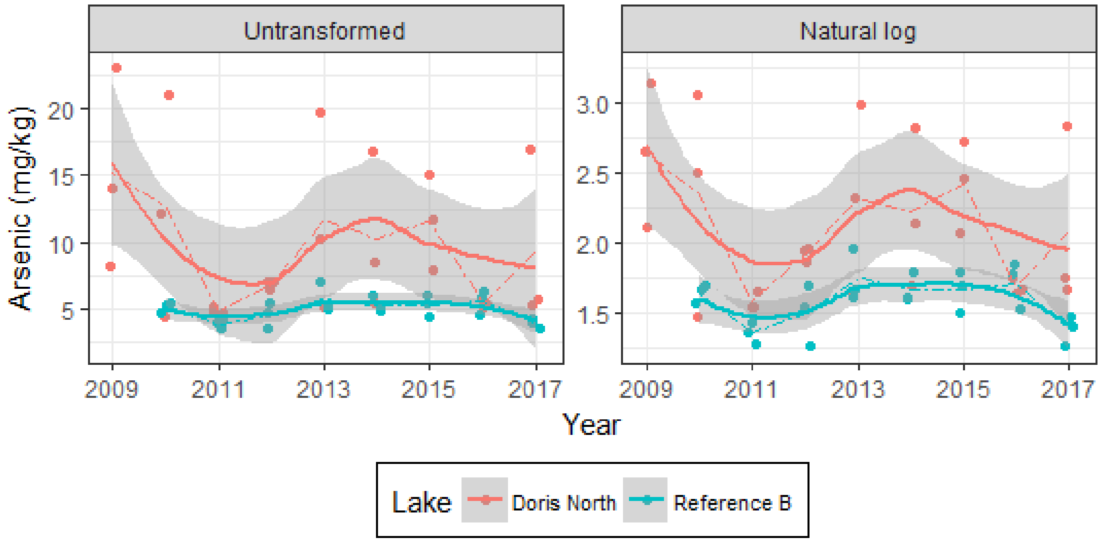
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.2.2 Analysis of Arsenic

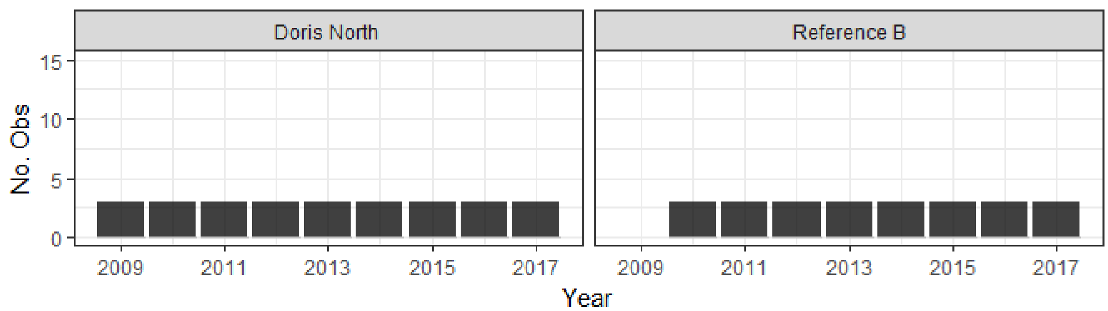
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

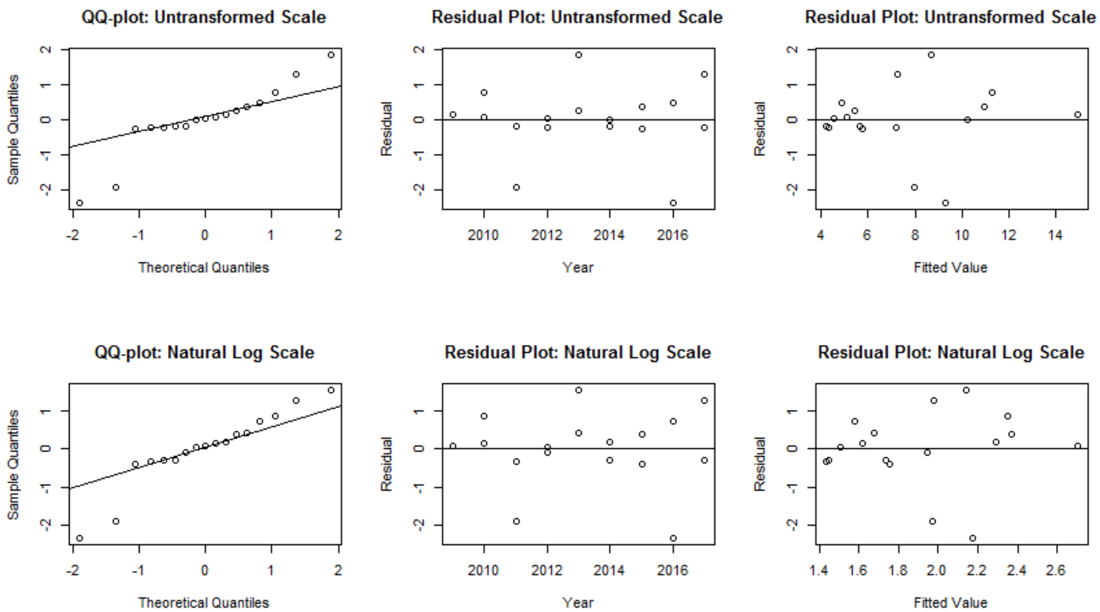
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	27	0	0	7.110
Reference B	24	0	0	4.975

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

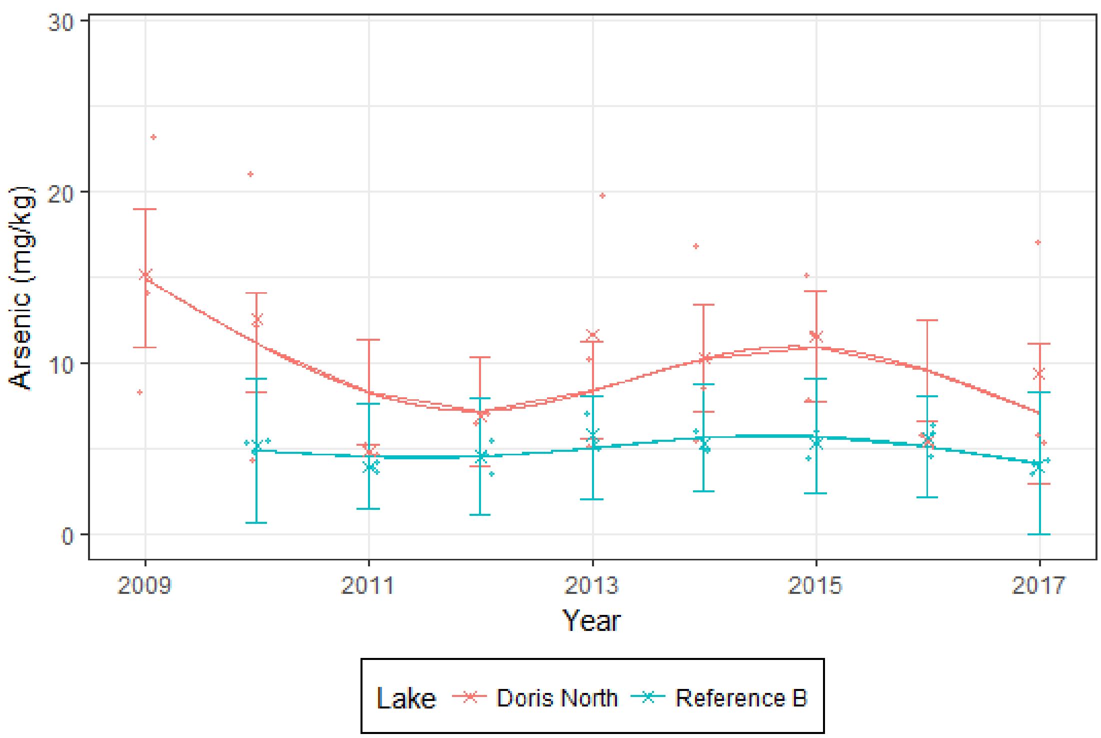
Analysis	Chi.sq	DF	P.value
Compare to slope 0	16.686	3	0.0008
Compare to Reference B	2.774	3	0.4279

Conclusions:

Doris Lake North lake appears to show significant deviation from no trend. Doris Lake North lake did not exhibit significant deviation from the trend of Reference B lake.

Observed Data and Fitted Values

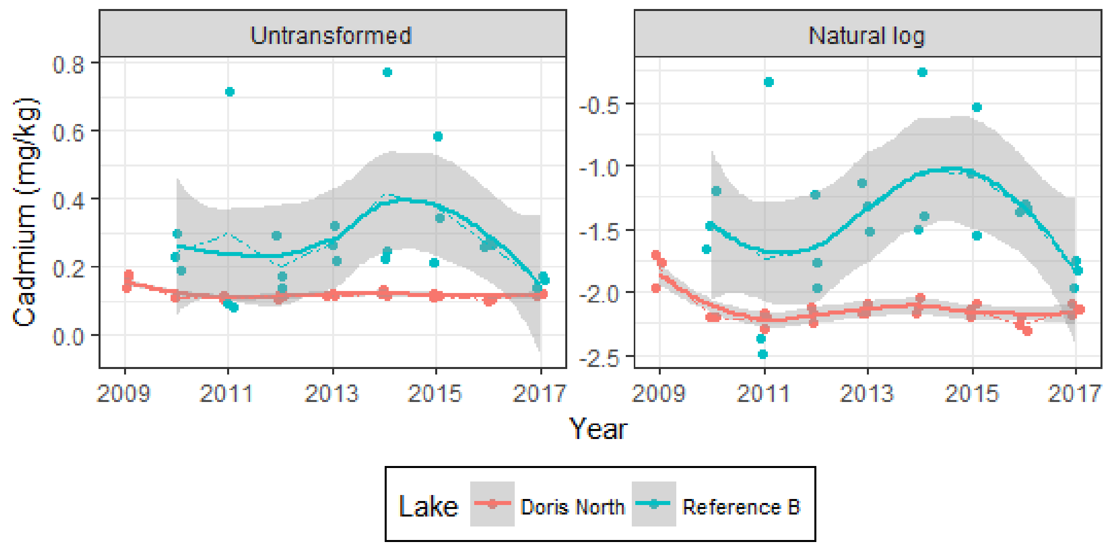
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.2.3 Analysis of Cadmium

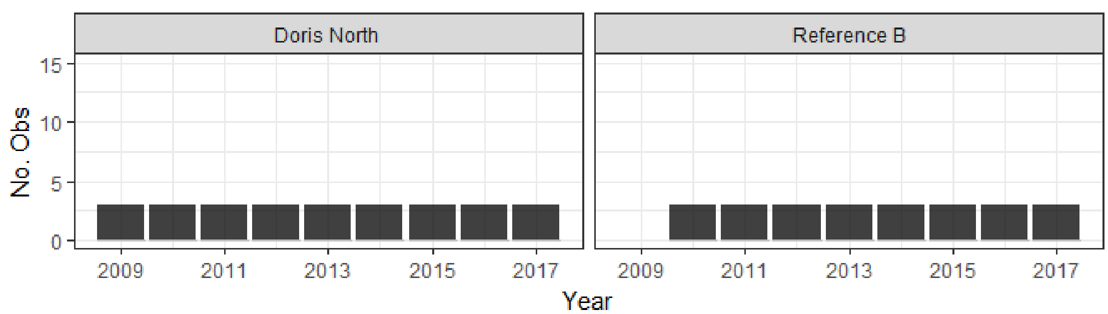
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

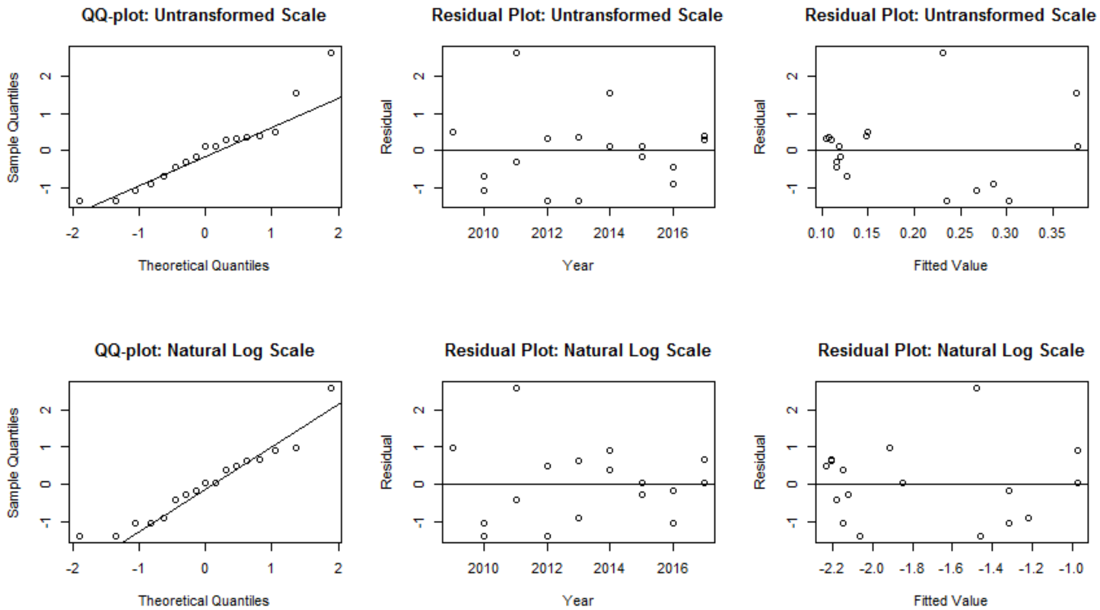
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	27	0	0	0.115
Reference B	24	0	0	0.239

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

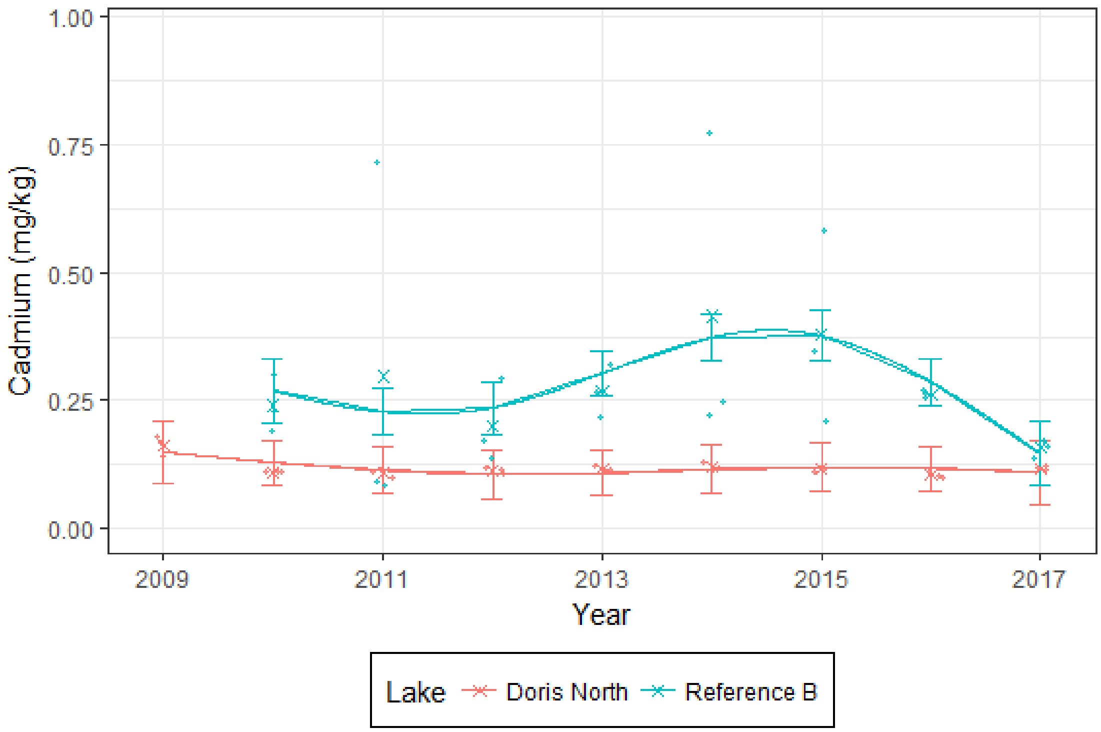
Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.095	3	0.5530

Conclusions:

Doris Lake North did not exhibit significant deviation from no trend.

