Doris Project

2018 Aquatic Effects Monitoring Program Report

March 2019

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DORIS PROJECT

2018 Aquatic Effects Monitoring Program Report

ERM Consultants Canada Ltd.
1111 West Hastings Street
15th Floor
Vancouver, BC

EXECUTIVE SUMMARY

The Doris Project (the Project) is located on the Hope Bay Belt (the Belt), an 80 by 20 km property along the south shore of Melville Sound in Nunavut. TMAC Resources Inc. (TMAC) acquired the Belt from Newmont Corporation in March 2013. The acquisition included exploration and mineral rights over the Belt, including the Doris Gold Mine and its permits, licences, and authorizations for development received by previous owners. In late 2012, prior to the sale, the Hope Bay Belt Project was placed into care and maintenance, and the site was seasonally closed during the winter of 2012/2013. TMAC re-opened the Doris Camp in March of 2013 for the purposes of conducting site water management and environmental compliance programs and to support exploration activities. Following notification to the Nunavut Water Board (NWB) and Nunavut Impact Review Board (NIRB), construction was resumed during the summer of 2015. The Project transitioned from a construction phase into commercial operations in early 2017, and operations have continued through 2018.

This report presents the results of the 2018 Aquatic Effects Monitoring Program (AEMP) for the Project. The 2018 AEMP was conducted according to the Hope Bay Project: Doris Aquatic Effects Monitoring Plan (the Plan; TMAC 2016). The Plan focuses on pathways of potential effects in Doris Lake, since most mine infrastructure is adjacent to Doris Lake and this waterbody has the greatest potential to be affected by the Project. Mining activities also have the potential to draw down the water level in Doris Lake due to permitted water withdrawal for Project use and water loss through the recharge of mine-intercepted groundwater (TMAC 2016).

Two lake sites were monitored as part of the 2018 AEMP in accordance with the Plan: Doris Lake North and Reference Lake B. Aquatic components evaluated in 2018 included the following: under-ice water level; under-ice dissolved oxygen concentration; water temperature; water quality; and phytoplankton biomass. Statistical and/or graphical analyses were performed in order to determine whether there were any apparent effects of Project activities on the aquatic monitoring components at the exposure site (Doris Lake North) in 2018. The analyses included comparisons of baseline data (pre-2010) to data collected during mine construction (2010 to 2016) and operations (2017 onward) phases and comparisons between the reference site (Reference Lake B) and the potentially affected site (Doris Lake North) over time.

Table 1 presents a summary of the overall findings of the evaluation of effects for the 2018 AEMP, as well as the corresponding section in this report in which to find the discussion of the evaluation of effects for each monitoring component.

Table 1: Summary of Evaluation of Effects for 2018 Aquatic Effects Monitoring Program

Evaluated Variable	Doris Lake North (exposure site)	Low Action Level Triggered?	Report Section
Under-ice Water Level	no effect	No	3.1
Under-ice Dissolved Oxygen	no effect	No	3.2
Temperature	no effect	No	3.2
Water Quality	possible effect (total molybdenum)	No	3.3
Phytoplankton Biomass	no effect	No	3.4

ACKNOWLEDGEMENTS

This report was prepared for TMAC Resources Inc. by ERM. The 2018 fieldwork was conducted by ERM scientists Leanne Elchyshyn (M.Sc.), Adam Chateauvert (M.Sc.), and Cameron Evans (E.I.T.), with the support of TMAC on-site environmental coordinators Kyle Conway and Sarah Warnock. Fieldwork was completed with the enthusiastic and competent support of TMAC field assistants Shannon Evetalegak, Patrick Jolliffe, George Kavana, Terence Milton, Jamal Nirlungayuk, Daniel Skinner, and Junior Tikhak. The report was written by Carol Adly (M.Sc.), statistical analyses were completed by Joanna Zhao (M.Sc.) and Laurie Ainsworth (Ph.D.), and the report was reviewed by Erin Forster (B.Sc., R.P.Bio.) and Mike Henry (Ph.D.). The compliance program was managed by Nicole Bishop (B.Sc.) and Danielle Willmon (B.Sc.). Marc Wen (M.Sc., R.P.Bio.) was the Partner in Charge. Graphics production was coordinated by Jason Widdes, Geographical Information System (GIS) production was coordinated by Luke Powell (M.Sc.), and report publishing was coordinated by Agnes Untz (B.A.).

Field-related logistics support was provided by TMAC, Acasta HeliFlight, Braden Burry Expediting, and Nuna Logistics.

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ACRONYMS AND ABBREVIATIONS

AEMP	Aquatic Effects Monitoring Program
ALS	ALS Laboratory Group
BACI	Before-after control-impact
the Belt	Hope Bay Belt
Benthos	Benthic invertebrates
CB	Comparison to benchmarks
CCME	Canadian Council of Ministers of the Environment
Censored value	A value that is only partially known, e.g., a variable concentration that is reported as being below a specified detection limit, although the actual concentration is not known.
Chl *a*	Chlorophyll *a*
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.
CTD	Conductivity, temperature, depth probe
Ds	Secchi depth
DL	Detection limit
DOC	Dissolved organic carbon
DQO	Data quality objective
ERM	ERM Consultants Canada Ltd.
Exposure site	Site anticipated to be potentially influenced by Project-related activities as part of the Doris Project (i.e., Doris Lake North).
GA	Graphical analysis
k	Light extinction coefficient
LME	Linear mixed effects
LOESS	Locally estimated scatterplot smoothing
NIRB	Nunavut Impact Review Board
NTU	Nephelometric turbidity units
NWB	Nunavut Water Board
the Plan	Hope Bay Project: Doris Aquatic Effects Monitoring Plan
the Project	the Doris Project
QA/QC	Quality assurance/quality control
Reference site	Site located beyond any Project influence (i.e., Reference Lake B).

Salinity	No units, dimensionless. Historically, many units have been assigned to salinity, for example, parts per thousand (ppt or ‰), Practical Salinity Units (PSU), and Practical Salinity Scale 1978 (PSS-78). Salinity is defined on the PSS-78 as the conductivity ratio of a seawater sample to a standard KCl solution. As PSS-78 is a ratio, it has no units.
SA	Statistical analysis
SD	Standard deviation
SE	Standard error of the mean
TIA	Tailings Impoundment Area
TMAC	TMAC Resources Inc.
TOC	Total organic carbon
TSS	Total suspended solids
$Z_{1\%}$	The 1% euphotic depth, i.e., the depth of the water column at which 1% of the surface irradiance reaches.

1. INTRODUCTION

The Doris Project (the Project) is located on the Hope Bay Belt (the Belt), an 80 by 20 km property along the south shore of Melville Sound in mainland Nunavut (Figure 1-1). The Belt consists of a greenstone belt that contains three main gold deposits. The Doris and Madrid deposits are located in the northern portion of the belt, and the Boston deposit is at the southern end. The Project is approximately 125 km southwest of Cambridge Bay (Iqaluktuttiaq) and the nearest communities are Umingmaktok (75 km to the southwest of the property), Cambridge Bay, and Kingaok (Bathurst Inlet; 160 km to the southwest of the property).

TMAC Resources Inc. (TMAC) acquired the Belt from Newmont Corporation in March 2013. The acquisition included exploration and mineral rights over the Belt, including the Doris Gold Mine and its permits, licences, and authorizations for development received by previous owners. In late 2012, prior to the sale, the Hope Bay Belt Project was placed into care and maintenance, and the site was seasonally closed during the winter of 2012/2013. TMAC re-opened the Doris Camp in March 2013 for the purposes of conducting site water management and environmental compliance programs and to support exploration activities. Following notification to the Nunavut Water Board (NWB) and Nunavut Impact Review Board (NIRB), construction was resumed during the summer of 2015. The Project transitioned from a construction phase into commercial operations in early 2017, and operations have continued through 2018.

This report presents the results of the 2018 Aquatic Effects Monitoring Program (AEMP) for the Project. The AEMP was conducted according to the Hope Bay Project: Doris Aquatic Effects Monitoring Plan (the Plan; TMAC 2016), which was approved with the issuance of Amendment No. 1 of the Type A Water Licence (No. 2AM-DOH0713) by the Nunavut Water Board (NWB) on December 16, 2016 (Motion Number 2016-11-P7-08). This Plan replaced the original AEMP plan for the Doris Project (Rescan 2010b). In the original mine plan, the discharge of mine contact water and saline groundwater from the Tailings Impoundment Area (TIA) was to be directed to Doris Creek, a fish-bearing stream that flows from Doris Lake and eventually into Roberts Bay. However, under the terms of the current Project Certificate No. 003 and Water Licence 2AM-DOH1323, the planned discharge of TIA water has been redirected from the freshwater environment (Doris Creek) to the marine environment (Roberts Bay). Given that there is no longer anticipated to be point-source effluent discharge to the freshwater environment, the revised Plan was designed to detect effects to the freshwater environment from non-point source inputs of dust and runoff from Project-related activities. The Plan focuses on pathways of potential effects in Doris Lake, since most mine infrastructure is adjacent to Doris Lake and this waterbody has the greatest potential to be affected by the Project. Mining activities also have the potential to draw down the water level in Doris Lake due to permitted water withdrawal for Project use and water loss through the recharge of mine-intercepted groundwater (TMAC 2016).

1.1 Objectives

The objectives of the AEMP are to monitor and evaluate potential effects of Project activities on the following components of the freshwater environment in the Project area:

- under-ice water level in Doris Lake;
- dissolved oxygen concentration and water temperature;
- water quality;
- sediment quality (not monitored in 2018);
- phytoplankton biomass; and
- benthic invertebrate community (not monitored in 2018).

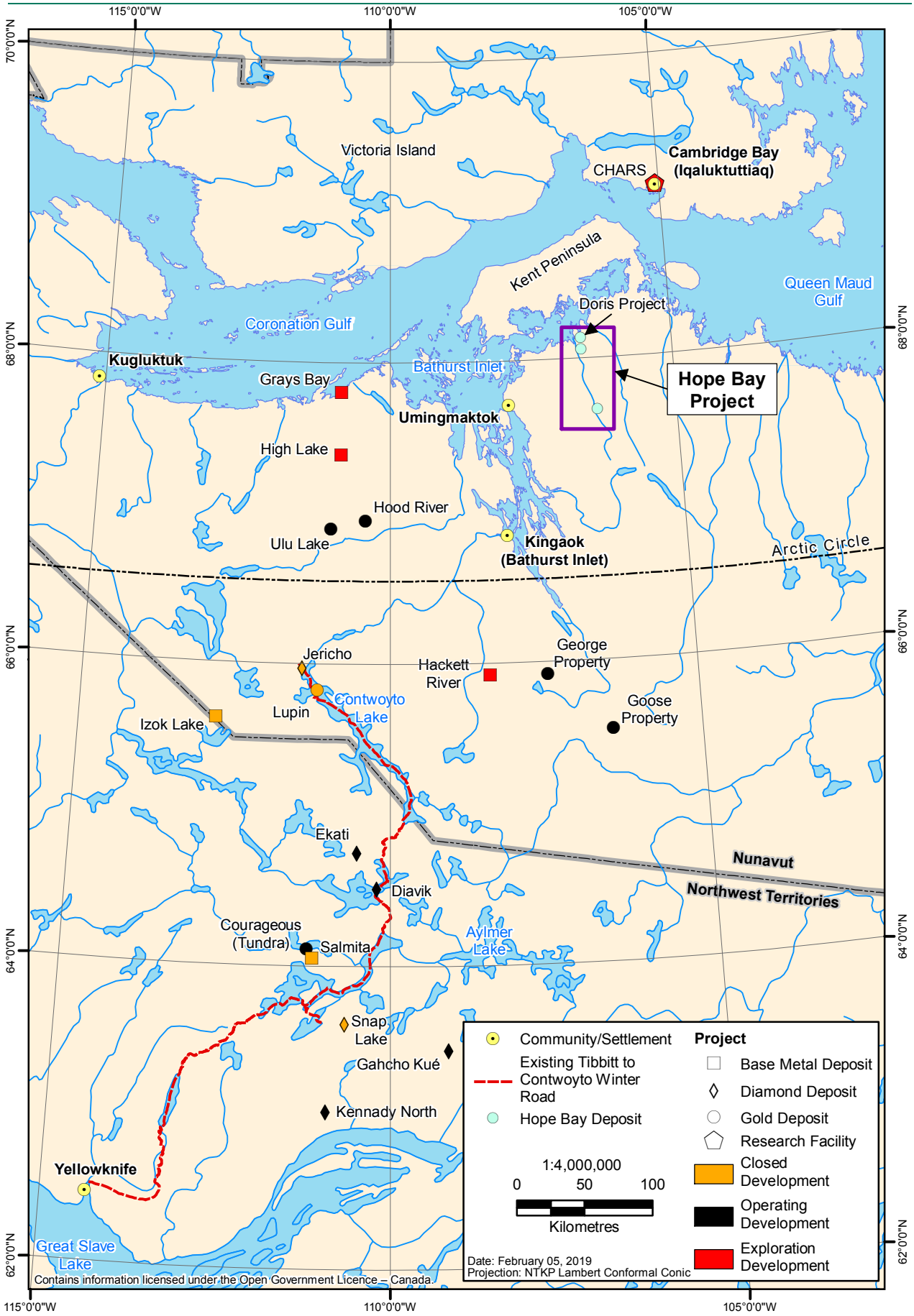


Figure 1-1: Doris Project Location

1.2 2018 Project Activities

Existing infrastructure associated with the Doris Project is shown in Figure 1.2-1. In 2018, commercial operations continued at Doris. Infrastructure constructed included a fabric tent structure over the primary crusher of the mill and an enclosure for the detoxified tailings conveyor exiting the mill building. Two dorms were added to allow an additional 98 bed spaces at Doris Camp. Earthworks continued to complete the Doris Airstrip south apron expansion and lined aircraft de-icing and refueling pad. Construction of the TIA South Dam and associated access road were completed in 2018. Additionally, construction of the access road and outfall berm for the Roberts Bay ocean discharge line and fusing of the discharge pipeline began in 2018. To accommodate increased fuel storage required for future Project activities, the Roberts Bay single tank farm berm was raised to allow full use of the 5ML tank and this tank was recommissioned in 2018. The Doris Connector Vent Raise access road was constructed to support continued underground development. The final section of Pad T was completed in 2018 to allow additional ore and waste rock storage within the permitted footprint.

Underground mining continued in 2018. Crown Pillar Recovery also occurred from surface in the fourth quarter of 2018 with the completion of surface blasting and hauling of ore and waste from the Doris Crown Pillar Trench. In the fall, TMAC concluded another successful sealift operation including the purchase and delivery of diesel fuel and Jet-A fuel as well as explosives and reagents to support mining and milling activities. The sealift also included additional heavy equipment and supplies to support mining and construction operations.

Project infrastructure and associated activities have the potential to affect the aquatic freshwater environment of Doris Lake through dust generation and runoff. Mitigation measures to reduce the potential for adverse effects to freshwater habitats in the Project area included surface water runoff management, dust abatement measures, site water management, tailings management, quarry and waste rock management, and waste management.

1.3 Report Structure

This document presents the methods, effects analysis, and conclusions of the 2018 Doris AEMP. Detailed sampling and data analysis methodology, raw data, and results from the 2018 AEMP (including water level, ice thickness, water column structure, water quality, and primary producers) are provided in Appendix A. Supplemental information relevant to the 2018 statistical analysis of effects is provided in Appendix B.

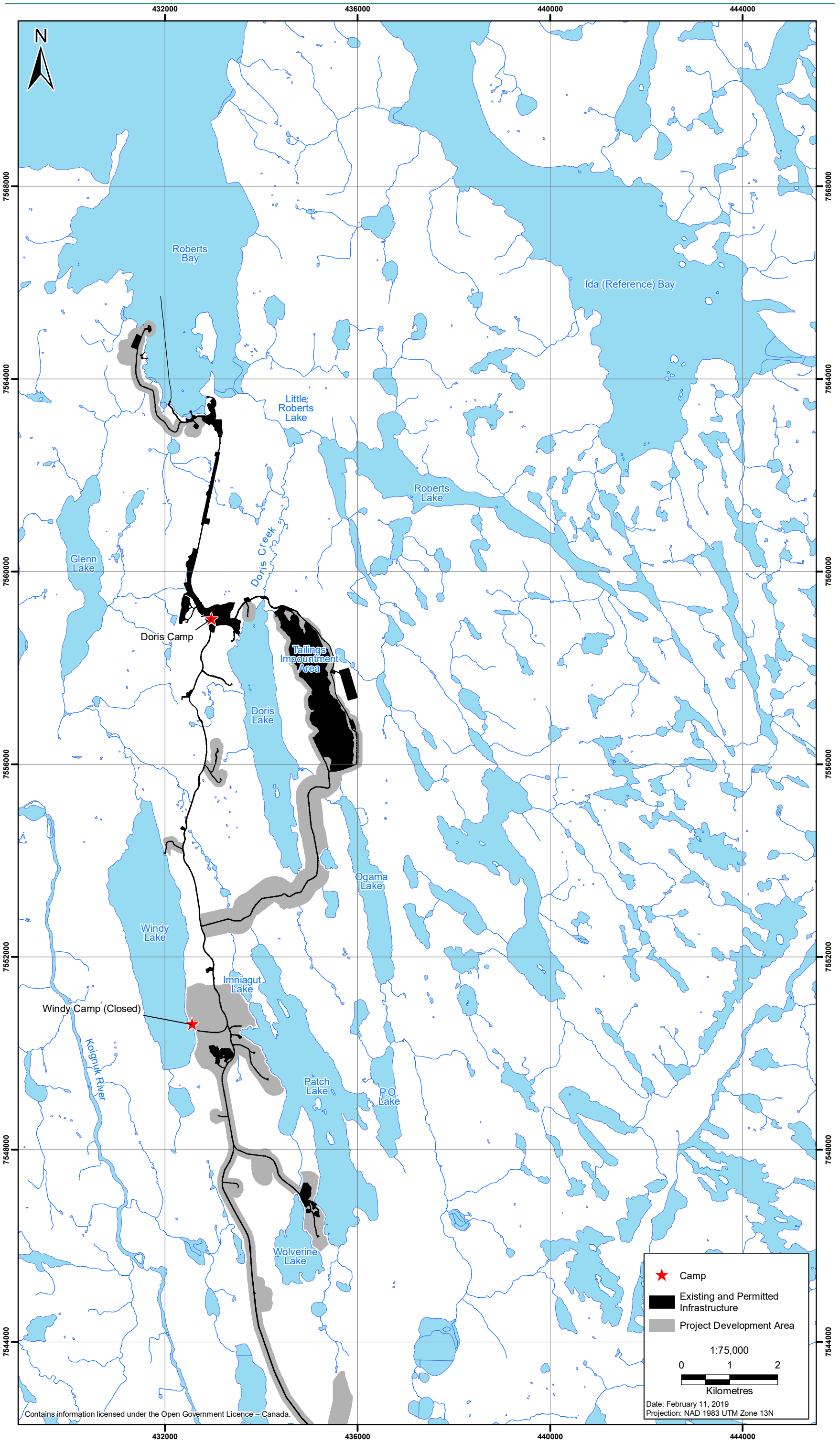


Figure 1.2-1: Existing Infrastructure, Doris Project

2. METHODS

2.1 Summary of Study Design

The 2018 program was conducted in accordance with the Hope Bay Project: Doris Aquatic Effects Monitoring Plan (TMAC 2016).

2.1.1 Sampling Locations

The AEMP study area includes two lakes sites: 1) Doris Lake North (exposure site), which has the potential to be influenced by Project-related activities; and 2) Reference Lake B (reference site), which is outside of the anticipated zone of Project influence (Table 2.1-1). Sampling sites, the aquatic components sampled, and Project infrastructure are shown in Figure 2.1-1.

Table 2.1-1: AEMP Sampling Locations, Descriptions, and Sampling Rationale, Doris Project, 2018

Sampling Location	Coordinates (13W)	Description	Sampling Rationale
Lakes			
Doris Lake North	433815E 7558222N	Large lake (3.4 km^2) located south of main Project site. North part of lake is adjacent to Project infrastructure.	Potential exposure site due to close proximity of Project infrastructure including explosives storage
Reference Lake B	424050E 7532000N	Large reference lake (7.7 km^2) located southwest of the Project.	Reference lake meant to closely resemble the morphology, hydrological and habitat features of Doris Lake, but located outside of the zone of Project influence

There were no Project activities near the selected reference site. A major consideration in reference site selection was that the reference site be located beyond the reach of any potential wind-borne particulates from Project-related sources. Reference Lake B is approximately 25 km from Project infrastructure.

2.1.2 2018 Sampling Schedule

Sampling in 2018 was conducted in accordance with the schedule outlined in the Plan (TMAC 2016) and is summarized in Table 2.1-2. For 2018, the water level in Doris Lake was monitored continuously, and the sampling program commenced in April with under-ice sampling and ended in September.
Physical profiles (e.g., temperature, dissolved oxygen) and water quality (e.g., nutrients and metals) were collected four times during the sampling period, at least one month apart (whenever possible).
Phytoplankton biomass (as chlorophyll *a*) was collected once in August. Sediment quality and the benthic invertebrate (benthos) community were last sampled in 2017, and were not sampled in 2018 according to the monitoring schedule outlined in the Hope Bay Project: Doris Aquatic Effects Monitoring Plan (TMAC 2016). Full details of the 2018 AEMP sampling methods are provided in Appendix A.

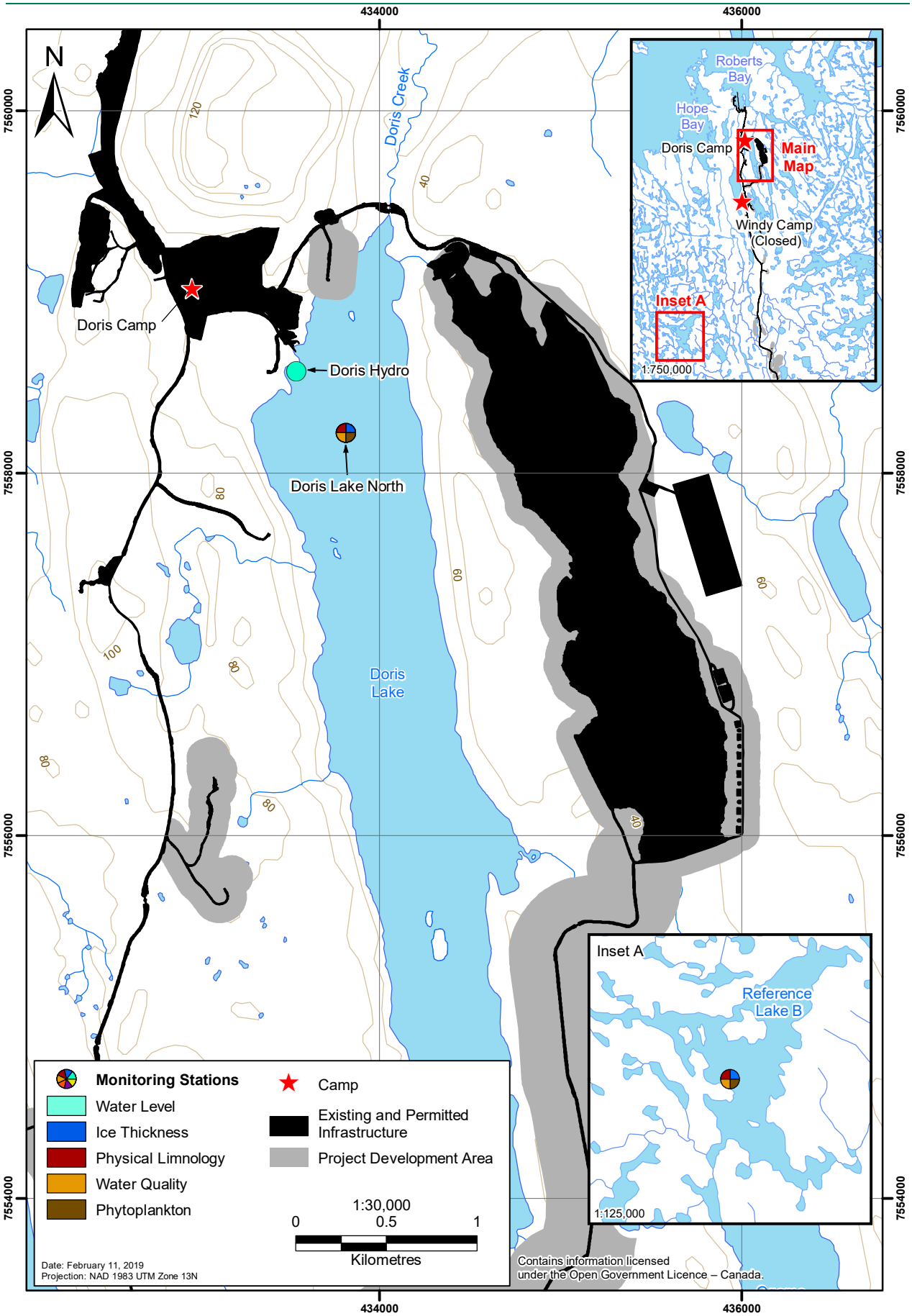


Figure 2.1-1: AEMP Sampling Locations, Doris Project, 2018

Table 2.1-2: Sampling Schedule Summary, Doris Project, 2018

Variable	Sampling Dates
Water Level in Doris Lake	Continuous from September 2017 to June 2018
Ice Thickness	April 16, 2018
Physical Limnology	April 16, 2018 July 14, 2018 August 21-26, 2018 September 15, 2018
Water Quality	April 14-16, 2018 July 14, 2018 August 19-26, 2018 September 15, 2018
Phytoplankton Biomass	August 19-26, 2018

2.2 Evaluation of Effects Methodology

For each variable subjected to an evaluation of effects, baseline data collected prior to 2010 in the Project area were incorporated into the analysis to determine if there were any apparent changes in the evaluated variables over time that might be attributable to Doris Project construction and operation activities. Temporal trends in Reference Lake B were examined alongside the trends in Doris Lake to determine if potential changes over time were naturally occurring or potentially Project-related.

2.2.1 Variables Subjected to Effects Analysis

Table 2.2-1 presents the physical, chemical, and biological variables that were evaluated in 2018. Under-ice water level in Doris Lake was included in the effects analysis to determine whether Project-related water use could affect overwintering fish populations and fish habitat. Water quality variables for which the Canadian Council of Ministers of the Environment (CCME) has established guidelines for the protection of aquatic life were included in the effects analysis to ensure the protection of freshwater organisms residing within the zone of Project influence. Phytoplankton biomass, a biological variable that can be used as an indicator of nutrient loading or other changes to freshwater environments, was also evaluated.

Table 2.2-1: Variables Subjected to Analysis of Effects, Doris Project, 2018

Category	Variable
Water Level and Ice Thickness	Winter Drawdown April Ice Thickness
Physical Limnology	Dissolved Oxygen Temperature
Water Quality	pH Total Suspended Solids (TSS) Turbidity Chloride Fluoride Total Ammonia Nitrate Nitrite

Category	Variable
	Total Phosphorus Total Aluminum (Al) Total Arsenic (As) Total Boron (B) Total Cadmium (Cd) Total Chromium (Cr) Total Copper (Cu) Total Iron (Fe) Total Lead (Pb) Total Mercury (Hg) Total Molybdenum (Mo) Total Nickel (Ni) Total Selenium (Se) Total Silver (Ag) Total Thallium (Tl) Total Uranium (U) Total Zinc (Zn)
Phytoplankton	Phytoplankton Biomass (as Chlorophyll *a*)

2.2.2 Overview of Assessment Methodology

For each variable subjected to an analysis of effects, potential mine effects were evaluated by a visual examination of graphical trends over time and, where possible, statistical analysis of trends over time. This section provides an overview of the statistical analysis methodology; a complete description of the statistical analyses, including detailed methodology and results, is presented in Appendix B. All statistical analyses were conducted using R version 3.5.0.

Regression models were used to examine temporal trends over the monitoring period. Linear mixed effects (LME) regression or Tobit regression analysis were used to test whether or not there was evidence of a temporal trend at each monitored lake. Tobit regression was used when a moderate amount of data (between 10 and 60%) for a given variable within a given lake was below the analytical detection limit. For profile data (dissolved oxygen and temperature) and highly censored data (i.e., datasets in which > 60% of values were below detection limits), trends were evaluated using graphical analysis. If 100% of concentrations of a given variable were below the detection limit for the current assessment year (i.e., 2018), it was concluded that there was no evidence of an effect of the Project on that variable, and no further analyses were performed.

The first step of the statistical analysis was to determine whether there was evidence of a change in a given variable over time (i.e., was the slope of the trend over time significantly different from a slope of zero). This first step did not give any information about the direction of the trend (e.g., increasing or decreasing), only that there was a significant change in the variable over time. For most variables, only an increasing concentration over time would be considered an adverse mine effect (e.g., TSS, arsenic and copper in water), although for some variables, an increasing or decreasing trend could be of concern (e.g., phytoplankton biomass or pH in water).

If the first step of the analysis determined that there was evidence of a significant change in a variable over time in Doris Lake, the variable was carried forward to the second step of the statistical analysis where the trend in Doris Lake was compared to the trend in Reference Lake B. If the first step determined that the slope of the temporal trend was significantly different from zero, but the second step determined that the temporal trends in Doris Lake and Reference Lake B were not significantly different from each other, then it was concluded that the increasing or decreasing trend in the study lakes was naturally

occurring and not related to Project activities. If, on the other hand, the second step of the analysis revealed that the trend in Reference Lake B was significantly different from the trend in Doris Lake, the differential trend in Doris Lake was carried forward as a potential mine effect and investigated further.

There are several reasons unrelated to Project activities that there could be a significant, differential trend in a variable in Doris Lake that was not paralleled in Reference Lake B. For example, trends over time could vary due to local differences in meteorological conditions, or naturally variable inputs related to weathering and erosion or runoff from the natural landscape. These changes would not necessarily affect all lakes in the region equally, and may not co-occur in Doris Lake and Reference Lake B. A difference in trends between lakes is therefore not conclusive evidence of a mine effect.

As well, any statistical analysis can result in a type I error (finding a significant effect where an effect is not present, i.e., false positive) or a type II error (failing to find a significant effect where an effect is present, i.e., false negative). In the monitoring context, a false positive is more tolerable than a false negative. There is a direct trade-off between the two error rates, as reducing one type of error generally increases in the other type of error. No correction for the large number of statistical tests was applied to the false positive (type I) error rate. Therefore, there may be false positives in the analyses that were conducted, which is a conservative and environmentally protective approach. For this AEMP, the unadjusted type I error rate (or significance level) was set to 0.05, indicating that approximately 5% of the time, statistical results will show a significant effect (i.e., p value of < 0.05) by random chance alone where an effect is not actually present.

Any finding of a potential mine effect was interpreted using professional judgement and any other relevant information or supporting data to determine the likely cause of the effect. If the detected change was concluded to be a mine effect, the variable concentration was compared to benchmarks established through the Doris AEMP Response Framework (see Section 2.2.3) to determine what follow-up actions may be needed. If benchmarks were not exceeded and there concluded to be no apparent ecological risk to freshwater aquatic organisms, the variables will continue to be monitored through the AEMP with no further follow-up action. However, if benchmarks were exceeded, follow-up actions would be triggered as described in the Response Framework (TMAC 2016). Figure 2.2-1 illustrates the steps of the AEMP analysis and how the AEMP analysis of effects feeds into the Response Framework.

2.2.3 Doris AEMP Response Framework

Potential effects to Doris Lake and the freshwater receiving environment are adaptively managed through the Response Framework (TMAC 2016), which links the results of the AEMP effects analysis to management actions so that significant adverse effects arising from mine operation can be avoided (Figure 2.2-1). The Response Framework acts as an early-warning system with defined action levels that initiate monitoring and/or management actions within an adequate timeframe to ensure that significant adverse effects do not occur (TMAC 2016).

For each variable subjected to an analysis of effects, the Plan describes the benchmarks that will be applied to determine if potential Project-related effects could cause adverse environmental consequences. Through screening of the results of the AEMP evaluation of effects, the Plan outlines the conditions that must be met to trigger a “low action level” response. The triggers for a low action level response are designed to be conservative indicators that provide an early warning of potentially worsening conditions, before a benchmark is surpassed.

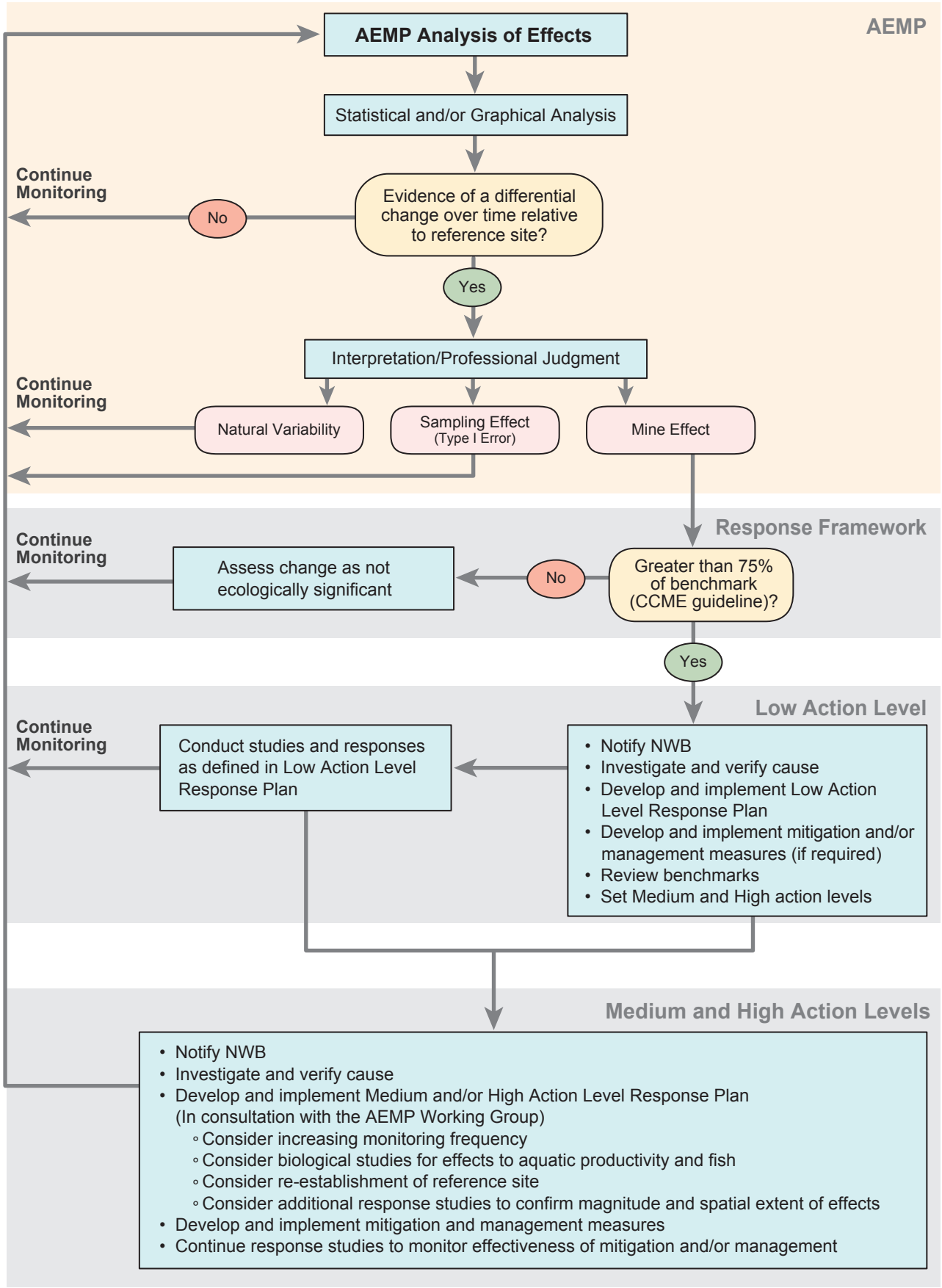


Figure 2.2-1: Doris AEMP Effects Analysis and Response Framework

2.2.3.1 Water Level and Ice Thickness

For water level and ice thickness in Doris Lake, the safe threshold or benchmark for over-wintering fish eggs is considered to be -2.74 m. This is because the winter drawdown of Doris Lake water level varied by a maximum of 0.74 m during baseline years and April ice thickness on Doris Lake varied from 1.9 to 2.0 m (Figure 2.2-2; TMAC 2015, 2016). If the combined winter drawdown and ice thickness exceeds -2.74 m (the maximum observed during baseline years), the survival of over-wintering fish eggs could be reduced. To avoid exceeding this threshold, the trigger for a low action level response according to the Response Framework is 1) identification that the water level has passed its median baseline natural drawdown and baseline ice thickness (-2.42 m), and 2) confirmation that there is a corresponding intrusion of groundwater into the mine. The low action level threshold of -2.42 m allows for adaptive management of water levels in Doris Lake while water levels are still protective of over-wintering fish eggs, in advance of reaching the potentially more consequential benchmark of -2.74 m.

2.2.3.2 Water Quality

The benchmarks applied to water quality are the CCME freshwater water quality guidelines for the protection of aquatic life (Table 2.2-2; CCME 2018). CCME guideline values are meant to be protective of all aquatic life, including the most sensitive organisms (CCME 1999). Exceedance of these benchmarks could adversely affect the most sensitive freshwater organisms; therefore, the trigger for a low action level is defined as 1) identification of a statistically significant increase in the AEMP effects analysis, 2) exceedance of 75% of the benchmark or CCME guideline, and 3) the absence of a similar change at the reference location (TMAC 2016). Setting the low action level trigger to 75% of the CCME guideline allows for adaptive management measures to be implemented before concentrations that could negatively affect the most sensitive freshwater life are reached. Table 2.2-2 presents the water quality benchmarks and 75% of these benchmarks that were used to screen the water quality results.

Table 2.2-2: Long-term Water Quality Benchmarks for the Doris Project

Water Quality Variable	Benchmark[a]	75% of Benchmark
Dissolved Oxygen	6.5 mg/L	Not applicable
Temperature	Thermal additions must not alter thermal stratification regime, turnover date(s), and maximum weekly temperature	Not applicable
pH	6.5 – 9.0	6.62 – 8.88[b]
Total Suspended Solids (TSS)	Increase of 5 mg/L from background	Increase of 3.75 mg/L from background
Turbidity	Increase of 2 NTU from background	Increase of 1.5 NTU from background
Chloride	120 mg/L	90 mg/L
Fluoride	0.12 mg/L	0.09 mg/L
Total Ammonia-N	Temperature- and pH-dependent	Temperature- and pH-dependent
Nitrate-N	3.0 mg/L	2.25 mg/L
Nitrite-N	0.06 mg/L	0.045 mg/L
Total Phosphorus	Guidance framework: dependent on baseline conditions and ecosystem goals	Not applicable
Total Aluminum	0.10 mg/L if pH ≥ 6.5 0.005 mg/L if pH < 6.5	0.075 mg/L if pH ≥ 6.5 0.00375 mg/L if pH < 6.5
Total Arsenic	0.005 mg/L	0.00375 mg/L

Water Quality Variable	Benchmark[a]	75% of Benchmark
Total Boron	1.5 mg/L	1.125 mg/L
Total Cadmium	0.00004 mg/L for hardness[c] (as $CaCO_3$) of < 17 mg/L; $10^{(0.83[\log(\text{hardness})]-2.46)}$/1000 mg/L for hardness of ≥ 17 to ≤ 280 mg/L; 0.00037 mg/L for hardness of > 280 mg/L	75% of hardness-dependent benchmark
Total Chromium	0.0089 mg/L for Cr (III); 0.001 mg/L for Cr (VI)	0.00668 mg/L for Cr (III); 0.00075 mg/L for Cr (VI)
Total Copper	0.002 mg/L for hardness[c] (as $CaCO_3$) of < 82 mg/L; $e^{(0.8545[\ln(\text{hardness})]-1.465)}$/1000 mg/L for hardness of ≥ 82 to ≤ 180 mg/L; 0.004 mg/L for hardness of > 180 mg/L	75% of hardness-dependent benchmark
Total Iron	0.3 mg/L	0.225 mg/L
Total Lead	0.001 mg/L for hardness[c] (as $CaCO_3$) of ≤ 60 mg/L; $e^{(1.273[\ln(\text{hardness})]-4.705)}$/1000 mg/L for hardness of > 60 to ≤ 180 mg/L; 0.007 mg/L for hardness of > 180 mg/L	75% of hardness-dependent benchmark
Total Mercury	0.026 µg/L	0.0195 µg/L
Total Molybdenum	0.073 mg/L	0.055 mg/L
Total Nickel	0.025 mg/L for hardness[c] (as $CaCO_3$) of ≤ 60 mg/L; $e^{(0.76[\ln(\text{hardness})]+1.06)}$/1000 mg/L for hardness of > 60 to ≤ 180 mg/L; 0.15 mg/L for hardness of > 180 mg/L	75% of hardness-dependent benchmark
Total Selenium	0.001 mg/L	0.00075 mg/L
Total Silver	0.00025 mg/L	0.0001875 mg/L
Total Thallium	0.0008 mg/L	0.0006 mg/L
Total Uranium	0.015 mg/L	0.01125 mg/L
Total Zinc	0.030 mg/L	0.0225 mg/L

Notes:

[a] CCME Freshwater Water Quality Guidelines for the Protection of Aquatic Life, Summary Table (CCME 2018).

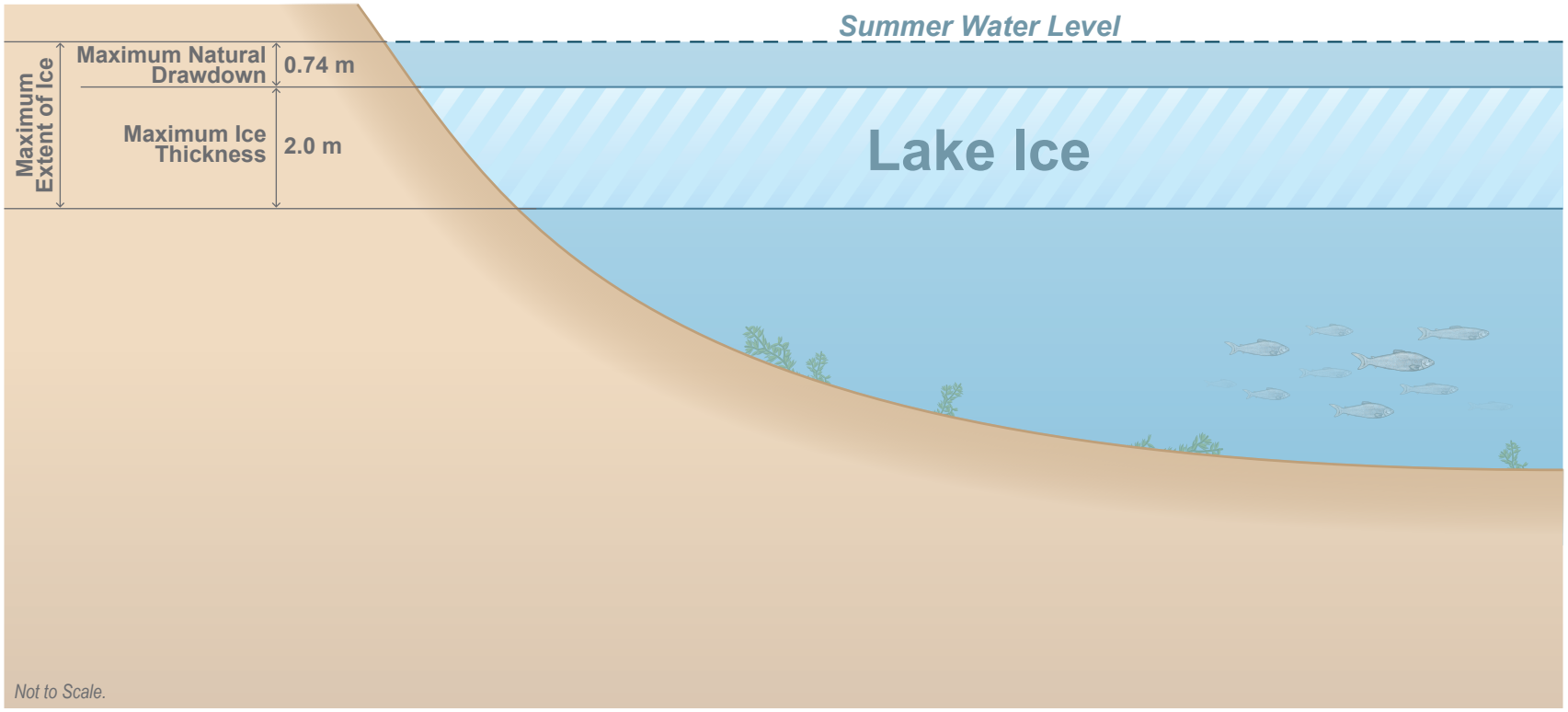
[b] pH benchmark values were converted to hydrogen ion concentrations for the calculations of 75% benchmark levels.

[c] Hardness (as $CaCO_3$) in Doris Lake North ranged from 39 to 62 mg/L between 2003 and 2018; hardness in Reference Lake B ranged from 12 to 24 mg/L between 2009 and 2018.

The CCME guideline for zinc was updated by Environment and Climate Change Canada (ECCC) on September 18, 2018, and is now a guideline for dissolved zinc that is calculated from the site-specific pH, hardness, and dissolved organic carbon (DOC) concentrations. Because the new zinc guideline was issued after the completion of water quality sampling for the 2018 AEMP, and dissolved zinc and DOC concentrations were not routinely measured as part of the 2018 water quality program, the former guideline for total zinc of 0.03 mg/L was used to screen the 2018 water quality samples. However, the new pH- and DOC-dependent dissolved zinc benchmark will be used to screen 2019 samples and dissolved zinc and DOC will be added to the list of analyzed water quality variables.

Figure 2.2-2

Schematic of Natural Water Level Drawdown and Ice Thickness on Doris Lake



2.2.3.3 Phytoplankton Biomass

Potential effects to phytoplankton biomass (as chlorophyll *a*) are evaluated against existing baseline conditions. The trigger for a low action level response according to the Response Framework is 1) the identification of a significant change from baseline conditions, and 2) the absence of a similar change at the reference site (TMAC 2016).

2.2.4 Historical Data

Baseline physical, chemical, and biological data have been collected in the Doris Project area since 1995. Figures 2.2-3 and 2.2-4 show the specific locations within Doris Lake and Reference Lake B where historical water quality (Figure 2.2-3) and phytoplankton biomass (Figure 2.2-4) data were collected. Historical samples have been collected from a variety of locations and depths within both of the AEMP study lakes. The frequency and seasonal timing of sampling has also varied since 1995, as have sampling methodologies. For these reasons, professional judgment was used in the selection of historical data that could be used in the analysis of effects.

Key determining factors for the inclusion of historical data in the evaluation of effects included the proximity of historical sampling sites to AEMP sampling sites, sampling methodology, and data quality (e.g., the inclusion of historical data with poor analytical detection limits confounds the interpretation of effects and adds little value to the analysis).

Historical data used or considered for the effects analyses were from the following reports: Klohn-Crippen Consultants Ltd. (1995), Rescan (1997, 1998, 1999, 2001, 2010a, 2011, 2012, 2013), RL&L Environmental Services Ltd. and Golder Associates Ltd. (2003), Golder Associates Ltd. (2005, 2006, 2007, 2008, 2009), ERM Rescan (2014), and ERM (2015, 2016, 2017, 2018). Full details of the rationale used in the selection of baseline data that were included in evaluation of effects are provided in Appendix B.

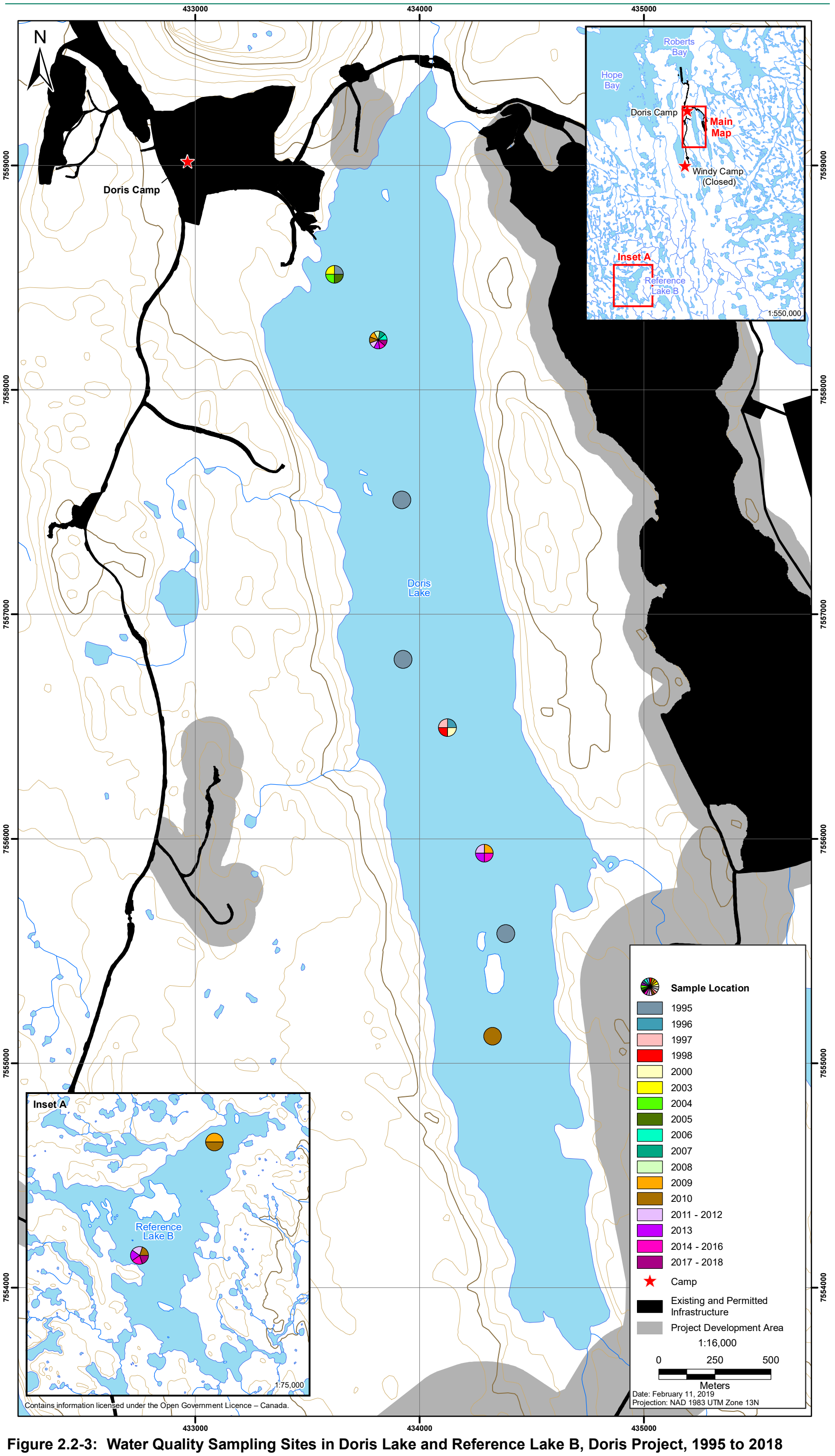


Figure 2.2-3: Water Quality Sampling Sites in Doris Lake and Reference Lake B, Doris Project, 1995 to 2018

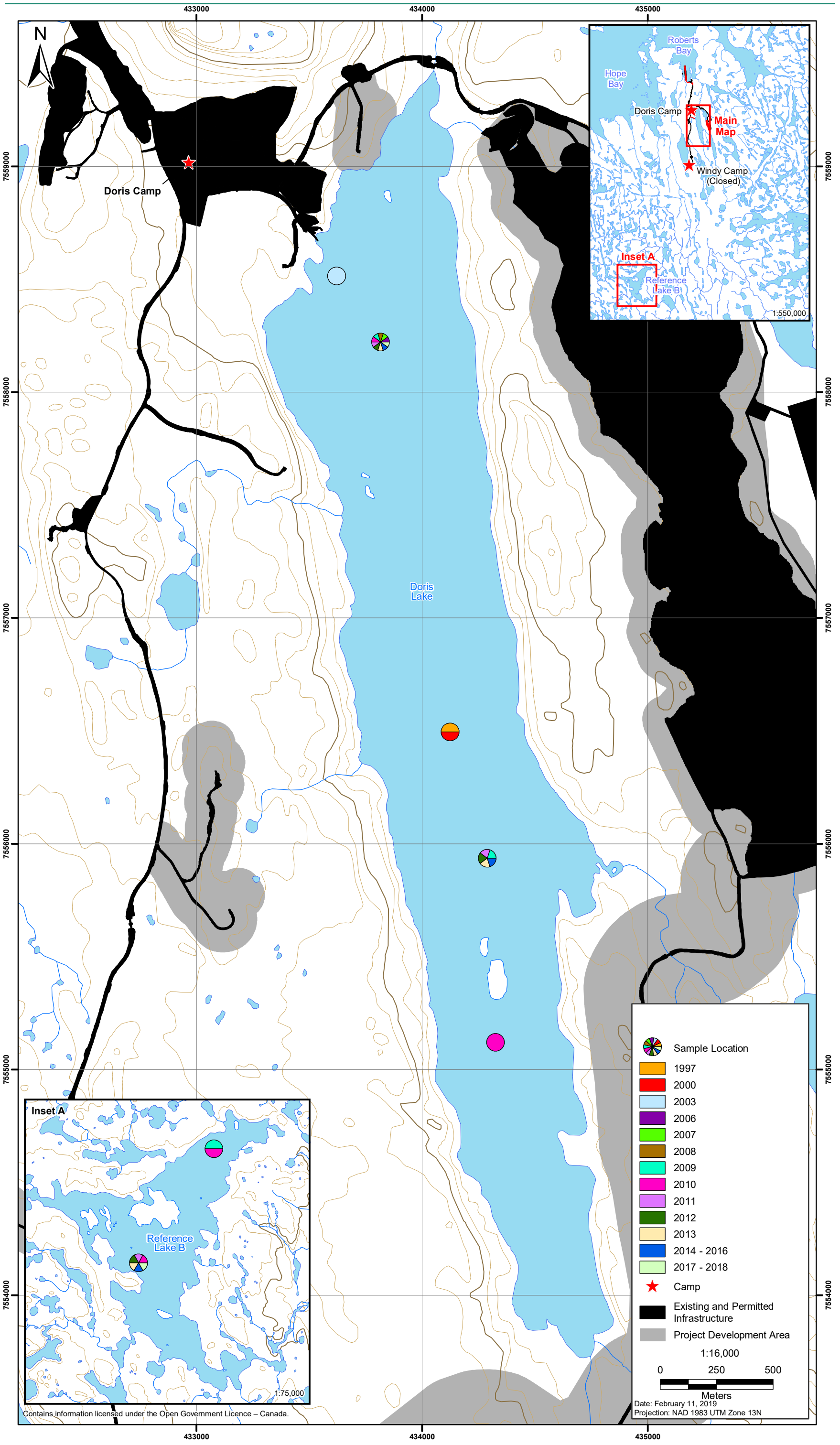


Figure 2.2-4: Phytoplankton Biomass (as Chlorophyll a) Sampling Sites in Doris Lake and Reference Lake B, Doris Project, 1997 to 2018

3. EVALUATION OF EFFECTS

In 2018, physical profiles, water 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; and
- phytoplankton biomass.

Physical, chemical, and biological data from 2018 (the second year of operations with ongoing construction activities) were evaluated against historical data. The evaluation of effects was based on graphical and statistical analyses of trends over time both within Doris Lake North and between Doris Lake North and Reference Lake B, comparisons to baseline conditions, comparisons to benchmarks based on CCME water quality guidelines for the protection of aquatic life (CCME 2018), and professional judgement. If the evaluation of effects concluded that there may be a Project-related effect on a component of the freshwater environment, and the magnitude of the effect exceeded the low action level, further actions may be taken as described in the Response Framework within the Plan (TMAC 2016).

Details of the 2018 AEMP sampling program (including methodology and results) are provided in Appendix A, and details of the statistical analyses (including methodology and results) are provided in Appendix B.

3.1 Water Level and Ice Thickness in Doris Lake

Potential adverse effects of water use in Doris Lake on fish habitat and populations were evaluated using continuous, daily, mean water-level data and measured April ice thickness (all raw data are provided in Appendix A). The data were assessed by comparing the winter lake drawdown and measured ice thickness to the threshold extent of ice penetration of -2.74 m (i.e., 2.74 m below the fall lake surface level). The maximum threshold of -2.74 m is based on the maximum natural ice thickness and maximum natural water-level variability over 11 years of baseline monitoring in Doris Lake (TMAC 2015).

In 2018, the maximum extent of ice penetration did not reach the maximum ice penetration benchmark of -2.74 m, nor the low action level threshold of -2.42 m. The combined winter water-level drawdown (-0.1 m) and ice depth (-1.80 m) reached -1.90 m in 2018 (Figure 3.1-1; Appendix A). Thus, there was no evidence of an adverse effect of Project-related water use on fish and fish habitat in Doris Lake.

3.2 Physical Limnology

Dissolved oxygen and temperature profiles were collected in Doris Lake North and Reference Lake B in April, July, August, and September 2018. Raw data are provided in Appendix A, and potential Project-related effects to dissolved oxygen concentrations and water temperature are discussed in the following sections.

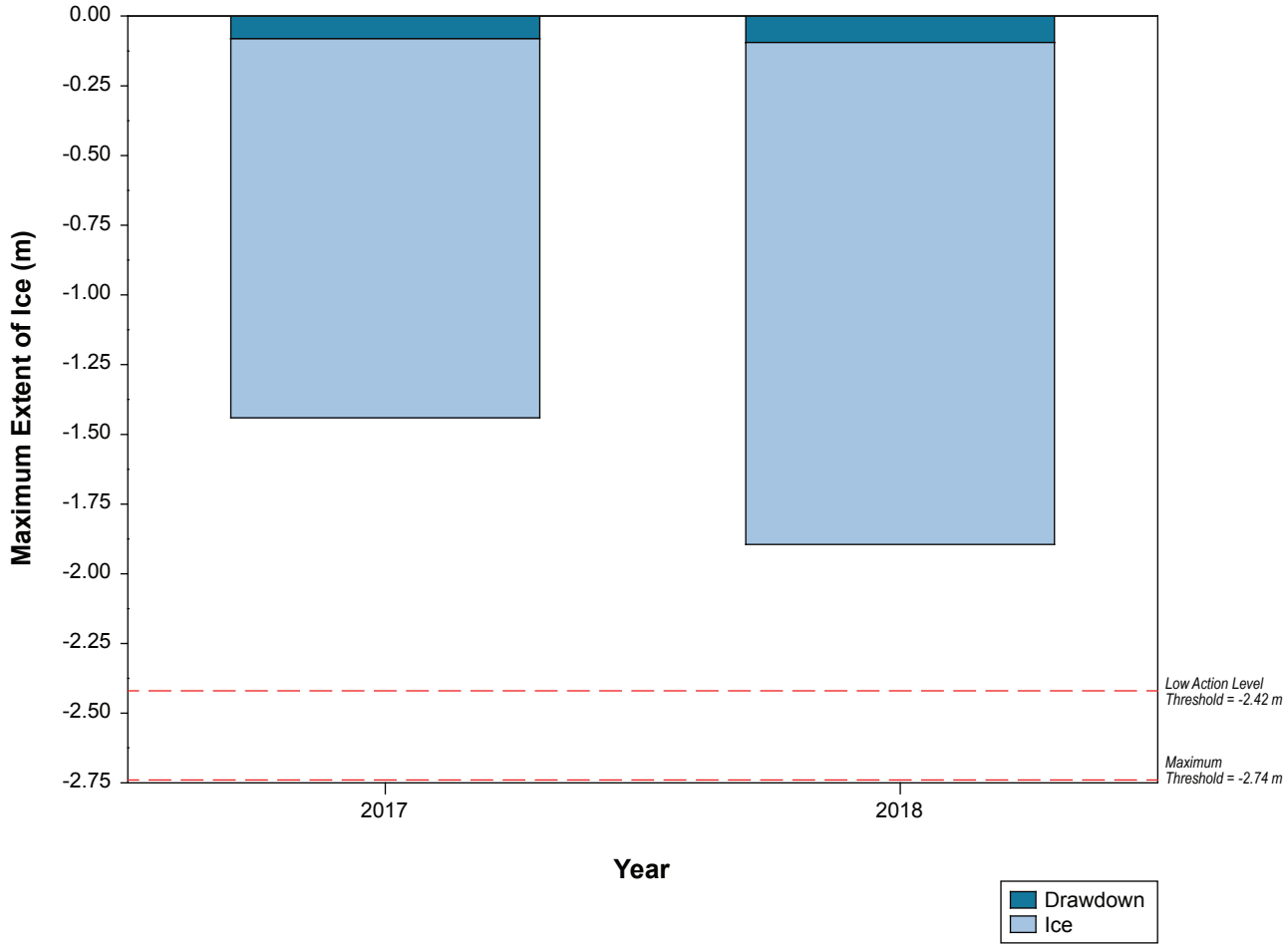


Figure 3.1-1: Maximum Extent of Ice in Doris Lake, Doris Project, 2017 to 2018

3.2.1 Under-ice Season Dissolved Oxygen

Potential Project-related effects on dissolved oxygen concentrations were evaluated using under-ice dissolved oxygen profiles since concentrations are lowest during the under-ice period, and therefore pose the greatest concern for aquatic life. The potential for effects to under-ice dissolved oxygen concentration was assessed by graphical analysis. To conclude that the Project had an effect on under-ice dissolved oxygen concentrations in Doris Lake, dissolved oxygen profiles from 2018 had to be noticeably different from all available baseline years. Profiles and inter-annual trends at the reference site were also considered. An adverse Project effect on under-ice season dissolved oxygen concentrations would be manifested as a decrease in dissolved oxygen concentration, since inputs of nutrients or organic carbon to a lake can fuel productivity and the microbial respiration of organic matter. If dissolved oxygen concentrations drop below the CCME guidelines for the protection of aquatic life of 9.5 mg/L for early life stages or 6.5 mg/L for other life stages (CCME 2018), this could negatively affect fish populations.

Ice cover usually forms in October or November in the Doris region, and remains until June or July of the following year. Doris Lake would not be exposed to any inputs of dust or runoff that could be generated by Project activities while it is covered in ice. Therefore, the under-ice water column that is profiled in April or May reflects activities from the previous year. For example, profiles collected in April 2010 reflect activities from 2009 rather than 2010. For this reason, profiles collected in the spring of 2010 are considered baseline data despite 2010 being considered year one of the construction phase.

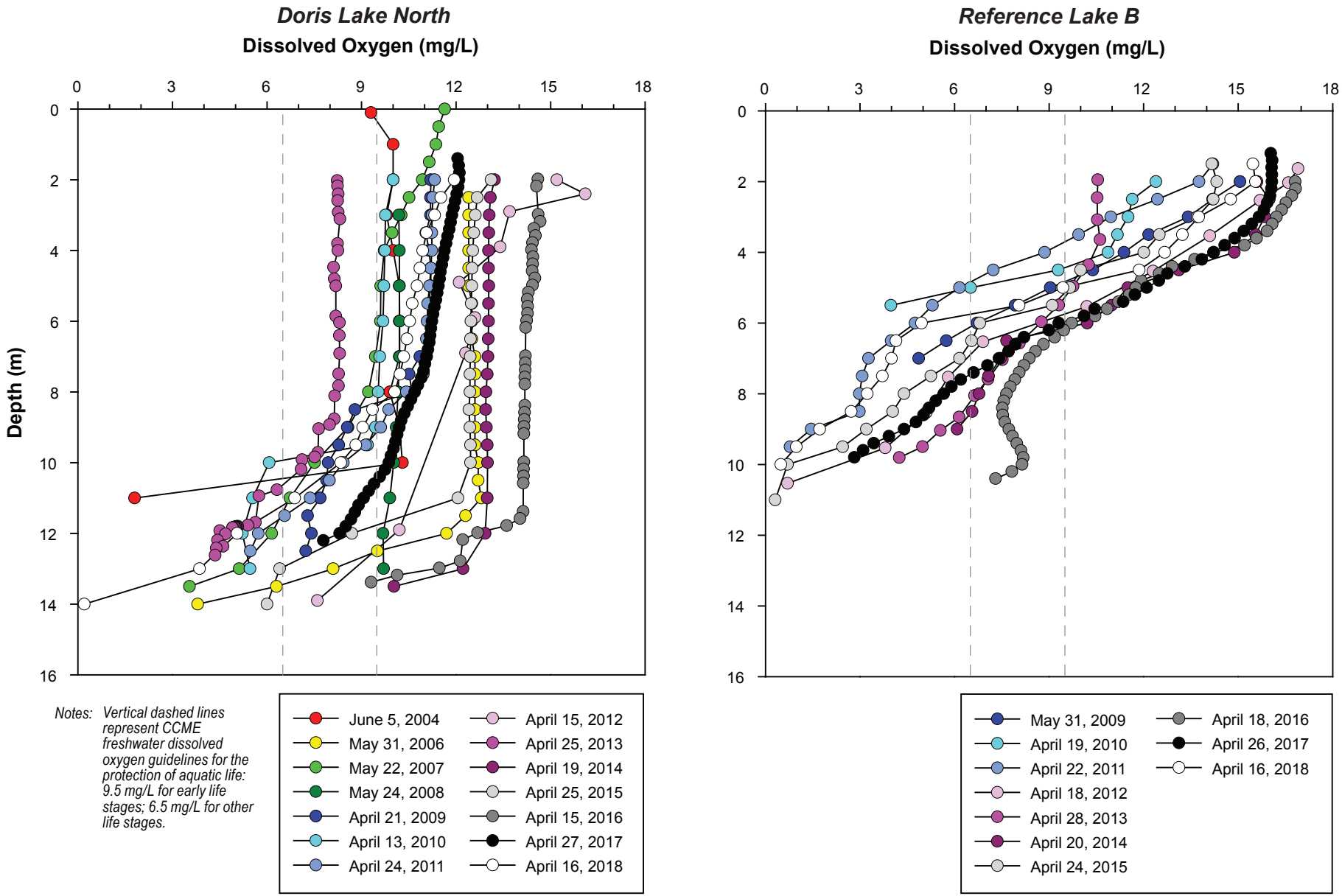
Under-ice dissolved oxygen concentrations at most depths in Doris Lake North in April 2018 were higher than under-ice concentrations measured during four of the six available baseline years (i.e., 2004, 2007, 2008, and 2010; Figure 3.2-1). The under-ice dissolved oxygen concentrations recorded in Doris Lake North since the start of Project construction and operation activities have been among the highest concentrations recorded (e.g., 2012, 2014, 2015, 2016, and 2017). April 2018 concentrations were not as high as recent years; which may be due to the relatively high water temperatures in Doris Lake in April 2018 compared to previous years (dissolved oxygen solubility decreases with increasing water temperature; Figure 3.2-2). A similar trend is evident in Reference Lake B, where April 2018 water temperatures were relatively high, and under-ice dissolved oxygen concentrations were within the range of historical concentrations but not as high as recent years (e.g., 2014, 2016, and 2017; Figures 3.2-1 and 3.2-2).

Dissolved oxygen concentrations from April 2018 in both Doris Lake North and Reference Lake B were higher than the CCME guidelines of 6.5 and 9.5 mg/L at the surface, but dropped to below 6.5 mg/L at depth, reaching minimums of 0.20 and 0.49 mg/L in Doris Lake North and Reference Lake B, respectively (Figure 3.2-1). A decrease in under-ice dissolved oxygen concentrations at depth, particularly near the lakebed, is a common phenomenon in seasonally stratified lakes, and has been observed nearly every year at both Doris Lake North and Reference Lake B (Figure 3.2-1).

Overall, there was no evidence of an adverse effect of Project activities on under-ice dissolved oxygen concentrations in Doris Lake and the low action level was not exceeded.

3.2.2 Temperature

Under the terms of the current Project Certificate No. 003 and Water Licence 2AM-DOH1323, the discharge of groundwater and TIA water will be directed to the marine receiving environment, and this discharge will be at ambient temperature. There are no plans to release heated effluent to the freshwater environment, thus there are not anticipated to be Project-related changes to water temperature, thermal stratification regime, or turnover dates in Doris Lake or any other waterbody in the Project area. However, temperature is included in the evaluation of effects because there is a CCME guideline for temperature, and temperature is included in the Plan as a variable that will be evaluated.



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.

