

AGNICO EAGLE

Hope Bay Project

2020 Aquatic Effects Monitoring Program Report

March 2021

Project No. 0557080-0002

The business of sustainability

ERM

March 2021

Hope Bay Project

2020 Aquatic Effects Monitoring Program Report

ERM Consultants Canada Ltd.
120 Adelaide Street West, Suite 2010
Toronto, ON
Canada M5H 1T1

T: +1 416 646 3608
F: +1 416 642 1269

EXECUTIVE SUMMARY

The Hope Bay Project (the Project) is a gold mining development in the West Kitikmeot region of mainland Nunavut. The Project property is approximately 153 km southwest of Cambridge Bay on the southern shore of Melville Sound and contains a greenstone belt (the Belt) that runs 80 km in a north-south direction varying in width between 7 km and 20 km. The Project continued to be operated by TMAC Resources Inc. (TMAC) in 2020. On February 2, 2021 TMAC was purchased by Agnico Eagle Mines Ltd. (Agnico Eagle) but TMAC continues to exist as a legal entity and is now a wholly owned subsidiary of Agnico Eagle. TMAC remains the operator of the Hope Bay Project.

The Project consists of three developments: Doris, Madrid, and Boston. Construction of the Doris Mine and associated infrastructure began in 2010, and commercial operations began in 2017. Construction of mining infrastructure at the Madrid North development began in April 2019, followed by a transition to operations in August 2019 with mining of the Naartok East Crown Pillar trench. As of December 2020, construction had not begun at the Madrid South or Boston developments.

This report presents the results of the 2020 Aquatic Effects Monitoring Program (AEMP), the second year of implementation of the approved Belt-wide *Hope Bay Project: Aquatic Effects Monitoring Plan* (the Plan; TMAC 2018). The primary goals of the AEMP are to evaluate potential Project effects on the surrounding freshwater environment during the construction and operation of the Project, verify predictions from the Madrid-Boston *Final Environmental Impact Statement* (FEIS; TMAC 2017b), support current and future *Fisheries Act* Authorizations, and provide a mechanism to respond to potential Project effects in the freshwater environment through the Response Framework. This framework sets environmental thresholds that, if exceeded, would trigger further investigation and/or mitigation.

The 2020 AEMP includes lakes adjacent to proposed infrastructure that have the greatest potential to receive non-point-source inputs such as runoff or dust (i.e., Doris and Patch lakes) and lakes that could be affected by water loss due to permitted water withdrawal and groundwater seepage into the mines through underground workings (i.e., Windy, Glenn, Patch, Imniagut, P.O., Ogama, Doris, and Little Roberts lakes). Aquatic components evaluated in 2020 included the following: fish habitat (water level and ice thickness), under-ice dissolved oxygen concentration, water temperature, water quality, and phytoplankton biomass. Statistical and/or graphical analyses were undertaken to determine whether there were any apparent effects of Project activities on these aquatic components in the monitored lakes.

Table 1 presents a summary of the overall findings of the evaluation of effects for the 2020 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. No adverse Project-related effects to fish habitat (water level and ice thickness), under-ice dissolved oxygen concentrations, water temperature, or phytoplankton biomass were detected in the exposure lakes (i.e., lakes with the potential to be influenced by the Project). The evaluation of effects concluded that there was a potential Project effect on open-water season turbidity levels in Doris Lake, as 2020 turbidity was elevated compared to baseline turbidity; however, the regression analysis showed that this apparent change was not statistically significant, thus a low action level response under the Response Framework was not triggered for Doris Lake turbidity.

Table 1: Summary of Evaluation of Effects for 2020 AEMP

Variable	Exposure Lakes Included in Evaluation of Effects	Conclusion of Effect	Low Action Level Triggered?	Report Section
Fish Habitat (Water Level and Ice Thickness)	Windy Lake, Glenn Lake, Patch Lake, Imniagut Lake, P.O. Lake, Ogama Lake, Doris Lake, Little Roberts Lake	No Effect	No	3.1; Appendix B
Physical Limnology (Dissolved Oxygen and Temperature)	Windy Lake, Patch Lake, Doris Lake	No Effect	No	3.2
Water Quality	Windy Lake, Patch Lake, Doris Lake	Possible Effect on Open-water Turbidity in Doris Lake	No	3.3
Phytoplankton Biomass (as Chlorophyll *a*)	Patch Lake, Doris Lake	No Effect	No	3.4

ACKNOWLEDGEMENTS

This report was prepared for Agnico Eagle Mines Ltd. (Agnico Eagle) by ERM Consultants Canada Ltd. (ERM). The 2020 fieldwork was conducted by on-site Environmental Superintendents Kyle Conway and Sarah Warnock, and Environmental Technicians Brian McCardle and Patrick Jolliffe. Fieldwork was completed with the support of field assistant Scott Adlem-Qilluniq and Rob Bond. Field-related logistics support was provided by TMAC Resources Inc. (TMAC), Acasta HeliFlight, and Braden Burry Expediting. The report was written by Carol Adly (M.Sc., R.P.Bio.) with support from Cam Evans (B.A.Sc.) and Patricia House (P.Eng.), statistical analyses were completed by Joanna Zhao (M.Sc.) and Haoyao Ruan (M.Sc.), and the report was reviewed by Erin Forster (B.Sc., R.P.Bio.). The compliance program was managed by Nicole Bishop (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.).

CONTENTS

List of Tables

List of Figures

ACRONYMS AND ABBREVIATIONS

AEMP	Aquatic Effects Monitoring Program
Agnico Eagle	Agnico Eagle Mines Ltd.
ALS	ALS Laboratory Group
BA	Before-After
BACI	Before-After/Control-Impact
the Belt	Hope Bay Belt
Benthos	Benthic invertebrates
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
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
ERM	ERM Consultants Canada Ltd.
Exposure site	Site potentially influenced by Project-related activities (e.g., Doris Lake, Patch Lake, Windy Lake).
FEIS	Final Environmental Impact Statement
GLMM	Generalized linear mixed effects model
ISQG	Interim sediment quality guideline
k	Light extinction coefficient

LME	Linear mixed effects
LOESS	Local regression
MDMER	Metal and Diamond Mining Effluent Regulations
NIRB	Nunavut Impact Review Board
NPAG	Not-potentially acid generating
NTU	Nephelometric turbidity units
NWB	Nunavut Water Board
PEL	Probable effects level
the Plan	Hope Bay Project: Aquatic Effects Monitoring Plan
the Project	the Hope Bay Project
QA/QC	Quality assurance/quality control
Reference site	Site located beyond any Project influence (i.e., Reference Lake B).
RPD	Relative percent difference
SD	Standard deviation
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

1.1 Background

The Hope Bay Project (the Project) is a gold mining development in the West Kitikmeot region of mainland Nunavut. The Project property is approximately 153 km southwest of Cambridge Bay on the southern shore of Melville Sound and contains a greenstone belt (the Belt) that runs 80 km in a north-south direction varying in width between 7 km and 20 km. The Project continued to be operated by TMAC Resources Inc. (TMAC) in 2020. On February 2, 2021 TMAC was purchased by Agnico Eagle Mines Ltd. (Agnico Eagle) but TMAC continues to exist as a legal entity and is now a wholly owned subsidiary of Agnico Eagle. TMAC remains the operator of the Hope Bay Project.

The Project area consists of three developments: Doris, Madrid (North and South), and Boston (Figure 1.1-1). Doris is the northernmost development situated near Roberts Bay and contains the Doris North Gold Mine (Doris Mine) that operates under amended Project Certificate No. 003 (last amended in September 2016). Construction of the Doris Mine and associated infrastructure began in 2010, and commercial operations began in 2017. The Madrid and Boston developments are in the north-central and southernmost parts of the Belt. TMAC submitted the Madrid-Boston *Final Environmental Impact Statement* (FEIS; TMAC 2017b) to the Nunavut Impact Review Board (NIRB) and corresponding application for a Type A Water Licence to the Nunavut Water Board (NWB) in December 2017. The NIRB issued Project Certificate No. 009 in November 2018 following their review of the FEIS. In January 2019, a new Type A Water Licence 2AM-BOS1835 for the Boston development and an amendment to the Type A Water Licence 2AM-DOH1335 (Amendment 2) for the Doris and Madrid developments was approved by the NWB. Construction of mining infrastructure at the Madrid North development began in April 2019, followed by a transition to operations in August 2019 with mining of the Naartok East Crown Pillar trench. As of December 2020, construction had not begun at the Madrid South or Boston developments. All mining and development activity was suspended at Madrid North in March 2020 and did not re-commence for the duration of the year.

The *Hope Bay Project: Aquatic Effects Monitoring Plan* (the Plan; TMAC 2018) describes the Aquatic Effects Monitoring Program (AEMP) for the freshwater environment over the entire Project area. The Plan is Belt-wide in scope, integrating the monitoring proposed for the Madrid-Boston developments (TMAC 2017a) with the monitoring conducted as part of the Doris Aquatic Effects Monitoring Plan (TMAC 2016). The Plan also harmonizes the AEMP and Environment Effects Monitoring (EEM) requirements under the *Metal and Diamond Mining Effluent Regulations* (MDMER; SOR/2002-222), and includes an adaptive management component through the Response Framework. The Response Framework sets environmental threshold levels that, if exceeded, would trigger further investigation and/or mitigation. Implementation of the Plan was one of the conditions of the new and amended Type A Water Licences (thus superseding the Doris Aquatic Effects Monitoring Plan (TMAC 2016)).

This report presents the results of the 2020 AEMP, the second year of implementation of the approved Belt-wide Plan (TMAC 2018).

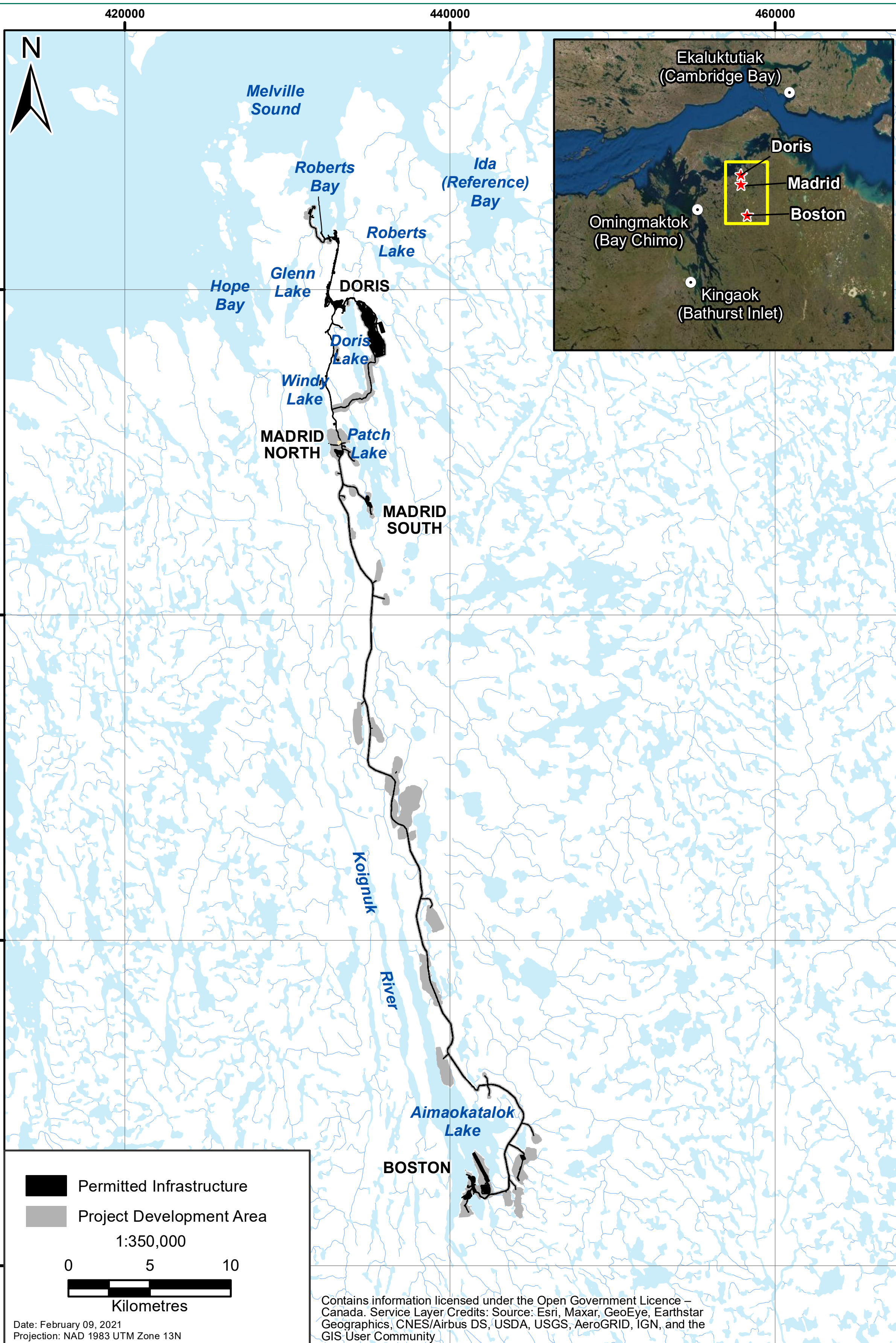


Figure 1.1-1: Hope Bay Project Location

1.2 Objectives

The primary goals of the AEMP are to evaluate potential Project effects on the surrounding freshwater environment during the construction and operation of the Project, verify predictions from the Madrid-Boston FEIS (TMAC 2017b), support current and future *Fisheries Act* Authorizations, and provide a mechanism to respond to potential Project effects in the freshwater environment through mitigation and management actions. The 2020 AEMP includes lakes adjacent to existing and proposed infrastructure that have the greatest potential to receive non-point-source inputs such as runoff or dust (i.e., Doris and Patch lakes) and lakes that could be affected by water loss due to permitted water withdrawal and groundwater seepage into the mines through underground workings (i.e., Windy, Glenn, Patch, Imniagut, P.O., Ogama, Doris, and Little Roberts lakes). The 2020 AEMP evaluates potential effects of Project activities on the following components of the freshwater environment in the Project area:

- fish habitat (water level and ice thickness);
- physical limnology (dissolved oxygen and water temperature);
- water quality; and
- phytoplankton biomass.

1.3 2020 Project Activities

Infrastructure associated with the Hope Bay Project is shown in Figure 1.1-1. Project activities occurring in and around this infrastructure have the potential to affect the freshwater environment through the generation of dust and/or runoff of site and mine contact water, which can settle onto or flow into lakes and streams in the Project area. The following list summarizes the Project activities that occurred in 2020 by development area:

Doris

- Full operations continued until March 2020. Workforce reduction due to Covid-19 pandemic in March 2020.
- Underground mining operations continued at Doris Mine, Madrid underground and surface operations were suspended in March.
- Northern workforce sent home in March to eliminate risk of Covid-19 transmission to communities.
- Milling operations continued at reduced rate with one rotation processing ore and opposite rotation conducting maintenance.
- Expansion of TIA reclaim jetty conducted in July to August.
- Maintenance conducted on airstrip.
- Roberts Bay Discharge system commissioned in January including Water Treatment Plant for treating underground effluent for total suspended solids (TSS). Commenced effluent discharge to Roberts Bay in accordance with MDMER in February.
- Discharge to Roberts Bay was suspended in August.
- Water Management Sump 3 installed to manage potential contact water.
- New building to house ambient air quality monitoring samplers was placed east of Doris pad (awaiting installation and commissioning of air quality monitors delayed due to Covid-19 pandemic).
- Sealift operation with delivery of supplies, diesel fuel, explosives and reagents to support mining and milling activities.

- Hazardous waste backhauled without incident.
- Heavy equipment that had been used for the Naartok East Crown Pillar Recovery mining was removed from site on sealift.

Madrid North

- Completed collaring underground portal and continued underground decline development until March 2020.
- Installation of three water management sumps around perimeter of waste rock pad prior to freshet.
- Completed contouring and armouring of Naartok East Crown Pillar overburden pile.
- Continued mining of Naartok East Crown Pillar trench until March.
- Performed maintenance on Madrid North Contact Water Pond.
- New building to house ambient air quality monitoring samplers was placed east of Doris pad (awaiting installation and commissioning of air quality monitors delayed due to Covid-19 pandemic).

As of December 2020, construction had not yet commenced at the Madrid South or Boston developments.

1.4 Report Structure

This document presents the methodology, results, and conclusions of the evaluation of effects of the 2020 Hope Bay AEMP. Detailed sampling and data analysis methodology, the quality assurance and quality control (QA/QC) program, and results of the 2020 AEMP (including ice thickness, temperature and dissolved oxygen profiles, water quality, and phytoplankton biomass) are provided in Appendix A. Water level and streamflow monitoring results and conclusions are provided in Appendix B. Supplemental information relevant to the 2020 analysis of effects (i.e., rationale for inclusion/exclusion of historical data, detailed statistical analysis methodology and results) is provided in Appendix C.

2. METHODS

2.1 Study Design

The 2020 program was conducted in accordance with the Plan (TMAC 2018). The study design is summarized in the following sections, and full details of the 2020 AEMP sampling methods are provided in Appendix A.

2.1.1 Sampling Locations

AEMP sampling locations were selected based on the potential for Project effects to occur during specific Project development and operational phases (TMAC 2018). Table 2.1-1 describes the Project phases that sequentially ‘trigger’ or mark the beginning of monitoring in specific study lakes identified as being potentially affected by those Project phases (TMAC 2018). In 2020, mining operations continued at the Doris and Madrid North developments. Construction had not commenced at the Madrid South or Boston developments as of December, 2020. Accordingly, sampling locations for the 2020 AEMP were those sites triggered by Doris and Madrid North construction or operations activities (Table 2.1-1), with the exception of Wolverine Lake where water level monitoring was undertaken in 2020 to augment the baseline data for this lake. As described in the Plan, Wolverine Lake will be included in the evaluation of effects once construction begins at Madrid South (TMAC 2018). The 2020 sites sampled, the aquatic components sampled, and Project infrastructure are shown in Figure 2.1-1 and summarized in Table 2.1-2.

Table 2.1-1: AEMP Sampling Locations, Monitoring Triggers, and Sampling Rationale, Hope Bay Project, 2020

Watershed	Study Area	Monitoring Trigger	Sampling Rationale
Windy Watershed	Windy Lake	Doris, Madrid North, and Madrid South construction and operations	Water withdrawal for domestic use (potable water); drawdown from Madrid North mine groundwater inflow
	Glenn Lake	Doris, Madrid North, and Madrid South construction and operations	Glenn Lake is downstream of Windy Lake, therefore indirect effects may be observed in Glenn Lake as a result of water withdrawal from Windy Lake
Doris Watershed	Wolverine Lake	Madrid South construction and operations	Drawdown from Madrid South mine groundwater inflow; inputs (e.g., dust deposition, runoff) due to proximity to infrastructure
	Patch Lake	Madrid North and South construction and operations	Drawdown from Madrid North and South mines groundwater inflow; inputs (e.g., dust deposition, runoff) due to proximity to infrastructure
	Imniagut Lake	Madrid North and South operations	Drawdown from Madrid North mine groundwater inflow
	P.O. Lake	Madrid North and South operations	Drawdown from Madrid North mine groundwater inflow
	Ogama Lake	Madrid North and South operations	Drawdown from Madrid North mine groundwater inflow

Watershed	Study Area	Monitoring Trigger	Sampling Rationale
Doris Watershed *(cont'd)*	Doris Lake	Doris, Madrid North, and Madrid South construction and operations; Boston operations	Water withdrawal for industrial use (e.g., dust suppression, wash bays and machine shops, process water); drawdown from Doris mine groundwater inflow; inputs (e.g., dust deposition, runoff) due to proximity to infrastructure
	Little Roberts Lake	Doris, Madrid North, and Madrid South construction and operations; Boston operations	Little Roberts Lake is downstream of Doris Lake, therefore indirect effects may be observed in Little Roberts Lake as a result of drawdown and water withdrawal from Doris Lake
Aimaokatalok Watershed	Stickleback Lake	Boston construction and operations	Inputs (e.g., dust deposition, runoff) due to proximity to infrastructure
	Aimaokatalok Lake	Boston construction and operations	Inputs (e.g., dust deposition, runoff) due to proximity to infrastructure; permitted discharge
Reference Watershed	Reference Lake B	Doris, Madrid, and Boston construction and operations	Reference area for AEMP located outside of the zone of Project influence

2.1.2 Sampling Schedule

Sampling in 2020 was conducted in accordance with the schedule outlined in the Plan (TMAC 2018). Specific sampling dates are provided in Table 2.1-3. In 2020, water levels in the study lakes were monitored continuously throughout the open-water season, with the exception of Doris Lake which was monitored year round. The sampling program included two sampling periods: under-ice sampling in April/May and open-water sampling in August. Temperature and dissolved oxygen profiles and water quality samples (e.g., nutrients and metals) were collected in both April and August, 2020. Phytoplankton biomass (as chlorophyll *a*) samples were collected once in August.

2.2 Evaluation of Effects Methodology

For each variable subjected to an evaluation of effects, historical data collected in the Project area were incorporated into the analysis to determine if there are any apparent changes in the evaluated variables over time that might be attributable to Doris or Madrid North construction and operations activities. Trends in Reference Lake B were also examined alongside the trends in the exposure lakes (i.e., lakes potentially influenced by Project-related activities) to determine if detected changes over time are likely naturally occurring or 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 2020. Ice thickness and water level were included in the effects analysis to determine whether Project-related water use could affect overwintering fish populations and fish habitat, to confirm predictions from the Madrid-Boston FEIS, and to inform potential fisheries offsetting under applicable *Fisheries Act* Authorizations.