Observed Fata and Fitted Values

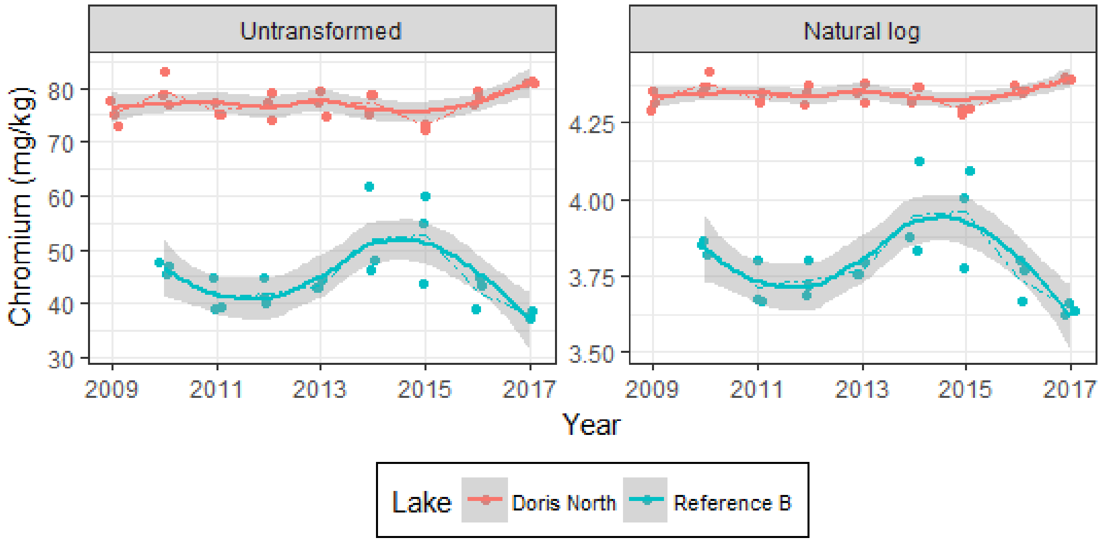
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.2.4 Analysis of Chromium

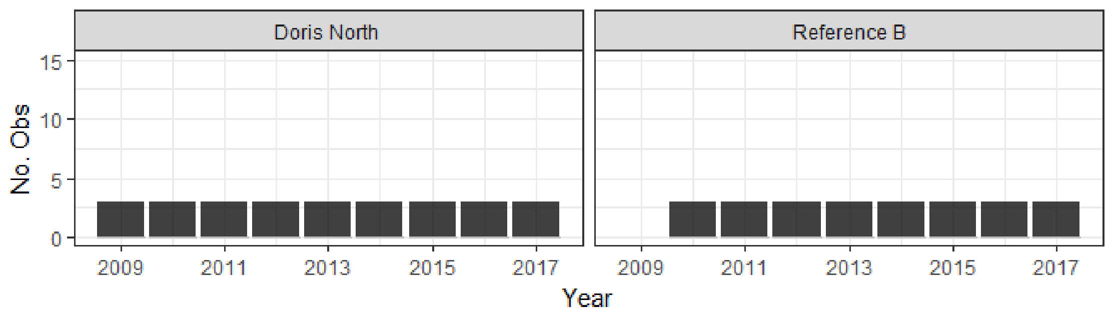
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

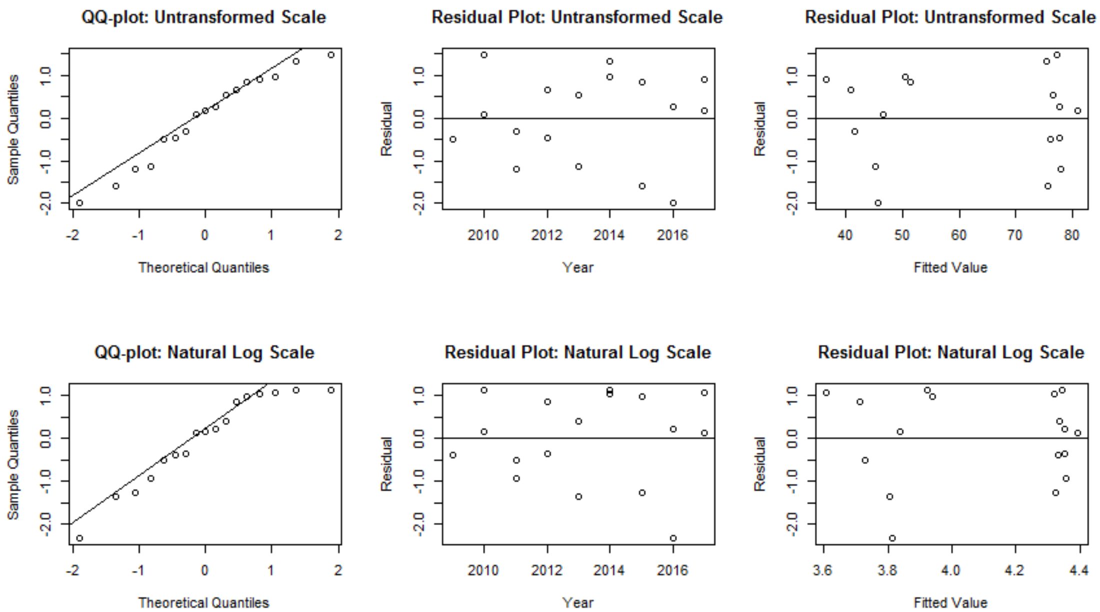
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	27	0	0	77.5
Reference B	24	0	0	44.0

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The natural log-transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

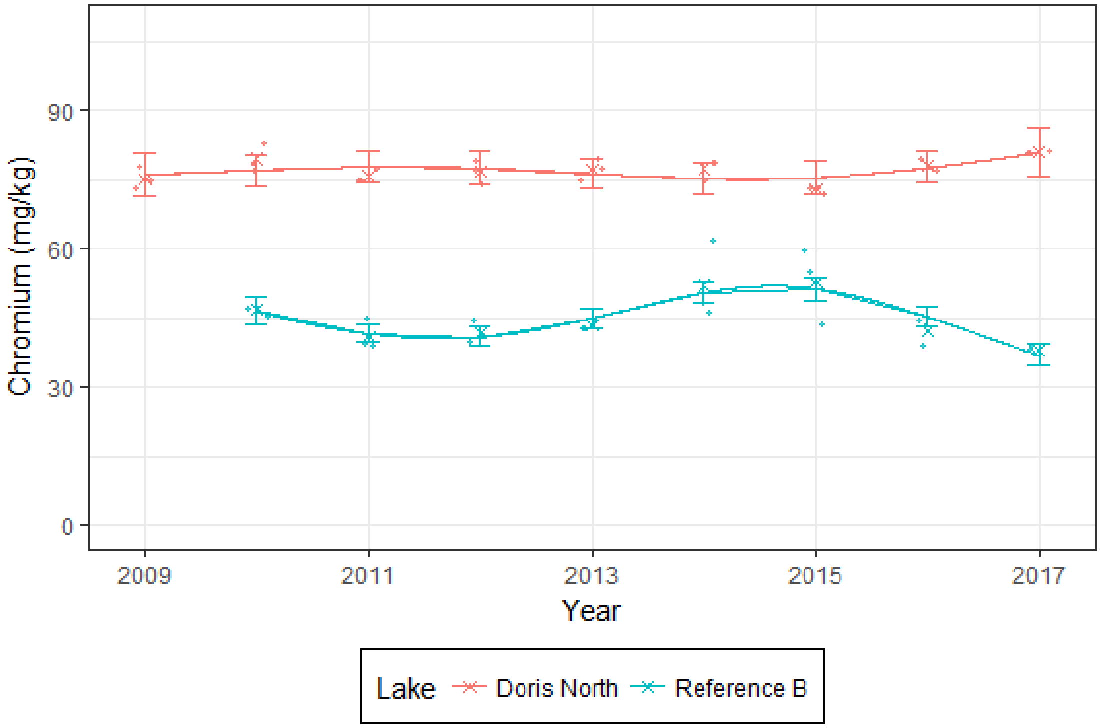
Analysis	Chi.sq	DF	P.value
Compare to slope 0	4.742	3	0.1917

Conclusions:

Doris Lake North did not exhibit significant deviation from no trend.

Observed Data and Fitted Values

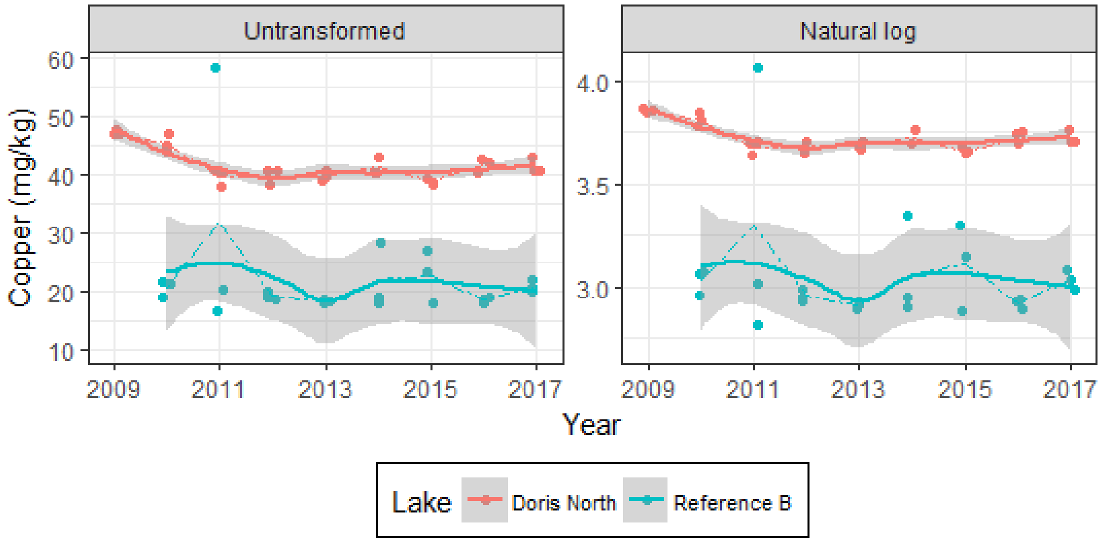
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.2.5 Analysis of Copper

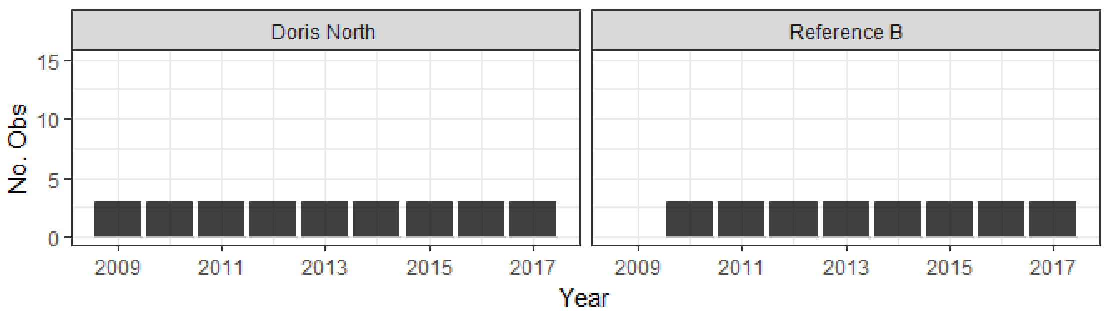
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

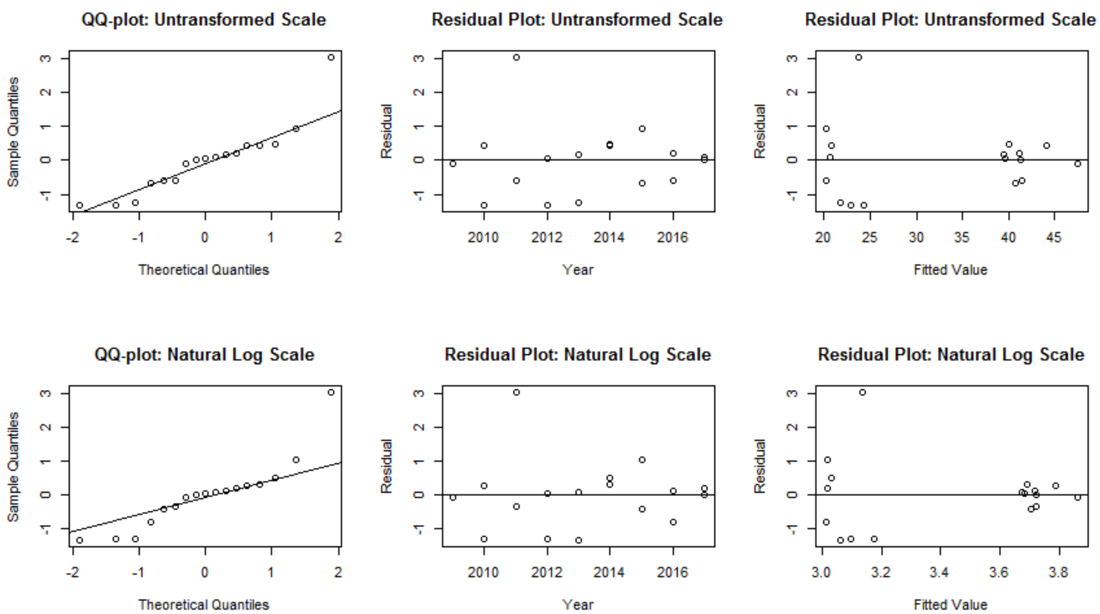
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	27	0	0	40.60
Reference B	24	0	0	19.15

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
11	Reference B	2011	Open-water	Deep	31.93333	23.67926	3.038753

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
11	Reference B	2011	Open-water	Deep	31.93333	3.134742	3.041371