Figure 3.2-1: Under-ice Season Dissolved Oxygen Concentrations, Doris Project, 2004 to 2018

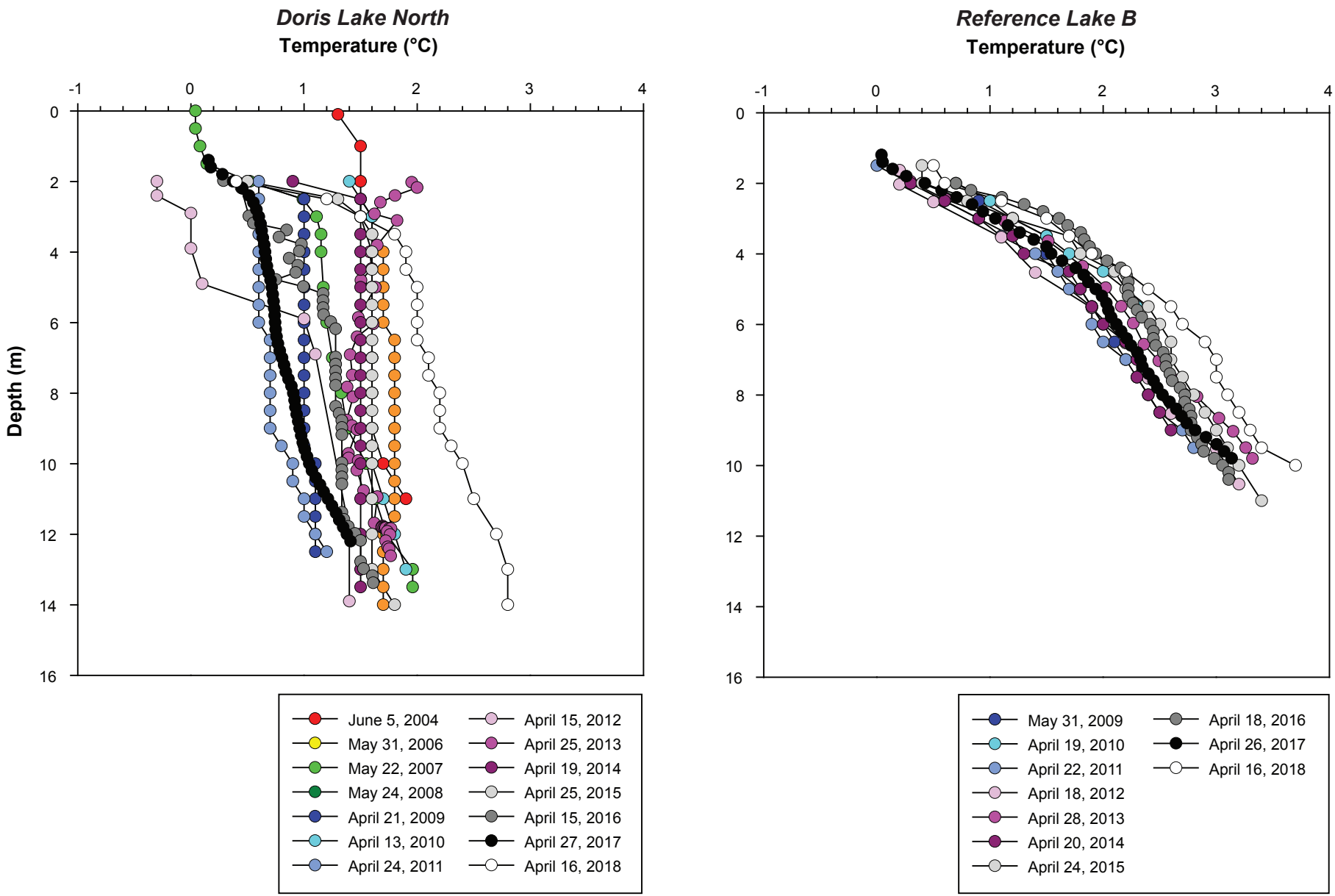


Figure 3.2-2: Under-ice Season Temperature Profiles, Doris Project, 2004 to 2018

Historical temperature profiles in Doris Lake have been collected during the under-ice season (typically in April, but sometimes in May or early June) and open-water seasons (July, August, and/or September). For the purposes of the evaluation, profiles from the under-ice season as well as August profiles from the open-water season were assessed, since the warmest water temperatures typically occur in August. Assessing under-ice and open-water (August) temperature profiles should cover the entire range of water temperatures in Doris Lake. The potential for effects on water temperature was assessed by graphical analysis. To conclude that the Project had an effect on under-ice or August water temperature in Doris Lake, temperature profiles had to be noticeably different from all available baseline years. Temperature profiles and inter-annual trends at the reference site were also considered.

At the northern end of Doris Lake, under-ice temperature profiles were collected in 2004, 2006, 2007, and annually from 2009 to 2018, and August temperature profiles were collected annually from 2003 to 2005 and from 2007 to 2018. In Reference Lake B, both under-ice and August temperature profiles were collected annually from 2009 to 2018.

Both April and August temperature profiles from 2018 in Doris Lake North differed from previous years (Figures 3.2-2 and 3.2-3). In April 2018, water temperatures in Doris Lake North at depths below 3 m were the highest on record for this sampling period, while in August 2018, water temperatures throughout the water column were the lowest on record for this sampling period (except at depths below 11 m, where 2018 temperatures were among the lowest but not the lowest on record). However, similar trends in water temperature during the under-ice (April) and open-water (August) seasons were observed in Reference Lake B, suggesting that the temperature trends seen in Doris Lake are not Project-related and reflect natural climatic variability (Figures 3.2-2 and 3.2-3).

Overall, there was no evidence of a Project-related change in water temperature, and the low action level was not triggered.

3.3 Water Quality

Water quality samples were collected from one exposure lake site (Doris Lake North) and one reference lake site (Reference Lake B) in 2018. A subset of water quality variables (see Table 2.2-1) was evaluated to determine whether Project activities resulted in adverse changes to water quality over time. Statistical and graphical analyses were used to determine if there were changes in water quality variables in the Project area over time. Trends in Doris Lake North were also directly compared to trends in Reference Lake B to establish whether changes in water quality in Doris Lake were likely naturally occurring or Project-related. Water quality trends over the open-water season and under-ice season were assessed separately since large seasonal changes could confound the identification of inter-annual trends.

Water quality variable concentrations were compared to CCME water quality guidelines for the protection of aquatic life (CCME 2018) to assess whether existing concentrations could adversely affect freshwater biota. Water quality data were also compared against 75% of the CCME guidelines as described in Section 2.2.3.2 to determine whether a low action level threshold was exceeded. The zinc water quality guideline was updated on September 18, 2018, and is now a guideline for dissolved zinc that is calculated from the pH, hardness, and DOC concentration. As explained in Section 2.2.3.2, zinc concentrations could not be screened against this new guideline because dissolved zinc and DOC were not routinely measured for 2018 samples (which were collected prior to the issuance of the new zinc guideline); therefore, the total zinc guideline of 0.03 mg/L was used as a benchmark to screen the 2018 water quality samples.

Graphs showing water quality trends in lakes over time are shown in Figures 3.3-1 to 3.3-25. Raw water quality data for 2018 are presented in Appendix A, and all statistical analysis results are presented in Appendix B.

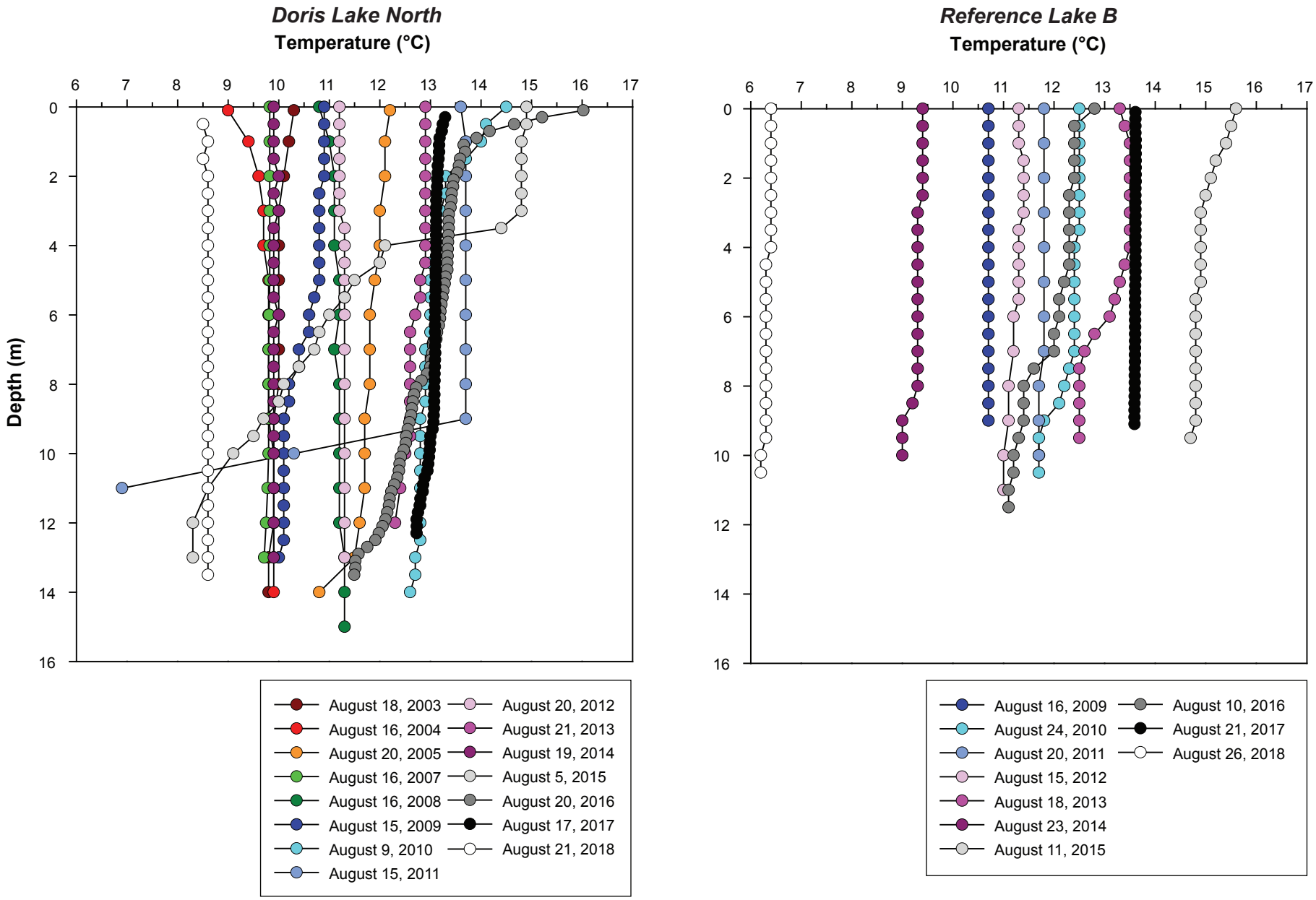


Figure 3.2-3: Open-water Season (August) Temperature Profiles, Doris Project, 2003 to 2018

3.3.1 pH

pH levels measured in 2018 in Doris Lake North were within the CCME guideline range of 6.5 to 9.0 (Figure 3.3-1). During the under-ice season, pH levels recorded from 2004 to 2008 were highly variable, and lower overall compared to the relatively consistent pH levels measured between 2009 and 2018 (Figure 3.3-1). The results of the statistical analysis showed that the temporal trend in under-ice pH in Doris Lake North was significantly different from a slope of zero ($p = 0.0007$) but not significantly different from the trend in Reference Lake B ($p = 0.5026$), suggesting that the observed variability in under-ice pH was not Project-related.

During the open-water season, pH levels in Doris Lake North were generally consistent from 2003 to 2018, and did not exhibit an obvious increase or decrease over time (Figure 3.3-1). This was supported by the results of the statistical analysis, which showed that the trend in open-water pH over time in Doris Lake North was not significantly different from a slope of zero ($p = 0.5377$).

Overall, there was no evidence for a differential change in under-ice pH over time in Doris Lake North compared to Reference Lake B, and there was no evidence of any change in open-water pH over time in Doris Lake North. The pH levels in 2018 also remained within the CCME guideline range and the low action level threshold range described in Table 2.2-2.

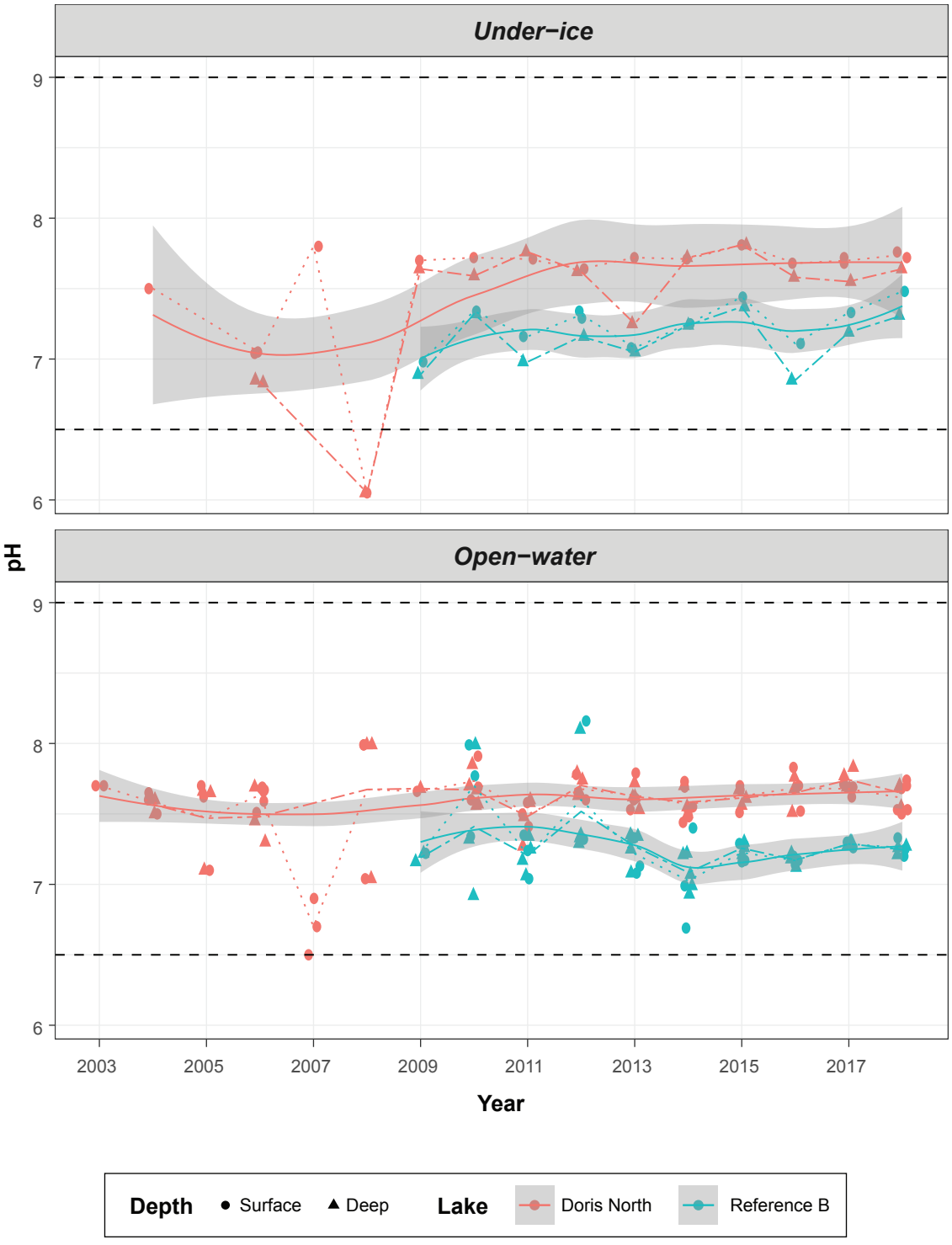
3.3.2 Total Suspended Solids

Open-water TSS concentrations were relatively consistent over time in Doris Lake North (Figure 3.3-2). This was confirmed by the results of the statistical analysis, which showed that TSS concentrations over time did not significantly differ from a slope of zero ($p = 0.6507$). There was evidence of a non-zero trend in under-ice TSS concentrations in Doris Lake North over time ($p = 0.0094$). However, TSS concentrations recorded in April 2018, ranged from below the detection limit (< 1.0 mg/L) to 2.8 mg/L and were within the range of under-ice baseline concentrations, which ranged from < 1.0 to 4.0 mg/L. Therefore, there was no evidence of a Project-related increase in under-ice TSS in Doris Lake North. Due to the high proportion of censored values (i.e., concentrations below detection limits) within the TSS dataset for Reference Lake B, statistical results for Reference Lake B could not be compared to Doris Lake North results.

The CCME guideline for TSS is based on an increase from background levels (for clear-flow waters with background TSS levels below 25 mg/L, a maximum increase of 25 mg/L is allowable for any short-term exposure or 5 mg/L for longer term exposure; CCME 2018). Given that TSS concentrations did not increase over time in Doris Lake North, concentrations remained below the CCME and low action level thresholds, and the low-action level for TSS concentrations was not exceeded.

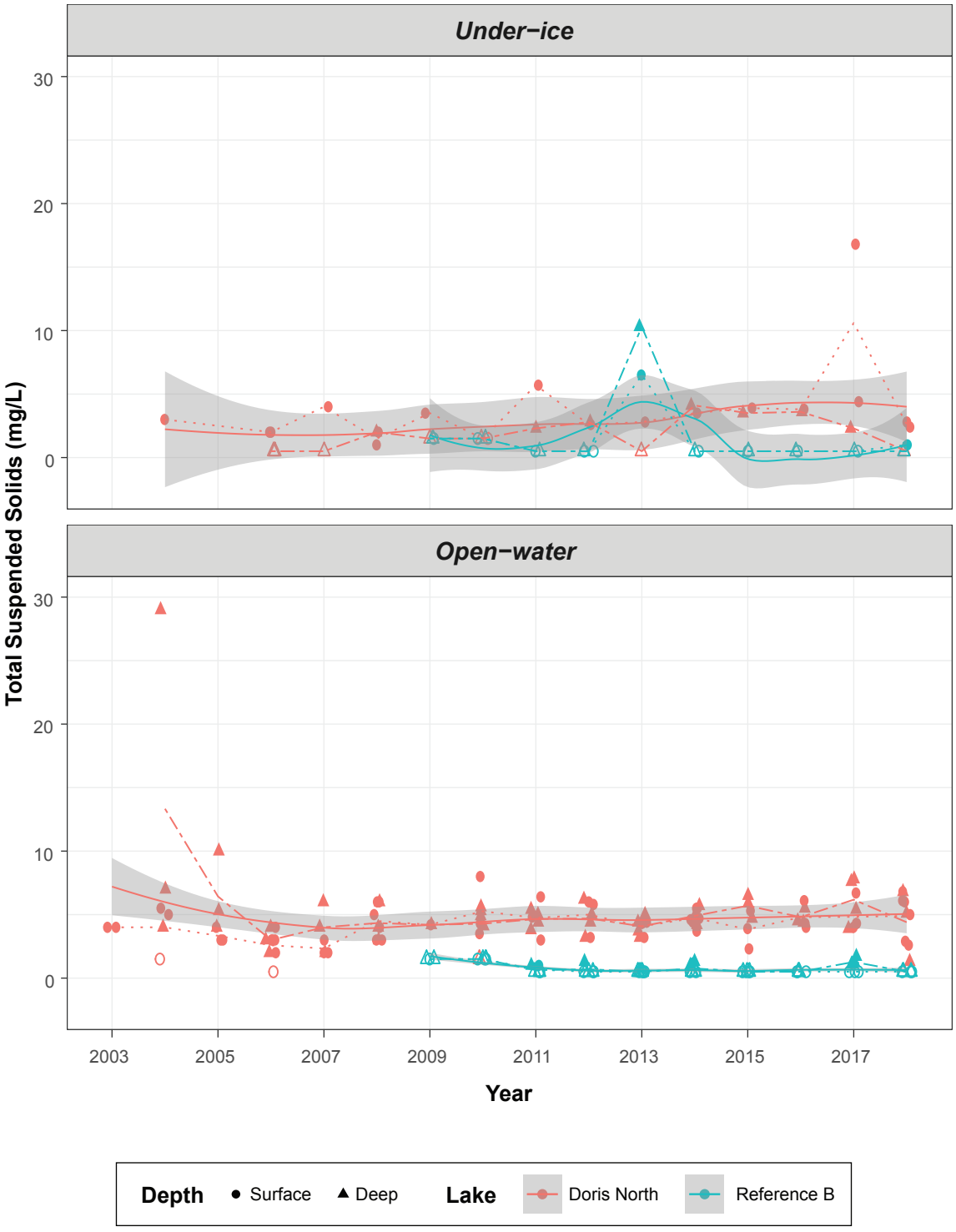
3.3.3 Turbidity

Both under-ice and open-water turbidity increased slightly over time in Doris Lake North between baseline years and 2016 or 2017, but 2018 levels were lower than in recent years, and similar to baseline levels (Figure 3.3-3). The trends in both under-ice and open-water turbidity over time were significantly different from a slope of zero ($p = 0.0034$ for under-ice; $p = 0.0001$ for open-water). However, there were no significant differences between the Doris Lake North and the Reference Lake B trends ($p = 0.3251$ for under-ice; $p = 0.4680$ for open-water), suggesting that the apparent trends in turbidity in Doris Lake were unrelated to the Project.



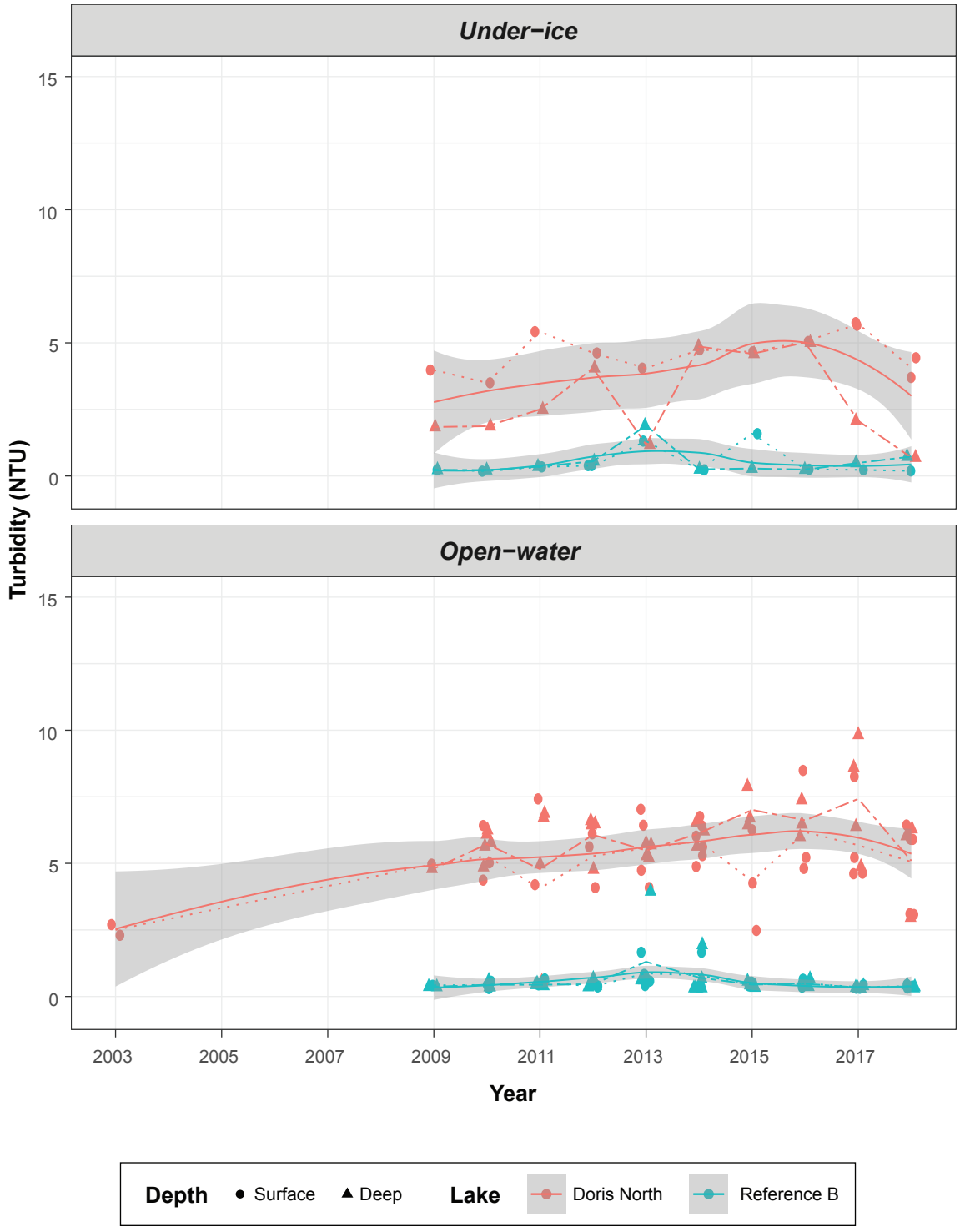
Note: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME guideline pH range (6.5 to 9.0).

Figure 3.3-1: pH in Lakes, Doris Project, 2003 to 2018



Note: 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 or dotted 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.
The CCME guideline for total suspended solids is dependent upon background levels.

Figure 3.3-2: Total Suspended Solids Concentrations in Lakes, Doris Project, 2003 to 2018



Note: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted 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.
The CCME guideline for turbidity is dependent upon background levels.

Figure 3.3-3: Turbidity in Lakes, Doris Project, 2003 to 2018

The CCME guideline for turbidity is based on an increase from background levels (for clear-flow waters with background turbidity levels below 8 NTU, a maximum increase of 8 NTU is allowable for any short-term exposure or 2 NTU for longer term exposure; CCME 2018). Overall, there was no evidence for a Project-related increase in turbidity in Doris Lake North compared to baseline levels and to Reference Lake B, and turbidity levels remained below the CCME guideline and the low-action level threshold.

3.3.4 Chloride

Chloride concentrations recorded between 2010 and 2018 were within the range of baseline concentrations recorded between 2003 and 2009 (Figure 3.3-4). However, the statistical analysis showed that the under-ice and open-water chloride trends in Doris Lake North were significantly different from a slope of zero ($p < 0.0001$ for under-ice; $p = 0.0037$ for open-water) and from the corresponding trends in Reference Lake B ($p < 0.0001$ for both under-ice and open-water). The graphical analysis showed that chloride concentrations in Doris Lake North have not increased over time from 2003 to 2018, and have been decreasing in recent years (Figure 3.3-4). Therefore, there was no evidence of a Project-related adverse change in chloride concentrations in Doris Lake North over time. All chloride concentrations remained below the CCME guideline of 120 mg/L and the low action level threshold of 90 mg/L.

3.3.5 Fluoride

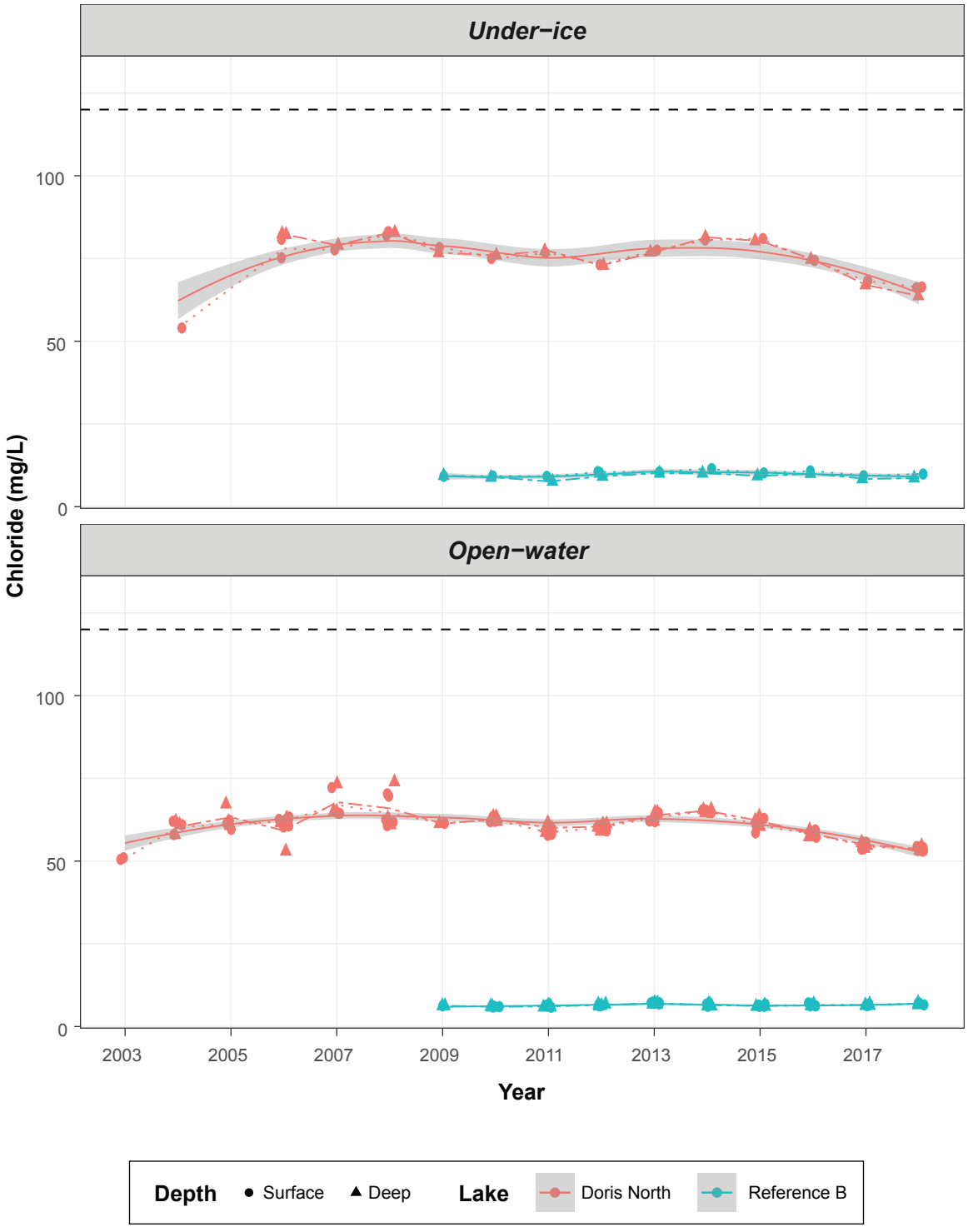
Fluoride concentrations changed little over time in Doris Lake North (Figure 3.3-5), and there was no significant difference between under-ice and open-water fluoride trends and a slope of zero ($p = 0.8048$ for under-ice; $p = 0.3603$ for open-water). Therefore, there was no evidence of a Project-related effect on fluoride concentration in Doris Lake North. Fluoride concentrations in Doris Lake North recorded since the start of Project construction in 2010 also remained below the CCME guideline of 0.12 mg/L and the low action level threshold of 0.09 mg/L.

3.3.6 Total Ammonia

There was no apparent change in under-ice season total ammonia concentrations in Doris Lake North over time (Figure 3.3-6), and the statistical analysis confirmed that the trend in under-ice total ammonia concentration in Doris Lake North was not significantly different from a slope of zero ($p = 0.5423$). During the open-water season, most total ammonia concentrations were below analytical detection limits, including the total ammonia concentration in five of nine samples collected in 2018 (Appendix A). Because of the high proportion of censored data, statistical analysis of open-water season total ammonia trends could not be conducted. However, open-water total ammonia concentrations do not appear to be increasing over time (Figure 3.3-6), so there is no evidence of a Project-related adverse effect on total ammonia concentrations in Doris Lake North. All ammonia concentrations in Doris Lake North remained well below the pH- and temperature-dependent CCME guideline and low action level threshold.

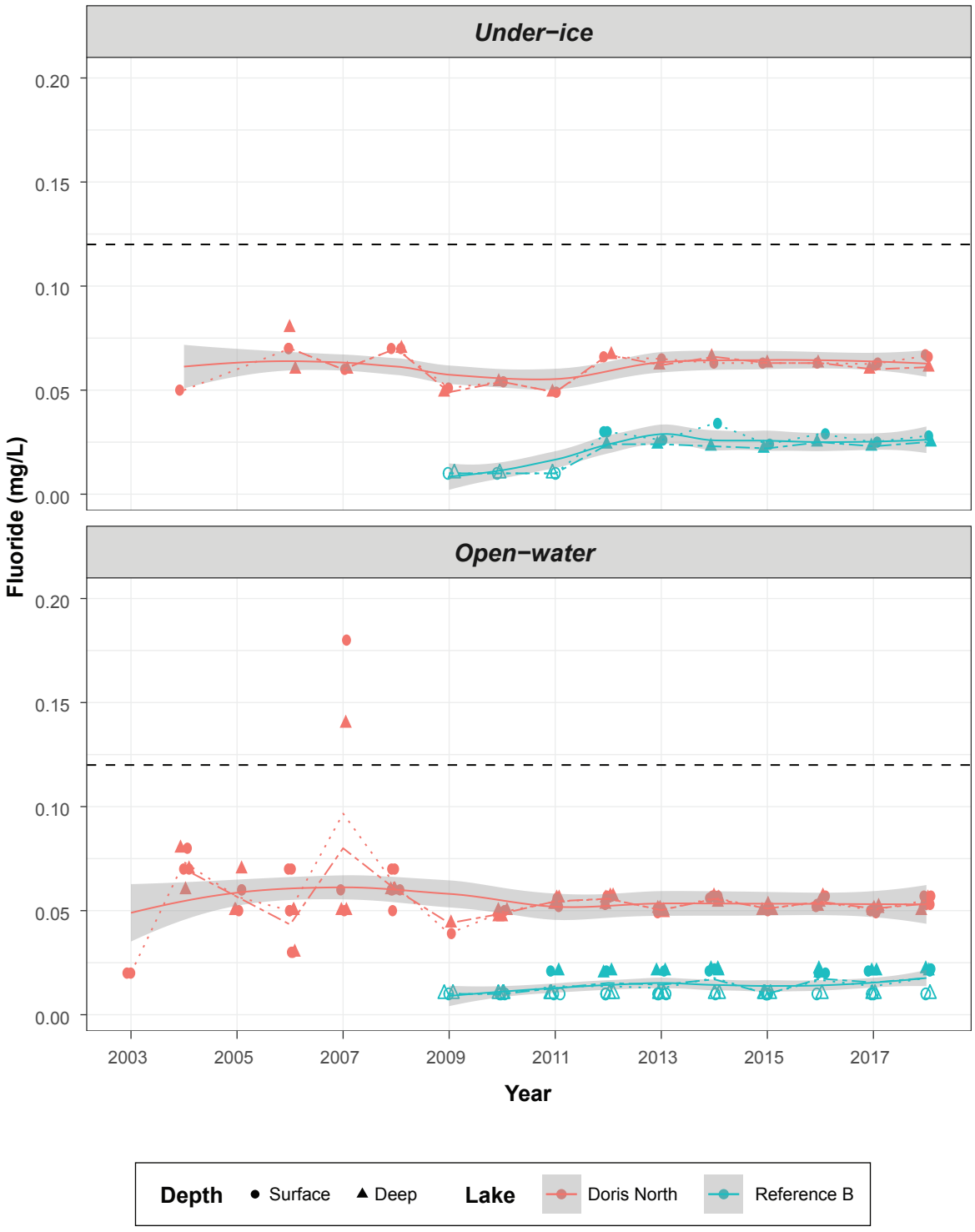
3.3.7 Nitrate

Under-ice season nitrate concentrations in Doris Lake North were variable over time, but were generally similar to concentrations in Reference Lake B (Figure 3.3-7). Although the trend over time in under-ice nitrate concentrations was significantly different from a slope of zero ($p < 0.0001$) and from the trend in Reference Lake B ($p = 0.0001$), there was no indication of an increase in concentrations over time as 2018 concentrations were similar to baseline concentrations (Figure 3.3-7), suggesting that Project activities have not adversely affected under-ice nitrate concentrations in Doris Lake North.



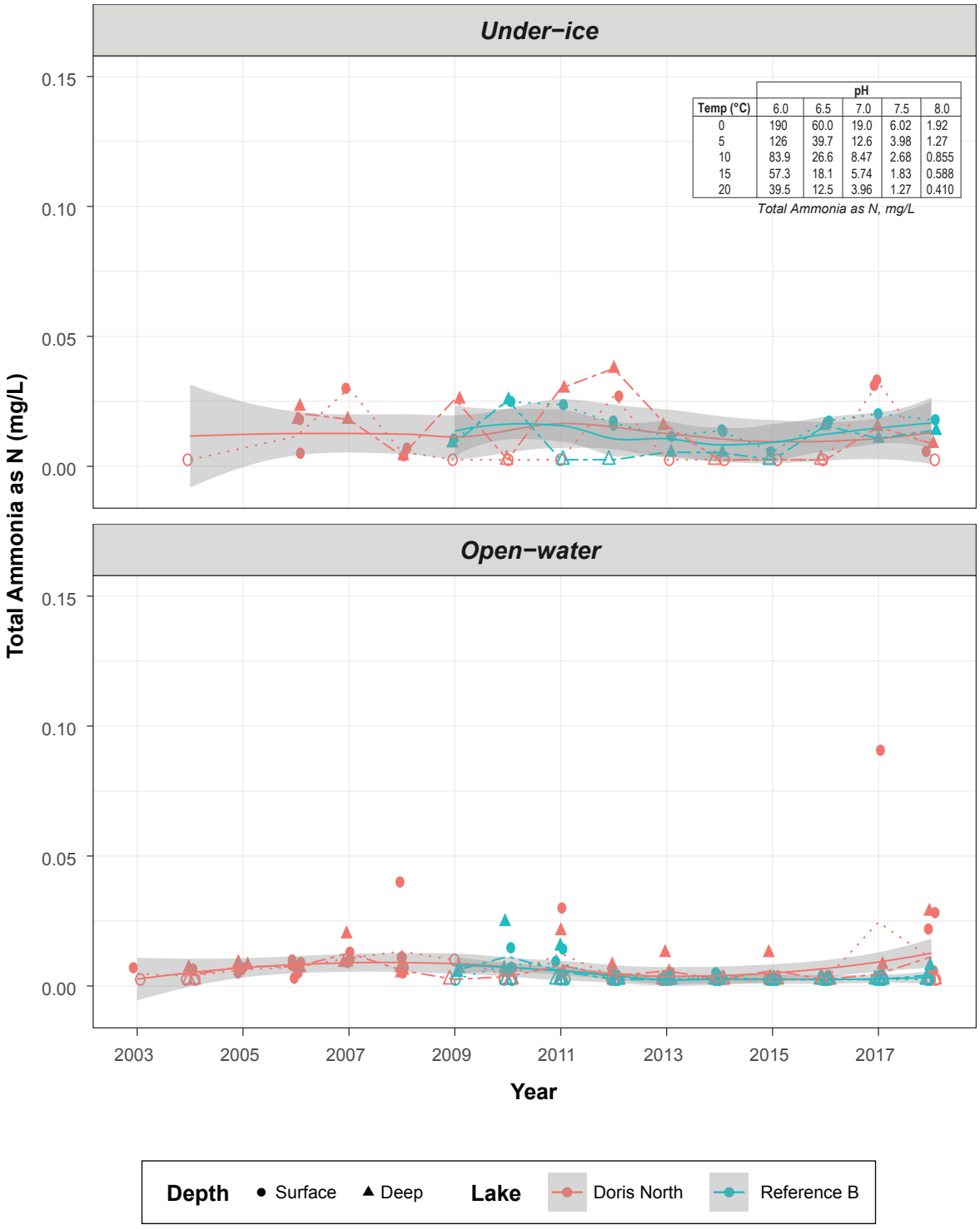
Note: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Black dashed lines represent the CCME long-term guideline for chloride (120 mg/L).

Figure 3.3-4: Chloride Concentrations in Lakes, Doris Project, 2003 to 2018



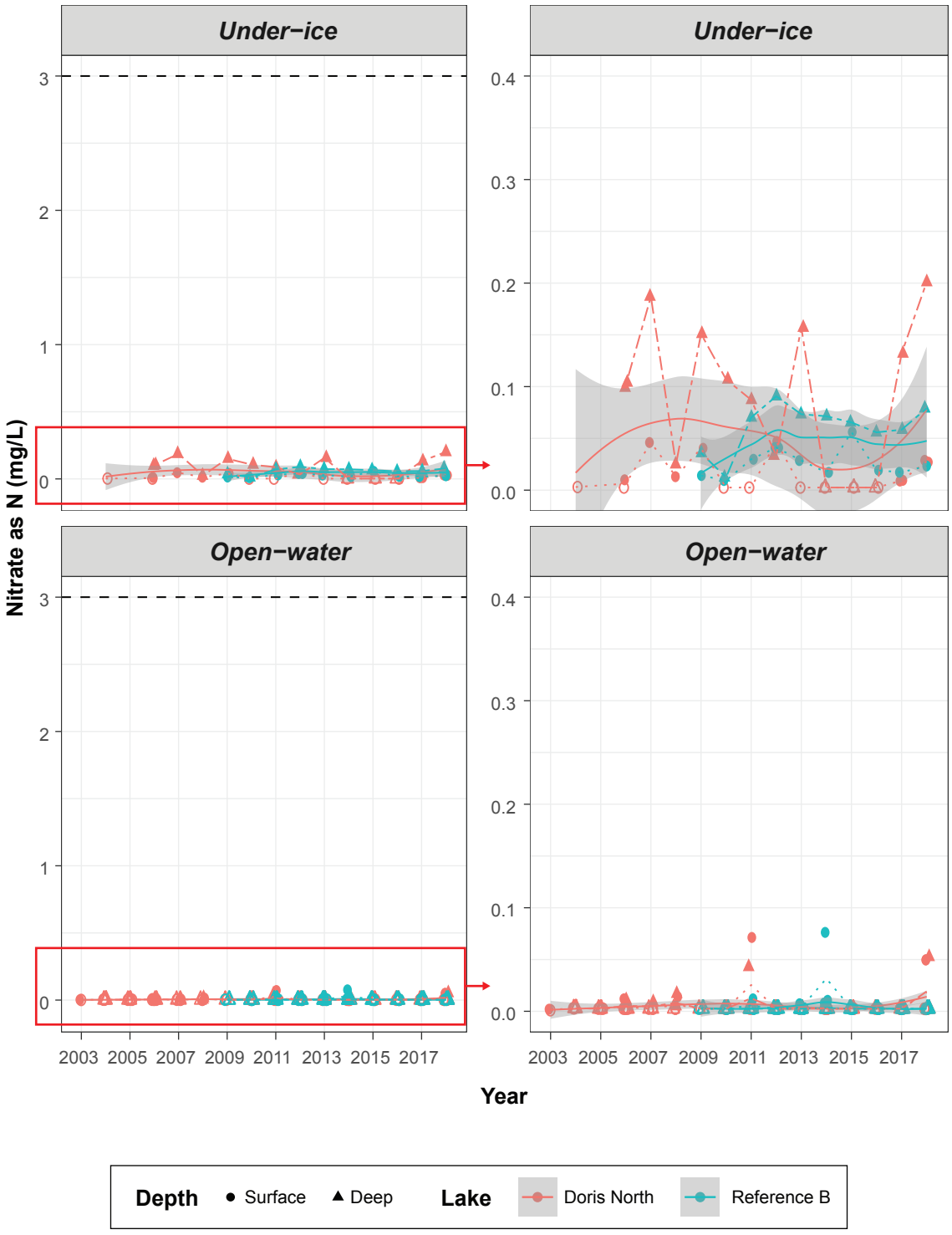
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 interim guideline for fluoride (0.120 mg/L).

Figure 3.3-5: Fluoride Concentrations in Lakes, Doris Project, 2003 to 2018



Note: 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 or dotted 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.
Inset table shows the pH- and temperature-dependent CCME guideline for total ammonia as N.

Figure 3.3-6: Total Ammonia Concentrations in Lakes, Doris Project, 2003 to 2018



Note: 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 or dotted 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 long-term guideline for nitrate as N (3.0 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-7: Nitrate Concentrations in Lakes, Doris Project, 2003 to 2018

Because of the high proportion of censored data, statistical analysis of open-water season nitrate trends could not be conducted. Three out of nine 2018 open-water season nitrate concentrations in Doris Lake North were below analytical detection limits, and there was no evidence of a Project-related effect on open-water nitrate concentrations (Figure 3.3-7). Under-ice and open-water nitrate concentrations in Doris Lake North remained well below the long-term CCME guideline of 3.0 mg nitrate-N/L and the low action level threshold of 2.25 mg nitrate-N/L.

3.3.8 Nitrite

Of the 12 nitrite concentrations measured in Doris Lake North water samples in 2018, 11 concentrations were below the analytical detection limit (<0.001 mg/L) and all concentrations were well below the CCME guideline of 0.06 mg nitrite-N/L and the low action level threshold of 0.045 mg nitrite-N/L (Figure 3.3-8). Therefore, there was no evidence of an adverse Project effect on nitrite concentrations in Doris Lake North. Statistical analysis of nitrite trends could not be conducted because of the high proportion of censored data.

3.3.9 Total Phosphorus

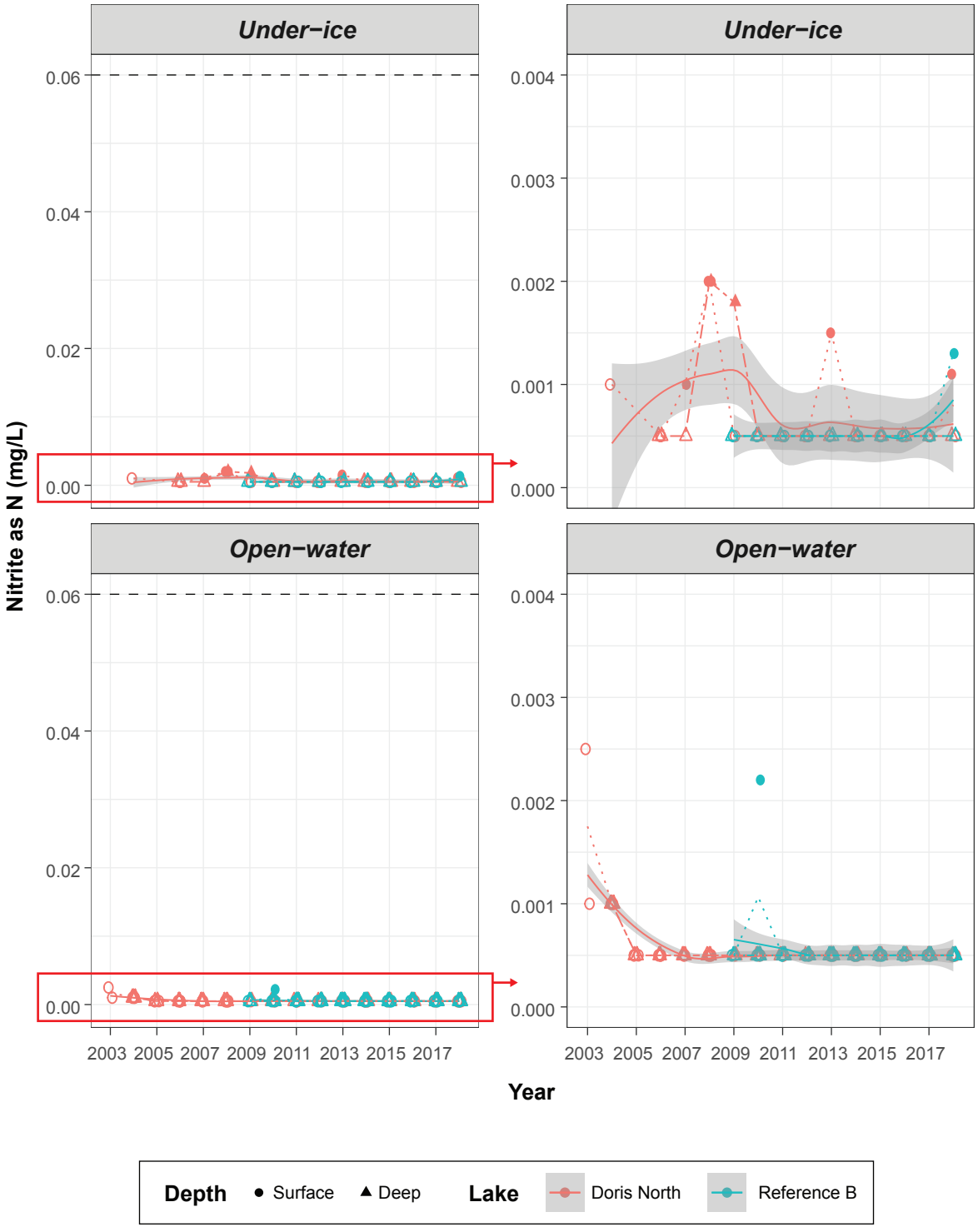
Total phosphorus concentrations measured in Doris Lake North ranged from 0.01 to 0.05 mg/L between 2004 and 2018 (characteristic of a mesotrophic to eutrophic lake; CCME 2018) and averaged 0.026 mg/L (Figure 3.3-9). Under-ice and open-water season total phosphorus concentrations changed little over time in Doris Lake North (Figure 3.3-9). This was confirmed by the statistical analysis, which showed that total phosphorus trends over time did not significantly differ from a slope of zero ($p = 0.3943$ for under-ice; $p = 0.9280$ for open-water). Overall, there was no evidence of a change in total phosphorus concentration in Doris Lake North due to Project activities, and the low action level for total phosphorus was not exceeded.

3.3.10 Total Aluminum

Under-ice and open-water season total aluminum concentrations changed little over time in Doris Lake North (Figure 3.3-10). This was confirmed by the statistical analysis, which showed that there was no significant difference between total aluminum trends over time and a slope of zero ($p = 0.6544$ for under-ice; $p = 0.9302$ for open-water). Total aluminum concentrations measured in Doris Lake North in August of 2018 were slightly higher than the CCME guideline of 0.1 mg/L (for waters with pH above 6.5); however, total aluminum concentrations were also sporadically elevated above this guideline during baseline years (2004 to 2009) and the construction phase (2010 to 2016) in Doris Lake North, and in Reference Lake B (2013). Total aluminum concentrations in Doris Lake North were also occasionally higher than the low action level threshold of 0.075 mg/L in 2018 as well as in baseline years; however, the low action level was not exceeded because there was no evidence of a Project-related change in total aluminum concentrations in Doris Lake North.

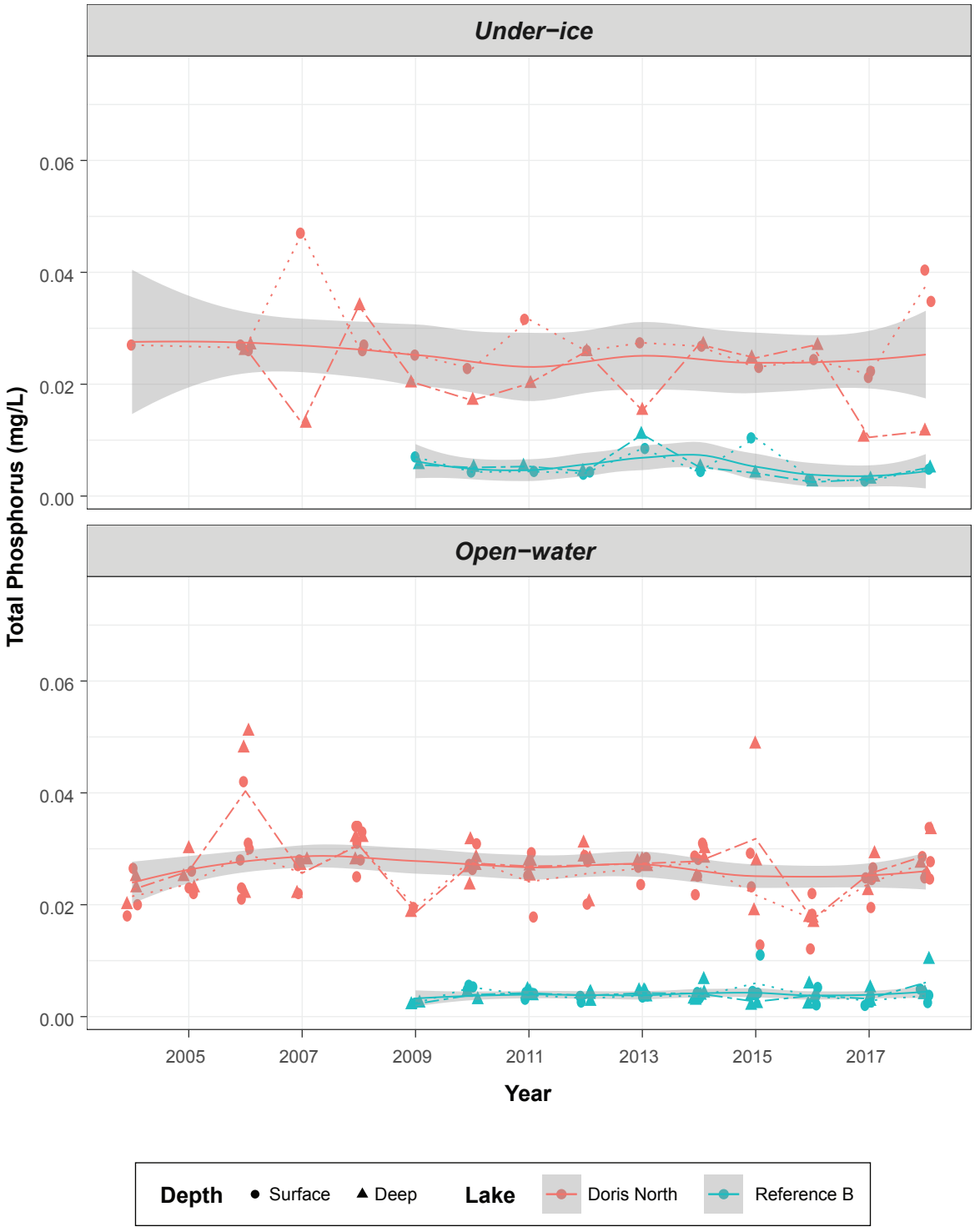
3.3.11 Total Arsenic

Both under-ice and open-water season total arsenic concentrations have decreased over time in Doris Lake North (Figure 3.3-11). The trends in total arsenic concentration were significantly different from a slope of zero ($p < 0.0001$ for under-ice; $p = 0.0009$ for open-water). The under-ice trend in Doris Lake North also differed from the Reference B under-ice trend ($p = 0.0059$), while the open-water season trends between lakes were not significantly different ($p = 0.1014$). Since the change in total arsenic concentrations over time was a decrease compared to baseline concentrations and a decrease is not an environmental concern, there was no apparent adverse effect of the Project on total arsenic in Doris Lake North. Total arsenic concentrations remained well below the CCME guideline of 0.005 mg/L and the low action level threshold of 0.00375 mg/L.



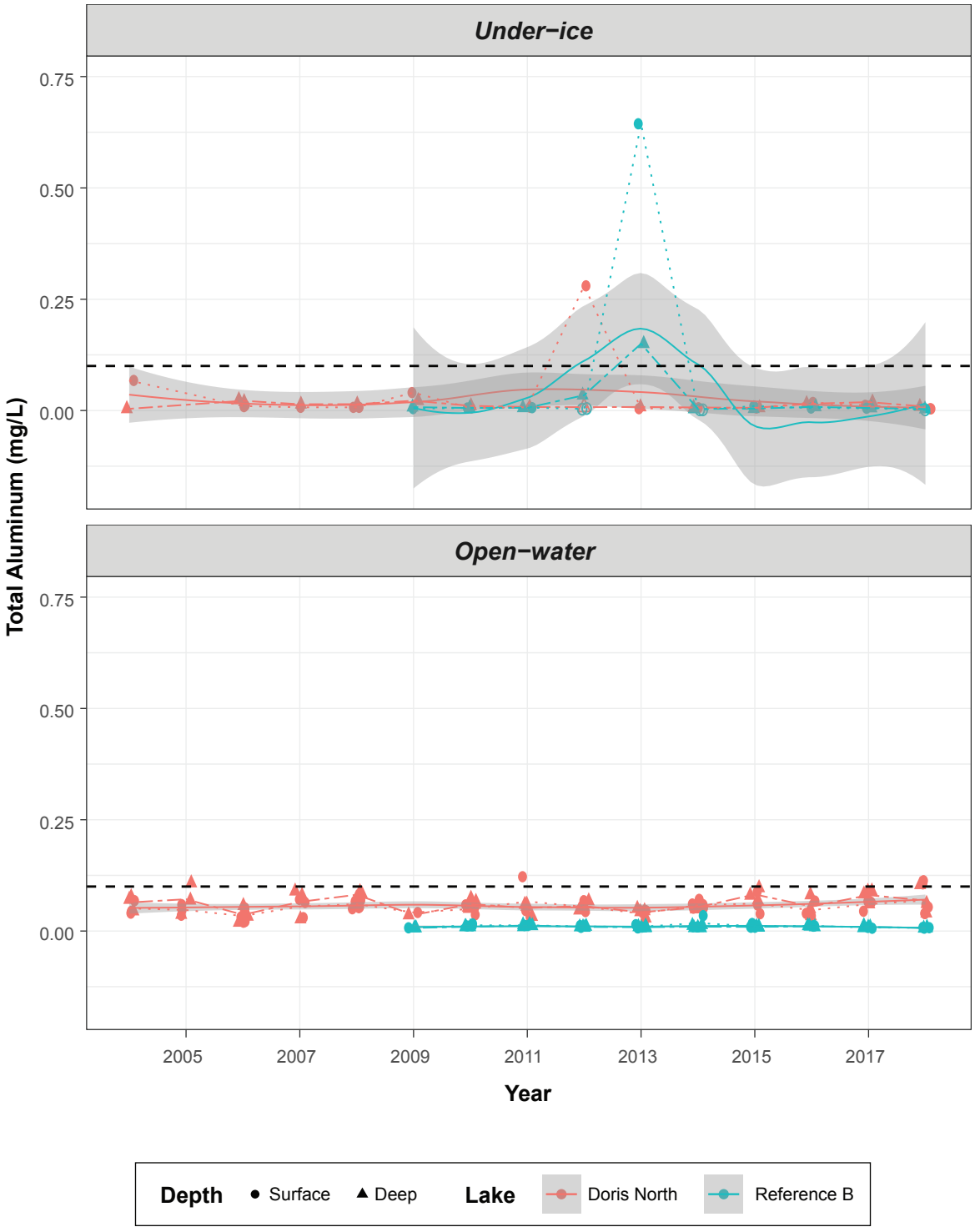
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 guideline for nitrite as N (0.06 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-8: Nitrite Concentrations in Lakes, Doris Project, 2003 to 2018



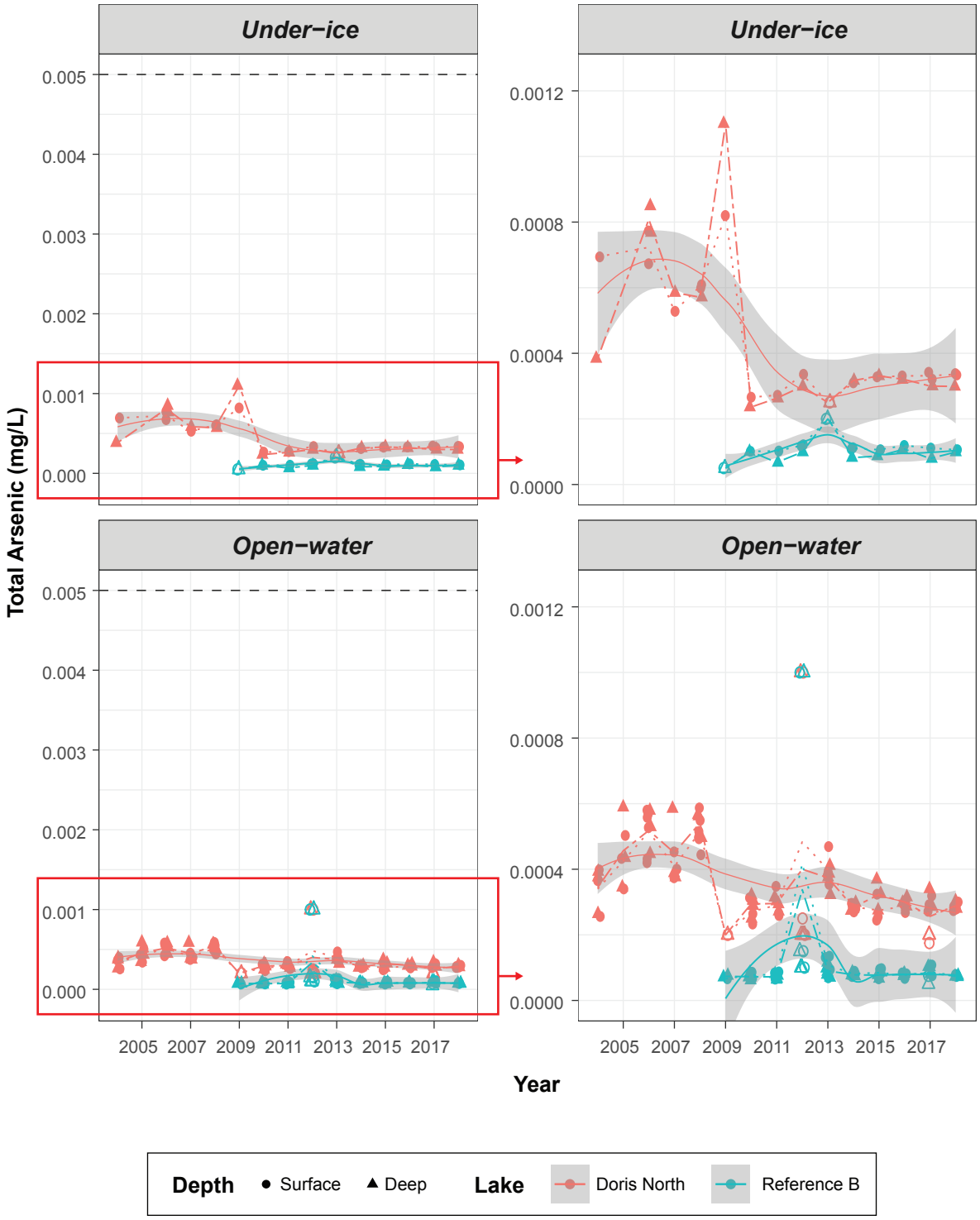
Note: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent the annual means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.
Total phosphorus trigger ranges from CCME guidance framework: <0.004 mg/L = ultra-oligotrophic; 0.004 to 0.010 mg/L = oligotrophic; 0.01 to 0.02 mg/L = mesotrophic; 0.02 to 0.035 mg/L = meso-eutrophic; 0.035 to 0.1 mg/L = eutrophic; >0.1 mg/L = hyper-eutrophic.

Figure 3.3-9: Total Phosphorus Concentrations in Lakes, Doris Project, 2004 to 2018



Note: 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 or dotted 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 pH-dependent CCME guideline for aluminum (0.1 mg/L at pH ≥ 6.5; 0.05 mg/L at pH < 6.5);
pH was greater than 6.5 in all lake samples in 2018.

Figure 3.3-10: Aluminum Concentrations in Lakes, Doris Project, 2004 to 2018



Note: 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 or dotted 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 guideline for arsenic (0.005 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-11: Arsenic Concentrations in Lakes, Doris Project, 2004 to 2018

3.3.12 Total Boron

Both under-ice and open-water season total boron concentrations in Doris Lake North increased slightly from 2004 to 2015, and decreased back to baseline concentrations between 2015 and 2018 (Figure 3.3-12). These trends were significantly different from a slope of zero ($p < 0.0001$ for both under-ice and open-water), but the trends were not significantly different from the Reference B trends ($p = 0.5250$ for under-ice; $p = 0.1261$ for open-water). Therefore, there was no evidence of a differential change in total boron concentrations occurring in Doris Lake North but not in Reference Lake B as a result of Project activities. Total boron concentrations remained well below the CCME long-term guideline of 1.5 mg/L and the low action level threshold of 1.125 mg/L.

3.3.13 Total Cadmium

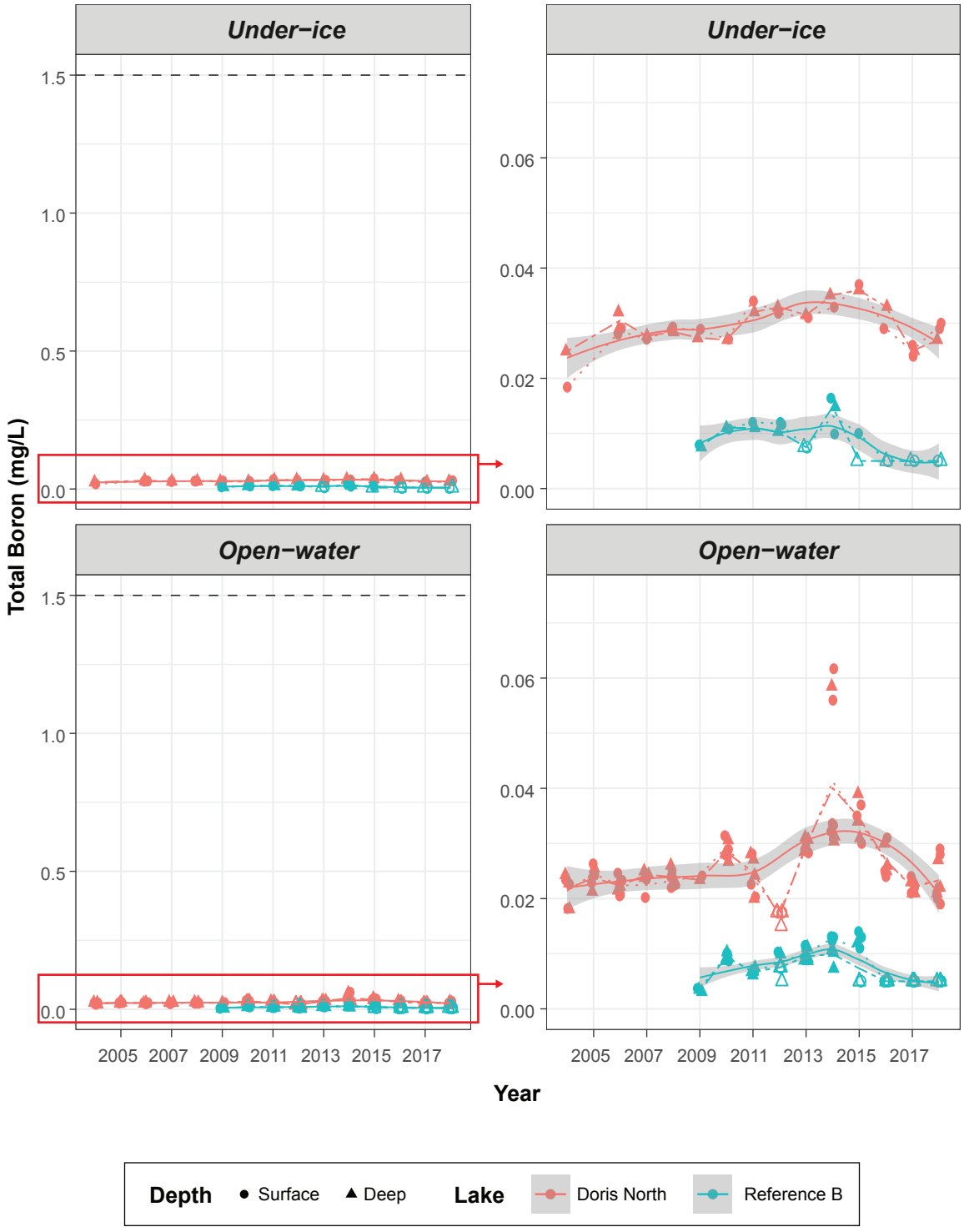
All 2018 total cadmium concentrations measured in Doris Lake North and Reference Lake B were below the analytical detection limit (<0.000005 mg/L), and there was no apparent change in total cadmium concentrations over time (Figure 3.3-13). Therefore, there is no evidence of an adverse effect of Project activities on total cadmium concentrations in Doris Lake North. All total cadmium concentrations remained below the hardness-dependent CCME guideline and low action level threshold.

3.3.14 Total Chromium

Total chromium concentrations in Doris Lake North changed little over time from 2004 to 2018, with most concentrations below analytical detection limits (Figure 3.3-14). In 2018, only 2 out of 12 samples collected at Doris Lake North contained detectable concentrations of total chromium (0.00098 and 0.00118 mg/L on August 19, duplicate shallow samples; Appendix A). The concentration of 0.00118 mg/L was higher than the CCME guideline of 0.001 mg/L and the low action level threshold of 0.00075 mg/L for hexavalent chromium but lower than the CCME guideline of 0.0089 mg/L and the low action level threshold of 0.0068 mg/L for trivalent chromium. Sporadic increases above the CCME guideline and low action level for hexavalent chromium have also been observed in samples from Reference Lake B (e.g., 2013 and 2014), and are not necessarily indicative of a Project effect. Because of the high proportion of censored data, it was not possible to perform a statistical analysis of the total chromium dataset; however, the absence of an increasing trend over time (Figure 3.3-14) suggests that the Project has not adversely affected total chromium concentrations in Doris Lake North, and the low action level for total chromium was not exceeded.

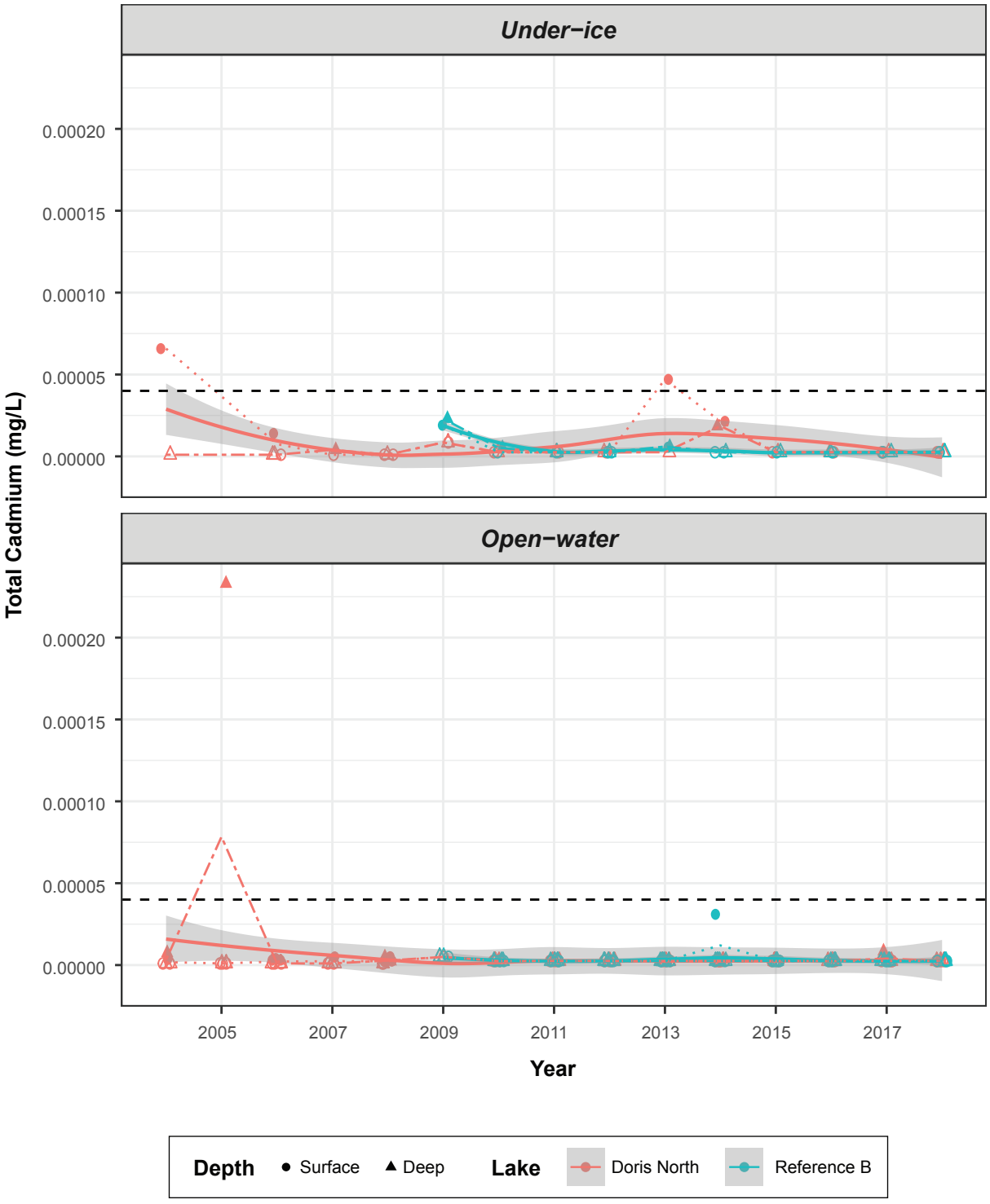
3.3.15 Total Copper

Under-ice and open-water total copper concentrations in Doris Lake North changed little over time (Figure 3.3-15). This was confirmed by the statistical analysis, which showed that the total copper trends over time were not significantly different from a slope of zero ($p = 0.3920$ for under-ice; $p = 0.8739$ for open-water). Thus, there is no indication that the Project has adversely affected total copper concentrations in Doris Lake North. One of the 12 total copper concentrations measured in Doris Lake North in 2018 was higher than the hardness-dependent CCME guideline of 0.002 mg/L (0.00242 mg/L on August 18), while 5 of the 12 concentrations were higher than the hardness-dependent low action level threshold of 0.0015 mg/L. However, total copper concentrations in Doris Lake North did not trigger the low action level since concentrations did not change from baseline levels.