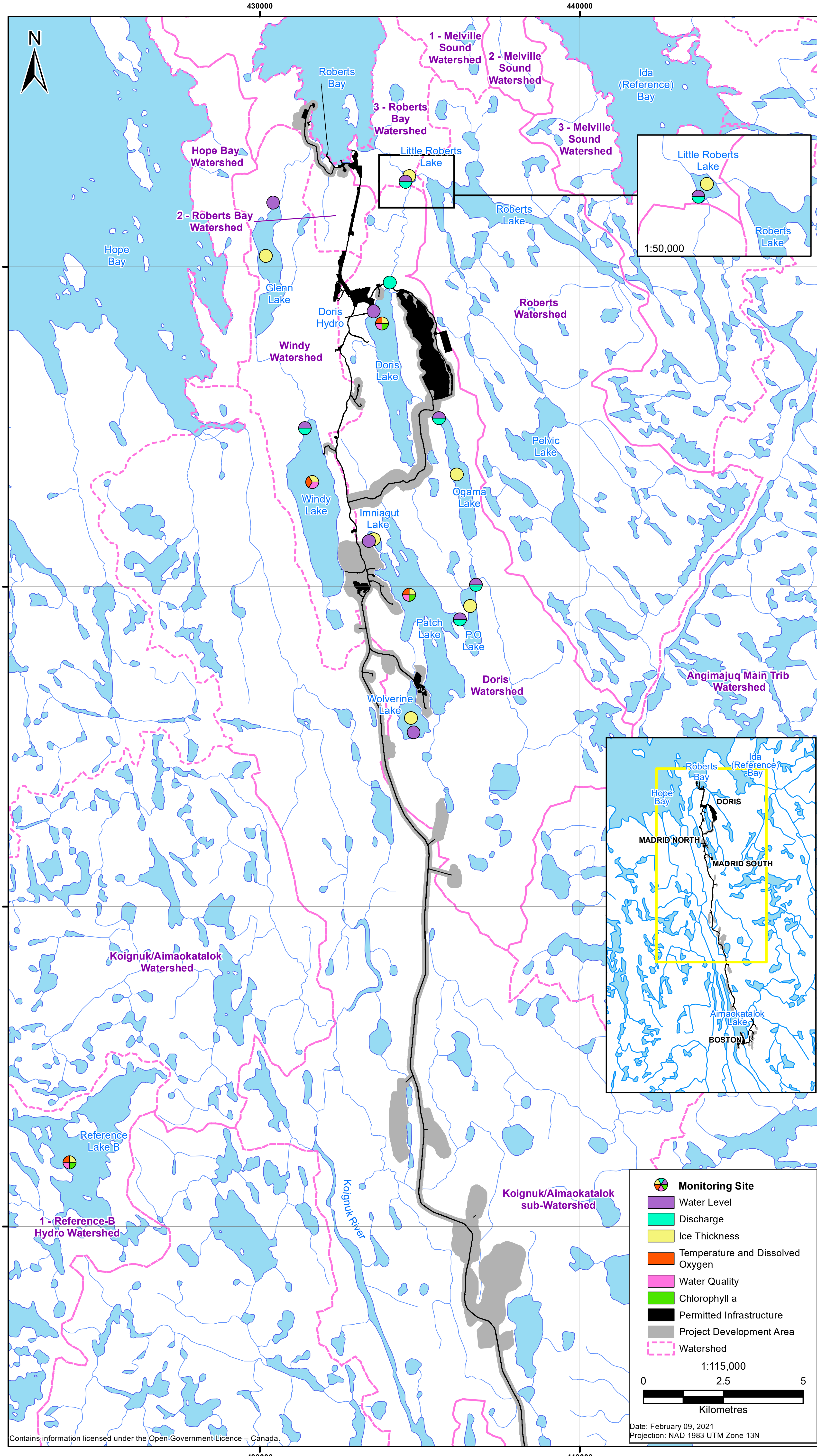


Figure 2.1-1: AEMP Sampling Locations, Hope Bay Project, 2020

Table 2.1-2: AEMP Sampling Locations and Monitoring Components, Hope Bay Project, 2020

Site	NAD83, UTM Zone 13N		Ice Thickness	Water Level	Discharge	Temperature and Dissolved Oxygen Profiles	Water Quality	Phytoplankton Biomass (as chlorophyll *a*)
	Easting	Northing						
Windy Lake	431630	7553269	X			X	X	
Windy Outflow Hydro	431404	7554948		X	X			
Glenn Lake	430183	7560337	X					
Glenn Lake Hydro	430410	7562001		X				
Wolverine Lake	434720	7545890	X					
Wolverine Lake Hydro	434802	7545443		X				
Patch Lake	434660	7549739	X			X	X	X
Patch Outflow Hydro	436248	7548973		X	X			
Imniagut Lake	433559	7551490	X					
Imniagut Lake Hydro	433403	7551421		X				
P.O. Lake	436576	7549393	X					
P.O. Outflow Hydro	436749	7550055		X	X			
Ogama Lake	436148	7553517	X					
Ogama Outflow Hydro	435595	7555262		X	X			
Doris Lake	433815	7558222	X			X	X	X
Doris Lake-2 Hydro	433547	7558601		X				
Doris Creek TL-2 Hydro	434059	7559504			X			
Little Roberts Lake	434665	7562826	X					
Little Roberts Outflow Hydro	434548	7562652		X	X			
Reference Lake B	424050	7532000	X			X	X	X

Table 2.1-3: Sampling Schedule Summary, Hope Bay Project, 2020

Monitoring Component	Sampling Dates
Water Level	Continuous from June 2020 to September 2020 (except Doris Lake which was monitored year round)
Ice Thickness	April 9 to 13 and May 3 to 5, 2020
Temperature and Dissolved Oxygen Profiles/ Water Quality	April 9 to 13, 2020 August 12 to 25, 2020
Phytoplankton Biomass	August 12 to 25, 2020

Table 2.2-1: Variables Subjected to Analysis of Effects, Hope Bay Project, 2020

Category	Variable
Fish Habitat	Water Level Ice Thickness
Physical Limnology	Dissolved Oxygen Temperature
Water Quality	pH Total Suspended Solids Turbidity Chloride Fluoride Total Ammonia Nitrate Nitrite 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) Dissolved Manganese (Mn) Dissolved Zinc (Zn)
Phytoplankton Biomass	Chlorophyll *a*

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. Phytoplankton biomass was also evaluated as an indicator of nutrient loading or other changes to freshwater environments (Table 2.2-1).

2.2.2 Overview of Assessment Methodology

For each variable subjected to an evaluation of effects, potential mine effects were assessed 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 C. All statistical analyses were conducted using R version 4.0.2 (R Core Team 2021).

For Doris Lake, the large dataset (10+ years for most variables) and good temporal coverage allowed for the use of regression models 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 in an evaluated variable in Doris Lake. Tobit regression was used when a moderate amount of data (between 10 and 50%) for a given variable within the study lake were below the analytical detection limit (i.e., censored data—data that are partially known because they are bounded by a detection limit). Time effects were modelled using natural cubic regression spline curves to allow for non-linearity. The first step of the regression analysis was to determine whether there was evidence of a change in a given variable over time (i.e., is the slope of the fitted spline curve significantly different from a slope of zero). This first step revealed whether or not there was a significant change in the variable over time, but did not give any information about the direction of the trend (e.g., increasing or decreasing). For most variables, only an increasing concentration over time would be considered an adverse mine effect (e.g., TSS, arsenic and copper in water or sediments), although for some variables, an increasing or decreasing trend would be considered adverse (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 exposure lake trend was compared to the trend in Reference Lake B. This second step of the analysis included only the years of data that were comparable between lakes. 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 the exposure lake and Reference Lake B were not significantly different from each other, then it was concluded that the increasing or decreasing trend in Doris Lake was likely 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 the exposure lake, the differential trend was carried forward as a potential mine effect and investigated further.

For Patch and Windy lakes, there were fewer than 10 years of continuous historical data available for most variables, and temporal coverage was more sporadic than Doris and Little Roberts lakes. For these lakes, the statistical analysis consisted of a two-step approach. The first step was to conduct a before-after (BA) analysis that compared a given variable's mean concentration in the before (i.e., years up to and including 2018) period to the after (i.e., 2020) period to determine whether there was a significant difference between time periods that could suggest a Project effect. If there was no significant difference between time periods, the analysis was concluded here; however, if there was a significant difference, the analysis proceeded to the second step: a before-after/control-impact (BACI) analysis. The BACI analysis compares the before-after trend at the exposure site with the before-after trend at a corresponding reference site. The BACI analysis included only the years of data that were comparable between the reference and exposure lakes. If the BACI analysis determined that the before-after trends at the exposure and reference sites were not significantly different from each other, then the observed change was attributed to a natural process. However, if there was a significant difference in the before-after trends between reference and exposure sites, the differential trend 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 between exposure sites and the reference site. For example, trends over time could vary due to local differences in meteorological conditions, runoff from the natural landscape, or naturally variable inputs related to weathering and erosion. These changes would not necessarily affect all lakes in the region equally, and may not co-occur in exposure sites and Reference Lake B. A difference in trends between lakes may therefore not be conclusive evidence of a mine effect.

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 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.

For profile data (dissolved oxygen and temperature) and highly censored data (i.e., datasets in which greater than 50% of values were below detection limits), trends were evaluated using graphical analysis. Half of the analytical detection limit was substituted for values below detection limits for graphing purposes. If 100% of concentrations of a given variable were below the detection limit for the current assessment year (i.e., 2020), it was concluded that there was no evidence of an effect of the Project on that variable, and no further analyses were performed.

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 potential effect was screened against the conditions required to trigger a 'low action level' response through the Response Framework (see Section 2.2.3) to determine what follow-up actions may be needed. If the conditions for triggering a low action level response were not met, then there was concluded to be little to no apparent ecological risk to freshwater aquatic organisms, and monitoring would continue through the AEMP with no further follow-up action. However, if the conditions of a low action level response were met, follow-up actions would be triggered as described in the Response Framework (TMAC 2018). 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 Response Framework

Potential effects to the freshwater receiving environment are adaptively managed through the Response Framework described within the Plan (TMAC 2018). The Response Framework links the results of the AEMP effects analysis to management actions to avoid significant adverse effects arising from Project activities (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 so that significant adverse effects to aquatic life do not occur (TMAC 2018).

Through the Response Framework, the results of the AEMP evaluation of effects are screened against a set of conditions that must be met to trigger a 'low action level' response. These conditions include comparisons of the magnitudes of the AEMP evaluated variables in the current assessment year (i.e., 2020) to baseline or reference conditions, as well as comparison to benchmarks that are considered to be protective of aquatic life. The following sections describe the low action level conditions by monitoring component.

2.2.3.1 Water Quality

As described in the Response Framework (TMAC 2018), the four conditions that must be met to trigger a low action level response for water quality are:

1. identification of a statistically significant and potentially adverse change[1] from baseline concentrations;
2. the concentration of the water quality variable is outside of the normal range based on baseline concentrations;
3. the concentration of the water quality variable exceeds 75% of a benchmark; and
4. if a potentially adverse change[1] is detected at the exposure site, there is no similar change at the reference site.

---

[1] For most evaluated water quality variables, only an increase would be considered a potentially adverse change; however, for dissolved oxygen concentration, only a decrease would be considered potentially adverse, and for pH, a change in either direction would be considered potentially adverse.

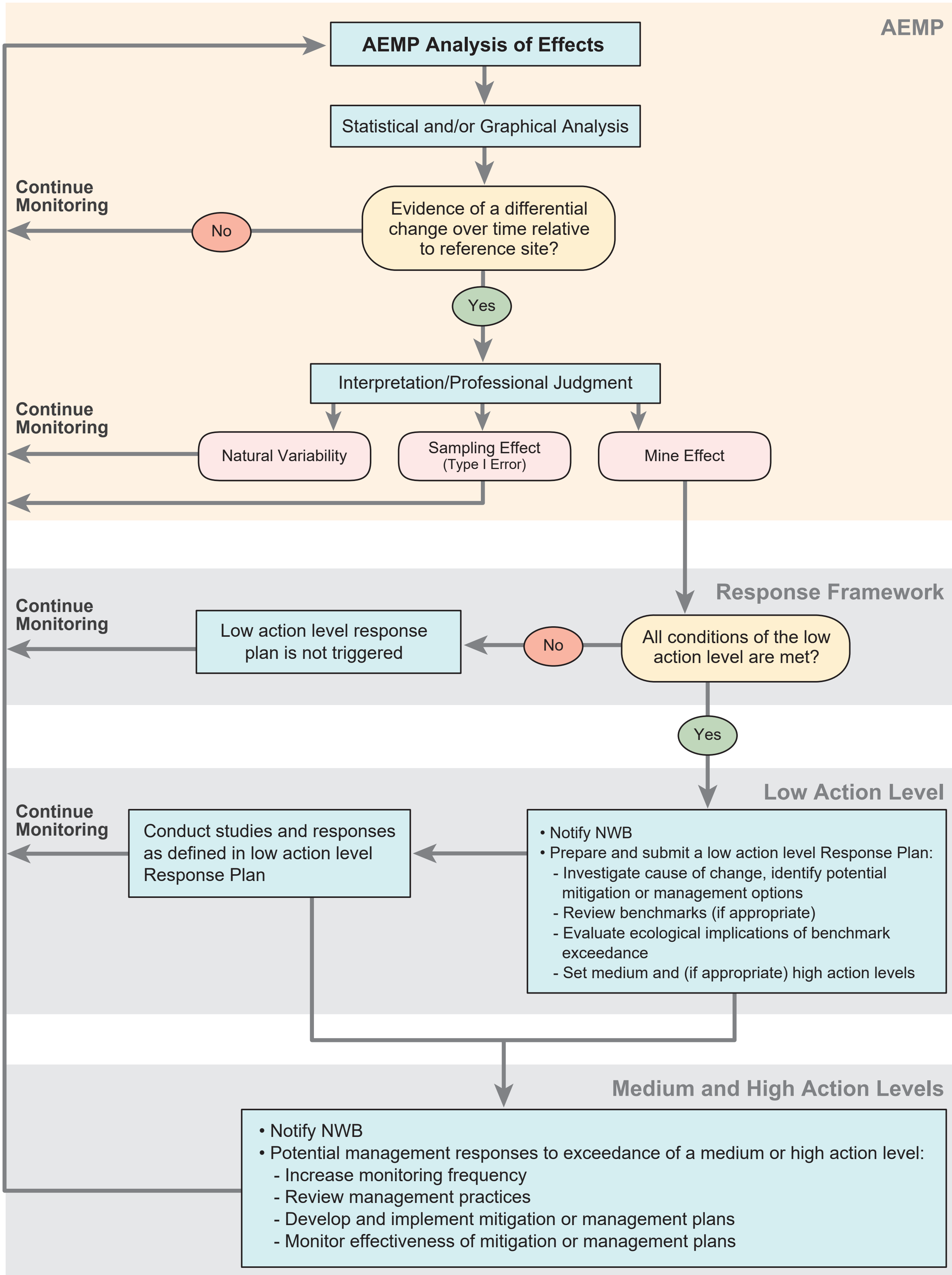


Figure 2.2-1: AEMP Analysis of Effects and Response Framework

In some cases, it may not be possible for a given variable to meet all four conditions (e.g., because there was no information available for the reference site, or it was not possible to conduct a statistical analysis on the data). For this reason, in order to trigger a low action level, it is sufficient to show that all conditions were met excluding the ones that did not apply for a particular variable. For example, if all reference site concentrations of a particular variable were below the detection limit and it was not possible to statistically analyze the reference site data, Condition 4 was excluded and a low action level was triggered if the remaining conditions were met. Conversely, in order to conclude that a low action level was not triggered, it was sufficient to show that at least one condition was not met.

The benchmarks defined for water quality variables are the CCME water quality guidelines for the protection of aquatic life (Table 2.2-2; CCME 2020). CCME guidelines are conservative benchmarks that are meant to be protective of all aquatic life (CCME 1999). Concentrations greater than the CCME guidelines are not necessarily indicative of an adverse ecological impact, as the derivation of a CCME guideline typically includes a safety factor to ensure that it is protective of the most sensitive life stage of the most sensitive species over the long-term (CCME 2007). Setting the low action level condition to 75% of the water quality benchmark 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: Long-term Water Quality Benchmarks for the Hope Bay Project

Water Quality Variable	Benchmark[a]
Dissolved Oxygen	9.5 mg/L (cold-water biota: early life stages); 6.5 mg/L (cold-water biota: other life stages)
Temperature	Thermal additions must not alter thermal stratification regime, turnover date(s), and maximum weekly temperature
pH	6.5 – 9.0
Total Suspended Solids	Maximum average increase of 5 mg/L from background (for clear-flow waters; long-term exposure)
Turbidity	Maximum average increase of 2 NTUs from background (for clear-flow waters; long-term exposure)
Chloride	120 mg/L (long term)
Fluoride	0.12 mg/L
Total Ammonia-N	Temperature- and pH-dependent
Nitrate-N	3.0 mg/L (long term)
Nitrite-N	0.06 mg/L
Total Aluminum	0.005 mg/L (if pH < 6.5); 0.1 mg/L (if pH ≥ 6.5)
Total Arsenic	0.005 mg/L
Total Boron	1.5 mg/L
Total Cadmium	0.00004 mg/L for hardness (as $CaCO_3$) of < 17 mg/L; $10^{(0.83[\log(\text{hardness})]-2.46)}$/1,000 mg/L for hardness of ≥ 17 to ≤ 280 mg/L; 0.00037 mg/L for hardness of > 280 mg/L (long term)
Total Chromium	0.001 mg/L for Cr (VI); 0.0089 mg/L for Cr (III)
Total Copper	0.002 mg/L for hardness (as $CaCO_3$) of < 82 mg/L; $e^{(0.8545[\ln(\text{hardness})]-1.465)}$/1,000 mg/L for hardness of ≥ 82 to ≤ 180 mg/L; 0.004 mg/L for hardness of > 180 mg/L
Total Iron	0.3 mg/L

Water Quality Variable	Benchmark[a]
Total Lead	0.001 mg/L for hardness (as $CaCO_3$) of ≤ 60 mg/L; $e^{(1.273[\ln(\text{hardness})]-4.705)}$/1,000 mg/L for hardness of > 60 to ≤ 180 mg/L; 0.007 mg/L for hardness of > 180 mg/L
Total Mercury	0.026 µg/L
Total Molybdenum	0.073 mg/L
Total Nickel	0.025 mg/L for hardness (as $CaCO_3$) of ≤ 60 mg/L; $e^{(0.76[\ln(\text{hardness})]+1.06)}$/1,000 mg/L for hardness of > 60 to ≤ 180 mg/L; 0.15 mg/L for hardness of > 180 mg/L
Total Selenium	0.001 mg/L
Total Silver	0.00025 mg/L
Total Thallium	0.0008 mg/L
Total Uranium	0.015 mg/L
Dissolved Manganese	Hardness- and pH-dependent benchmark is found in look-up table in CCME (2019). At hardness (as $CaCO_3$) of 50 mg/L and pH of 7.5, the benchmark is 0.43 mg/L. The values in the look-up table are valid between hardness 25 and 670 mg/L and pH 5.8 and 8.4.
Dissolved Zinc	$e^{(0.947[\ln(\text{hardness})]-0.815[\text{pH}]+0.398[\ln(\text{DOC})]+4.625)}$/1,000 mg/L for hardness of 23.4 to 399 mg/L, pH of 6.5 to 8.13, and DOC of 0.3 to 22.9 mg/L; 0.007 mg/L for hardness (as $CaCO_3$) of 50 mg/L, pH of 7.5, DOC of 0.5 mg/L

Notes:

[a] *Source: CCME Freshwater Water Quality Guidelines for the Protection of Aquatic Life, Summary Table (CCME 2020).*

2.2.3.2 Phytoplankton Biomass

Potential effects to phytoplankton biomass (as chlorophyll *a*) are evaluated against baseline and reference conditions. The following conditions must be met for an exceedance of the low action level for chlorophyll *a* concentration (TMAC 2018):

1. the identification of a statistically significant change from baseline concentrations;
2. the concentration of chlorophyll *a* is outside of the normal range based on baseline concentrations; and
3. if a change is detected at the exposure site, there is no similar change at the reference site.

2.2.4 Historical Data

Physical, chemical, and biological data have been collected in the Doris and Madrid development areas of the Hope Bay Project since 1995. Figures 2.2-2 to 2.2-4 show the specific locations in the 2020 AEMP study lakes where historical physical limnology (Figure 2.2-2), 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 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 and sampling methodology. Full details of the rationale used in the selection of historical data that were included in evaluation of effects are provided in Appendix C.

Historical data used or considered for the effects analyses were from the following reports: Klohn-Crippen Consultants Ltd. (1995), Rescan (1997, 1998, 1999, 2001, 2010, 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, 2017a, 2017b, 2018, 2019a, 2019b, 2020).