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

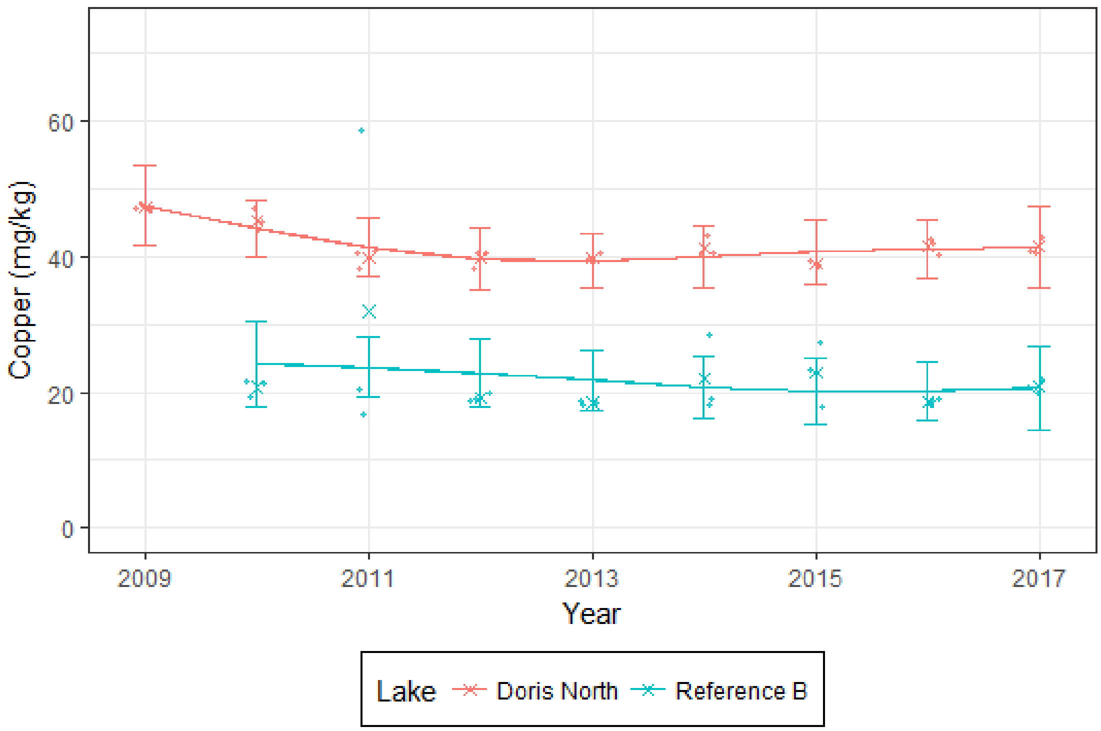
Analysis	Chi.sq	DF	P.value
Compare to slope 0	7.266	3	0.0639

Conclusions:

Doris Lake North did not exhibit significant deviation from no trend.

Observed Data and Fitted Values

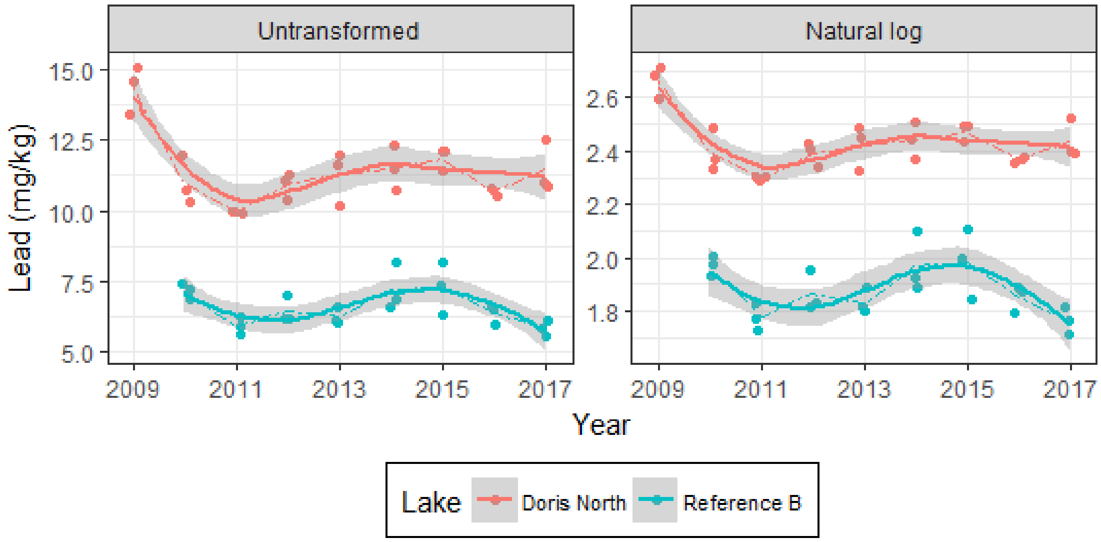
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.2.6 Analysis of Lead

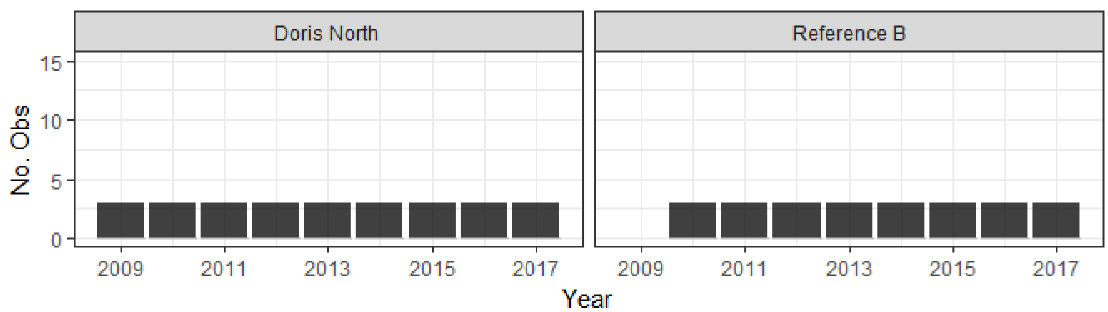
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

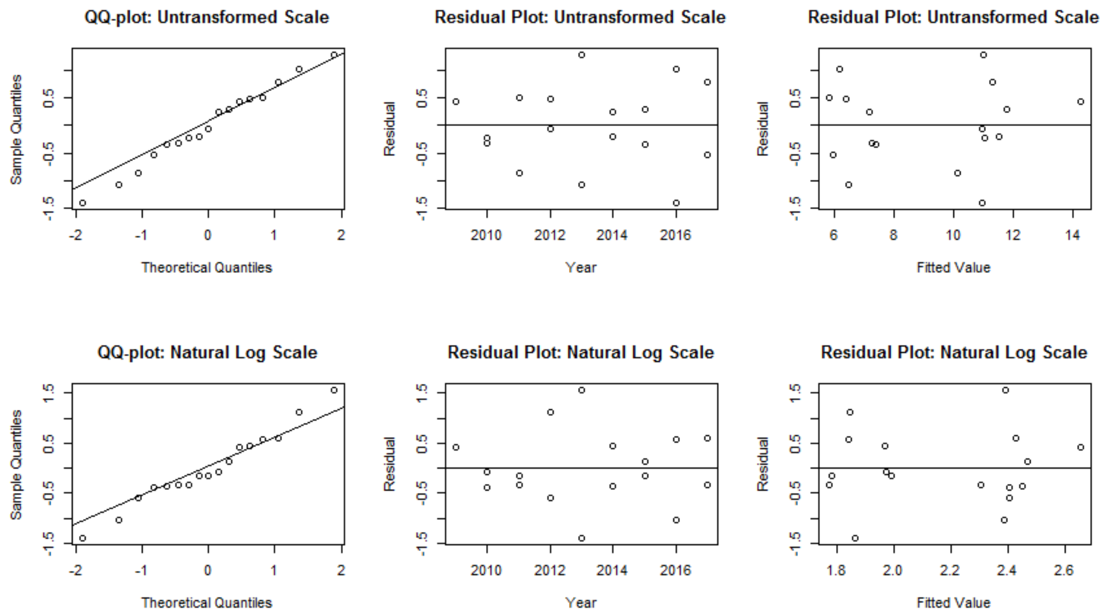
The sample sizes and median values per lake are summarized in the table below.

Lake	**# Obs**	**# Under DL**	**% Under DL**	**Median**
Doris North	27	0	0	11.100
Reference B	24	0	0	6.415

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The natural log-transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

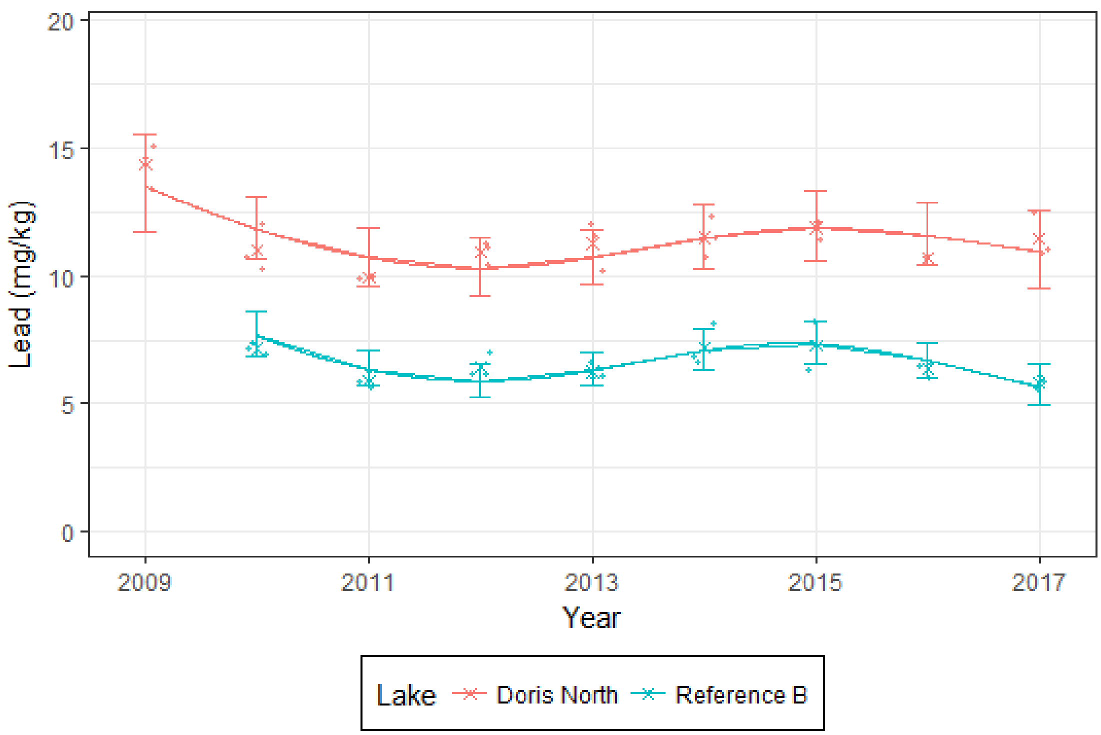
Analysis	Chi.sq	DF	P.value
Compare to slope 0	16.776	3	0.0008
Compare to Reference B	40.197	3	0.0000

Conclusions:

Doris Lake North lake appears to show significant deviation from no trend. Doris Lake North lake appears to show significant deviation from the trend of Reference B lake.

Observed Data and Fitted Values

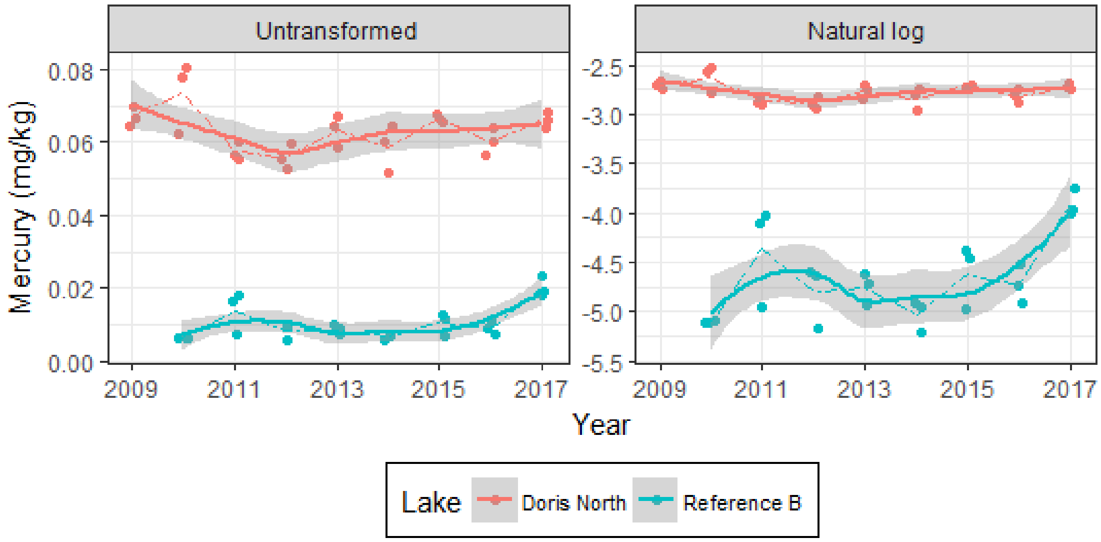
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.2.7 Analysis of Mercury

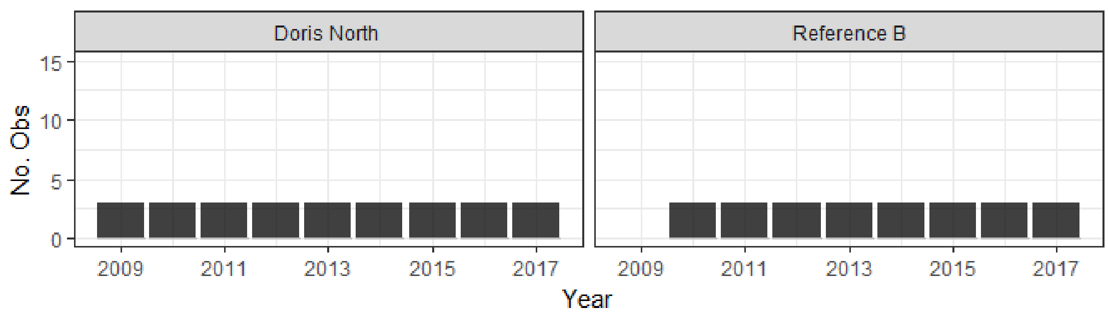
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

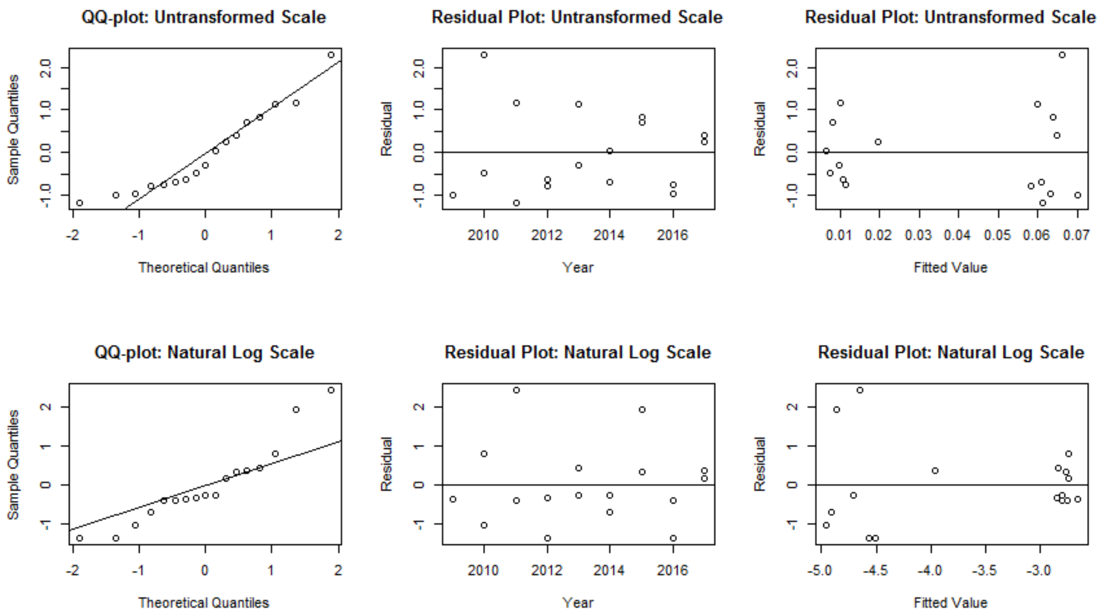
The sample sizes and median values per lake are summarized in the table below.