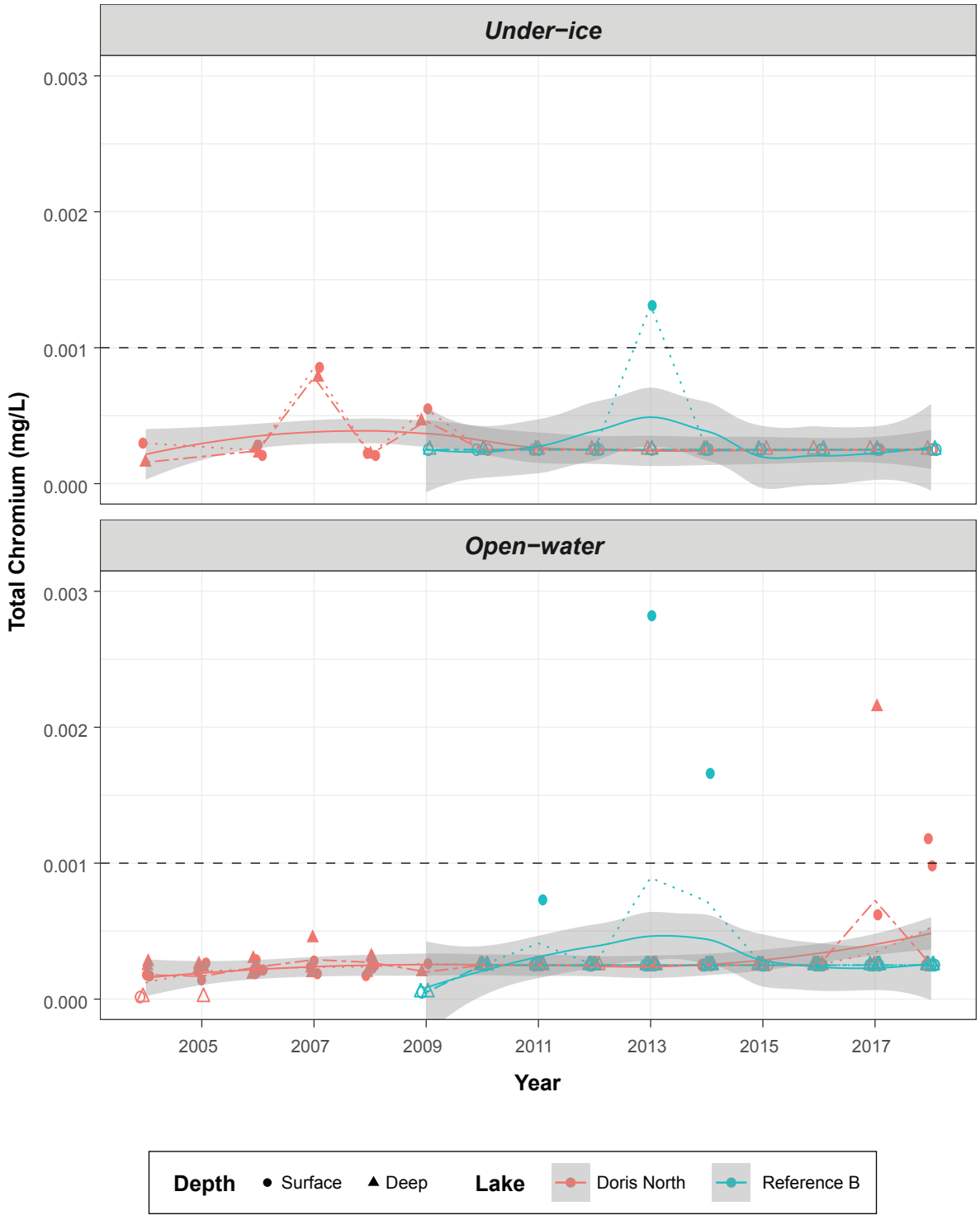
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 long-term guideline for boron (1.5 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-12: Boron Concentrations in Lakes, Doris Project, 2004 to 2018



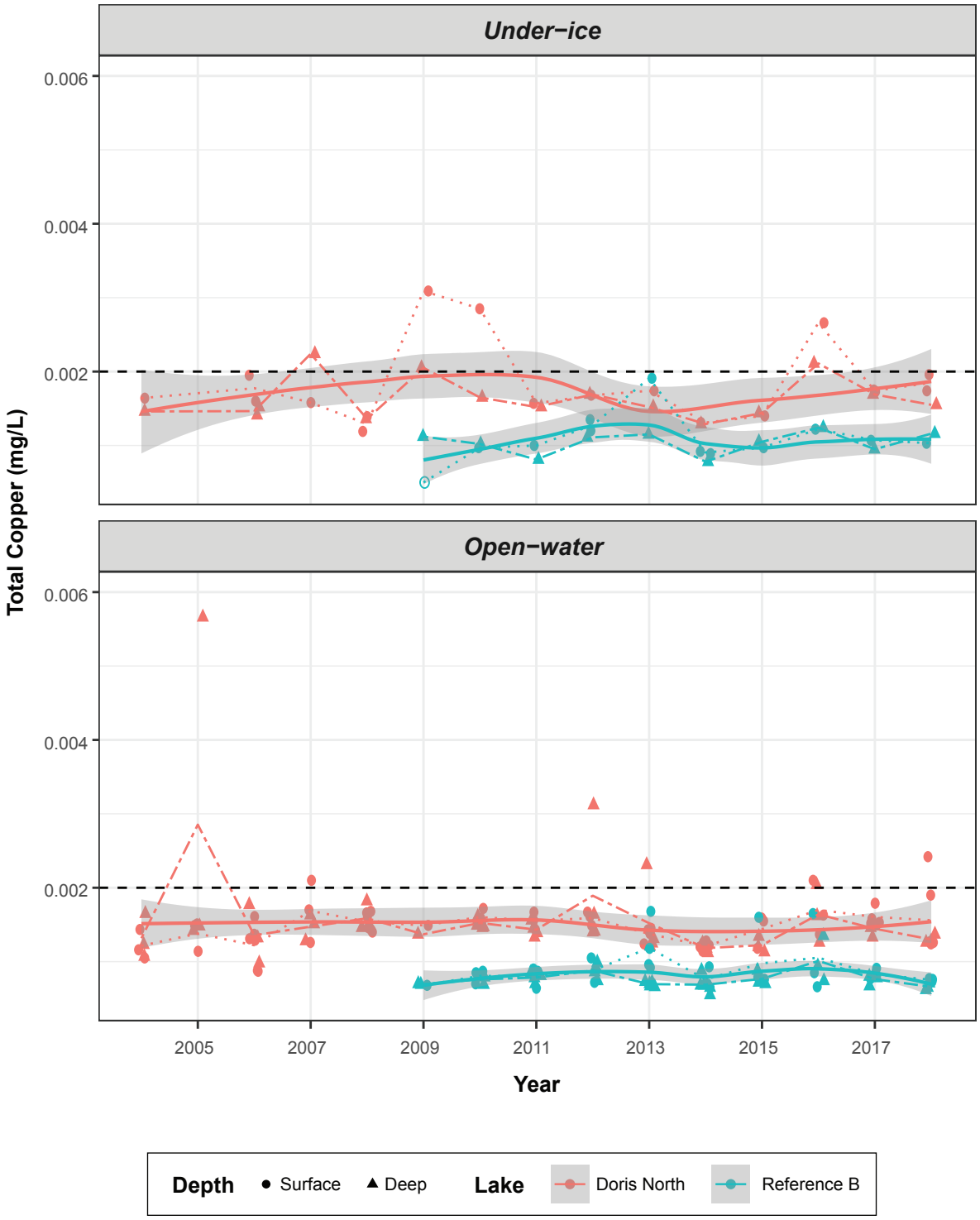
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 minimum hardness-dependent CCME long-term guideline for cadmium of 0.00004 mg/L (for hardness as CaCO3 of < 17 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-13: Cadmium Concentrations in Lakes, Doris Project, 2004 to 2018



Note: 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 or dotted 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 guideline for hexavalent chromium (0.001 mg/L);
the CCME interim guideline for trivalent chromium (0.0089 mg/L) is not shown.

Figure 3.3-14: Chromium Concentrations in Lakes, Doris Project, 2004 to 2018



Note: 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 or dotted 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 minimum hardness-dependent CCME guideline for copper of 0.002 mg/L
(for hardness as CaCO3 of < 82 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-15: Copper Concentrations in Lakes, Doris Project, 2004 to 2018

3.3.16 Total Iron

All 2018 total iron concentrations in Doris Lake North remained below the CCME guideline of 0.3 mg/L; however, all July 2018 concentrations were higher than the low action level threshold of 0.225 mg/L. Total iron concentrations in Doris Lake North were relatively consistent over time in both the under-ice and open-water seasons (Figure 3.3-16). This was confirmed by the statistical analysis, which showed that the total iron trends over time were not significantly different from a slope of zero ($p = 0.5444$ for under-ice; $p = 0.6275$ for open-water). Therefore, total iron concentrations did not trigger the low action level since there was no significant change from baseline levels.

3.3.17 Total Lead

Total lead concentrations in Doris Lake North changed little over time from 2004 to 2018, with most concentrations below analytical detection limits (Figure 3.3-17). In 2018, only 3 out of 12 samples collected at Doris Lake North contained detectable concentrations of total lead, and these concentrations were slightly higher than the analytical detection limit of 0.00005 mg/L (range of detectable concentrations: 0.000052 to 0.000122 mg/L; Appendix A). Although historical total lead concentrations in both Doris Lake North and Reference Lake B were sporadically elevated above the minimum hardness-dependent CCME guideline of 0.001 mg/L, all 2018 concentrations remained below this guideline, and below the low action level threshold.

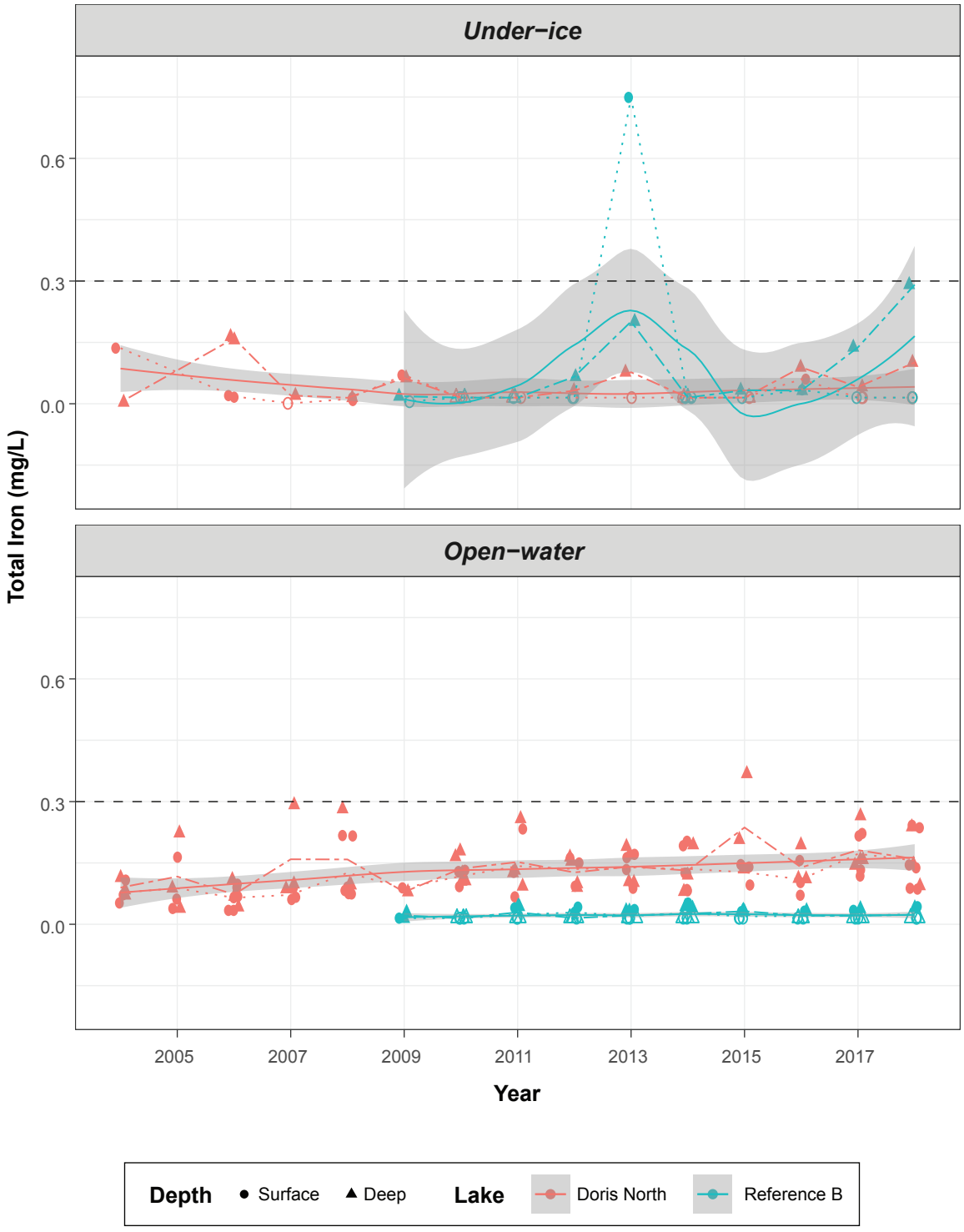
Because of the high proportion of censored data, it was not possible to perform a statistical analysis of total lead concentrations; however, the absence of an increasing trend over time (Figure 3.3-17) suggests that the Project has not adversely affected total lead concentrations in Doris Lake North, and the low action level for total lead was not exceeded.

3.3.18 Total Mercury

Under-ice and open-water total mercury concentrations in Doris Lake North between 2003 and 2018 were generally similar to Reference B concentrations (Figure 3.3-18). The results of the statistical analysis showed that total mercury trends over time were not significantly different from a slope of zero ($p = 0.8194$ for under-ice; $p = 0.8720$ for open-water), suggesting that total mercury concentrations in Doris Lake North have not been adversely affected by Project activities. Total mercury concentrations were also well below the CCME guideline of 0.026 µg/L and the low action level benchmark of 0.0195 µg/L.

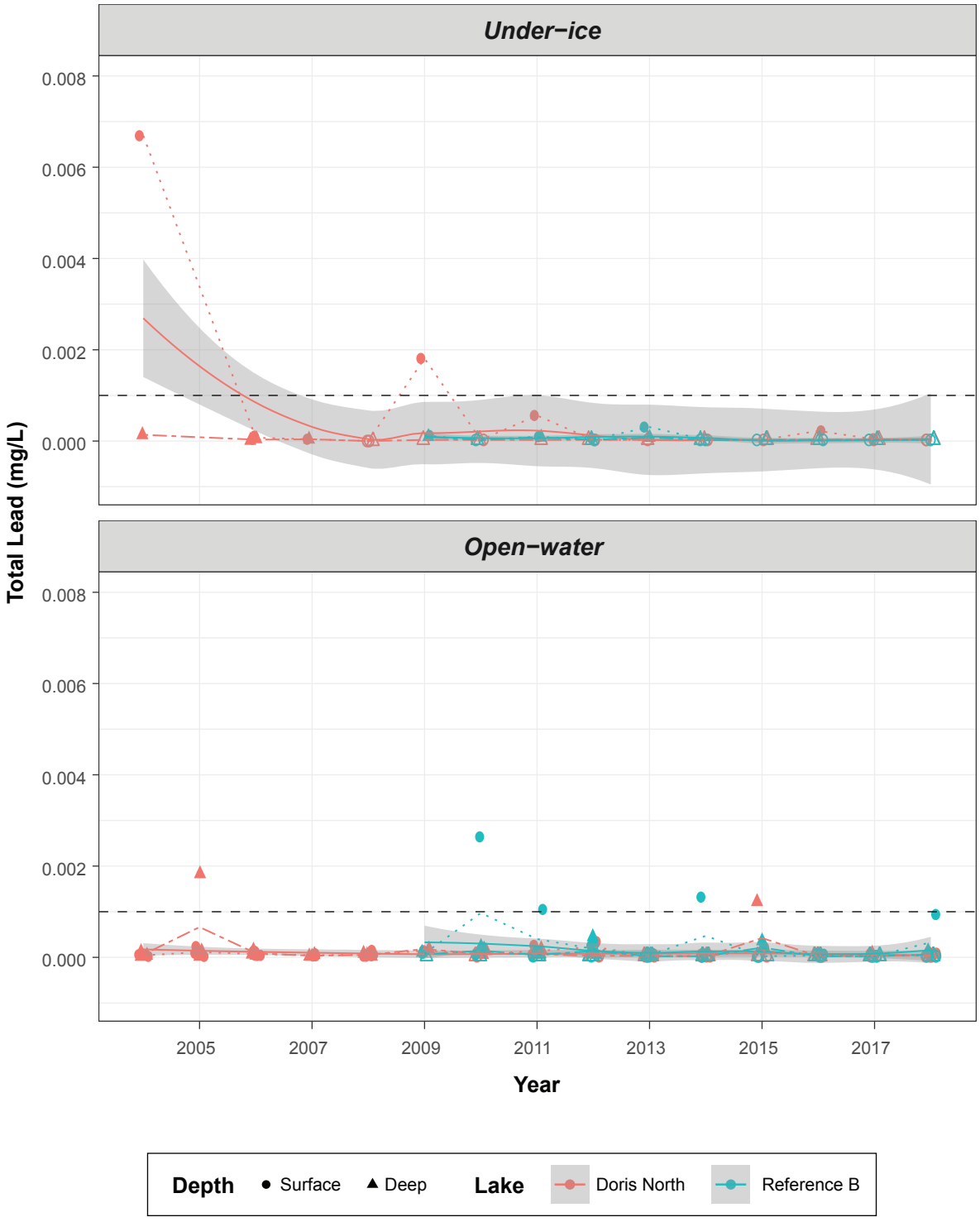
3.3.19 Total Molybdenum

Molybdenum concentrations in Doris Lake North increased slightly over time in both the under-ice and open water seasons, and were consistently higher than concentrations in Reference Lake B (Figure 3.3-19). The under-ice and open-water trends in total molybdenum in Doris Lake North were significantly different from a slope of zero ($p < 0.0001$ for both under-ice and open-water). Because of the high proportion of censored data in the dataset for total molybdenum in Reference Lake B, it was not possible to statistically compare the trends between the exposure and reference lakes to determine whether this increase in total molybdenum could be naturally occurring rather than Project related. At present, the cause for the increase in total molybdenum is unknown. A Project-related effect on total molybdenum concentrations cannot be ruled out; however, even if the slight but significant increase in total molybdenum concentrations was due to the Project, total molybdenum concentrations remained more than an order of magnitude below the CCME guideline of 0.073 mg/L and the low action level threshold of 0.055 mg/L; therefore, total molybdenum concentrations remain protective of aquatic life, and the low action level was not exceeded.



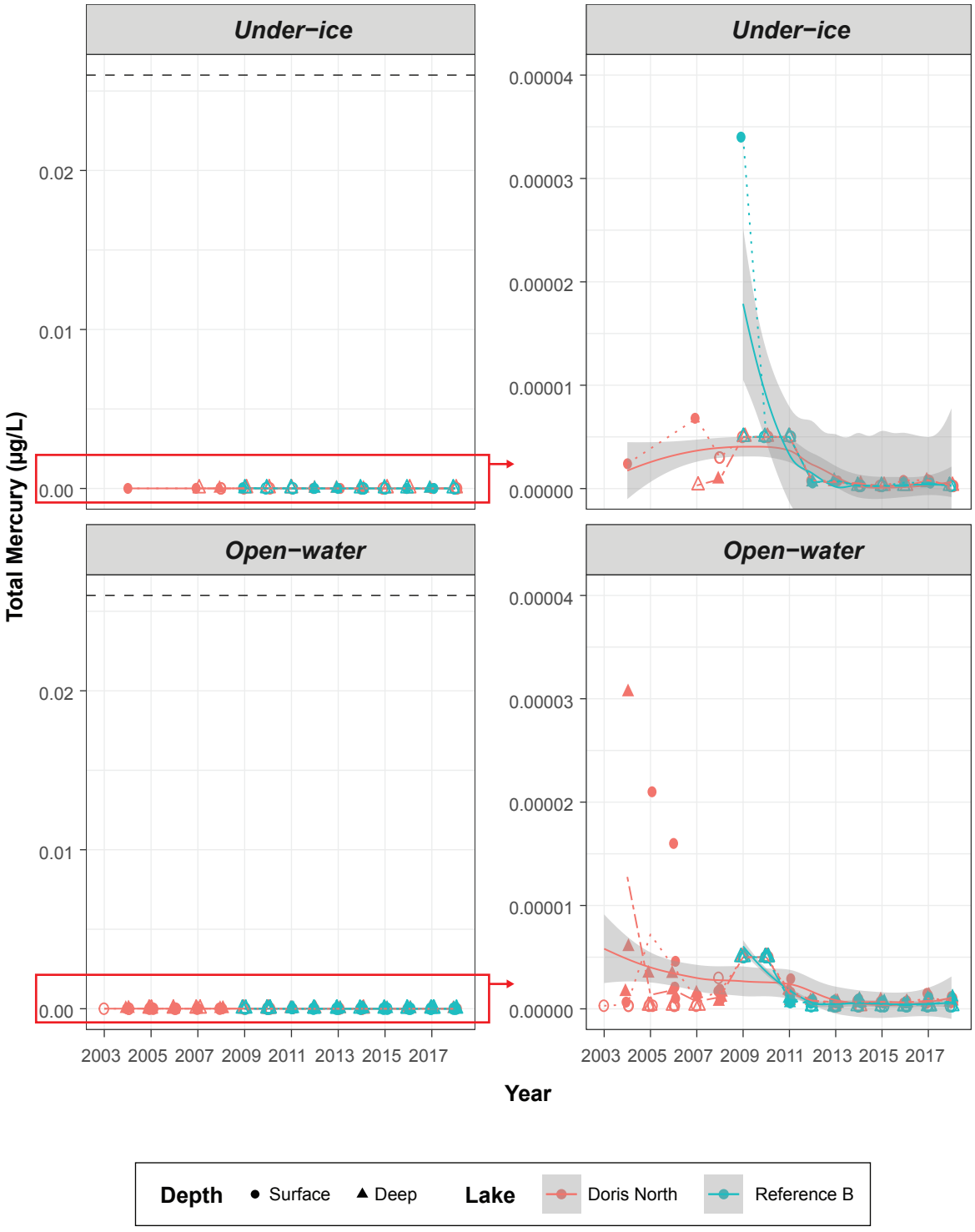
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 guideline for iron (0.3 mg/L).

Figure 3.3-16: Iron Concentrations in Lakes, Doris Project, 2004 to 2018



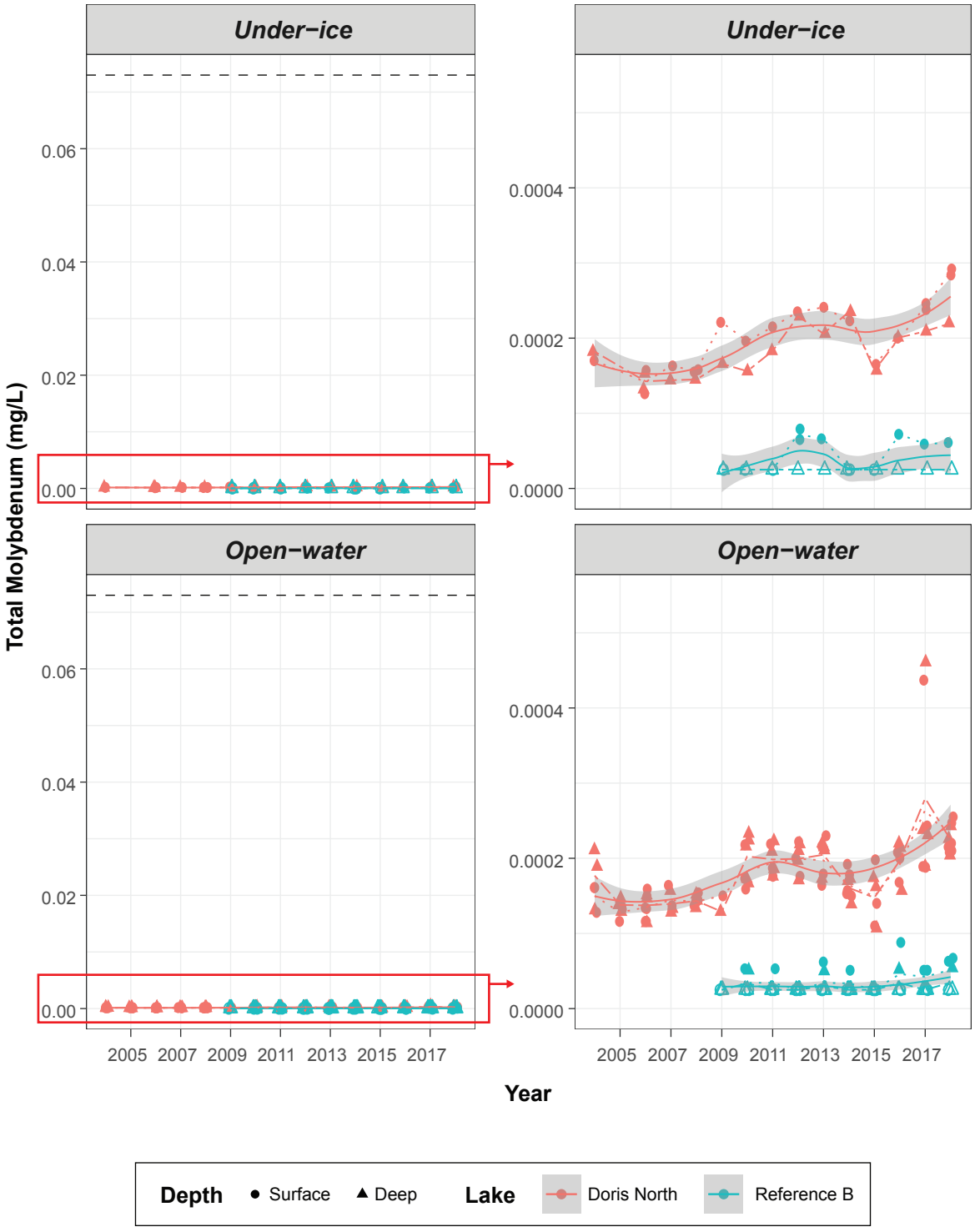
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 minimum hardness-dependent CCME guideline for lead of 0.001 mg/L (for hardness as CaCO3 of ≤ 60 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-17: Lead Concentrations in Lakes, Doris Project, 2004 to 2018



Note: 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 or dotted 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 guideline for mercury (0.026 µg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-18: Mercury Concentrations in Lakes, Doris Project, 2003 to 2018



Note: 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 or dotted 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 interim guideline for molybdenum (0.073 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-19: Molybdenum Concentrations in Lakes, Doris Project, 2004 to 2018

3.3.20 Total Nickel

Under-ice and open-water total nickel concentrations in Doris Lake North changed little over time (Figure 3.3-20). This was confirmed by the statistical analysis, which showed that the total nickel trends over time were not significantly different from a slope of zero ($p = 0.6703$ for under-ice; $p = 0.6036$ for open-water). Therefore, there was no apparent Project effect on total nickel concentrations in Doris Lake North. All 2018 total nickel concentrations remained below the minimum hardness-dependent CCME guideline of 0.025 mg/L and the low action level threshold.

3.3.21 Total Selenium

Total selenium concentrations in Doris Lake North measured during baseline years (2004 to 2009) were generally higher than total selenium concentrations measured since the start of Project construction in 2010 (Figure 3.3-21). Only 2 out of 12 total selenium concentrations measured in Doris Lake North in 2018 were above the analytical detection limit of 0.0002 mg/L (0.00038 mg/L in two samples collected on August 19). Selenium concentrations in 2018 remained below the CCME guideline of 0.001 mg/L, and the low action level threshold of 0.00075 mg/L. Statistical analysis of total selenium trends was not conducted because of the high proportion of censored data. Overall, there was no evidence of an adverse Project effect on total selenium concentrations in Doris Lake North.

3.3.22 Total Silver

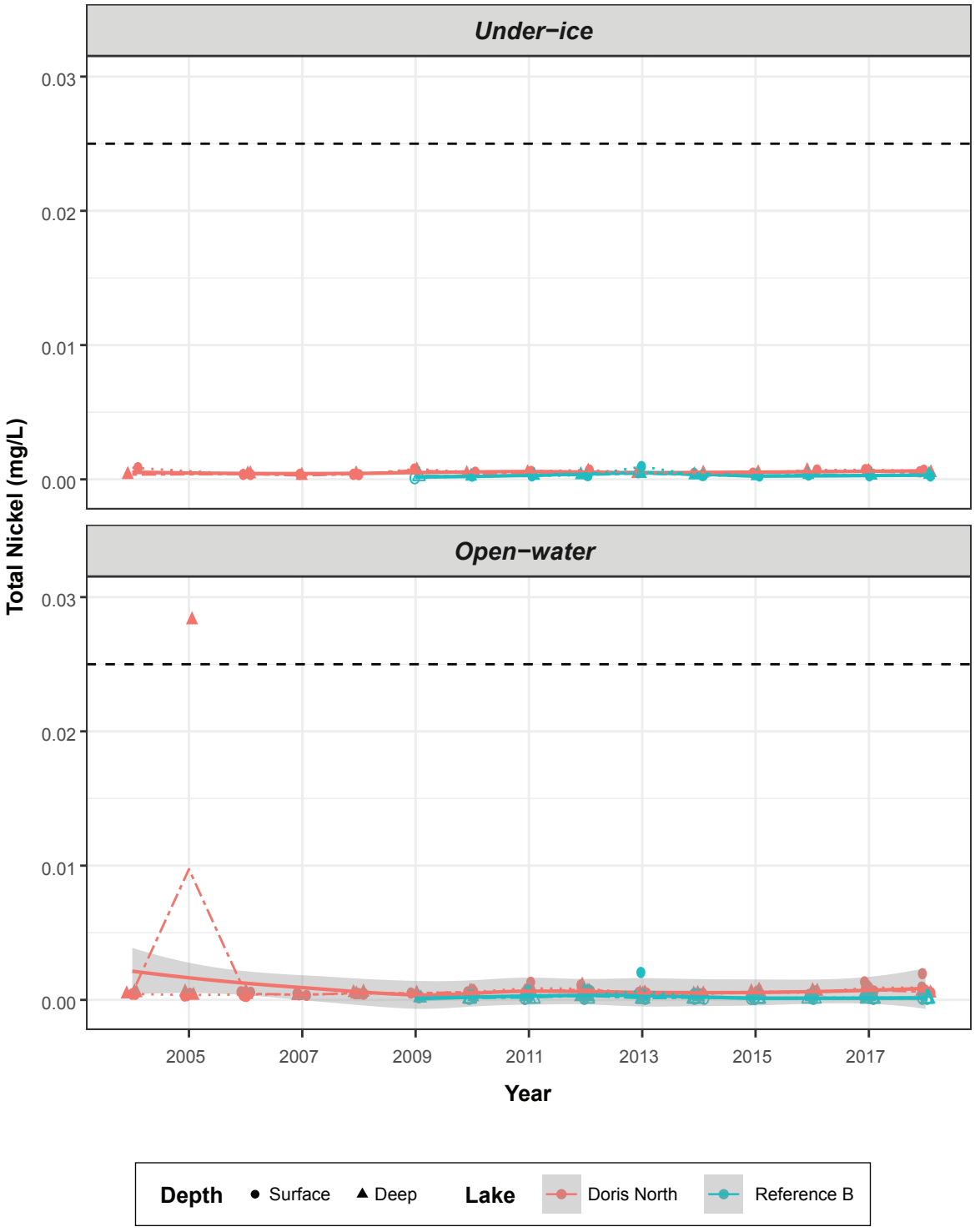
All total silver concentrations in Doris Lake North in 2018 were below the analytical detection limit of 0.000005 mg/L, the CCME guideline of 0.00025 mg/L, and the low action threshold of 0.00019 mg/L. Statistical analysis of total silver trends was not conducted, but there was no apparent increase in concentrations over time (Figure 3.3-22). There was no evidence of a Project effect on total silver concentrations in Doris Lake North.

3.3.23 Total Thallium

All 2018 total thallium concentrations in Doris Lake North were below the analytical detection limit of 0.000005 mg/L, the CCME guideline of 0.0008 mg/L, and the low action level threshold of 0.0006 mg/L. Statistical analysis was not conducted, but there was no apparent increase in concentrations over time (Figure 3.3-23). There was no evidence of a Project effect on total thallium concentrations in Doris Lake North.

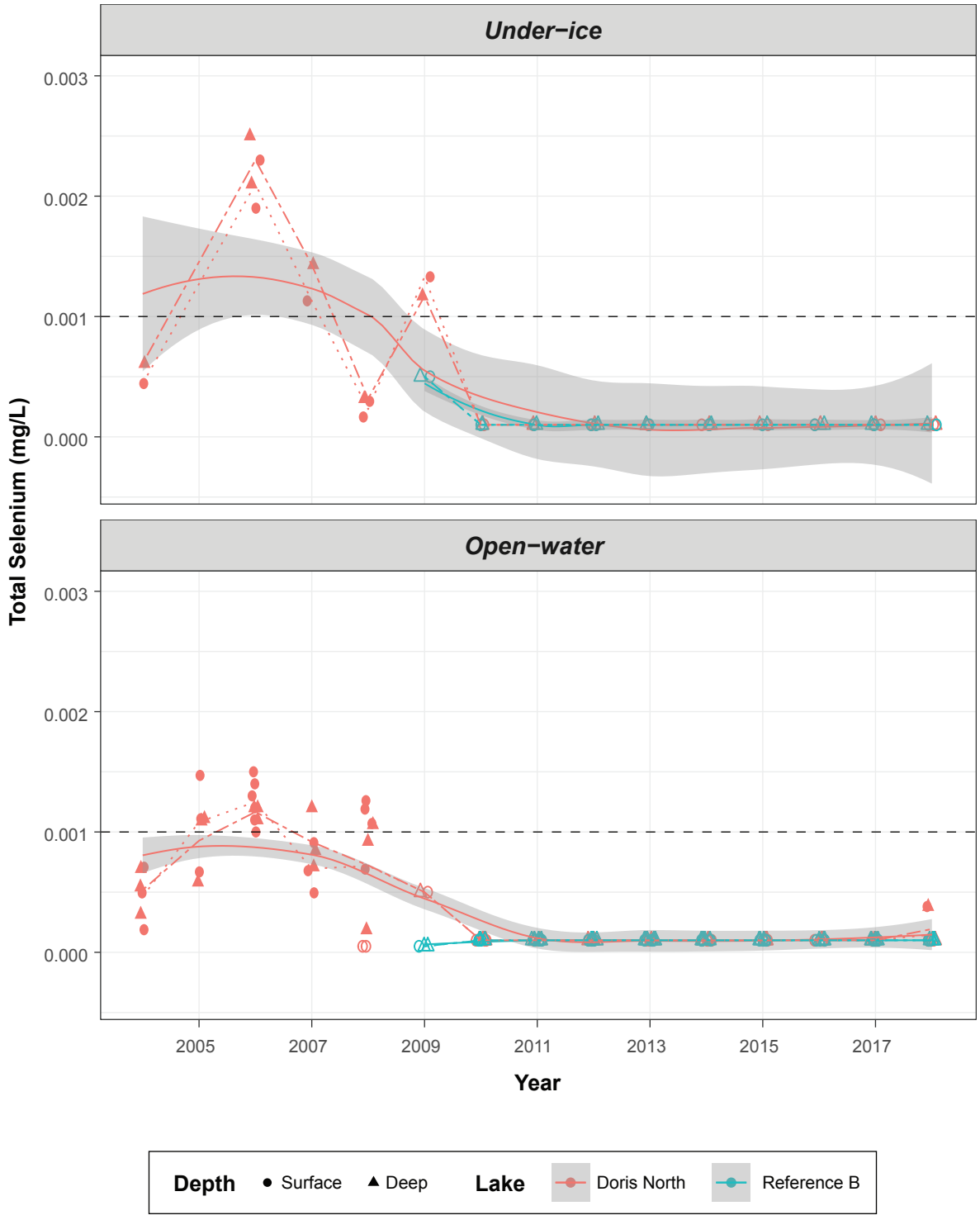
3.3.24 Total Uranium

Under-ice and open-water total uranium concentrations increased slightly over time in Doris Lake North, but were within the range of concentrations measured in Reference Lake B (Figure 3.3-24). The statistical analysis revealed that the total uranium trends were significantly different from a slope of zero for both the under-ice season ($p < 0.0001$) and the open-water season ($p = 0.0119$). The comparison of trends between Doris Lake North and Reference Lake B revealed that the open-water trends between lakes were not significantly different ($p = 0.5338$); however, the under-ice trends between lakes were significantly different ($p = 0.0498$). Total uranium concentrations in Reference Lake B have been more variable over time than in Doris Lake North; however, maximum under-ice total uranium concentrations in Reference Lake B have been higher than maximum concentrations in Doris Lake North in 8 of the last 10 years including 2018. Therefore, total under-ice uranium concentrations in Doris Lake North are not elevated relative to the reference site, and a Project effect on total uranium concentrations in Doris Lake North is considered unlikely (Figure 3.3-24). All total uranium concentrations in Doris Lake North were well below the CCME long-term guideline of 0.015 mg/L and the low action level threshold of 0.01125 mg/L; therefore the low action level for total uranium was not exceeded.



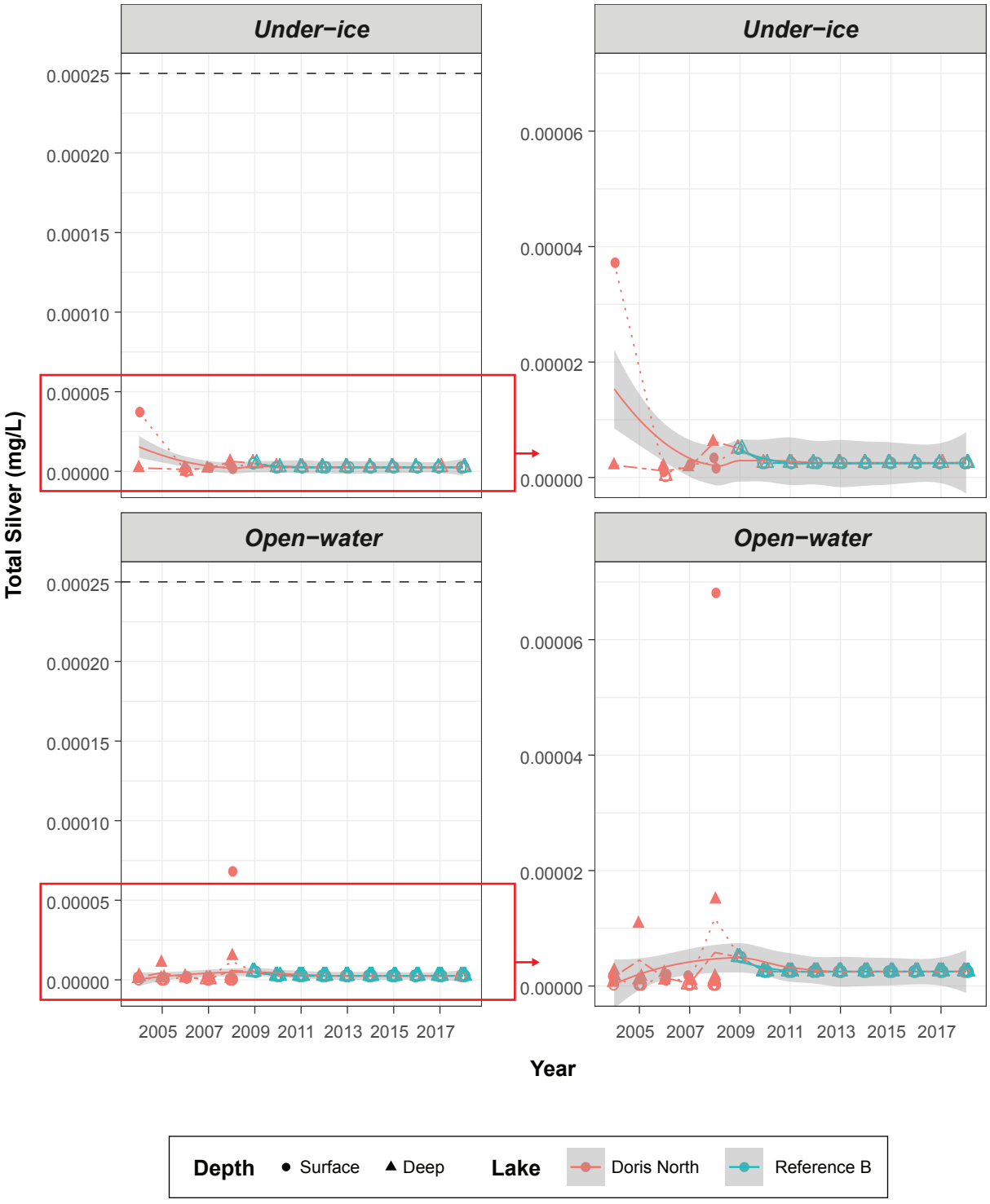
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 minimum hardness-dependent CCME guideline for nickel of 0.025 mg/L (for hardness as CaCO3 of ≤ 60 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-20: Nickel Concentrations in Lakes, Doris Project, 2004 to 2018



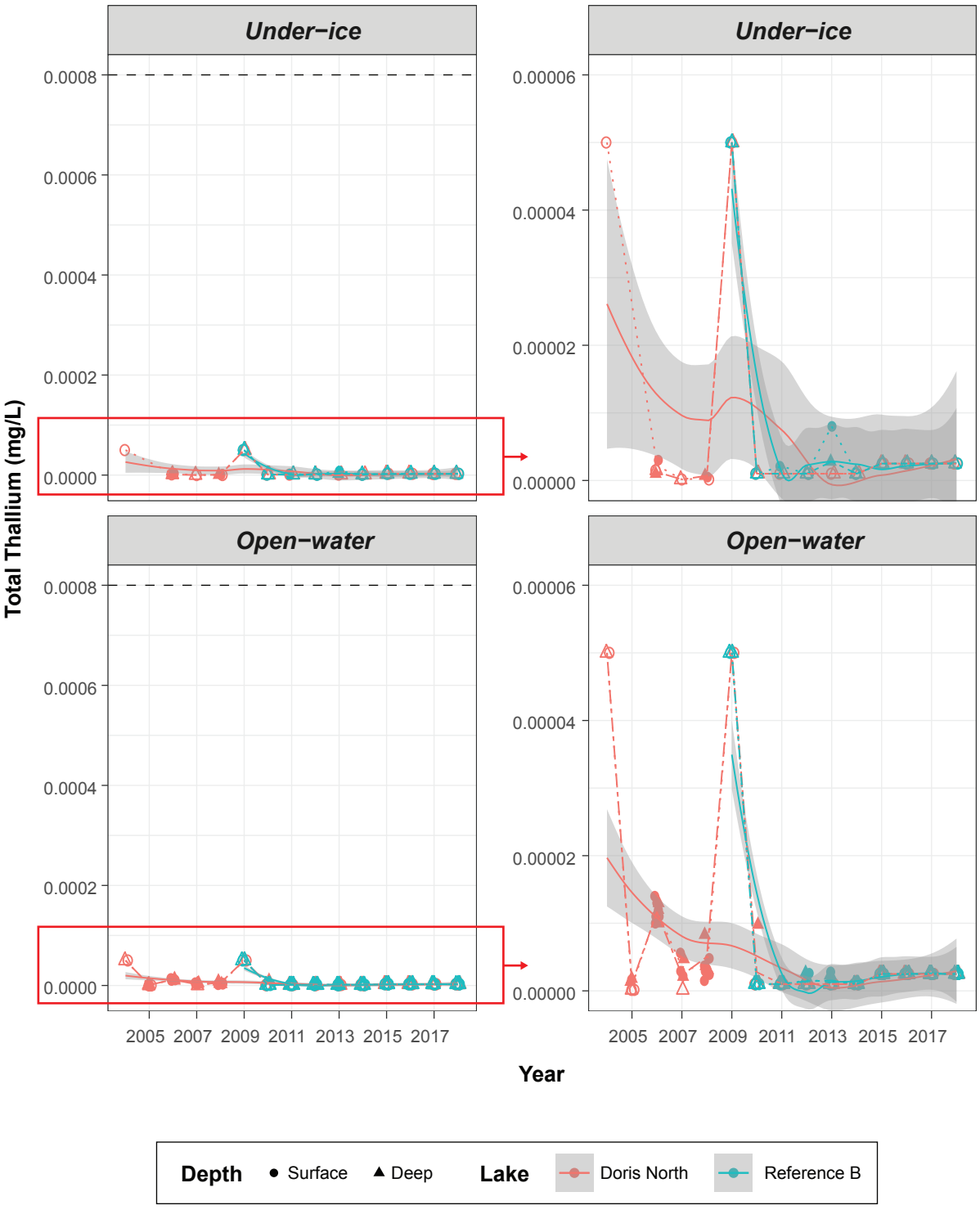
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 guideline for selenium (0.001 mg/L).

Figure 3.3-21: Selenium Concentrations in Lakes, Doris Project, 2004 to 2018



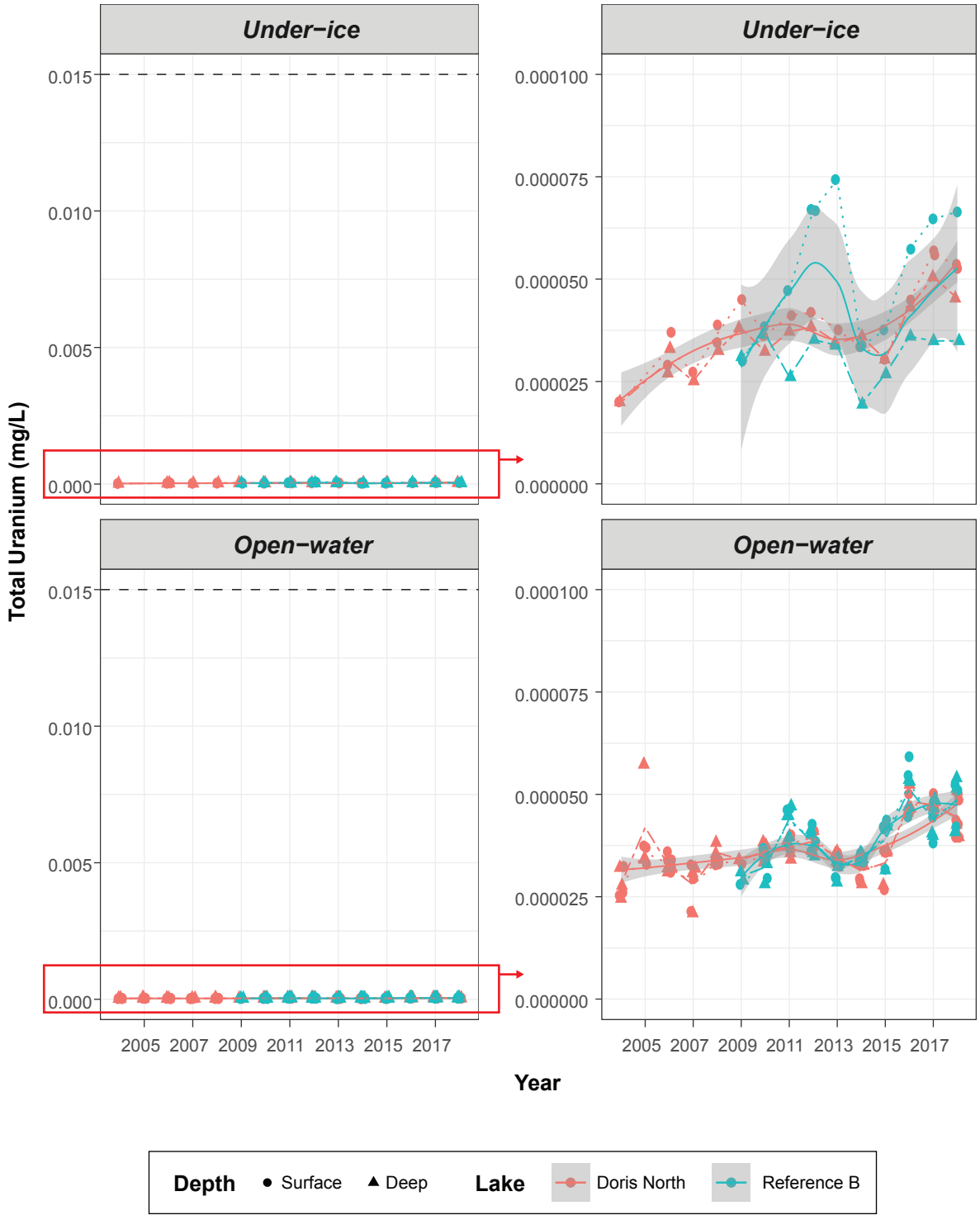
Note: Symbols represent observed data values.
Observations below the analytical detection limit are represented by open symbols and plotted at half the detection limit.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted lines drawn through the scatter plots represent 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 long-term guideline for silver (0.00025 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-22: Silver Concentrations in Lakes, Doris Project, 2004 to 2018



Note: 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 or dotted 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 guideline for thallium (0.0008 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-23: Thallium Concentrations in Lakes, Doris Project, 2004 to 2018



Note: Symbols represent observed data values.
Observations are slightly jittered along the x-axis for legibility.
Dashed or dotted 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 long-term guideline for uranium (0.015 mg/L).
Graphs on the left show the same data as graphs on the right but at different y-axis scales to show the data relative to CCME guidelines.

Figure 3.3-24: Uranium Concentrations in Lakes, Doris Project, 2004 to 2018

Note that a significance level of 0.05 was used for all statistical analyses, so a p-value of 0.0498 can be considered marginally significant. Given the large number of statistical tests conducted, there is a high likelihood that, in some cases, the statistical test will conclude that a difference exists when there is no actual difference (i.e., a false positive), which is a more environmentally protective approach than lowering the significance level to account for the large number of statistical comparisons being made (see discussion of type I error in Section 2.2.2). The differential trends in under-ice total uranium between Doris Lake North and Reference Lake B may have resulted from a false positive in the statistical output (i.e., a type I error).

3.3.25 Total Zinc

All 2018 total zinc concentrations in Doris Lake North were below the analytical detection limit of 0.003 mg/L, the CCME guideline of 0.03 mg/L, and the low action level threshold of 0.0225 mg/L. Statistical analysis was not conducted, but there was no apparent increase in total zinc concentrations over time (Figure 3.3-25). Overall, there was no evidence of a change in total zinc concentrations in Doris Lake North due to the Project.

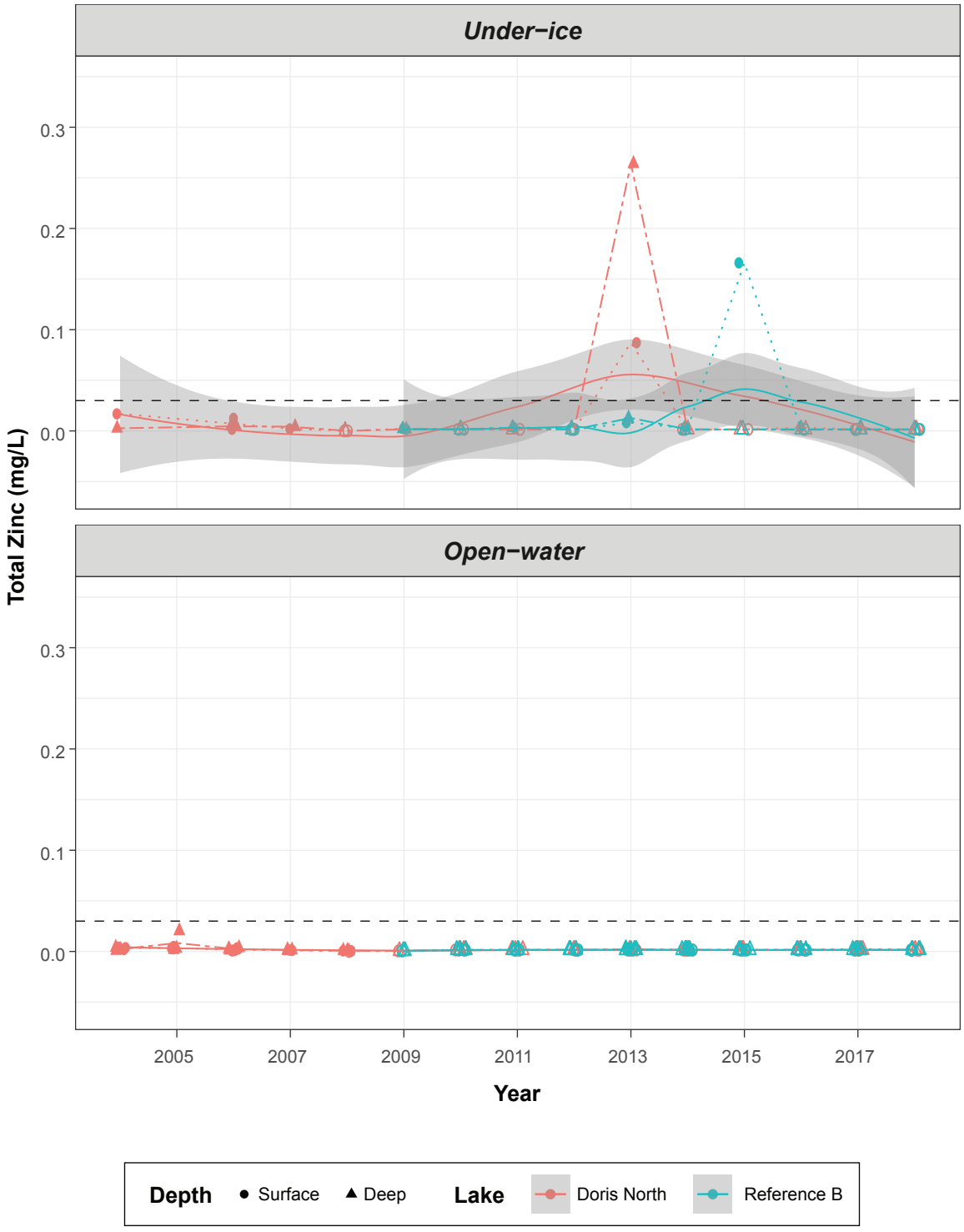
3.4 Phytoplankton

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 2018 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 sites to determine whether a low action level was exceeded according to the Response Framework.

Raw biomass data collected in 2018 are presented in Appendix A, and all statistical analysis results are presented in Appendix B.

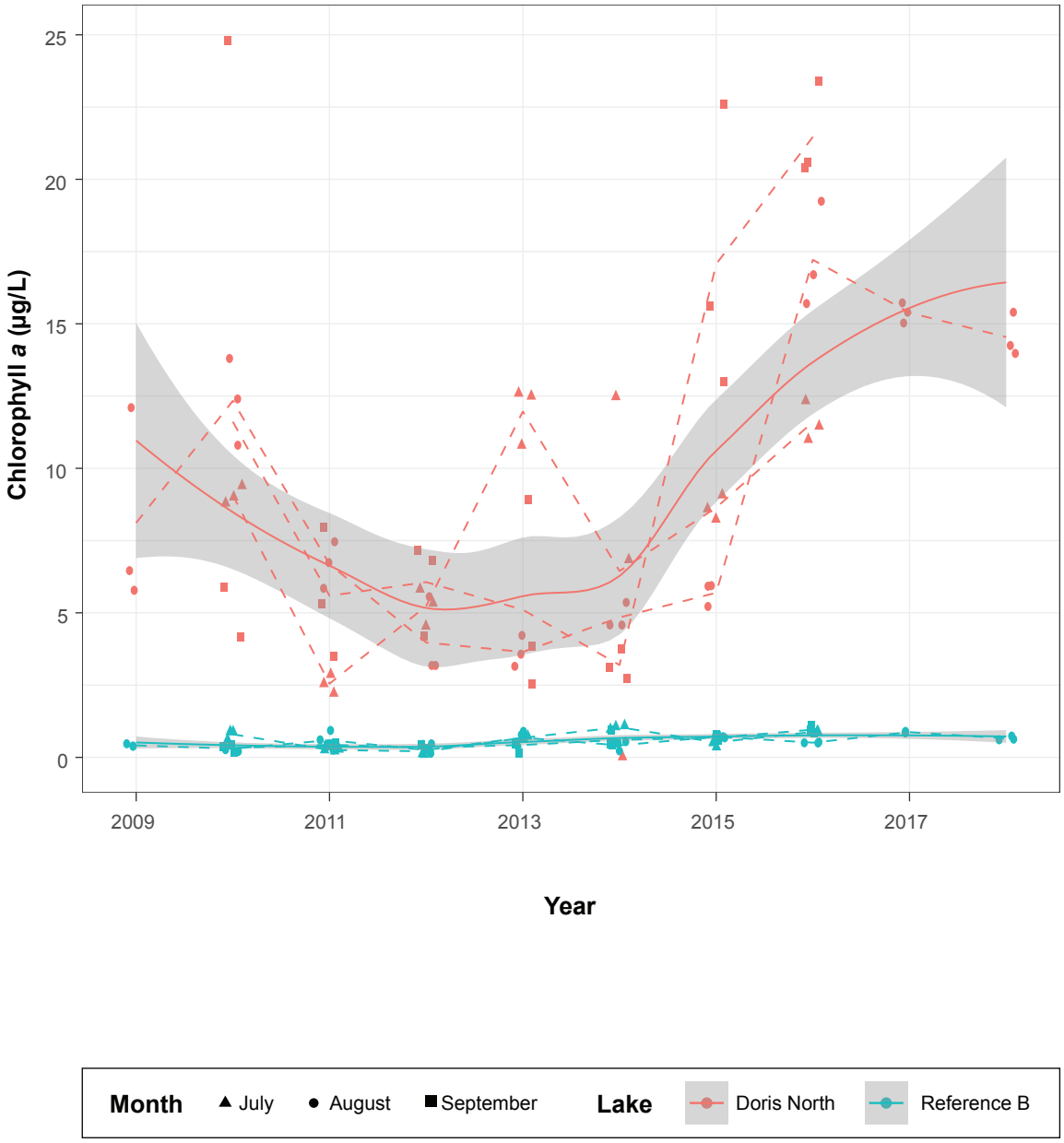
3.4.1 Phytoplankton Biomass as Chlorophyll a

Chlorophyll *a* concentrations were higher in Doris Lake North than in Reference Lake B between 2009 and 2018, and were inter- and intra-annually variable at Doris Lake North (Figure 3.4-1). Between 2009 and 2018, 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 accordance with the Plan, 2018 chlorophyll *a* samples were collected only during August, and the mean concentration was 14.5 µg chl *a*/L (Figure 3.4-1; Appendix A). Mean monthly chlorophyll *a* concentrations in Doris Lake North were relatively similar from 2011 to 2014, and increased from 2014 to 2016; however, concentrations have decreased over the last two years (Figure 3.4-1). The trend in mean chlorophyll *a* concentrations in Doris Lake North 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 ($p = 0.0898$), indicating that parallel changes occurred in the exposure and reference sites and these 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 exceeded.



Note: 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 or dotted 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 guideline for zinc (0.03 mg/L).

Figure 3.3-25: Zinc Concentrations in Lakes, Doris Project, 2004 to 2018



Note: 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 monthly means.
LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively.

Figure 3.4-1: Phytoplankton Biomass (as Chlorophyll *a*) in Lakes, Doris Project, 2009 to 2018

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 3.4-1), the range of chlorophyll *a* concentrations in Doris Lake North 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 2018; 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 2018; Figure 3.3-9; Table 3.4-1). 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 observed chlorophyll *a* trends in Doris Lake North are not Project related.

Table 3.4-1: 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)

4. SUMMARY OF EFFECTS ANALYSIS

In 2018, physical profiles, water quality samples, and phytoplankton biomass 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; and
- phytoplankton biomass.

Physical, chemical, and biological data from 2018 (the second year of operations with ongoing construction activities) were evaluated against historical data collected during baseline years (pre-2010), the construction phase (2010 to 2016), and the early operations phase (2017). The evaluation of effects was 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 quality guidelines for the protection of aquatic life (CCME 2018), 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, 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 an increase in the concentration of one variable in Doris Lake North: total molybdenum (Table 4-1). Total molybdenum increased slightly over time in Doris Lake North relative to baseline and reference lake concentrations. A naturally occurring increase in total molybdenum concentrations could not be ruled out because of the absence of information about the molybdenum trend in Reference Lake B (since most total molybdenum concentrations in the reference lake were below detection limits). Although the slight increase in total molybdenum was statistically significant, it was not ecologically or biologically significant as concentrations of total molybdenum remained far below the CCME guideline and low-action level threshold. Therefore, total molybdenum concentrations remain protective of aquatic life in Doris Lake, and the low action level was not exceeded.

Table 4-1: Summary of Evaluation of Effects for Doris Lake North, Doris Project, 2018

Variable	Method of Evaluation [a]	Statistical Analysis: Linear Mixed Model or Tobit Regression				Graphical Analysis/Interpretation		Conclusion of Effect [d]		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	No	☐	No	No	No effect	No effect	No	No
Total Suspended Solids	GA, SA, CB	Yes	◆	No	☐	No	No	No effect	No effect	No	No
Turbidity	GA, SA, CB	Yes	No	Yes	No	No	No	No effect	No effect	No	No
Chloride	GA, SA, CB	Yes	Yes	Yes	Yes	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	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	No	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 effect	Possible 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	Yes	Yes	No	No	No	No effect	No effect	No	No
Total Zinc	GA, CB	◆	◆	◆	◆	No	No	No effect	No effect	No	No
Phytoplankton											
Biomass	GA, SA, CB	-	-	Yes	No	-	No	-	No effect	-	No

Notes:

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

[b] Statistically significant difference at p<0.05

[c] For water temperature and pH and phytoplankton biomass, a change in any direction is considered to be an adverse effect. For winter dissolved oxygen concentrations, only a decrease is considered to be an adverse effect. For all remaining variables, only an increase is considered to be an adverse effect.

[d] Conclusion of effect is based on graphical analysis, statistical analysis, comparison to benchmark, and professional judgment.

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 assessment method or for a particular season.

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APPENDIX A 2018 DATA REPORT

March 2019

DORIS PROJECT

2018 Aquatic Effects Monitoring Program Report

Appendix A: 2018 Data Report

ERM Consultants Canada Ltd.
1111 West Hastings Street
15th Floor
Vancouver, BC

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Appendix A: 2018 Data Report

This report presents the sampling methodology, the raw data, and summary graphs and tables of the results of the 2018 Aquatic Effects Monitoring Program (AEMP) for the Doris Gold Mine Project. The 2018 AEMP included the following: measurements of water level in Doris Lake; and ice thickness, Secchi depth, physical profiles of temperature and dissolved oxygen, water quality, and phytoplankton biomass in Doris Lake and Reference Lake B. Sediment quality and the benthic invertebrate (benthos) community were last sampled in 2017, and were not sampled in 2018 according to the monitoring schedule outlined in the *Hope Bay Project: Doris Aquatic Effects Monitoring Plan* (TMAC 2016). 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 2018 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.

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.

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. Two Solinst Leveloggers are deployed at depths of approximately 7 m to avoid potential ice-damage and allow continuous data collection throughout the year. The pressure transducers are unvented and are paired with a Barologger located at Doris Camp to compensate for changes in atmospheric pressure. Data are recorded in 15-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 16, 2018 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).