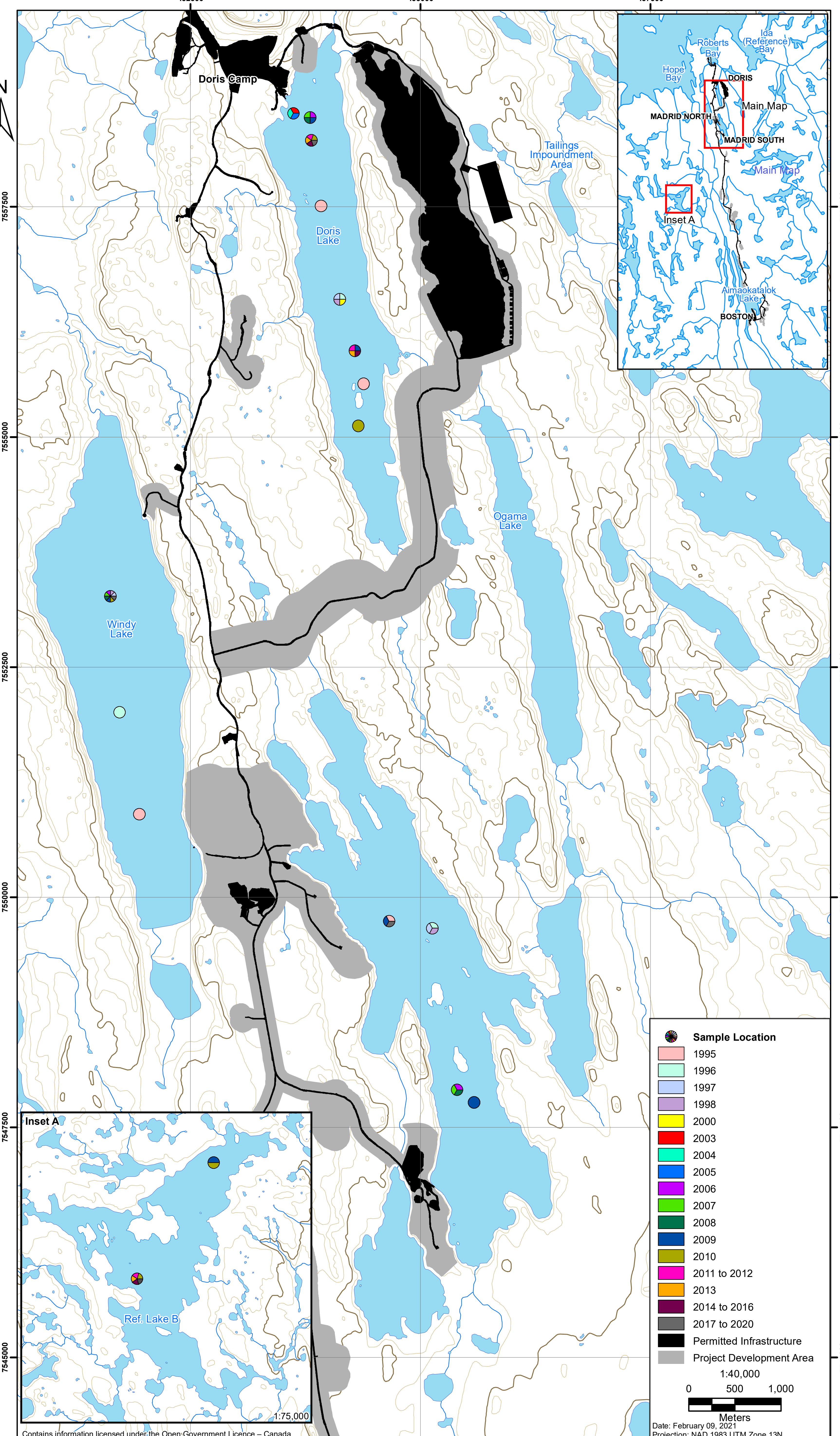


Figure 2.2-2: Physical Limnology Sampling Sites in Patch Lake, Doris Lake, Windy Lake, and Reference Lake B, 1995 to 2020

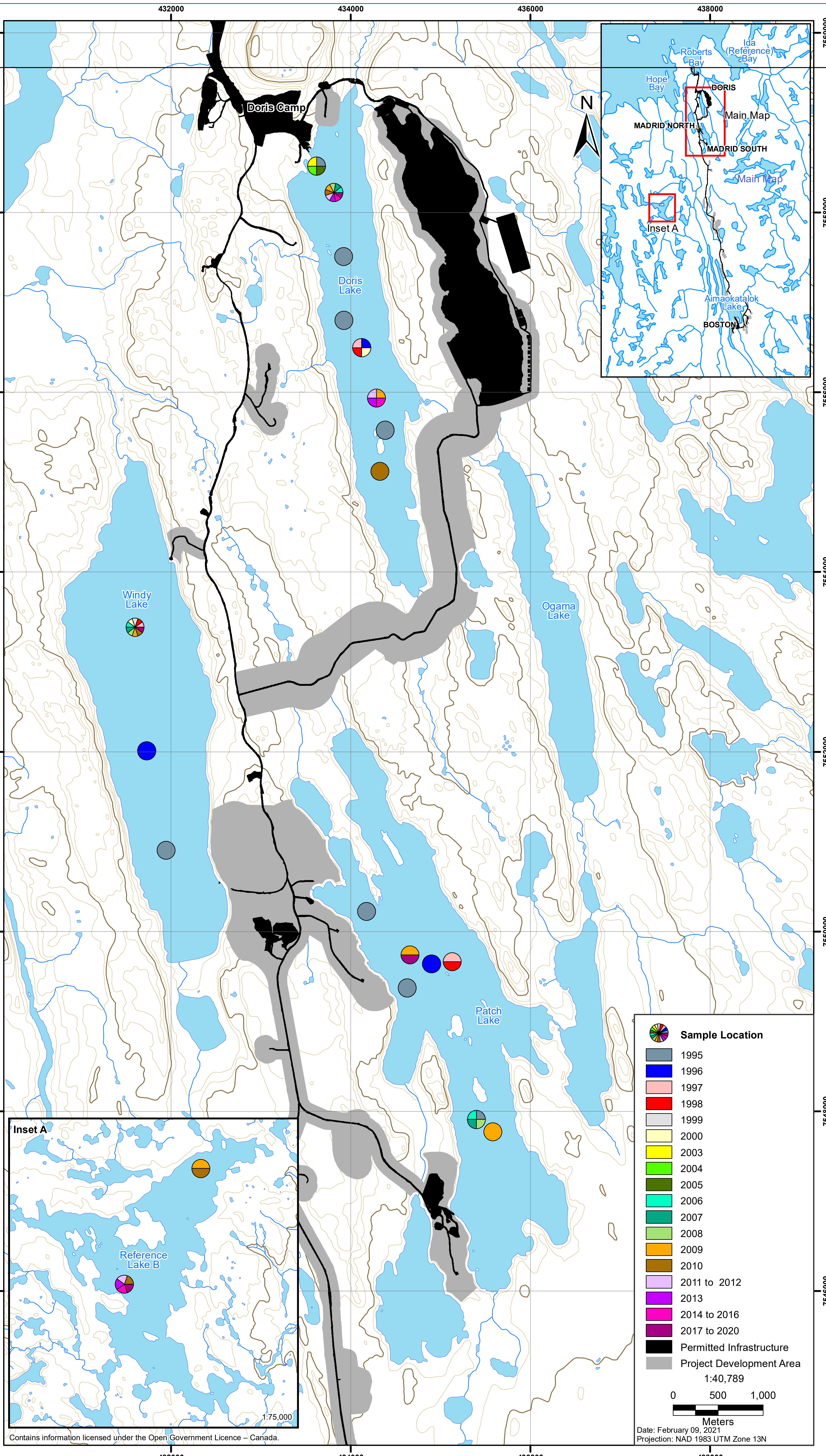


Figure 2.2-3: Water Quality Sampling Sites in Patch Lake, Doris Lake, Windy Lake, and Reference Lake B, 1995 to 2020

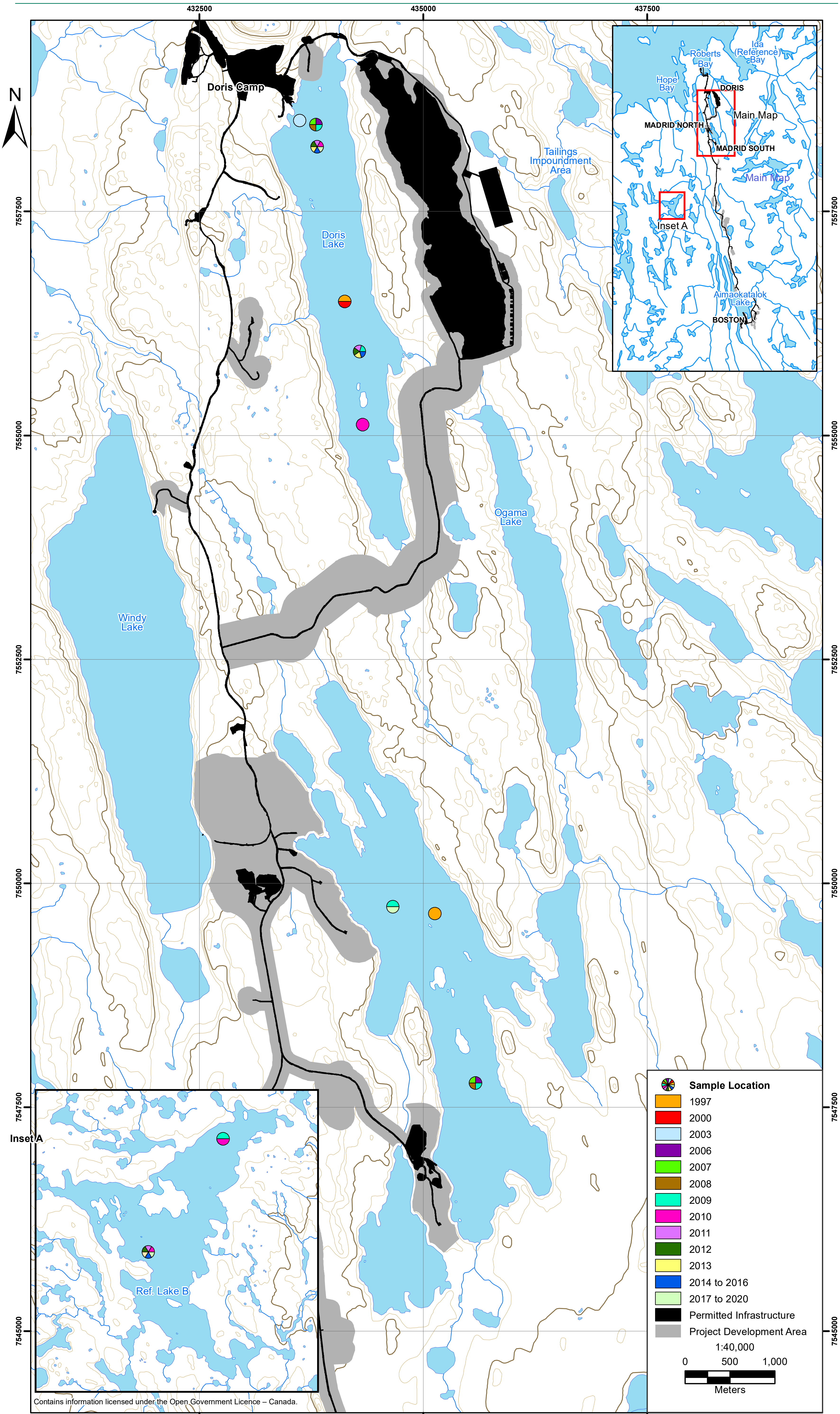


Figure 2.2-4: Phytoplankton Biomass (as Chlorophyll a) Sampling Sites in Patch Lake, Doris Lake, and Reference Lake B, 1997 to 2020

Date: February 09, 2021
Projection: NAD 1983 UTM Zone 13N

3. EVALUATION OF EFFECTS

In 2020, data were collected from several exposure lakes potentially affected by Project activities and one reference lake (Reference Lake B) to evaluate the potential for Project-related effects to the following components of the freshwater environment:

- fish habitat (water level and ice thickness);
- physical limnology (dissolved oxygen and water temperature);
- water quality; and
- phytoplankton biomass.

Physical, chemical, and biological data from 2020 (the fourth year of Doris operations and the second year of Madrid North operations) were evaluated against historical data. The evaluation of effects was based on graphical and statistical analyses of trends over time within each exposure lake and between exposure and reference lakes, comparisons to baseline conditions, 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 Project-related effect met the conditions for triggering a low action level response, further actions were taken as described in the Response Framework within the Plan (TMAC 2018).

Details of the 2020 AEMP sampling program (including methodology and results) are provided in Appendix A, water level and streamflow monitoring results and conclusions are provided in Appendix B, and details of the statistical analyses (including rationale for inclusion/exclusion of historical data, methodology, and results) are provided in Appendix C.

3.1 Water Level and Ice Thickness

Project-related water use, water withdrawal, and underground mining have the potential to reduce lake level and streamflow, which could adversely affect fish habitat. Water withdrawal from lakes may cause a decrease in the availability and/or suitability of overwintering or spawning habitat under the thick winter ice cover or potentially expose overwintering eggs to air, resulting in mortality (Cott 2007; TMAC 2017b). A reduction in discharge at lake outflow streams may result in reduced availability and/or suitability of fish habitat for migration, rearing, and spawning (TMAC 2017b). If habitat loss is anticipated to occur as a consequence of Project activities, fisheries offsetting under applicable *Fisheries Act* Authorizations may be sought to compensate for the loss of fish habitat.

3.1.1 Water Level Fluctuation and Ice Thickness

In the Madrid-Boston FEIS (TMAC 2017b), maximum baseline variation in open-water lake surface elevation and maximum baseline ice thickness were summed to derive a maximum naturally occurring reduction in under-ice lake surface elevation. Overwintering fish populations could be at risk if the volume of water under the ice is reduced compared to the baseline range. Project activities are predicted to potentially affect the water level and discharge from some exposure lakes, but are not predicted to affect lake ice thickness (TMAC 2017b). However, the thickness of lake ice affects the availability of under-ice habitat to fish, as there may be less overwintering fish habitat available if the ice cover is thicker than the normal baseline range. Potential effects of ice-thickness variation to fish habitat are also related to the volume of the lake; where the ice-thickness variability is of lesser consequence to a large volume lake, and a more important consideration for small-volume lakes.

This assessment of under-ice fish habitat considers the ice-covered season from approximately October 2019 to June 2020. In 2020, ice thickness was measured in April in conjunction with water quality monitoring, and again in May in conjunction with lake level monitoring. Figure 3.1-1 shows historical and

2020 ice thickness data for each lake. Ice thickness measurements collected in April 2020 were within the range of historical levels, while May 2020 ice thicknesses in several lakes (Windy, Glenn and P.O.) were higher than previously measured.

Table 3.1-1 presents maximum reduction in the baseline under-ice lake water surface elevation as reported in the FEIS, as well as 2019-2020 data for comparison. The water level fluctuations occurring during the open-water season of 2019 determine the water elevation at the start of freeze-up in 2019, so 2019 open-water season data are included in Table 3.1-1 for an assessment of the 2019-2020 under-ice fish habitat. There was a greater reduction in lake surface elevation over the 2019-2020 season compared to the maximum naturally occurring reduction in nearly all monitored lakes (Table 3.1-1). However, this is not considered to be a Project effect for several reasons. The large variation in the 2019 open-water season lake level (which exceeded the baseline maximum in all but one lake) was likely due to 2019 being a wetter than normal year with very high runoff observed (Appendix B; ERM 2020). In this case, the large open-water season fluctuation in lake levels is due to a higher than usual starting elevation because of the high freshet observed in 2019, rather than a lower than usual elevation at the end of the open-water season. The thick ice cover measured in May 2020 is also not considered a Project effect, but the combination of high 2019 open-water season lake level fluctuation and thick 2020 ice cover results in a calculated reduction in under-ice lake level that exceeds the baseline range.

Table 3.1-1: Lake Level Variability and Ice Thickness, 2019 to 2020

Lake	FEIS[a]			Ice-covered Season of 2019/2020		
	A	B	A + B	A	B	A+B
	Max. Baseline Water Level Fluctuation (m)	Max. Baseline Ice Thickness (m)	Max. Reduction in Under-ice Lake Surface Elevation (m)	Observed Water Level Fluctuation (m)[e]	2020 Max. Ice Thickness (m)	Reduction in Under-ice Lake Surface Elevation (m)
Windy	0.24	1.90	2.14	**0.270**	**2.02**	**2.29**
Glenn	0.26	1.95[b]	2.21	**0.468**	**2.02**	**2.49**
Patch	0.44	2.05	2.49	**0.492**	1.96	2.45
Imniagut	0.09[c]	1.91[c] (1.99[b])	2.00 (2.08)	**0.179**	1.92	**2.10**
P.O.	0.64	1.85	2.49	0.503	**2.04**	**2.54**
Ogama	0.46	1.95	2.41	**0.630**	1.86	**2.49**
Doris	0.74	2.00 (2.4[d])	2.74 (3.89)	**0.779**	2.04	2.82
Little Roberts	0.63	2.3[d]	2.93	**0.969**	2.08	**3.05**

Notes:

Values in parentheses indicate updates of baseline predictions from the FEIS based on the more complete baseline dataset of ice thickness values included in Figure 3.1-1.

Bold values indicate values that are higher than the baseline maximum.

[a] *Unless otherwise indicated, data source: Table 1.2.6 of Volume 5, Chapter 1 (Surface Hydrology) and Table 6.5-10 of Volume 5, Chapter 6 (Freshwater Fish); Madrid-Boston FEIS (TMAC 2017b).*

[b] *Data source: Rescan 2010.*

[c] *Field collected baseline data not available, variation in open-water lake surface elevation calculated as the average difference between simulated baseline lake surface elevation in September and June (Years 1 to 22), and ice thickness estimated as the average of all other lakes with baseline data (TMAC 2017b).*

[d] *Data source: Golder Associates Ltd. 2007.*

[e] *Data source: Appendix B; ERM 2020.*

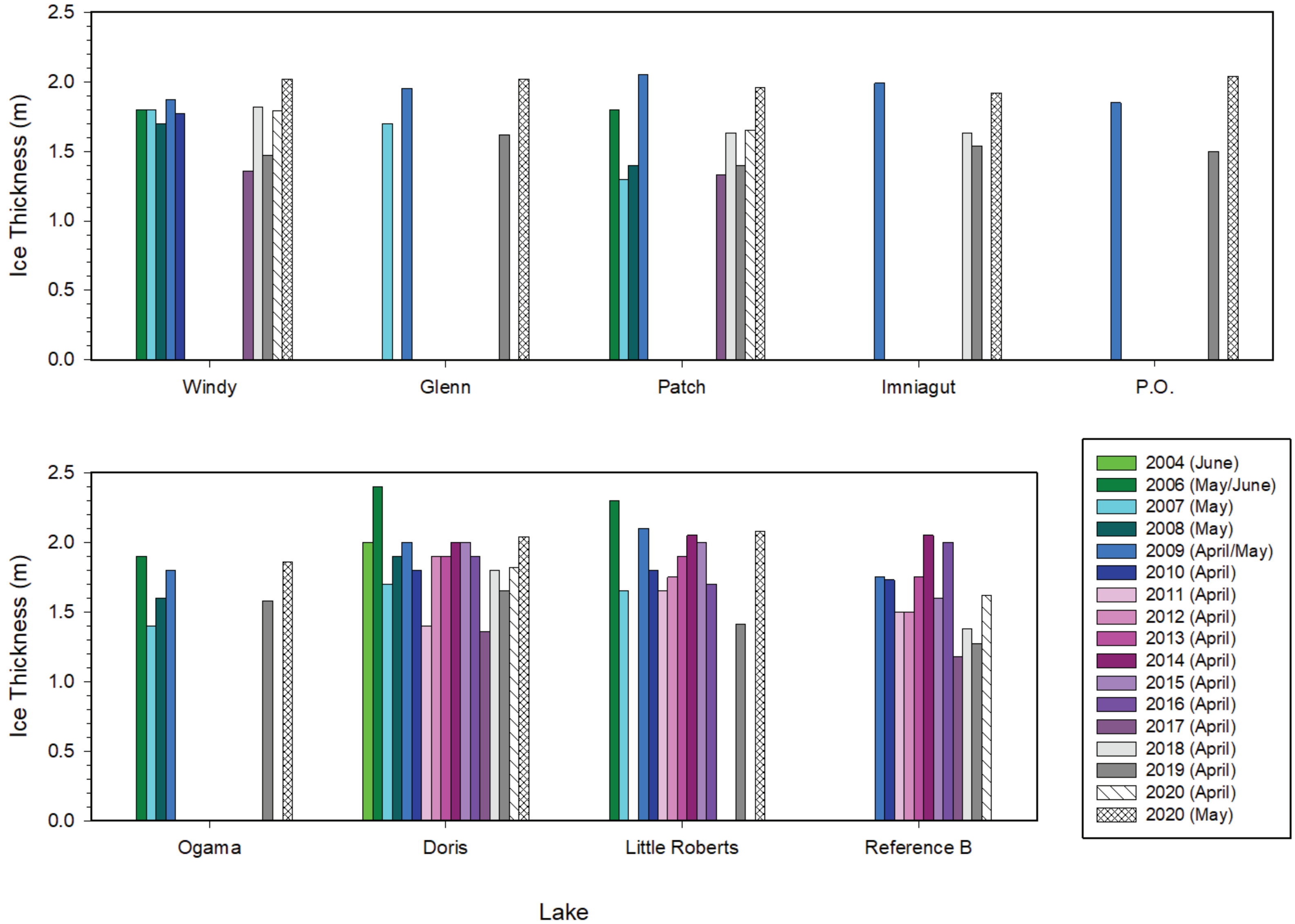


Figure 3.1-1: Thickness of Lake Ice Cover, Hope Bay Project, 2004 to 2020

3.1.2 Under-Ice Lake Volume

Another way to determine whether there is any evidence of a Project-related reduction in under-ice fish habitat is to assess under-ice lake volume changes over time. The 2016 to 2020 under-ice lake volumes are plotted in Figure 3.1-2. Data are limited to this 2016 to 2020 range as winter water levels were not collected prior to this. Glenn Lake and Little Roberts Lake data were not included in the assessment of under-ice lake volume over time as there is no bathymetric data available for Glenn Lake, and Little Roberts Lake under-ice water measurements do not correspond to open-water elevation (i.e., under-ice elevation is greater than open-water).

The under-ice volume comparison was done using subsurface contours for the lakes created from bathymetric survey information collected in 2006 and 2008, and this was related to lake elevation as described in Appendix B; however, there are some drawbacks to this method. These include limited lake elevation referencing between local and geodetic datums for bathymetry reference elevations, rounding of elevations to identify contours, and measurement of the under-ice water elevation.

Not all bathymetry data available was referenced to geodetic elevation for the day the lake was surveyed. An estimate can be made using the discharge on the day (or approximate day) of the survey and relating it to the current stage with the rating curve; however, the estimated elevation could be too high or too low due to incorrect assumed survey date or changes in the rating curve.

Lake volume is also can significantly change depending on the subsurface. The contour resolution used for these comparisons is 0.25 m; therefore rounding of elevations to the nearest contour can also lead to over- or under-estimation of lake volume. In the upper 2.5 m of the lakes (i.e., ice influenced range), a single contour change can result in a 2 to 40% difference in lake volume. The higher percentage changes occur in smaller lakes that have rapidly changing bathymetry due to their shallower depth (i.e., lake depth <5 m).

The Real Time Kinematic (RTK) system used to survey the under-ice water elevation has a lower accuracy than the water level surveys made during the open-water season. The lower accuracy leads to some discrepancies in the results, such as P.O. Lake having a higher reported water level than Patch Lake despite being downstream, and Little Roberts Lake having a higher reported water level during the under-ice season than all open-water season water levels.

Based on the limitations of the method, it is difficult to identify small changes in under-ice fish habitat year to year as being Project-related effects versus naturally occurring. Baseline monitoring of the smaller lakes has identified that they occasionally freeze to the bottom in winter (e.g., Imniagut in 2009; Rescan 2010) or nearly to the bottom (e.g., P.O. in 2009, Little Roberts in 2006; Golder Associates Ltd. 2007; Rescan 2010), so this is a naturally occurring phenomenon that is unlikely related to the Project. Even where there are large changes between years, such as seen in Imniagut between 2019 and 2020 (Figure 3.1-2), these differences would be expected to occur naturally, based on annual variability in hydrological and climactic conditions.