Lake	**# Obs**	**# Under DL**	**% Under DL**	**Median**
Doris North	27	0	0	0.06410
Reference B	24	0	0	0.00885

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed model better meets the residual assumptions. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

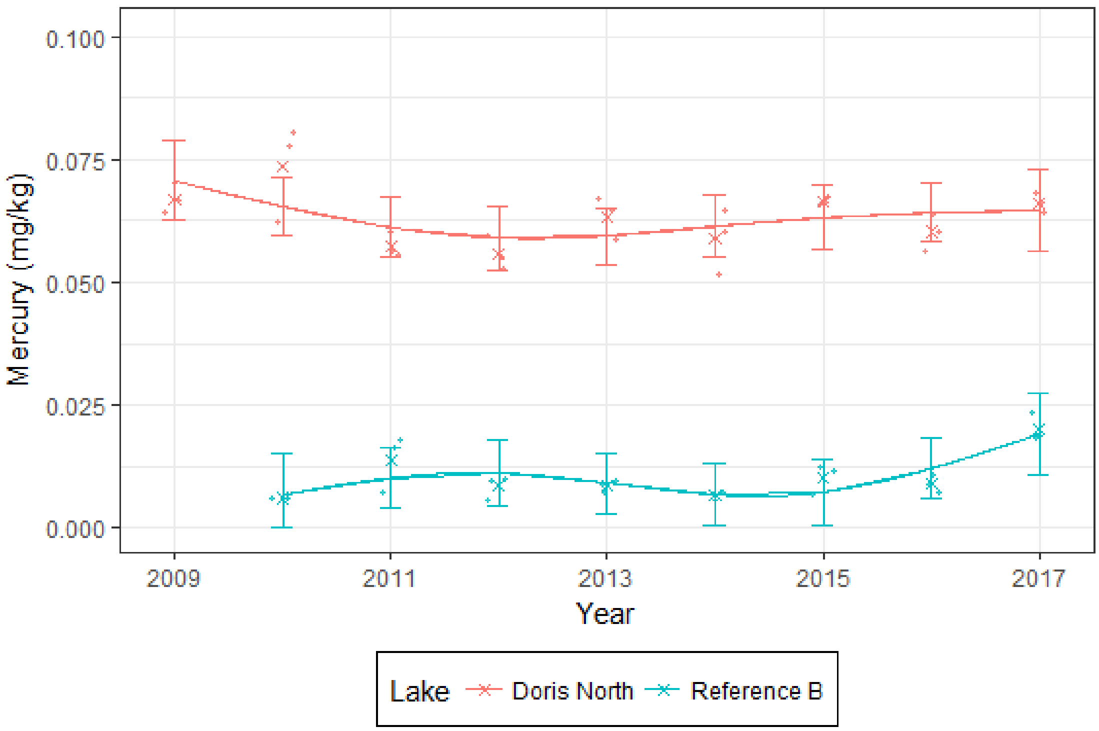
Analysis	Chi.sq	DF	P.value
Compare to slope 0	8.835	3	0.0316
Compare to Reference B	8.528	3	0.0363

Conclusions:

Doris Lake North lake appears to show significant deviation from no trend. Doris Lake North lake appears to show significant deviation from the trend of Reference B lake.

Observed Data and Fitted Values

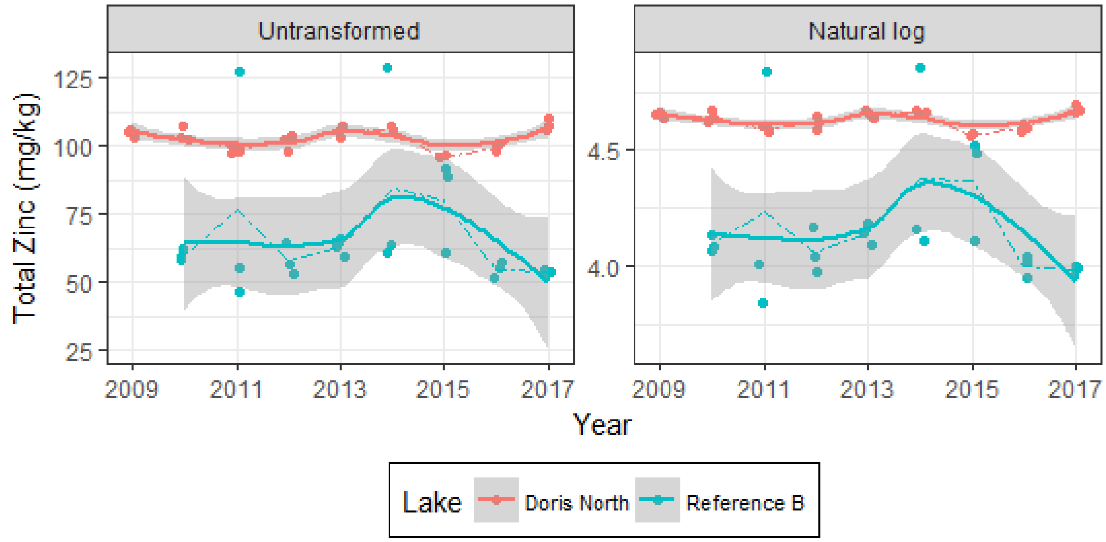
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.2.8 Analysis of Total Zinc

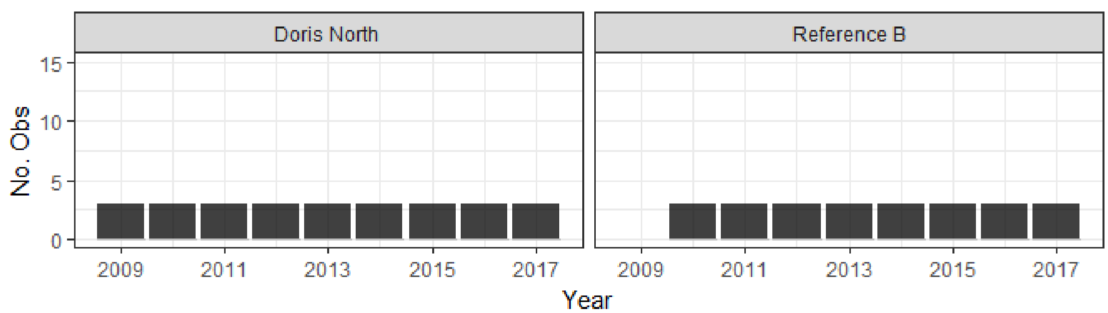
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April and open-water samples were collected in July, August, and September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

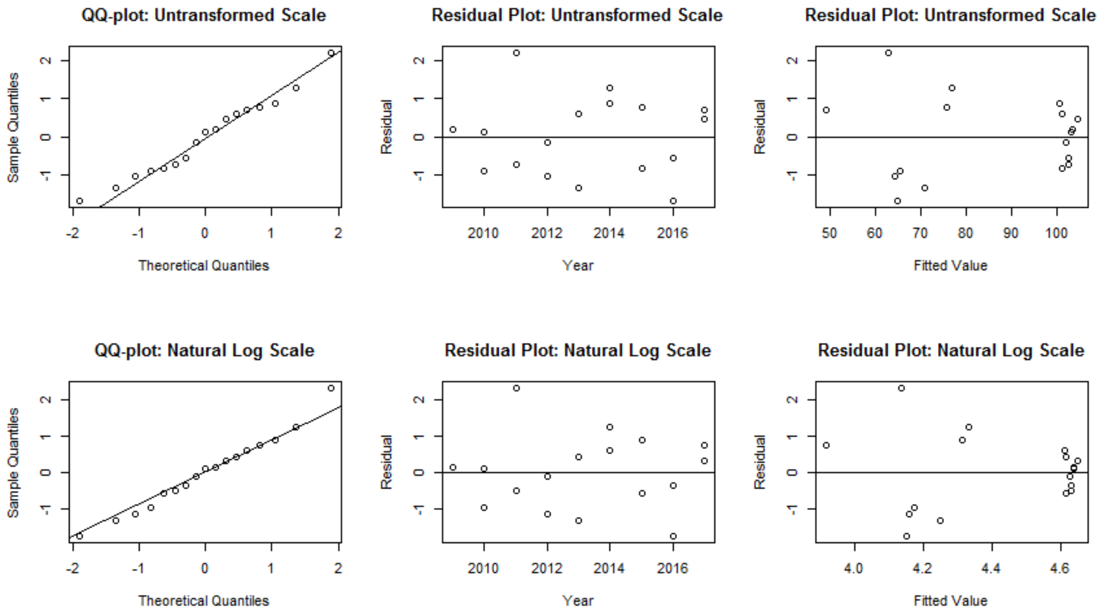
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	27	0	0	103.0
Reference B	24	0	0	59.6

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed model better meets the residual assumptions. Analysis proceeds with untransformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

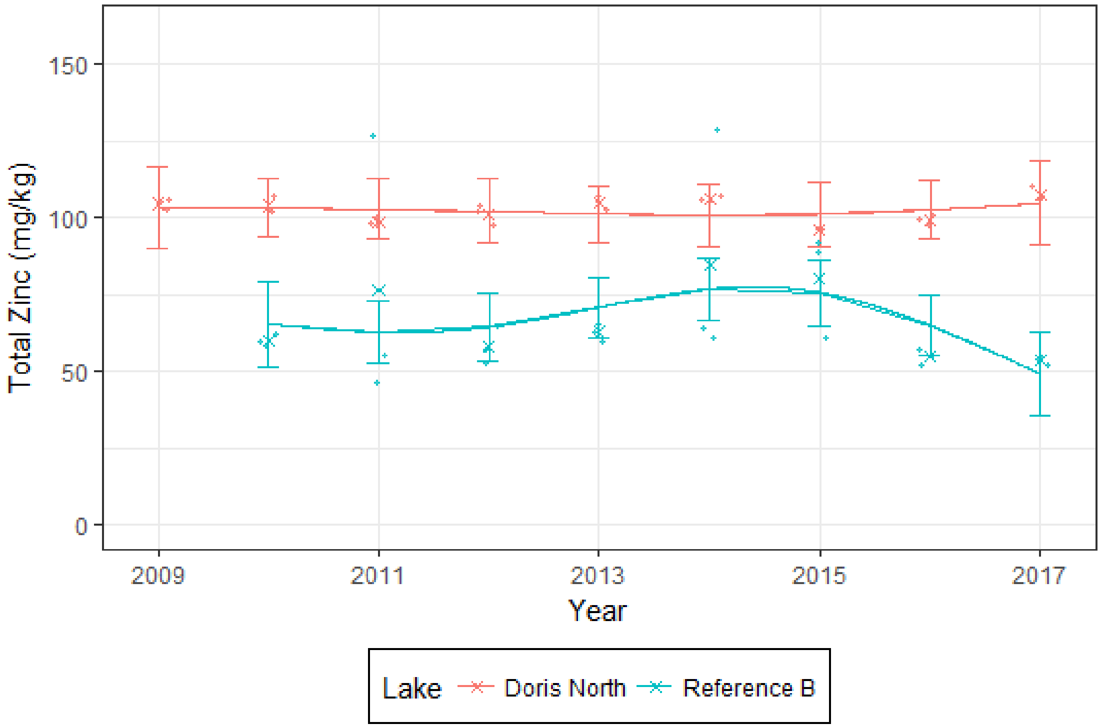
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.352	3	0.9499

Conclusions:

Doris Lake North did not exhibit significant deviation from no trend.

Observed Data and Fitted Values

Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

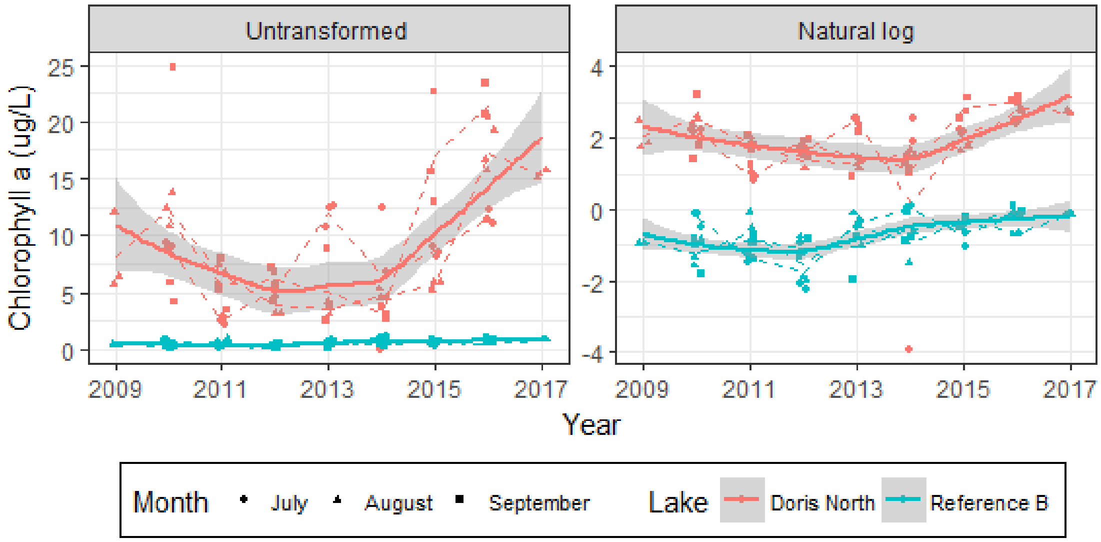


B.3.3 Phytoplankton

B.3.3.1 Analysis of Phytoplankton Biomass (as Chlorophyll a)

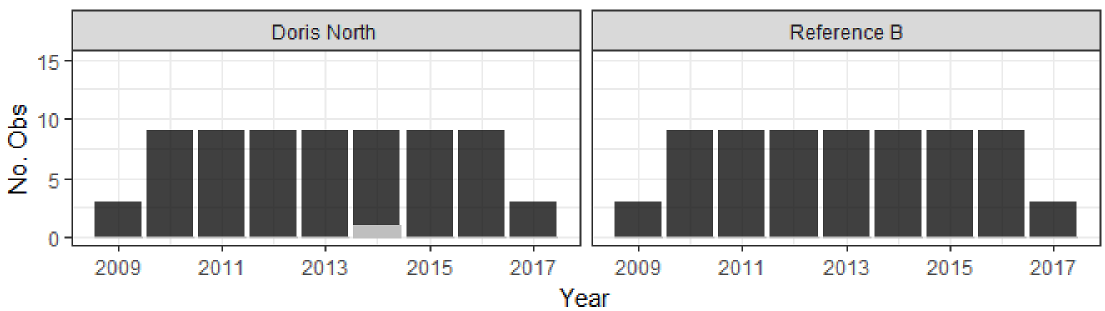
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake that were less than the detection limit (grey) or greater than the detection limit (black). Observations at or below the analytical detection limit were considered censored.