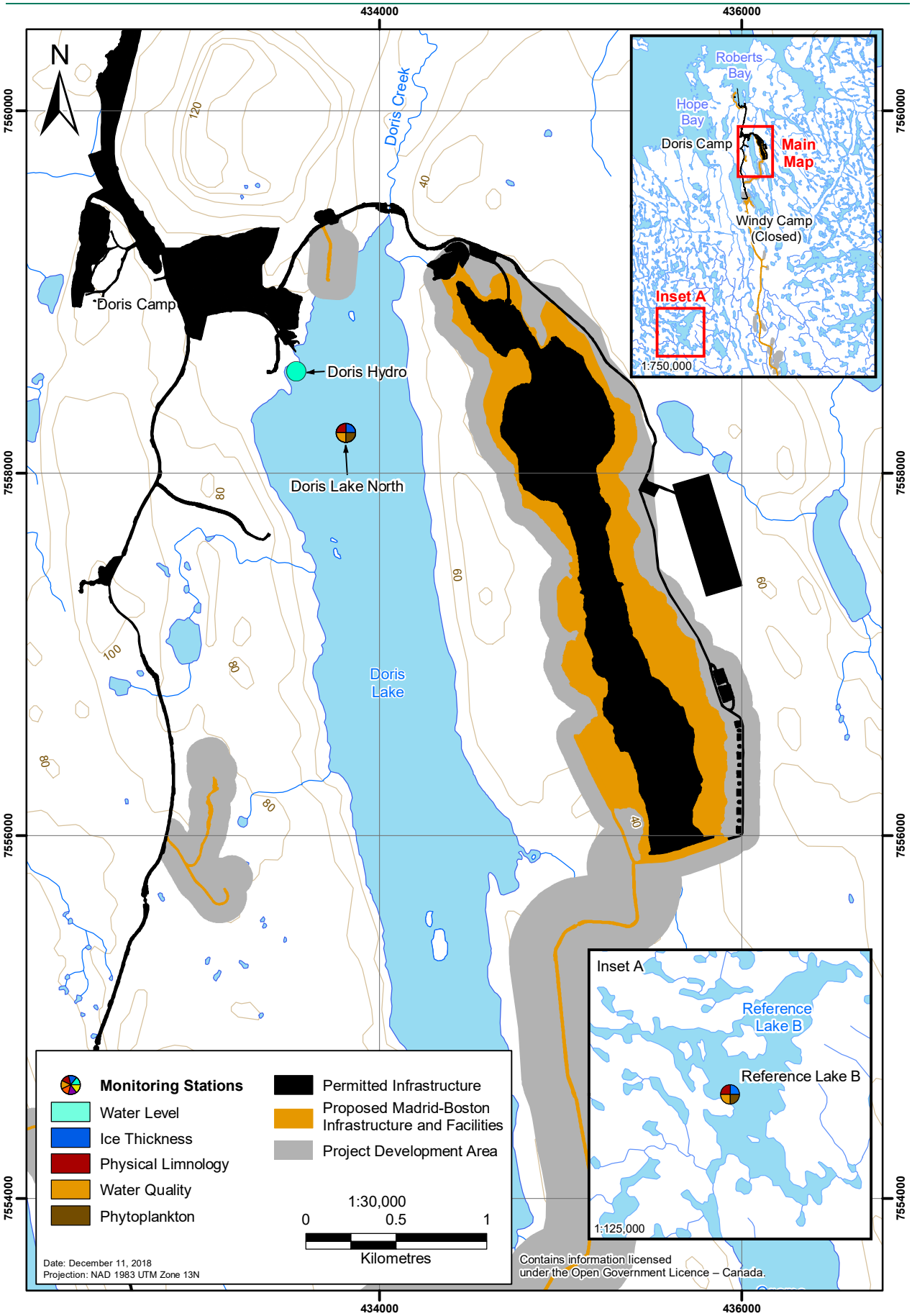


Figure A.1-1: AEMP Sampling Locations, Doris Project, 2018

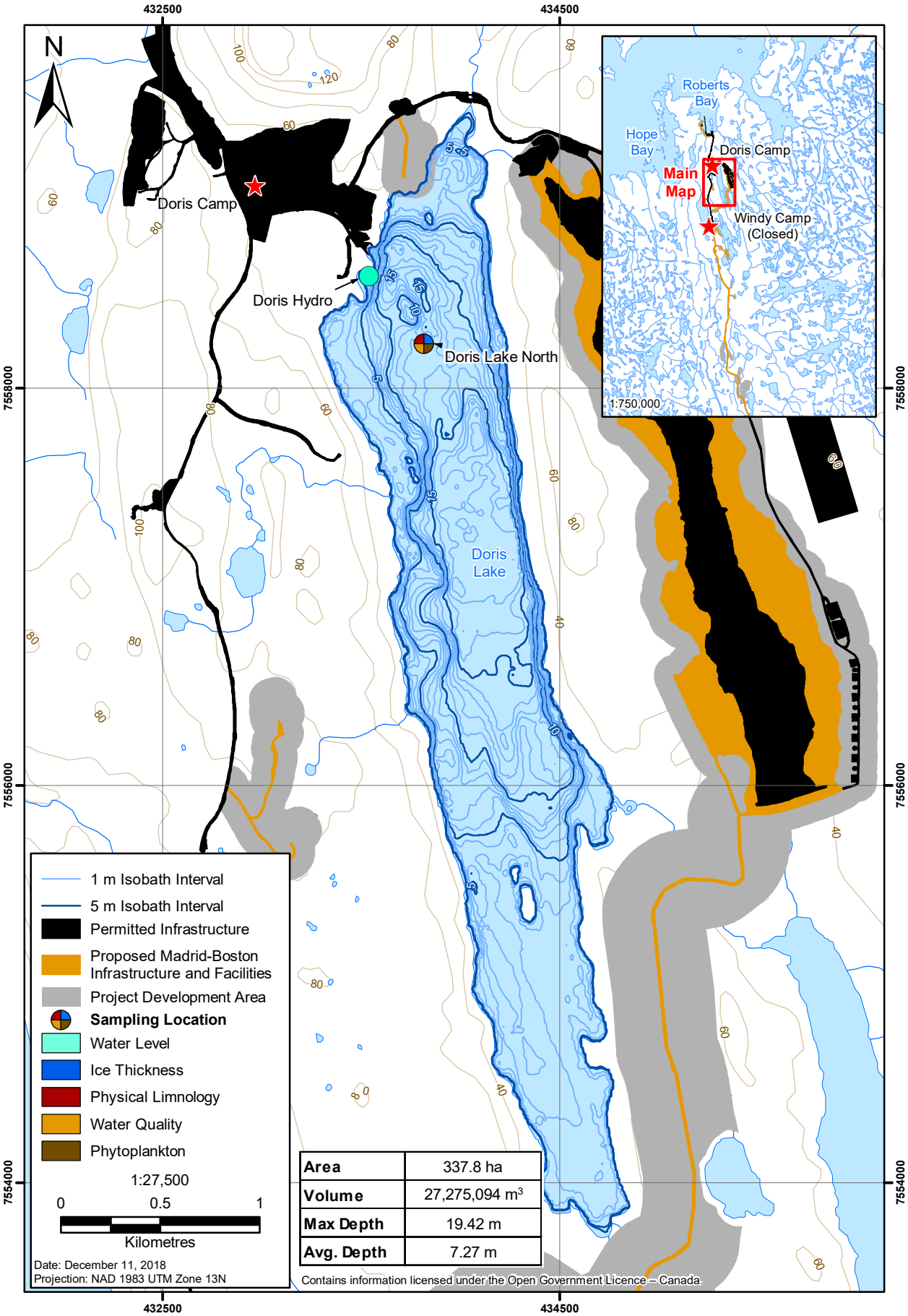


Figure A.1-2: Doris Lake Sampling Location, Doris Project, 2018

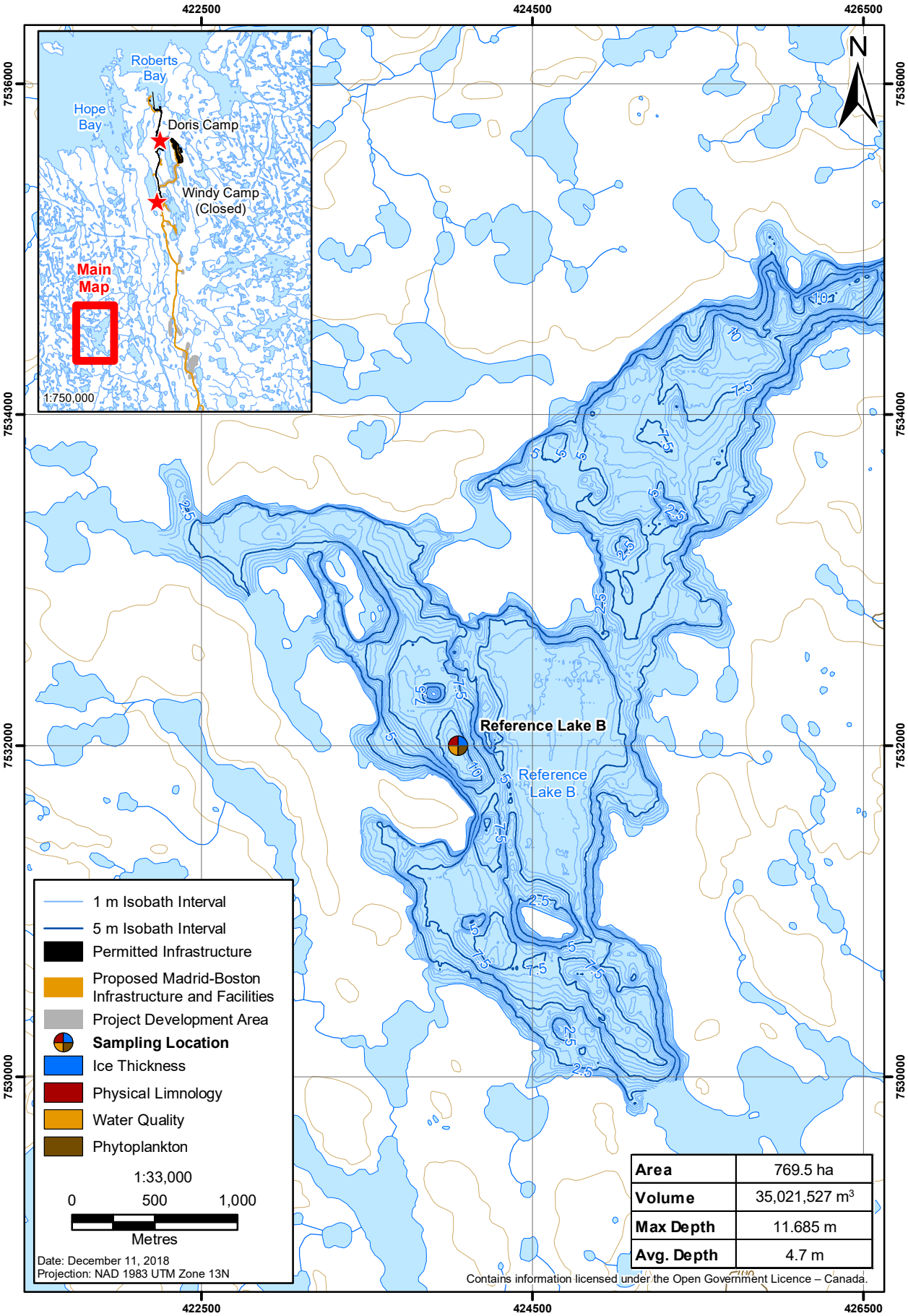


Figure A.1-3: Reference Lake B Sampling Location, Doris Project, 2018

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

Monitoring Variable	Sampling Frequency	Sample Replication and Depths	Sampling Dates / Timing	Sampling Device
Water Level				
	continuous	n = 1 @ Doris Hydro Station	Every 15 minutes (since June 1, 2016)	Solinst Levelogger /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 (not sampled in 2018)				
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 (not sampled in 2018)				
Density and taxonomy	1× every 3 years	n = 5/site (3 composite subsamples/replicate)	August	Ekman grab, 500-µm sieve

A.1.3.1 Quality Assurance and Quality Control

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

In addition, field crews were trained so that ice thickness measurement methods are consistent and reliable, which ensures the comparability of data across years.

A.1.4 Physical Limnology

Under-Ice Season

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 and dissolved oxygen (DO) measurements were collected using a YSI ProODO sonde equipped with an optical DO sensor. Profiles extended from the surface to approximately 1 m above the sediment surface to reduce suspension of bottom sediments, with data recorded manually at 0.5- or 1‑m intervals.

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, depth) sonde with internally logged data post-processed by binning data into 0.5-m depth classes, and a YSI ProODO sonde equipped with an optical DO sensor (temperature, dissolved oxygen) with data recorded manually at 0.5- or 1-m intervals as the probe was lowered into the water.

The euphotic zone depth was estimated from the 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 recorded, and the disk was slowly raised until it once again became visible and this depth was also 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):

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

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

A.1.5 Water Quality

Water quality samples were collected at both lake sites during the under-ice season in April, and the open-water season in July, August, and September 2018. 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.

Table A.1-2: Physical Limnology and Water Quality Sampling Dates and Depths, Doris Project, 2018

Site	Sampling Date	Water Quality Sampling Depth(s) (m)	Physical Limnology Sampling Depths
Doris Lake North	16-Apr-18	2.8, 12	Throughout water column
	14-Jul-18	1.0, 12.0	Throughout water column
	19-Aug-18	1.0, 11.0	Throughout water column
	15-Sep-18	1.0, 11.7	Throughout water column
Reference Lake B	16-Apr-18	2.5, 8.5	Throughout water column
	14-Jul-18	1.0, 8.0	Throughout water column
	26-Aug-18	1.0, 8.0	Throughout water column
	15-Sep-18	1.0, 8.7	Throughout water column

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

During open-water season sampling, water samples were collected using an acid-washed, Teflon-lined 5 L GO-FLO sampling bottle. 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 parameters, 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.

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.

The relative percent difference (RPD) between field duplicate water quality samples was calculated as described in Clark (2003) according to the formula:

$$RPD = 2*|A-B|/(A+B)*100\%$$

where A and B represent the concentrations of the water quality parameter in each duplicate sample.

As recommended by Clark (2003), RPDs were calculated for specific water quality parameters if at least one duplicate concentration was greater than five times the analytical detection limit, with RPD values >20% indicating a potential issue (caution interpreting results), and >50% indicating a problem (most likely sample contamination or lack of sample representativeness) that requires follow-up (e.g., determination of cause, affect on sample data).

Table A.1-3: Water Quality Variables and Realized Detection Limits, Doris Project, 2018

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

The laboratory QA/QC program included reviews of maximum holding times, and the use of method blanks, laboratory replicates, certified reference materials, internal reference materials, laboratory control samples, matrix spikes, and calibration verification standards. ALS has set data quality objectives (DQOs) for QA/QC samples with acceptable limits for sample recovery, precision, and accuracy. When DQOs are not met, ALS flags the sample for follow-up or adjusts the detection limit as required.

A.1.6 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 19 to 26, 2018).

Phytoplankton biomass samples were collected in triplicate in opaque, clean, 1-L sample bottles that were thoroughly rinsed with surface water at each site. For each phytoplankton sample, the water sampler (5 L GO-FLO) was lowered to the appropriately 1 m below the water surface 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.1.6.1 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.2 2018 Water Level and Ice Thickness

The following section presents the water level and ice thickness data for 2018. 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 2017 to June 2018 are presented in Annex A.2-1.

Table A.2-1: Ice Thickness Measurements and Winter Drawdown in Doris Lake, Doris Project, 2018

Lake	Measured Ice Thickness (m)	Fall Lake Surface Level (m)	Winter Minimum Lake Surface Level (m)	Maximum Ice Extent (m)
Doris	1.80 (April 16, 2018)	21.766	21.671	-1.90
Reference B	1.38 (April 16, 2018)	-	-	-

Annex A.2-1: Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2018

September 2017	
Date	**Surface Elevation (m)**
1-Sep-2017	21.716
2-Sep-2017	21.711
3-Sep-2017	21.708
4-Sep-2017	21.706
5-Sep-2017	21.706
6-Sep-2017	21.708
7-Sep-2017	21.711
8-Sep-2017	21.728
9-Sep-2017	21.744
10-Sep-2017	21.753
11-Sep-2017	21.756
12-Sep-2017	21.758
13-Sep-2017	21.760
14-Sep-2017	21.760
15-Sep-2017	21.763
16-Sep-2017	21.764
17-Sep-2017	21.766
18-Sep-2017	21.768
19-Sep-2017	21.773
20-Sep-2017	21.773
21-Sep-2017	21.773
22-Sep-2017	21.772
23-Sep-2017	21.770
24-Sep-2017	21.769
25-Sep-2017	21.769
26-Sep-2017	21.769
27-Sep-2017	21.767
28-Sep-2017	21.772
29-Sep-2017	21.770
30-Sep-2017	21.772

October 2017	
Date	**Surface Elevation (m)**
1-Oct-2017	21.767
2-Oct-2017	21.764
3-Oct-2017	21.758
4-Oct-2017	21.747
5-Oct-2017	21.747
6-Oct-2017	21.748
7-Oct-2017	21.745
8-Oct-2017	21.744
9-Oct-2017	21.743
10-Oct-2017	21.742
11-Oct-2017	21.744
12-Oct-2017	21.742
13-Oct-2017	21.740
14-Oct-2017	21.739
15-Oct-2017	21.738
16-Oct-2017	21.738
17-Oct-2017	21.735
18-Oct-2017	21.733
19-Oct-2017	21.728
20-Oct-2017	21.727
21-Oct-2017	21.725
22-Oct-2017	21.725
23-Oct-2017	21.724
24-Oct-2017	21.723
25-Oct-2017	21.720
26-Oct-2017	21.717
27-Oct-2017	21.716
28-Oct-2017	21.714
29-Oct-2017	21.712
30-Oct-2017	21.710
31-Oct-2017	21.708

Notes:
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.

Annex A.2-1: Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2018

November 2017	
Date	**Surface Elevation (m)**
1-Nov-2017	21.706
2-Nov-2017	21.704
3-Nov-2017	21.702
4-Nov-2017	21.703
5-Nov-2017	21.705
6-Nov-2017	21.703
7-Nov-2017	21.701
8-Nov-2017	21.699
9-Nov-2017	21.692
10-Nov-2017	21.684
11-Nov-2017	21.687
12-Nov-2017	21.687
13-Nov-2017	21.685
14-Nov-2017	21.684
15-Nov-2017	21.683
16-Nov-2017	21.681
17-Nov-2017	21.678
18-Nov-2017	21.677
19-Nov-2017	21.675
20-Nov-2017	21.674
21-Nov-2017	21.676
22-Nov-2017	21.676
23-Nov-2017	21.672
24-Nov-2017	21.671
25-Nov-2017	21.673
26-Nov-2017	21.673
27-Nov-2017	21.674
28-Nov-2017	21.675
29-Nov-2017	21.676
30-Nov-2017	21.676

December 2017	
Date	**Surface Elevation (m)**
1-Dec-2017	21.676
2-Dec-2017	21.676
3-Dec-2017	21.675
4-Dec-2017	21.674
5-Dec-2017	21.674
6-Dec-2017	21.676
7-Dec-2017	21.677
8-Dec-2017	21.679
9-Dec-2017	21.678
10-Dec-2017	21.678
11-Dec-2017	21.678
12-Dec-2017	21.677
13-Dec-2017	21.678
14-Dec-2017	21.677
15-Dec-2017	21.676
16-Dec-2017	21.676
17-Dec-2017	21.676
18-Dec-2017	21.676
19-Dec-2017	21.676
20-Dec-2017	21.676
21-Dec-2017	21.675
22-Dec-2017	21.675
23-Dec-2017	21.674
24-Dec-2017	21.674
25-Dec-2017	21.677
26-Dec-2017	21.677
27-Dec-2017	21.677
28-Dec-2017	21.678
29-Dec-2017	21.676
30-Dec-2017	21.675
31-Dec-2017	21.676

Note:
Highlighted value indicates minimum winter surface water level.

Annex A.2-1: Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2018

January 2018	
Date	Surface Elevation (m)
1-Jan-2018	21.676
2-Jan-2018	21.676
3-Jan-2018	21.680
4-Jan-2018	21.678
5-Jan-2018	21.672
6-Jan-2018	21.673
7-Jan-2018	21.673
8-Jan-2018	21.680
9-Jan-2018	21.683
10-Jan-2018	21.681
11-Jan-2018	21.675
12-Jan-2018	21.674
13-Jan-2018	21.674
14-Jan-2018	21.676
15-Jan-2018	21.674
16-Jan-2018	21.674
17-Jan-2018	21.677
18-Jan-2018	21.682
19-Jan-2018	21.686
20-Jan-2018	21.689
21-Jan-2018	21.688
22-Jan-2018	21.688
23-Jan-2018	21.685
24-Jan-2018	21.681
25-Jan-2018	21.675
26-Jan-2018	21.674
27-Jan-2018	21.672
28-Jan-2018	21.677
29-Jan-2018	21.679
30-Jan-2018	21.680
31-Jan-2018	21.680

February 2018	
Date	Surface Elevation (m)
1-Feb-2018	21.682
2-Feb-2018	21.680
3-Feb-2018	21.679
4-Feb-2018	21.681
5-Feb-2018	21.678
6-Feb-2018	21.685
7-Feb-2018	21.683
8-Feb-2018	21.677
9-Feb-2018	21.679
10-Feb-2018	21.680
11-Feb-2018	21.681
12-Feb-2018	21.680
13-Feb-2018	21.685
14-Feb-2018	21.686
15-Feb-2018	21.683
16-Feb-2018	21.681
17-Feb-2018	21.687
18-Feb-2018	21.686
19-Feb-2018	21.687
20-Feb-2018	21.683
21-Feb-2018	21.684
22-Feb-2018	21.689
23-Feb-2018	21.678
24-Feb-2018	21.678
25-Feb-2018	21.675
26-Feb-2018	21.674
27-Feb-2018	21.677
28-Feb-2018	21.678

Annex A.2-1: Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2018

March 2018	
Date	Surface Elevation (m)
1-Mar-2018	21.681
2-Mar-2018	21.683
3-Mar-2018	21.681
4-Mar-2018	21.683
5-Mar-2018	21.681
6-Mar-2018	21.681
7-Mar-2018	21.682
8-Mar-2018	21.686
9-Mar-2018	21.689
10-Mar-2018	21.685
11-Mar-2018	21.685
12-Mar-2018	21.689
13-Mar-2018	21.689
14-Mar-2018	21.682
15-Mar-2018	21.691
16-Mar-2018	21.688
17-Mar-2018	21.684
18-Mar-2018	21.686
19-Mar-2018	21.685
20-Mar-2018	21.689
21-Mar-2018	21.687
22-Mar-2018	21.686
23-Mar-2018	21.685
24-Mar-2018	21.692
25-Mar-2018	21.693
26-Mar-2018	21.691
27-Mar-2018	21.694
28-Mar-2018	21.692
29-Mar-2018	21.687
30-Mar-2018	21.683
31-Mar-2018	21.684

April 2018	
Date	Surface Elevation (m)
1-Apr-2018	21.688
2-Apr-2018	21.685
3-Apr-2018	21.680
4-Apr-2018	21.681
5-Apr-2018	21.685
6-Apr-2018	21.687
7-Apr-2018	21.687
8-Apr-2018	21.689
9-Apr-2018	21.690
10-Apr-2018	21.689
11-Apr-2018	21.687
12-Apr-2018	21.684
13-Apr-2018	21.680
14-Apr-2018	21.682
15-Apr-2018	21.682
16-Apr-2018	21.687
17-Apr-2018	21.685
18-Apr-2018	21.685
19-Apr-2018	21.689
20-Apr-2018	21.691
21-Apr-2018	21.692
22-Apr-2018	21.692
23-Apr-2018	21.692
24-Apr-2018	21.689
25-Apr-2018	21.688
26-Apr-2018	21.689
27-Apr-2018	21.689
28-Apr-2018	21.687
29-Apr-2018	21.690
30-Apr-2018	21.689

Annex A.2-1: Water Level Monitoring of Doris Lake at Doris Hydro Station, Doris Project, 2018

May 2018	
Date	Surface Elevation (m)
1-May-2018	21.709
2-May-2018	21.709
3-May-2018	21.706
4-May-2018	21.708
5-May-2018	21.708
6-May-2018	21.705
7-May-2018	21.706
8-May-2018	21.710
9-May-2018	21.708
10-May-2018	21.704
11-May-2018	21.703
12-May-2018	21.706
13-May-2018	21.704
14-May-2018	21.706
15-May-2018	21.706
16-May-2018	21.703
17-May-2018	21.705
18-May-2018	21.704
19-May-2018	21.704
20-May-2018	21.710
21-May-2018	21.708
22-May-2018	21.706
23-May-2018	21.707
24-May-2018	21.707
25-May-2018	21.707
26-May-2018	21.711
27-May-2018	21.707
28-May-2018	21.706
29-May-2018	21.710
30-May-2018	21.709
31-May-2018	21.708

June 2018	
Date	Surface Elevation (m)
1-Jun-2018	21.710
2-Jun-2018	21.712
3-Jun-2018	21.711
4-Jun-2018	21.710
5-Jun-2018	21.709
6-Jun-2018	21.711
7-Jun-2018	21.716
8-Jun-2018	21.724
9-Jun-2018	21.741
10-Jun-2018	21.769
11-Jun-2018	21.804
12-Jun-2018	21.863
13-Jun-2018	21.960
14-Jun-2018	22.092
15-Jun-2018	22.212
16-Jun-2018	22.295
17-Jun-2018	22.352
18-Jun-2018	22.381
19-Jun-2018	22.389
20-Jun-2018	22.387
21-Jun-2018	22.380
22-Jun-2018	22.363
23-Jun-2018	22.343
24-Jun-2018	22.336
25-Jun-2018	22.340
26-Jun-2018	22.328
27-Jun-2018	22.314
28-Jun-2018	22.298
29-Jun-2018	22.281
30-Jun-2018	22.261

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

A.3 2018 Physical Limnology

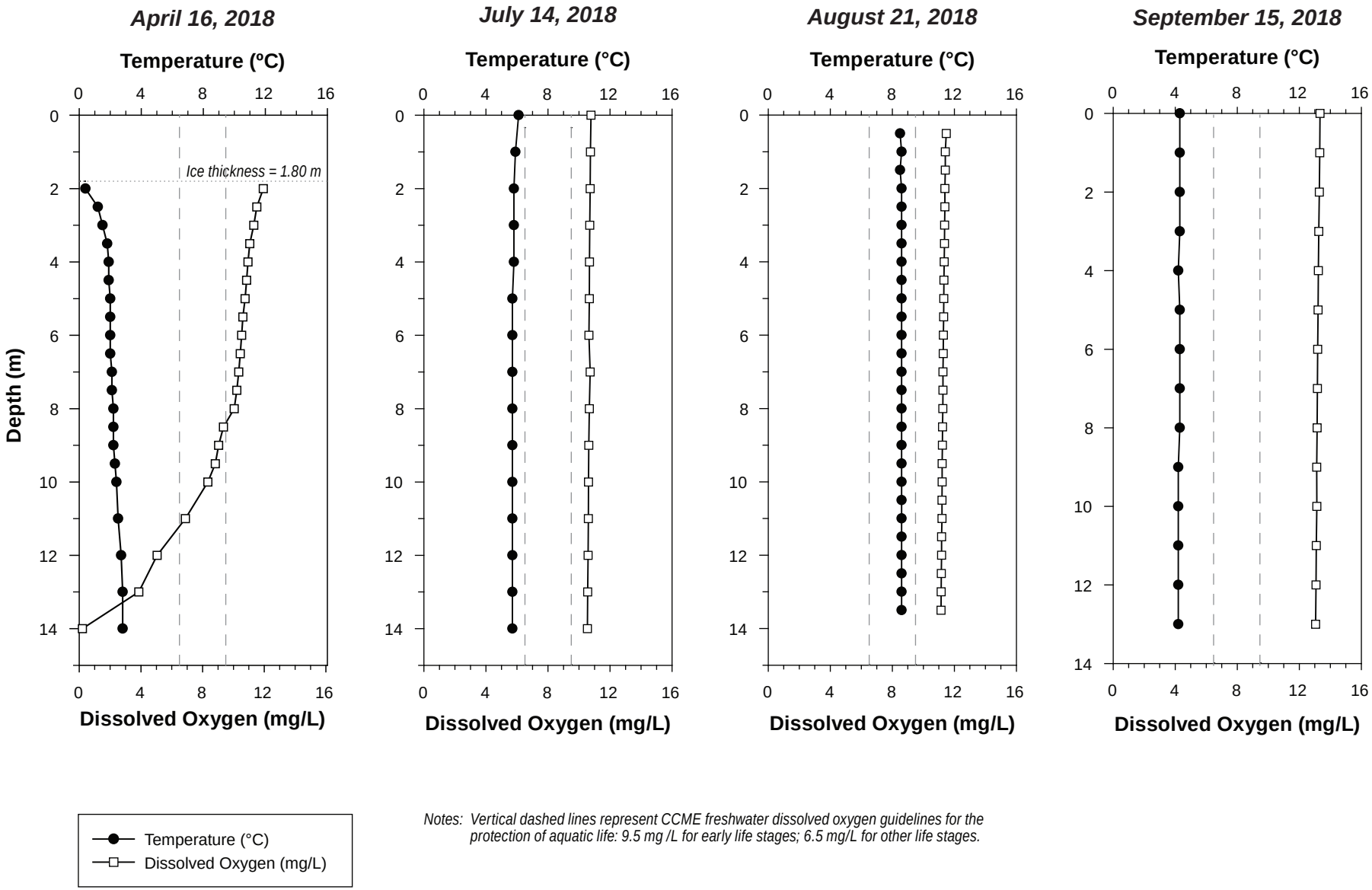
The following section presents the Secchi depth data and the physical profiles collected from April to September 2018 at Doris Lake and Reference Lake B.

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 2018; Annex A.3-1 provides the profile data in tabular form.

Table A.3-1: Lake Secchi Depths and Euphotic Zone Depths, Doris Project, 2018

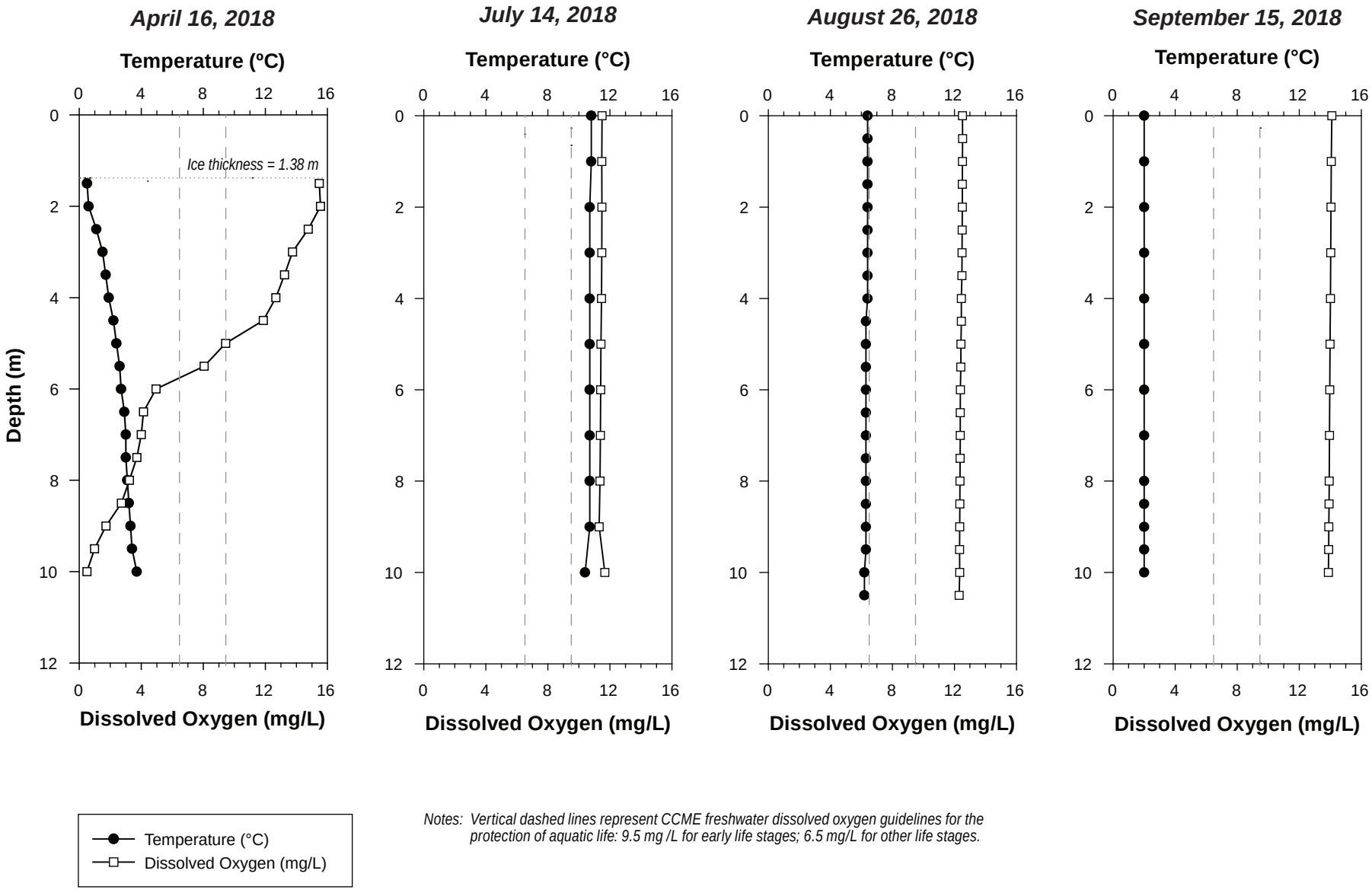
Lake Site	Sampling Date	Secchi Depth (Ds) (m)	Euphotic Zone Depth 1% Light Level (m)	Bottom Depth (m)
Doris Lake North	July 14, 2018	1.50	4.06	14.1
	August 21, 2018	1.38	3.73	13.7
	September 15, 2018	0.93	2.52	13.7
Reference Lake B	July 17, 2017	4.33	11.7*	10.5
	August 26, 2018	9.85	26.7*	10.7
	September 15, 2018	4.92	13.3*	10.7

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



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.

Figure A.3-1: Temperature and Dissolved Oxygen Profiles in Doris Lake North, Doris Project, 2018



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.

Figure A.3-2: Temperature and Dissolved Oxygen Profiles in Reference Lake B, Doris Project, 2018

Annex A.3-1: Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2018

Doris Lake North
April 16, 2018
Ice Thickness = 1.80 m
Sonde used: YSI ProODO

Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2.0	0.4	11.94	82.7
2.5	1.2	11.52	81.7
3.0	1.5	11.32	80.7
3.5	1.8	11.06	72.5
4.0	1.9	10.94	78.8
4.5	1.9	10.85	78.2
5.0	2.0	10.76	77.8
5.5	2.0	10.61	76.7
6.0	2.0	10.53	76.1
6.5	2.0	10.44	75.5
7.0	2.1	10.34	74.9
7.5	2.1	10.22	74.1
8.0	2.2	10.05	73.1
8.5	2.2	9.35	68.0
9.0	2.2	9.04	65.7
9.5	2.3	8.82	64.3
10.0	2.4	8.34	60.8
11.0	2.5	6.88	50.5
12.0	2.7	5.05	37.2
13.0	2.8	3.86	23.5
14.0	2.8	0.20	1.5

Doris Lake North
July 14, 2018
Secchi Depth = 1.50 m
Sonde used: YSI ProODO

Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.0	6.1	10.77	86.4
1.0	5.9	10.73	85.9
2.0	5.8	10.72	85.6
3.0	5.8	10.69	85.4
4.0	5.8	10.67	85.2
5.0	5.7	10.66	85.0
6.0	5.7	10.64	84.8
7.0	5.7	10.72	85.4
8.0	5.7	10.66	85.0
9.0	5.7	10.63	84.7
10.0	5.7	10.61	84.6
11.0	5.7	10.60	84.5
12.0	5.7	10.58	84.3
13.0	5.7	10.56	84.2
14.0	5.7	10.54	84.0

Annex A.3-1: Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2018

Doris Lake North
August 21, 2018
Secchi Depth = 1.38 m

Sonde used: YSI ProODO				RBR CTD
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
0.5	8.5	11.48	98.1	258
1.0	8.6	11.42	97.9	258
1.5	8.5	11.42	97.8	259
2.0	8.6	11.39	97.6	259
2.5	8.6	11.39	97.6	259
3.0	8.6	11.37	97.5	259
3.5	8.6	11.36	97.3	258
4.0	8.6	11.35	97.2	259
4.5	8.6	11.33	97.1	259
5.0	8.6	11.32	96.9	259
5.5	8.6	11.31	96.9	259
6.0	8.6	11.29	96.8	258
6.5	8.6	11.28	96.7	259
7.0	8.6	11.27	96.6	259
7.5	8.6	11.27	96.5	259
8.0	8.6	11.25	96.4	259
8.5	8.6	11.24	96.3	259
9.0	8.6	11.23	96.3	259
9.5	8.6	11.21	96.1	259
10.0	8.6	11.21	96.1	259
10.5	8.6	11.20	95.9	258
11.0	8.6	11.20	95.9	259
11.5	8.6	11.18	95.8	259
12.0	8.6	11.18	95.8	259
12.5	8.6	11.16	95.7	258
13.0	8.6	11.15	95.5	259
13.5	8.6	11.14	95.5	305

Doris Lake North
September 15, 2018
Secchi Depth = 0.93 m

Sonde used: YSI ProODO			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0	4.3	13.34	102.5
1	4.3	13.32	102.4
2	4.3	13.29	102.2
3	4.3	13.26	102.0
4	4.2	13.23	101.8
5	4.3	13.21	101.6
6	4.3	13.19	101.4
7	4.3	13.17	101.3
8	4.3	13.15	101.1
9	4.2	13.12	100.9
10	4.2	13.13	100.7
11	4.2	13.10	100.5
12	4.2	13.08	100.3
13	4.2	13.05	100.1

Annex A.3-1: Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2018

Reference Lake B
April 16, 2018
Ice Thickness = 1.38 m
Sonde used: YSI ProODO

Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.5	0.5	15.47	109.1
2.0	0.6	15.55	108.2
2.5	1.1	14.76	104.1
3.0	1.5	13.75	98.1
3.5	1.7	13.23	94.9
4.0	1.9	12.67	91.3
4.5	2.2	11.86	86.2
5.0	2.4	9.44	69.0
5.5	2.6	8.05	59.2
6.0	2.7	4.95	38.4
6.5	2.9	4.14	30.7
7.0	3.0	4.00	29.7
7.5	3.0	3.71	27.5
8.0	3.1	3.23	24.0
8.5	3.2	2.72	20.3
9.0	3.3	1.72	12.9
9.5	3.4	0.98	7.4
10.0	3.7	0.49	3.7

Reference Lake B
July 14, 2018
Secchi Depth = 4.3 m
Sonde used: YSI ProODO

Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0	10.8	11.49	103.7
1	10.8	11.47	103.5
2	10.7	11.48	103.4
3	10.7	11.47	103.3
4	10.7	11.45	103.1
5	10.7	11.42	102.8
6	10.7	11.40	102.7
7	10.7	11.38	102.5
8	10.7	11.36	102.3
9	10.7	11.30	101.8
10	10.4	11.67	104.5

Annex A.3-1: Temperature, Dissolved Oxygen, and Conductivity Profiles, Doris Project, 2018

Reference Lake B
August 26, 2018
Secchi Depth = 9.9 m

Sonde used: YSI ProODO				RBR CTD
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)	Conductivity (µS/cm)
0.0	6.4	12.52	101.6	68.4
0.5	6.4	12.53	101.6	67.9
1.0	6.4	12.52	101.6	68.6
1.5	6.4	12.51	101.5	68.5
2.0	6.4	12.51	101.5	68.8
2.5	6.4	12.50	101.4	68.4
3.0	6.4	12.49	101.3	69.0
3.5	6.4	12.48	101.3	68.6
4.0	6.4	12.45	101.0	69.2
4.5	6.3	12.45	100.8	68.5
5.0	6.3	12.42	100.5	69.5
5.5	6.3	12.41	100.4	69.1
6.0	6.3	12.39	100.3	68.5
6.5	6.3	12.38	100.2	69.4
7.0	6.3	12.38	100.2	69.0
7.5	6.3	12.37	100.1	69.0
8.0	6.3	12.36	100.1	68.7
8.5	6.3	12.35	100.0	68.9
9.0	6.3	12.34	99.9	69.4
9.5	6.3	12.33	99.8	68.8
10.0	6.2	12.34	99.7	69.2
10.5	6.2	12.31	99.4	91.4

Reference Lake B
September 15, 2018
Secchi Depth = 4.9 m

Sonde used: YSI ProODO			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.0	2.0	14.10	102.0
1.0	2.0	14.07	101.7
2.0	2.0	14.05	101.6
3.0	2.0	14.03	101.4
4.0	2.0	14.01	101.3
5.0	2.0	13.99	101.1
6.0	2.0	13.97	101.0
7.0	2.0	13.95	100.8
8.0	2.0	13.93	100.7
8.5	2.0	13.92	100.6
9.0	2.0	13.91	100.6
9.5	2.0	13.90	100.5
10.0	2.0	13.88	100.4

A.4 2018 Water Quality

The following sections present the water quality data collected from April to September 2018 from the AEMP sites, as well as the QA/QC water quality results. 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 2018). The CCME guideline for zinc was updated on September 18, 2018, and is now a guideline for dissolved zinc that is calculated from the site-specific pH, hardness, and dissolved organic carbon (DOC) concentration. Because the new zinc guideline was issued after the completion of water quality sampling for the 2018 AEMP, and dissolved zinc and DOC concentrations were not routinely measured as part of the 2018 water quality program, the former guideline for total zinc of 0.03 mg/L was used to screen the 2018 water quality samples. 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 approximately 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 2018. Figures A.4-1 to A.4-7 show seasonal trends for each evaluated water quality variable. Annex A.4-1 presents the full 2018 lake water quality dataset.

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

A.4.1.1 Field QA/QC

Relative Percent Difference Calculations

Within-site variability was accounted for by collecting field duplicates, which made up 20% of total samples. Relative percent difference (RPD) calculations for duplicate water quality samples are presented in Annex A.4-2.

Only two sets of duplicate parameter concentrations had an RPD of >20% but <50%: total ammonia in Doris Lake North in July (RPD of 25.1%) and total thorium in Doris Lake North in August (RPD of 24.9%). Three sets of duplicate parameter concentrations had an RPD of >50%: total manganese in Doris Lake North in April (RPD of 54.9%), dissolved orthophosphate in Doris Lake North in July (RPD of 118%), and total nickel in Doris Lake North in August (RPD of 69.0%). Of these parameters exceeding RPD thresholds, only total ammonia and total nickel are evaluated parameters. Aside from these infrequent exceedances of the 20% and 50% thresholds, the RPD calculations showed that there was generally good agreement between parameter concentrations in duplicate samples.

Blank QA/QC Data

Annex A.4-3 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.

All parameter concentrations in travel and field blanks were below analytical detection limits, indicating that there was no apparent contamination of water quality samples that can be attributed to sample handling, storage, and/or transportation.

A small subset of parameter concentrations in April, July, and September equipment blank samples were above detection limits. With the exception of a single conductivity measurement in the September equipment blank (2.5 µS/cm), which was barely over the detection limit of <2.0 µS/cm, concentrations of all physical parameters, nutrients, and anions were below detection limits (Annex A.4-3). This indicates that for these parameters, the Niskin or GO-FLO water samplers likely did not represent an important source of contamination.

Some metal concentrations were above detection limits in at least one equipment blank: aluminum, barium, manganese, strontium, and tin. In most cases, concentrations were only slightly higher than detection limits; however, for aluminum (in the August equipment blank) and barium (in the September equipment blank), concentrations were 7 times and 355 times the detection limit, respectively. Of these two metals, barium is not an evaluated parameter, so the potential barium contamination introduced by the sampling equipment does not affect the results and conclusions of the AEMP. Aluminum is an evaluated parameter, and the August blank concentration of 0.0221 mg/L is within the range of typical concentrations measured in Doris Lake North and Reference Lake B (Annex A.4-1). The mean August concentration of 0.108 mg/L total aluminum in Doris Lake North is more than 4 times higher than the equipment blank concentration; however, it is possible that equipment contamination could have contributed slightly to the aluminum concentrations measured in Doris Lake North in August (Figure A.4‑4). Nevertheless, this did not affect the results and conclusions of the AEMP, as the evaluation of effects for total aluminum showed that there was no evidence of elevated aluminum concentrations in Doris Lake North compared to historical concentrations (see main body of AEMP report). Any residual aluminum in the GO-FLO sampler was likely flushed out by the time Reference Lake B was sampled seven days after the equipment blank and Doris Lake North samples were collected, as the mean August Reference Lake B total aluminum concentration of 0.0073 mg/L was lower than the equipment blank concentration.

A.4.1.2 Laboratory QA/QC

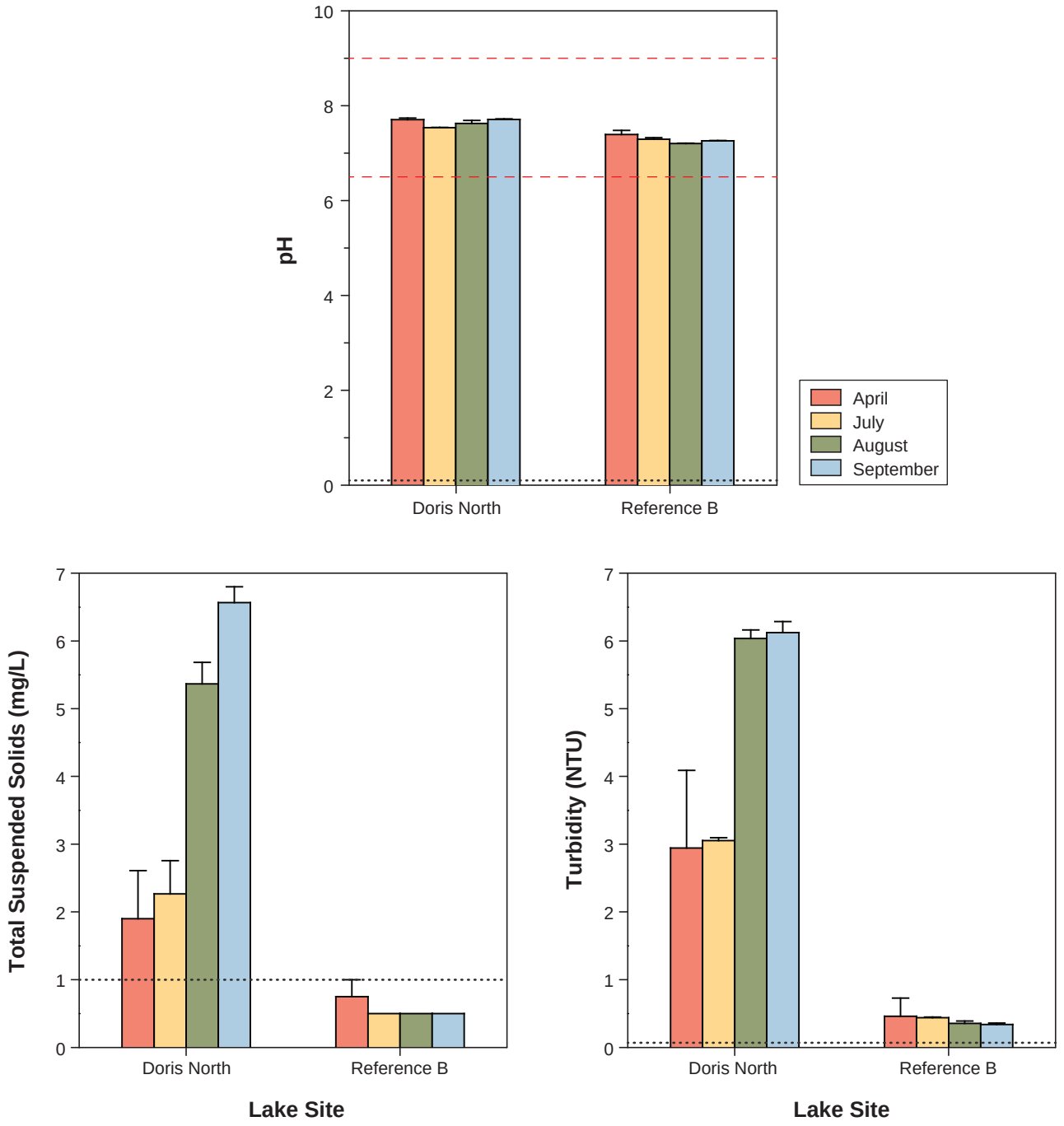
The laboratory QA/QC program included reviews of maximum holding times, and the use of method blanks, laboratory replicates, certified reference materials, internal reference materials, laboratory control samples, matrix spikes, and calibration verification standards. A summary of occurrences of when laboratory QA/QC samples did not meet DQOs is presented in Annex A.4-4.

Holding time recommendations were consistently not met for the same subset of parameters (pH, turbidity, nitrate, nitrite, orthophosphate-P) during each sampling session (April, July, August, and September), as well as for additional parameters during only one sampling session (TSS in July, total phosphorus in July, and total alkalinity in August; Annex A.4-4). Recommended hold times for these parameters range from 15 minutes for pH to 14 days for total alkalinity, with most of these parameters having a 3-day recommended hold time. These recommended hold times are often unattainable when sampling in remote environments and having to ship samples long distances from the study area to the analytical laboratory.

Method blank concentrations exceeded DQOs for sodium (in April, August, and September), strontium (in April), and potassium (in August; Annex A.4-4). For all these instances, associated sample results which are either below the detection limit or greater than five times the blank levels are considered reliable.

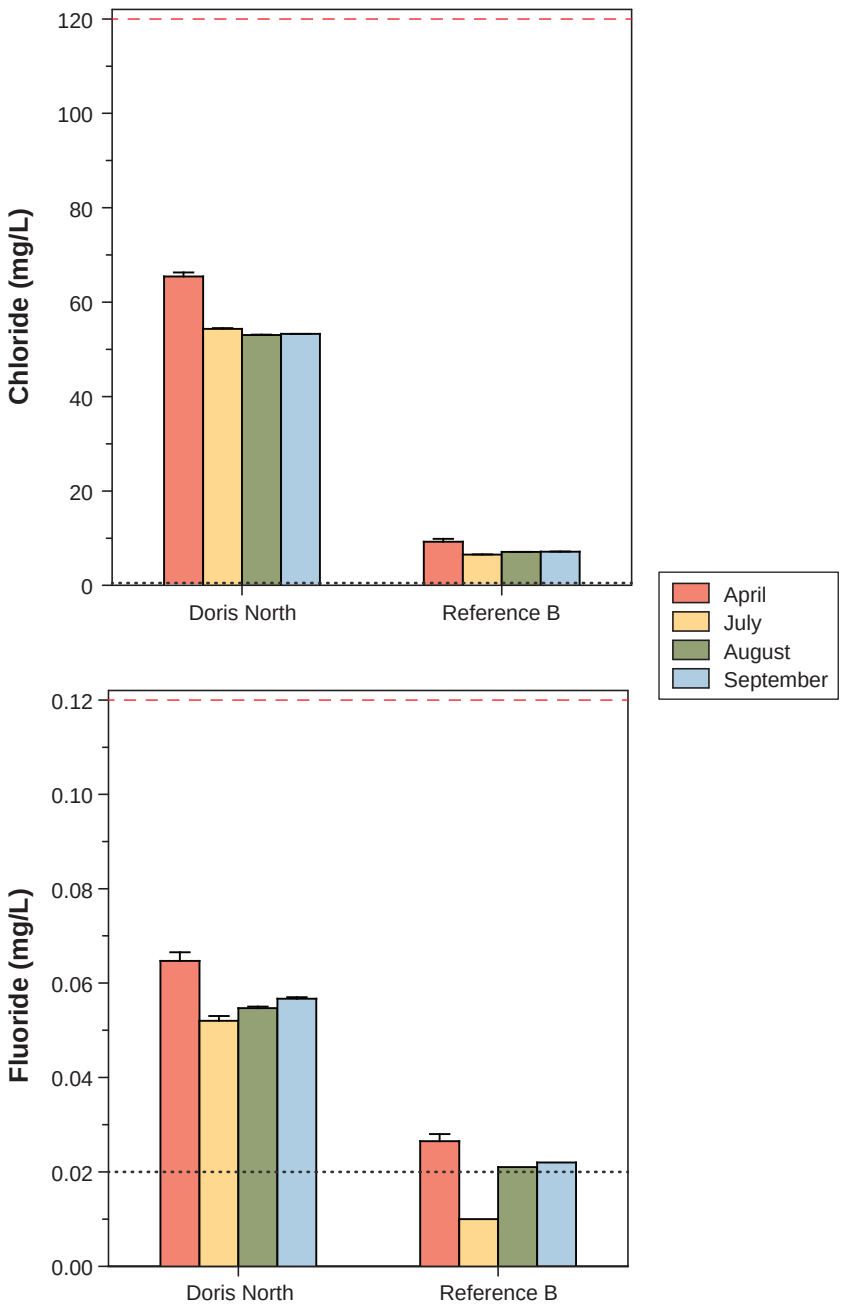
Given that method blank DQOs were met for all evaluated parameters, these exceedances of method blank DQOs would not affect the results and conclusions of the AEMP.

Laboratory control sample DQOs were not met for sodium (in April) and boron (in July; Annex A.4-4). Of these parameters, only boron is an evaluated parameter. ALS concluded that the DQO exceedance for boron in the laboratory control sample was marginal, and the sample results for total boron were considered acceptable.



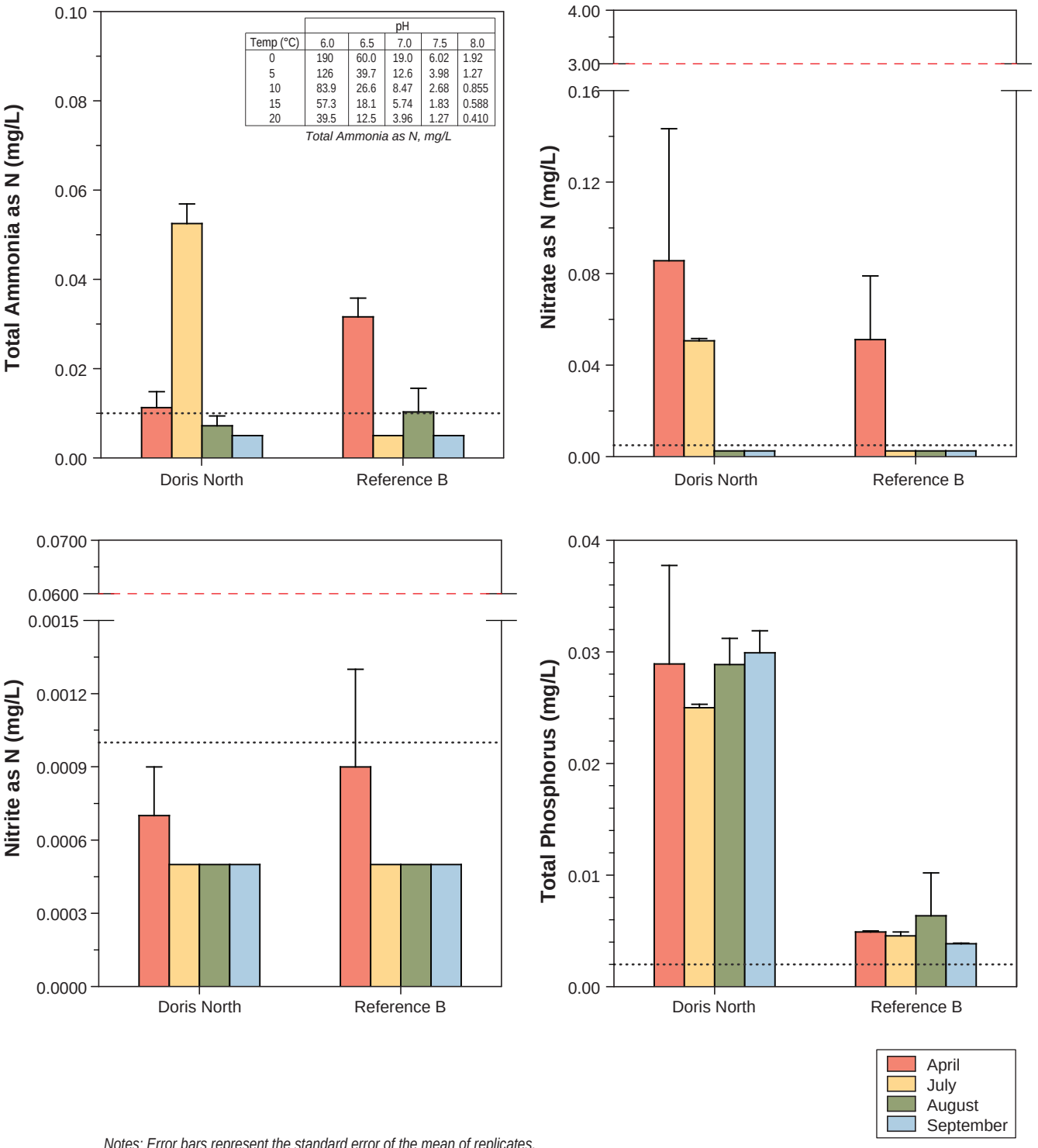
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guideline pH range (6.5–9.0).
The CCME guidelines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

Figure A.4-1: pH, Total Suspended Solids, and Turbidity in Lakes, Doris Project, 2018



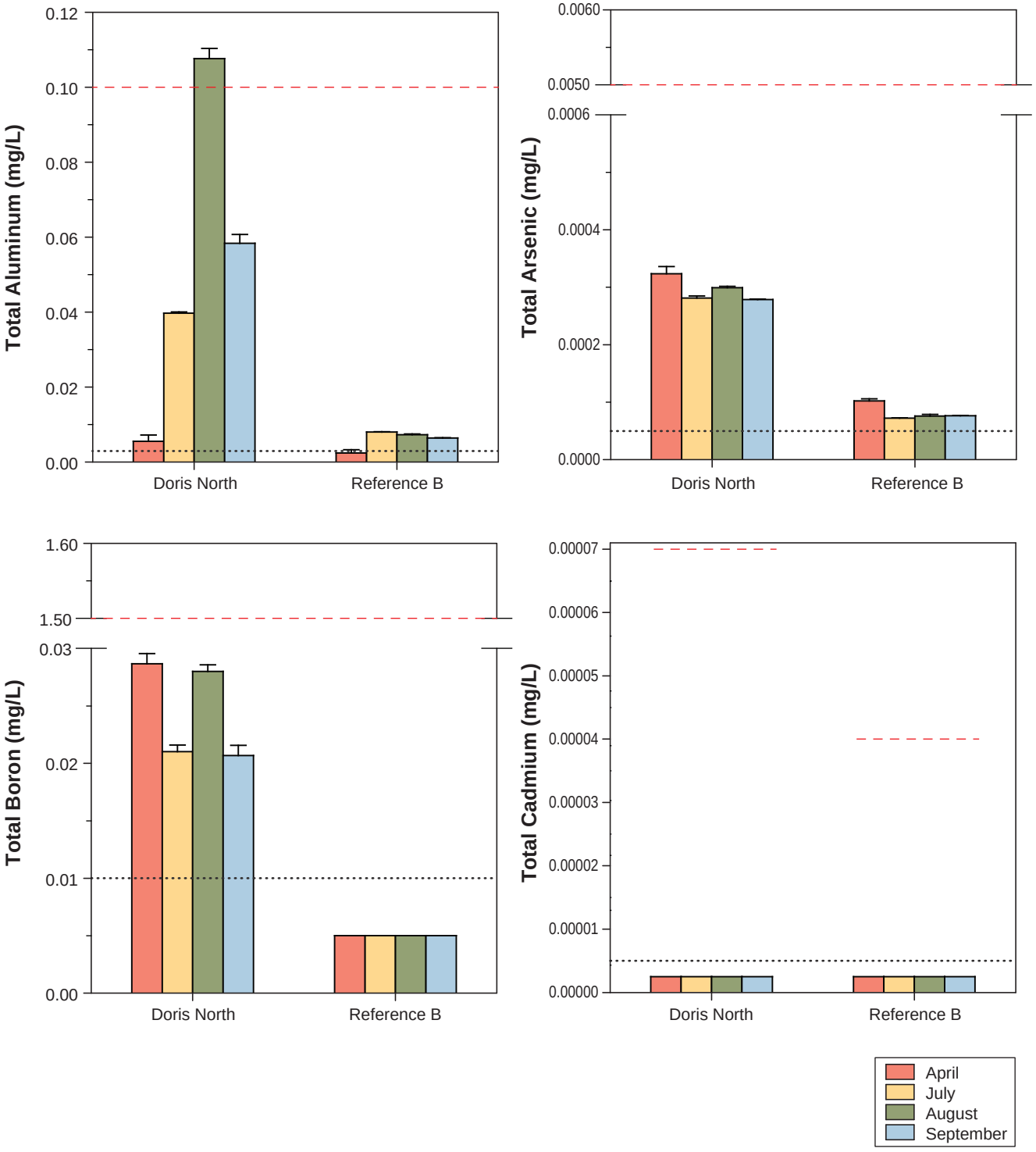
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent CCME guidelines for chloride (120 mg/L; long-term concentration)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

Figure A.4-2: Chloride and Fluoride Concentrations in Lakes, Doris Project, 2018



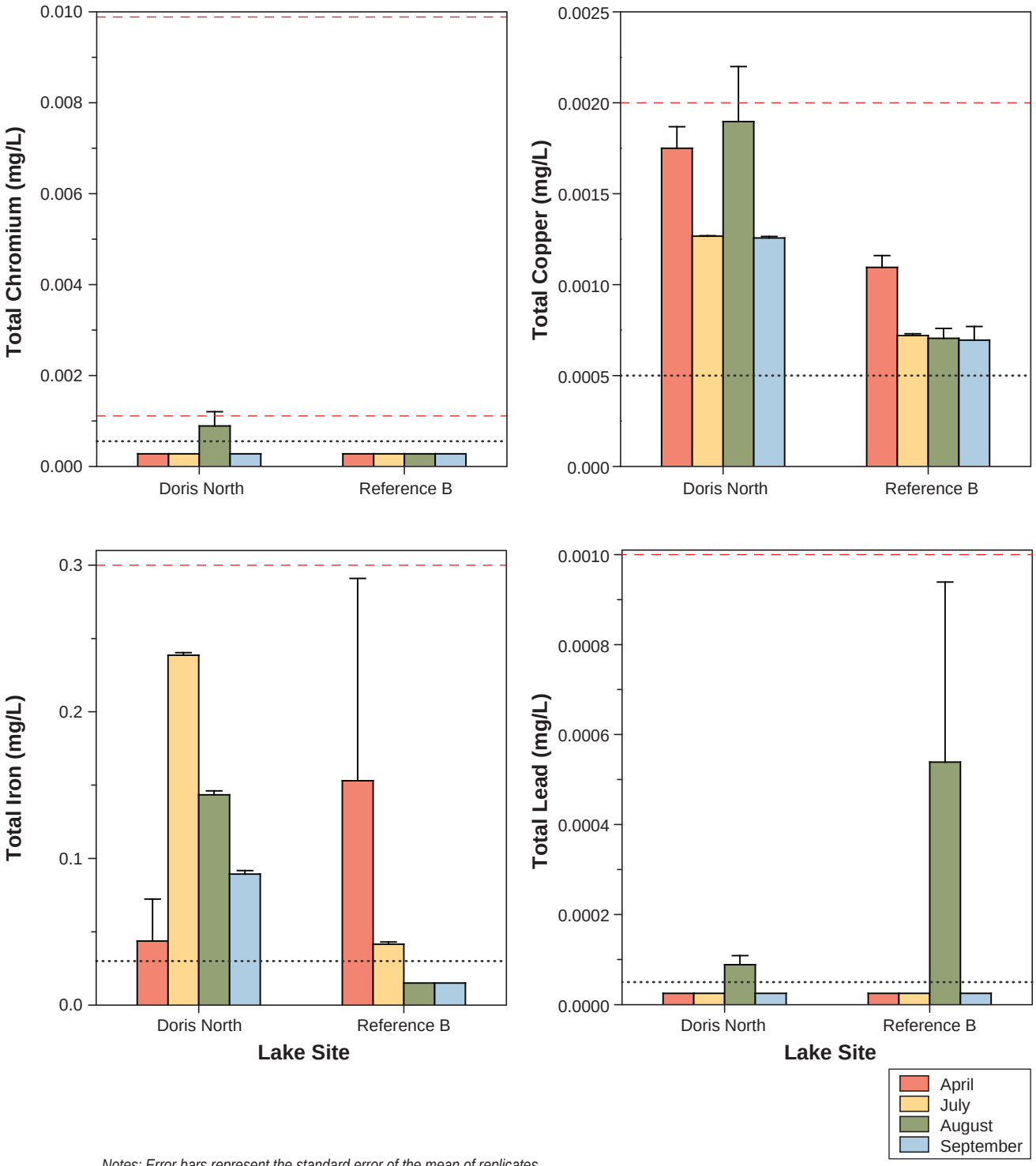
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Inset table shows the pH- and temperature-dependent CCME guideline for total ammonia 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.4-3: Ammonia, Nitrate, Nitrite, and Phosphorus Concentrations in Lakes, Doris Project, 2018



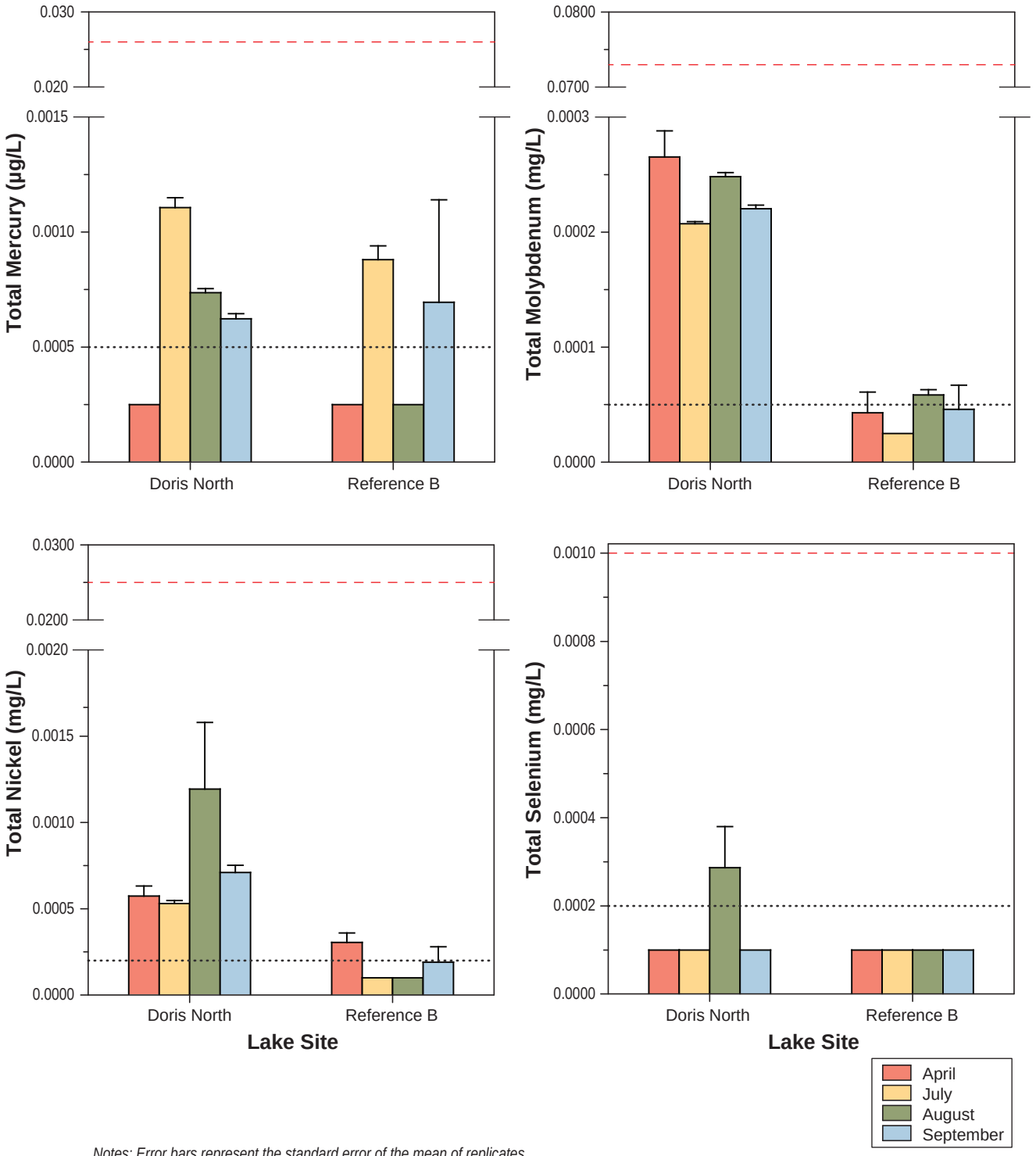
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the pH-dependent CCME guideline for aluminum (0.1 mg/L at 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 long-term hardness-dependent minimum CCME guideline for cadmium (0.00007 mg/L for Doris Lake North; 0.00004 mg/L for Reference Lake B).

Figure A.4-4: Aluminum, Arsenic, Boron, and Cadmium Concentrations in Lakes, Doris Project, 2018



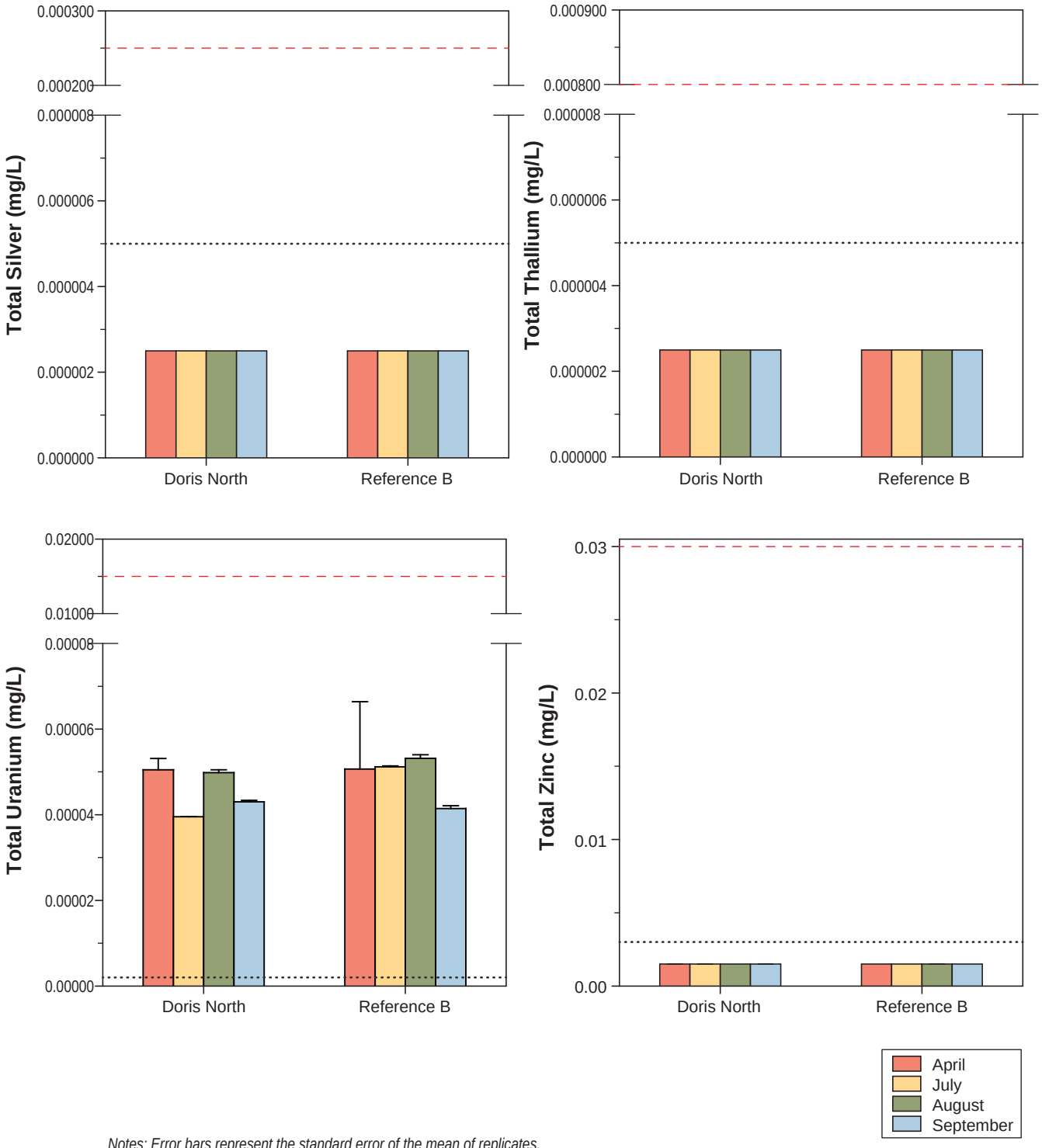
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guidelines for trivalent chromium (0.0089 mg/L), 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.4-5: Chromium, Copper, Iron, and Lead Concentrations in Lakes, Doris Project, 2018



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.4-6: Mercury, Molybdenum, Nickel, and Selenium Concentrations in Lakes, Doris Project, 2018



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).