The FEIS predicted that for all assessed lakes except for Imniagut Lake, maximum annual Project-related reductions in lake volumes in the Doris and Madrid North development areas would not exceed 2% of the lake volumes, and maximum reductions were projected to occur starting in 2018 for Windy Lake, but not until 2030 to 2032 for other assessed lakes (Patch, P.O., Ogama, and Doris lakes; TMAC 2017b). Such small annual changes in lake volume would likely not be detectable given the accuracy of water elevation measurements and lake volume estimates. For Imniagut Lake, a maximum reduction in lake volume of 86% was predicted, with the maximum reduction predicted to occur in 2032. This lake has been observed to freeze to the bottom during baseline years prior to the development of Madrid North; therefore, changes in lake volume would most likely be detected through the evaluation of open-water season elevation changes (as reported in Appendix B) and not through the evaluation of under-ice season lake volume or elevation.

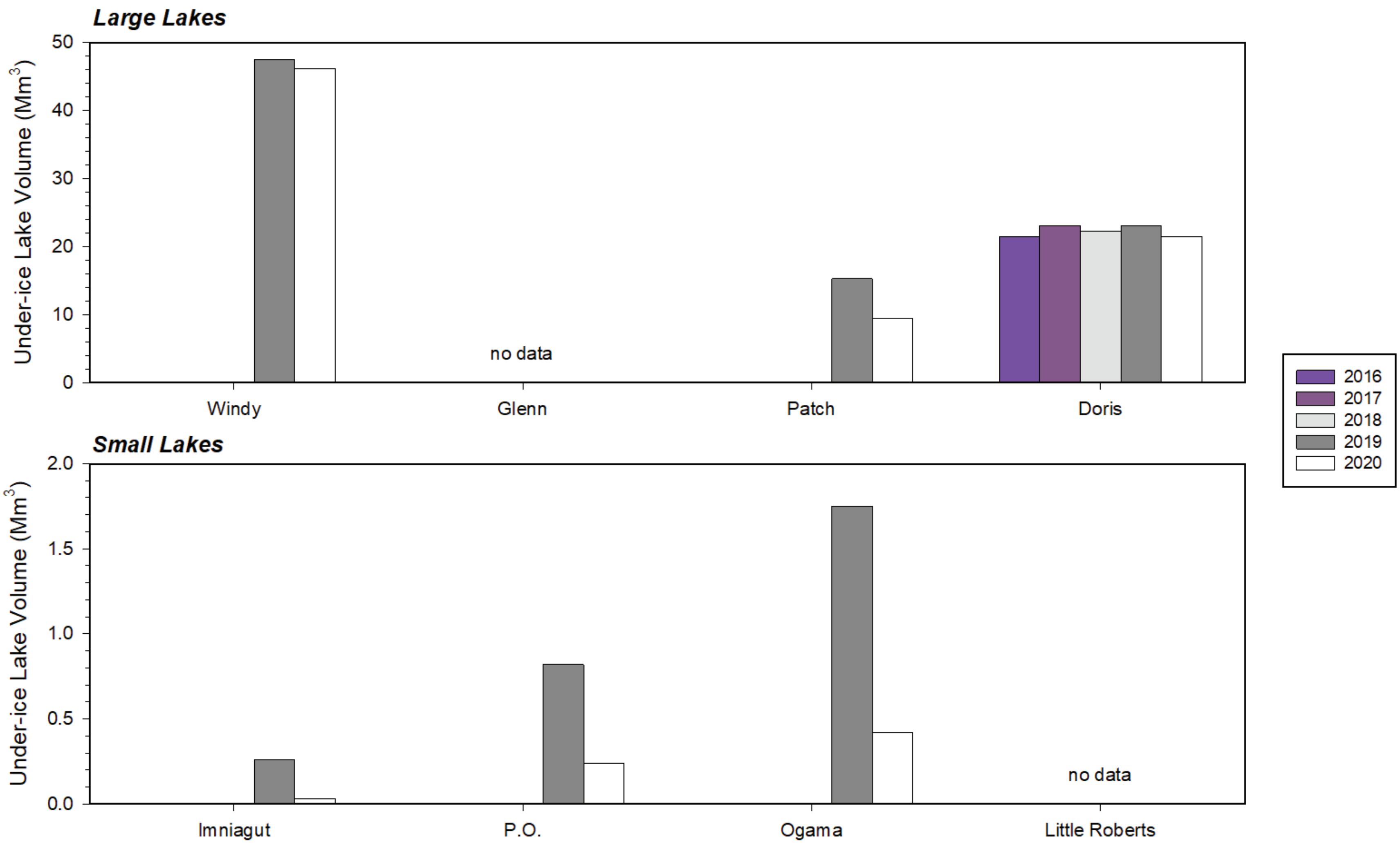


Figure 3.1-2: Under-ice Lake Volumes, Hope Bay Project, 2016 to 2020

3.1.3 Hydrology Summary

The hydrology compliance monitoring results show that there were no detectable Project-related effects to lake levels or outflow in 2020 (Appendix B). Observed water levels, runoff, and outflow were within the expected range for a drier than normal year.

Overall, data from 2020 show that there was as yet no evidence for a Project-related reduction in lake water levels and streamflow (see Appendix B). Mining at Madrid in 2020 was entirely in the permafrost, so no potential for water seep into the mine from surrounding lakes would be possible. Under-ice fish habitat from October 2019 to June 2020 may have been influenced by a wetter than normal year in 2019 and thicker than usual ice cover in 2020, but there is no evidence of a Project-related reduction in under-ice lake volumes (Table 3.1-2).

Table 3.1-2: Summary of Evaluation of Effects to Fish Habitat (Water Level and Ice Thickness), Hope Bay Project, 2019 to 2020

Exposure Lake	Evidence of a Project-related Decrease in Under-ice Lake Volume?	Evidence of Project-related Change in Water Level or Streamflow? (Appendix B)
Windy Lake	No	No
Glenn Lake	No	No
Patch Lake	No	No
Imniagut Lake	No	No
P.O. Lake	No	No
Ogama Lake	No	No
Doris Lake	No	No
Little Roberts Lake	No	No

3.2 Physical Limnology

Dissolved oxygen and temperature profiles were collected in Windy Lake, Patch Lake, Doris Lake, and Reference Lake B in April and August of 2020. Potential Project-related effects to dissolved oxygen concentrations and water temperature are discussed in the following sections.

3.2.1 Dissolved Oxygen

Potential Project-related effects on dissolved oxygen concentrations were evaluated using under-ice dissolved oxygen profiles since concentrations are typically lowest during the ice-covered period, and this season therefore represents the ‘worst case scenario’ for dissolved oxygen levels. 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, dissolved oxygen profiles from 2020 had to be outside the range of profiles from all available baseline years. Profiles and inter-annual trends at the reference site were also considered to aid in the assessment of whether deviations from baseline conditions are likely naturally occurring or Project related. 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 oxygen consumption through the microbial respiration of organic matter. If dissolved oxygen concentrations drop below the CCME guidelines for the protection of cold water aquatic life of 9.5 mg/L for early life stages or 6.5 mg/L for other life stages (CCME 2020), this could negatively affect fish populations.

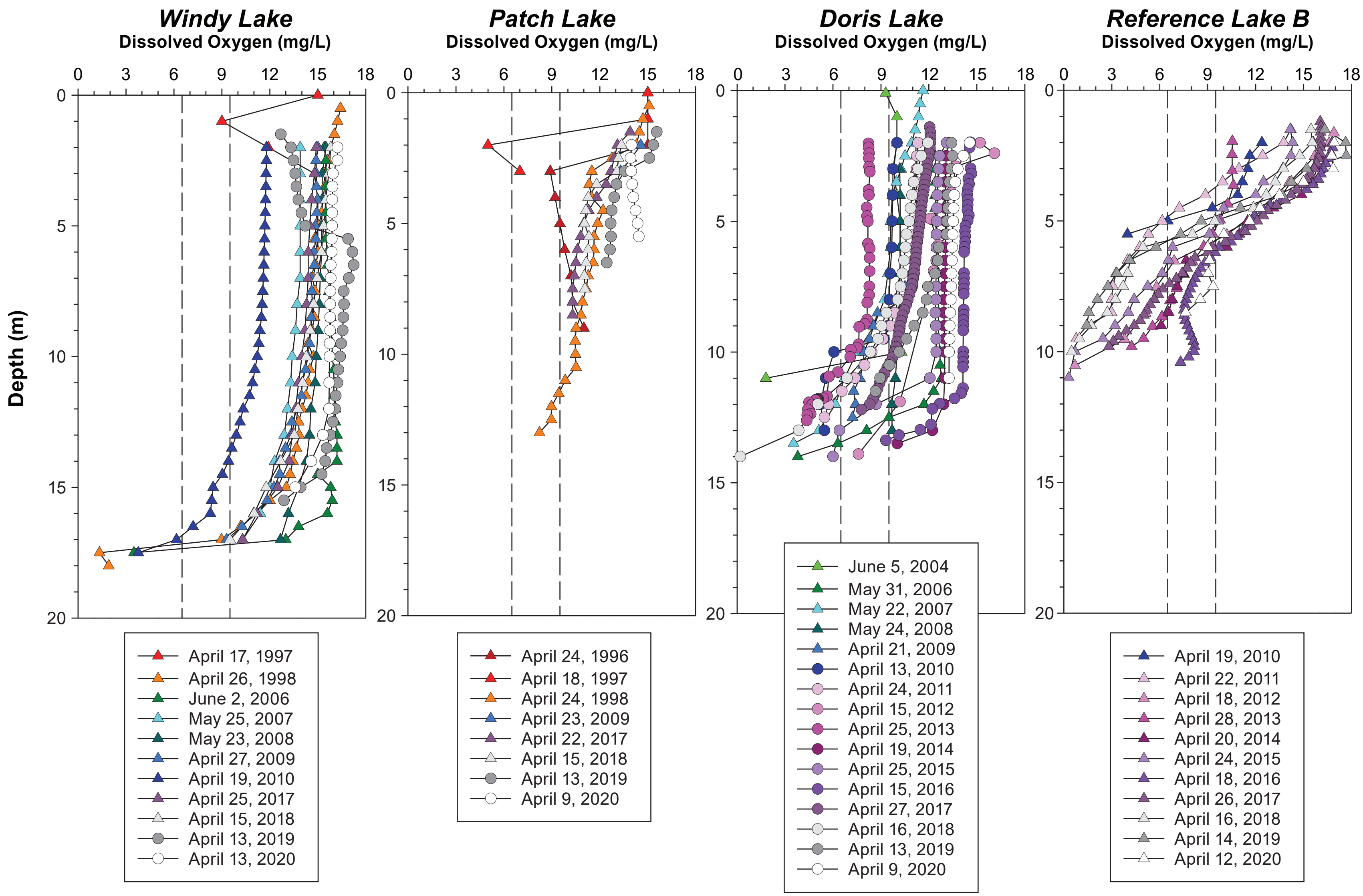
Figure 3.2-1a presents all under-ice dissolved oxygen profiles collected in each study lake between 1996 and 2020, and Figure 3.2-1b presents dissolved oxygen profiles collected during lake-specific baseline years (i.e., all years up to and including 2009 for Doris Lake, and all years up to and including 2018 for Windy and Patch lakes) in comparison to 2020 profiles for ease of interpretation. Dissolved oxygen concentrations measured in April 2020 remained above the CCME guidelines of 6.5 and 9.5 mg/L throughout the water columns of all three exposure lakes, but dropped below 6.5 mg/L in Reference Lake B below 6 m depth (Figure 3.2-1b). In all three exposure lakes, 2020 under-ice dissolved oxygen concentrations were within the range or slightly higher than baseline concentrations recorded before the start of any construction or operation activities in the Project area (Figure 3.2-1b). Although in some cases, 2020 under-ice dissolved oxygen concentrations were higher than baseline concentrations (e.g., Doris Lake and Patch Lake; Figure 3.2-1b), an increase in under-ice dissolved oxygen concentrations is not an adverse change, as only a decrease in dissolved oxygen would be expected to adversely affect overwintering fish populations. Overall, there was no evidence of an adverse effect of Project activities on under-ice dissolved oxygen concentrations in Windy, Patch, and Doris lakes compared to concentrations recorded during baseline years and concentrations in Reference Lake B.

3.2.2 Temperature

The Project is not anticipated to have any effect on the water temperature, thermal stratification regime, or turnover dates of exposure lakes, as there are no plans to release heated effluent to the freshwater environment. 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.

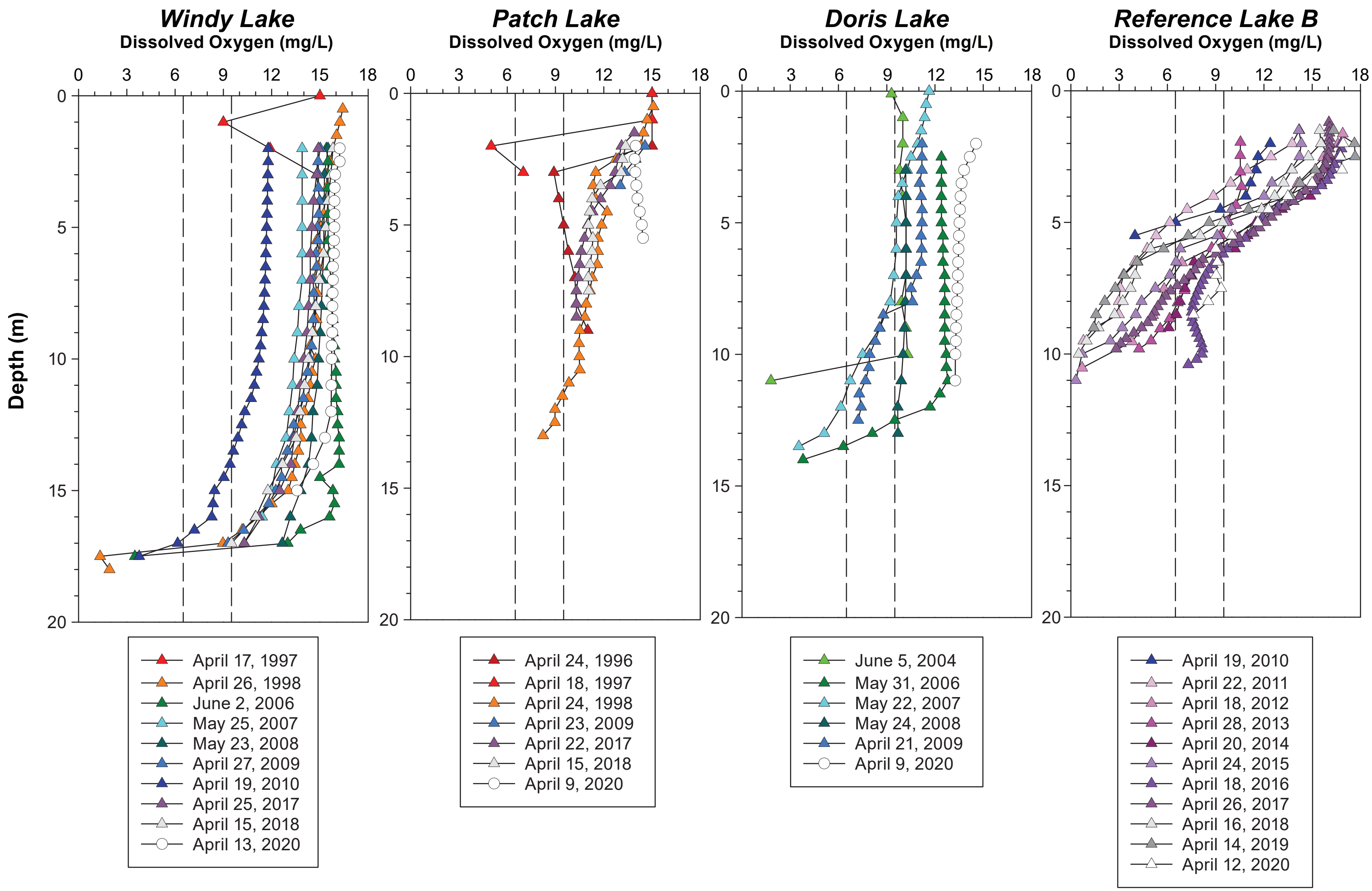
Temperature profiles in exposure lakes have historically been collected during the ice-covered season (typically in April, but sometimes in May or early June) and open-water seasons (July, August, and/or September). For the purposes of the evaluation of effects, historical under-ice profiles from April, May, and June were included in the plots for comparisons to April 2020 profiles; however, as water temperatures can be highly variable over the open-water season, only historical profiles collected in August were included for comparisons to August 2020 profiles. The warmest water temperatures typically occur in August; therefore, assessing under-ice and August (open-water) temperature profiles should cover the entire range of water temperatures in the exposure lakes. 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, 2020 temperature profiles had to be different from all available baseline years. Temperature profiles and inter-annual trends at the reference site were also considered.

Figure 3.2-2a presents all under-ice temperature profiles collected in each study lake between 1996 and 2020, and Figure 3.2-2b presents temperature profiles collected during lake-specific baseline years in comparison to 2020 profiles for ease of interpretation. Under-ice water temperatures in 2020 were generally within the range of baseline temperatures, except in Patch Lake where the water temperature of 1.6°C recorded at 2 m and 2.5 m was slightly higher than baseline water temperatures recorded at these depths (Figure 3.2-2b). This temperature of 1.6°C is within the range of under-ice baseline temperatures across all depths in Patch Lake (0.1 to 2.1°C; Figure 3.2-2b), and there is no discharge of heated effluent to Patch Lake, thus the slightly elevated water temperature at 2 m and 2.5 m depth relative to baseline under-ice temperatures at these depths is likely due to natural inter-annual variability or climactic conditions.



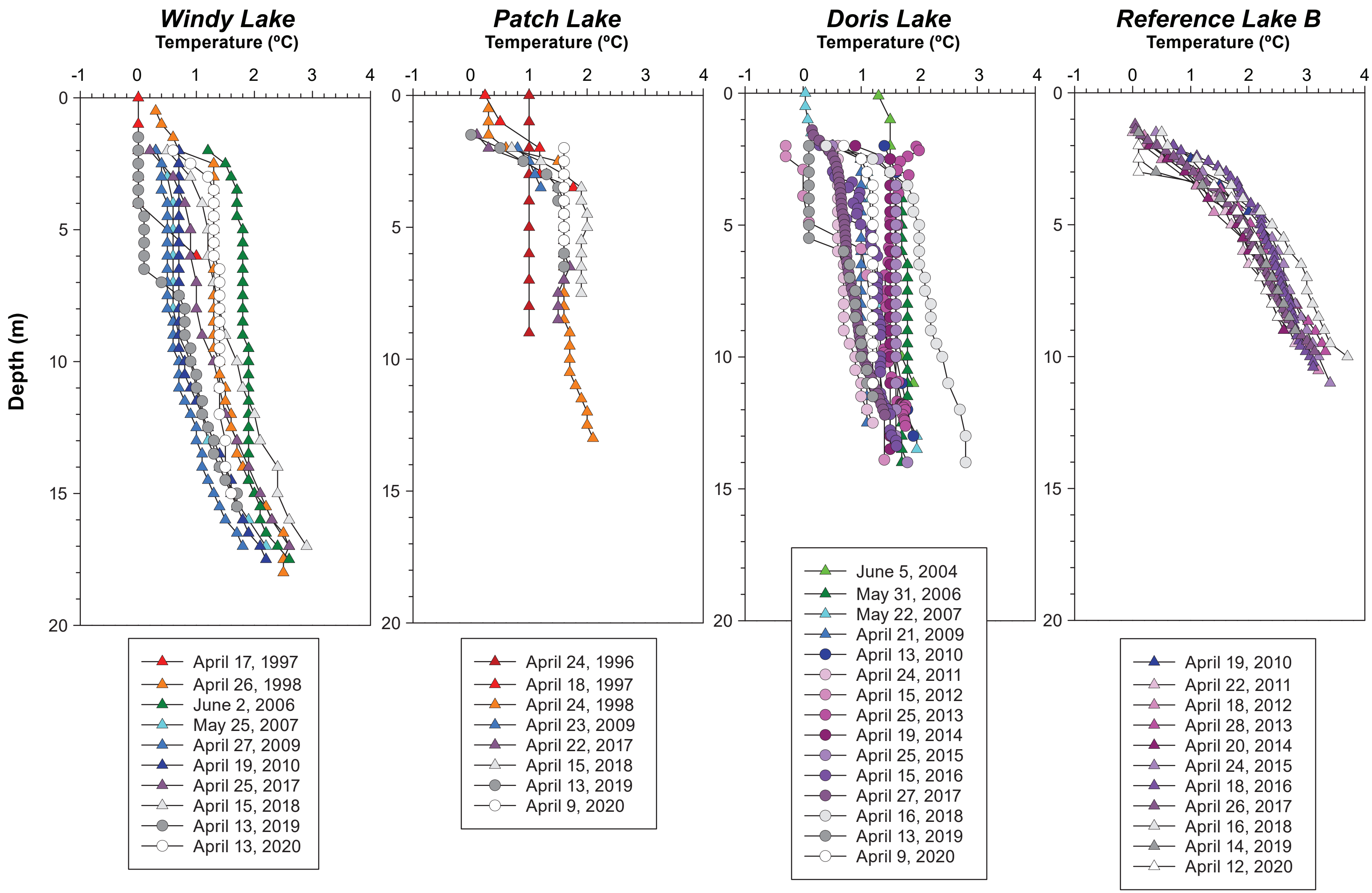
Notes: Vertical dashed lines represent CCME freshwater dissolved oxygen guidelines for the protection of cold water aquatic life: 9.5 mg/L for early life stages; 6.5 mg/L for other life stages
Triangle symbols represent baseline data (designated baseline years differ for each lake).