Analysis not performed if greater than 60% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2017) were censored.

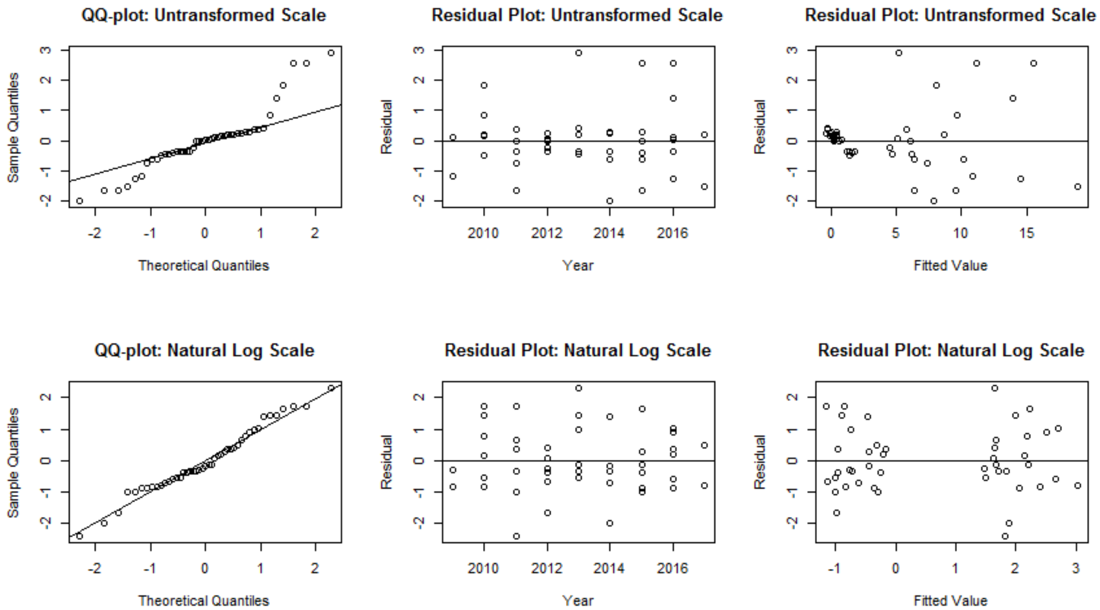
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	69	1	0.01	6.840
Reference B	69	0	0.00	0.503

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers are identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.

Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The natural log data better meets the residual assumptions. Analysis proceeds with natural log data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

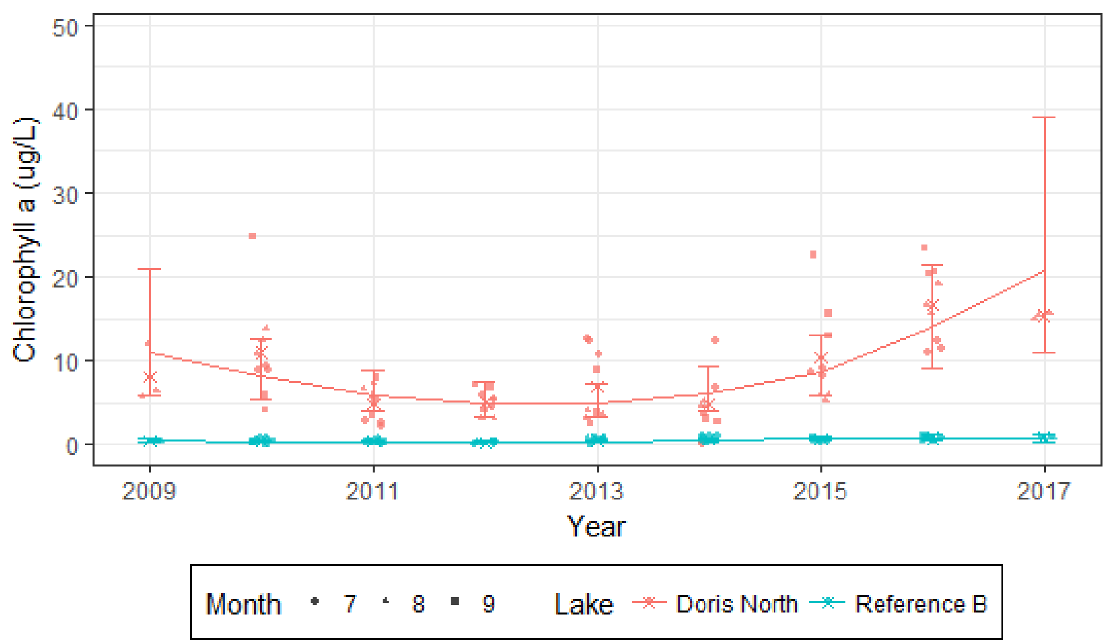
Analysis	Chi.sq	DF	P.value
Compare to slope 0	30.387	3	0.0000
Compare to Reference B	7.199	3	0.0658

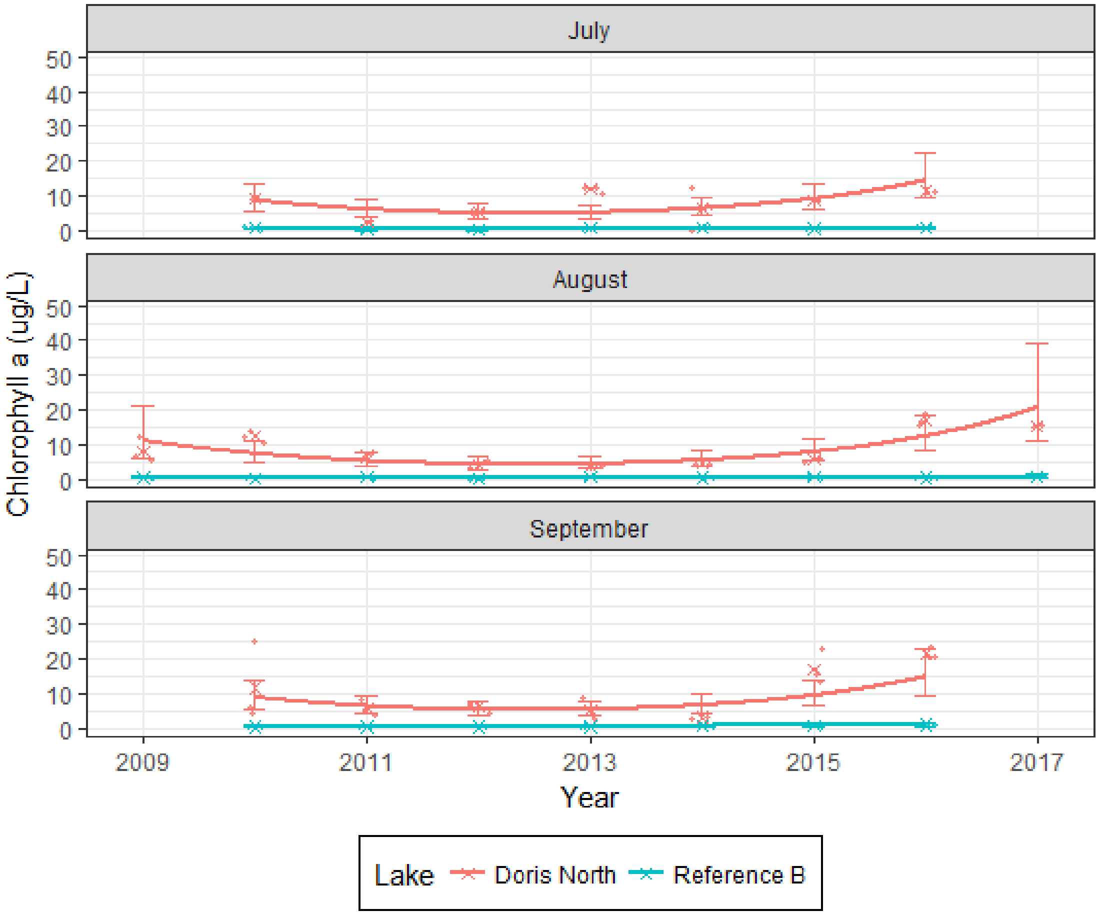
Conclusions:

Doris Lake North appears to show significant deviation from no trend. Doris Lake North did not exhibit significant deviation from the trend of Reference B lake.

Observed Data and Fitted Values

The sampling month was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over month and separated by month to visually assess the differences between samples. The symbols represent the observed data values (x's represent annual observed means). Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



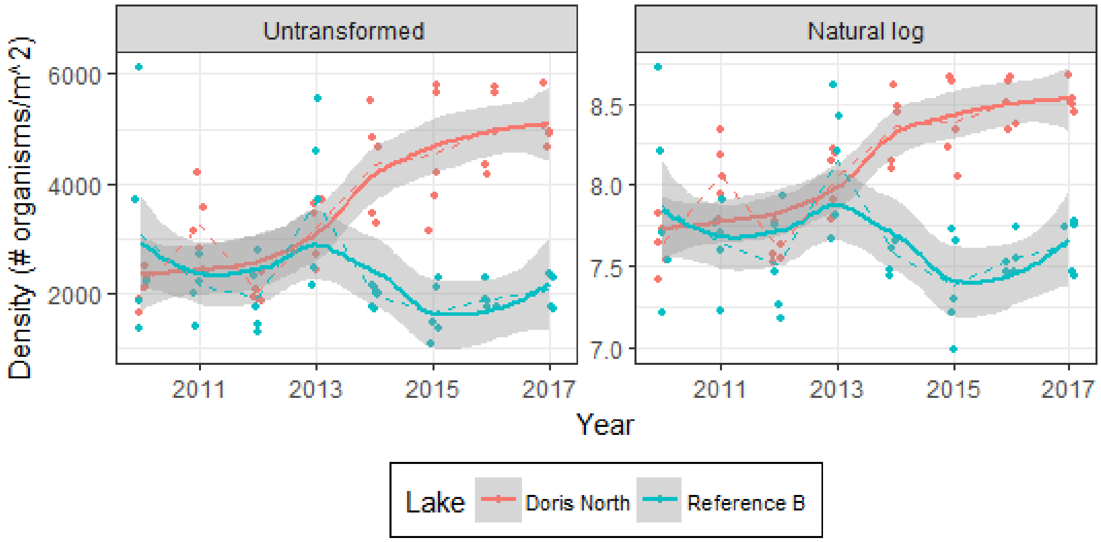


B.3.4 Benthic Invertebrates

B.3.4.1 Analysis of Benthos Density

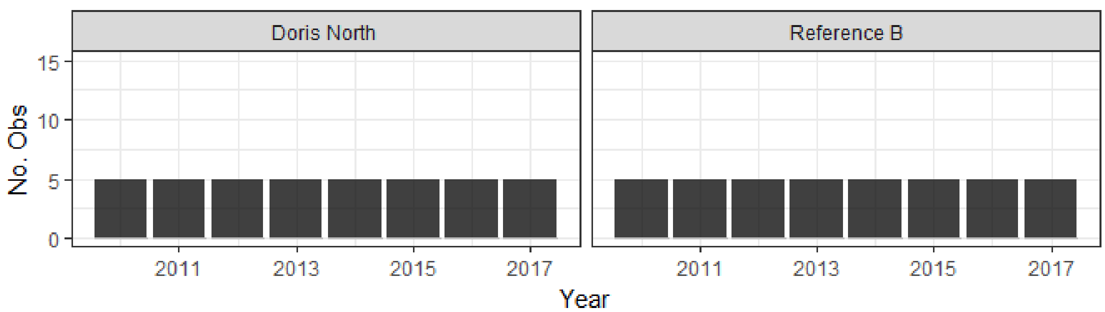
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and natural log scale. Samples were collected in August. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake.



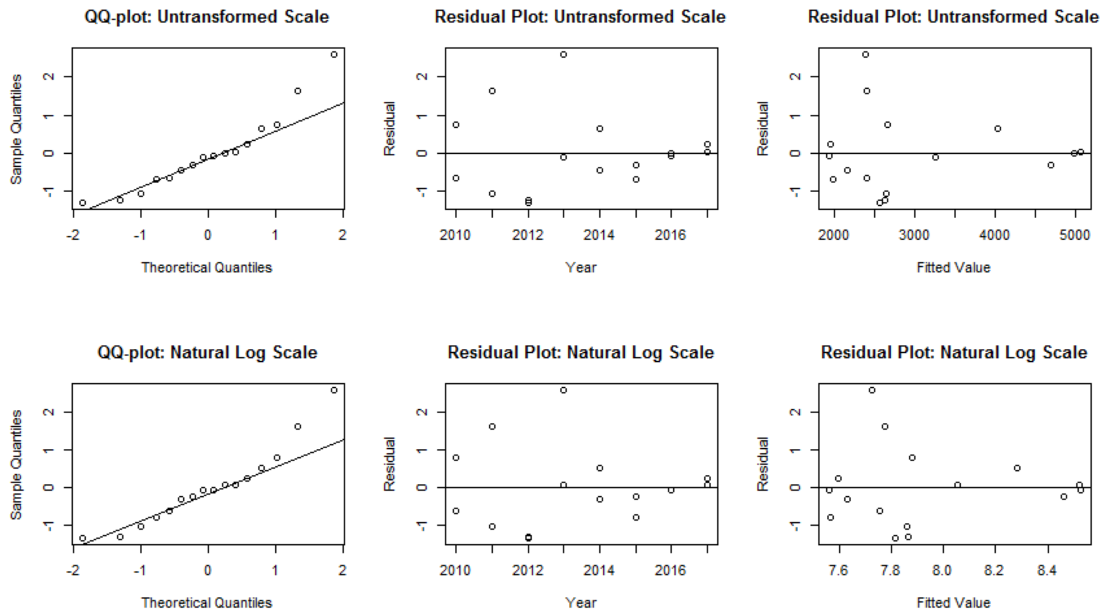
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	40	0	0	3607.400
Reference B	40	0	0	2111.109

The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on natural log scale:

None.

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed data.