Figure A.4-7: Silver, Thallium, Uranium, and Zinc Concentrations in Lakes, Doris Project, 2018

Annex A.4-1: Lake Water Quality Data, Doris Project, 2018

Site ID:				Doris North			Reference B		Doris North			Reference B	
Replicate:				1	2	1	1	1	1	2	1	1	1
Depth Sampled (m):				2.8	2.8	12	2.5	8.5	1	1	12	1	8
Date Sampled:		CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	16-Apr-2018	16-Apr-2018	16-Apr-2018	16-Apr-2018	16-Apr-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018
ALS Sample ID:	Units			L2081786-18	L2081786-20	L2081786-19	L2081786-16	L2081786-21	L2130870-1	L2130870-3	L2130870-2	L2130870-4	L2130870-5
Physical Tests													
Conductivity	uS/cm		2.0	302	296	281	72.4	69.3	242	238	238	49.7	49.6
Hardness (as $CaCO_3$)	mg/L		0.50	56.8	54.4	52.9	21.5	19.9	44.5	45.3	45.7	14.2	14.4
pH	pH	6.5 to 9.0	0.10	7.72	7.76	7.64	7.48	7.31	7.53	7.53	7.55	7.33	7.26
Total Suspended Solids	mg/L	dependent on background levels	1.0	2.8	2.4	<1.0	1	<1.0	2.6	2.9	1.3	<1.0	<1.0
Turbidity	NTU	dependent on background levels	0.10	4.44	3.70	0.69	0.19	0.73	3.11	3.08	2.97	0.45	0.43
Anions and Nutrients													
Alkalinity, Total (as $CaCO_3$)	mg/L		1.0	35.4	34.4	33.9	17.5	16.3	28.7	29.0	28.4	11.4	10.8
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0	<0.0050	0.0057	0.0087	0.0179	0.0137	0.0219	0.0282	0.0287	<0.0050	<0.0050
Bromide (Br)	mg/L		0.050	0.224	0.231	0.212	<0.050	<0.050	0.177	0.193	0.185	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.50	66.4	66.2	63.7	9.87	8.64	54.1	54.4	54.6	6.55	6.53
Fluoride (F)	mg/L	0.12[b]	0.020	0.067	0.066	0.061	0.028	0.025	0.053	0.053	0.050	<0.020	<0.020
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.0050	0.0288	0.0270	0.201	0.0233	0.0790	0.0495	0.0498	0.0526	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.0010	<0.0010	0.0011	<0.0010	0.0013	<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	0.0015	0.0058	0.0013	<0.0010	<0.0010
Phosphorus (P)-Total	mg/L	Trigger ranges from guidance framework[c]	0.0020	0.0348	0.0404	0.0116	0.0048	0.0050	0.0248	0.0246	0.0256	0.0049	0.0042
Sulphate (SO_4)	mg/L		0.30	3.30	3.28	2.99	2.60	2.30	2.43	2.42	2.47	1.70	1.70
Cyanides													
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic/Inorganic Carbon													
Dissolved Organic Carbon	mg/L		0.50	7.39	7.16	6.59	3.75	2.94					
Total Metals													
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0040	0.0037	0.0089	<0.0030	0.0033	0.0395	0.0393	0.0404	0.0081	0.0079
Antimony (Sb)	mg/L		0.000030	0.000051	0.000036	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030
Arsenic (As)	mg/L	0.005	0.00005	0.000338	0.000334	0.000299	0.000106	0.000099	0.000274	0.000286	0.000284	0.000073	0.000072
Barium (Ba)	mg/L		0.00010	0.00296	0.00292	0.00297	0.00243	0.00278	0.00709	0.00614	0.00366	0.00410	0.00637
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	0.029	0.030	0.027	<0.010	<0.010	0.020	0.022	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	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	10.10	10.0	9.9	5.06	4.75	7.60	8.07	7.98	3.36	3.28
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	0.000382	0.000062	0.000058	0.000057	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002[e]	0.00050	0.00196	0.00174	0.00155	0.00103	0.00116	0.00126	0.00127	0.00127	0.00073	0.00071
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	0.101	<0.030	0.291	0.236	0.242	0.238	0.043	0.040
Lead (Pb)	mg/L	0.001[f]	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00040	0.00439	0.00452	0.00404	0.00058	0.00052	0.00344	0.00368	0.00356	0.00085	0.00071
Magnesium (Mg)	mg/L		0.10	7.67	7.17	6.86	2.16	1.94	5.58	5.76	5.73	1.35	1.29
Manganese (Mn)	mg/L		0.00020	0.00522	0.00297	0.0167	0.00143	0.1320	0.0815	0.0819	0.0803	0.00494	0.00470
Mercury (Hg)	µg/L	Inorganic Hg: 0.026	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00119	0.00105	0.00108	0.00094	0.00082
Molybdenum (Mo)	mg/L	0.073[b]	0.000050	0.000292	0.000284	0.000220	0.000061	<0.000050	0.000208	0.000210	0.000204	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.025[g]	0.00020	0.00068	0.00056	0.00048	0.00025	0.00036	0.00056	0.00053	0.00050	<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

Annex A.4-1: Lake Water Quality Data, Doris Project, 2018

Site ID:				Doris North			Reference B		Doris North			Reference B	
Replicate:				1	2	1	1	1	1	2	1	1	1
Depth Sampled (m):				2.8	2.8	12	2.5	8.5	1	1	12	1	8
Date Sampled:		CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	16-Apr-2018	16-Apr-2018	16-Apr-2018	16-Apr-2018	16-Apr-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018
ALS Sample ID:	Units			L2081786-18	L2081786-20	L2081786-19	L2081786-16	L2081786-21	L2130870-1	L2130870-3	L2130870-2	L2130870-4	L2130870-5
Total Metals *(cont'd)*													
Potassium (K)	mg/L		2.0	2.5	2.4	2.3	<2.0	<2.0	<2.0	<2.0	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	0.00179	0.00176	0.00164	0.00126	0.00114	0.00148	0.00148	0.00150	0.000813	0.000777
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	2.27	2.14	2.30	0.29	0.93	1.62	1.65	1.64	0.18	0.16
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	33.2	33.4	31.8	5.6	4.8	26.0	27.0	27.9	3.7	3.6
Strontium (Sr)	mg/L		0.00020	0.0500	0.0501	0.0475	0.0254	0.0252	0.0359	0.0388	0.0385	0.0155	0.0168
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	0.0000065	0.0000069	0.0000084	<0.0000050	<0.0000050	0.0000191	0.0000209	0.0000207	0.0000074	0.0000059
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	<0.00020	<0.00020	<0.00020	0.00124	0.00125	0.00123	<0.00020	<0.00020
Tungsten (W)	mg/L		0.000010	0.000011	0.00001	<0.000010	<0.000010	<0.000010	0.000015	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000536	0.0000526	0.0000453	0.0000664	0.0000349	0.0000395	0.0000395	0.0000396	0.0000510	0.0000514
Vanadium (V)	mg/L		0.000050	0.000098	0.000090	0.000092	<0.000050	<0.000050	0.000154	0.000154	0.000155	<0.000050	<0.000050
Yttrium (Y)	mg/L		0.0000050	0.0000168	0.0000165	0.0000216	0.0000100	0.0000139	0.0000362	0.0000370	0.0000378	0.0000152	0.0000144
Zinc (Zn)	mg/L	0.03[h]	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	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000054	0.000059	0.000057	<0.000050	<0.000050

Notes:

April sampling depths are depths below the water surface and are equal to approximately 0.25 to 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) = $0.001*10^{\{1.016(\log[\text{hardness}]) - 1.71\}}$. 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) = $0.001*10^{\{0.83(\log[\text{hardness}]) - 2.46\}}$. 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) = $0.0002 * e^{\{0.8545[\ln(\text{hardness})]-1.465\}}$. 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)= $0.001*e^{\{1.273[\ln(\text{hardness})]-4.705\}}$. 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) = $0.001*e^{\{0.76[\ln(\text{hardness})]+1.06\}}$. At hardness >180 mg/L, the CWQG is 0.150 mg/L. If the hardness is unknown, the CWQG is 0.025 mg/L.*

[h] *The zinc water quality guideline was updated on September 18, 2018, and is now a guideline for dissolved zinc that is calculated from the pH, hardness, and dissolved organic carbon (DOC) concentration. Because the new zinc guideline was issued after the completion of water quality sampling for the 2018 AEMP and dissolved zinc and DOC concentrations were not routinely measured as part of the 2018 water quality program, zinc concentrations could not be screened against this new guideline, and the total zinc guideline of 0.03 mg/L was used as a benchmark to screen the 2018 water quality samples.*

Annex A.4-1: Lake Water Quality Data, Doris Project, 2018

Site ID:				Doris North			Reference B		Doris North			Reference B	
Replicate:				1	2	1	1	1	1	2	1	1	1
Depth Sampled (m):				1	1	11	1	8	1	1	11.7	1	8.7
Date Sampled:		CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	19-Aug-2018	19-Aug-2018	19-Aug-2018	26-Aug-2018	26-Aug-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018
ALS Sample ID:	Units			L2151927-1	L2151927-2	L2151927-3	L2154136-1	L2154136-2	L2166712-1	L2166712-3	L2166712-2	L2166712-4	L2166712-5
Physical Tests													
Conductivity	uS/cm		2.0	237	246	243	54.3	54.0	242	243	241	52.7	52.1
Hardness (as $CaCO_3$)	mg/L		0.50	43.4	44.2	43.3	14.8	13.7	39.6	40.3	40.3	14	14
pH	pH	6.5 to 9.0	0.10	7.50	7.68	7.70	7.20	7.21	7.70	7.74	7.69	7.25	7.27
Total Suspended Solids	mg/L	dependent on background levels	1.0	6.0	5.0	5.1	<1.0	<1.0	6.1	6.8	6.8	<1.0	<1.0
Turbidity	NTU	dependent on background levels	0.10	5.92	5.90	6.29	0.39	0.32	5.90	6.44	6.03	0.32	0.36
Anions and Nutrients													
Alkalinity, Total (as $CaCO_3$)	mg/L		1.0	28.1	29.6	30.2	11.9	11.9	29.1	29.4	28.8	11.9	11.9
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0	<0.0050	0.0058	<0.0050	<0.0050	0.0078	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.050	0.181	0.183	0.184	<0.050	<0.050	0.179	0.188	0.187	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.50	53.2	53.0	53.0	7.09	7.08	53.3	53.3	53.3	7.18	7.08
Fluoride (F)	mg/L	0.12[b]	0.020	0.055	0.055	0.054	0.021	0.021	0.057	0.057	0.056	0.022	0.022
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	0.001	<0.0010
Phosphorus (P)-Total	mg/L	Trigger ranges from guidance framework[c]	0.0020	0.0255	0.0277	0.0334	0.0025	0.0102	0.0338	0.0286	0.0274	0.0038	0.0039
Sulphate (SO_4)	mg/L		0.30	2.53	2.53	2.53	1.83	1.83	2.55	2.55	2.54	1.81	1.81
Cyanides													
Cyanide, Total	mg/L		0.0010										
Cyanide, Free	mg/L	0.005	0.0010										
Organic/Inorganic Carbon													
Dissolved Organic Carbon	mg/L		0.50										
Total Metals													
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.113	0.106	0.104	0.0075	0.0071	0.0538	0.0595	0.0618	0.0065	0.0063
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	0.000295	0.0003	0.000303	0.000079	0.000073	0.000277	0.000279	0.00028	0.000077	0.000076
Barium (Ba)	mg/L		0.00010	0.00377	0.00402	0.00389	0.00141	0.00165	0.00987	0.00401	0.00413	0.00254	0.00183
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	0.028	0.029	0.027	<0.010	<0.010	0.019	0.021	0.022	<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	8.23	8.5	8.39	3.57	3.38	7.32	7.51	7.58	3.44	3.50
Cesium (Cs)	mg/L		0.0000050	0.0000079	0.0000097	0.0000093	<0.0000050	<0.0000050	<0.0000050	0.0000054	0.0000053	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089[b]	0.00050	0.00118	0.00098	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	0.000076	0.000063	0.000063	<0.000050	<0.000050	0.000051	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002[e]	0.00050	0.00242	0.0019	0.00137	0.00076	0.00065	0.00127	0.00124	0.00126	0.00077	0.00062
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	0.138	0.145	0.147	<0.030	<0.030	0.086	0.088	0.094	<0.030	<0.030
Lead (Pb)	mg/L	0.001[f]	0.000050	0.000092	0.000122	0.000052	0.000939	0.000139	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00040	0.00432	0.00451	0.00419	0.00070	0.00082	0.00307	0.00313	0.00327	0.00048	0.00044
Magnesium (Mg)	mg/L		0.10	5.54	5.59	5.44	1.44	1.28	5.17	5.22	5.18	1.31	1.28
Manganese (Mn)	mg/L		0.00020	0.0199	0.0196	0.02	0.00142	0.00141	0.0150	0.0149	0.0157	0.00118	0.00106
Mercury (Hg)	µg/L	Inorganic Hg: 0.026	0.00050	0.00077	0.00071	0.00073	<0.00050	<0.00050	0.00058	0.00065	0.00064	<0.00050	0.00114
Molybdenum (Mo)	mg/L	0.073[b]	0.000050	0.000247	0.000255	0.000243	0.000063	0.000054	0.000215	0.000220	0.000226	0.000067	<0.000050
Nickel (Ni)	mg/L	0.025[g]	0.00020	0.00195	0.00095	0.00068	<0.00020	<0.00020	0.00073	0.00077	0.00063	0.00028	<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

Annex A.4-1: Lake Water Quality Data, Doris Project, 2018

Site ID:				Doris North			Reference B		Doris North			Reference B	
Replicate:				1	2	1	1	1	1	2	1	1	1
Depth Sampled (m):				1	1	11	1	8	1	1	11.7	1	8.7
Date Sampled:		CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	19-Aug-2018	19-Aug-2018	19-Aug-2018	26-Aug-2018	26-Aug-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018
ALS Sample ID:	Units			L2151927-1	L2151927-2	L2151927-3	L2154136-1	L2154136-2	L2166712-1	L2166712-3	L2166712-2	L2166712-4	L2166712-5
Total Metals *(cont'd)*													
Potassium (K)	mg/L		2.0	2.1	2.2	2.2	<2.0	<2.0	<2.0	<2.0	2.0	<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	0.0017	0.00182	0.00173	0.000853	0.000980	0.00144	0.00146	0.00155	0.000786	0.000775
Selenium (Se)	mg/L	0.001	0.00020	<0.00020	0.00038	0.00038	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.10	1.65	1.69	1.69	0.12	0.13	1.40	1.40	1.40	0.10	<0.10
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	28.1	29	28.7	3.8	3.7	24.9	24.9	25.1	3.7	3.8
Strontium (Sr)	mg/L		0.00020	0.0366	0.0361	0.0371	0.0166	0.0163	0.0354	0.0352	0.0353	0.0165	0.0161
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	0.0000264	0.0000339	0.0000326	0.0000051	0.0000057	0.0000162	0.0000227	0.0000202	<0.0000050	<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	0.00326	0.00352	0.00358	<0.00020	<0.00020	0.00192	0.00200	0.00234	<0.00020	<0.00020
Tungsten (W)	mg/L		0.000010	0.000011	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000012	0.000014	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000501	0.0000486	0.0000508	0.0000523	0.0000540	0.0000427	0.0000437	0.0000426	0.0000421	0.0000408
Vanadium (V)	mg/L		0.000050	0.000304	0.000318	0.000314	<0.000050	<0.000050	0.000230	0.000227	0.000234	<0.000050	<0.000050
Yttrium (Y)	mg/L		0.0000050	0.0000408	0.000043	0.000042	0.0000085	0.0000095	0.0000271	0.0000271	0.0000301	0.0000079	0.0000078
Zinc (Zn)	mg/L	0.03[h]	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	0.000064	0.000068	0.000064	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050

Notes:

April sampling depths are depths below the water surface and are equal to approximately 0.25 to 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) = $0.001*10^{\{1.016(\log[\text{hardness}]) - 1.71\}}$. 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) = $0.001*10^{\{0.83(\log[\text{hardness}]) - 2.46\}}$. 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) = $0.0002 * e^{\{0.8545[\ln(\text{hardness})]-1.465\}}$. 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)= $0.001*e^{\{1.273[\ln(\text{hardness})]-4.705\}}$. 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) = $0.001*e^{\{0.76[\ln(\text{hardness})]+1.06\}}$. At hardness >180 mg/L, the CWQG is 0.150 mg/L. If the hardness is unknown, the CWQG is 0.025 mg/L.*

[h] *The zinc guideline was updated on September 18, 2018, after the final AEMP sample was collected; therefore, April to September, 2018, concentrations were screened against the pre-September 18, 2018, guideline of 0.03 mg/L for total zinc. The new zinc guideline is now DOC- and hardness-dependent, and applies to dissolved zinc. Since DOC and dissolved zinc were not routinely collected as part of the AEMP sampling program, zinc concentrations could not be screened against this new guideline.*

Annex A.4-2: Relative Percent Difference Calculations for Duplicate Water Quality Samples, Doris Project, 2018

Lake				Doris North			Doris North			Doris North			Doris North		
Depth				2.8			1			1			1		
Date				16-Apr-2018			14-Jul-2018			19-Aug-2018			15-Sep-2018		
ALS Sample ID	Units	Realized Detection Limit	5x Realized Detection Limit	L2081786-18	L2081786-20	RPD (%)	L2130870-1	L2130870-3	RPD (%)	L2151927-1	L2151927-2	RPD (%)	L2166712-1	L2166712-3	RPD (%)
Physical Tests															
Conductivity	µS/cm	2	10	302	296	2.01	242	238	1.67	237	246	3.73	242	243	0.41
Hardness (as $CaCO_3$)	mg/L	0.5	2.5	56.8	54.4	4.32	44.5	45.3	1.78	43.4	44.2	1.83	39.6	40.3	1.75
pH	pH	0.1	0.5	7.72	7.76	0.52	7.53	7.53	0.00	7.50	7.68	2.37	7.70	7.74	0.52
Total Suspended Solids	mg/L	1	5	2.80	2.40	n/a	2.60	2.90	n/a	6.00	5.00	18.2	6.10	6.80	10.9
Turbidity	NTU	0.1	0.5	4.44	3.70	18.2	3.11	3.08	0.97	5.92	5.90	0.34	5.90	6.44	8.75
Anions and Nutrients															
Alkalinity, Total (as $CaCO_3$)	mg/L	1	5	35.4	34.4	2.87	28.7	29.0	1.04	28.1	29.6	5.20	29.1	29.4	1.03
Ammonia, Total (as N)	mg/L	0.005	0.025	<0.0050	0.00570	n/a	0.0219	0.0282	*25.1*	<0.0050	0.00580	n/a	<0.0050	<0.0050	n/a
Bromide (Br)	mg/L	0.05	0.25	0.224	0.231	n/a	0.177	0.193	n/a	0.181	0.183	n/a	0.179	0.188	n/a
Chloride (Cl)	mg/L	0.5	2.5	66.4	66.2	0.30	54.1	54.4	0.55	53.2	53.0	0.38	53.3	53.3	0.00
Fluoride (F)	mg/L	0.02	0.1	0.0670	0.0660	n/a	0.0530	0.0530	n/a	0.0550	0.0550	n/a	0.0570	0.0570	n/a
Nitrate (as N)	mg/L	0.005	0.025	0.0288	0.0270	6.45	0.0495	0.0498	0.60	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a
Nitrite (as N)	mg/L	0.001	0.005	<0.0010	0.00110	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a
Orthophosphate, Dissolved (as P)	mg/L	0.001	0.005	<0.0010	<0.0010	n/a	0.00150	0.00580	**118**	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a
Phosphorus, Total (as P)	mg/L	0.002	0.01	0.0348	0.0404	14.9	0.0248	0.0246	0.81	0.0255	0.0277	8.27	0.0338	0.0286	16.7
Sulphate (SO_4)	mg/L	0.3	1.5	3.30	3.28	0.61	2.43	2.42	0.41	2.53	2.53	0.00	2.55	2.55	0.00
Cyanides															
Cyanide, Total	mg/L	0.001	0.005	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	-	-	-	-	-	-
Cyanide, Free	mg/L	0.001	0.005	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a	-	-	-	-	-	-
Organic Carbon															
Dissolved Organic Carbon	mg/L	0.5	2.5	7.39	7.16	3.2	-	-	-	-	-	-	-	-	-
Total Metals															
Aluminum (Al)	mg/L	0.003	0.015	0.00400	0.00370	n/a	0.0395	0.0393	0.51	0.113	0.106	6.39	0.0538	0.0595	10.1
Antimony (Sb)	mg/L	0.00003	0.00015	0.0000510	0.0000360	n/a	<0.000030	<0.000030	n/a	<0.000030	<0.000030	n/a	<0.000030	<0.000030	n/a
Arsenic (As)	mg/L	0.00005	0.00025	0.000338	0.000334	1.19	0.000274	0.000286	4.29	0.000295	0.000300	1.68	0.000277	0.000279	0.72
Barium (Ba)	mg/L	0.0001	0.0005	0.00296	0.00292	1.36	0.00709	0.00614	14.4	0.00377	0.00402	6.42	0.00987	0.00401	0.00
Beryllium (Be)	mg/L	0.000005	0.000025	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Bismuth (Bi)	mg/L	0.00005	0.00025	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a
Boron (B)	mg/L	0.01	0.05	0.0290	0.0300	n/a	0.0200	0.0220	n/a	0.0280	0.0290	n/a	0.0190	0.0210	n/a
Cadmium (Cd)	mg/L	0.000005	0.000025	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Calcium (Ca)	mg/L	0.05	0.25	10.1	9.95	1.50	7.60	8.07	6.00	8.23	8.50	3.23	7.32	7.51	2.56
Cesium (Cs)	mg/L	0.000005	0.000025	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	0.0000079	0.0000097	n/a	<0.0000050	0.0000054	n/a
Chromium (Cr)	mg/L	0.0005	0.0025	<0.00050	<0.00050	n/a	<0.00050	<0.00050	n/a	0.00118	0.000980	n/a	<0.00050	<0.00050	n/a
Cobalt (Co)	mg/L	0.00005	0.00025	<0.000050	<0.000050	n/a	0.0000620	0.0000580	n/a	0.0000760	0.0000630	n/a	0.0000510	<0.000050	n/a
Copper (Cu)	mg/L	0.0005	0.0025	0.00196	0.00174	n/a	0.00126	0.00127	n/a	0.00242	0.00190	n/a	0.00127	0.00124	n/a
Gallium (Ga)	mg/L	0.00005	0.00025	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a
Iron (Fe)	mg/L	0.03	0.15	<0.030	<0.030	n/a	0.236	0.242	2.51	0.138	0.145	n/a	0.0860	0.0880	n/a
Lead (Pb)	mg/L	0.00005	0.00025	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a	0.0000920	0.000122	n/a	<0.000050	<0.000050	n/a
Lithium (Li)	mg/L	0.0004	0.002	0.00439	0.00452	2.92	0.00344	0.00368	6.74	0.00432	0.00451	4.30	0.00307	0.00313	1.94
Magnesium (Mg)	mg/L	0.1	0.5	7.67	7.17	6.74	5.58	5.76	3.17	5.54	5.59	0.90	5.17	5.22	0.96
Manganese (Mn)	mg/L	0.0002	0.001	0.00522	0.00297	**54.9**	0.0815	0.0819	0.49	0.0199	0.0196	1.52	0.0150	0.0149	0.67
Mercury (Hg)	µg/L	0.0005	0.0025	<0.00050	<0.00050	n/a	0.00119	0.00105	n/a	0.000770	0.000710	n/a	0.000580	0.000650	n/a
Molybdenum (Mo)	mg/L	0.00005	0.00025	0.000292	0.000284	2.78	0.000208	0.000210	n/a	0.000247	0.000255	3.19	0.000215	0.000220	n/a
Nickel (Ni)	mg/L	0.0002	0.001	0.000680	0.000560	n/a	0.000560	0.000530	n/a	0.00195	0.000950	**69.0**	0.000730	0.000770	n/a
Phosphorus (P)	mg/L	0.3	1.5	<0.30	<0.30	n/a	<0.30	<0.30	n/a	<0.30	<0.30	n/a	<0.30	<0.30	n/a
Potassium (K)	mg/L	2	10	2.50	2.40	n/a	<2.0	<2.0	n/a	2.10	2.20	n/a	<2.0	<2.0	n/a
Rhenium (Re)	mg/L	0.000005	0.000025	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a

Annex A.4-2: Relative Percent Difference Calculations for Duplicate Water Quality Samples, Doris Project, 2018

Lake				Doris North			Doris North			Doris North			Doris North		
Depth				2.8			1			1			1		
Date				16-Apr-2018			14-Jul-2018			19-Aug-2018			15-Sep-2018		
ALS Sample ID	Units	Realized Detection Limit	5x Realized Detection Limit	L2081786-18	L2081786-20	RPD (%)	L2130870-1	L2130870-3	RPD (%)	L2151927-1	L2151927-2	RPD (%)	L2166712-1	L2166712-3	RPD (%)
Total Metals *(cont'd)*															
Rubidium (Rb)	mg/L	0.00002	0.0001	0.00179	0.00176	1.69	0.00148	0.00148	0.00	0.00170	0.00182	6.82	0.00144	0.00146	1.38
Selenium (Se)	mg/L	0.0002	0.001	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00020	0.000380	n/a	<0.00020	<0.00020	n/a
Silicon (Si)	mg/L	0.1	0.5	2.27	2.14	5.90	1.62	1.65	1.83	1.65	1.69	2.40	1.40	1.40	0.00
Silver (Ag)	mg/L	0.000005	0.000025	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Sodium (Na)	mg/L	2	10	33.2	33.4	0.60	26.0	27.0	3.77	28.1	29.0	3.15	24.9	24.9	0.00
Strontium (Sr)	mg/L	0.0002	0.001	0.0500	0.0501	0.20	0.0359	0.0388	7.76	0.0366	0.0361	1.38	0.0354	0.0352	0.57
Tellurium (Te)	mg/L	0.00001	0.00005	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Thallium (Tl)	mg/L	0.000005	0.000025	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Thorium (Th)	mg/L	0.000005	0.000025	0.0000065	0.0000069	n/a	0.0000191	0.0000209	n/a	0.0000264	0.0000339	*24.9*	0.0000162	0.0000227	n/a
Tin (Sn)	mg/L	0.0002	0.001	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a
Titanium (Ti)	mg/L	0.0002	0.001	<0.00020	<0.00020	n/a	0.00124	0.00125	0.80	0.00326	0.00352	7.67	0.00192	0.00200	4.08
Tungsten (W)	mg/L	0.00001	0.00005	0.0000110	0.0000100	n/a	0.0000150	<0.000010	n/a	0.0000110	0.0000100	n/a	<0.000010	<0.000010	n/a
Uranium (U)	mg/L	0.000002	0.00001	0.0000536	0.0000526	1.88	0.0000395	0.0000395	0.00	0.0000501	0.0000486	3.04	0.0000427	0.0000437	2.31
Vanadium (V)	mg/L	0.00005	0.00025	0.0000980	0.0000900	n/a	0.000154	0.000154	n/a	0.000304	0.000318	4.50	0.000230	0.000227	n/a
Yttrium (Y)	mg/L	0.000005	0.000025	0.0000168	0.0000165	n/a	0.0000362	0.0000370	2.19	0.0000408	0.0000430	5.25	0.0000271	0.0000271	0.00
Zinc (Zn)	mg/L	0.003	0.015	<0.0030	<0.0030	n/a	<0.0030	<0.0030	n/a	<0.0030	<0.0030	n/a	<0.0030	<0.0030	n/a
Zirconium (Zr)	mg/L	0.00005	0.00025	<0.000050	<0.000050	n/a	0.0000540	0.0000590	n/a	0.0000640	0.0000680	n/a	<0.000050	<0.000050	n/a

Notes:

n/a = not applicable when both duplicate values are less than five times the detection limit.

Red and italicized values exceed 20% relative percent difference when at least one duplicate is greater than five times the detection limit.

Red and bold values exceed 50% relative percent difference when at least one duplicate is greater than five times the detection limit.

Annex A.4-3: Blank Data for Water Quality Sampling, Doris Project, 2018

Blank Type:		Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Field Blank	Travel Blank
Date Sampled:		14-Apr-2018	15-Apr-2018	15-Apr-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018	19-Aug-2018	23-Aug-2018	25-Aug-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018
ALS Sample ID:	Units	L2081786-7	L2081786-14	L2081786-15	L2130870-6	L2130870-7	L2130870-8	L2151900-2	L2154114-2	L2154114-6	L2166712-6	L2166712-7	L2166712-8
Physical Tests													
Conductivity	µS/cm	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	**2.5**	<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
pH	pH	5.23	5.32	5.28	5.51	5.44	5.45	5.55	5.58	5.58	5.07	5.31	5.33
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
Turbidity	NTU	<0.10	<0.10	<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
Ammonia, Total (as N)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
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
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
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
Nitrate (as N)	mg/L	<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
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
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
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
Cyanides													
Cyanide, Total	mg/L	<0.0010	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-
Cyanide, Free	mg/L	<0.0010	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-
Organic Carbon													
Dissolved Organic Carbon	mg/L	<0.50	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	mg/L	<0.50	<0.50	<0.50	-	-	-	<0.50	<0.50	<0.50	-	-	-
Total Metals													
Aluminum (Al)-Total	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	**0.0221**	<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
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	<0.000050
Barium (Ba)-Total	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**0.0355**	<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
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
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
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
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
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
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
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
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
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
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
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
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
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
Manganese (Mn)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	**0.00036**	<0.00020	<0.00020
Mercury (Hg)-Total	µg/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
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
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
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
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

Annex A.4-3: Blank Data for Water Quality Sampling, Doris Project, 2018

Blank Type:		Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Field Blank	Travel Blank	Equipment Blank	Field Blank	Travel Blank
Date Sampled:		14-Apr-2018	15-Apr-2018	15-Apr-2018	14-Jul-2018	14-Jul-2018	14-Jul-2018	19-Aug-2018	23-Aug-2018	25-Aug-2018	15-Sep-2018	15-Sep-2018	15-Sep-2018
ALS Sample ID:	Units	L2081786-7	L2081786-14	L2081786-15	L2130870-6	L2130870-7	L2130870-8	L2151900-2	L2154114-2	L2154114-6	L2166712-6	L2166712-7	L2166712-8
Total Metals *(cont'd)*													
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
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
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
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
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
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
Strontium (Sr)-Total	mg/L	**0.00024**	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	**0.00025**	<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
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
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
Tin (Sn)-Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	**0.00055**	<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	<0.00020
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
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
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
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
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
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

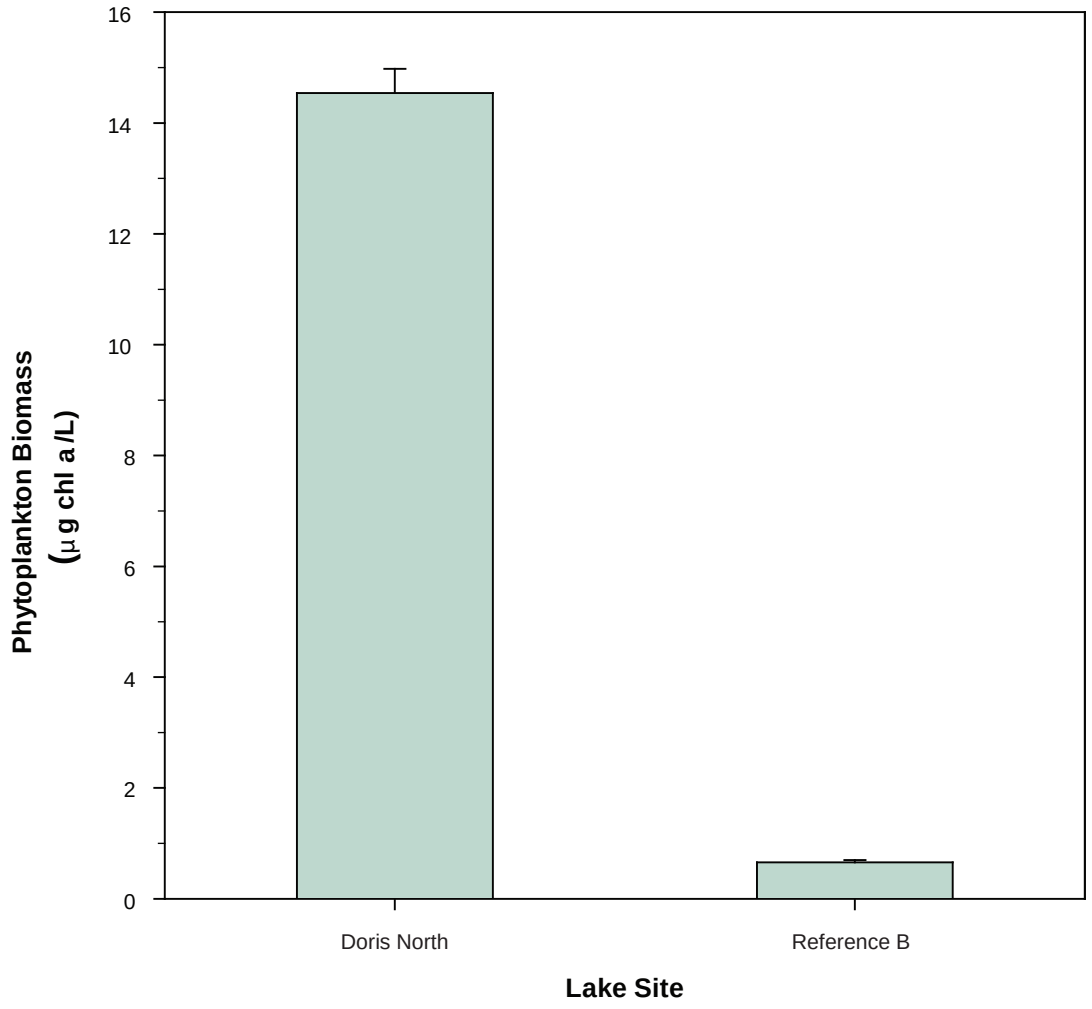
Notes:
Bold and highlighted values represent concentrations that are higher than analytical detection limits.
"-" indicates paramerter not analyzed

Annex A.4-4: Laboratory QA/QC Results, Doris Project, 2018

Sampling Month	ALS Work Order Number	QC Lot Did Not Meet ALS Hold Time Recommendations	QC Lot Did Not Meet ALS DQOs	
			Laboratory Control Sample	Method Blank
April	L2081786	pH, turbidity, nitrate-N, nitrite-N, orthophosphate-P	sodium	sodium, strontium
July	L2130870	pH, TSS, turbidity, nitrate-N, nitrite-N, orthophosphate-P, total phosphorus	boron	
August	L2151927	pH, turbidity, total alkalinity, nitrate-N, nitrite-N, orthophosphate-P		sodium
August	L2154136	pH, turbidity, nitrate-N, nitrite-N, orthophosphate-P		potassium, sodium
September	L2166712	pH, turbidity, nitrate-N, nitrite-N, orthophosphate-P		sodium

A.5 2018 Primary Producers

The following sections present the phytoplankton biomass (chlorophyll *a*) data collected in August 2018 at the AEMP lake sites. Figure A.5-1 shows the average phytoplankton biomass measured in Doris Lake and Reference Lake B. Annex A.5-1 presents the full phytoplankton biomass dataset.



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

Figure A.5-1: Lake Phytoplankton Biomass (as Chlorophyll a), Doris Project, August 2018

Annex A.5-1: Lake Phytoplankton Biomass Data, Doris Project, 2018

Lake Site	Replicate #	Date Sampled	Depth Sampled (m)	ALS Sample ID	Phytoplankton Biomass (µg chl *a* /L)	Mean	SE
Doris North	1	19-Aug-18	1	L2154438-1	15.4	14.54	0.436
	2	19-Aug-18	1	L2154438-2	13.98		
	3	19-Aug-18	1	L2154438-3	14.25		
Reference B	1	26-Aug-18	1	L2154438-4	0.607	0.658	0.04
	2	26-Aug-18	1	L2154438-5	0.629		
	3	26-Aug-18	1	L2154438-6	0.737		

Note:
SE = standard error of the mean

A.6 References

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APPENDIX B 2018 EVALUATION OF EFFECTS SUPPORTING INFORMATION

March 2019

DORIS PROJECT

2018 Aquatic Effects Monitoring Program Report

Appendix B: 2018 Evaluation of Effects Supporting Information

ERM Consultants Canada Ltd.
1111 West Hastings Street
15th Floor
Vancouver, BC

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Appendix B: 2018 Evaluation of Effects Supporting Information

B.1 Historical Data Selection Rationale for Evaluation of Effects

The tables presented in this section present a summary of the water quality and phytoplankton biomass data collected at the AEMP lake sites, as well as the rationale for the inclusion or exclusion of certain baseline data from the 2018 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 2018 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 2018 sampling locations, methodology, and sampling depth.

Table B.1-1: Historical Data Selection Rationale for Water Quality Evaluation of Effects, Doris Project, 2018

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	

Sampling Sites	Years Sampled	Months Sampled	Data Included in Graphs and Statistical Analyses	Data Excluded from Graphs and Statistical Analyses	Rationale for Exclusion
	2005	July, August, September	All	None	
	2006 to 2008	May, July, August, September	All	None	
	2009	April, August	All	None	
	2010 to 2017	April, July, August, September	All	None	
Reference Lake B	2009	May, August	All	None	
	2010 to 2017	April, July, August, September	All	None	

B.1.2 Phytoplankton Biomass

Table B.1-2 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 2018 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 2018 AEMP sampling sites, and the comparability of sampling methodologies.

Table B.1-2: Historical Data Selection Rationale for Phytoplankton Biomass (as Chlorophyll *a*) Evaluation of Effects, Doris Project, 2018

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 2018).
	2006	September	None	All	Phytoplankton biomass sampling method not described in report.

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
	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 2018).
	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 2017	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 2017	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.

B.2 Statistical Methodology for Water Quality and Phytoplankton Biomass Evaluation of Effects

B.2.1 General Statistical Methodology

Regression models were used to assess data from Doris Lake North and examine any time trends over the monitoring period (2003 to 2018). Hypothesis tests were conducted to assess time trends for particular water or biological 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 are presented graphically to support the interpretation of results. Sections B.2.2 to B.2.3 describe modifications to the general methodology for specific variables.

B.2.1.1 Non-detects

If all data in the current assessment year (2018) 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. For LME models, observations below the analytical detection limit were substituted by half the detection limit. Then, the lake, year (as well as depth and season, if applicable) average was calculated. For Tobit models, the fact that each censored measurement falls between 0 and the detection limit was used to obtain the estimated range for the average in a given lake and year (as well as depth and season, if applicable). This interval was used in the Tobit regression analysis.

B.2.1.2 Linear Mixed Effects (LME) Regression

Model Form

Let y denote a water 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:

$$y = Lake + s(Year) + Lake*s(Year),$$

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 10 to 16 years of data are available, the number of knots chosen was 4 and 5 for variables with 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 a 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 $\widehat{y}(x)$ denote the fitted value for lake *i* in year x, defined as:

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

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

$$e_{ix} = y_i(x) - \hat{y}_i(x).$$

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, …, 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 $y_1,...,y_{n1}$ and $y'_1,....,y'_{n2}$ 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 the 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 3.5.0 (R Development Core Team 2018). The following versions of packages were used for the analyses:

- dplyr (0.7.7);
- stringr (1.3.1);
- tidyr (0.8.2);
- lubridate (1.7.4);
- ggplot2 (3.1.0);
- knitr (1.20);
- 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 … *K*.

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

H_a: $\beta_{kMj} \neq \beta_{kRj}$ for at least one *k* = 1 … *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 Phytoplankton Biomass

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.

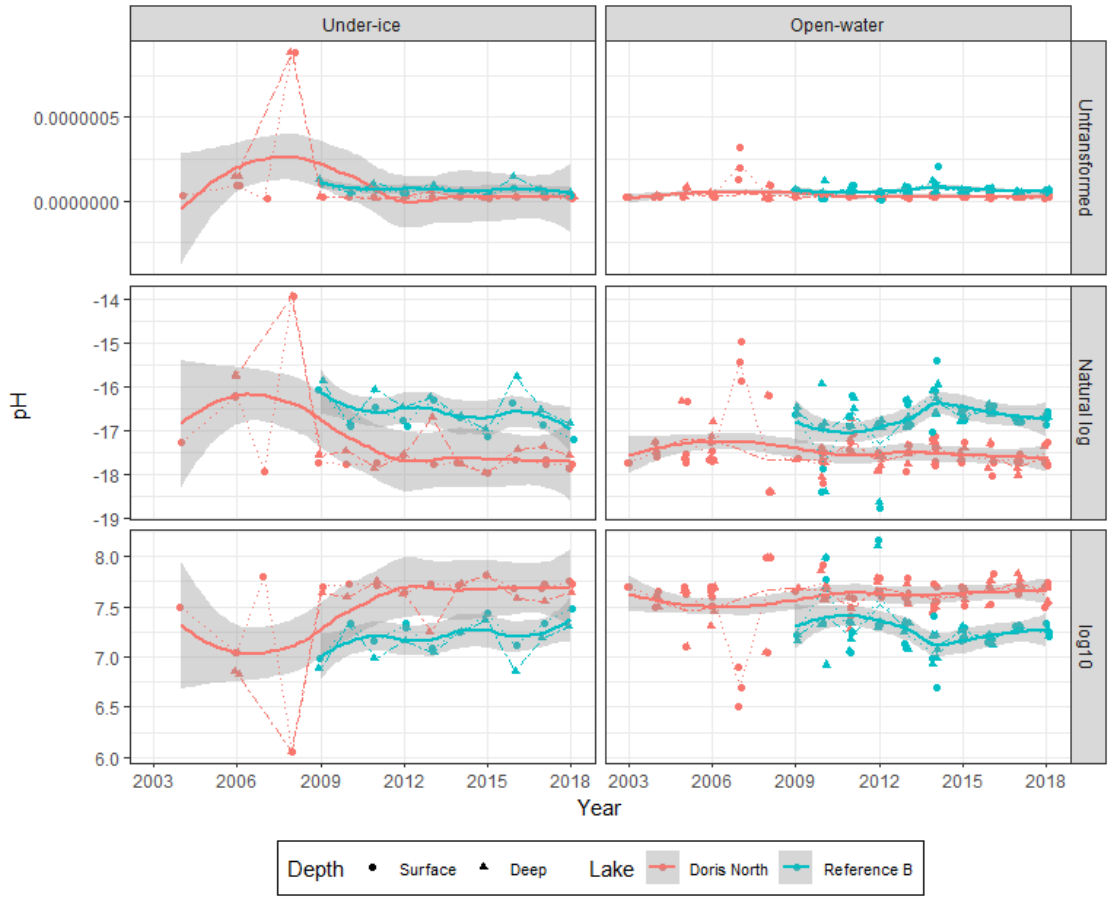
B.3 Statistical Results for Water Quality and Phytoplankton Biomass Evaluation of Effects

B.3.1 Water Quality

B.3.1.1 Analysis of pH

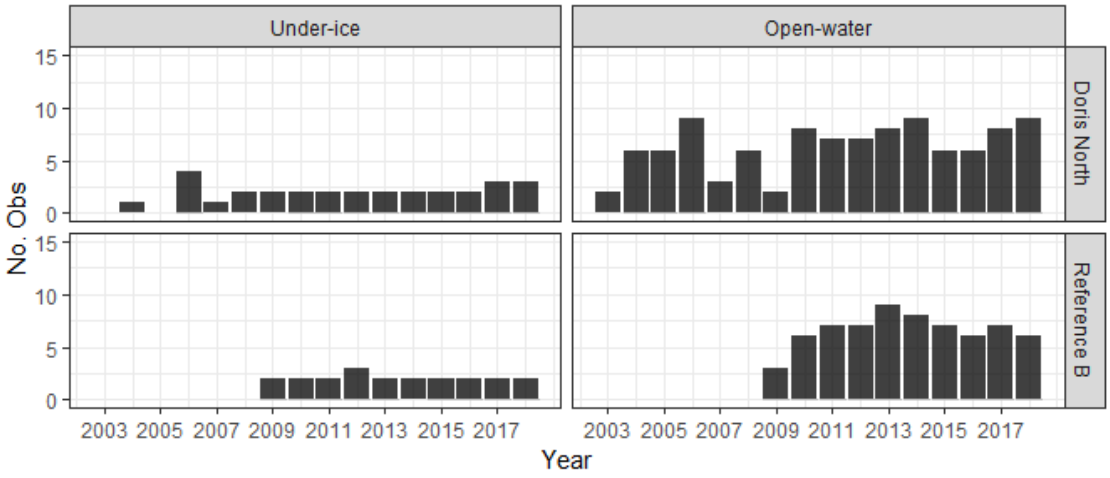
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

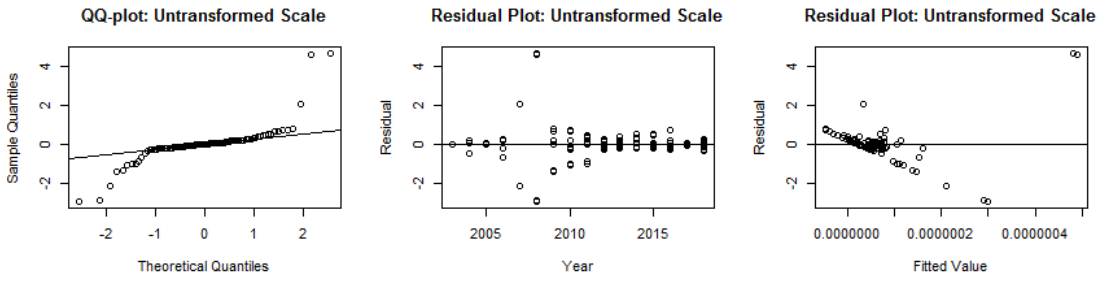
The sample sizes and median values per lake and season are summarized in the table below.

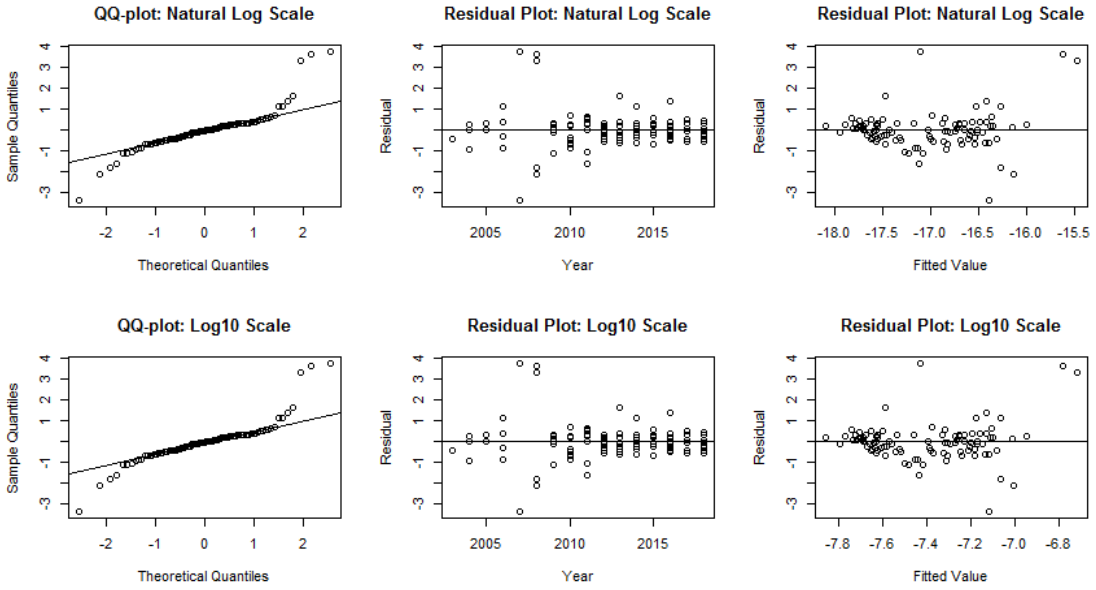
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	30	0	0	0.0000000
Doris North	Open-water	102	0	0	0.0000000
Reference B	Under-ice	21	0	0	0.0000001
Reference B	Open-water	66	0	0	0.0000001

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 on the untransformed, natural log, and log base 10 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	4.564664
17	Doris North	2008	Under-ice	Surface	0.0000009	0.0000005	4.659166

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
13	Doris North	2007	Under-ice	Surface	0.0000000	-16.39251	-3.380490
15	Doris North	2007	Open-water	Surface	0.0000002	-17.10923	3.776685
16	Doris North	2008	Under-ice	Deep	0.0000009	-15.46804	3.315251
17	Doris North	2008	Under-ice	Surface	0.0000009	-15.61260	3.626967

Outliers on log10 scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
13	Doris North	2007	Under-ice	Surface	0.0000000	-7.119175	-3.380490
15	Doris North	2007	Open-water	Surface	0.0000002	-7.430443	3.776685
16	Doris North	2008	Under-ice	Deep	0.0000009	-6.717685	3.315251
17	Doris North	2008	Under-ice	Surface	0.0000009	-6.780465	3.626967

The log10 data meets residual assumptions better than the untransformed data. Analysis proceeds with log10 data since pH is in log base 10 units. However, there were outliers 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	17.150	3	0.0007
Compare to Reference B	2.352	3	0.5026

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

Open-Water

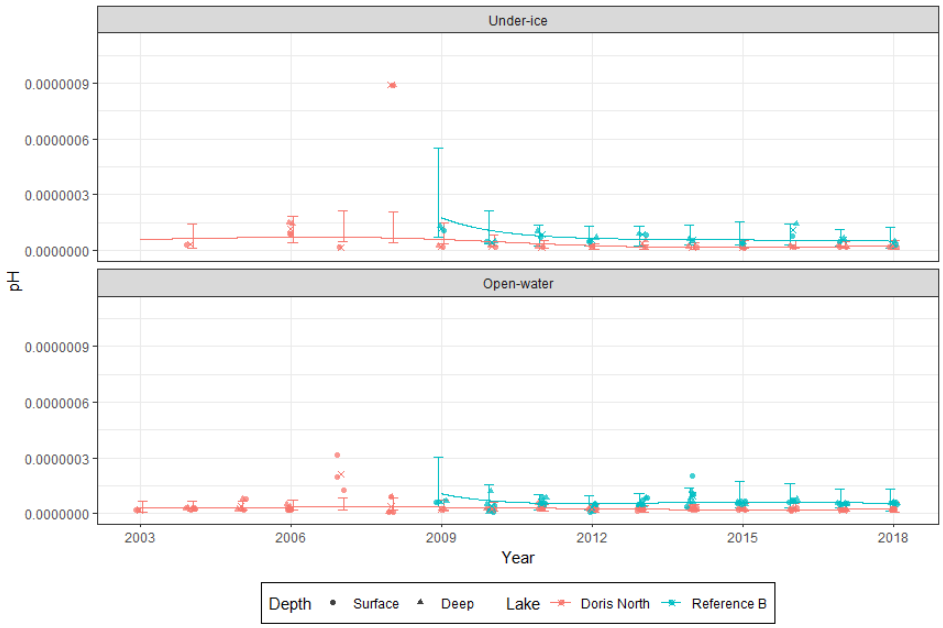
Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.171	3	0.5377

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

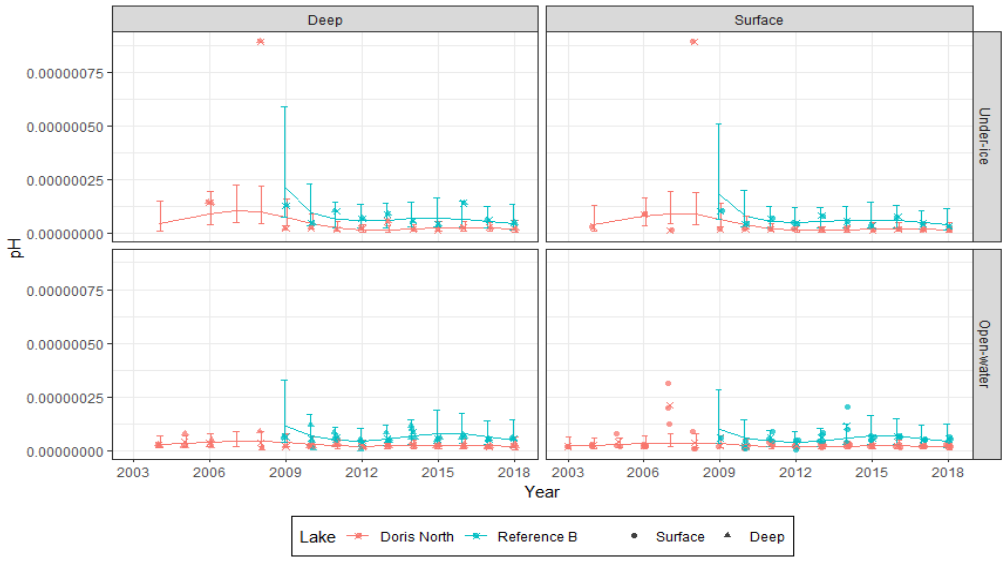
Observed Data and Fitted Values

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:



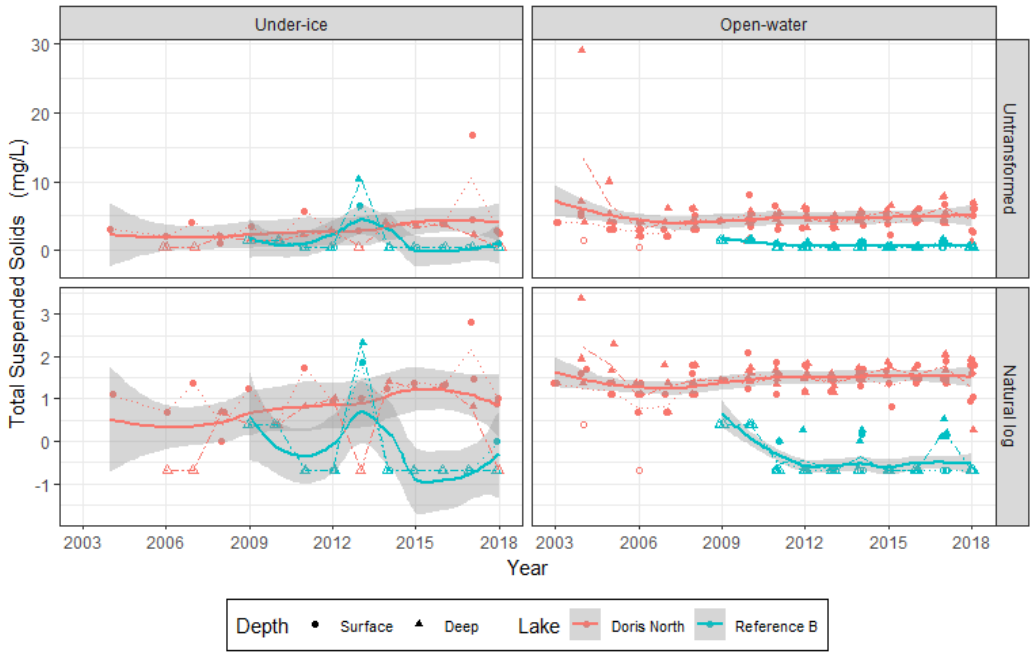
Plot of observed and fitted data separated by depth:



B.3.1.2 Analysis of Total Suspended Solids

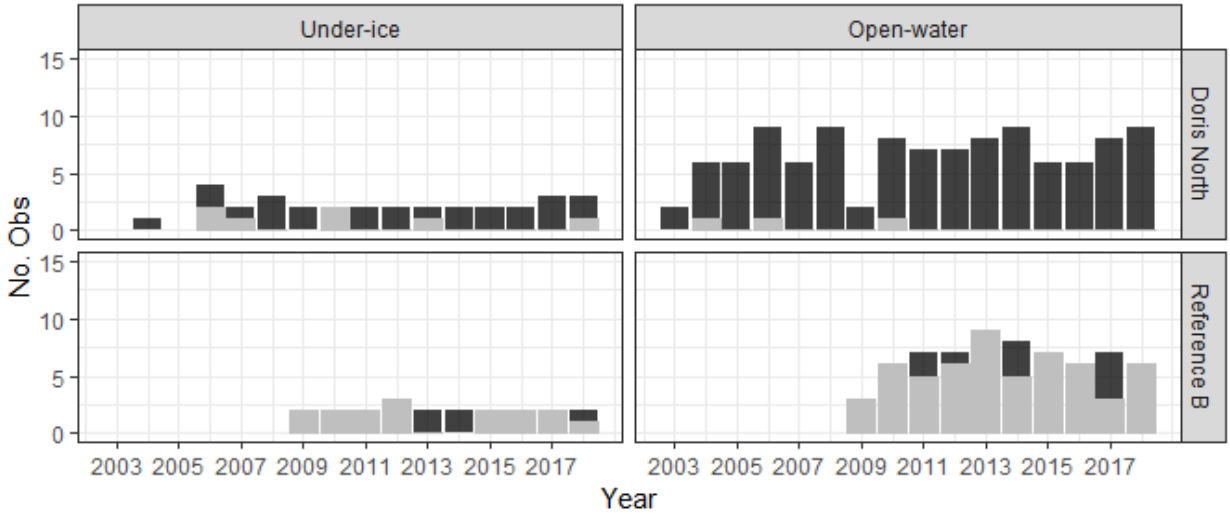
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

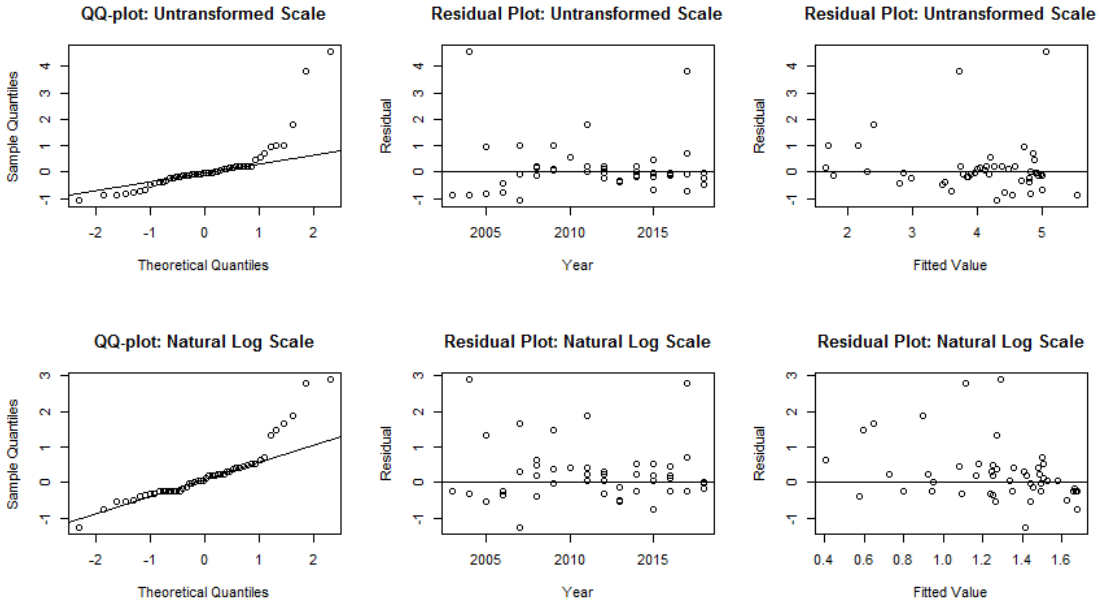
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	32	8	25	2.80
Doris North	Open-water	108	3	3	4.35
Reference B	Under-ice	21	18	86	1.00
Reference B	Open-water	66	56	85	1.00

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	5.068027	4.559736
53	Doris North	2017	Under-ice	Surface	10.60000	3.714577	3.798494

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	11.472	3	0.0094

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

Open-Water

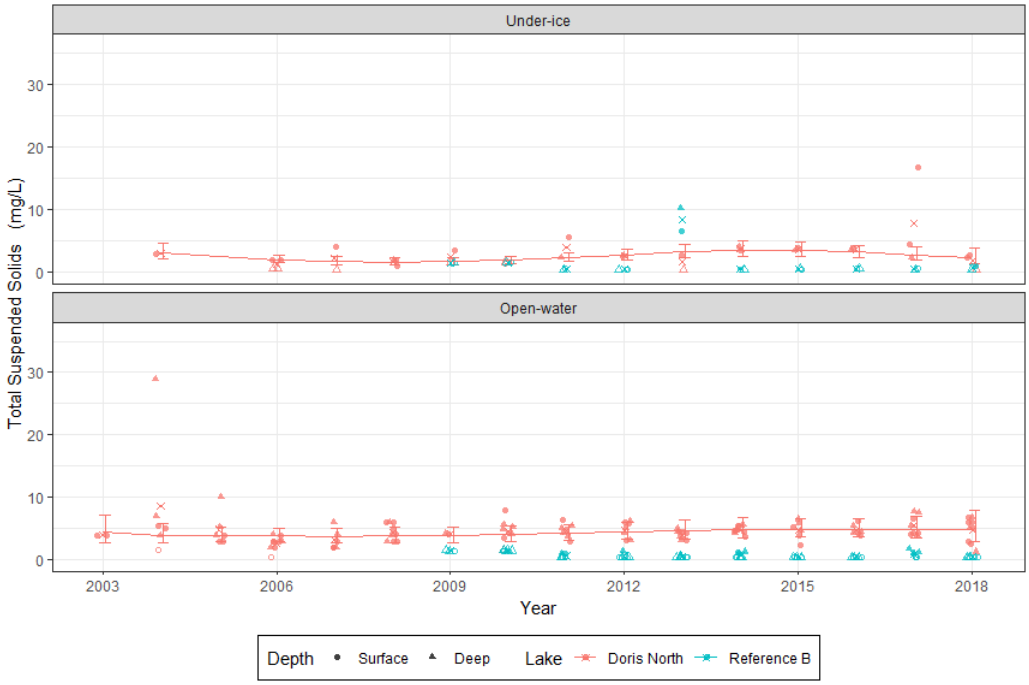
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.638	3	0.6507

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

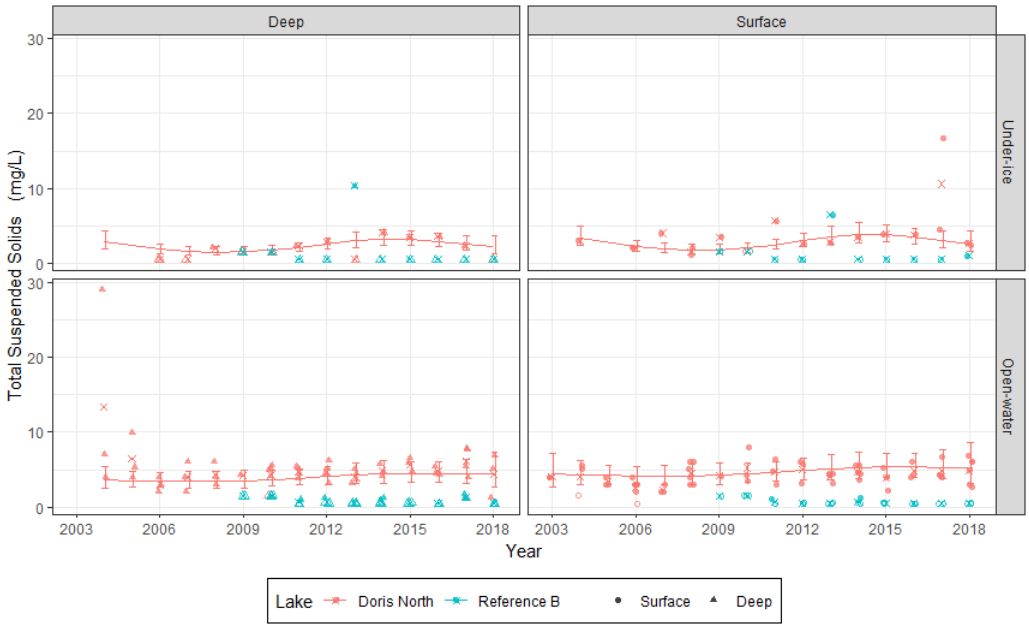
Observed Data and Fitted Values

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:



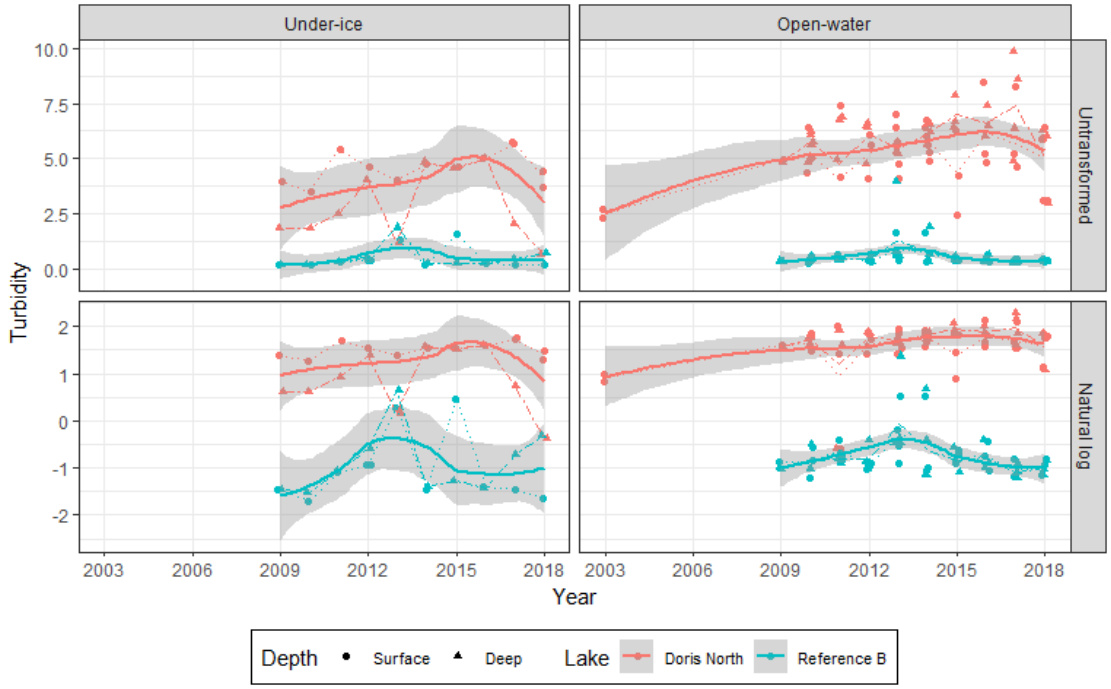
Plot of observed and fitted data separated by depth:



B.3.1.3 Analysis of Turbidity

Observed Data

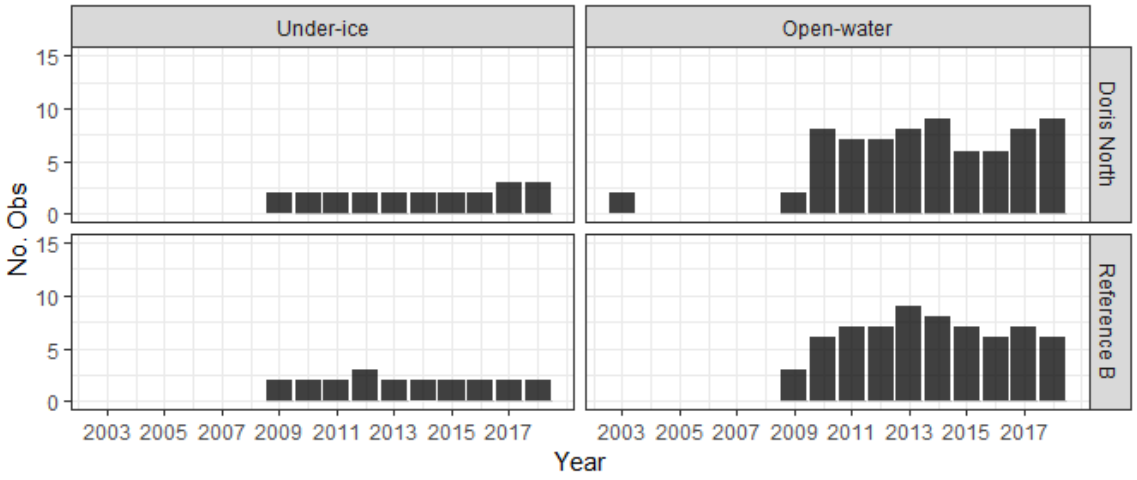
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



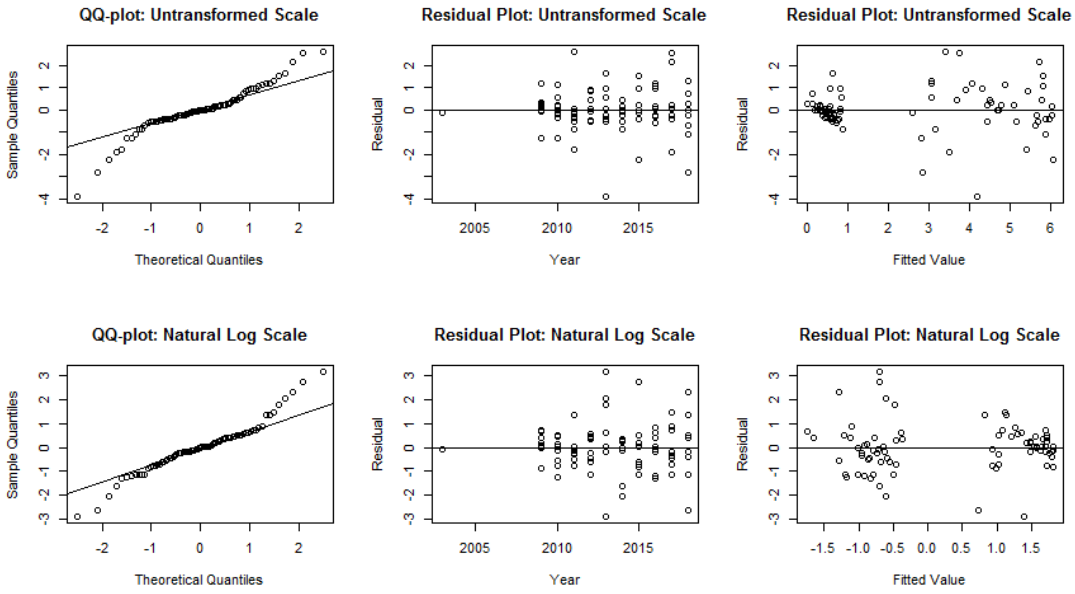
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	22	0	0	4.245
Doris North	Open-water	72	0	0	5.765
Reference B	Under-ice	21	0	0	0.280
Reference B	Open-water	66	0	0	0.415

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:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
36	Doris North	2013	Under-ice	Deep	1.18	4.191906	-3.902093

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
81	Reference B	2013	Under-ice	Deep	1.89	-0.6944216	3.172274

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed 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	13.664	3	0.0034
Compare to Reference B	3.467	3	0.3251

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

Open-Water

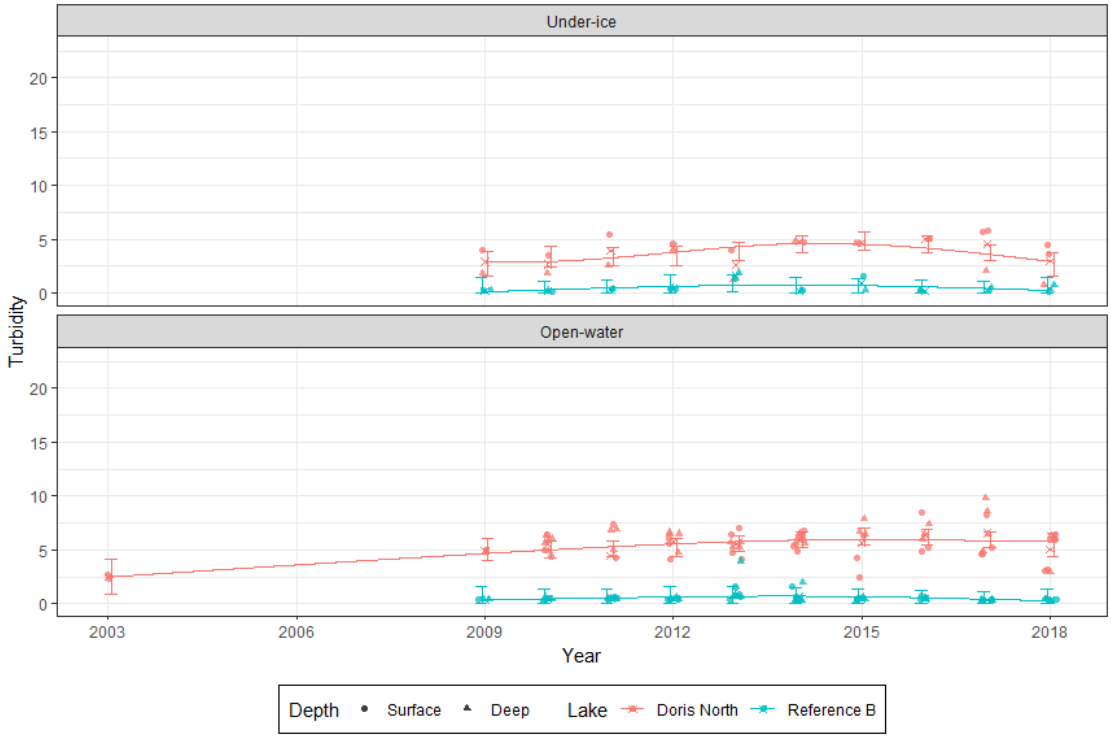
Analysis	Chi.sq	DF	P.value
Compare to slope 0	21.023	3	0.0001
Compare to Reference B	2.541	3	0.4680