Figure 3.2-1a: Under-ice Dissolved Oxygen Concentrations, Hope Bay Project, 1996 to 2020



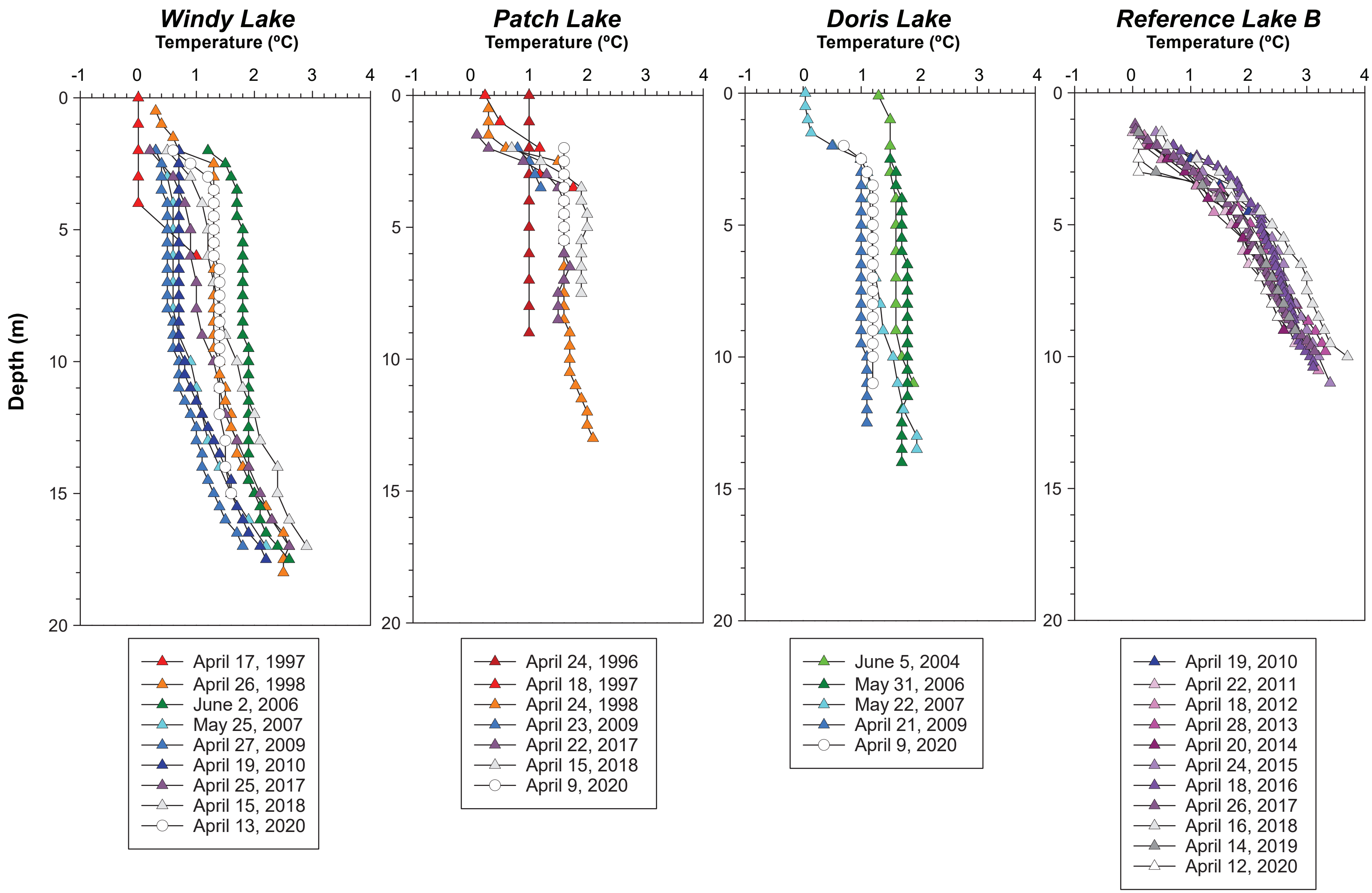
Notes: Vertical dashed lines represent CCME freshwater dissolved oxygen guidelines for the protection of cold water aquatic life: 9.5 mg/L for early life stages; 6.5 mg/L for other life stages
Triangle symbols represent baseline data (designated baseline years differ for each lake).

Figure 3.2-1b: Under-ice Dissolved Oxygen Concentrations, Hope Bay Project, Baseline and 2020



Note: Triangle symbols represent baseline data (designated baseline years differ for each lake).

Figure 3.2-2a: Under-ice Temperature Profiles, Hope Bay Project, 1996 to 2020



Note: Triangle symbols represent baseline data (designated baseline years differ for each lake).

Figure 3.2-2b: Under-ice Temperature Profiles, Hope Bay Project, Baseline and 2020

Figure 3.2-3a presents all August temperature profiles collected in each study lake between 1996 and 2020, and Figure 3.2-3b presents August temperature profiles collected during lake-specific baseline years in comparison to 2020 profiles. In the shallower study lakes, Patch Lake and Reference Lake B, August 2020 temperature profiles were within the range of baseline temperatures (Figure 3.2-2b). However, in the deeper lakes, Windy and Doris, temperatures were warmer than usual in the upper portion of the water column, and the water column was more strongly stratified than usual. This is likely due to climatic conditions, as the summer of 2020 was unusually warm. According to the Environment and Climate Change Canada (ECCC) 1981-2010 climate normals for Cambridge Bay A weather station, the daily average temperatures for July and August are 8.9°C and 6.8°C, respectively (ECCC 2020a). In 2020, the average daily temperatures for July and August at this station were 10.9°C and 8.3°C, respectively, or +2°C and +1.5°C above the monthly normals (ECCC 2020b, 2020c). July 2020 in particular was the hottest July ever recorded in the Northern Hemisphere (NOAA 2020), with several extreme temperature records broken at Nunavut's Eureka weather station (Patar 2020). Unlike Windy and Doris lakes, elevated surface temperatures and thermal stratification were not observed in Reference Lake B and Patch Lake in August 2020 because these lakes are shallow enough that wind energy was sufficient to fully mix the water column. In the deepest lakes, the mixed layer extends to approximately 10 m (Figure 3.2-3b), but wind-driven mixing was not sufficient to overcome the stronger than usual density stratification and cause lake overturn. Overall, the open-water season temperature profiles in Windy and Doris lakes were noticeably different from baseline temperature profiles; however, warmer water temperatures are likely related to warmer than usual climactic conditions rather than Project activities.

3.2.3 Physical Limnology Summary

Overall, there was no evidence of an adverse Project-related change in either under-ice dissolved oxygen concentrations or water temperatures in exposure lakes. Under-ice dissolved oxygen concentrations in 2020 were similar to or higher than baseline concentrations, which is not considered an adverse change. Under-ice water temperatures were generally comparable to baseline temperatures, while August water temperatures were higher than usual in two of the exposure lakes (Windy and Doris). There is no discharge of heated effluent to the exposure lakes, and no plausible Project-related mechanism to account for an increase in water temperature. This deviation from baseline August water temperatures can be explained by climactic conditions as the summer of 2020 was unusually warm. A low action level response was not triggered for temperature or dissolved oxygen concentrations because there were no adverse Project-related changes to these variables. Table 3.2-1 presents a summary of the evaluation of effects for these physical components.

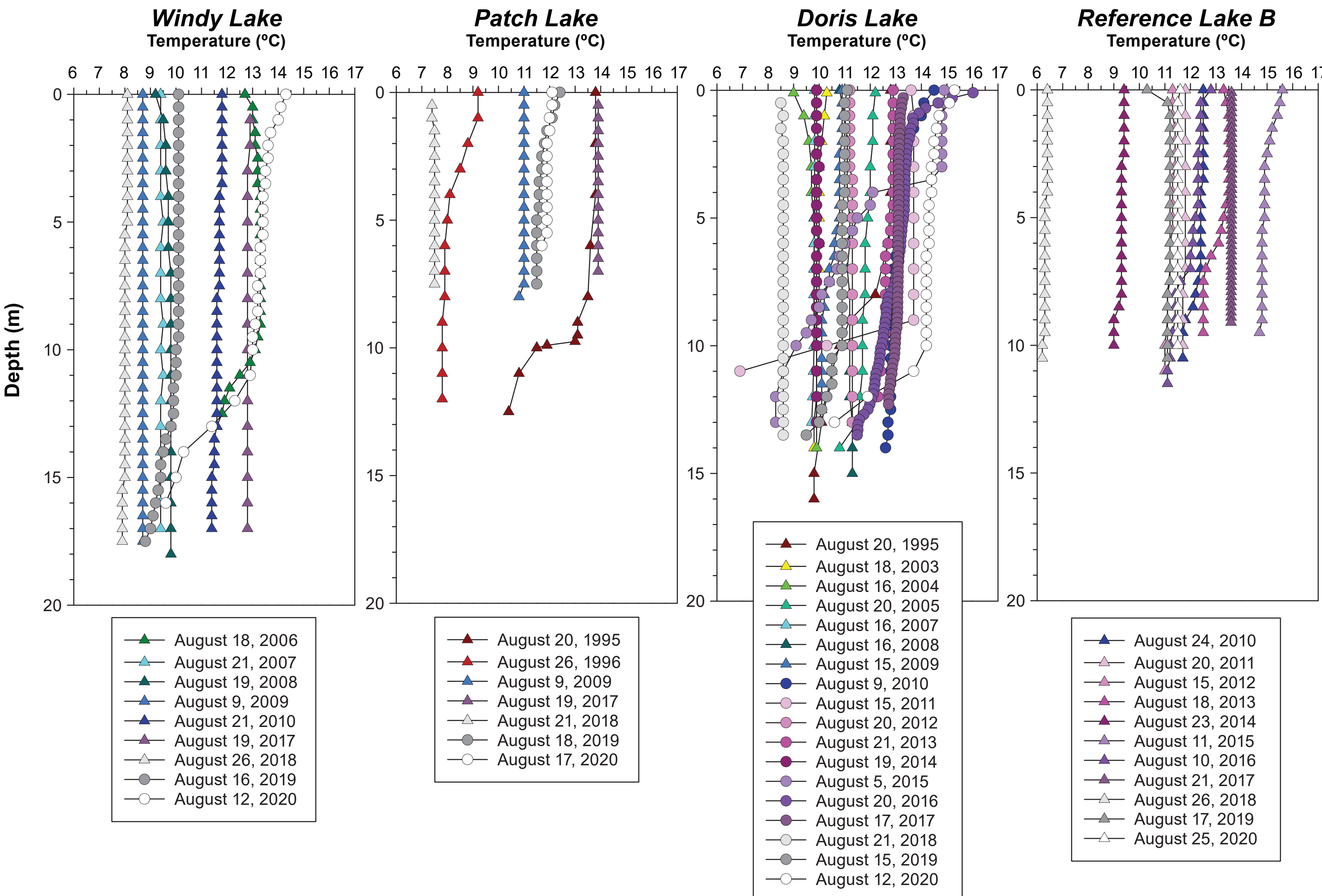
Table 3.2-1: Summary of Evaluation of Physical Limnology Effects for Hope Bay Project, 2020

Variable	Evidence of an Adverse[a] Change Relative to Baseline?		Conclusion of Effect [b]		Low Action Level Triggered?	
	Under-ice	Open-water	Under-ice	Open-water	Under-ice	Open-water
Dissolved Oxygen	No	-	No effect	-	No	-
Temperature	No	Yes (Windy and Doris)	No effect	No effect	No	No

Notes:

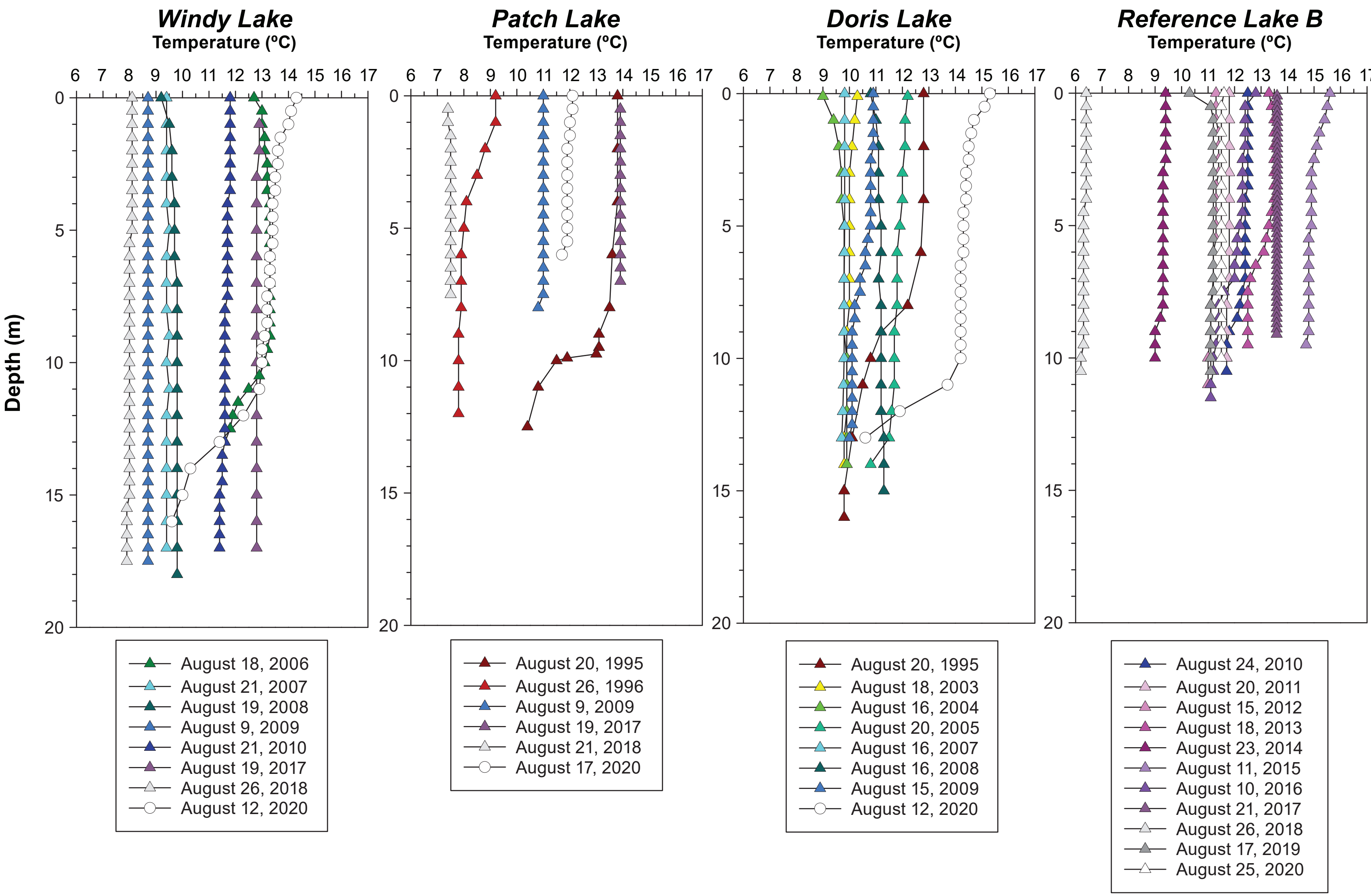
[a] *For water temperature, a change in any direction is considered to be an adverse effect. For under-ice dissolved oxygen concentration, only a decrease is considered to be an adverse effect.*

[b] *Conclusion of effect is based on graphical analysis and professional judgment.*



Note: Triangle symbols represent baseline data (designated baseline years differ for each lake).

Figure 3.2-3a: Open-water (August) Temperature Profiles, Hope Bay Project, 1995 to 2020



Note: Triangle symbols represent baseline data (designated baseline years differ for each lake).

Figure 3.2-3b: Open-water (August) Temperature Profiles, Hope Bay Project, Baseline and 2020

3.3 Water Quality

Water quality samples were collected from three exposure lakes (Doris, Patch, and Windy lakes) and one reference lake (Reference Lake B) in 2020. 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. Statistical and graphical analyses were used to determine if there are apparent changes in water quality in the Project area over time. The statistical analyses consisted of a regression analysis for Doris Lake and a before-after or BACI analysis for Patch and Windy lakes (see Section 2.2-2 for an overview of the assessment methodology). For Patch and Windy lakes, water quality data collected in the years up to and including 2018 represent baseline conditions prior to the start to Madrid North construction activities in 2019. For Doris Lake, water quality data collected in the years up to and including 2009 represent baseline conditions prior to the start of Doris construction activities in 2010.

Trends in the exposure lakes were directly compared to trends in Reference Lake B to establish whether any changes in water quality are likely naturally occurring or Project-related. Water quality trends over the open-water and ice-covered seasons were assessed separately since 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 2020) to assess whether existing concentrations could adversely affect freshwater biota. CCME guidelines were also applied as water quality benchmarks as per the Response Framework, and 2020 data were screened against 75% of the benchmark as well as baseline and reference conditions as described in Section 2.2.3.1 to determine whether a low action level response was triggered.

The following sections present the evaluation of effects for water quality variables. Water quality data for 2020 are presented in Appendix A, and all statistical analysis results are presented in Appendix C.

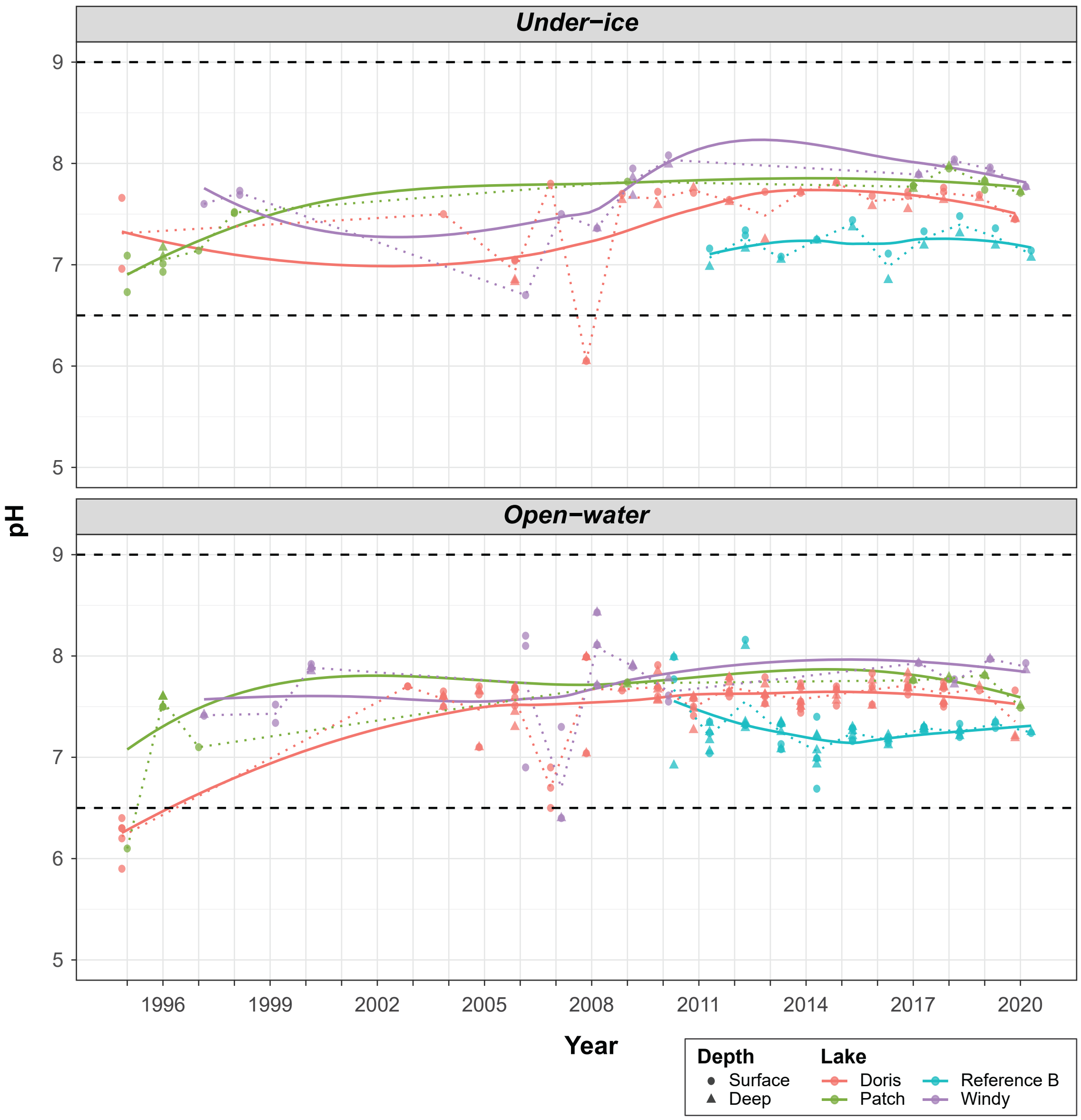
3.3.1 pH

pH levels in all three exposure lakes were variable from the mid-1990s to 2008, but relatively stable since 2009. pH levels recorded in 2020 were within the baseline ranges for each exposure lake, and within the CCME guideline range of 6.5 to 9.0 (Figure 3.3-1).

For Windy and Patch lakes, the ‘before’ (all years up to and including 2018) mean pH was not significantly different from the ‘after’ (2020) mean for both the under-ice ($p = 0.747$ for Windy Lake; $p = 0.590$ for Patch Lake) and open-water seasons ($p = 0.514$ for Windy Lake; $p = 0.827$ for Patch lake).

For Doris Lake, the regression analysis showed that the pH trend had a statistically significant non-zero slope during both the under-ice ($p = 0.0017$) and open-water seasons ($p < 0.0001$), which was likely driven by the lower and more variable pH levels recorded between 1995 and 2008 compared to the relatively consistent pH from 2009 to 2020 (Figure 3.3-1). There was no significant difference in under-ice season pH trends between Doris Lake and Reference Lake B ($p = 0.442$); suggesting that there was no Project effect on under-ice season pH. However, there was a significant difference in open-water season pH trends between Doris Lake and Reference Lake B ($p = 0.0487$). The statistically significant difference in open-water season pH trends between Doris Lake and Reference Lake B is not interpreted as evidence of a Project-related effect as 2020 pH levels in Doris Lake were within the range of baseline levels, and there was no apparent increase or decrease in pH from baseline years to 2020.

Overall, there is no evidence for a Project-related change in pH in Windy, Patch, or Doris lakes, and a low action level response was not triggered for pH.



Notes: Observations are slightly jittered along the x-axis for legibility.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME guideline pH range (6.5 to 9.0).