<u>Test Results for Monitored lake</u>

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

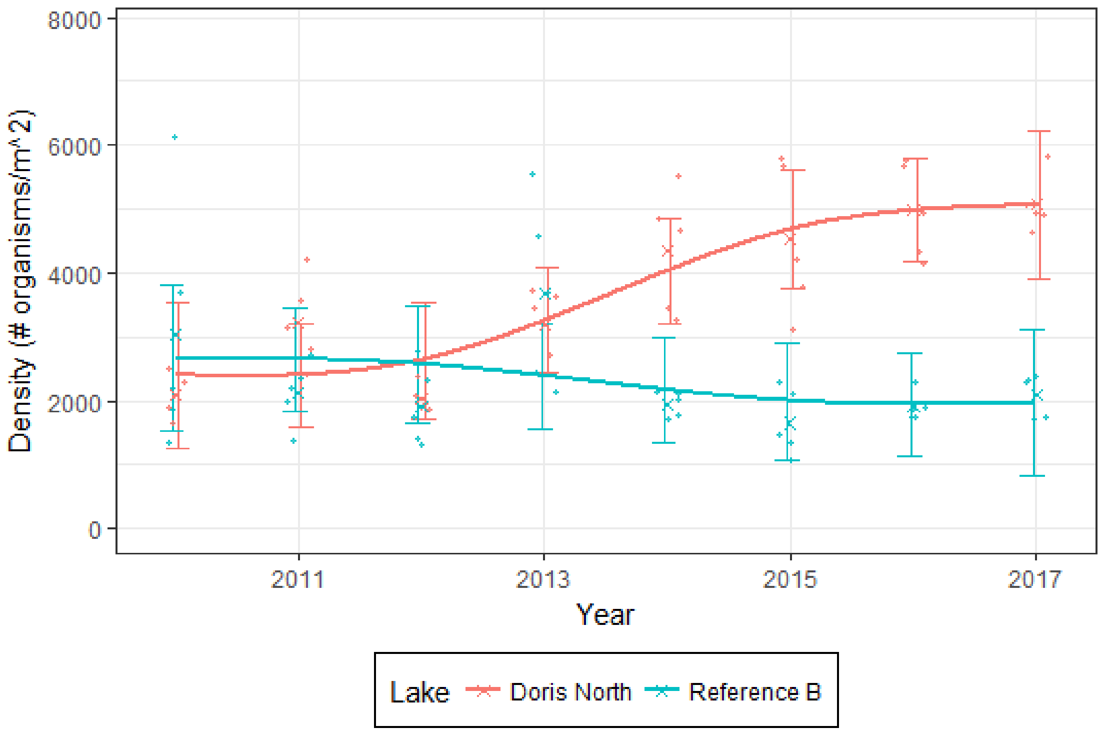
Analysis	**Chi.sq**	**DF**	**P.value**
Compare to slope 0	37.125	3	0.0000
Compare to Reference B	30.040	3	0.0000

Conclusions:

Doris Lake North appears to show significant deviation from no trend. Doris Lake North appears to show significant deviation from the trend of Reference B lake.

Observed Data and Fitted Values

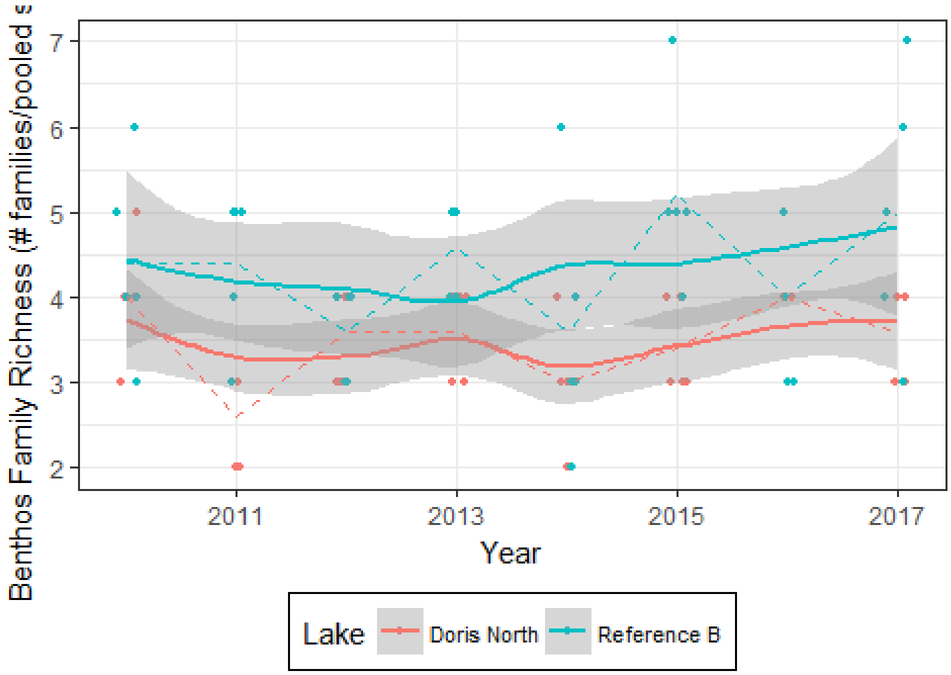
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.4.2 Analysis of Benthos Family Richness

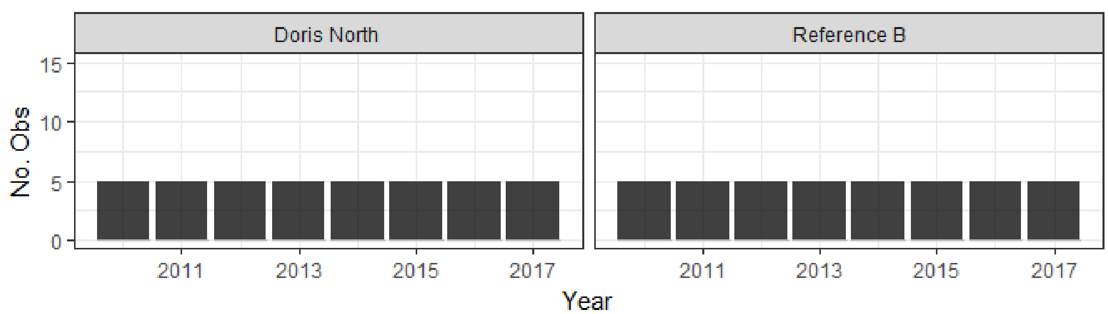
Observed Data

The following plots show all the observed data. Samples were collected in August. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake.

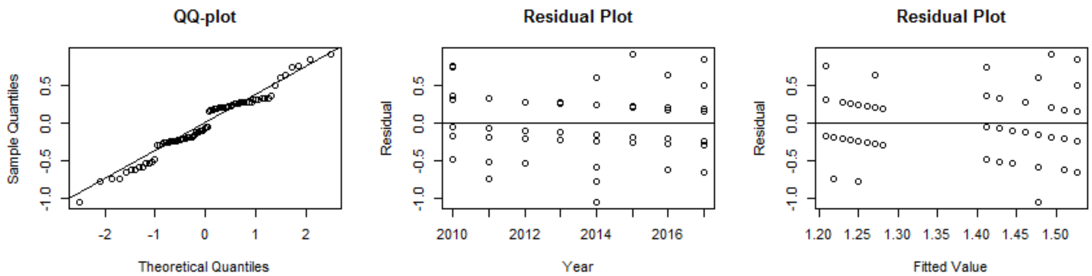


The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	40	0	0	3.5
Reference B	40	0	0	4.0

None of the lakes exhibited greater than 10% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

Initial Model Fit



Outliers:

None.

Test Results for Monitored Lake

The trend of family richness in Doris Lake North over time was assessed. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

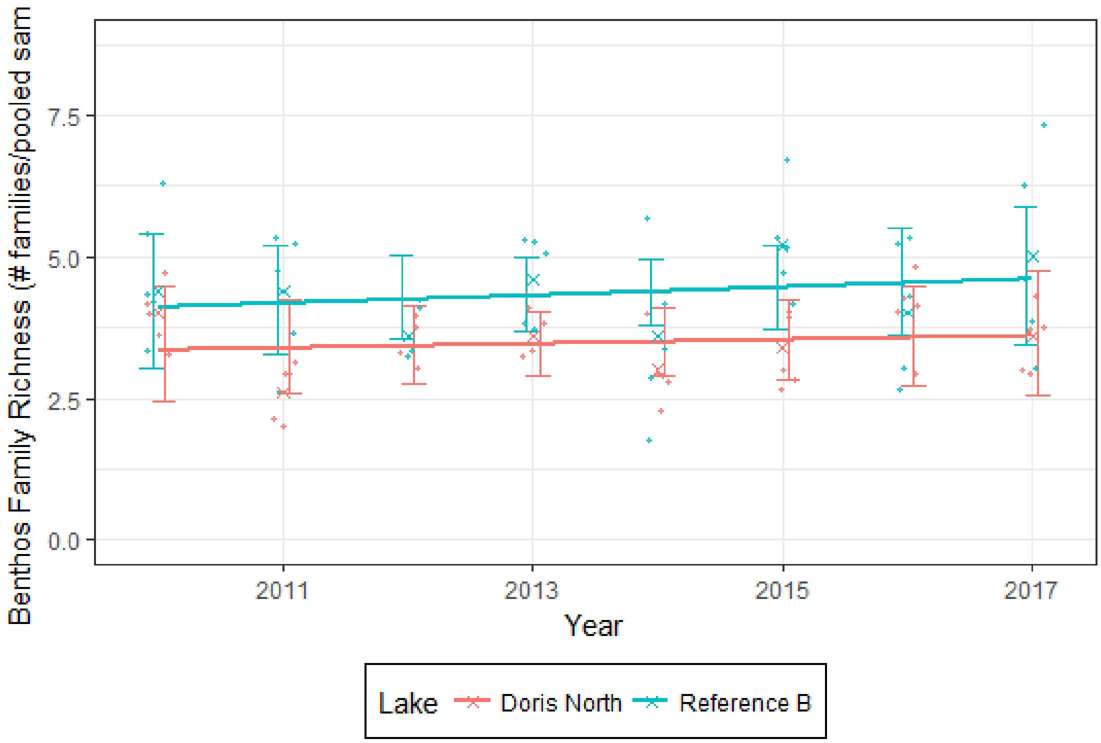
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.077	1	0.7813

Conclusions:

Doris Lake North did not exhibit significant deviation from no change over time

Observed Data and Fitted Values

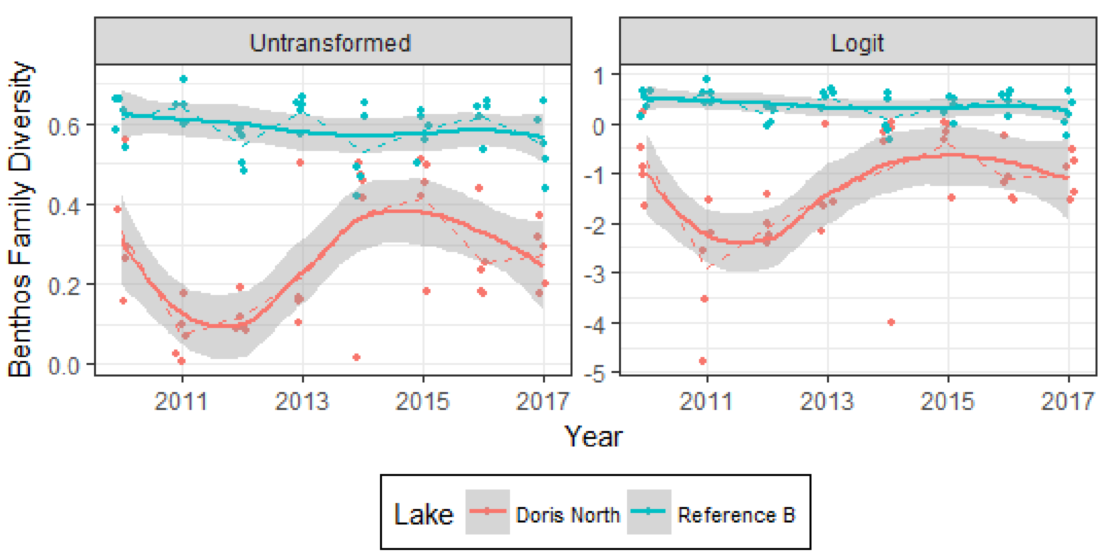
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.4.3 Analysis of Benthos Family Diversity

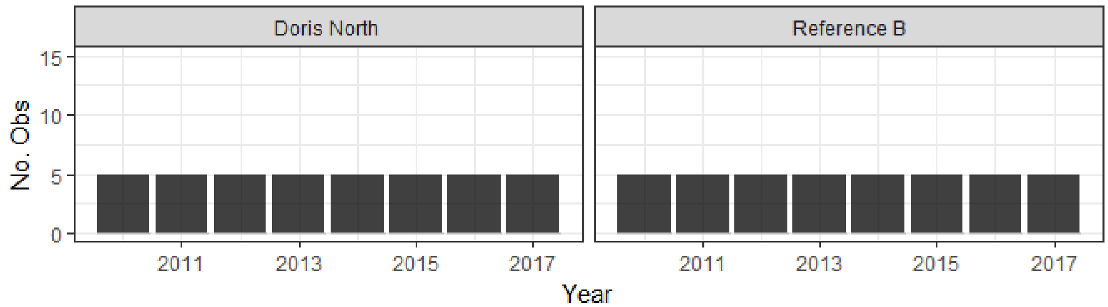
Observed Data

The following plots show all the observed data on the untransformed and logit scale. The logit transformation was selected since the observed data lies in the interval [0, 1]. Samples were collected in August. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake.



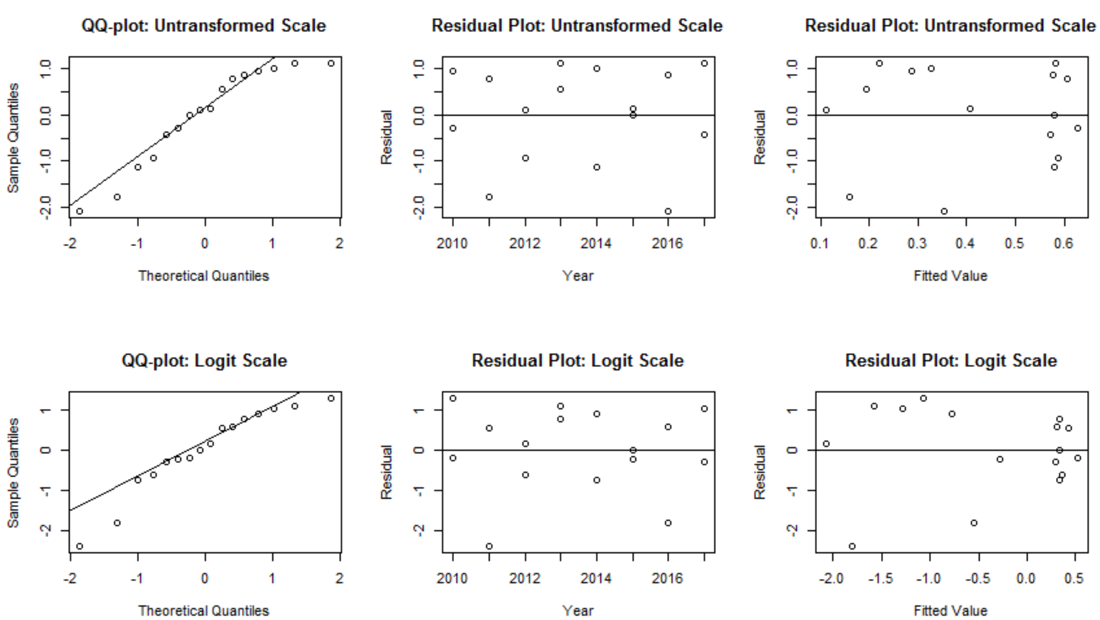
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	40	0	0	0.19645
Reference B	40	0	0	0.60490

The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and logit scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on logit scale:

None.