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

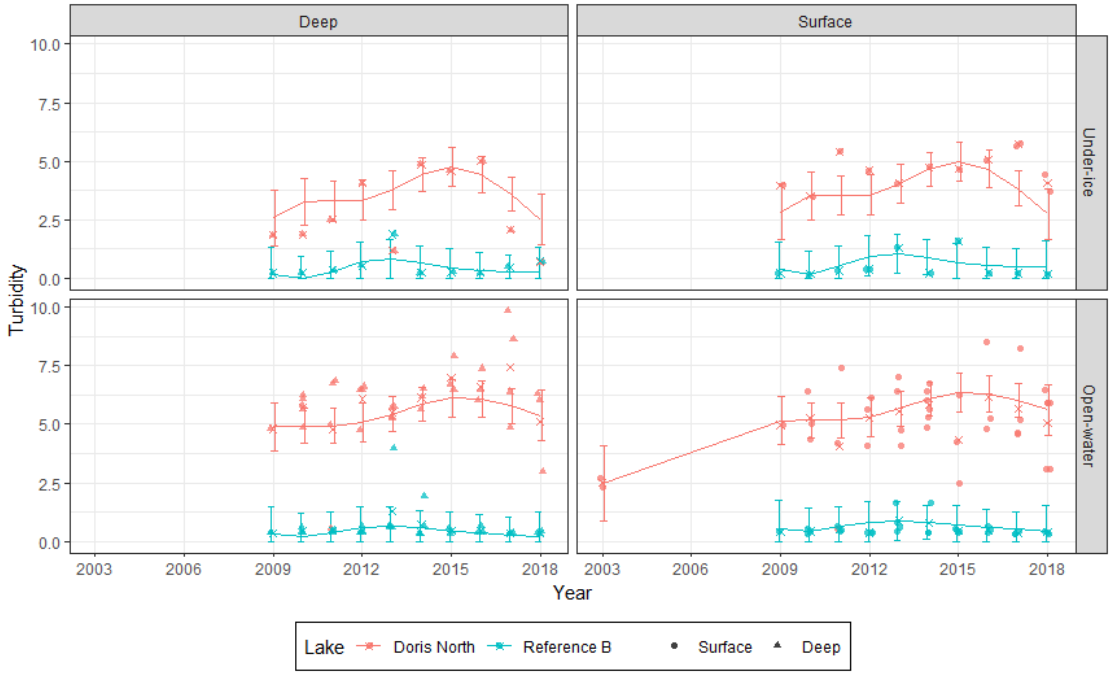
Observed Data and Fitted Values

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:



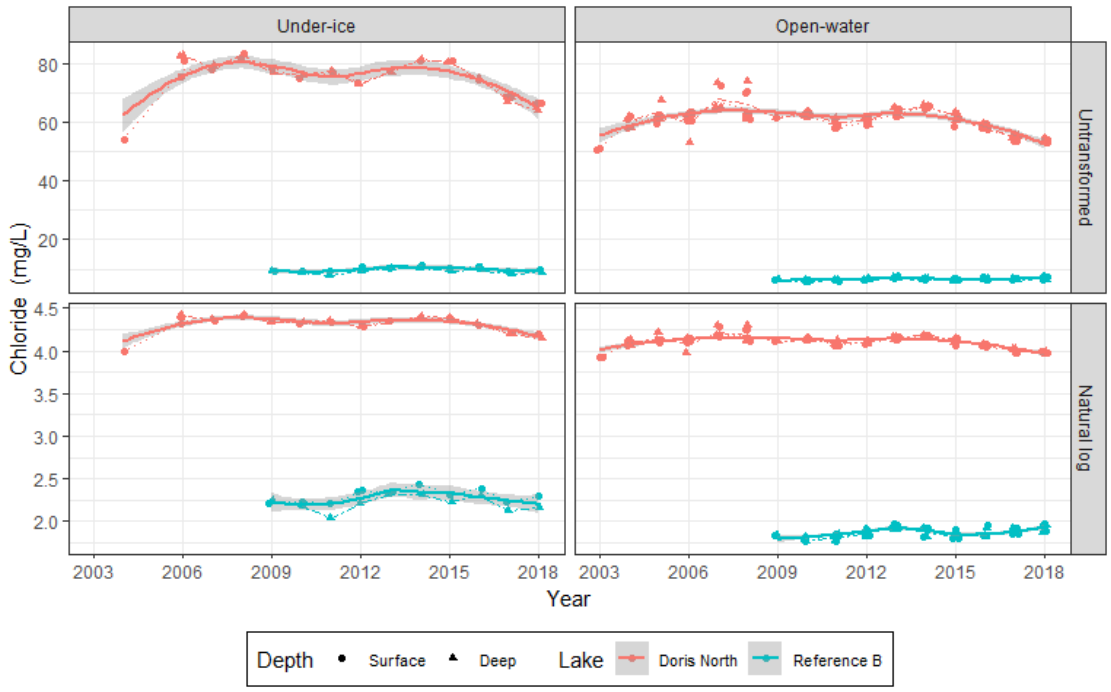
Plot of observed and fitted data separated by depth:



B.3.1.4 Analysis of Chloride

Observed Data

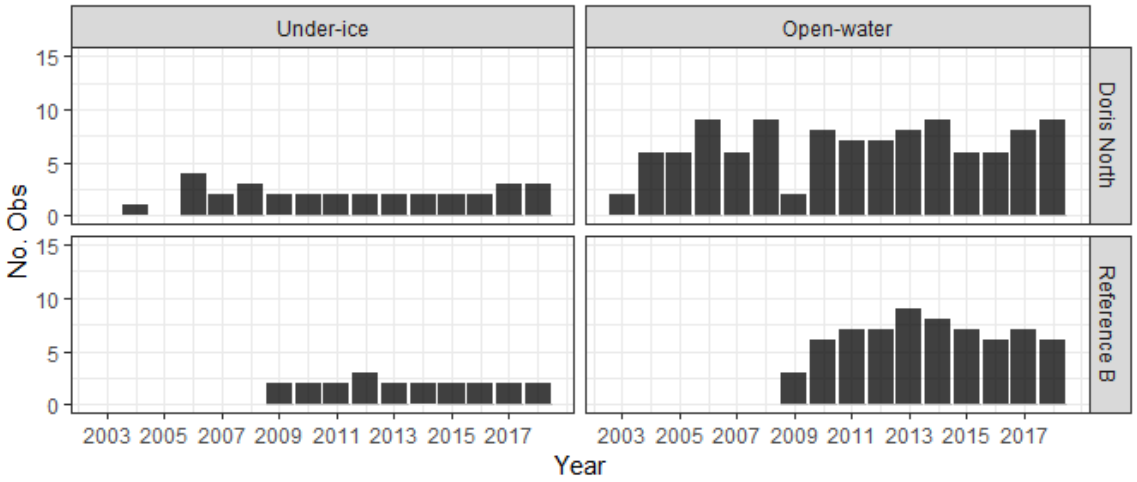
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



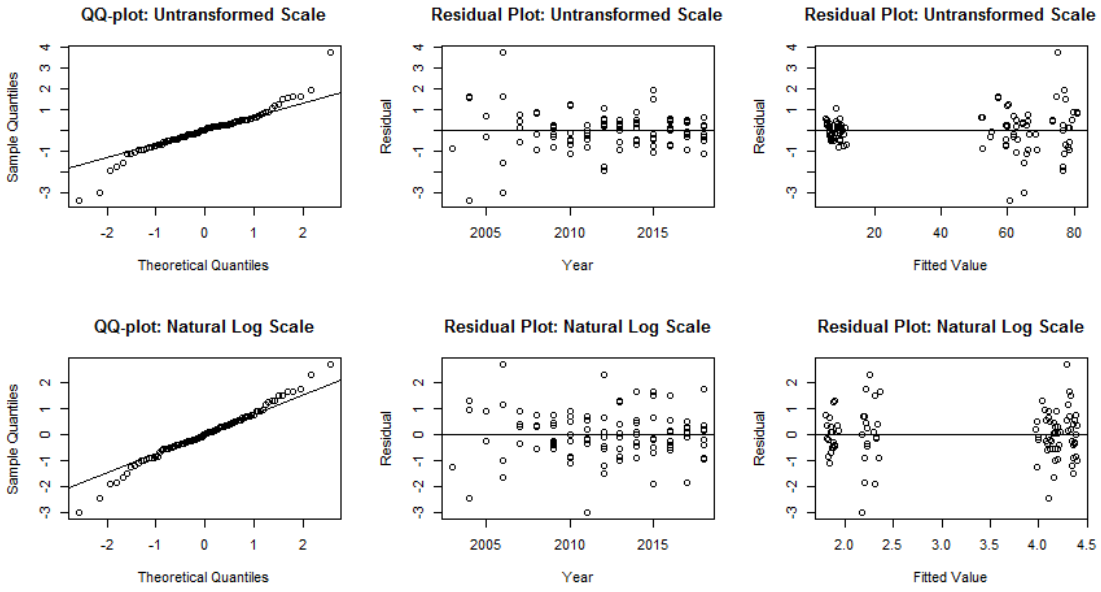
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	32	0	0	76.800
Doris North	Open-water	108	0	0	61.385
Reference B	Under-ice	21	0	0	9.390
Reference B	Open-water	66	0	0	6.395

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
3	Doris North	2004	Under-ice	Surface	54.00	60.64682	-3.384824
8	Doris North	2006	Under-ice	Deep	82.35	74.95222	3.767238
10	Doris North	2006	Open-water	Deep	59.20	65.12897	-3.019263

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
64	Reference B	2011	Under-ice	Deep	7.66	2.170416	-3.029727

The natural log transformed model 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	32.807	3	0.0000
Compare to Reference B	24.004	3	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

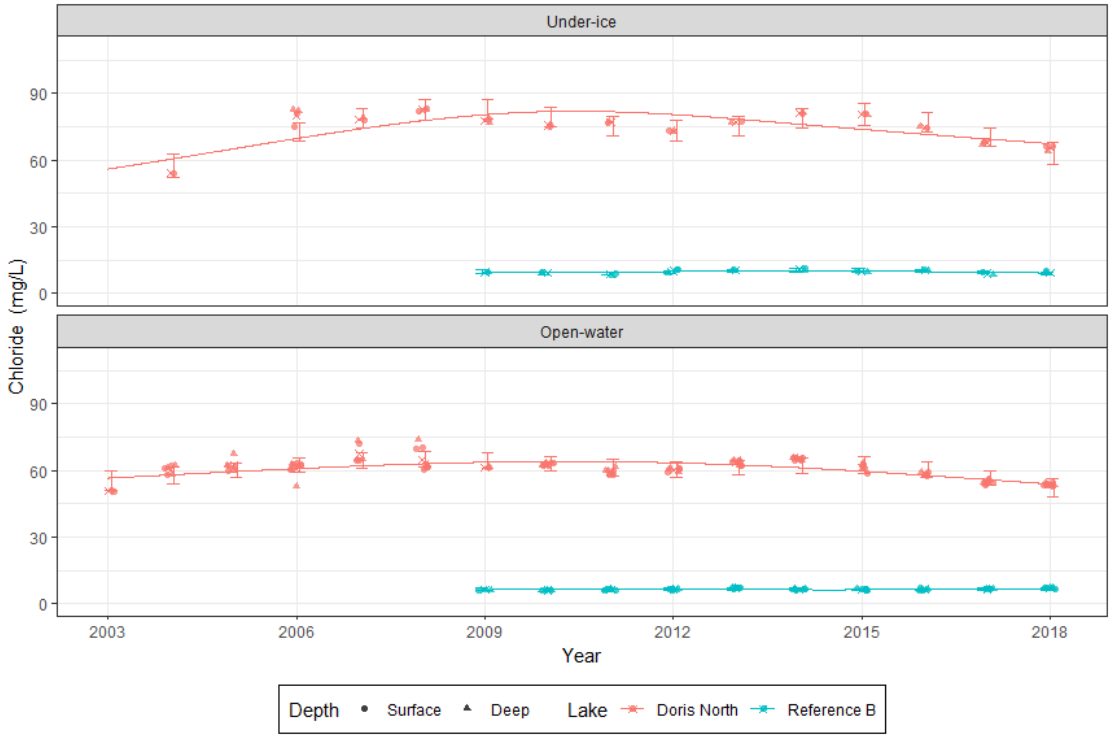
Analysis	Chi.sq	DF	P.value
Compare to slope 0	13.464	3	0.0037
Compare to Reference B	29.770	3	0.0000

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.

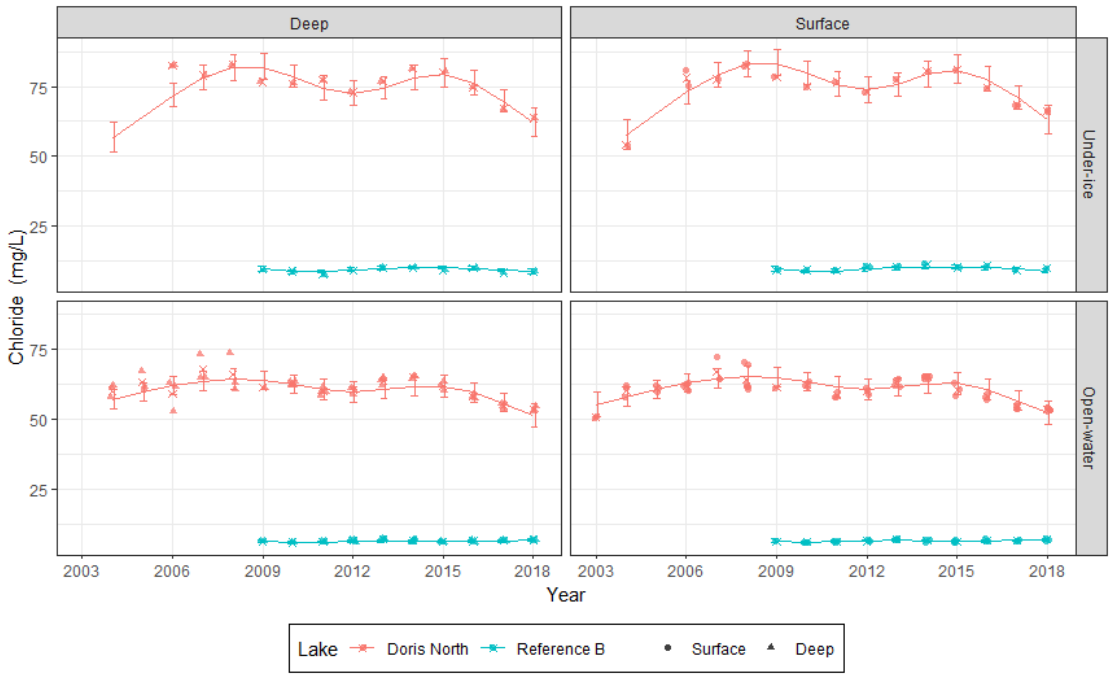
Observed Data and Fitted Values

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:



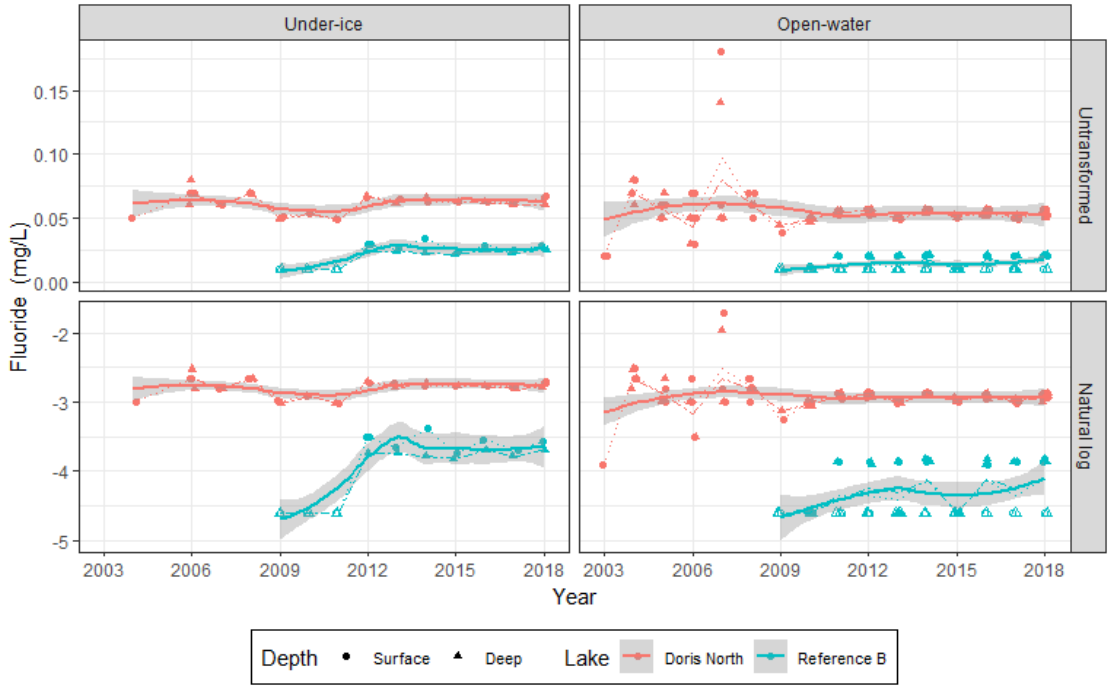
Plot of observed and fitted data separated by depth:



B.3.1.5 Analysis of Fluoride

Observed Data

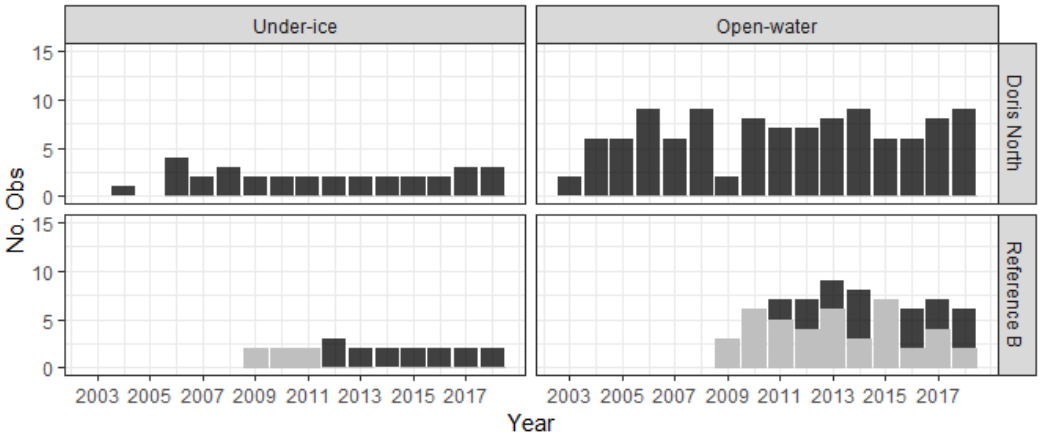
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



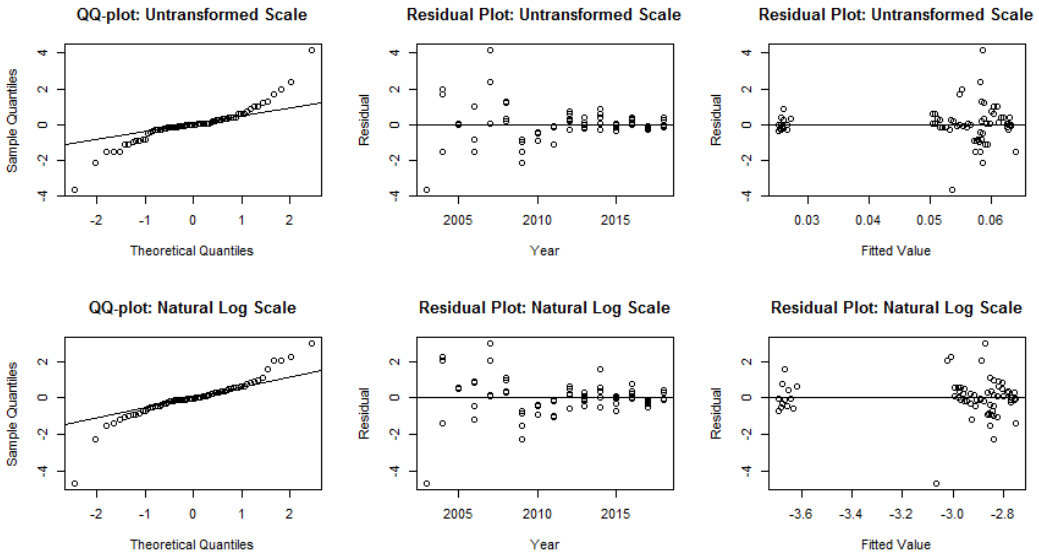
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	32	0	0	0.063
Doris North	Open-water	108	0	0	0.053
Reference B	Under-ice	21	6	29	0.024
Reference B	Open-water	66	42	64	0.020

Reference B Open-water exhibited more than 60% data under detection limit, and was removed from the analysis. Though only 29% of data in Reference B Under-ice was under detection limit, inclusion of Reference B 2009 - 2011 data led to unstable results. Hence, Reference B Under-ice 2009 - 2011 data were removed from the analysis, and 2012-2018 data were kept in the analysis. Reference B Under-ice exhibited more than 10% of data under detection limit. 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
1	Doris North	2003	Open-water	Surface	0.0200000	0.0537195	-3.697369
15	Doris North	2007	Open-water	Surface	0.0966667	0.0586582	4.167661

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2003	Open-water	Surface	0.02	-3.067082	-4.699505

The natural log transformed model 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	0.985	3	0.8048

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

Open-Water

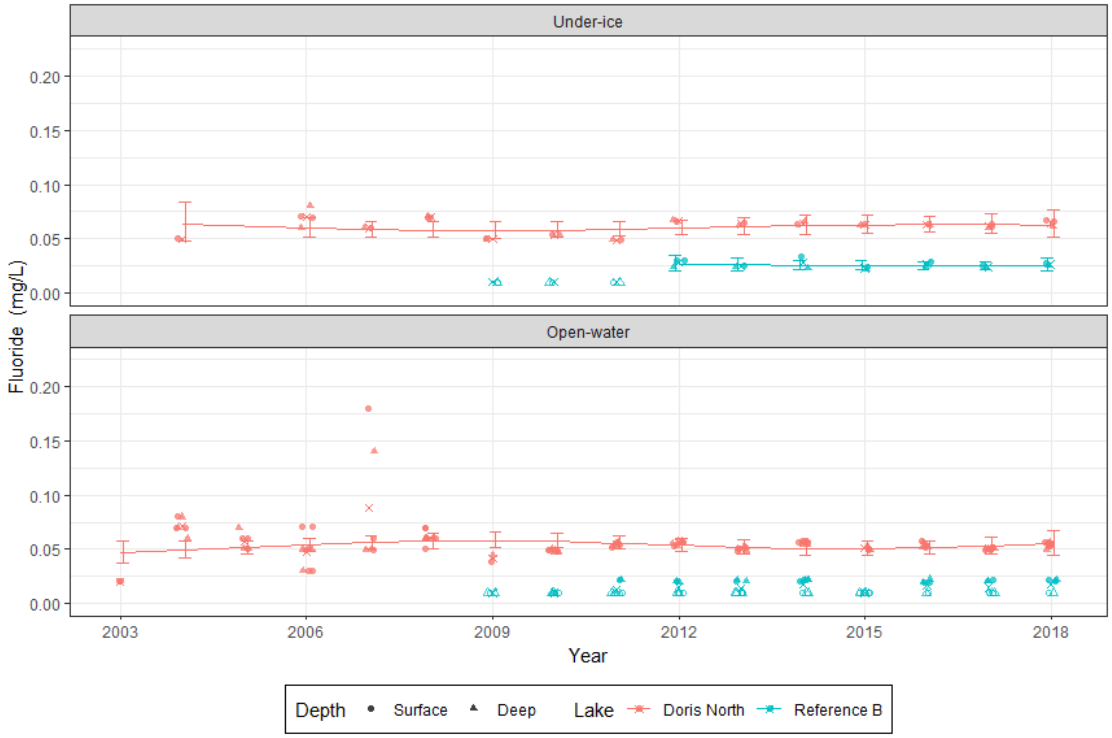
Analysis	Chi.sq	DF	P.value
Compare to slope 0	3.211	3	0.3603

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

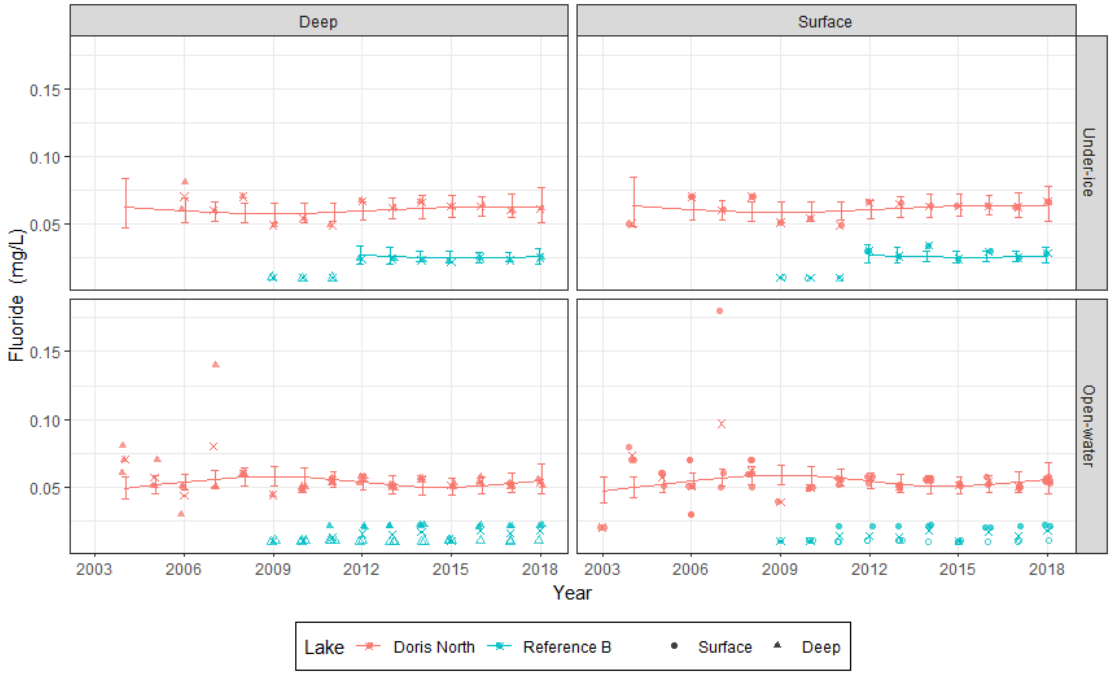
Observed Data and Fitted Values

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:



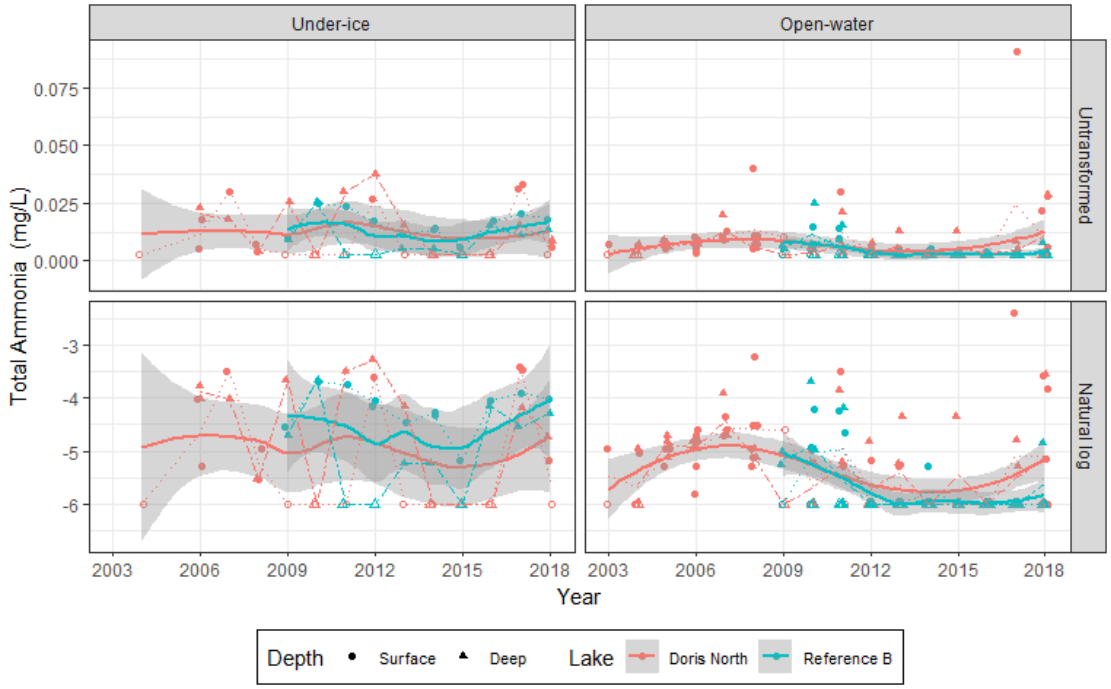
Plot of observed and fitted data separated by depth:



B.3.1.6 Analysis of Total Ammonia

Observed Data

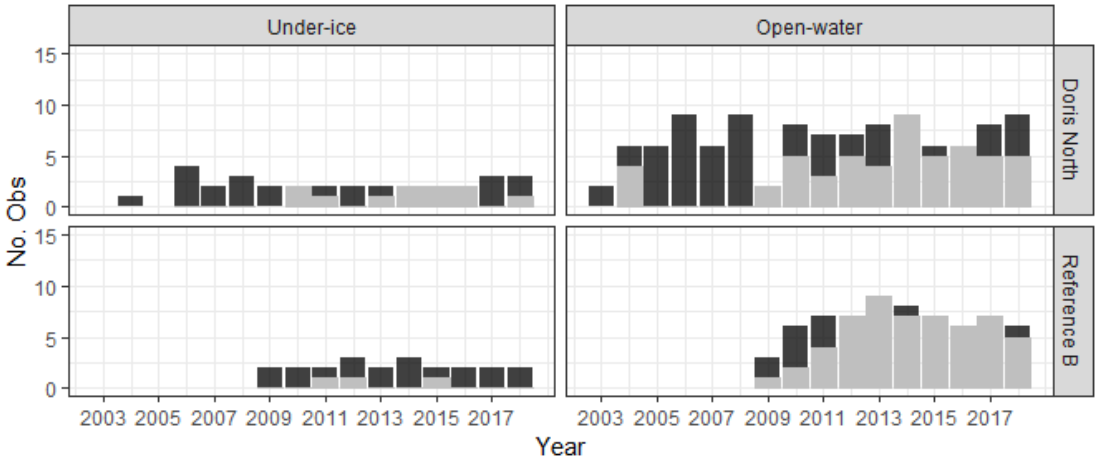
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



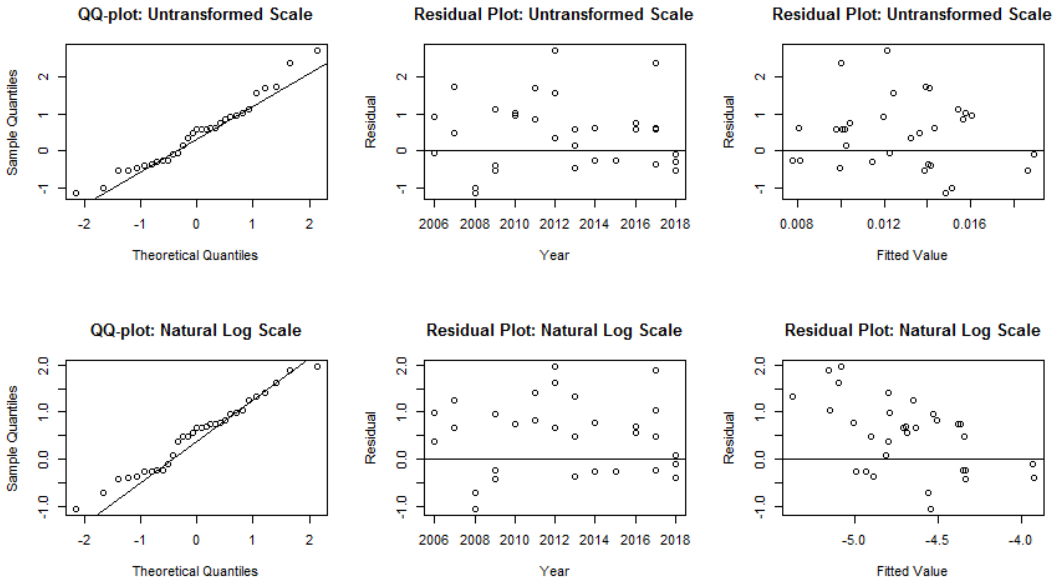
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	32	13	41	0.00535
Doris North	Open-water	108	54	50	0.00500
Reference B	Under-ice	22	3	14	0.01355
Reference B	Open-water	66	55	83	0.00500

Reference B Open-water exhibited more than 60% data under detection limit, and was removed from the analysis. Though only 50% of data in Doris North Open-water was under detection limit, inclusion of Doris North Open-water led to unstable results. Hence Open-water data were 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:

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

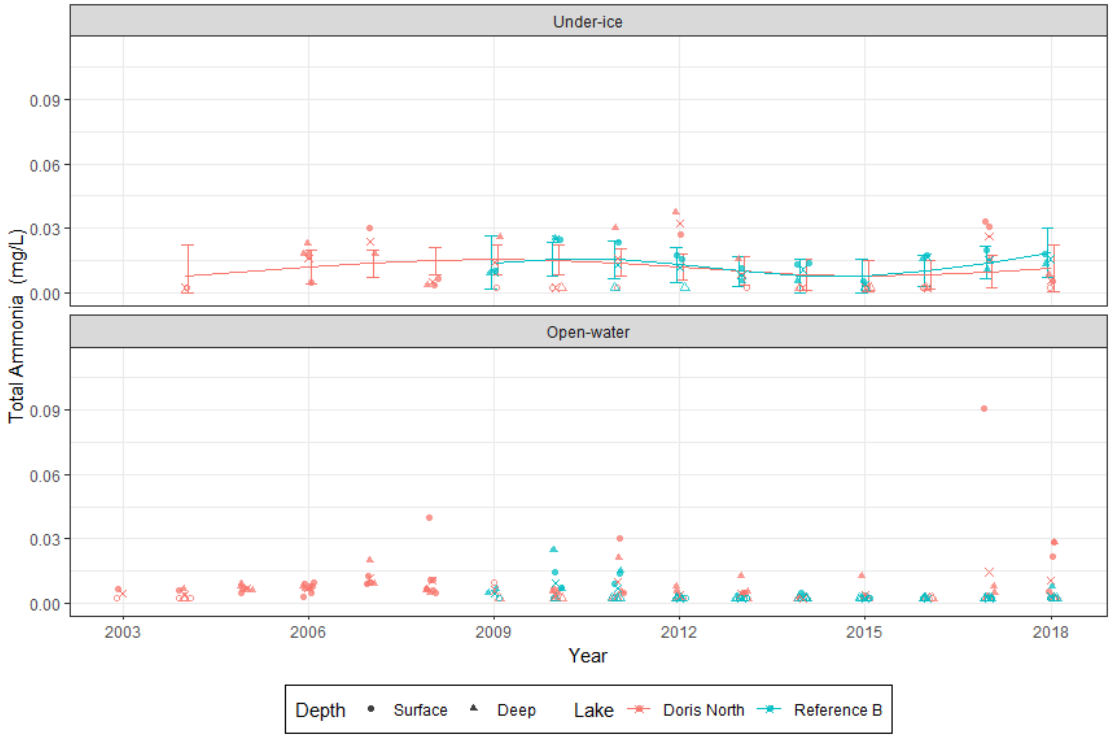
Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.148	3	0.5423

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

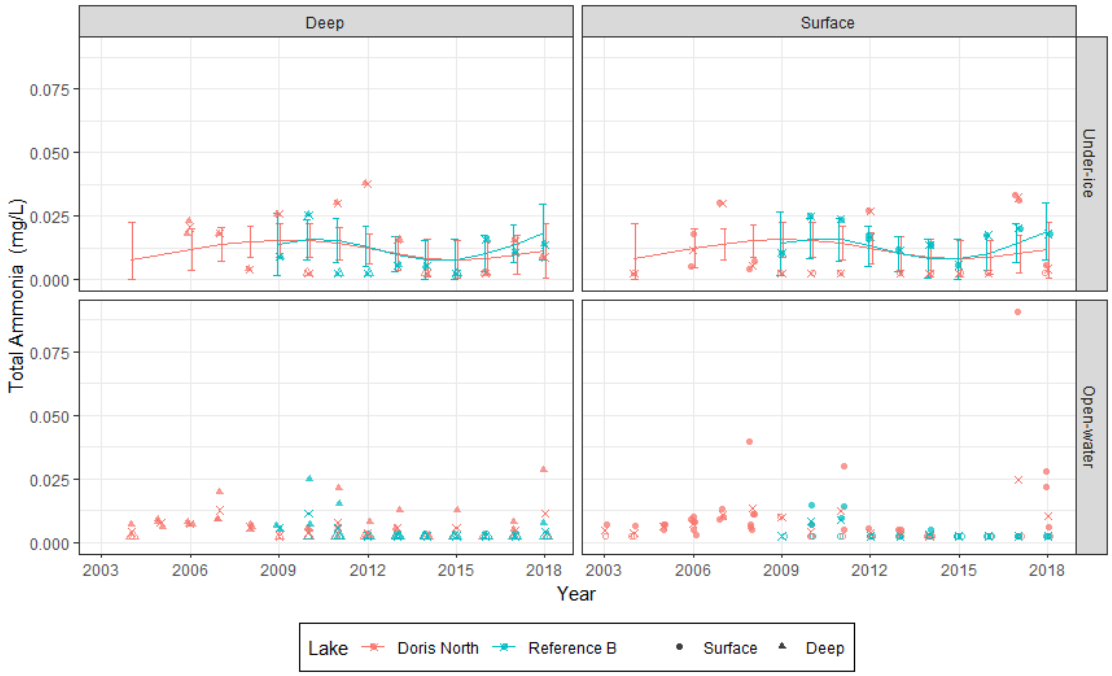
Observed Data and Fitted Values

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:



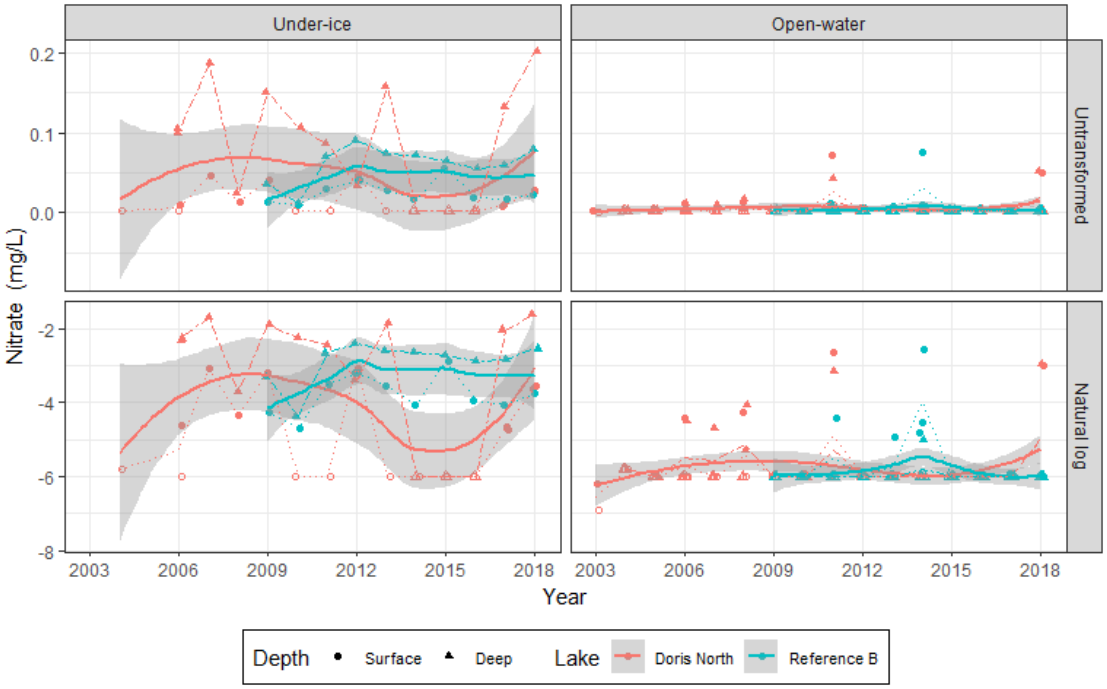
Plot of observed and fitted data separated by depth:



B.3.1.7 Analysis of Nitrate

Observed Data

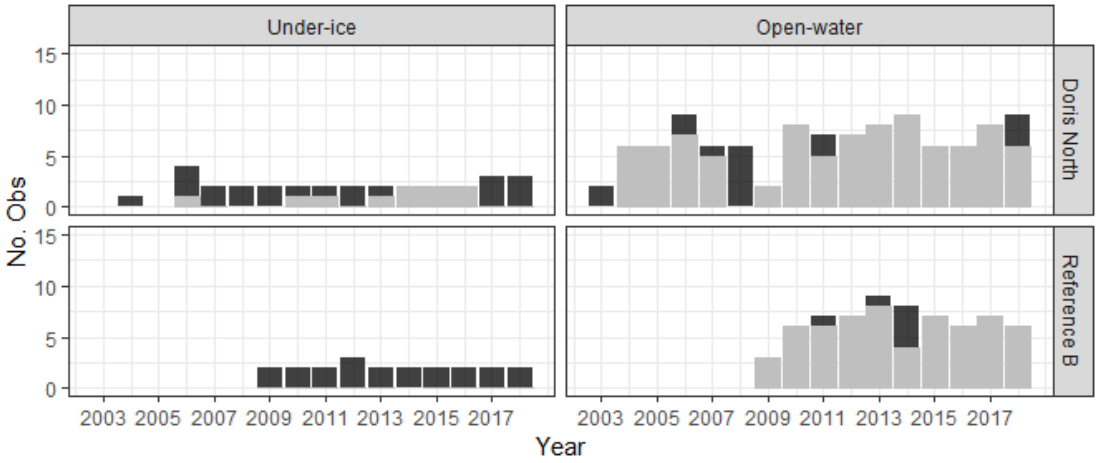
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



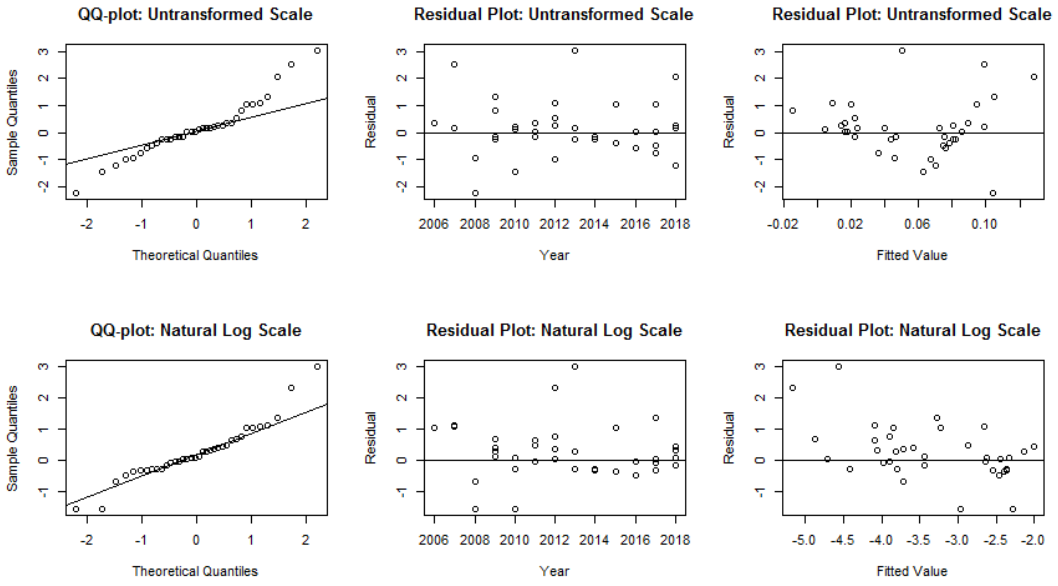
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	31	11	35	0.025
Doris North	Open-water	105	93	89	0.005
Reference B	Under-ice	21	0	0	0.041
Reference B	Open-water	66	60	91	0.005

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	0.0501286	3.038186

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

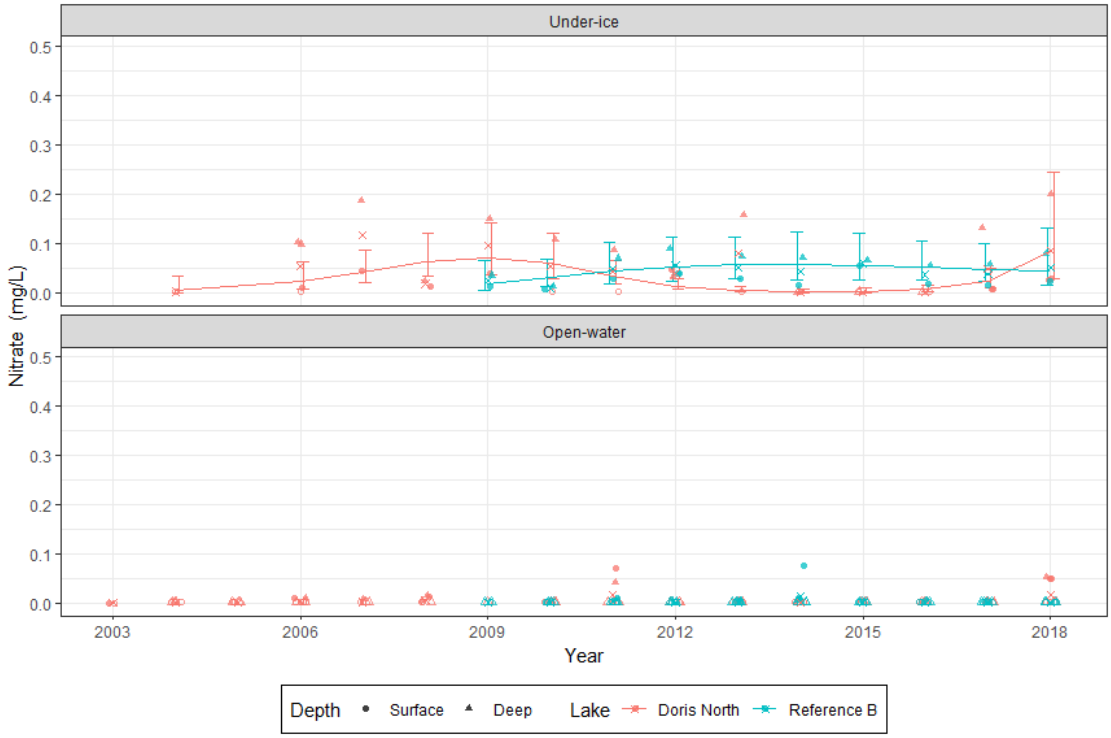
Analysis	Chi.sq	DF	P.value
Compare to slope 0	24.704	3	0.0000
Compare to Reference B	21.296	3	0.0001

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.

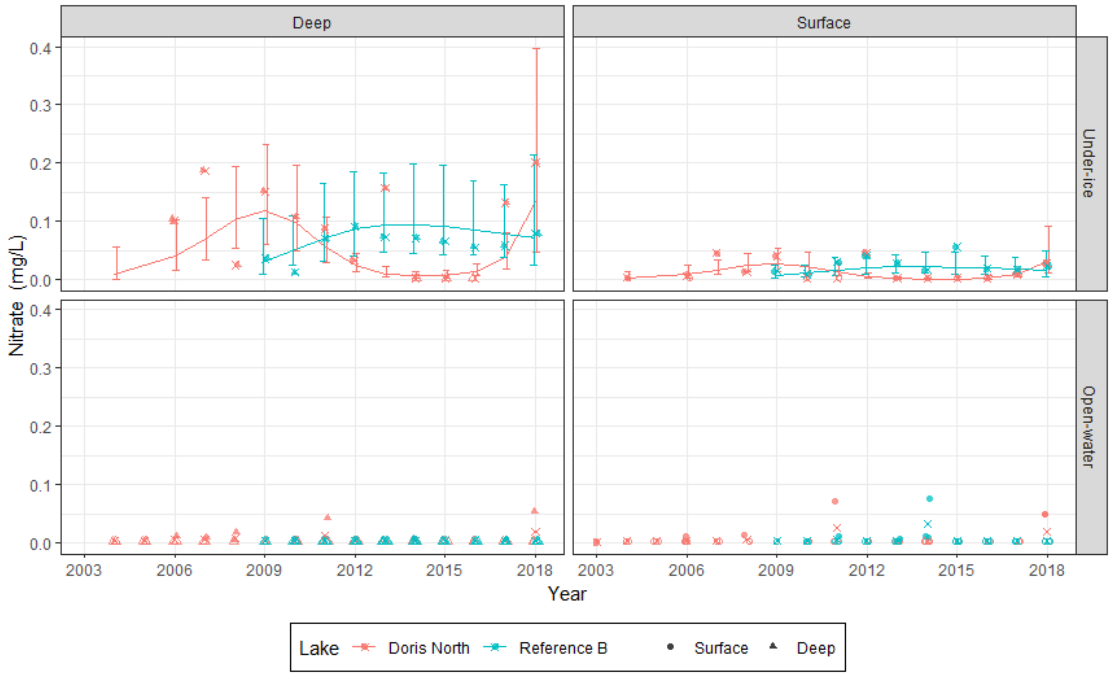
Observed Data and Fitted Values

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:



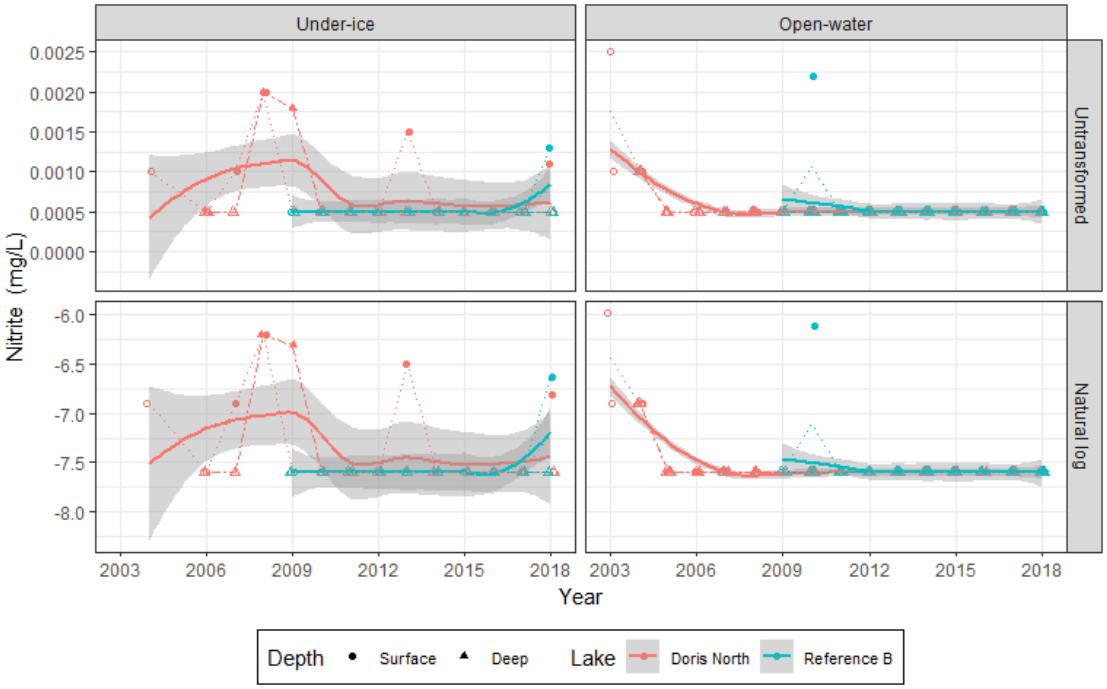
Plot of observed and fitted data separated by depth:



B.3.1.8 Analysis of Nitrite

Observed Data

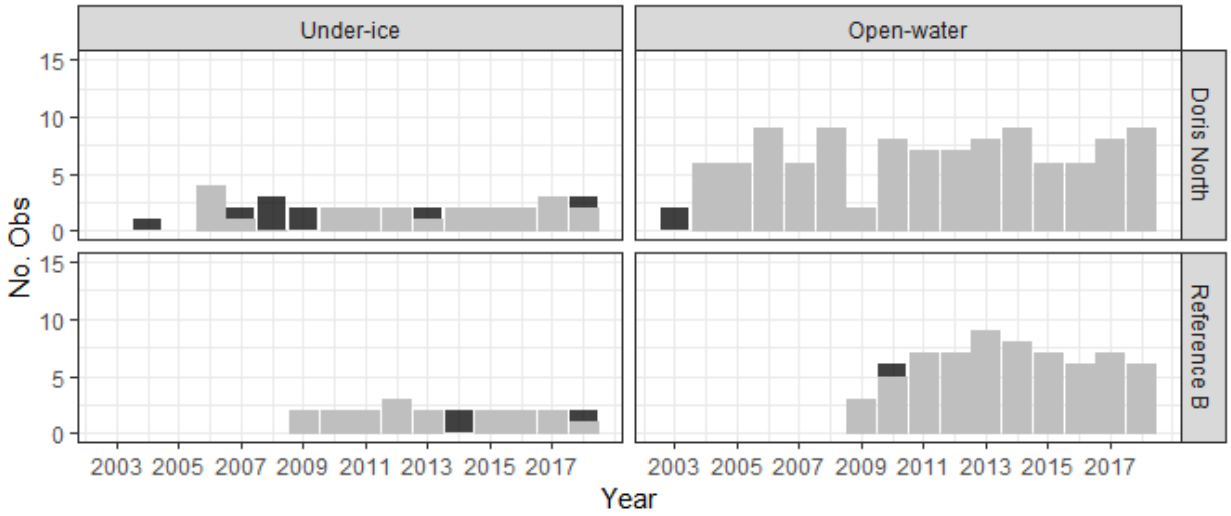
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



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

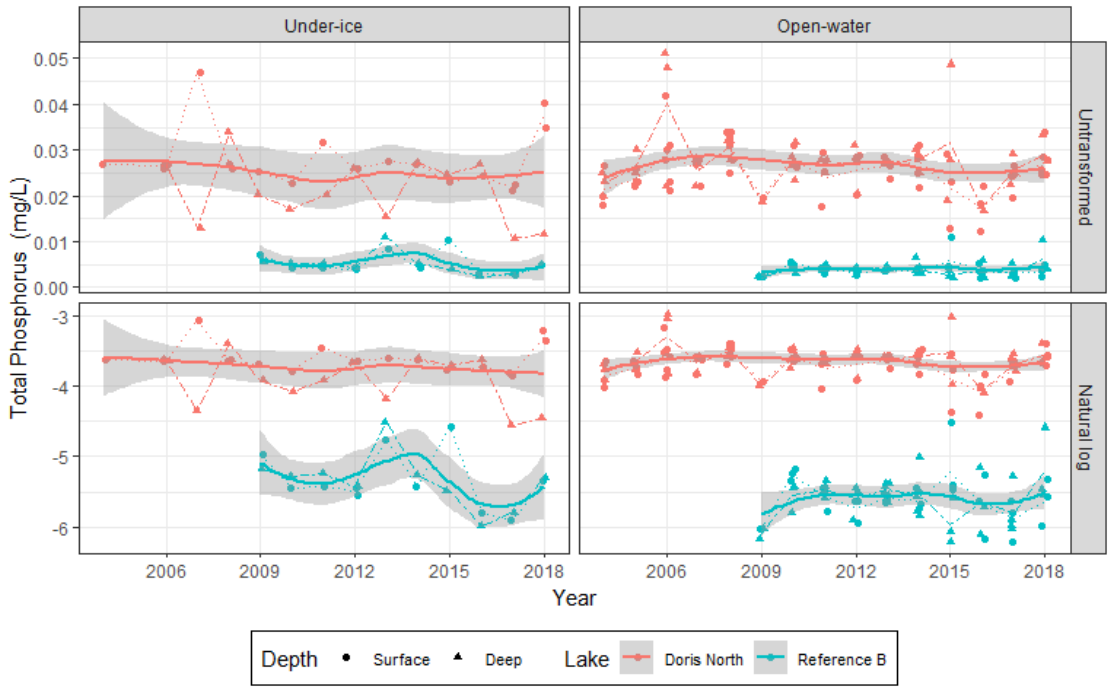
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	32	25	78	0.001
Doris North	Open-water	108	108	100	0.001
Reference B	Under-ice	21	20	95	0.001
Reference B	Open-water	66	65	98	0.001

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

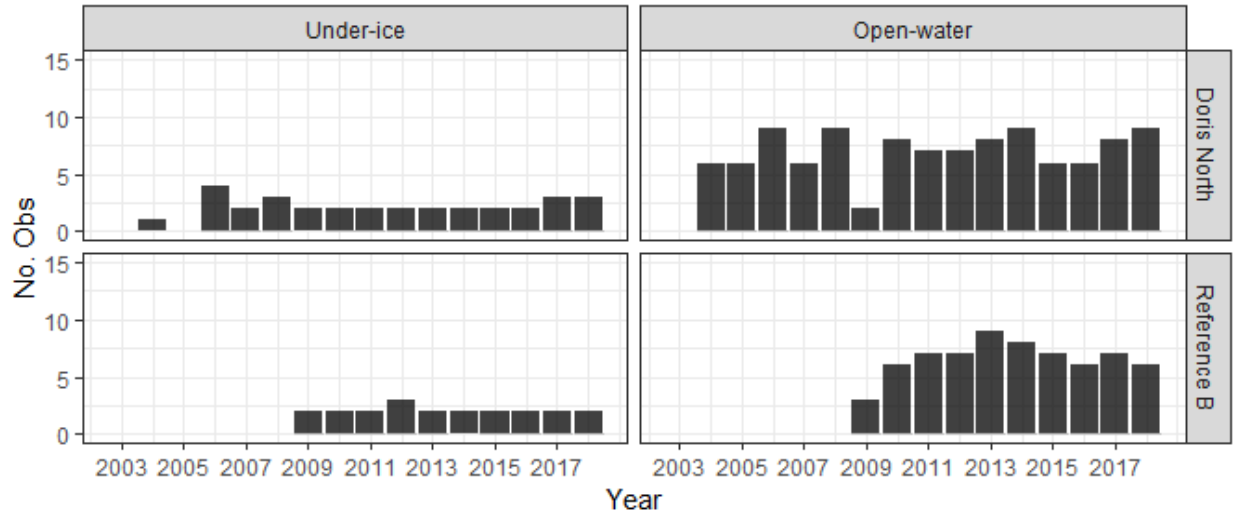
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

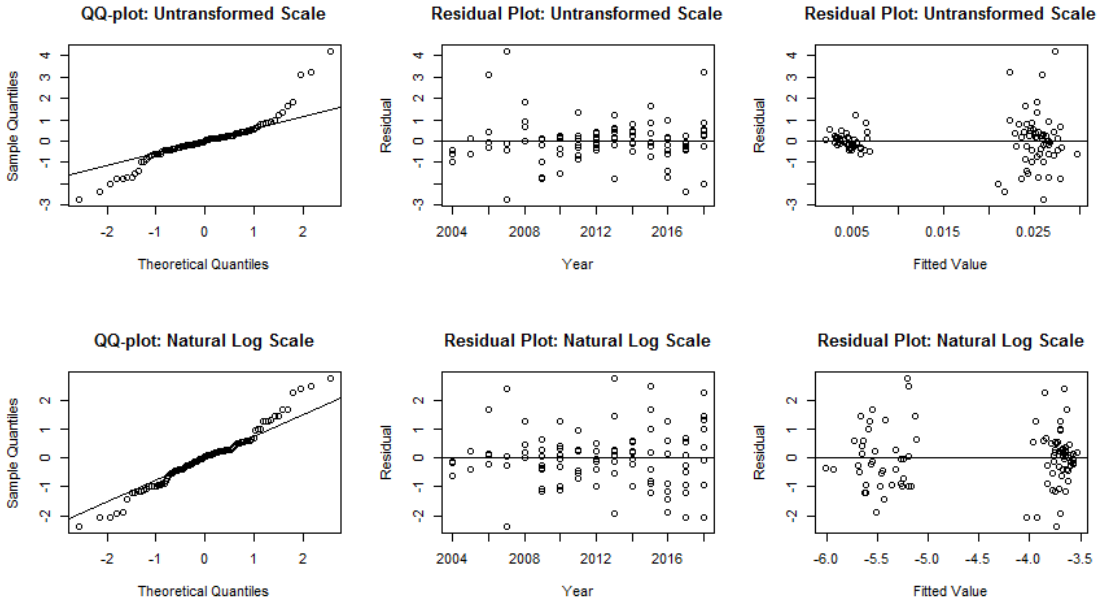
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	32	0	0	0.02600
Doris North	Open-water	106	0	0	0.02685
Reference B	Under-ice	21	0	0	0.00440
Reference B	Open-water	66	0	0	0.00380

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	0.0258641	3.089325
13	Doris North	2007	Under-ice	Surface	0.0470000	0.0272799	4.210449
57	Doris North	2018	Under-ice	Surface	0.0376000	0.0223613	3.253614

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	2.983	3	0.3943

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

Open-Water

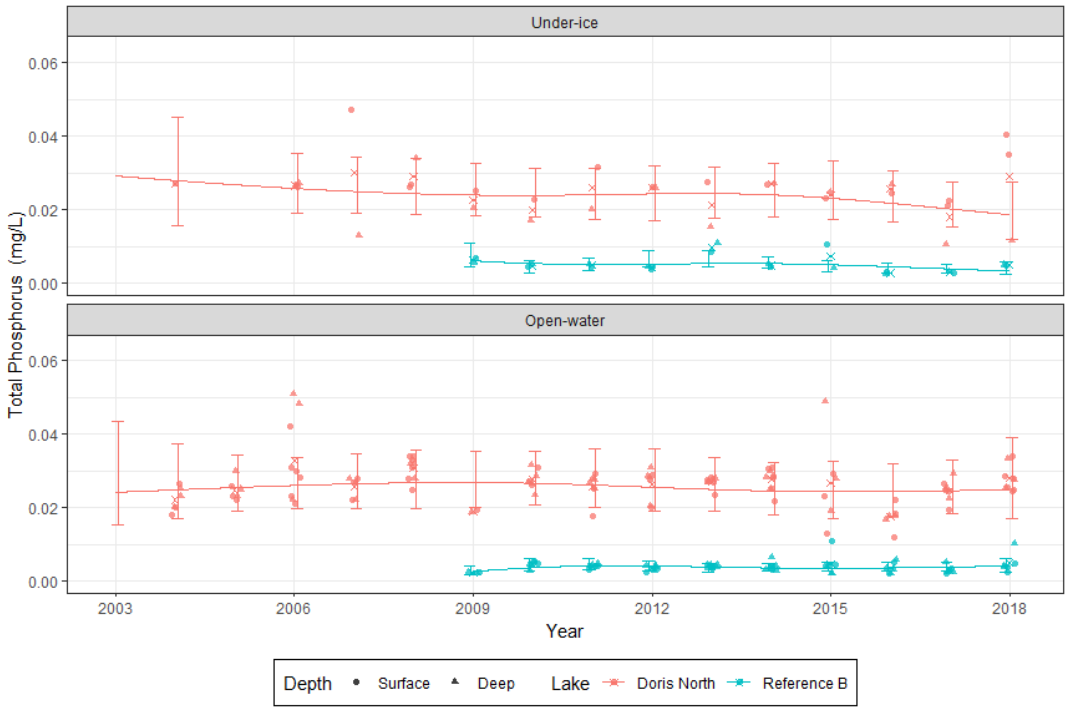
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.458	3	0.9280

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

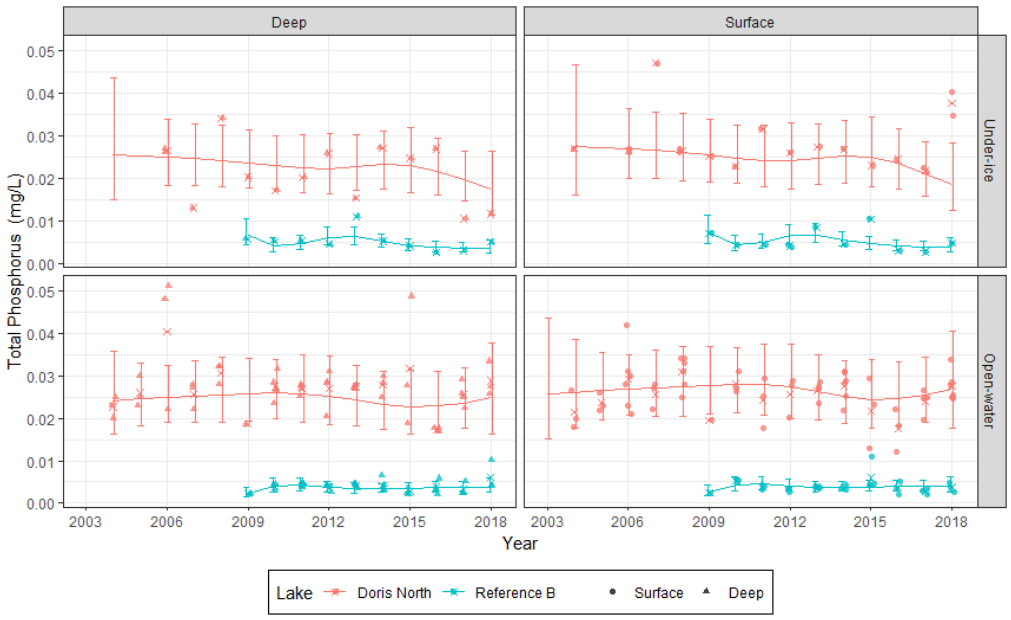
Observed Data and Fitted Values

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:



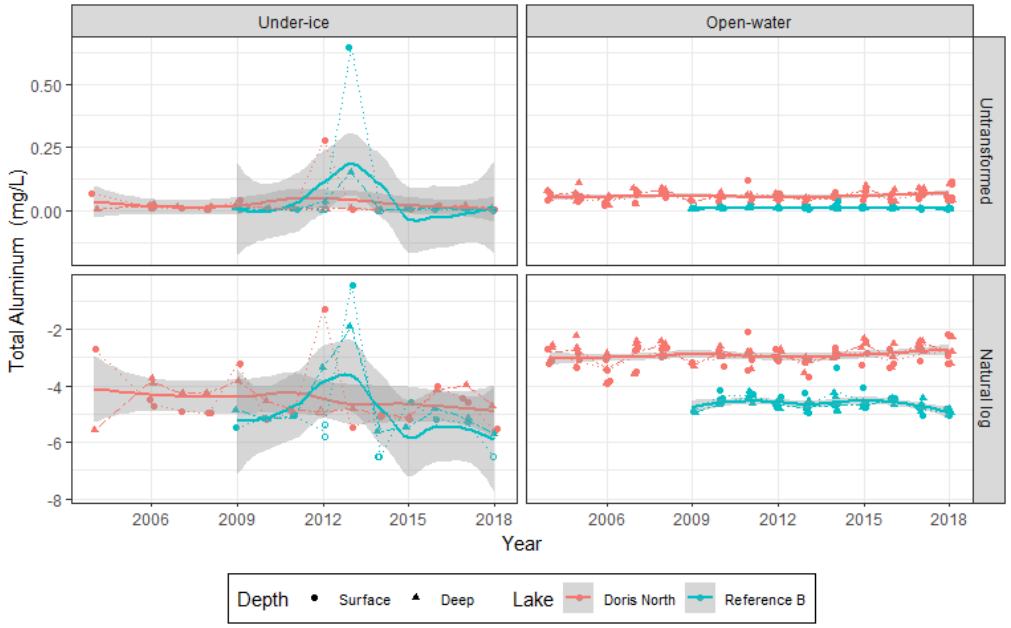
Plot of observed and fitted data separated by depth:



B.3.1.10 Analysis of Total Aluminum

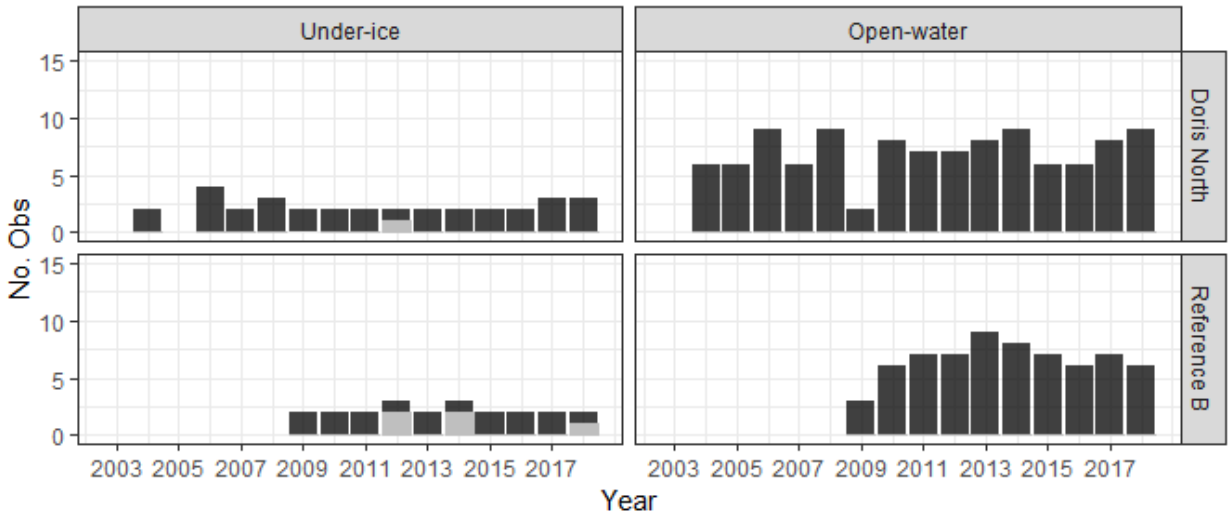
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

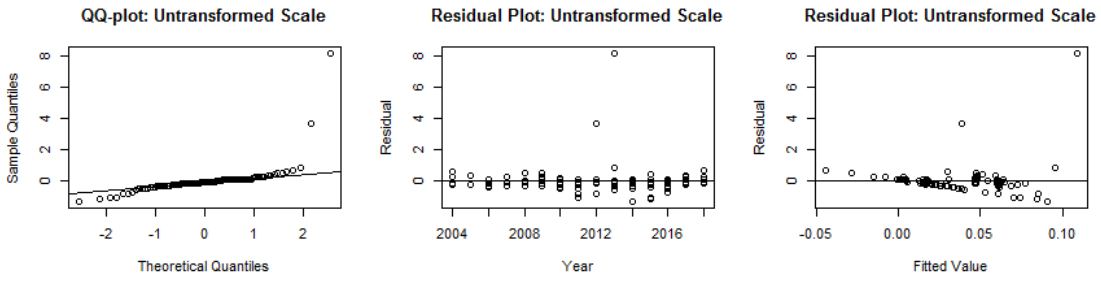
The sample sizes and median values per lake and season are summarized in the table below.