Figure 3.3-1: pH in Lakes, Hope Bay Project, 1995 to 2020

3.3.2 Total Suspended Solids

During the 2020 ice-covered season, TSS concentrations were below the detection limit (<1.0 mg/L) in Patch Lake and at or below the detection limit in Windy Lake (<1.0 to 1.1 mg/L). Statistical analysis was not performed because of the high proportion of censored data (concentrations that were below the detection limit). During the 2020 open-water season, the mean TSS concentration of 1.8 mg/L in Patch Lake was not significantly different from the baseline mean (p = 0.964). For Windy Lake, open-water season TSS concentrations measured in 2020 were at or below the detection limit (< 1.0 to 1.1 mg/L) and statistical analysis was not performed because of the high proportion of censored data. 2020 under-ice and open-water concentrations of TSS in Patch and Windy lakes were within the range of baseline concentrations and graphical analysis of the data did not find evidence of an increase in concentrations over time (Figure 3.3-2). Thus, there is no indication of a Project effect on TSS concentrations in these lakes.

In Doris Lake, under-ice TSS concentrations were inter-annually variable (Figure 3.3-2), and the regression analysis showed that there was a statistically significant non-zero trend over time (p = 0.0036). Although it was not possible to compare this trend to the trend in Reference Lake B because of the high proportion of censored concentrations in the reference lake dataset, there was no evidence of an increasing trend in under-ice TSS concentrations in Doris Lake, and 2020 concentrations were within the range of pre-2010 baseline concentrations (Figure 3.3-2). Therefore, there was no indication of an adverse change in under-ice TSS levels in Doris Lake. During the open-water season, TSS concentrations in Doris Lake were consistent over time and the TSS trend did not differ from a slope of zero (p = 0.814). The variability between replicate TSS concentrations collected in Doris Lake in August 2020 was flagged in the QA/QC analysis (Appendix A; relative percent difference [RPD] of 23.3%) as exceeding the target RPD of 20%; however, the slightly elevated RPD had a negligible effect on the evaluation of effects, as both concentrations were within the range of baseline concentrations.

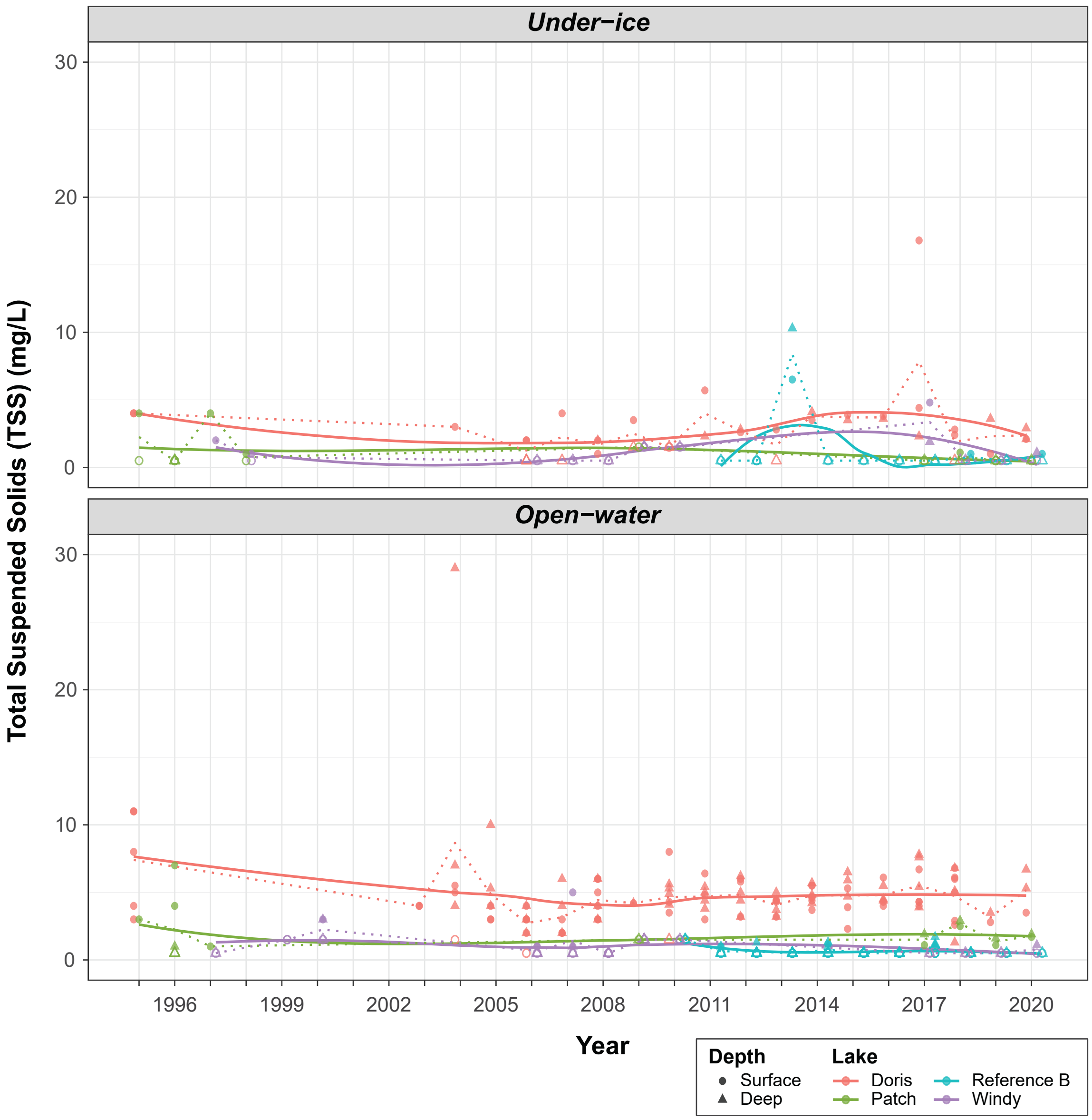
Overall, there was no evidence for a Project-related adverse change in TSS concentrations in Windy, Patch, or Doris lakes, and a low action level response was not triggered. 2020 TSS concentrations in the evaluated exposure lakes remained within baseline ranges and CCME guidelines, which are based on background levels.

3.3.3 Turbidity

Turbidity levels measured in Windy and Patch lakes during the 2020 ice-covered and open-water seasons were similar to or slightly lower than baseline levels (Figure 3.3-3). The statistical analyses showed that there were no significant differences in means between before and after periods (Windy Lake: p = 0.398 for under ice, p = 0.420 for open water; Patch Lake: p = 0.946 for under ice, p = 0.657 for open water).

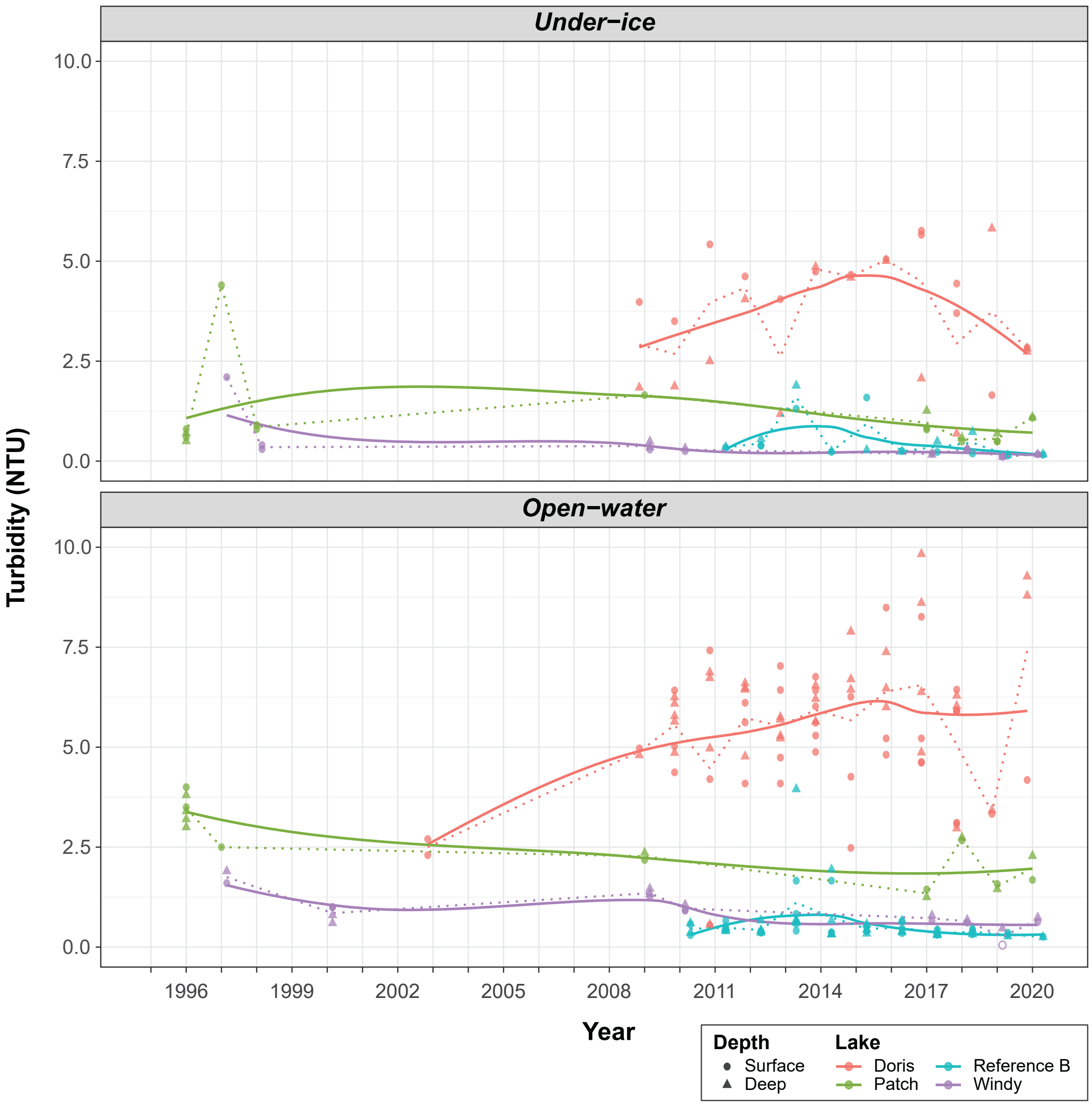
Under-ice and open-water turbidity levels in Doris Lake were inter- and intra-annually variable (Figure 3.3-3). The LOESS smoothing curve drawn through the data shows that there was a slight increase in under-ice turbidity between 2009 and 2015, followed by a decrease from 2015 to 2020. Under-ice season turbidity in 2020 was similar to baseline levels and lower than in recent years. The regression analysis showed that the slope of the under-ice turbidity trend over time was not significantly different from zero (p = 0.193).

During the open-water season, the mean 2020 turbidity in Doris Lake (7.4 NTU) was higher than previous annual means (Figure 3.3-3). There was some overlap between the ranges of open-water season turbidity levels recorded during baseline years (2.3 to 5.0 NTU) and 2020 (4.2 to 9.3 NTU); however, the turbidity recorded in the two deep-water samples in August 2020 both exceeded the baseline range. The CCME guideline for turbidity in clear flow waters is an increase of 2 NTU from background levels for a long-term exposure (CCME 2020). Although the baseline data for turbidity in the northern end of Doris Lake are limited (only two years of monitoring: 2003 and 2009), the mean 2020 open-water season turbidity of 7.4 NTU is more than 2 NTU higher than the mean baseline turbidity of 3.7 NTU, indicating that the CCME guideline was exceeded.



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.

Figure 3.3-2: Total Suspended Solids Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.

Figure 3.3-3: Turbidity in Lakes, Hope Bay Project, 1995 to 2020

The graphical analysis and the comparison to baseline levels suggest that there may be a Project effect on open-water turbidity in Doris Lake; however, the regression analysis showed that the change in turbidity is not statistically significant as the slope of the trend is not significantly different from zero ($p = 0.381$). Trends in turbidity generally closely follow trends in TSS, and open-water season TSS levels have been relatively stable over the last two decades (Section 3.3.2), which is inconsistent with the observation of elevated turbidity in 2020 compared to baseline years. It is possible that turbidity was unusually low in the limited baseline dataset available for Doris Lake, particularly in the samples collected in 2003 (Figure 3.3-3). Overall, the determination of whether there is a Project effect on open-water turbidity in Doris Lake is inconclusive. The regression analysis for open-water turbidity in Doris Lake indicates that there is no Project effect, while the comparison to baseline levels indicates that there may be a Project effect on turbidity. Turbidity was not directly assessed in the 2017 FEIS predictions of Project effects to the freshwater environment, but TSS was assessed and was predicted to increase sporadically relative to baseline levels in the Doris Watershed downstream of Doris Lake during all Project phases (TMAC 2017b).

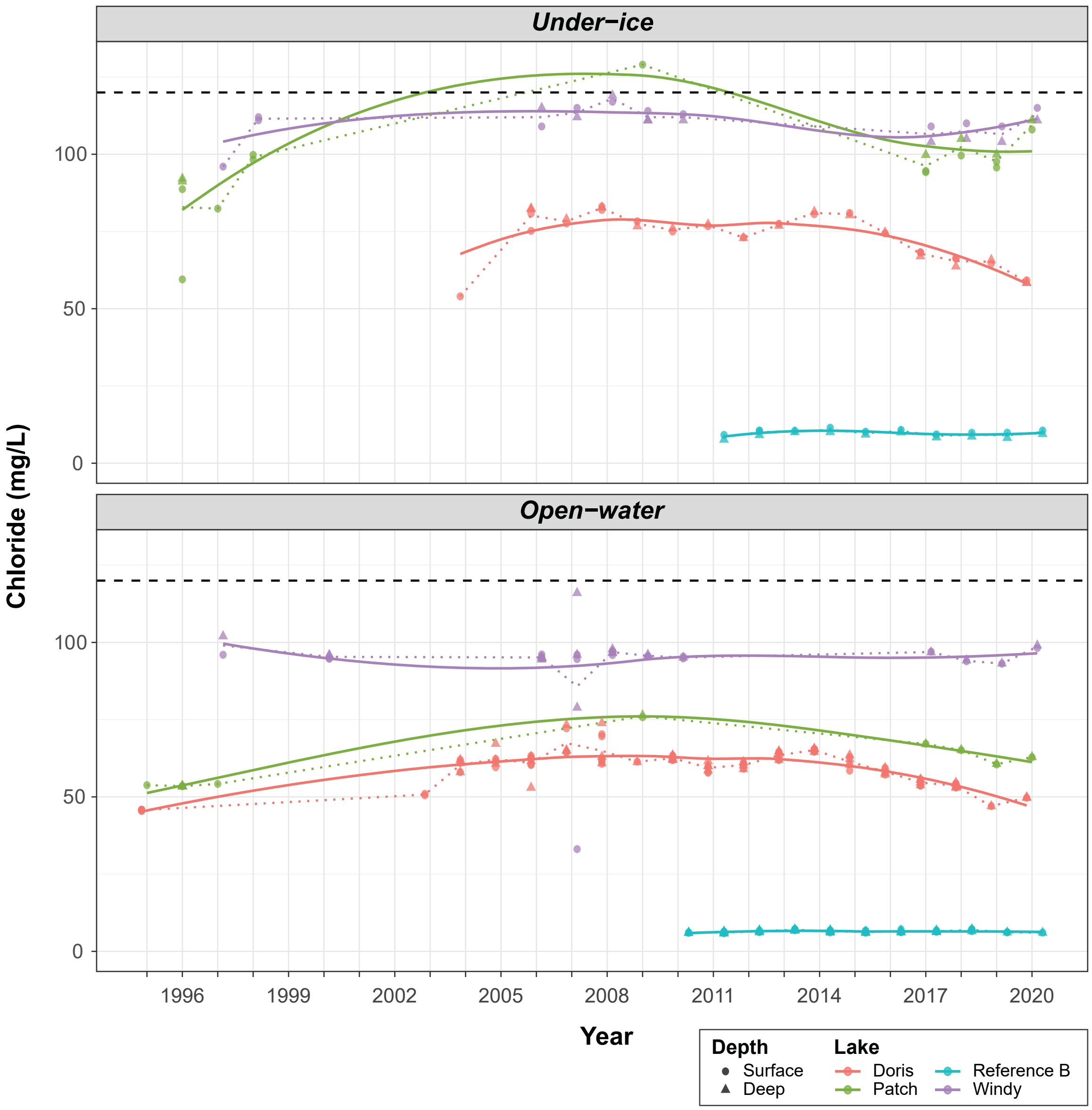
For Doris (under-ice season), Patch, and Windy lakes, there was no apparent Project effect on water turbidity in 2020 and a low action level response was not triggered. For the open-water season samples collected from Doris Lake, a potential Project effect was identified because 2020 turbidity levels were higher than baseline levels and exceeded the CCME guideline and 75% of the water quality benchmark. However, for a low action level response to be triggered, all the conditions described in Section 2.2.3.1 must be met, including the identification of a statistically significant and potentially adverse change from baseline concentrations. A low action level response for open-water turbidity in Doris Lake was not triggered because this condition was not met.

3.3.4 Chloride

In both Windy and Patch lakes, 2020 chloride concentrations were within the range of baseline concentrations (Figure 3.3-4), and the before-after analyses confirmed that 2020 means were not significantly different from baseline means (Windy Lake: $p = 0.645$ for under ice, $p = 0.399$ for open water; Patch Lake: $p = 0.619$ for under ice, $p = 0.866$ for open water). Thus there was no evidence of a Project-related change in chloride concentrations in these lakes.

For Doris Lake, the statistical analyses showed that the under-ice and open-water chloride trends were significantly different from a slope of zero ($p < 0.0001$ for both under ice and open water) and from the corresponding trends in Reference Lake B ($p < 0.0001$ for both under ice and open water). However, graphical analysis suggests that under-ice and open-water chloride concentrations in Doris Lake have not increased relative to baseline levels, and concentrations 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 over time.

All 2020 chloride concentrations in the monitored lakes remained below the CCME guideline of 120 mg/L. Although some or all 2020 chloride concentrations in Windy and Patch lakes were higher than 90 mg/L (i.e., 75% of the water quality benchmark), the low action level was not triggered because there was no apparent increase in chloride concentrations relative to baseline concentrations.



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME long-term guideline for chloride (120 mg/L).

Figure 3.3-4: Chloride Concentrations in Lakes, Hope Bay Project, 1995 to 2020

3.3.5 Fluoride

Fluoride concentrations remained relatively unchanged over time in each of the exposure lakes (Figure 3.3-5). The statistical analyses confirmed this consistency over time, as the mean baseline fluoride concentrations in Windy and Patch Lake were not significantly different from 2020 means (Windy Lake: $p = 0.901$ for under ice, $p = 0.899$ for open water; Patch Lake: $p = 0.754$ for under-ice, $p = 0.713$ for open-water), and the fluoride trends in Doris Lake were not significantly different from a slope of zero ($p = 0.149$ for under ice, $p = 0.872$ for open water). Therefore, there was no evidence of a Project-related effect on fluoride concentrations in exposure lakes.

All 2020 fluoride concentrations in the monitored lakes remained below the CCME guideline of 0.12 mg/L. Under-ice fluoride concentrations measured in Patch and Windy lakes in 2020 were higher than 0.09 mg/L (i.e., 75% of the water quality benchmark); however, the low action level was not triggered for any exposure lake because there was no apparent increase in fluoride concentrations relative to baseline concentrations.

3.3.6 Total Ammonia

Concentrations of total ammonia in the exposure lakes were variable over time; however, 2020 concentrations were within the range of baseline concentrations (Figure 3.3-6). The statistical analyses showed that baseline and 2020 mean total ammonia concentrations were not significantly different for both Windy ($p = 0.948$ for under ice, $p = 0.821$ for open water) and Patch lakes ($p = 0.174$ for under ice, open-water analysis not performed because of the high proportion of censored data), and the total ammonia trends in Doris Lake were not significantly different from a slope of zero ($p = 0.685$ for under ice, $p = 0.303$ for open water).

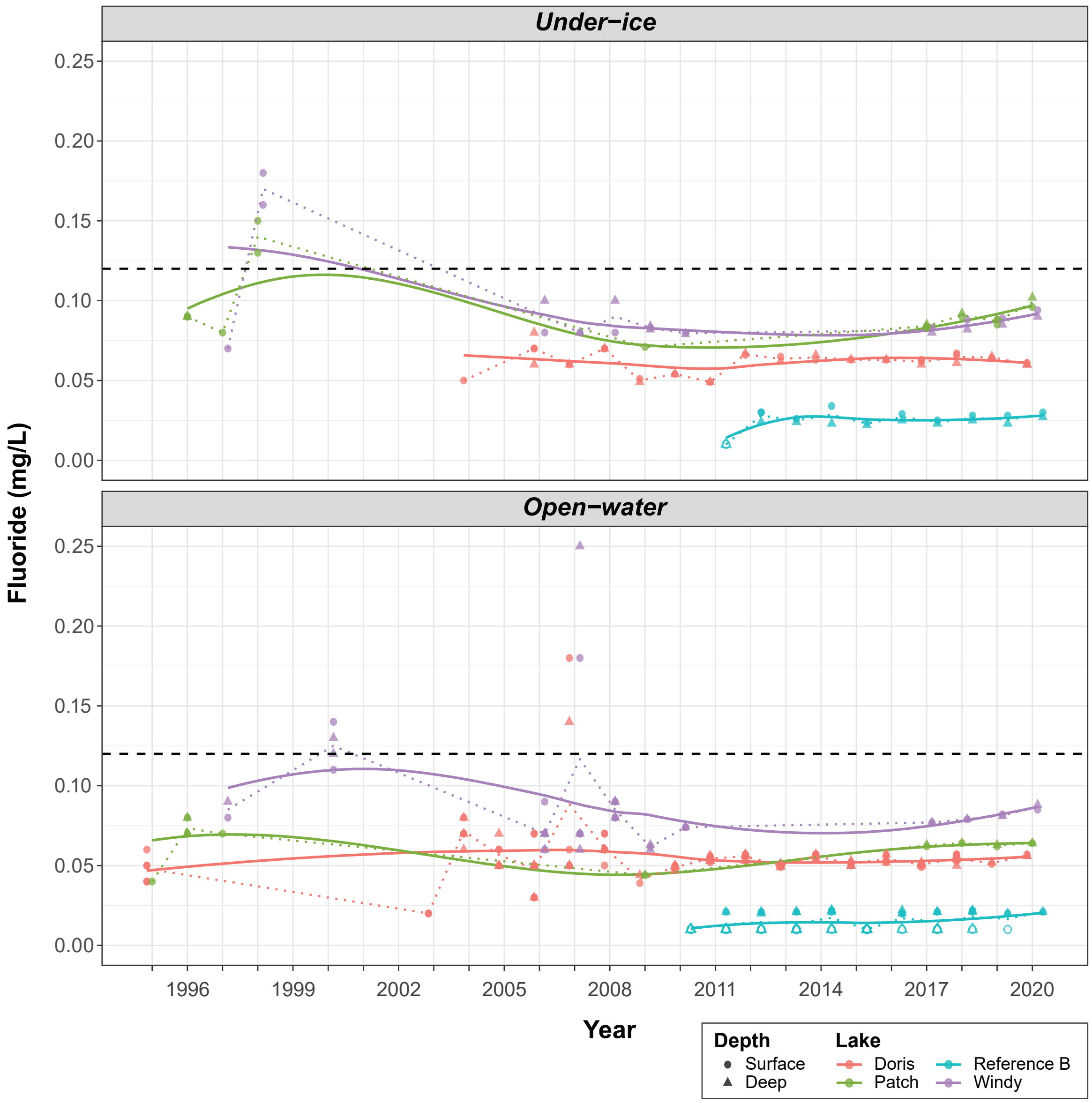
There was no evidence of a Project effect on total ammonia concentrations in any exposure lake and all 2020 total ammonia concentrations remained below the pH- and temperature-dependent CCME guideline (Figure 3.3-6). A low action level response was not triggered for total ammonia.