The logit transformed data better meets the residual assumptions. Analysis proceeds with logit transformed data.

Test Results for Monitored Lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

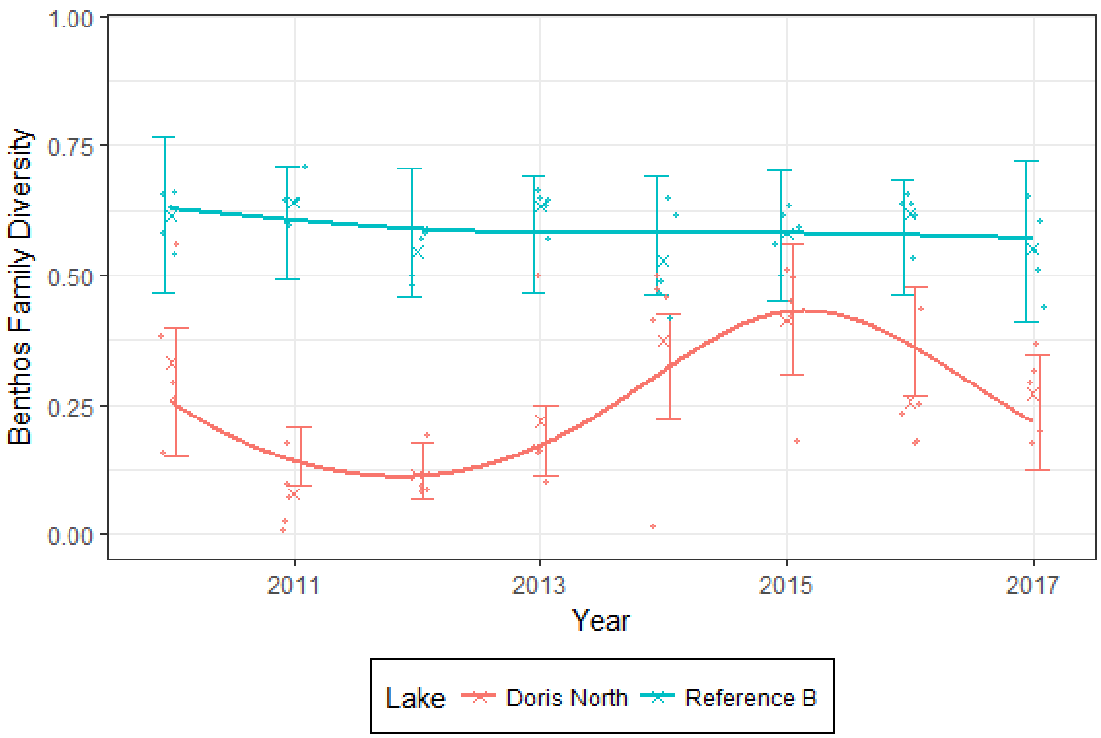
Analysis	**Chi.sq**	**DF**	**P.value**
Compare to slope 0	33.173	3	0.0000
Compare to Reference B	17.787	3	0.0005

Conclusions:

Doris Lake North appears to show significant deviation from no trend. Doris Lake North appears to show significant deviation from the trend of Reference B lake.

Observed Data and Fitted Values

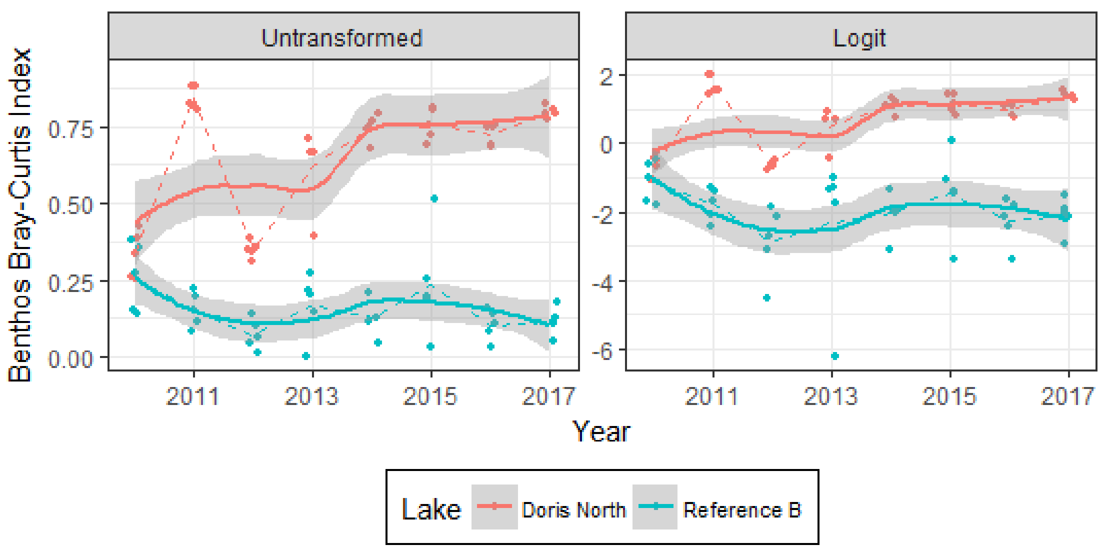
Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



B.3.4.4 *Analysis of Benthos Bray-Curtis Index*

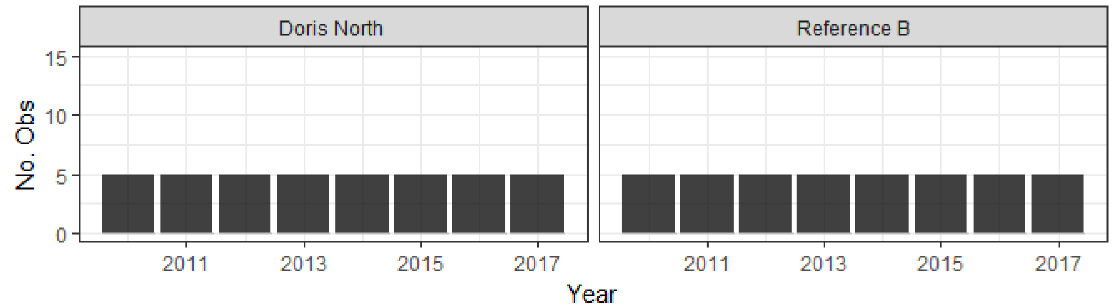
<u>Observed Data</u>

The following plots show all the observed data on the untransformed and logit scale. The logit transformation was selected since the observed data lies in the interval [0, 1]. Samples were collected in August. Observations are slightly jittered along the x-axis for legibility. The lines drawn through the scatter plots represent the annual means. Mean lines and corresponding 95% confidence intervals (represented by grey shading) are shown to provide a clearer display of the trends in the observed data.



Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake.



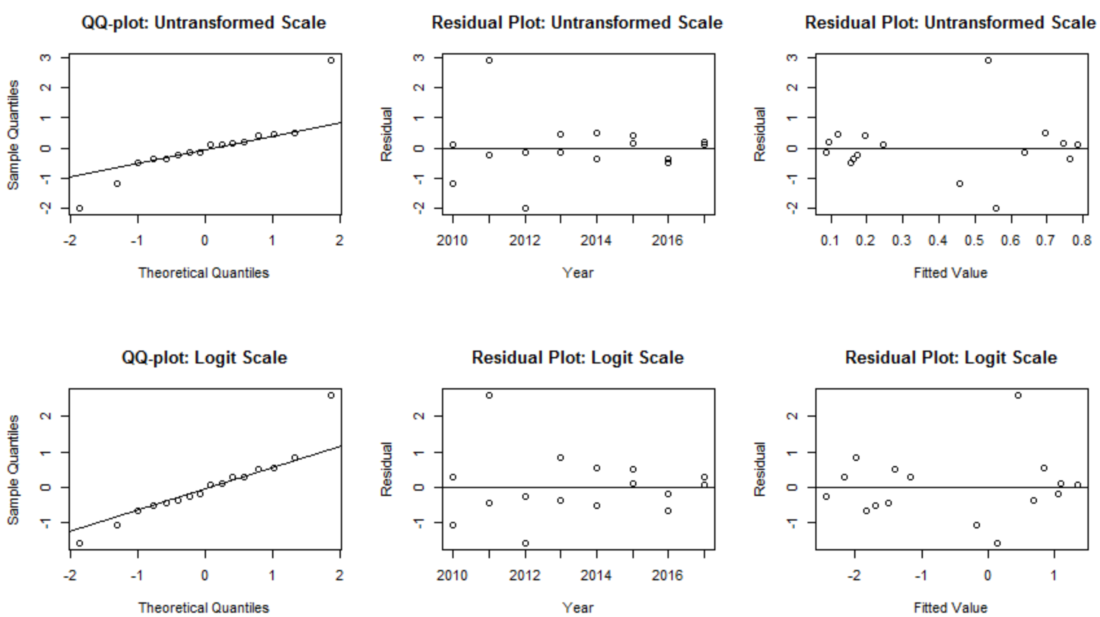
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	40	0	0	0.73485
Reference B	40	0	0	0.13885

The analysis proceeds with linear mixed model regression.

Initial Model Fit

A model was fit both on the untransformed and logit scale to assess the need for transformations. Outliers were identified from the model fit as standardized residuals greater than 3, and flagged to caution interpretation of results but not removed from the analysis.



Outliers on untransformed scale:

None.

Outliers on logit scale:

None.

The logit transformed data better meets the residual assumptions. Analysis proceeds with logit transformed data.

Test Results for Monitored lake

The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

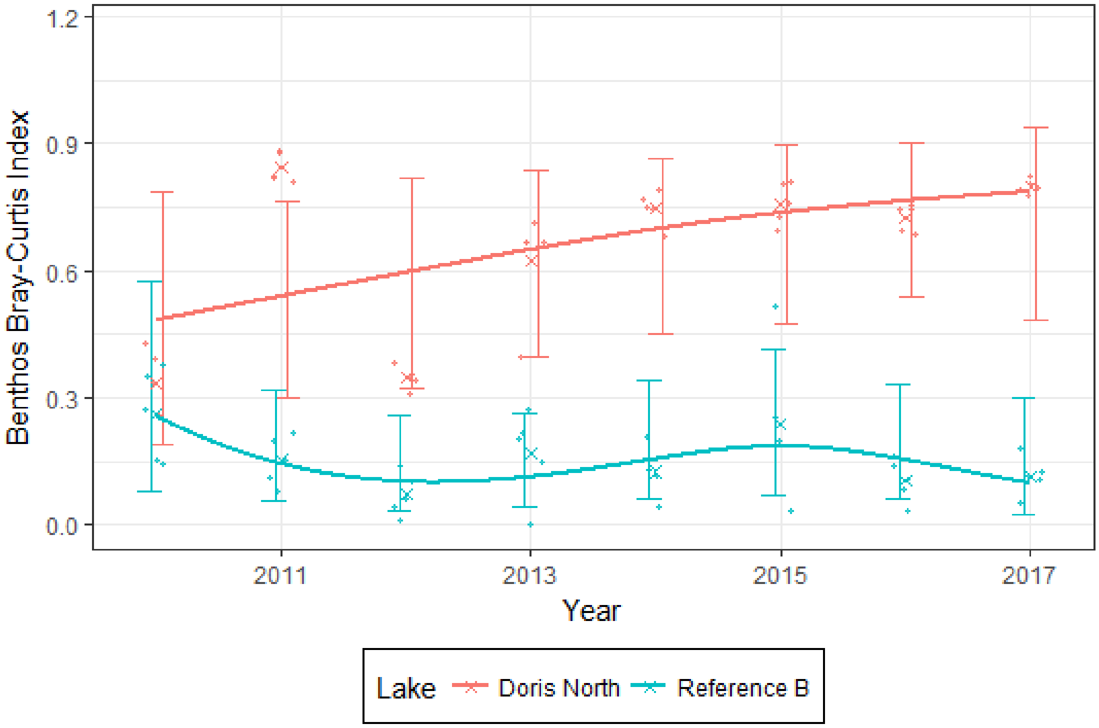
Analysis	Chi.sq	DF	P.value
Compare to slope 0	5.884	3	0.1174

Conclusions:

Doris Lake North did not exhibit significant deviation from no trend.

Observed Data and Fitted Values

Below are plots of the observed and fitted data. The observed data and means are represented by circles and x's, respectively. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



1.2
0.9
0.6
0.3
0.0
Benthos Bray-Curtis Index
2011
2013
2015
2017
Year
Lake
Doris North
Reference B

Appendix C

Aquatic Response Plan for Benthos Density

APPENDIX C. AQUATIC RESPONSE PLAN FOR BENTHOS DENSITY

TABLE OF CONTENTS

GLOSSARY AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AEMP Aquatic Effects Monitoring Program

BACI Before-after control-impact

Benthos Benthic invertebrates

Chlorophyll *a* An essential light-harvesting pigment for photosynthetic organisms including phytoplankton. Because of the difficulty involved in the direct measurement of plant carbon, chlorophyll *a* is routinely used as a 'proxy' estimate for plant biomass in aquatic studies.

the Plan Hope Bay Project: Doris Aquatic Effects Monitoring Plan

the Project the Doris Project

TMAC TMAC Resources Inc.

TSS Total suspended solids

1. INTRODUCTION

This report presents TMAC's *Aquatic Response Plan for Benthos Density* for the Doris Project. The primary objectives of the response plan are to: 1) provide background information about benthic invertebrates (benthos), 2) describe the most likely cause(s) of the observed increase in benthos density in Doris Lake ("North" sampling site), 3) describe the potential ecological risk(s) associated with the observed increase in density, and 4) recommend response actions to address the observed increase, including the setting of medium and high action levels. The response plan is written in accordance with the Doris AEMP Response Framework described in the *Hope Bay Project: Doris Aquatic Effects Monitoring Plan* (the Plan; TMAC 2016).

2. BACKGROUND

2.1 DESCRIPTION OF VARIABLE

Benthic invertebrates reside in the benthic region (the bottom) of lakes and streams. These secondary producers feed on organic matter, primary producers, or other secondary producers, and are an important food source for fish in freshwater systems. Benthos comprise a diverse assortment of organisms that have different mechanisms of feeding. Benthic invertebrate assemblages in lakes in the Doris Project area (e.g., Doris, Ogama, Glenn, Windy, and Little Roberts lakes) are typically dominated by chironomids (order Diptera, family Chironomidae), a ubiquitous and diverse group of freshwater insects also known as non-biting midges (Rescan 2010a; ERM 2017). Other benthic invertebrates commonly observed in Doris Project area lakes include bivalve molluscs (order Veneroida, family Pisidiidae) and oligochaete worms (order Haplotaxida, family Naididae).

Benthic invertebrate communities are widely used as bio-indicators of ecosystem health as different taxa respond differently to environmental change. As environmental conditions vary, the competitive abilities of different species (i.e., their ability to acquire resources relative to the other species present) and each species' ability to tolerate changes in water or sediment quality can shape the structure of communities. Benthos communities can also respond indirectly to changes in environmental conditions through trophic cascades if other trophic levels are affected.