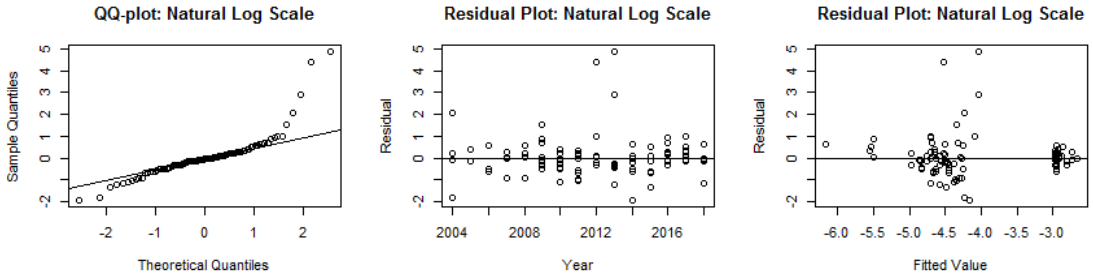
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	1	3	0.00890
Doris North	Open-water	106	0	0	0.05395
Reference B	Under-ice	22	5	23	0.00570
Reference B	Open-water	66	0	0	0.00945

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	0.0386691	3.677906
77	Reference B	2013	Under-ice	Surface	0.644	0.1092163	8.150156

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
33	Doris North	2012	Under-ice	Surface	0.280	-4.517640	4.397490
77	Reference B	2013	Under-ice	Surface	0.644	-4.029694	4.865017

The natural log transformed model better meets the residual assumptions. Analysis proceeds with natural log transformed data. However, there were outliers 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	1.622	3	0.6544

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

Open-Water

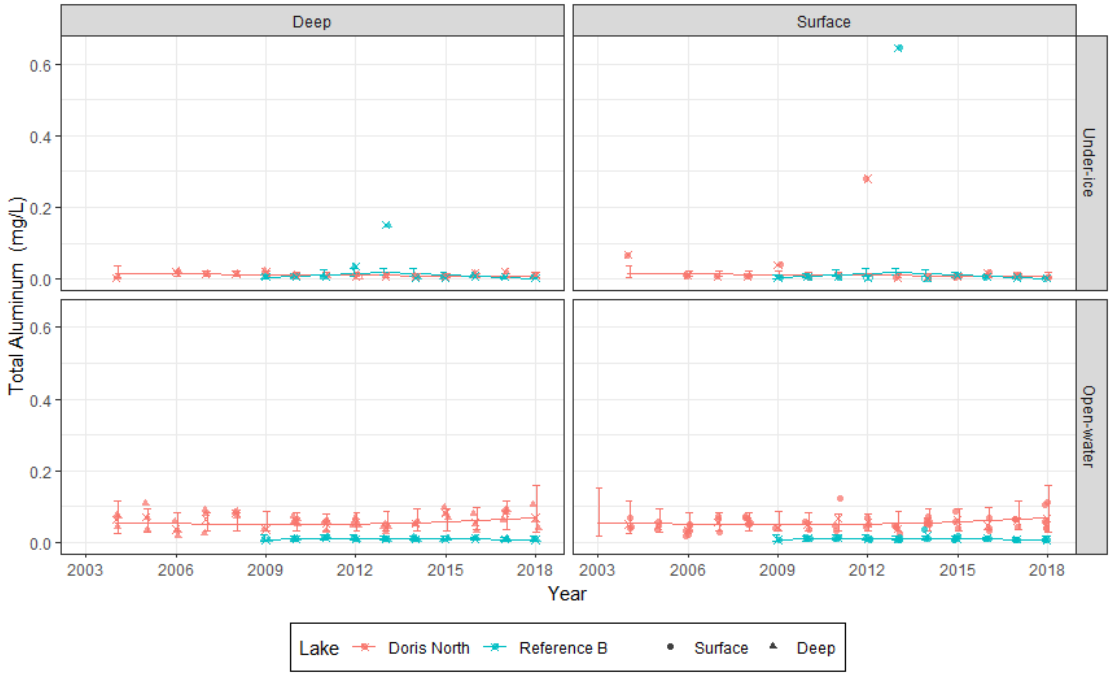
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.448	3	0.9302

Doris Lake North does 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

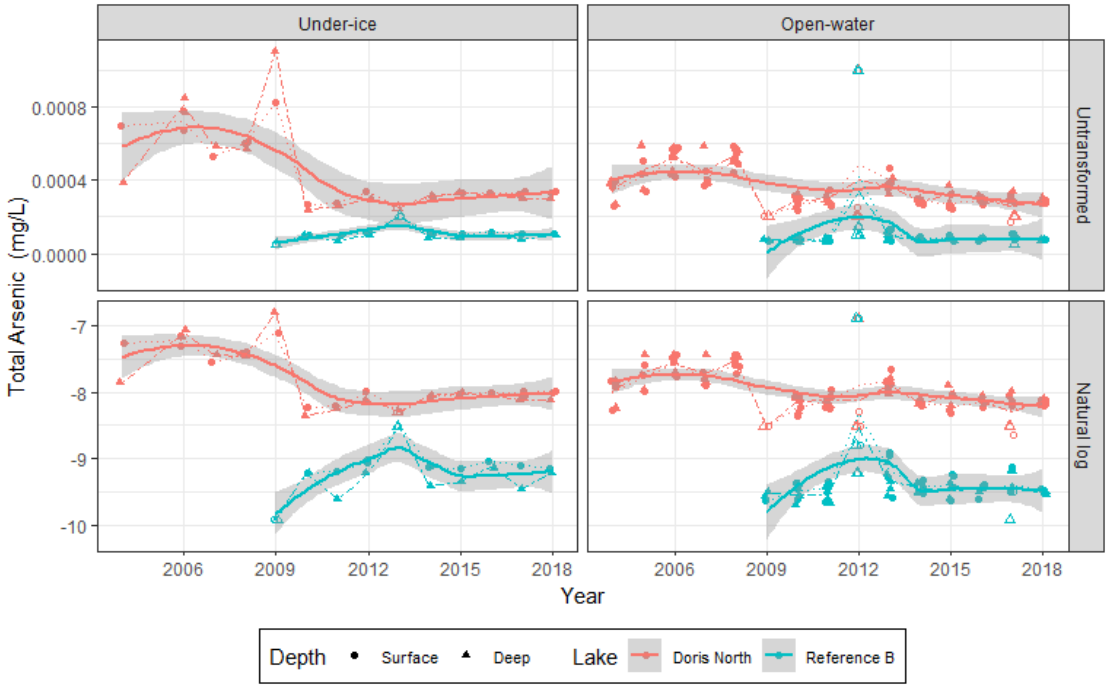
Plot of observed and fitted data separated by depth:



B.3.1.11 Analysis of Total Arsenic

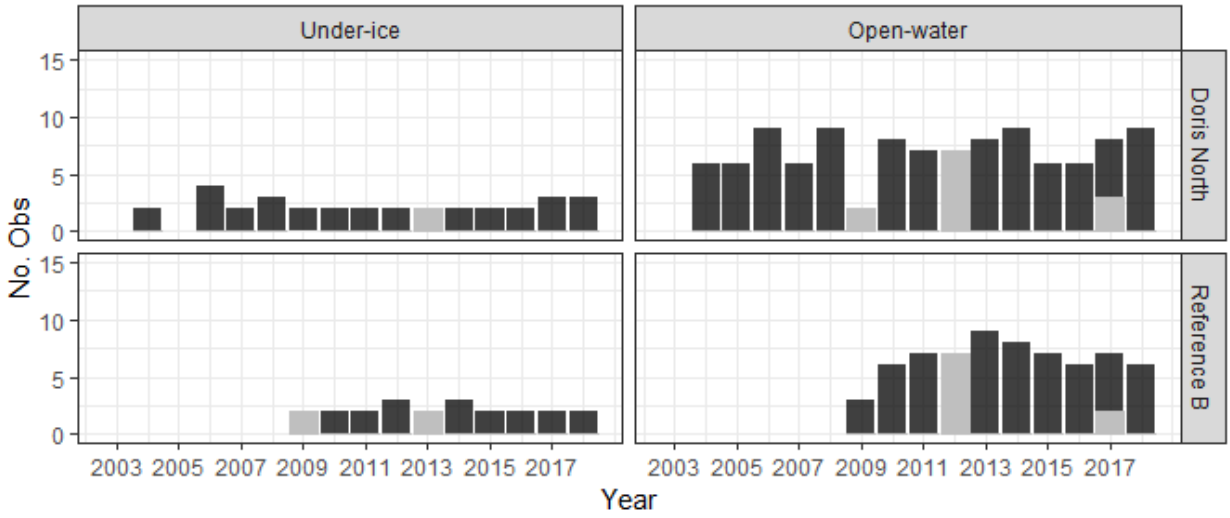
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

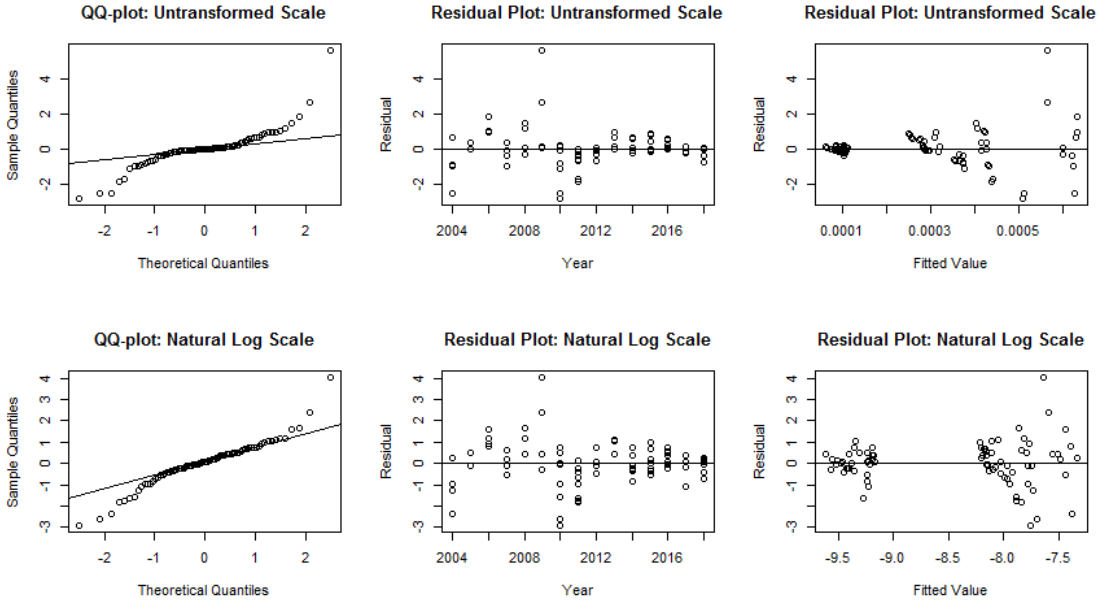
The sample sizes and median values per lake and season are summarized in the table below.

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.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	2	6	0.0003380
Doris North	Open-water	106	12	11	0.0003465
Reference B	Under-ice	22	4	18	0.0001040
Reference B	Open-water	66	9	14	0.0000810

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	0.000564	5.616941

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
20	Doris North	2009	Under-ice	Deep	0.0011	-7.639167	4.038336

The natural log transformed model 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	52.813	3	0.0000
Compare to Reference B	12.491	3	0.0059

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

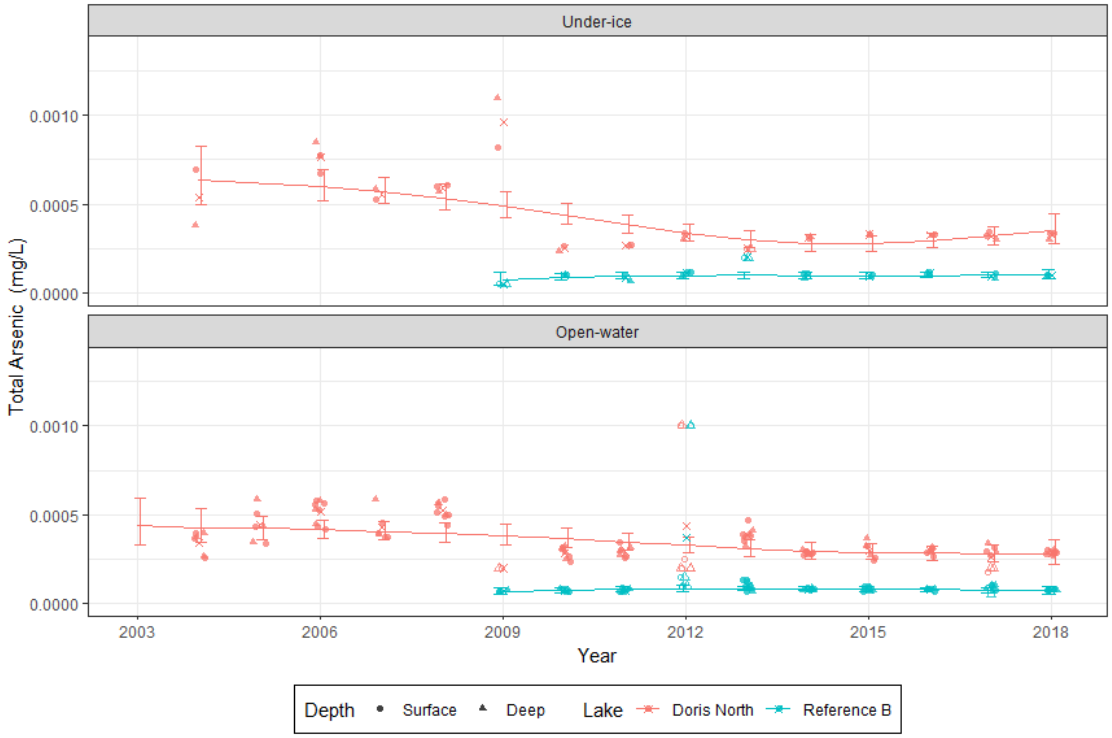
Analysis	Chi.sq	DF	P.value
Compare to slope 0	16.401	3	0.0009
Compare to Reference B	6.219	3	0.1014

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

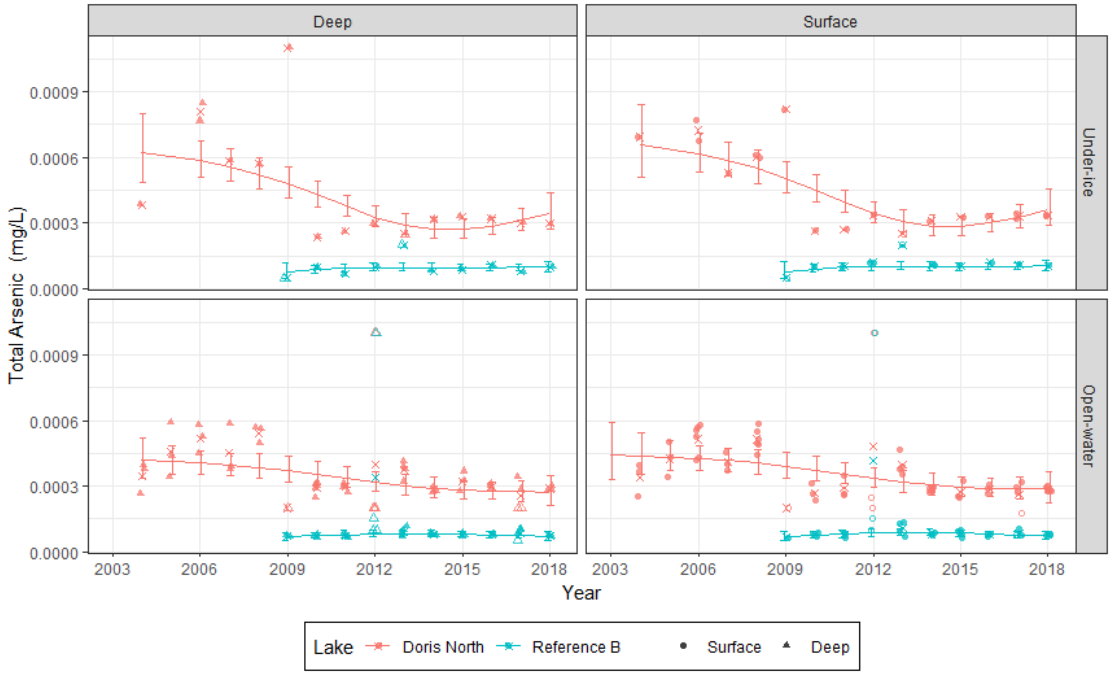
Observed Data and Fitted Values

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:



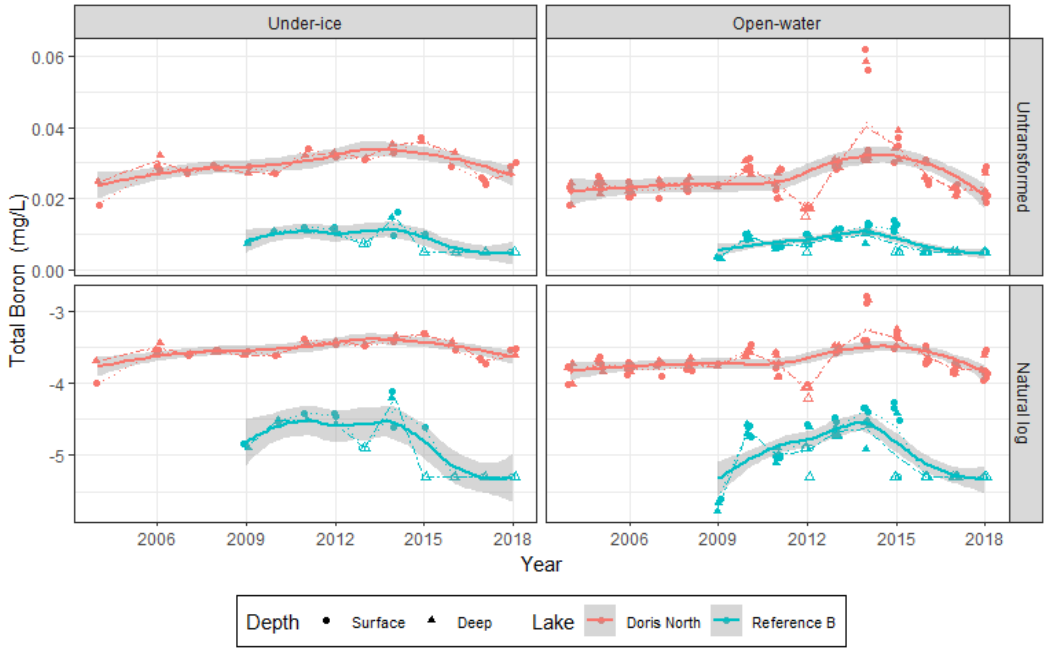
Plot of observed and fitted data separated by depth:



B.3.1.12 Analysis of Total Boron

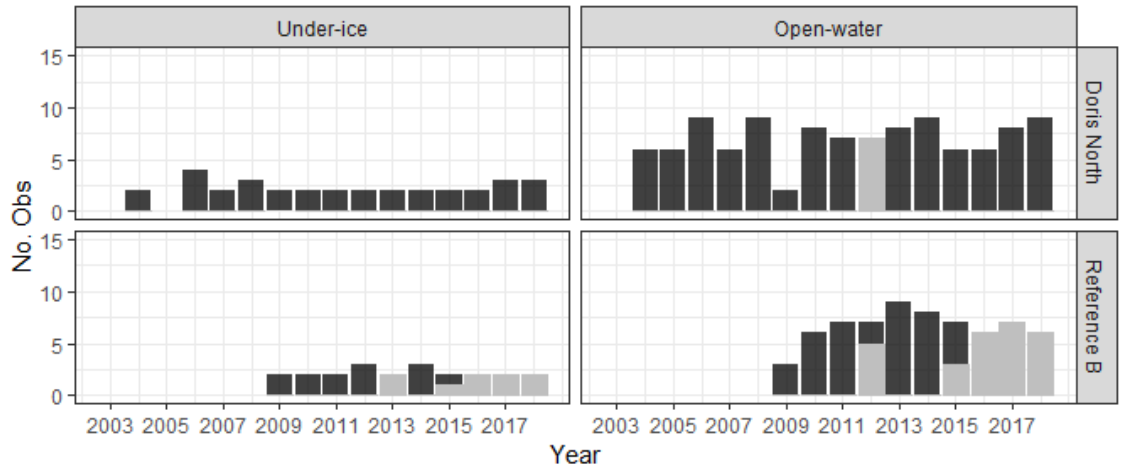
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

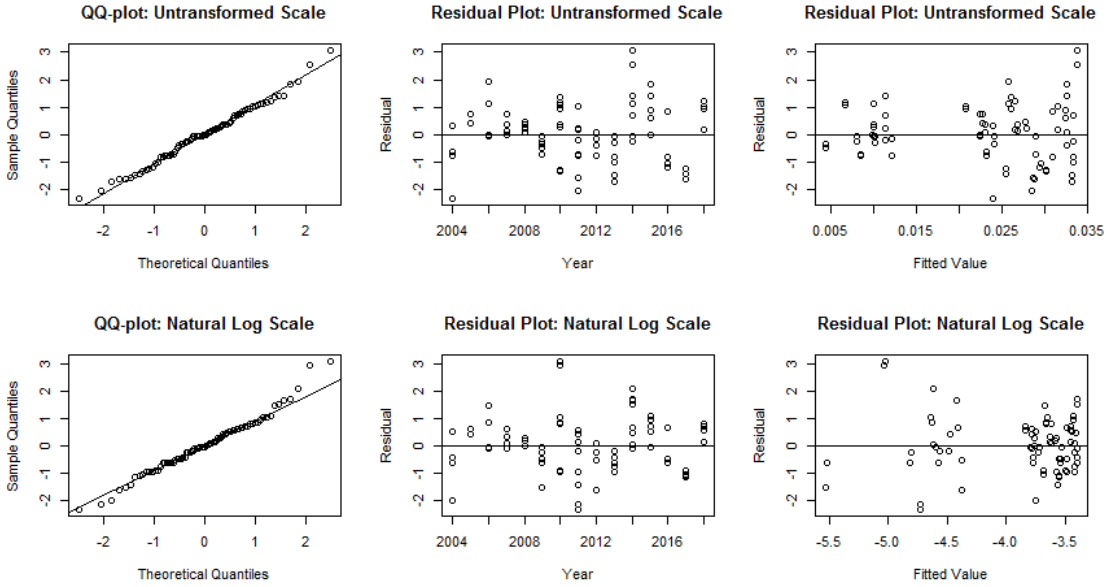
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	0	0	0.02900
Doris North	Open-water	106	7	7	0.02495
Reference B	Under-ice	22	9	41	0.01015
Reference B	Open-water	66	27	41	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:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
43	Doris North	2014	Open-water	Surface	0.0412667	0.0338412	3.068178

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
67	Reference B	2010	Open-water	Surface	0.0095667	-5.027047	3.105203

The untransformed and natural log-transformed model fit the data equally well. Analysis proceeds with untransformed 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	40.808	3	0.0000
Compare to Reference B	2.236	3	0.5250

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

Open-Water

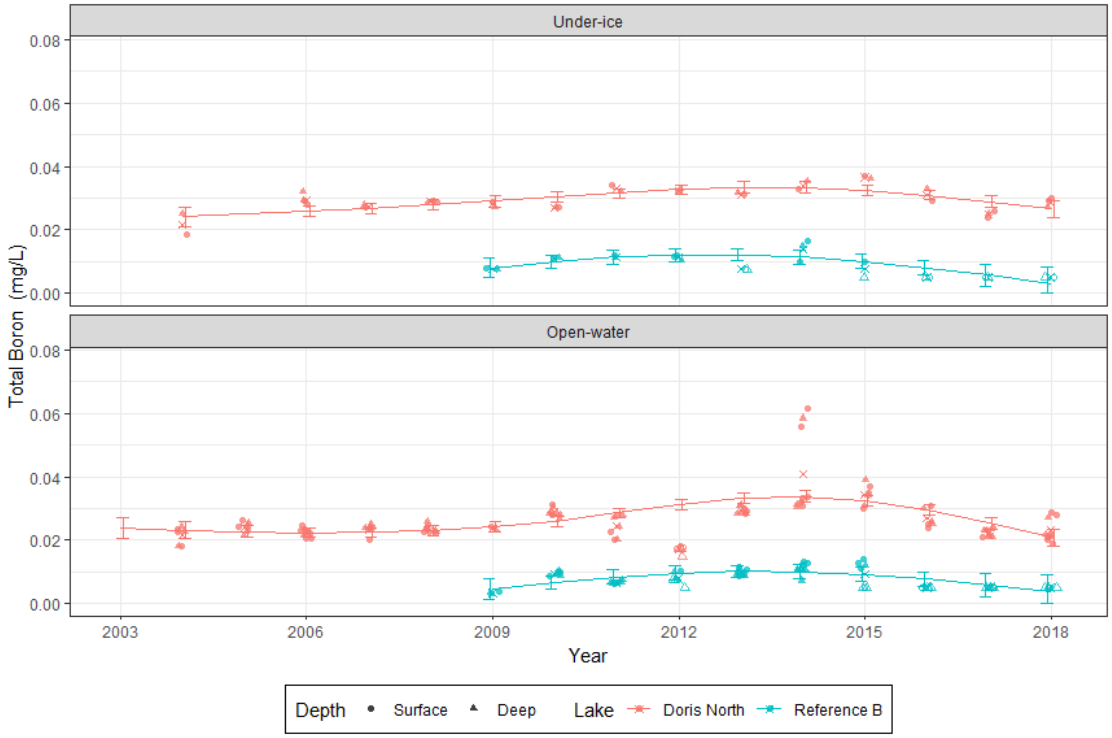
Analysis	Chi.sq	DF	P.value
Compare to slope 0	89.916	3	0.0000
Compare to Reference B	5.720	3	0.1261

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

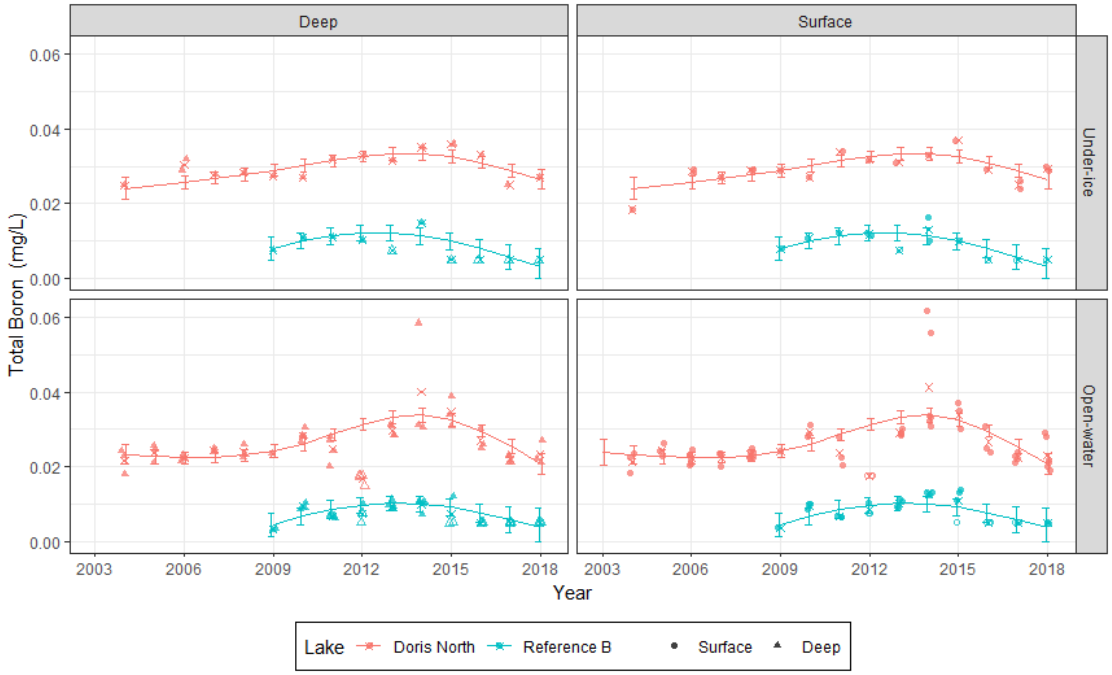
Observed Data and Fitted Values

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:



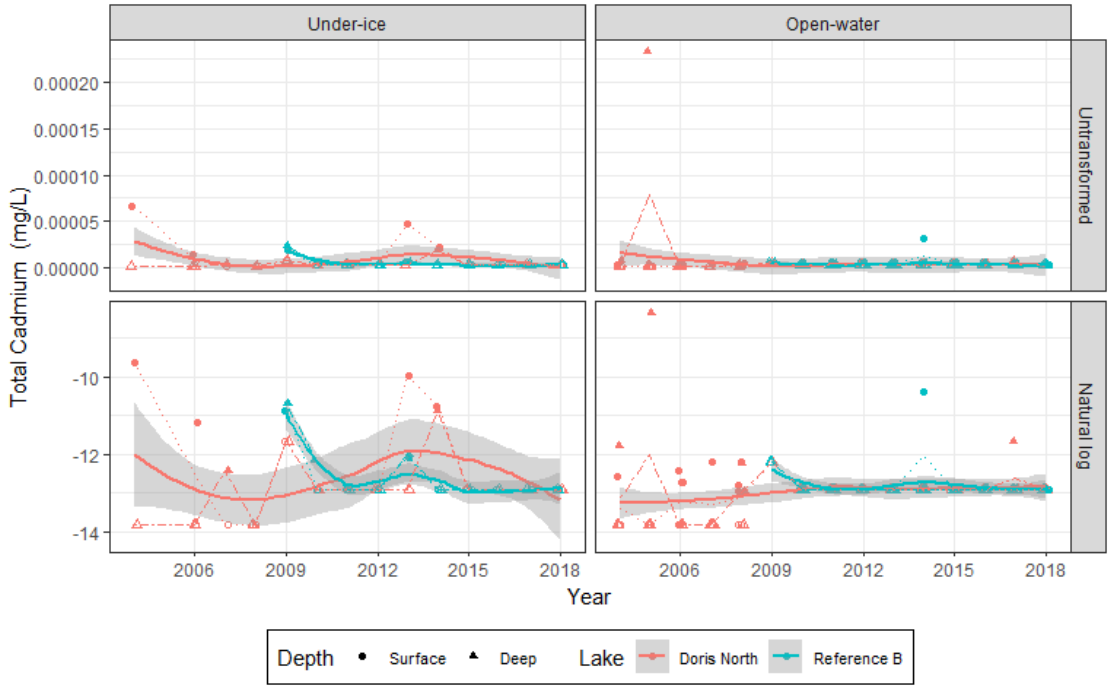
Plot of observed and fitted data separated by depth:



B.3.1.13 Analysis of Total Cadmium

Observed Data

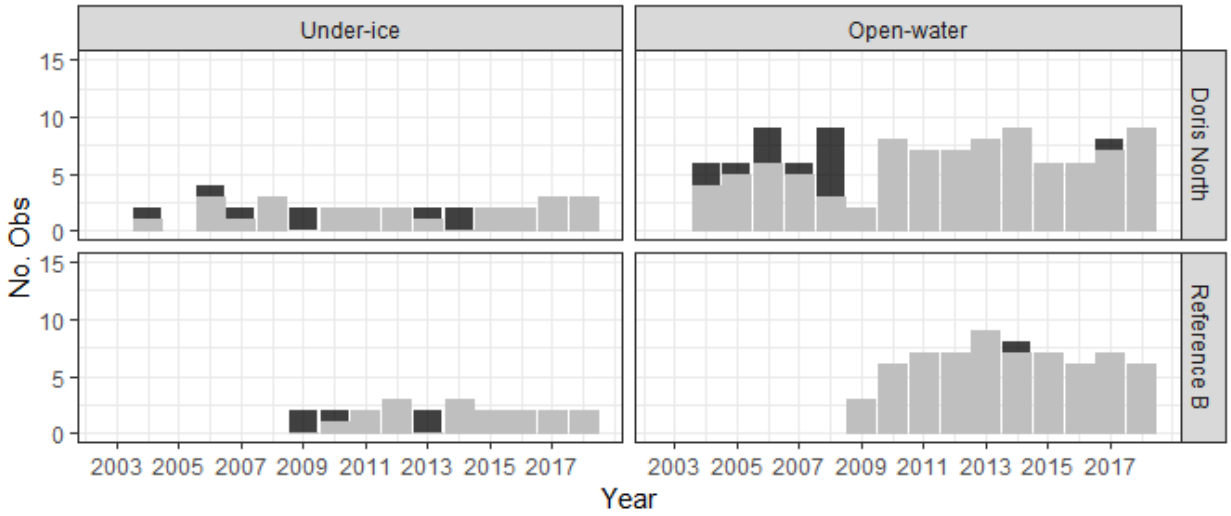
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



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

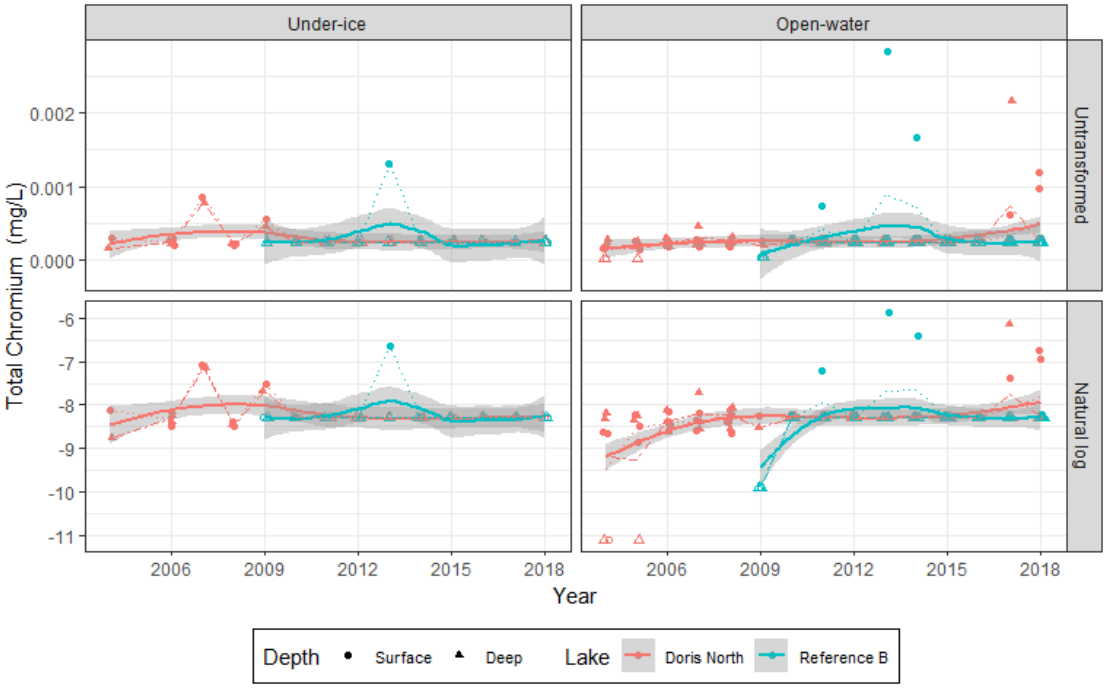
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	27	82	0.000005
Doris North	Open-water	106	92	87	0.000005
Reference B	Under-ice	22	17	77	0.000005
Reference B	Open-water	66	65	98	0.000005

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

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

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

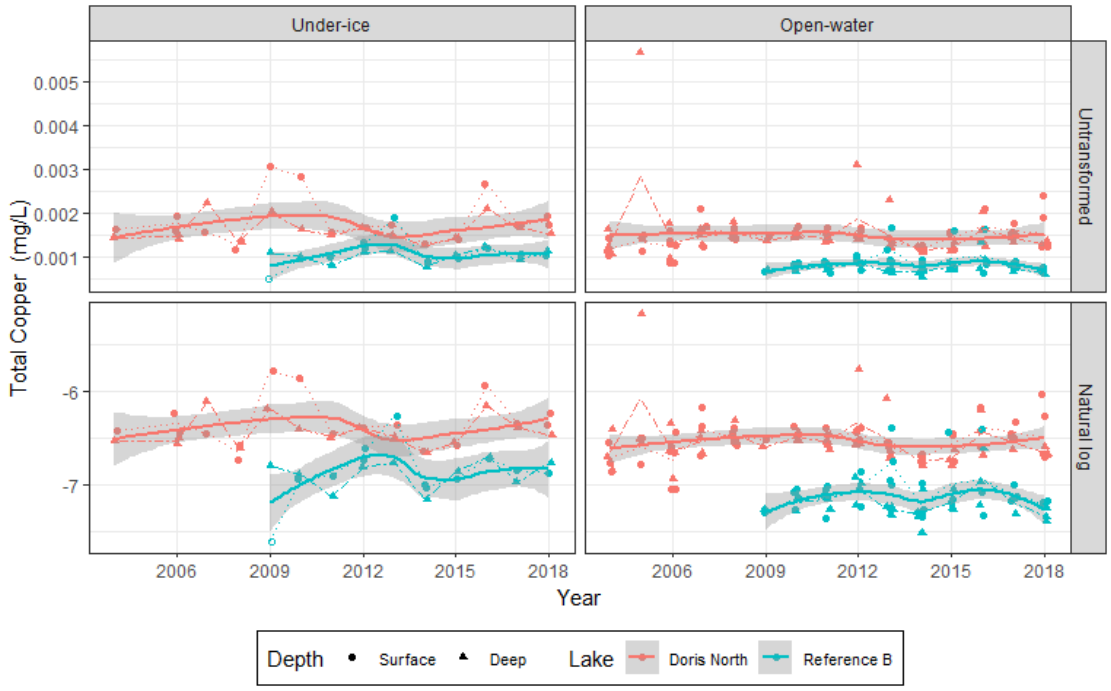
More than 60% of data under detection limit for Doris North and Reference B. Doris North and Reference B removed from the analyses. No statistical analyses were performed.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	20	61	0.0005
Doris North	Open-water	106	67	63	0.0005
Reference B	Under-ice	22	21	95	0.0005
Reference B	Open-water	66	63	95	0.0005

B.3.1.15 Analysis of Total Copper

Observed Data

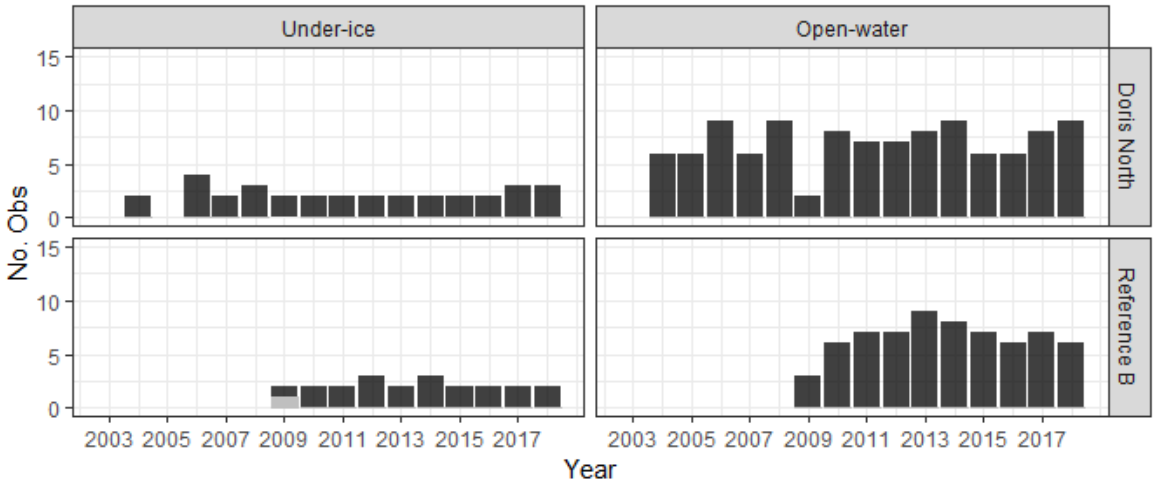
The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.



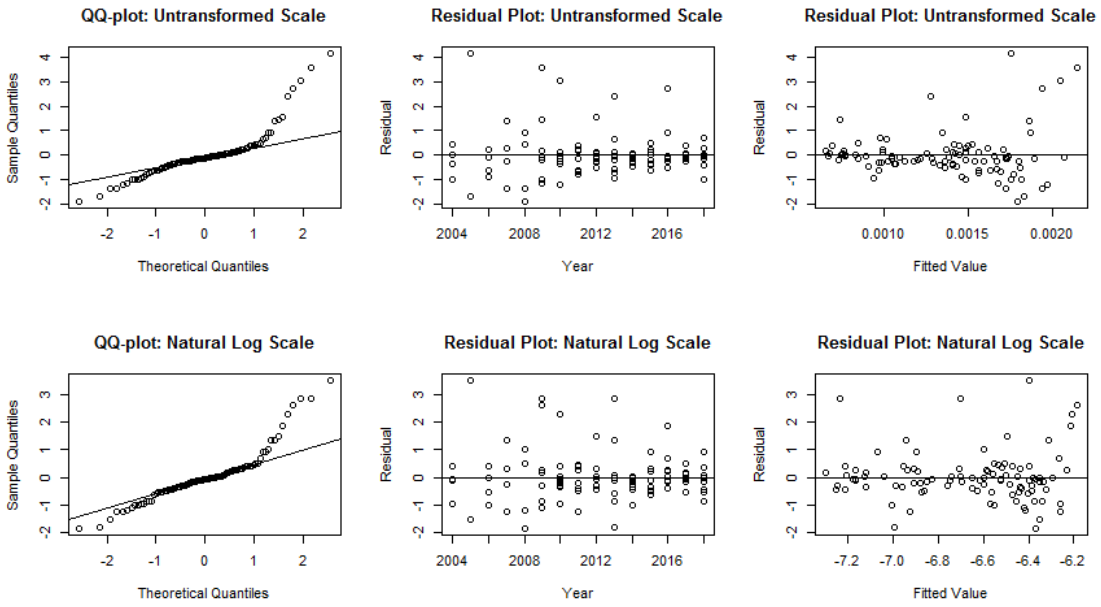
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	0	0	0.0016400
Doris North	Open-water	106	0	0	0.0014425
Reference B	Under-ice	22	1	5	0.0010400
Reference B	Open-water	66	0	0	0.0007700

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	0.0017549	4.150938
21	Doris North	2009	Under-ice	Surface	0.0030900	0.0021507	3.549425
25	Doris North	2010	Under-ice	Surface	0.0028500	0.0020495	3.024966

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
6	Doris North	2005	Open-water	Deep	0.0028533	-6.398979	3.491851

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	2.998	3	0.3920

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

Open-Water

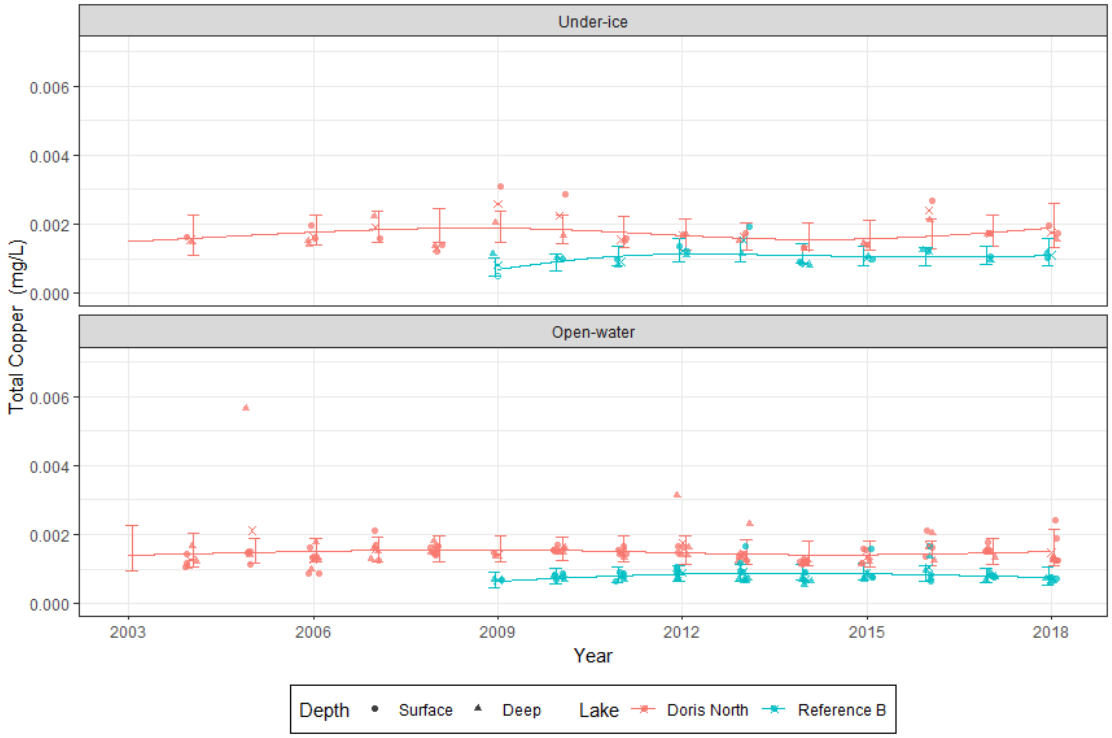
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.697	3	0.8739

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

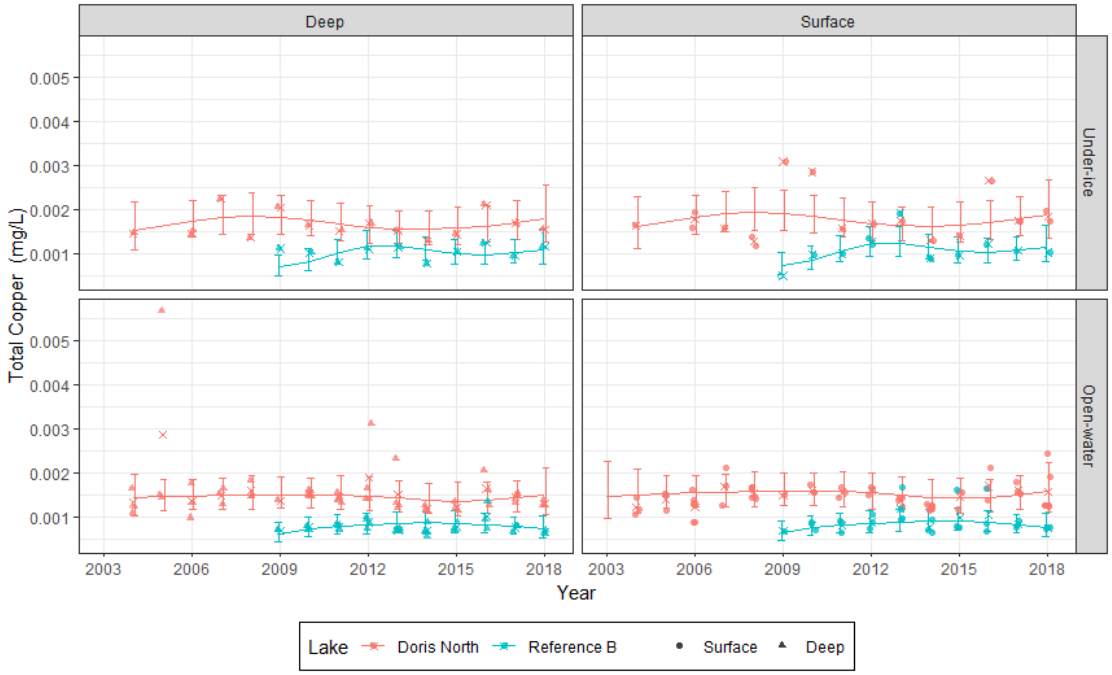
Observed Data and Fitted Values

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:



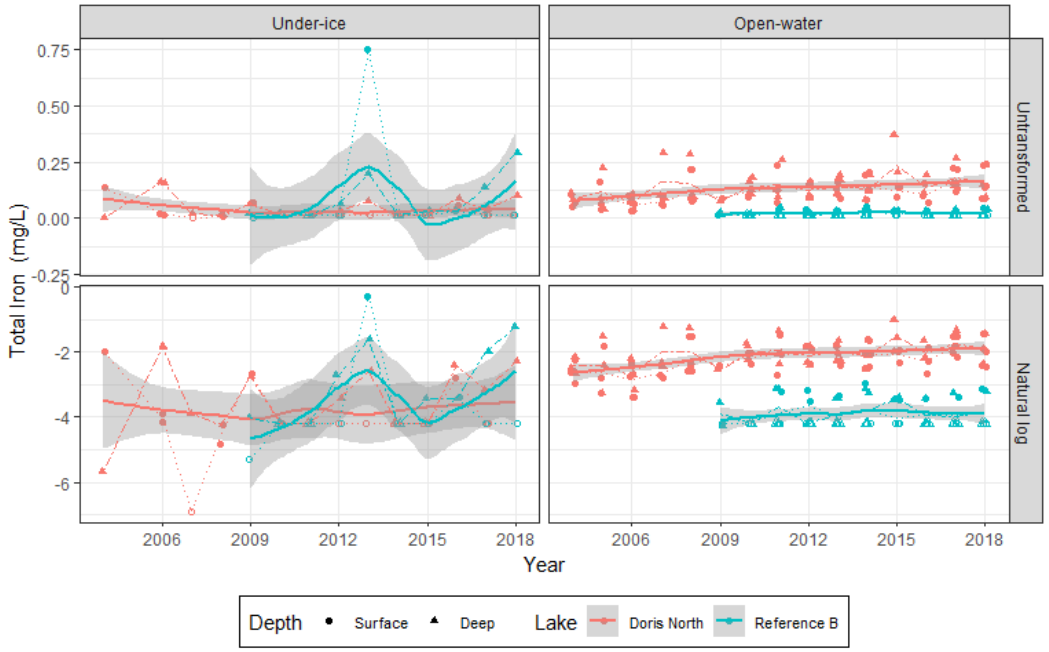
Plot of observed and fitted data separated by depth:



B.3.1.16 Analysis of Total Iron

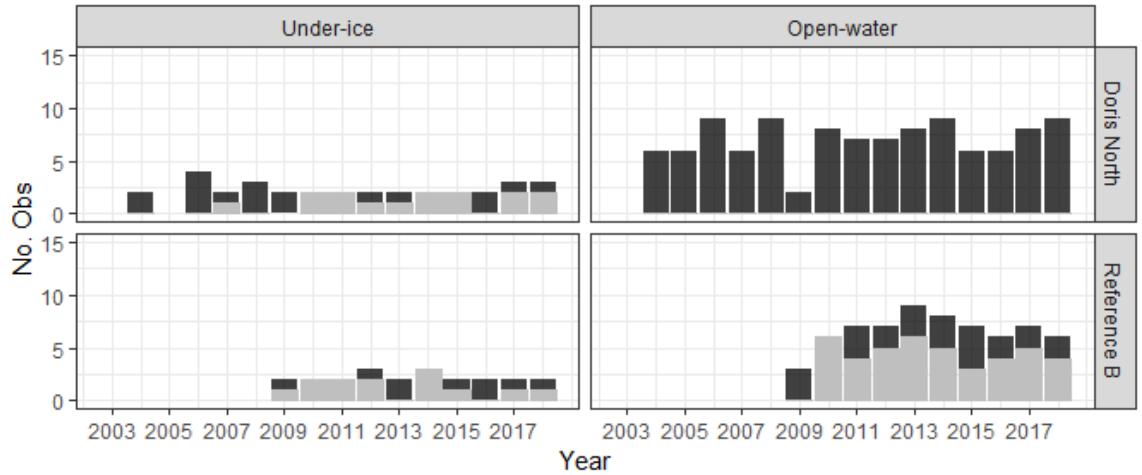
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

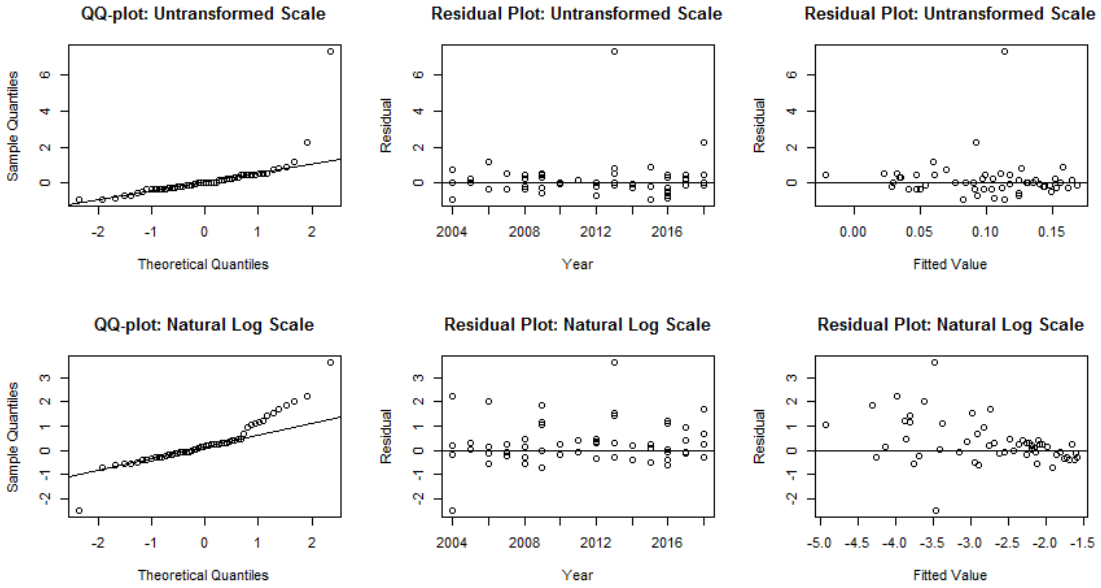
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	15	45	0.030
Doris North	Open-water	106	0	0	0.113
Reference B	Under-ice	22	13	59	0.030
Reference B	Open-water	66	42	64	0.030

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. More than 60% of data under detection limit in Reference B Open-water. Data from Reference B 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
69	Reference B	2013	Under-ice	Surface	0.749	0.1141295	7.284657

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
69	Reference B	2013	Under-ice	Surface	0.749	-3.483398	3.623923

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	2.137	3	0.5444

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

Open-Water

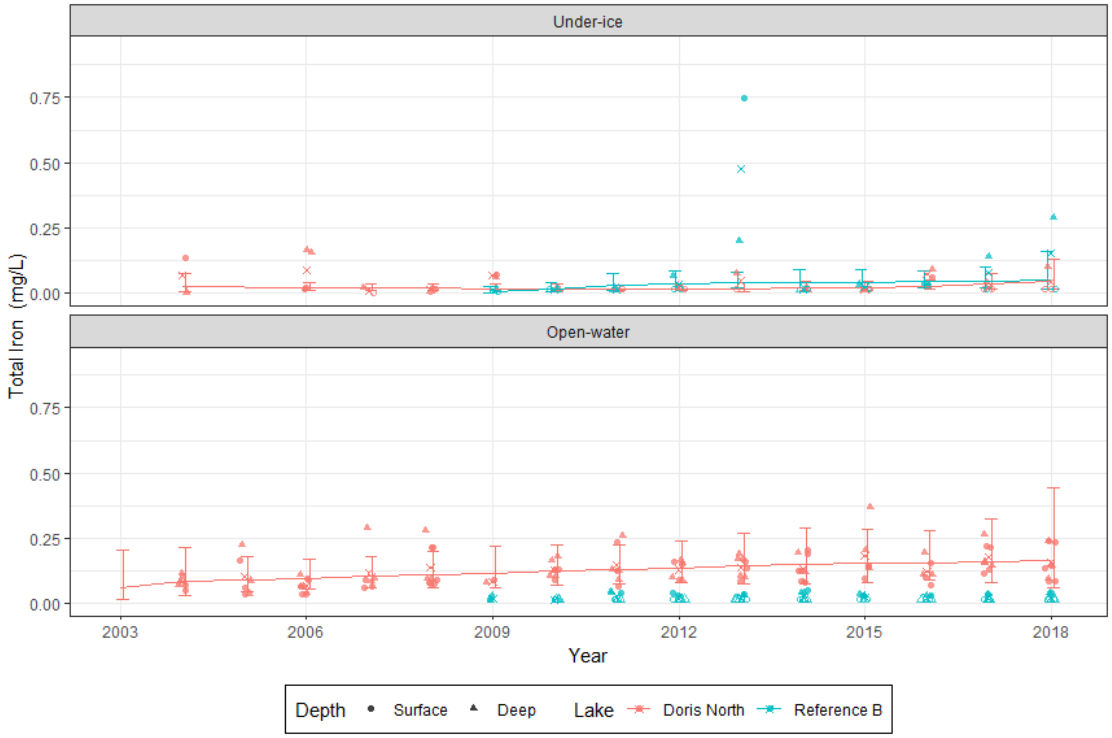
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.743	3	0.6275

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

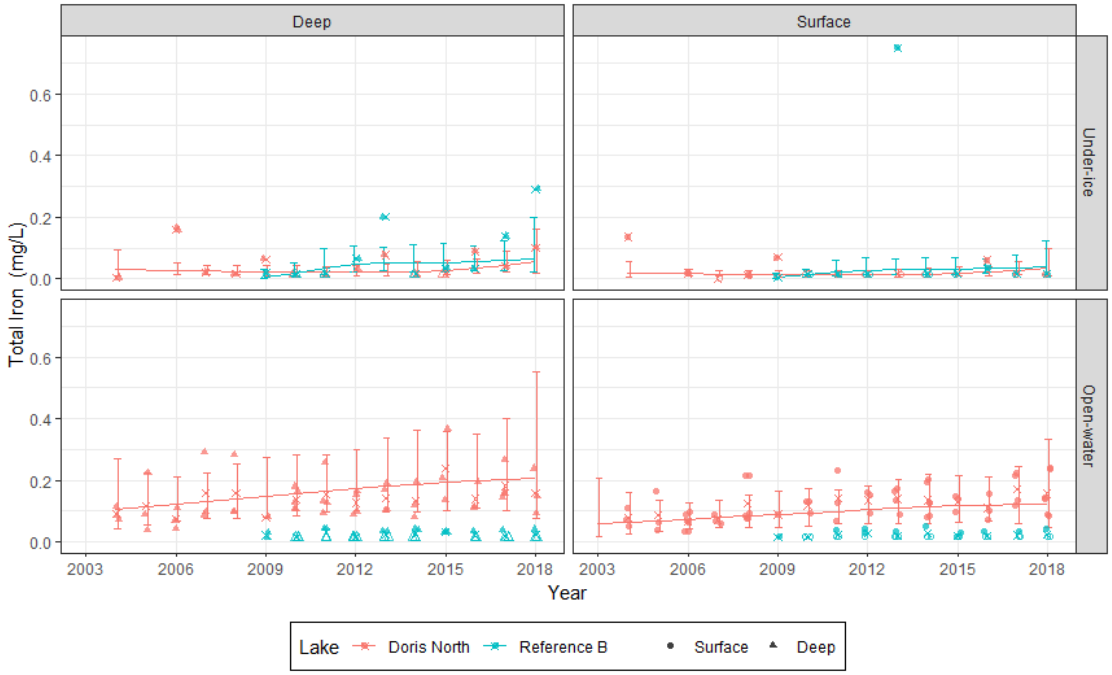
Observed Data and Fitted Values

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:



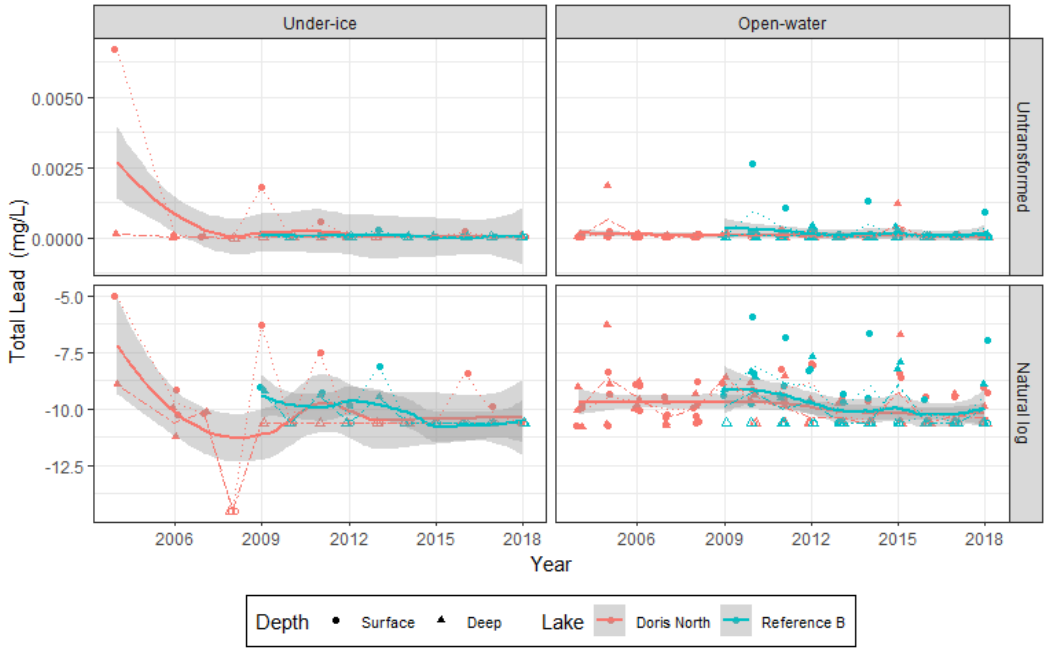
Plot of observed and fitted data separated by depth:



B.3.1.17 Analysis of Total Lead

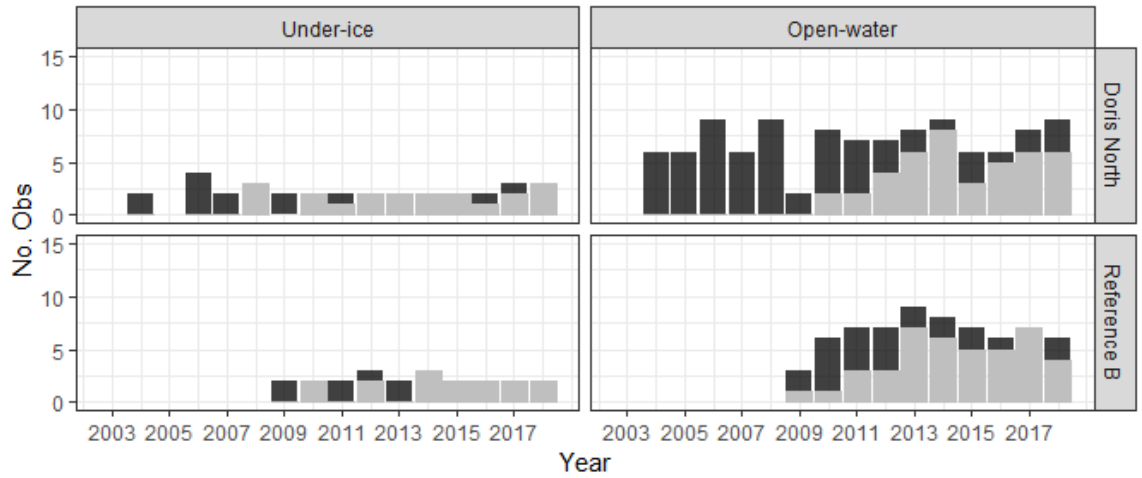
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

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

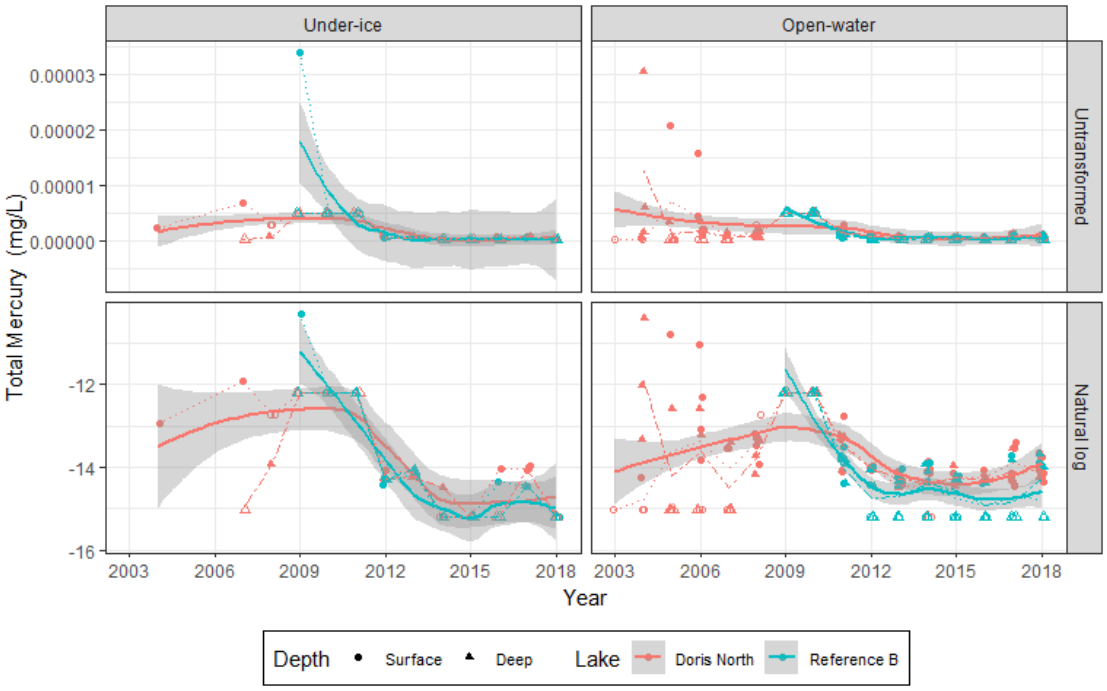
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	21	64	0.00005
Doris North	Open-water	106	42	40	0.00005
Reference B	Under-ice	22	15	68	0.00005
Reference B	Open-water	66	42	64	0.00005

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 Doris North Under-ice. Data for Doris North Under-ice will be removed from the analysis. Though only 40% of data was under detection limit for Doris North Open-water, inclusion of Doris North Open-water led to unstable results. Hence, no statistical analyses were performed.

B.3.1.18 Analysis of Total Mercury

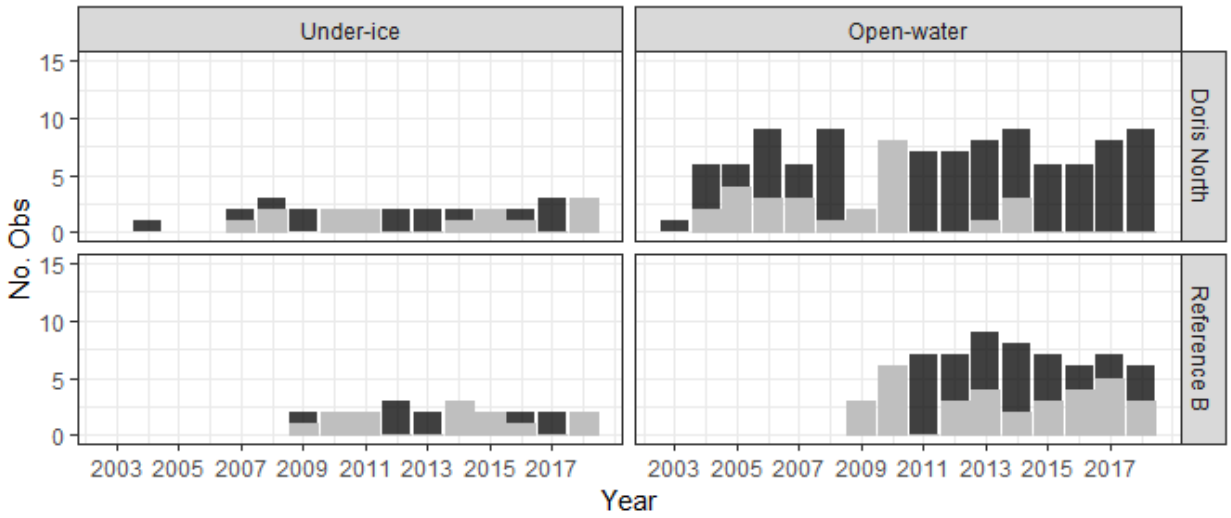
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

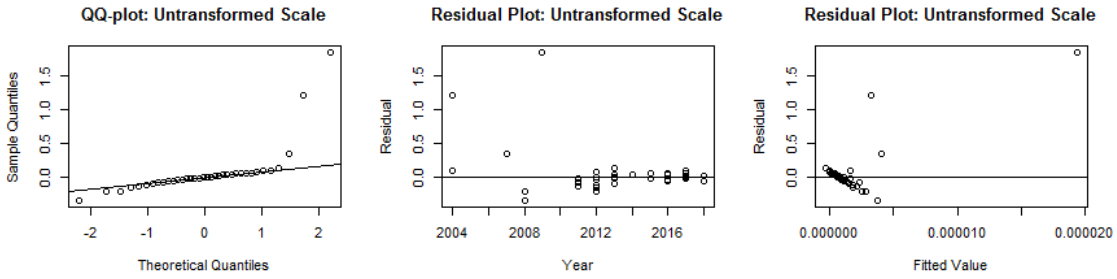
The sample sizes and median values per lake and season are summarized in the table below.