3.3.7 Nitrate

All under-ice nitrate concentrations measured in Windy Lake in 2020 were below the analytical detection limit (< 0.005 mg/L; Figure 3.3-7), and no statistical analysis was performed. For Patch Lake, April 2020 nitrate concentrations were within the range of baseline concentrations, and the before-after analysis confirmed that there was no significant difference between baseline and 2020 mean under-ice nitrate concentrations ($p = 0.827$). During August 2020, all nitrate concentrations in Windy and Patch lakes were below the detection limit (< 0.005 mg nitrate-N/L; Figure 3.3-7) and no statistical analyses were performed. Therefore, there was no evidence of a Project effect on under-ice or open-water season nitrate concentrations in these lakes.

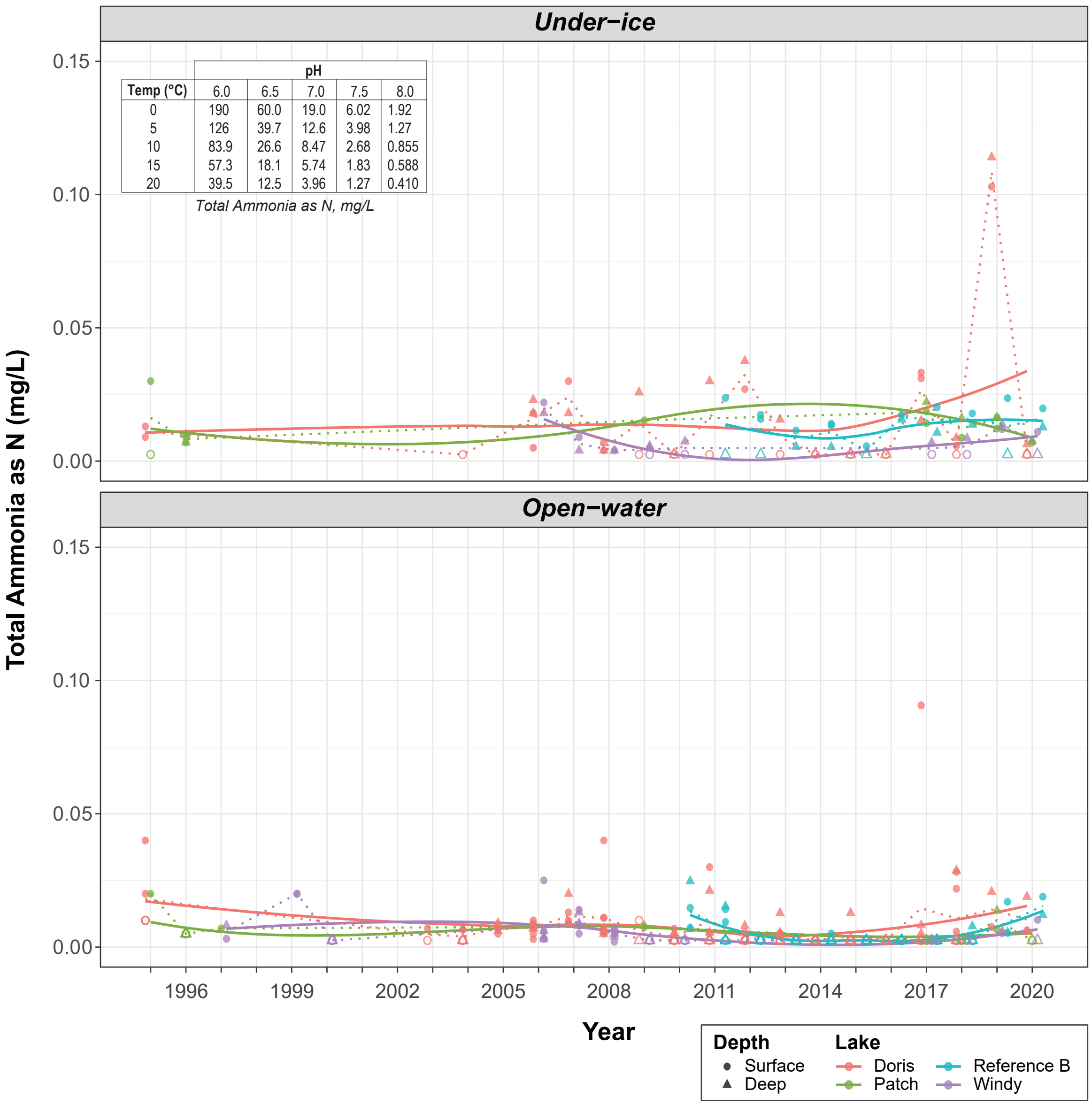
Nitrate concentrations were more variable over time in Doris Lake compared to the other monitored lakes (Figure 3.3-7). Under-ice and open-water season nitrate concentrations measured in Doris Lake in 2020 were within the range of baseline concentrations. However, the regression analysis showed that the under-ice nitrate trend in Doris Lake was significantly different from a slope of zero ($p = 0.0006$) and significantly different from the trend in Reference Lake B ($p < 0.0001$), which is likely due to the high inter-annual variability in the data. There is no evidence of an overall increasing trend in under-ice nitrate concentrations in Doris Lake, and thus no apparent Project-related adverse effect on under-ice nitrate concentrations.

Of the three open-water season samples collected in Doris Lake in August 2020, concentrations of nitrate were below the detection limit in the duplicate samples collected at depth (< 0.005 mg/L), and 0.0116 mg/L in the surface sample. A regression analysis could not be performed because of the high proportion of censored data; however, there was no evidence of an adverse Project effect on nitrate concentrations as August 2020 concentrations were within the range of baseline concentrations.



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME interim guideline for fluoride (0.12 mg/L).

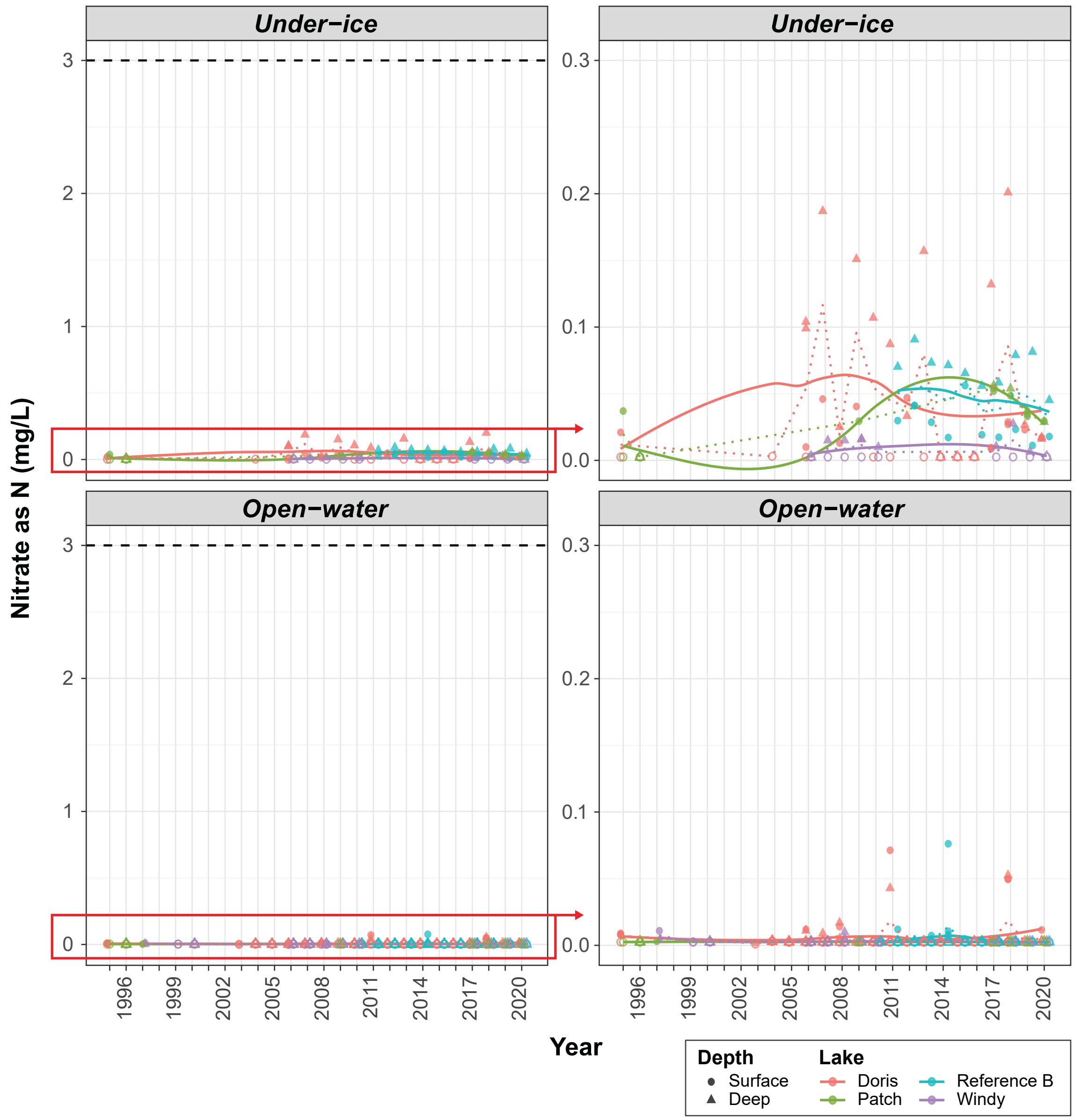
Figure 3.3-5: Fluoride Concentrations in Lakes, Hope Bay Project, 1995 to 2020



	pH				
Temp (°C)	6.0	6.5	7.0	7.5	8.0
0	190	60.0	19.0	6.02	1.92
5	126	39.7	12.6	3.98	1.27
10	83.9	26.6	8.47	2.68	0.855
15	57.3	18.1	5.74	1.83	0.588
20	39.5	12.5	3.96	1.27	0.410

Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Inset table shows the pH- and temperature-dependent CCME guideline for total ammonia as N.

Figure 3.3-6: Total Ammonia Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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 the CCME guideline.

Figure 3.3-7: Nitrate Concentrations in Lakes, Hope Bay Project, 1995 to 2020

Nitrate contamination was flagged as a potential issue in the QA/QC analysis presented in Appendix A because of elevated nitrate concentrations in the April field blank and the August equipment blank samples. Although it is possible that nitrate concentrations in lake samples could have been biased high due to contamination, this did not influence the evaluation of effects as the conclusion of the analysis is that there was no Project effect on nitrate concentration in any exposure lake (and thus no potential for a "false positive" result).

Under-ice and open-water nitrate concentrations in all three exposure lakes remained below the long-term CCME guideline of 3.0 mg nitrate-N/L and a low action level response was not triggered.

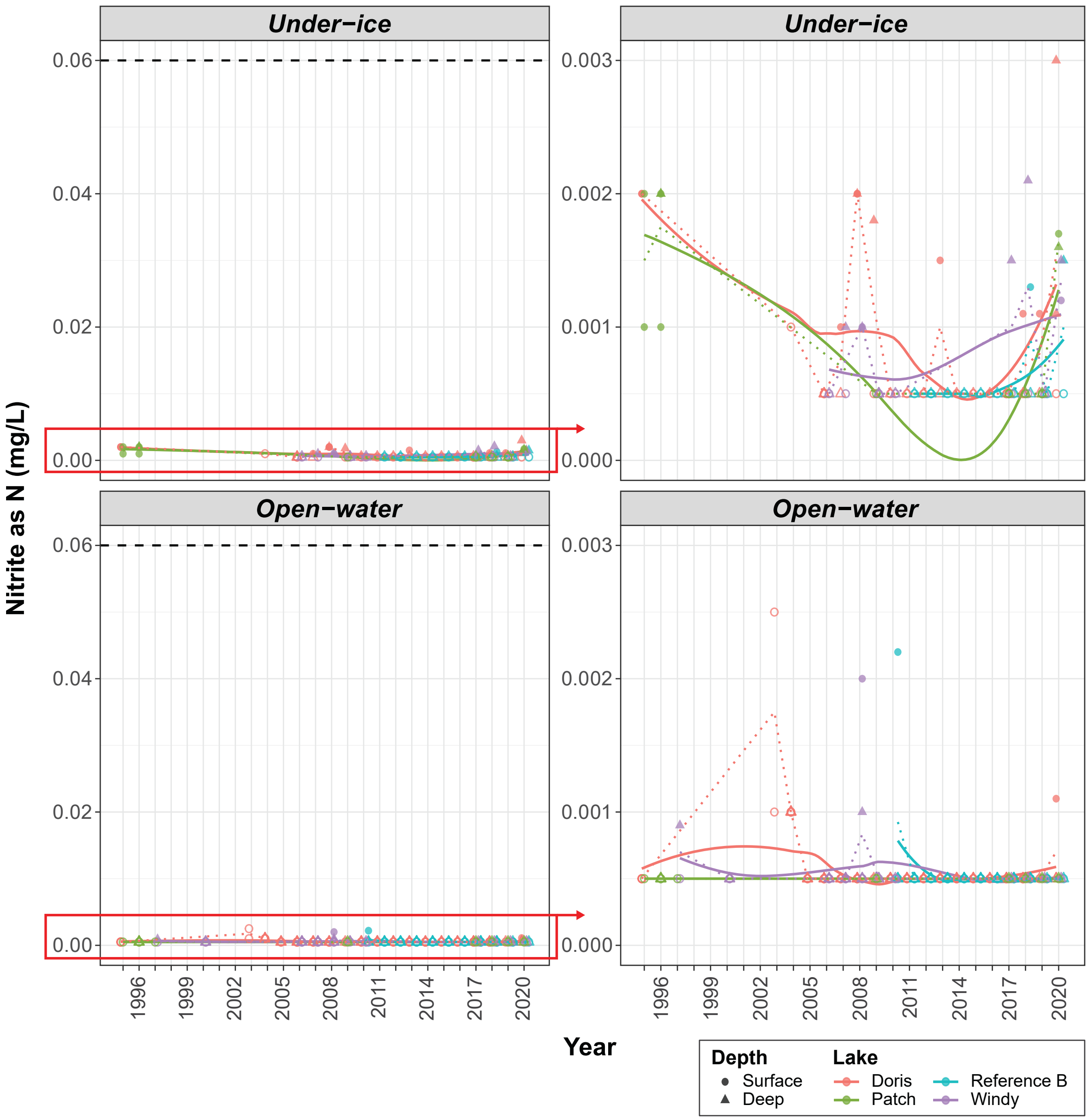
3.3.8 Nitrite

Statistical analysis of nitrite concentrations in lakes was not performed because of the high proportion of censored values in the datasets for all exposure lakes. It is difficult to evaluate trends when such a large proportion of the data are below detection limits; however, there does not appear to be an increasing trend in nitrite concentrations during either sampling season in any exposure lake (Figure 3.3-8), suggesting that the Project did not adversely affect nitrite concentrations in exposure lakes. All 2020 nitrite concentrations were well below the CCME guideline of 0.06 mg nitrite-N/L, and 75% of the water quality benchmark (0.045 mg nitrite-N/L; Figure 3.3-8).

Nitrite concentrations measured in 2020 were always within the range of baseline concentrations, except for the concentration of 0.003 mg/L in one sample collected in April 2020 in Doris Lake. This concentration is slightly higher that the baseline maximum of 0.002 mg/L measured during the under-ice season in Doris Lake. As was the case for nitrate, nitrite was also flagged in the QA/QC analysis for potential sample contamination as the nitrite concentration in the April equipment blank was higher than the detection limit (Appendix A). Although there is the potential that samples collected in April 2020 could have been biased high due to contamination, this did not influence the conclusions of the evaluation of effects. There is no evidence of an adverse Project effect on nitrite concentrations in Windy, Patch, or Doris lakes, and a low action level response for nitrite was not triggered.

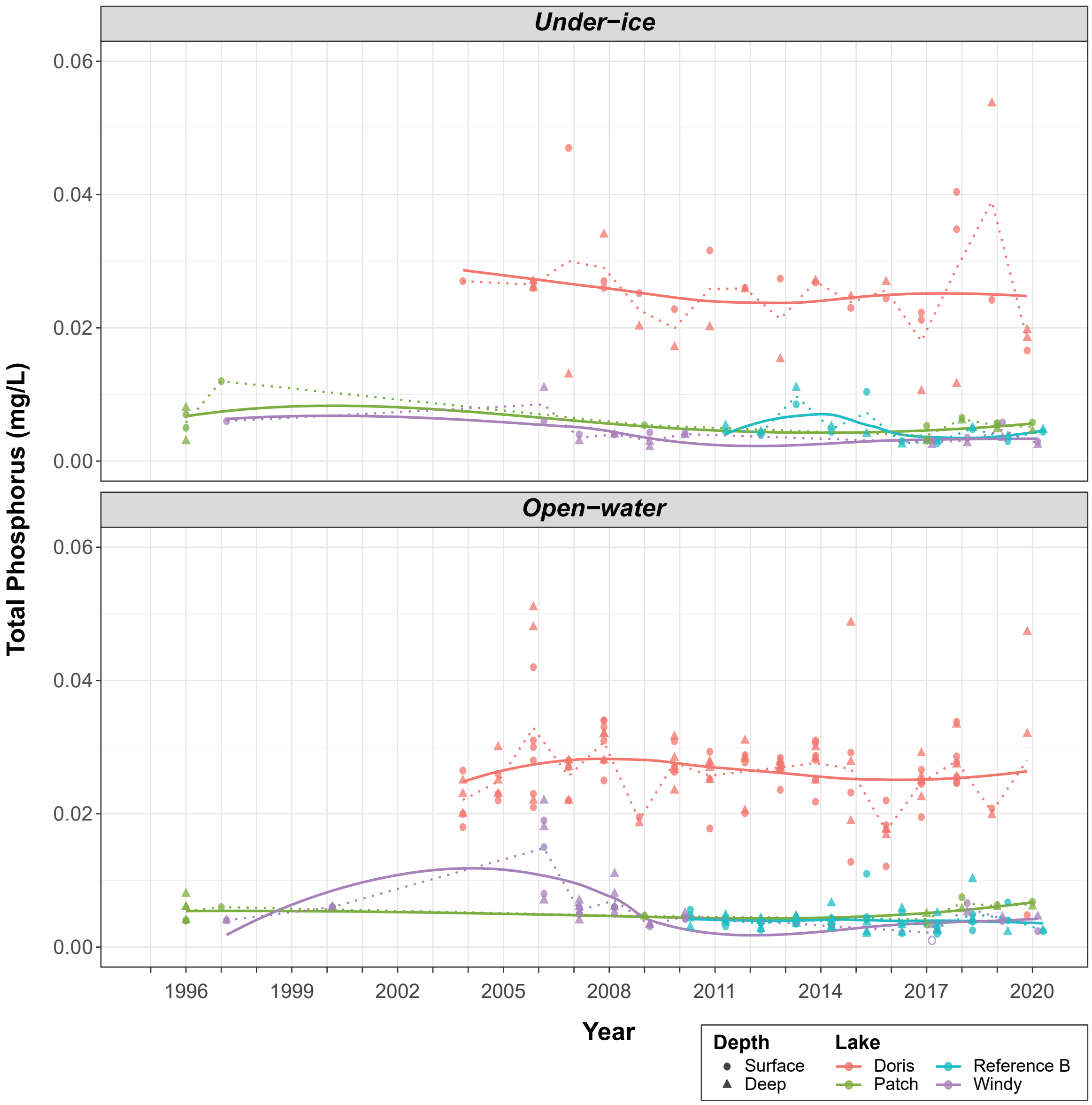
3.3.9 Total Phosphorus

Total phosphorus concentrations in the exposure lakes were generally similar between the ice-covered and open-water seasons (Figure 3.3-9). Baseline total phosphorus concentrations ranged from < 0.002 to 0.022 mg/L in Windy Lake and from 0.003 to 0.012 mg/L in Patch Lake. The average baseline total phosphorus concentration in both lakes was 0.006 mg/L, which is characteristic of oligotrophic lakes (CCME 2020). Under-ice and open-water total phosphorus concentrations measured in Windy and Patch lakes in 2020 were within the range of baseline concentrations, and the statistical analyses showed that there were no significant differences between 2020 means and baseline means (Windy Lake: $p = 0.300$ for under ice, $p = 0.504$ for open water; Patch Lake: $p = 0.780$ for under ice, $p = 0.342$ for open water). Thus there is no evidence of an adverse effect of the Project on total phosphorus concentrations in these lakes.



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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 the CCME guideline.