For environmental monitoring programs that investigate the potential effects of metal mining effluents on aquatic receiving environments, Environment Canada (2012) recommends that several benthos community descriptors be monitored, including total benthic invertebrate density, taxa richness, and other measures of community structure and diversity. The Doris Project Aquatic Effects Monitoring Program (AEMP) was not designed to detect effects related to the point-source discharge of mine effluent, since there is no effluent discharged to the freshwater environment; however, the sampling design of the AEMP considered the recommendations of Environment Canada (2012). The benthos community metrics that are used to describe the benthos assemblage for the Doris AEMP are total benthic invertebrate density, taxa richness, the Simpson's diversity index, and the Bray-Curtis similarity index. Of these, the only community descriptor that changed significantly over time according to the AEMP analysis of effects was total benthos density.

2.2 DETERMINATION AND CONFIRMATION OF ACTION LEVEL EXCEEDANCE

The Plan describes a Response Framework for adaptive management of the freshwater environment. The Response Framework is based on the concept of "action levels", which are a set of tiered triggers (low, medium, and high) linked to increasing magnitude of effects to the aquatic environment and corresponding management actions. The low, medium, and high action levels represent a gradient of increasing magnitudes of effects and associated responses, with the ultimate goal of avoiding or pre-empting the exceedance of the "significance threshold". The significance threshold is defined as a level of change in any monitored variable that results in a significant adverse effect (TMAC 2016).

For each variable monitored as part of the AEMP, the Response Framework defines what conditions would need to be met to trigger a low action level response. If a low action level response is triggered, medium and high action level thresholds are defined in the follow-up response plan (TMAC 2016). The low action level thresholds for water and sediment quality variables are set below Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life as they are meant to serve as early indicators of potentially adverse changes before any CCME guidelines are exceeded (which would indicate the potential for adverse toxicological effects). For biological variables such as benthos density that don't have set CCME guidelines, the conditions that need to be met to trigger a low action level response are:

- identification of a significant difference in the "before" and "after" periods in the AEMP effects analysis; and
- absence of a similar difference at the reference location (TMAC 2016).

As described in the AEMP report, the analysis of effects methodology has been modified from a before-after control-impact (BACI) design to a trend analysis for a more robust analysis. The BACI design used in previous AEMP reports included only pre-2010 baseline data and the current monitoring year (excluding all years in between), while the trend analysis makes use of all years of data to detect a potential change over time. For benthos, because of a change in sampling methodology starting in 2010 from discrete to composite replicate samples (which could affect several benthos metrics including taxa richness and diversity), baseline data collected prior to 2010 were not included in the analysis of effects.

Benthos density increased over time in Doris Lake North from a mean of 2,083 organisms/m^2 in 2010 to 5,079 organisms/m^2 in 2017, with the largest increase occurring between 2012 and 2015 and relatively consistent levels between 2015 and 2017. This trend was significantly different from a slope of zero ($p < 0.0001$) and from the trend observed at Reference Lake B ($p < 0.0001$), which fluctuated over time (see Figure 3.6-1 of the *Doris Project: 2017 Aquatic Effects Monitoring Program Report*, and Appendix B for statistical analysis outputs). The statistically significant increase in benthos density over time met the first condition of the low action level, while the absence of a similar trend at the reference site met the second condition of a low action level, thus the low action level for benthos density was exceeded. This response plan was prepared as a consequence of this exceedance.

2.3 LIKELY CAUSE OF ACTION LEVEL EXCEEDANCE

Benthos density is influenced by bottom-up (e.g., availability and/or quality of prey items) and top-down controls (e.g., predation pressure or food web dynamics), as well as environmental and hydrological conditions. An increase in density could be caused by enhanced nutrient availability, increased quality or quantity of food items such as organic detritus and primary or secondary producers, changes in environmental conditions such as higher dissolved oxygen concentrations, higher temperature, or alterations to the hydrological regime (e.g., water level, flow) that could favour the growth or emergence of a particular taxa or several different taxa. Changes to certain water quality variables such as conductivity or total suspended solids (TSS) could also affect benthic invertebrate communities, and could cause an increase in the densities of organisms that thrive or out-compete other species under these changing conditions. Top-down controls could also cause an increase in benthos density if changes to the structure and dynamics of food webs result in a reduction of predation pressure on benthic invertebrates. For example, a shift in the relative abundance of fish species that have a preference for pelagic rather than benthic prey types, or a change in fish demographies in which older piscivorous individuals become relatively more numerous than younger benthic-feeding individuals could result cause an increase in the density of benthic invertebrates.

A review of the monitoring data collected as part of the AEMP did not reveal an obvious cause for the observed increase in benthos density. There were no apparent Project-related increases in water column nutrient concentrations that might be indicative of eutrophication (i.e., ammonia (see Section 3.3.6 of the *Doris Project: 2017 Aquatic Effects Monitoring Program Report*), nitrate (Section 3.3.7), and total phosphorus (Section 3.3.8)), nor to any indicators of enhanced productivity such as sediment total organic carbon content (Section 3.4.1) and chlorophyll *a* concentrations (Section 3.5.1).

There was limited evidence of a slight increase in TSS concentrations in Doris Lake (Section 3.3.2); however, while the deposition of sediments could favour some benthos taxa over others (Logan 2007), increased sediment deposition is typically associated with an overall decline in the abundance of benthic invertebrates (e.g., de Castro Vasconcelos and Melo 2008).

The profiles of under-ice dissolved oxygen from April 2017 showed that the bottom waters of Doris Lake North contained higher dissolved oxygen concentrations than Reference Lake B (7.8 mg/L compared to 2.8 mg/L, respectively). The historical data show that bottom water dissolved oxygen concentrations are typically higher in Doris Lake North than in Reference Lake B, which could explain why there are differential responses of the benthic assemblages within these lakes. Under-ice dissolved oxygen concentrations in Doris Lake have been particularly high in recent years[1], with a marked increase in concentrations between April 2013 and April 2014 (see Figure 3.2-1 of the *Doris Project: 2017 Aquatic Effects Monitoring Program Report*). This coincides with the largest increase in benthos density which seems to have occurred between 2012 and 2015 (Figure 3.6-1). Benthos density between 2015 and 2017 has been relatively consistent; therefore, the cause of the increase may have

[1] Note that an increase in bottom water dissolved oxygen concentration is not indicative of eutrophication, as increased nutrient inputs would stimulate productivity and ultimately result in lower under-ice dissolved oxygen concentrations due to increased rates of organic matter decomposition.

occurred sometime in the past, such as an increase in under-ice dissolved oxygen concentrations from 2013 to 2014. As dissolved oxygen concentrations are typically lowest during the under-ice period, higher than usual dissolved oxygen concentrations during this period could stimulate benthic invertebrate density through increased reproduction, survival, growth, or emergence (Gaufin, Clubb, and Newell 1974).

Another possible cause of the observed change in density over time is natural variability. Benthos density data collected from Reference Lake B from 2010 to 2017 demonstrate that inter-annual variability and among-replicate variability is high. The benthos density in five replicate samples collected in Reference Lake B in 2010 ranged from 1,348 to 6,133 organisms/m^2, which spans a wider range than the observed increase in density over time in Doris Lake North, and illustrates the potential spatial heterogeneity in benthos density that can exist even within a relatively small area. The coefficient of variation for mean density over all years was similar between Doris Lake North and Reference Lake B (33% and 30%, respectively); indicating that the overall variation in mean density was comparable between the lakes; however the trend in Doris Lake North varied in a positive direction while the inter-annual density in Reference Lake B did not show a clear unidirectional trend. It is possible that the increasing trend in benthos density in Doris Lake North reflects a naturally occurring cyclical pattern of abundance. A 20-year study of chironomid species in an Icelandic Lake showed that there were large short-term fluctuations in the abundance of some species (of more than four orders of magnitude in some cases), but the long-term trend showed no significant changes in abundance (Gardarsson et al. 2004).

While there is not a trend of increasing temperature in Doris Lake, the effects of climate change (e.g., higher water temperature) could also result in an increase in benthos density in Doris Lake North, which would not necessarily co-occur in Reference Lake B. The benthic invertebrate community composition between these lakes is different (Doris Lake North is dominated by chironomids [84%], while Reference Lake B is dominated by bivalve molluscs [60%]), and different taxa could have differential responses to climate change or other environmental disturbances. Several studies have shown that chironomids are particularly sensitive indicators of climate change because their abundances tend to be correlated to temperature (e.g., Larocque, Hall, and Grahn 2001). Trends over time between lakes could also vary due to differences in lake morphology, productivity, catchment size, as well as variability in the magnitude of inputs of nutrients, sediments, or organic matter related to permafrost degradation, weathering and erosion, or runoff from the natural landscape. These changes would not necessarily affect all lakes in the region equally.

2.4 ECOLOGICAL IMPLICATIONS OF ACTION LEVEL EXCEEDANCE AND RELATION TO SIGNIFICANCE THRESHOLDS

Most monitoring programs that have studied the effects of mine discharges on freshwater benthic invertebrates communities have reported declines in benthos density as a result of the effects of metals in effluents (see AETE Program (1999) for a review). In contrast, the opposite effect (an increase in density) is seen in Doris Lake North (although this lake does not receive mine effluent, and is assessed because it may be affected by non-point sources inputs such as run-off or dust). An effect producing benthic invertebrate declines would be of greater concern for fish populations and ecosystem health than the observed increase in benthos density, as a negative effect could result in the exceedance of the "significance threshold" described in the AEMP Plan as "*the water of Doris Lake is not safe for fish* *and aquatic organisms that support the aquatic ecosystem and the growth of fish*" (TMAC 2016). The goal of the adaptive management of the freshwater environment is to avoid reaching this pre-defined significance threshold.

An increase in benthos density without a co-occurring change in an indicator of eutrophication (e.g., nutrient increase or phytoplankton biomass increase), and without any discernible change in benthic family composition, richness, and diversity, is likely of little ecological concern. The observed increase in density could simply have resulted from natural variability, or could be related to the relatively high concentrations of under-ice dissolved oxygen in Doris Lake measured in recent years. When observed on its own, benthos density without co-occurring changes in other variables could indicate an improvement of the overall ecosystem health in the lake, which could have positive effects on the fish community through increased prey abundance as population growth of arctic freshwater fish may often be limited by the availability of prey (McDonald, Hershey, and Miller 1996). In Project lakes, Lake Whitefish (*Coregonus clupeaformis)* and young Lake Trout (*Salvelinus namaycush*) prey heavily on chironomids (Rescan 2010b), the predominant benthic invertebrate taxa that has increased over time.

There could be an adverse ecological implication of an increase in benthos density if this were an early sign of eutrophication, if the increase in benthos was related to an undetected decline in the fish population leading to reduced predation pressure, or if there was an increase in the relative abundance of lower quality or unpalatable prey types for fish. However, the low action level was not triggered for any other variable monitored as part of the AEMP, so there is no reason to suspect that any Project-related eutrophication is occurring or that there are any Project-related changes to the freshwater environment that could adversely affect fish. The relative abundance of benthos families has also remained fairly similar over time with chironomids consistently representing the predominant family, thus there is no evidence of a shift to unpalatable prey types.

3. RESPONSE ACTIONS

Low, medium, and high action levels represent a gradient of increasing magnitudes of effects and associated response actions, with the ultimate goal of avoiding or pre-empting the exceedance of the "significance threshold" defined as "*the water of Doris Lake is not safe for fish and aquatic organisms that support the aquatic ecosystem and the growth of fish*" (TMAC 2016).

3.1 PROPOSED RESPONSE ACTIONS TO LOW ACTION LEVEL EXCEEDANCE

For benthos density, the environmental implication of a low action level exceedance because of an *increase* in density is not considered to be adverse (assuming there are no co-occurring indicators of a potentially adverse change), since an increase in the availability of prey items for benthic-feeding fish can have a positive effect on fish populations. A review of all the variables monitored as part of the AEMP did not reveal an obvious cause for the increase in benthos density, and the change may be related to natural variability, climate change, or high dissolved oxygen concentrations during the under-ice season.

Furthermore, the change in benthos density seems to have occurred some time in the past (between 2012 and 2015), as density over the last three years has been relatively consistent. Based on the relatively stable densities observed in the last three years and the absence of a significant increase in any variable that could indicate that eutrophication is occurring (e.g., nutrients, phytoplankton biomass), it is not expected that benthos density will continue to increase (although increases due to climate change or natural variability cannot be discounted).

For these reasons, no further response actions are recommended for the current low action level exceedance beyond the review of the possible influences (e.g. dissolved oxygen, natural variability) presented in Section 2.3. The next benthos community survey will be conducted in the summer of 2020, at which point the trend in benthos density over time can be re-assessed.

3.2 DEFINITION OF MEDIUM AND HIGH ACTION LEVELS

The concept of establishing medium and high action levels that approach but do not exceed the significance threshold does not apply to increasing benthos density, since an increase does not bring the aquatic ecosystem closer to the significance threshold of adversely affecting fish (rather, the system shifts further away from the significance threshold if there is a benefit to fish). A significant decrease in benthos density would be more ecologically relevant with respect to the significance threshold, as this could negatively affect the fish population in Doris Lake. Therefore, for benthos density, the medium and high action levels focus on a decreasing trend.

There is a potential for adverse ecological implications of an increase in benthos density if this were an early sign of eutrophication. However, the primary cause of such a change would likely be nutrient inputs to the system from runoff or dust deposition, and changes to nutrient concentrations would be managed directly through the response framework and the low action level triggers for those potentially increasing variables. Overall, there is no indication that TMAC's activities at the Doris site have affected the trophic status of Doris Lake and the benthos that reside in the lake.

3.2.1 Medium Action Level

The conditions that would trigger a **medium action level** for benthos density are defined as:

- the low action level has been triggered;
- the overall trend over time is a decrease; and
- the mean benthos density in the current year of monitoring is lower than the mean density observed in any previous year at Doris Lake North and falls outside of the range of natural variability for this site.

The medium action level conditions go beyond the low action triggers by specifying that only a decrease in density over time and only a decrease beyond the lower limit of natural variability would require the potential escalation of management efforts.

3.2.2 High Action Level

The conditions that would trigger a **high action level** for benthos density are defined as:

- the medium action level has been triggered;
- a unidirectional decreasing trend in benthos density is evident over the last three benthos surveys; and
- there is a co-occurring low, medium, or high action level exceedance for another variable that could explain a decrease in benthos density (e.g., water or sediment concentrations of potentially toxic metals; water column conductivity, pH, TSS, turbidity, under-ice dissolved oxygen concentration).

The high action level conditions go beyond the medium action conditions by requiring that the decrease be an ongoing concern that did not occur some time in the past, and that a possible cause of the decrease be apparent to rule out natural variability and to focus mitigation efforts on the most likely cause of the decrease.

4. SCHEDULE AND RECOMMENDED NEXT STEPS

The low action level exceedance caused by an increase in benthos density between 2010 and 2017 is considered to be of little ecological concern. Based on a review of available data, the most likely causes for the action level exceedance include natural variability (e.g., spatial heterogeneity in benthos distribution, cyclical fluctuations in the abundances of difference species over time) or higher than usual under-ice dissolved oxygen concentrations. An increase in benthos density without co-occurring changes in any other parameter indicative of eutrophication could signal an improvement in the ecosystem health in Doris Lake, and could be beneficial to the benthic-feeding fish in that lake.

The next benthos community survey will be conducted in the summer of 2020, at which point the trend in benthos density over time can be re-assessed. Other indicators of potential eutrophication (e.g., nutrient concentrations, phytoplankton abundance, sediment total organic carbon content) will be re-assessed in the 2018 AEMP report, and this will aid in the determination of whether the increase in benthos density may be related to one of these factors.

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