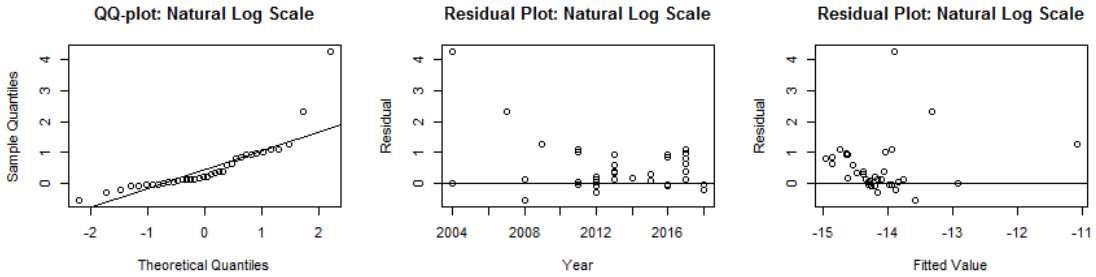
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	28	16	57	0.0000008
Doris North	Open-water	107	28	26	0.0000008
Reference B	Under-ice	22	13	59	0.0000006
Reference B	Open-water	66	33	50	0.0000006

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.

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:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
4	Doris North	2004	Open-water	Deep	0.0000128	-13.90632	4.256252

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	0.925	3	0.8194

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

Open-Water

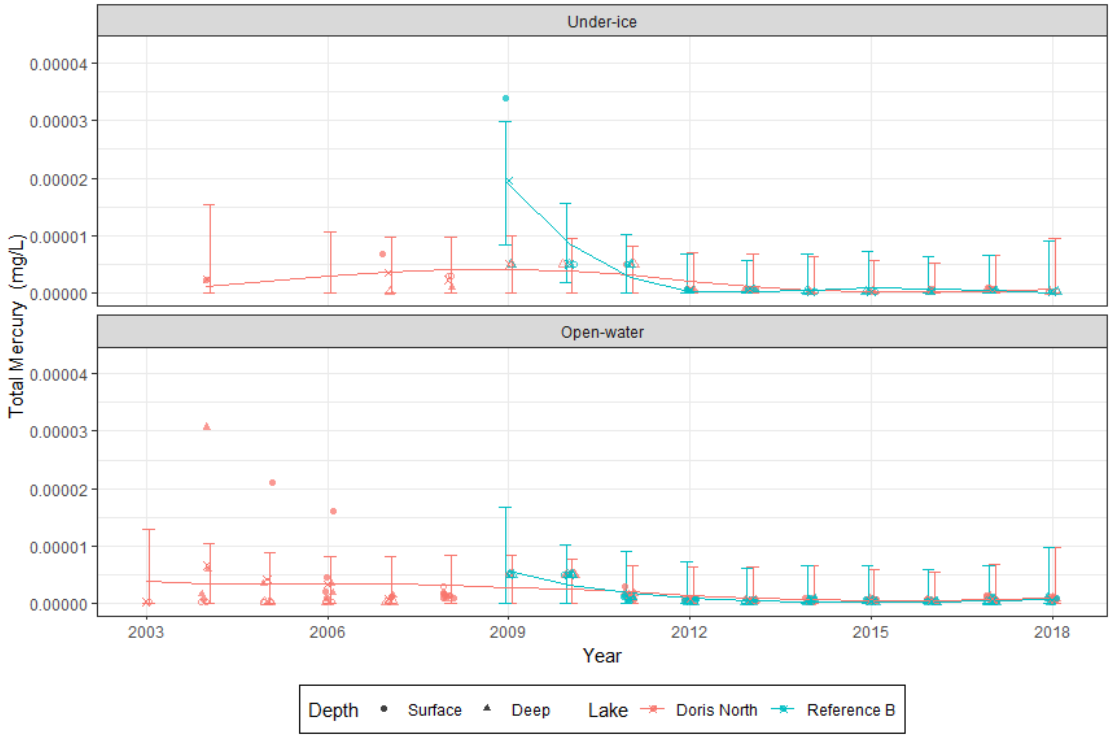
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.705	3	0.8720

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

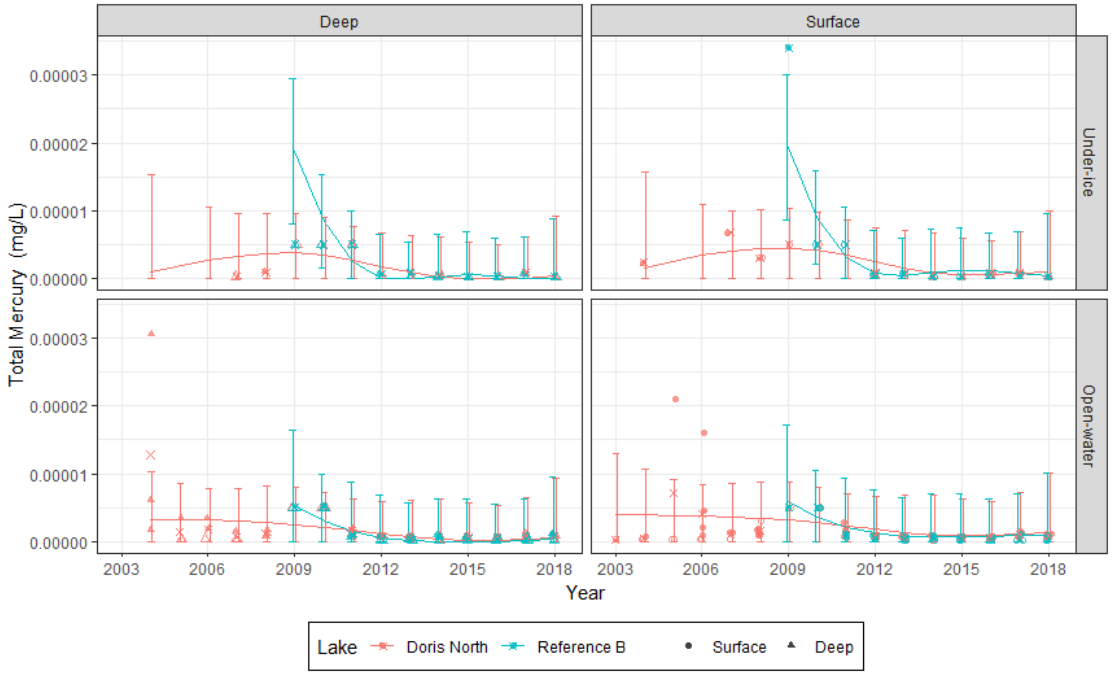
Observed Data and Fitted Values

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:



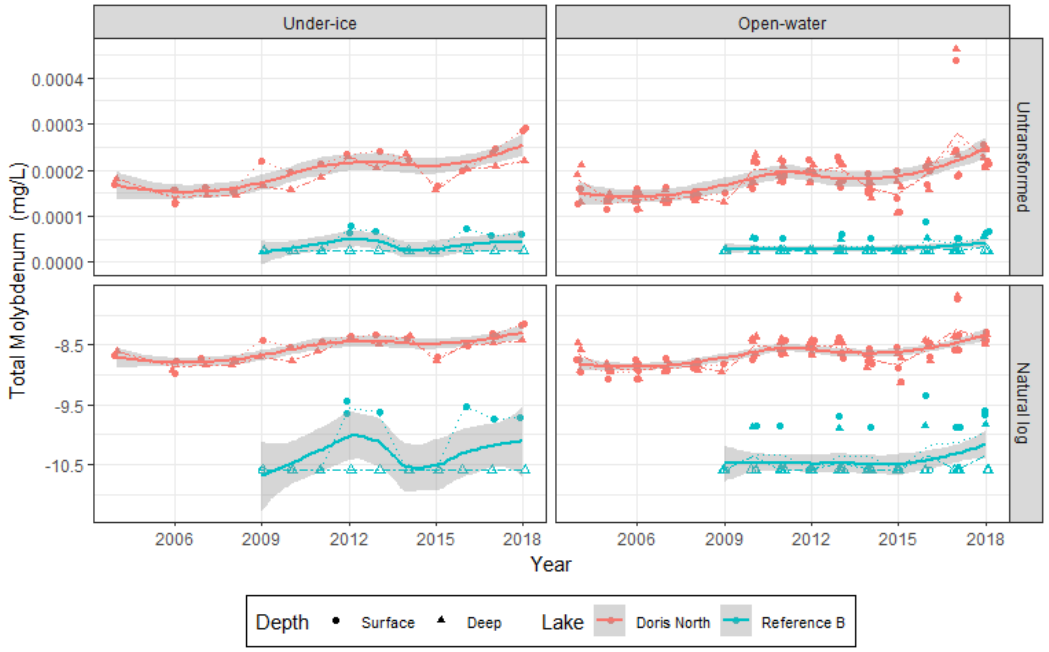
Plot of observed and fitted data separated by depth:



B.3.1.19 Analysis of Total Molybdenum

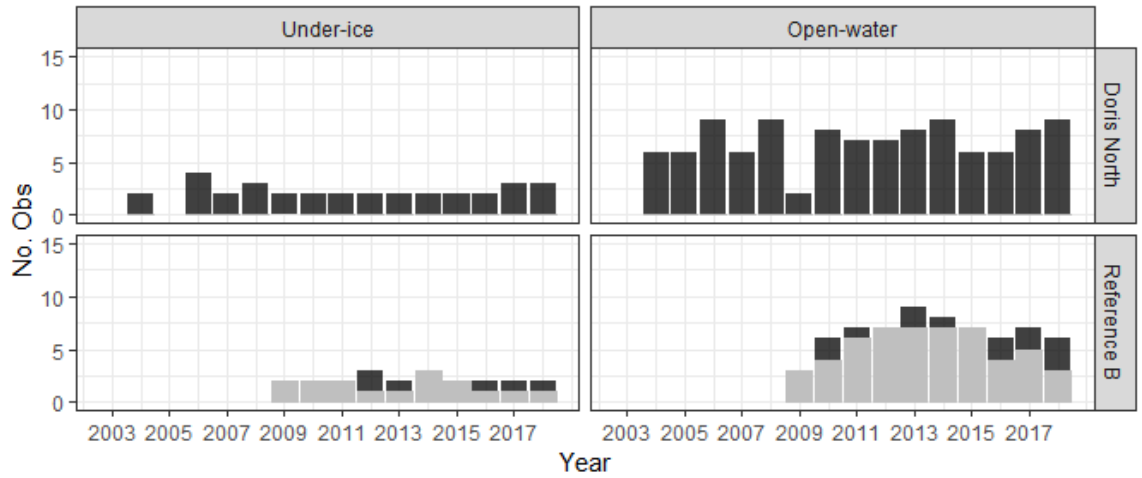
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

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

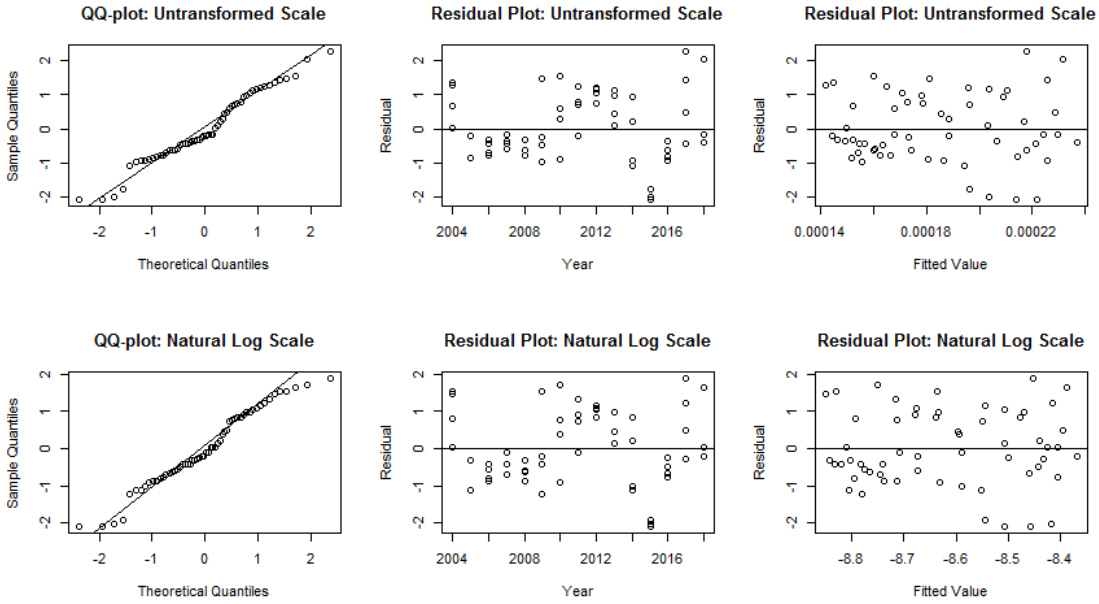
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	0	0	0.000196
Doris North	Open-water	106	0	0	0.000173
Reference B	Under-ice	22	16	73	0.000050
Reference B	Open-water	66	53	80	0.000050

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:

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	30.292	3	0.0000

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

Open-Water

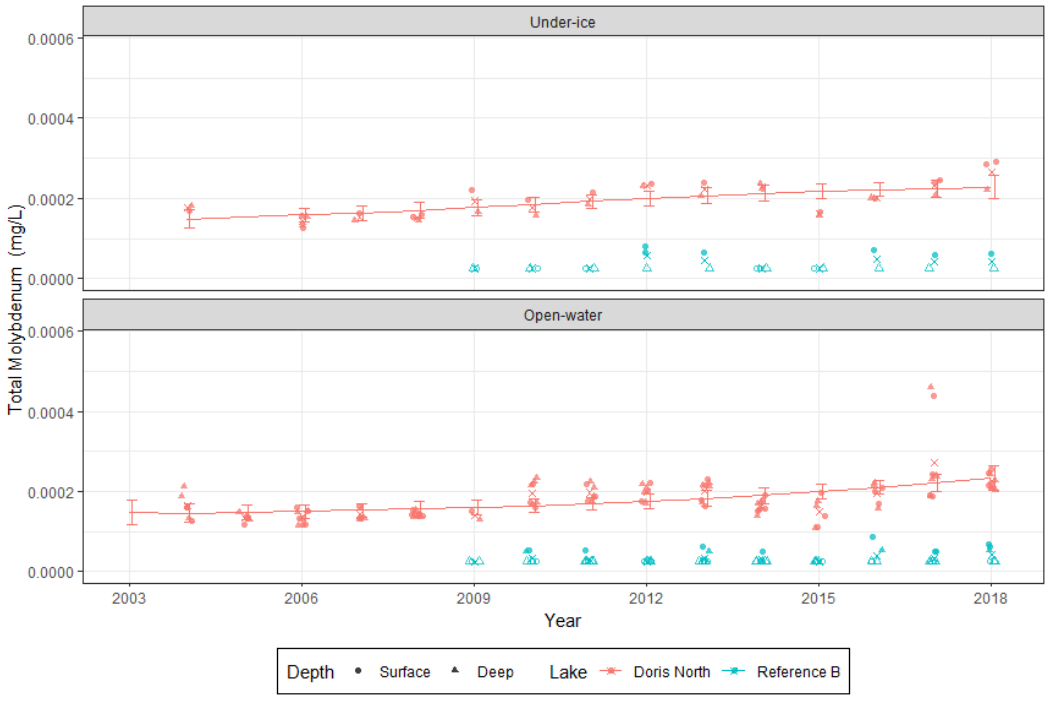
Analysis	Chi.sq	DF	P.value
Compare to slope 0	31.965	3	0.0000

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

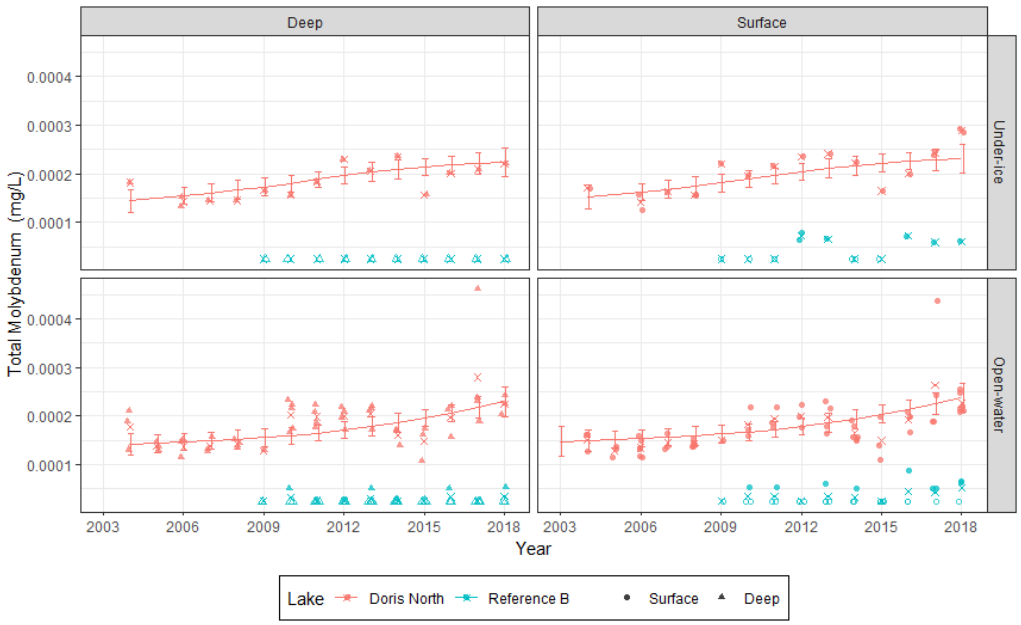
Observed Data and Fitted Values

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:



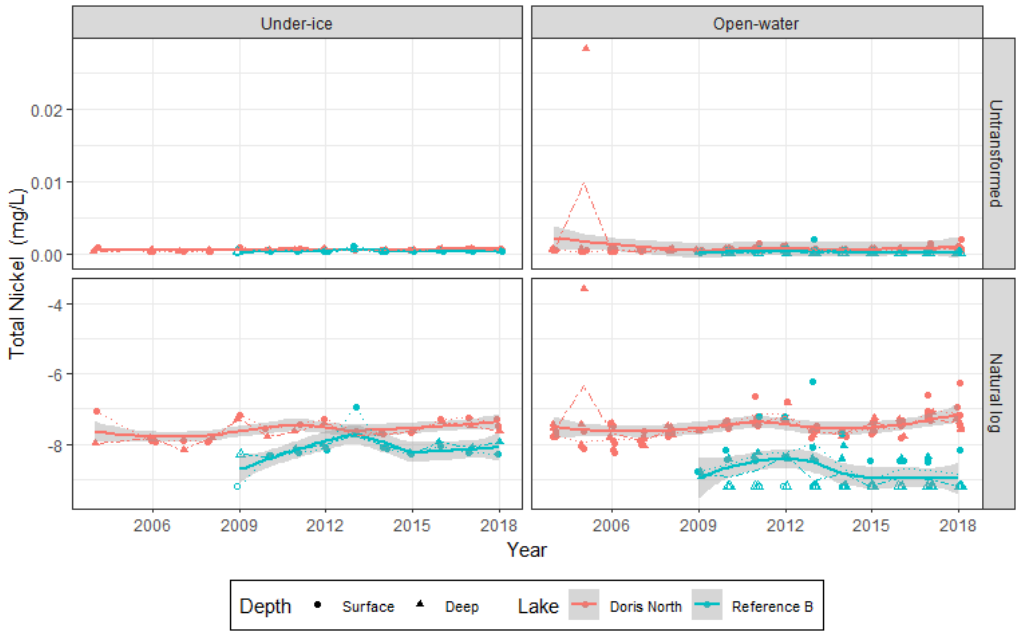
Plot of observed and fitted data separated by depth:



B.3.1.20 Analysis of Total Nickel

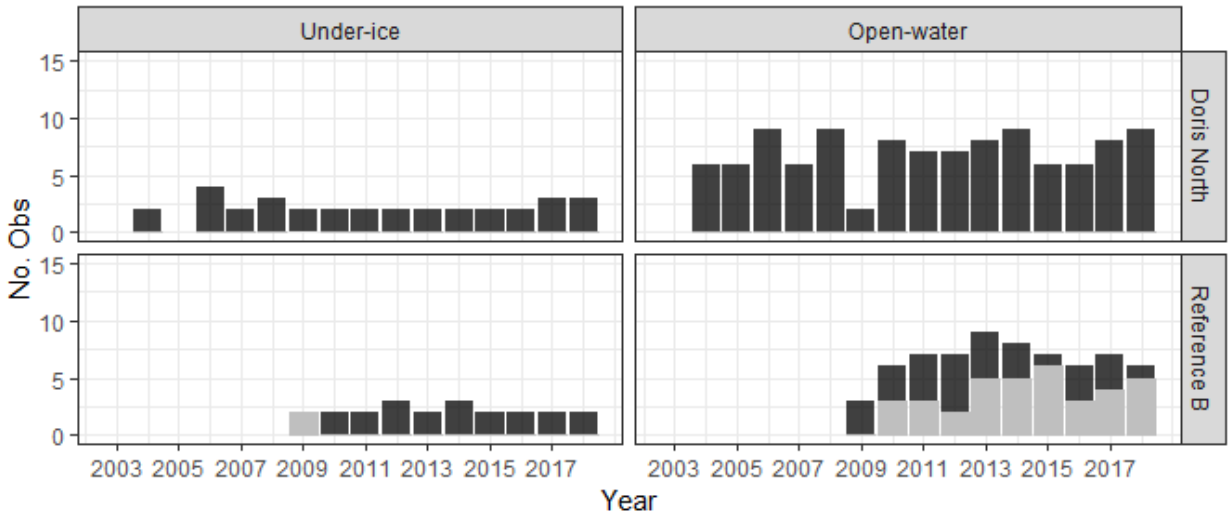
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

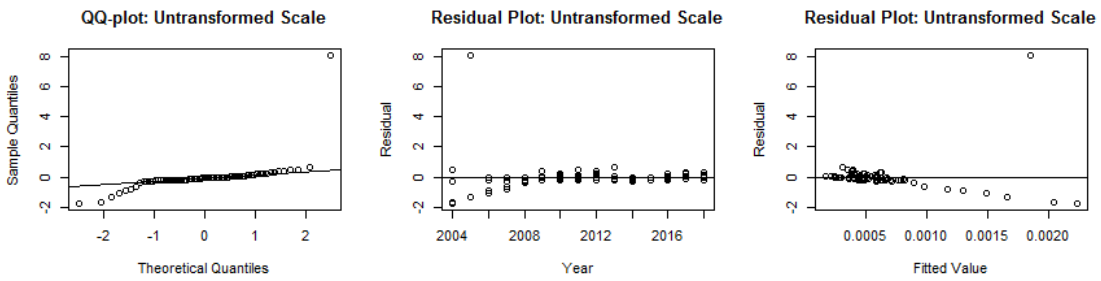
The sample sizes and median values per lake and season are summarized in the table below.

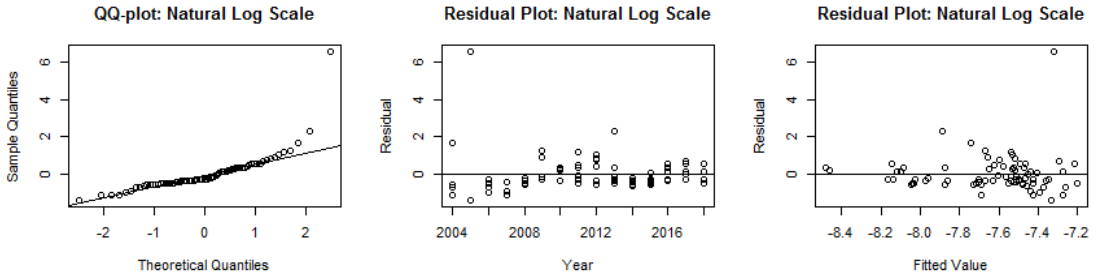
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	0	0	0.000480
Doris North	Open-water	106	0	0	0.000530
Reference B	Under-ice	22	2	9	0.000295
Reference B	Open-water	66	36	55	0.000200

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	0.0018471	8.041049

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
6	Doris North	2005	Open-water	Deep	0.0097363	-7.320324	6.582261

The natural log transformed model 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	1.552	3	0.6703

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

Open-Water

Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.852	3	0.6036

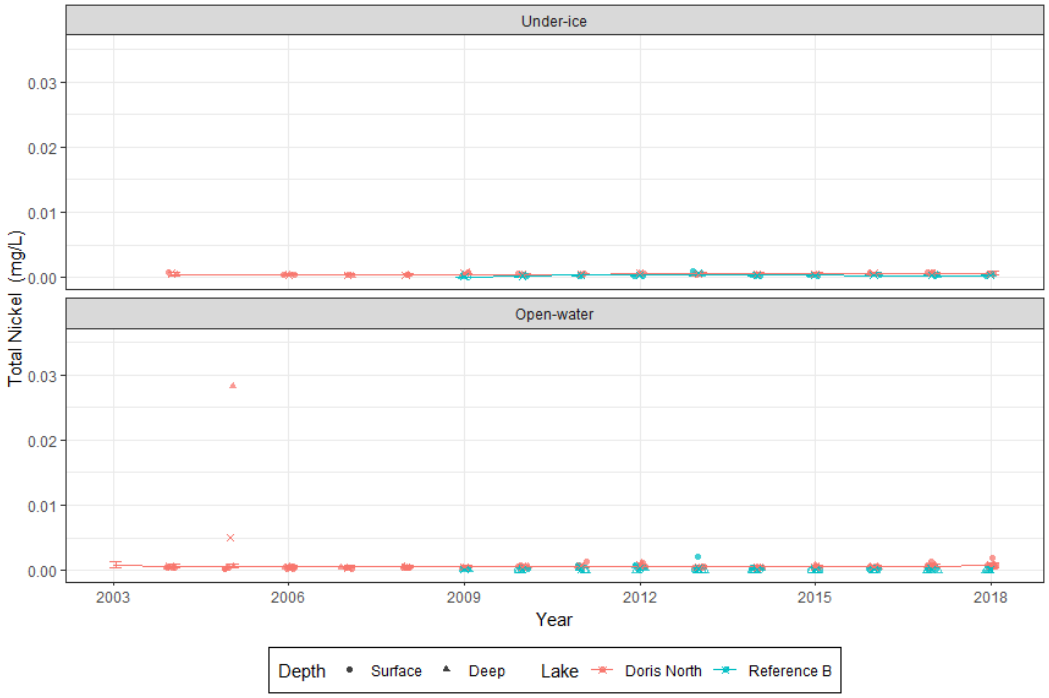
Doris Lake North does not exhibit significant deviation from no trend.

Observed Data and Fitted Values

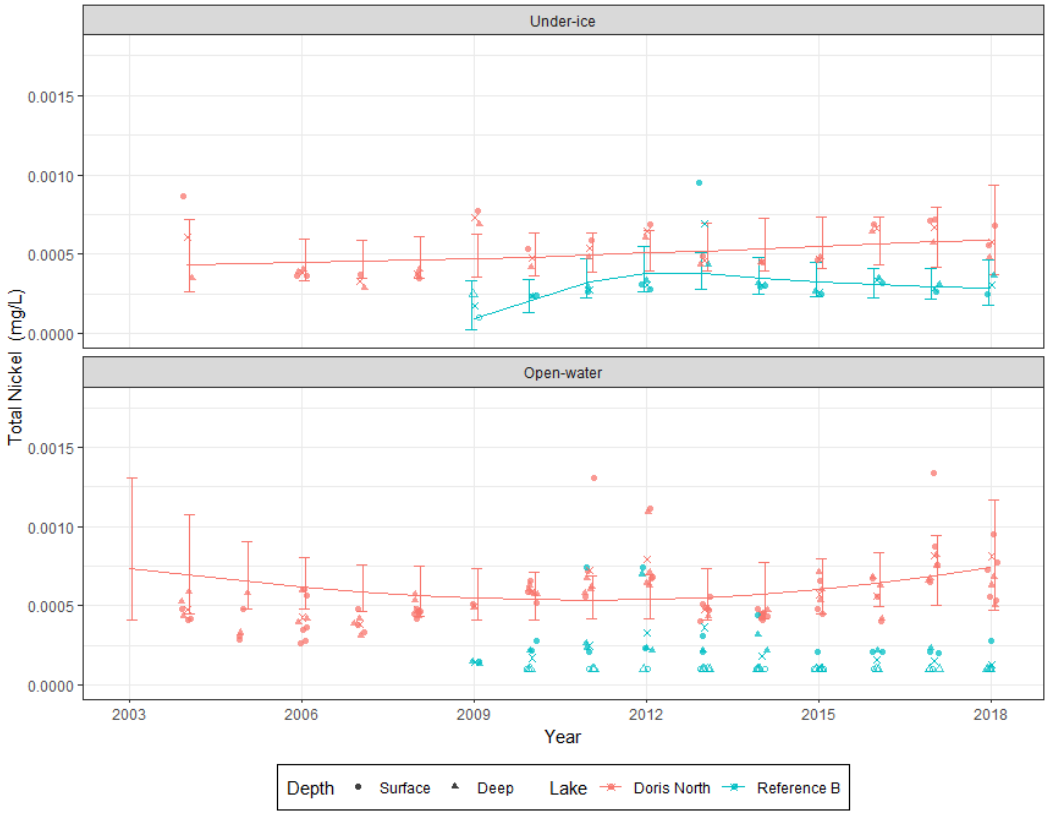
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data, both averaged over depth and separated by depth to visually assess the differences between shallow and deep samples. The symbols represent the observed 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.

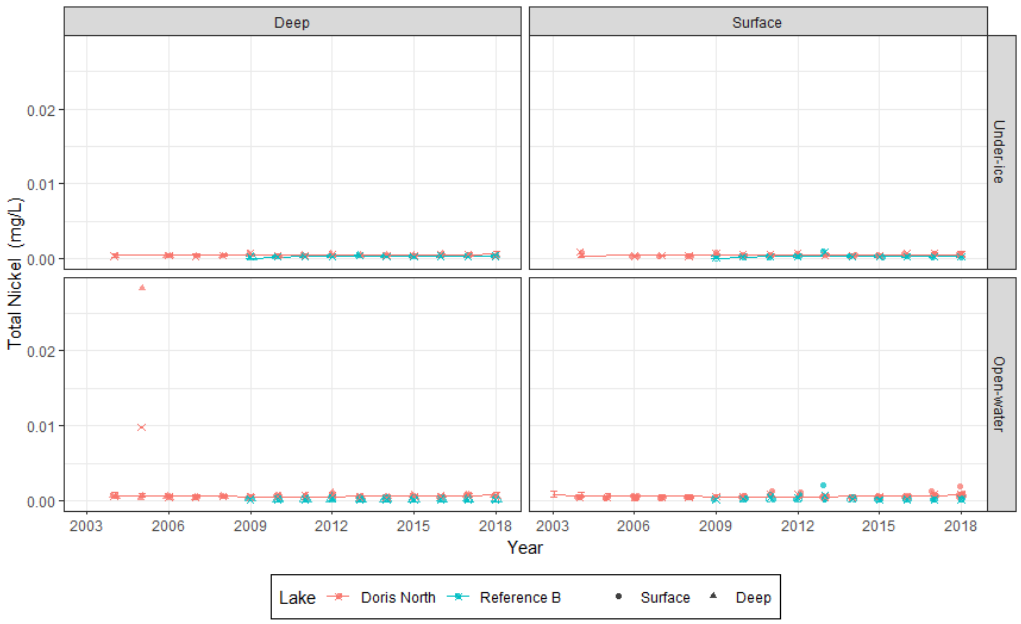
Plot of Observed and fitted data averaged over depth (full scale):



Plot of Observed and fitted data averaged over depth (zoomed in):



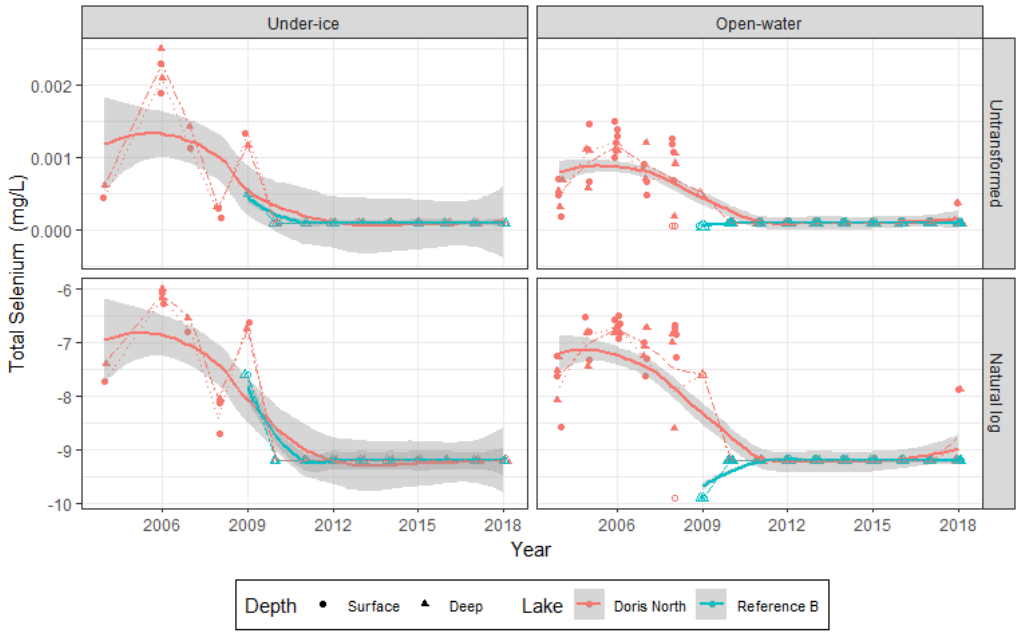
Plot of observed and fitted data separated by depth:



B.3.1.21 Analysis of Total Selenium

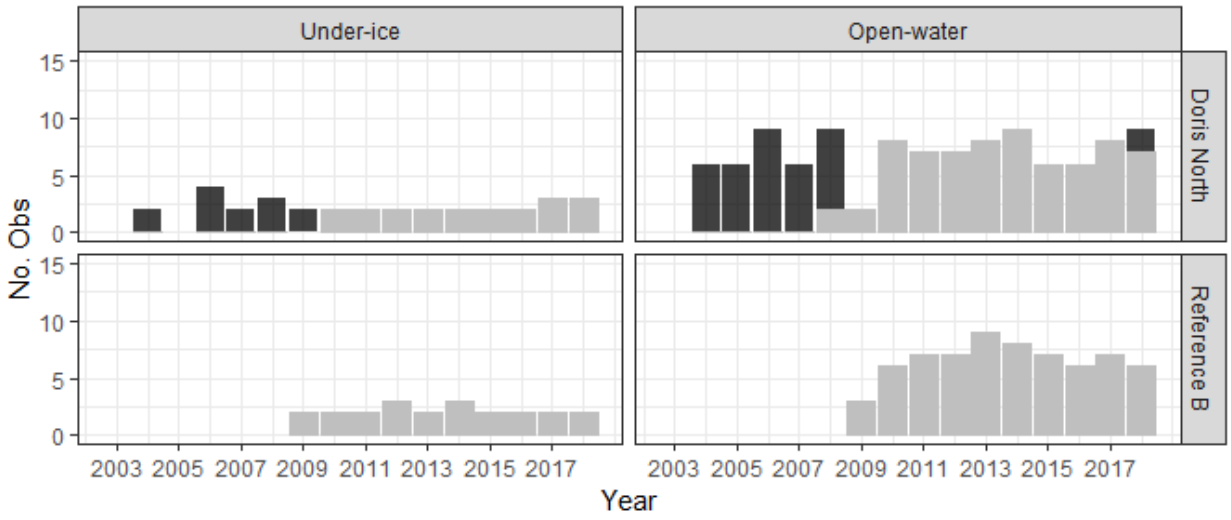
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

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

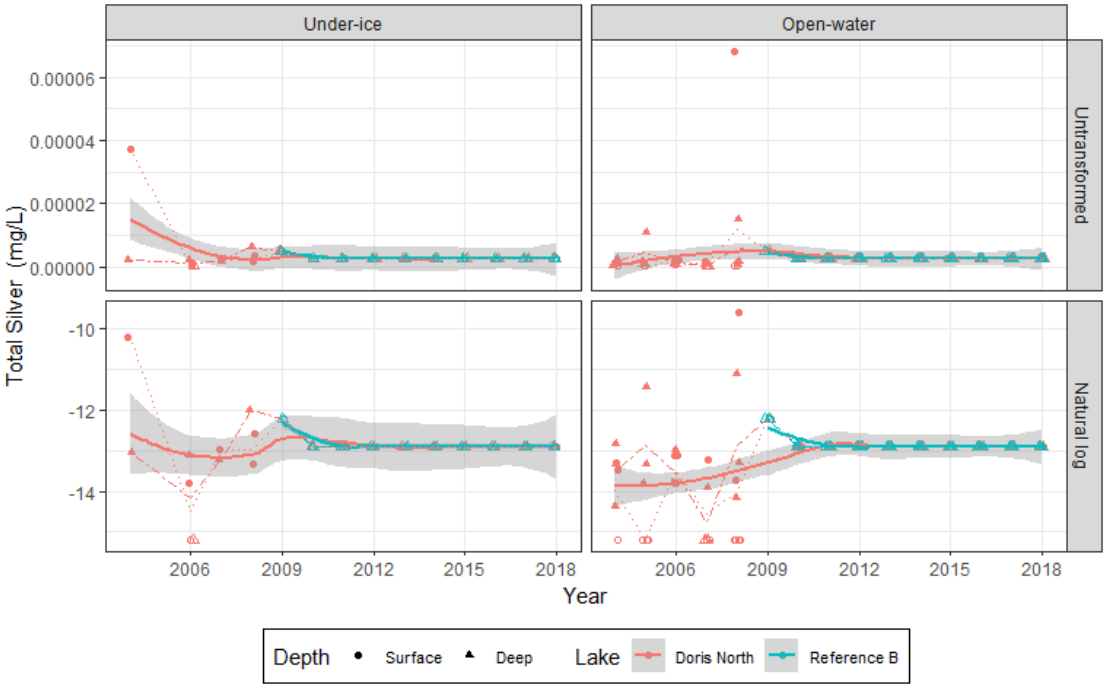
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	20	61	0.0002
Doris North	Open-water	106	70	66	0.0002
Reference B	Under-ice	22	22	100	0.0002
Reference B	Open-water	66	66	100	0.0002

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.3.1.22 Analysis of Total Silver

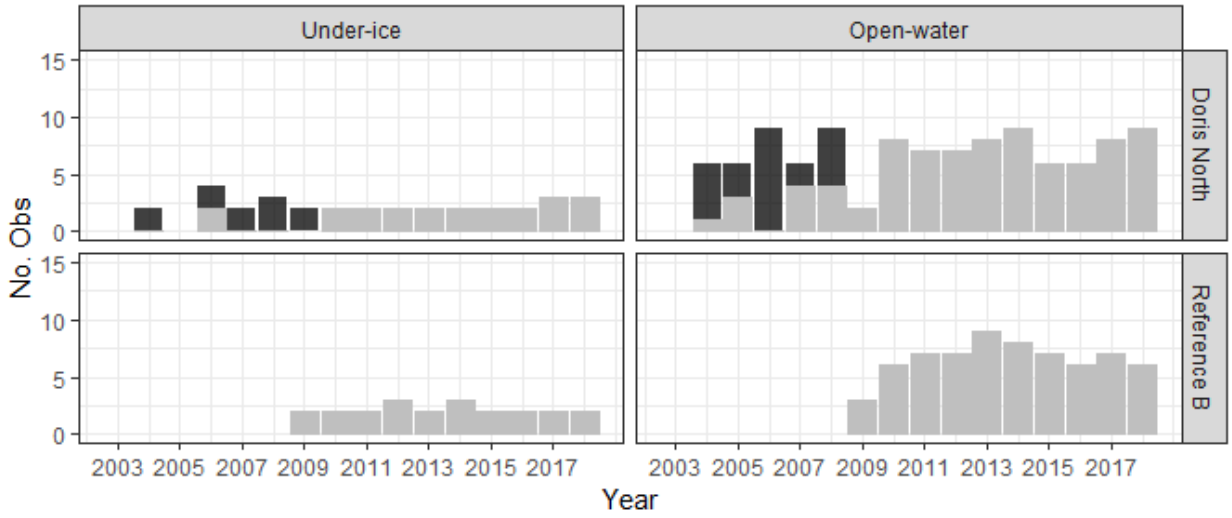
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

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

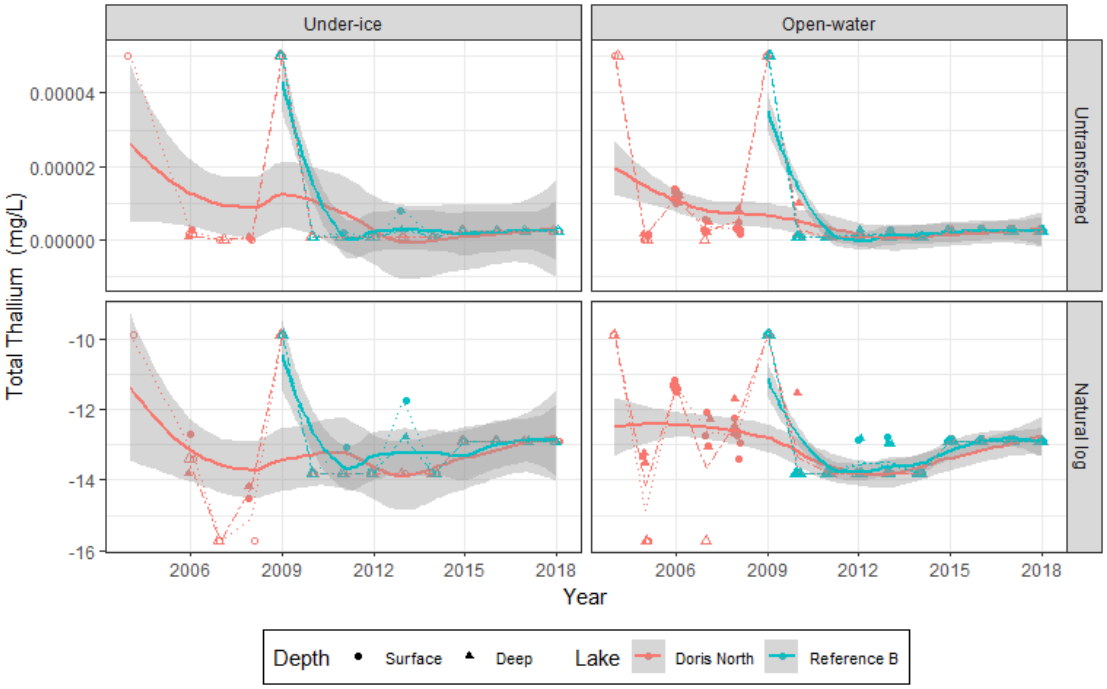
More than 60% of data under detection limit for Doris North and Reference B. Doris North and Reference B removed from the analyses. No statistical analyses were performed.

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	24	73	0.000005
Doris North	Open-water	106	82	77	0.000005
Reference B	Under-ice	22	22	100	0.000005
Reference B	Open-water	66	66	100	0.000005

B.3.1.23 Analysis of Total Thallium

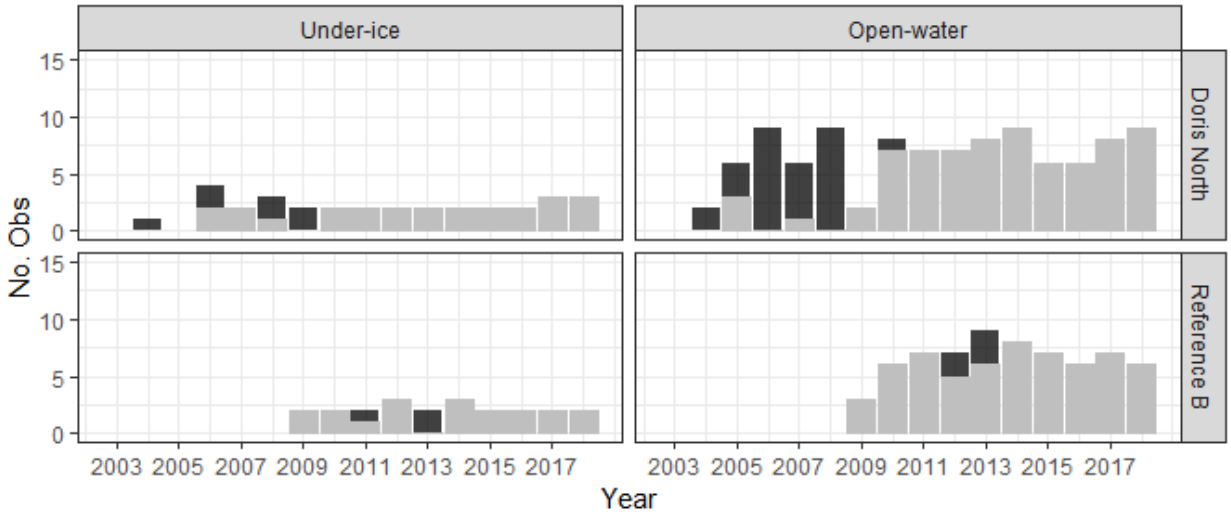
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

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

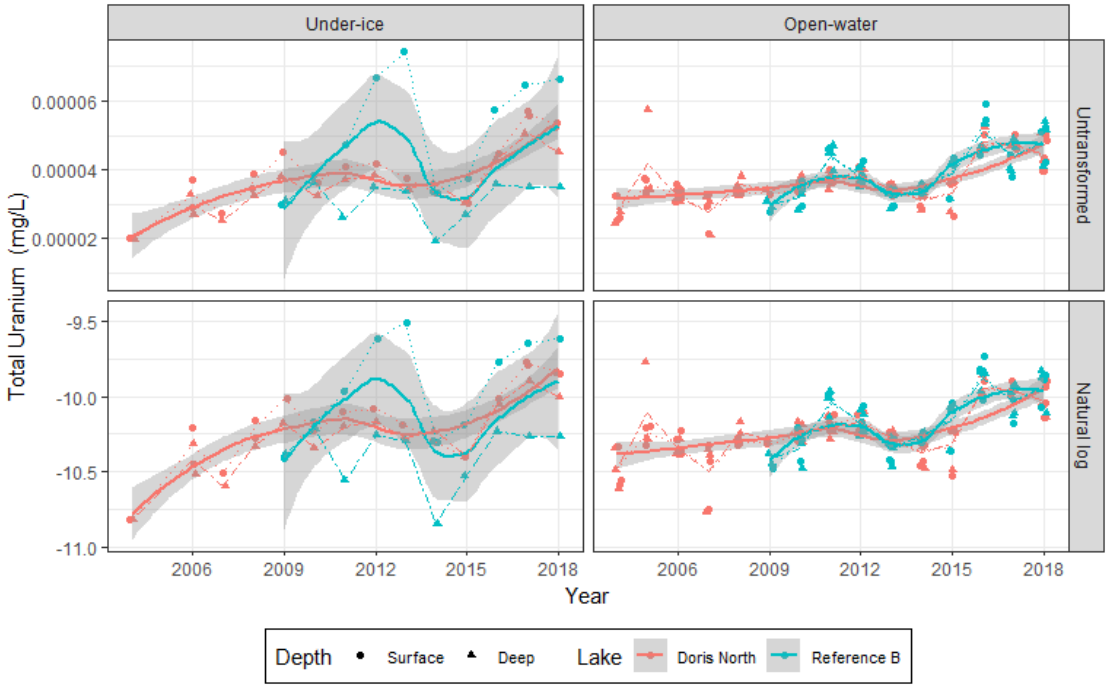
Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	32	28	88	0.0000025
Doris North	Open-water	102	75	74	0.0000030
Reference B	Under-ice	22	19	86	0.0000039
Reference B	Open-water	66	61	92	0.0000023

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

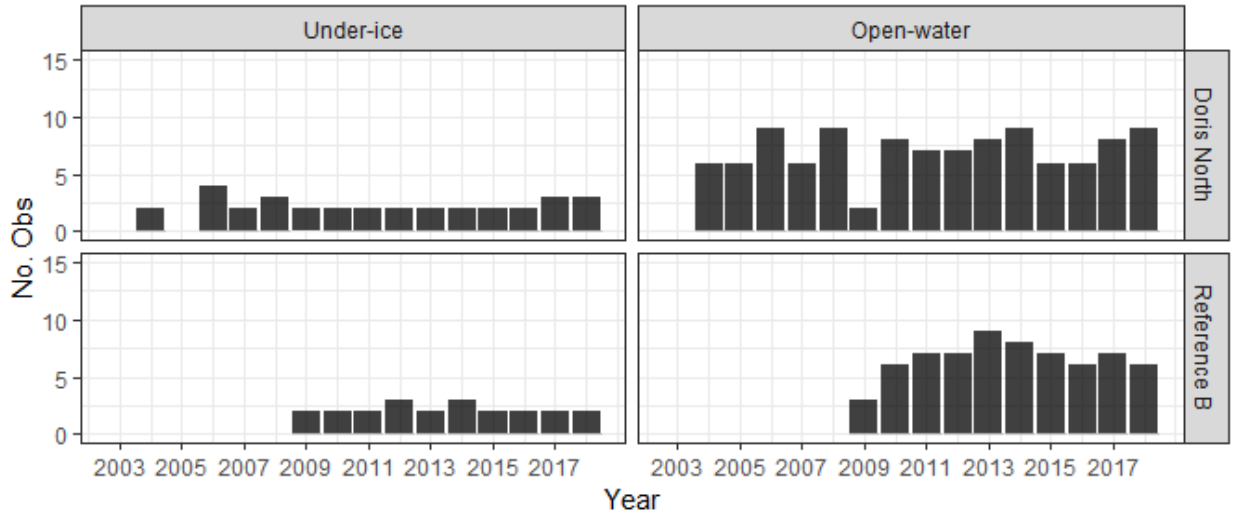
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

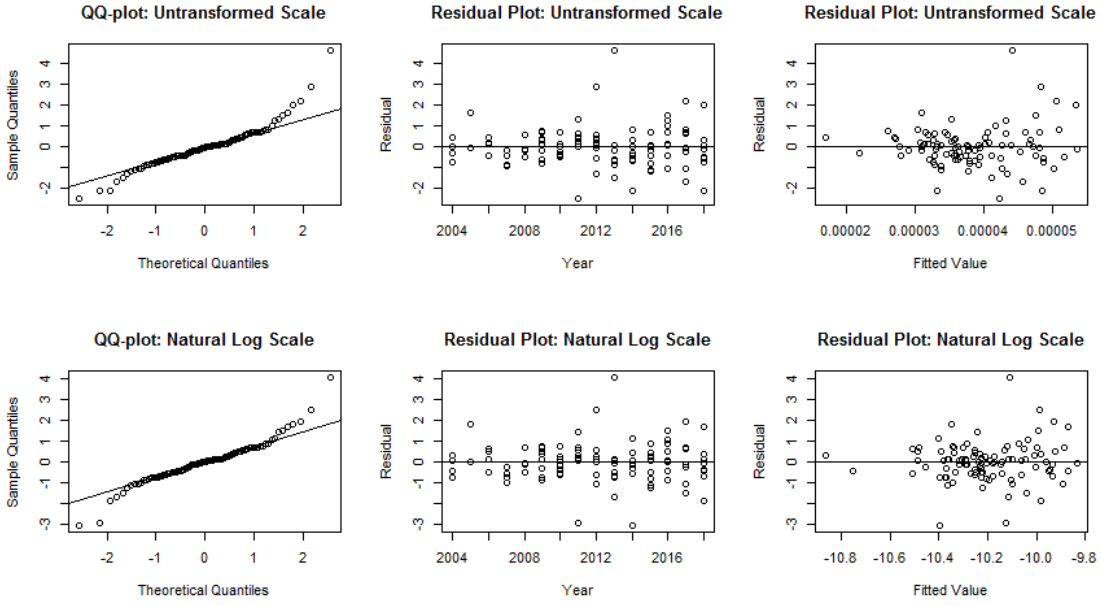
The sample sizes and median values per lake and season are summarized in the table below.

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

Lake	Season	# Obs	# Under DL	% Under DL	Median
Doris North	Under-ice	33	0	0	0.0000370
Doris North	Open-water	106	0	0	0.0000354
Reference B	Under-ice	22	0	0	0.0000356
Reference B	Open-water	66	0	0	0.0000383

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
77	Reference B	2013	Under-ice	Surface	0.0000743	0.0000442	4.623251

Outliers on natural log scale:

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
77	Reference B	2013	Under-ice	Surface	0.0000743	-10.10990	4.054332
80	Reference B	2014	Under-ice	Deep	0.0000194	-10.39525	-3.061667

The untransformed data better meets the residual assumptions. Analysis proceeds with untransformed 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	27.459	3	0.0000
Compare to Reference B	7.825	3	0.0498

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

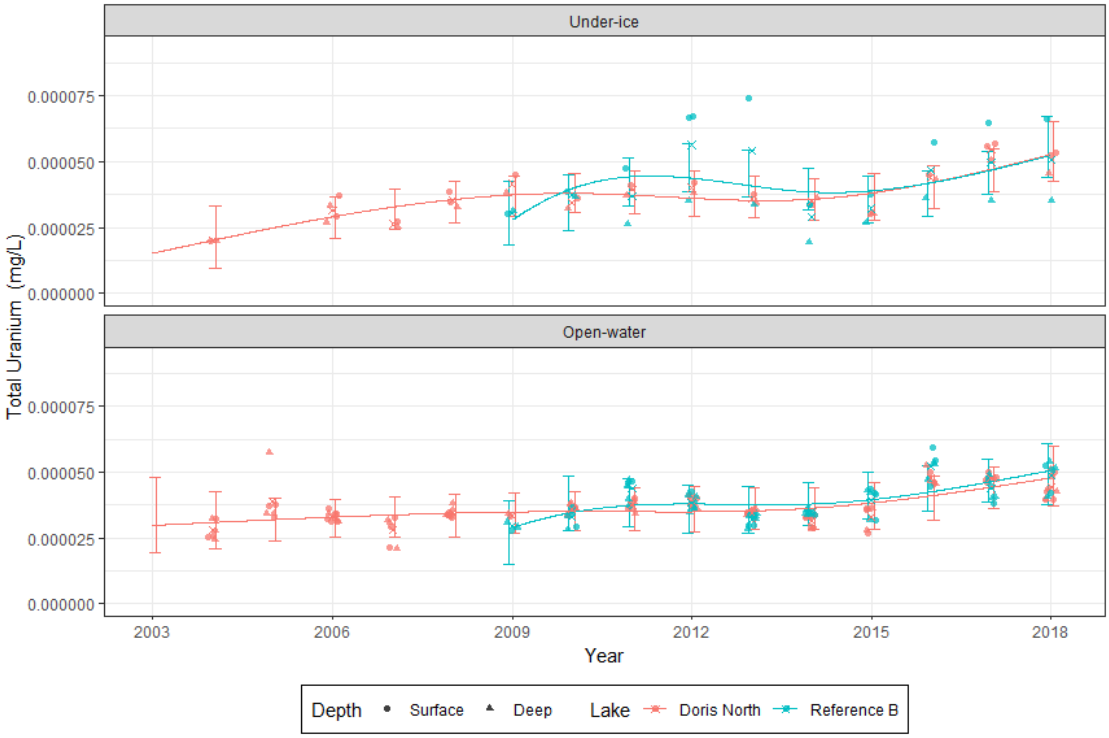
Analysis	Chi.sq	DF	P.value
Compare to slope 0	10.965	3	0.0119
Compare to Reference B	2.191	3	0.5338

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

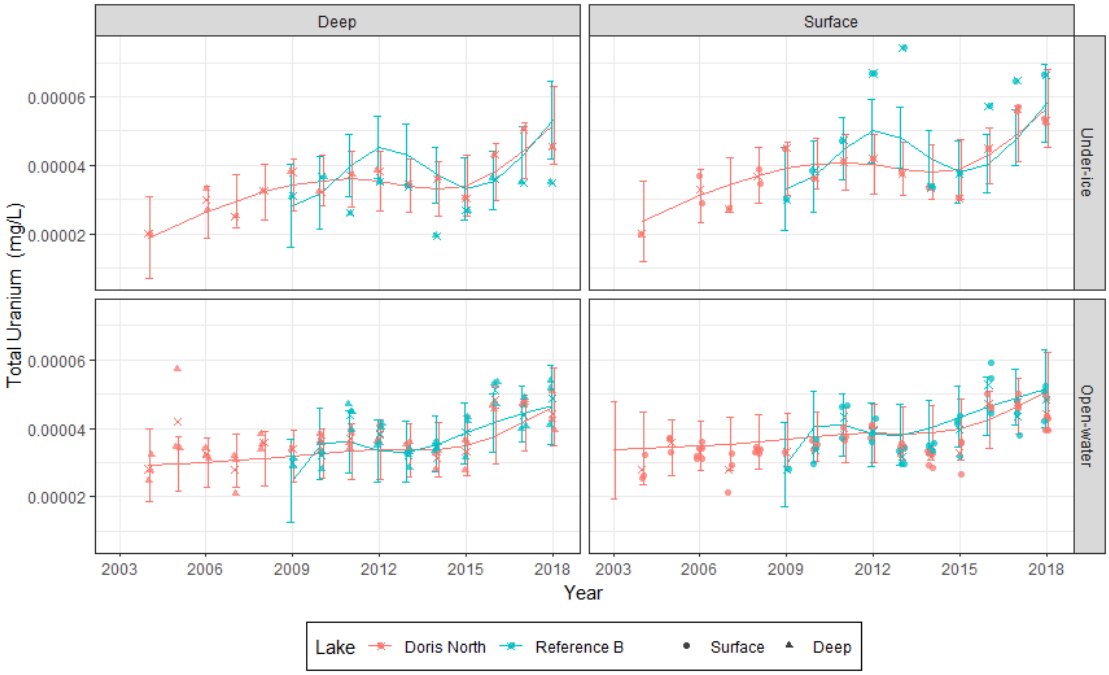
Observed Data and Fitted Values

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:



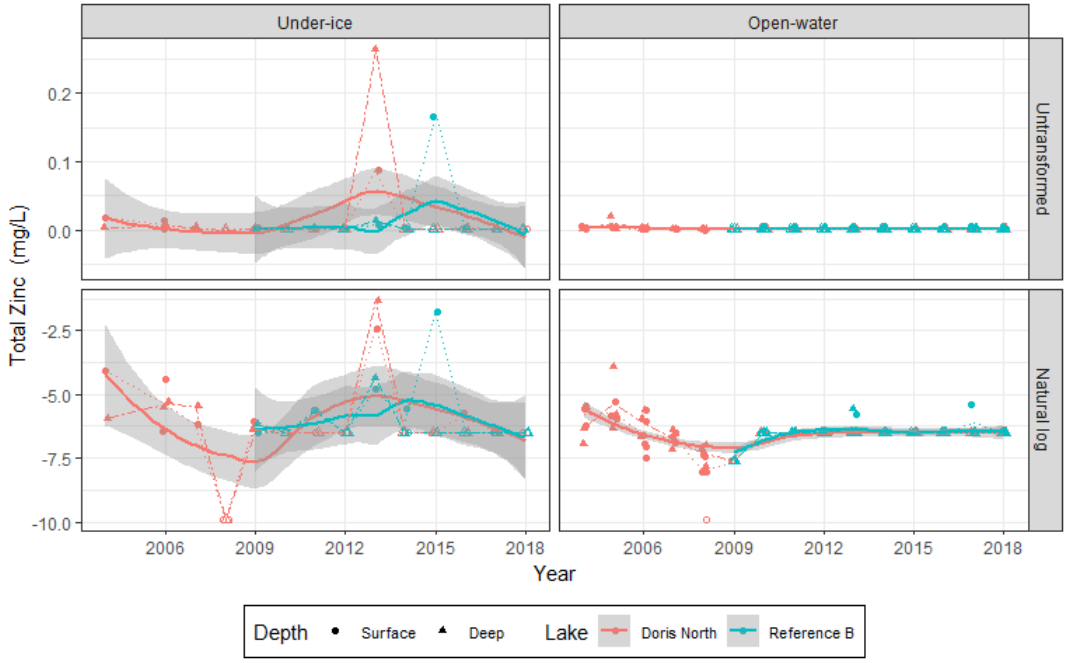
Plot of observed and fitted data separated by depth:



B.3.1.25 Analysis of Total Zinc

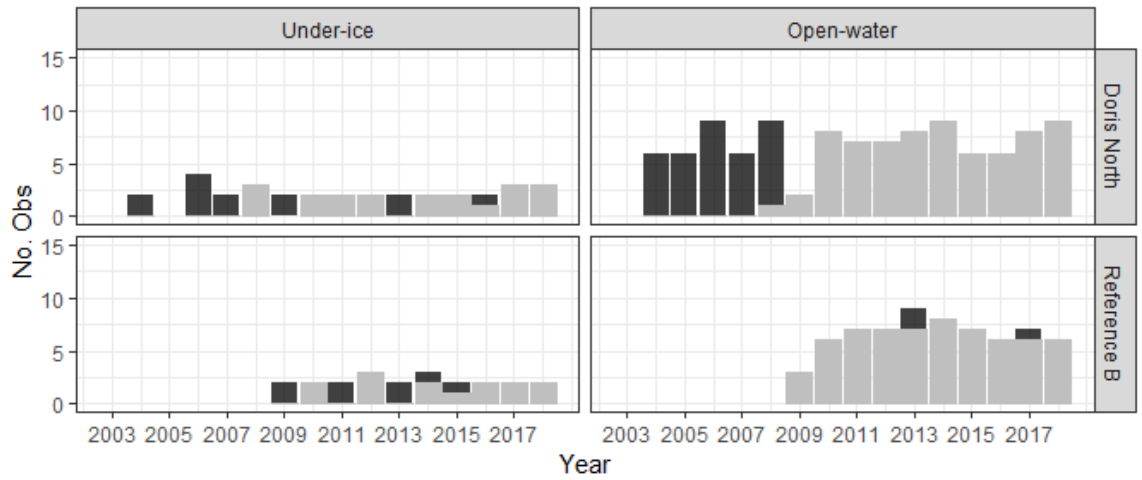
Observed Data

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. Dashed or dotted 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) 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	33	20	61	0.003
Doris North	Open-water	106	71	67	0.003
Reference B	Under-ice	22	14	64	0.003
Reference B	Open-water	66	63	95	0.003

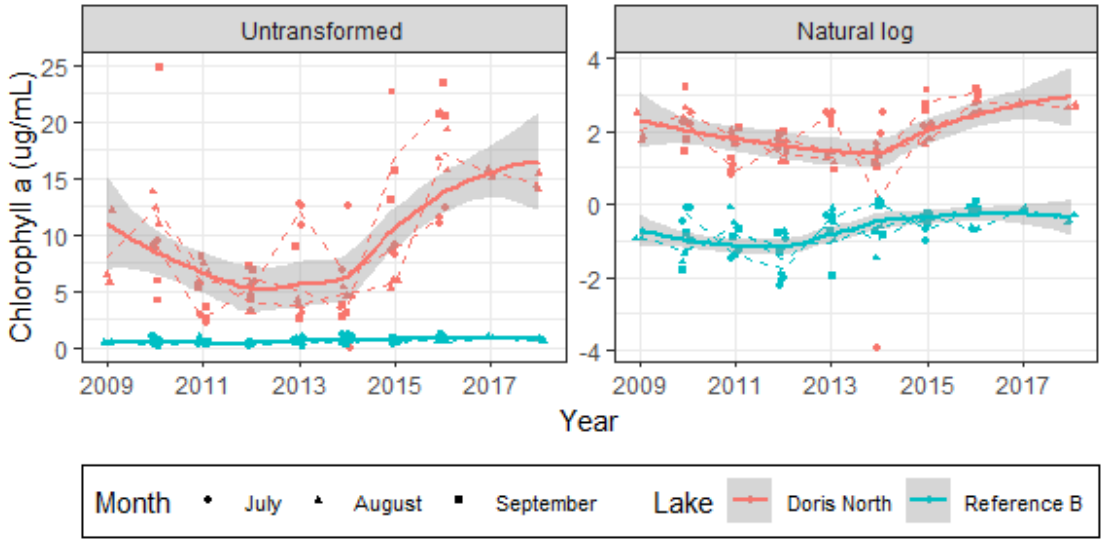
More than 60% of data under detection limit for Doris North and Reference B, and 100% of data from 2018 under detection limit. Doris North and Reference B removed from the analyses. No statistical analyses were performed.

B.3.2 Phytoplankton Biomass

B.3.2.1 Analysis of Phytoplankton Biomass (as Chlorophyll a)

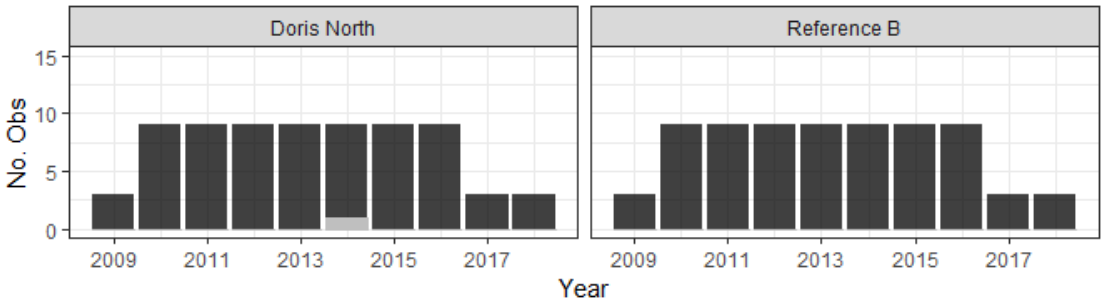
Observed Data

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. Dashed 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. LOESS smoothing curves and corresponding 95% confidence intervals are represented by solid lines and grey shading, respectively, 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., 2018) were censored.

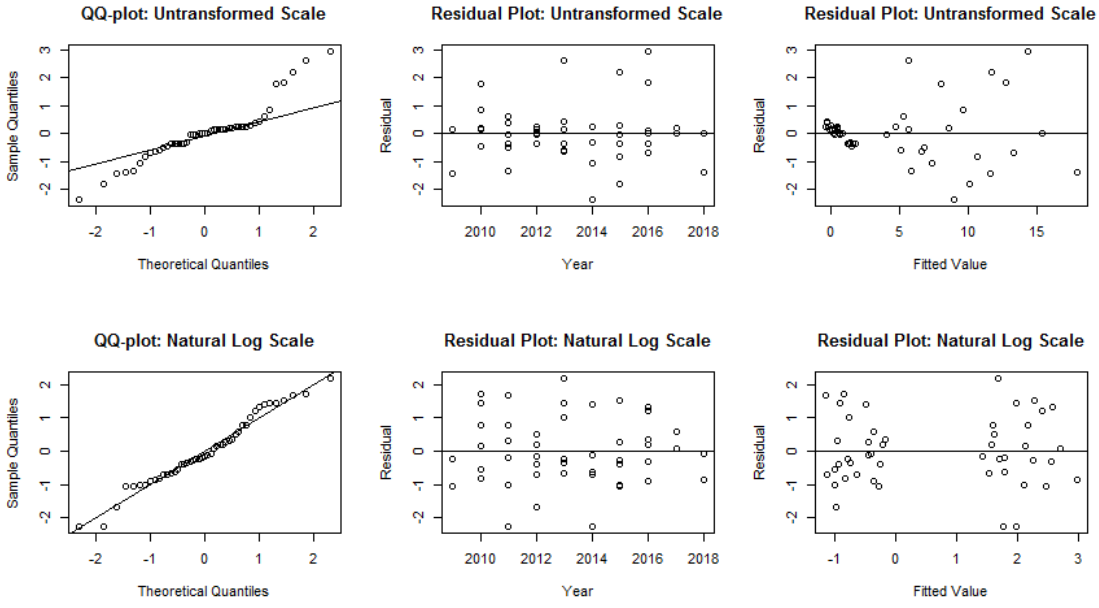
The sample sizes and median values per lake are summarized in the table below.

Lake	# Obs	# Under DL	% Under DL	Median
Doris North	72	1	1	7.315
Reference B	72	0	0	0.518

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

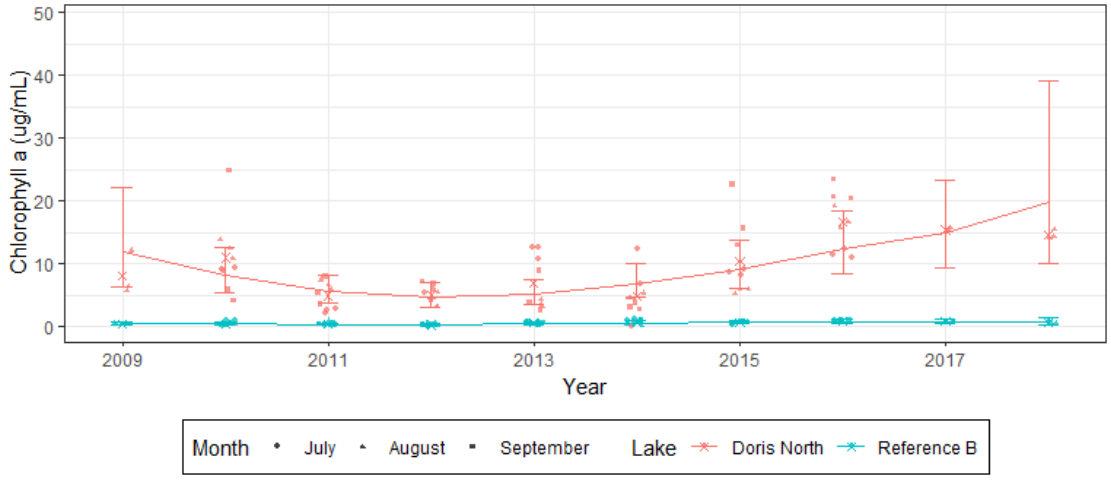
The trend of Doris Lake North was compared to a slope of 0. If there is a significant trend, then the trend of Doris Lake North is compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Analysis	Chi.sq	DF	P.value
Compare to slope 0	31.209	3	0.0000
Compare to Reference B	6.496	3	0.0898

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




July
August
September
Chlorophyll a (ug/mL)
0
10
20
30
40
50
2009
2011
2013
2015
2017
Year
Lake
Doris North
Reference B

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ERM's Vancouver Office
1111 West Hastings Street
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T: +1 604 689 9460
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