Figure 3.3-8: Nitrite Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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, Hope Bay Project, 1995 to 2020

Total phosphorus concentrations in Doris Lake are naturally higher than in Windy and Patch lakes (Figure 3.3-9). Baseline total phosphorus concentrations in Doris Lake ranged from 0.013 to 0.051 mg/L and averaged 0.027 mg/L, characteristic of a meso-eutrophic lake (CCME 2020). 2020 under-ice and open-water total phosphorus concentrations in Doris Lake were within the range of baseline concentrations, with the exception of the surface concentration of 0.0048 mg/L measured in August 2020, which was the lowest total phosphorus concentration measured at this site. This unusually low surface concentration was an order of magnitude lower than deep water concentrations of 0.032 and 0.047 mg/L, and likely resulted from biological uptake of phosphorus in the well-lit surface waters together with the unusually strong water column stratification observed in August 2020 (Figure 3.2-3b) that would restrict the mixing of phosphorus-rich bottom waters into the surface. Although the surface concentration of total phosphorus was unusually low, the regression analysis showed that there was no statistically significant change in total phosphorus concentrations in Doris Lake over time as the total phosphorus trends were not significantly different from a slope of zero ($p = 0.877$ for under ice, $p = 0.169$ for open water).

The variability between replicate total phosphorus concentrations in deep water samples collected from Doris Lake in August 2020 was flagged in the QA/QC analysis (Appendix A; RPD of 38.6%) as exceeding the target RPD of 20%; however, this variability likely had a negligible impact on the conclusions of the evaluation of effects, as these concentrations are consistent with baseline concentrations, and there was similar variability among samples in the historical dataset.

Overall, there was no evidence of an adverse change in total phosphorus concentrations in any exposure lake due to Project activities, and a low action level response was not triggered.

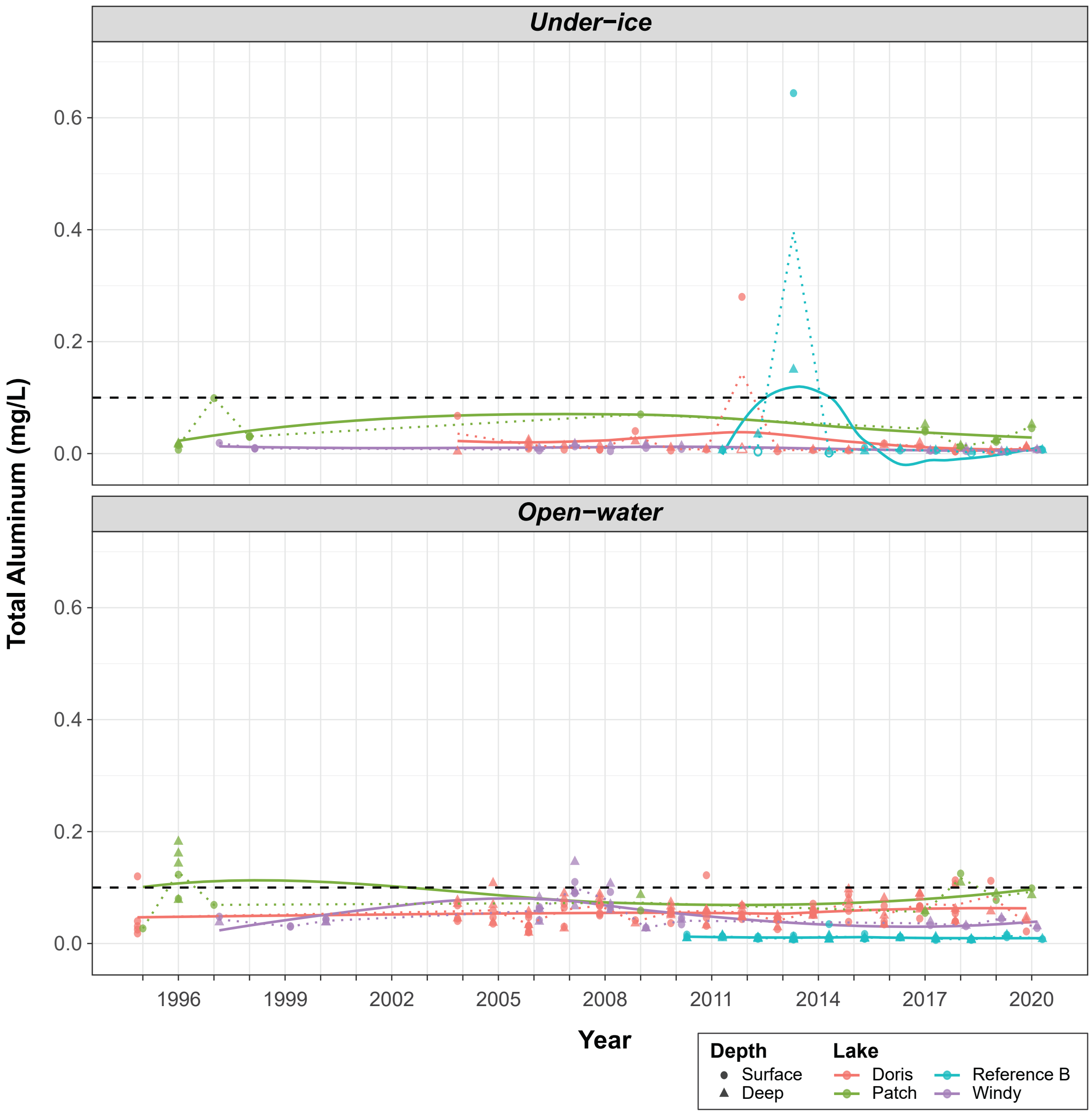
3.3.10 Total Aluminum

Under-ice and open-water season total aluminum concentrations changed little over time in the three exposure lakes (Figure 3.3-10). This was confirmed by the statistical analyses, which indicated that there were no significant differences between baseline and 2020 mean total aluminum concentrations in Windy Lake ($p = 0.439$ for under ice, $p = 0.359$ for open water) and in Patch Lake ($p = 0.780$ for under ice, $p = 0.653$ for open water), and the temporal trends in total aluminum concentrations in Doris Lake were not significantly different from a slope of zero ($p = 0.470$ for under ice, $p = 0.834$ for open water).

All total aluminum concentrations in exposure lakes in 2020 remained below the CCME guideline of 0.1 mg/L; however, the open-water season total aluminum concentrations of 0.0986 and 0.0865 mg/L measured in Patch Lake in 2020 exceeded 75% of the total aluminum benchmark (0.075 mg/L; Figure 3.3-10). A low action level response was not triggered because there was no indication that total aluminum concentrations increased in 2020 relative to baseline levels (which were also occasionally elevated above the 75% threshold).

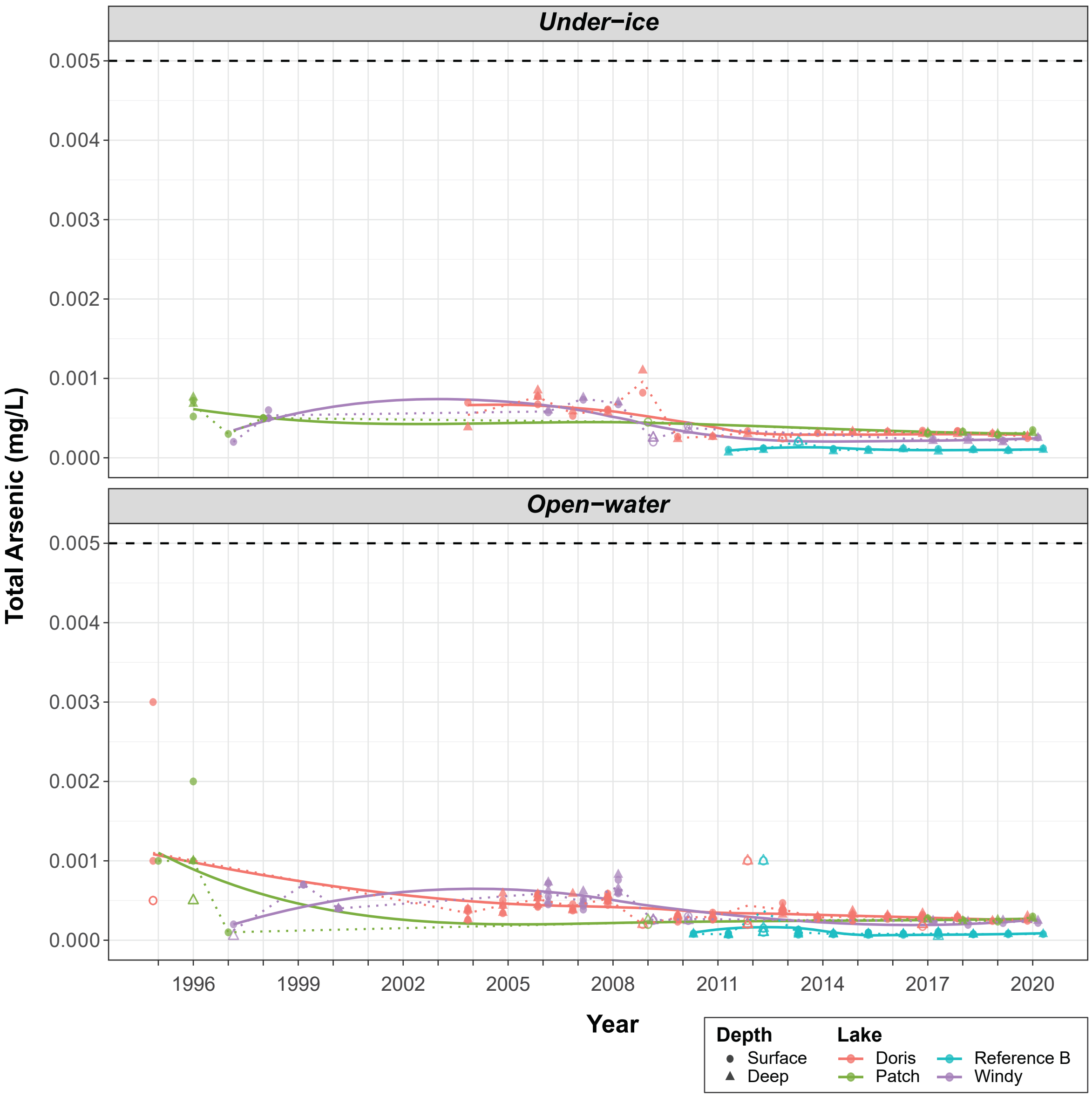
3.3.11 Total Arsenic

In Windy and Patch Lakes (both under-ice and open-water seasons) and Doris Lake (open-water season), total arsenic concentrations measured in 2020 were at the lower end of the range of baseline concentrations (Figure 3.3-11). The total arsenic concentrations of 0.00025 to 0.00027 mg/L measured in Doris Lake during the 2020 ice-covered season were lower than the minimum baseline concentration of 0.00038 mg/L. For both Windy and Patch lakes, mean baseline concentrations were not significantly different from 2020 mean concentrations (Windy Lake: $p = 0.511$ for under ice, $p = 0.589$ for open water; Patch Lake: $p = 0.571$ for under ice, $p = 0.879$ for open water). Total arsenic concentrations in Doris Lake showed a declining trend over time, driven by relatively high total arsenic concentrations measured between 2005 and 2009 (Figure 3.3-11). The regression analysis confirmed that there was a significant non-zero slope in both under-ice and open-water arsenic concentrations ($p < 0.0001$ for both seasons), but that the Doris Lake trends were not significantly different from the Reference Lake B trends ($p = 0.0715$ for under ice, $p = 0.483$ for open water). The similarity in trends between Doris Lake and Reference Lake B suggests that observed changes in arsenic over time were unrelated to the Project.



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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 2020.

Figure 3.3-10: Total Aluminum Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME guideline for arsenic (0.005 mg/L).

Figure 3.3-11: Total Arsenic Concentrations in Lakes, Hope Bay Project, 1995 to 2020

Total arsenic concentrations measured in Windy, Patch, and Doris lakes in 2020 remained below the CCME guideline of 0.005 mg/L and there was no apparent adverse effect of the Project on arsenic concentrations in the exposure lakes. A low action level response for total arsenic was not triggered.

3.3.12 Total Boron

In Windy and Patch lakes, 2020 under-ice and open-water season total boron concentrations were within the range of baseline concentrations (Figure 3.3-12), and the before-after analyses confirmed that there were no significant differences between baseline and 2020 mean concentrations (Windy Lake: $p = 0.577$ for under ice, $p = 0.653$ for open water; Patch Lake: $p = 0.652$ for under ice, $p = 0.761$ for open water).

In Doris Lake, both under-ice and open-water season total boron concentrations increased slightly from the earliest baseline years to 2015, and decreased back to baseline levels between 2015 and 2020 (Figure 3.3-12). These trends were significantly different from a slope of zero ($p < 0.0001$ for both under ice and open water). Although the trends in Reference Lake B could not be evaluated statistically due to the high proportion of concentrations that were below the detection limit, the reference data showed a similar pattern, with concentrations relatively elevated from 2010 to 2015 compared to concentrations from 2016 to 2020, which were consistently below the detection limit (Figure 3.3-12). Although there are significant trends in the Doris Lake total boron data, concentrations from the last six years show a decreasing trend over time, with 2020 concentrations within the baseline range. Therefore, was there is no apparent adverse Project effect on 2020 total boron concentrations in Doris Lake.

The QA/QC analysis (Appendix A) showed that there was the potential for contamination, because the August field blank total boron concentration was similar to August concentrations in lake samples. Although it is possible that lake concentrations were biased high due to contamination, it is unlikely that this affected the conclusions of the evaluation of effects as 2020 concentrations remained consistent with baseline concentrations and were not unusually high.

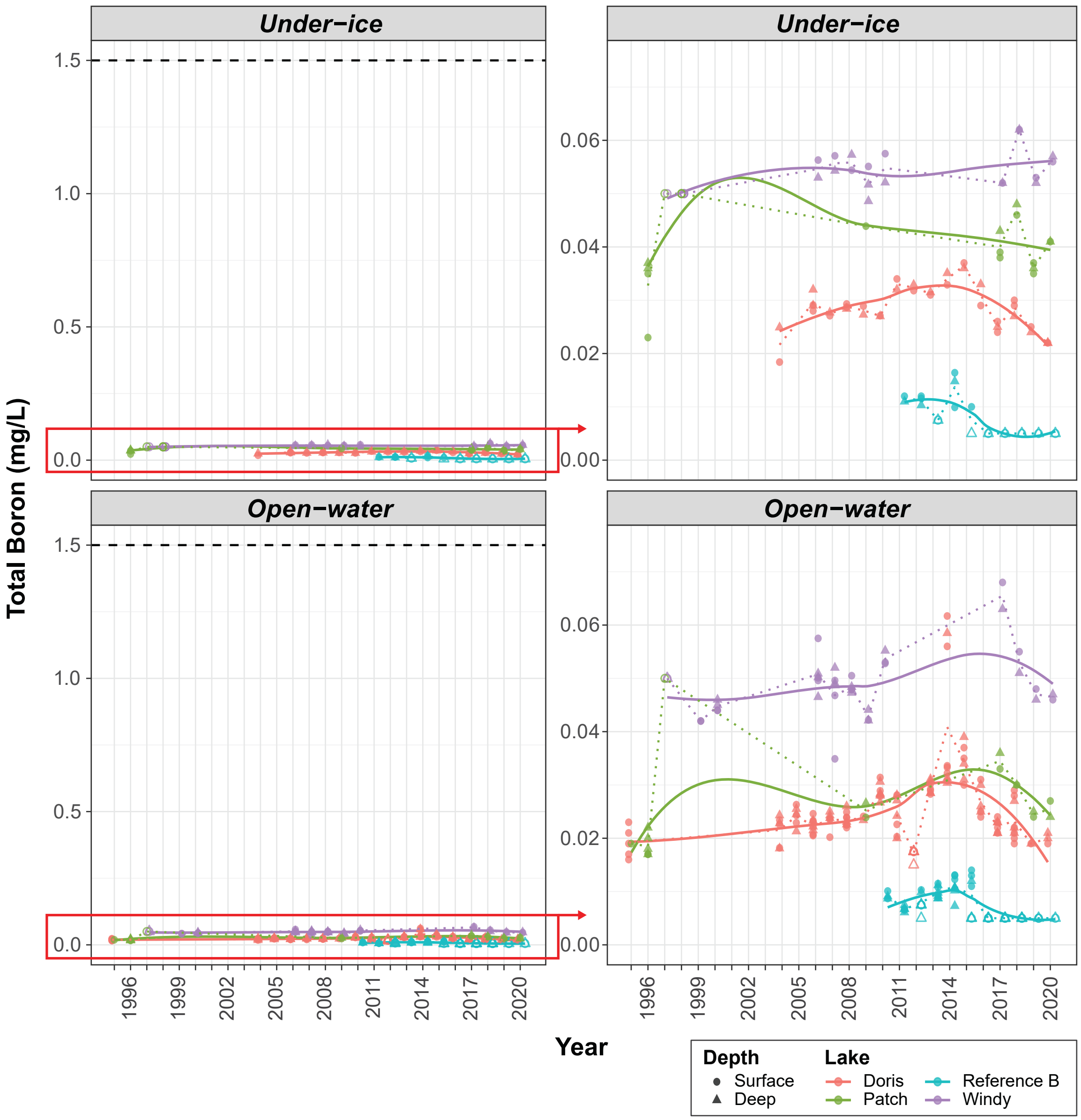
Total boron concentrations in all the exposure lakes remained below the CCME long-term guideline of 1.5 mg/L. There was no evidence of a Project effect on boron concentrations in the exposure lakes, and a low action level response was not triggered.

3.3.13 Total Cadmium

All 2020 total cadmium concentrations measured in exposure lakes were below the analytical detection limit (<0.000005 mg/L), except for one detectable concentration of 0.0000061 mg/L measured in Patch Lake during the under-ice season (Figure 3.3-13). No statistical analyses were performed because of the high proportion of censored data. There was no evidence of an adverse effect of Project activities on total cadmium concentrations in any exposure lake, and all total cadmium concentrations remained below the hardness-dependent CCME guideline. A low action level response was not triggered for total cadmium.

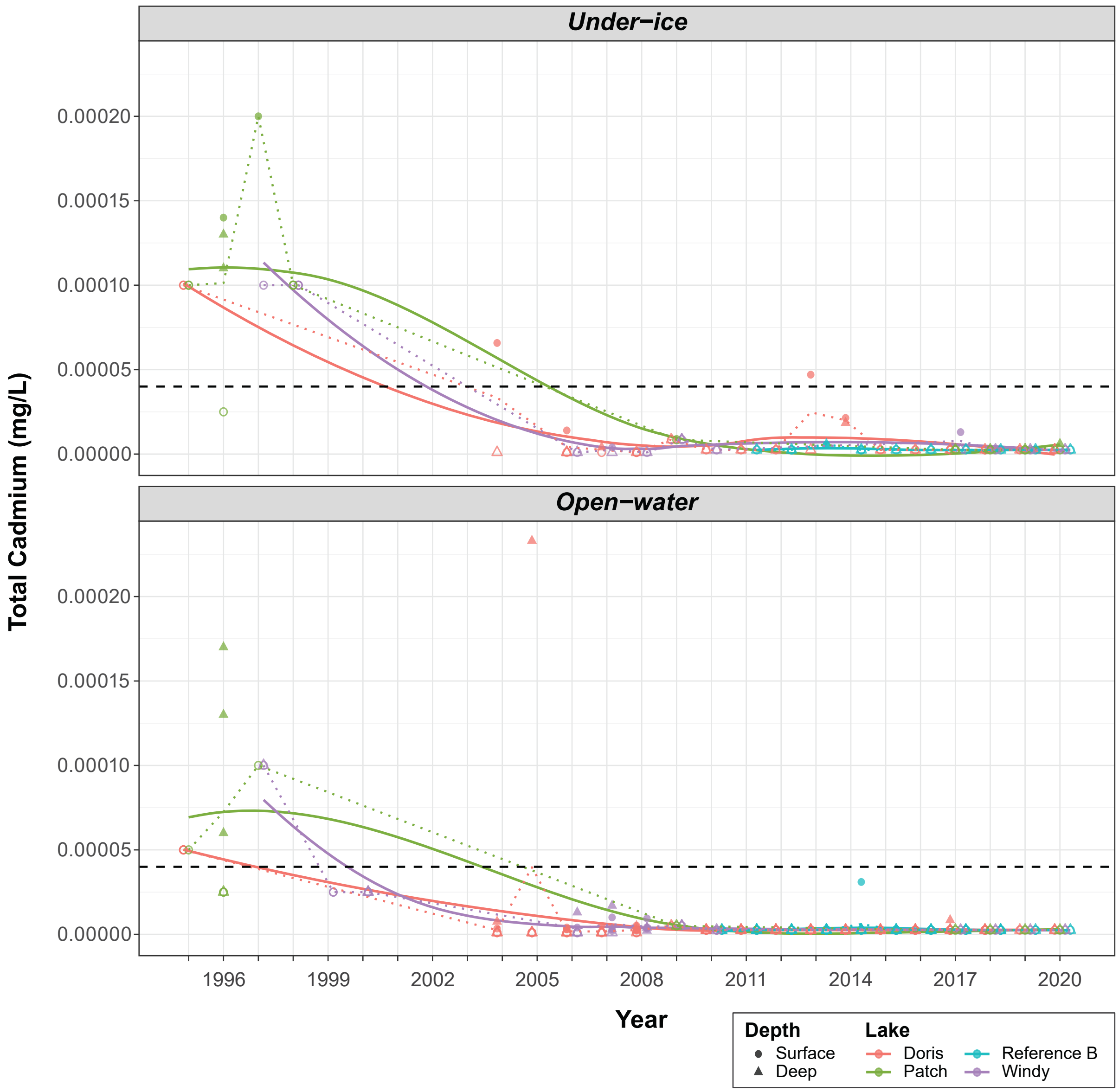
3.3.14 Total Chromium

All concentrations of total chromium in the exposure lakes were below the detection limit (< 0.0005 mg/L) in 2020, with the exception of one sample collected in Doris Lake in April, which had a total chromium concentration of 0.00066 mg/L (Figure 3.3-14). All 2020 concentrations were below the CCME guideline of 0.001 mg/L for hexavalent chromium, and the CCME guideline of 0.0089 mg/L for trivalent chromium (Figure 3.3-14). Statistical analyses were not performed because of the high proportion of censored data. Trends over time showed no indication of increasing chromium concentrations; therefore, there was no evidence of a Project effect on chromium concentrations in Windy, Patch, or Doris lakes, and a low action level response for total chromium was not triggered.



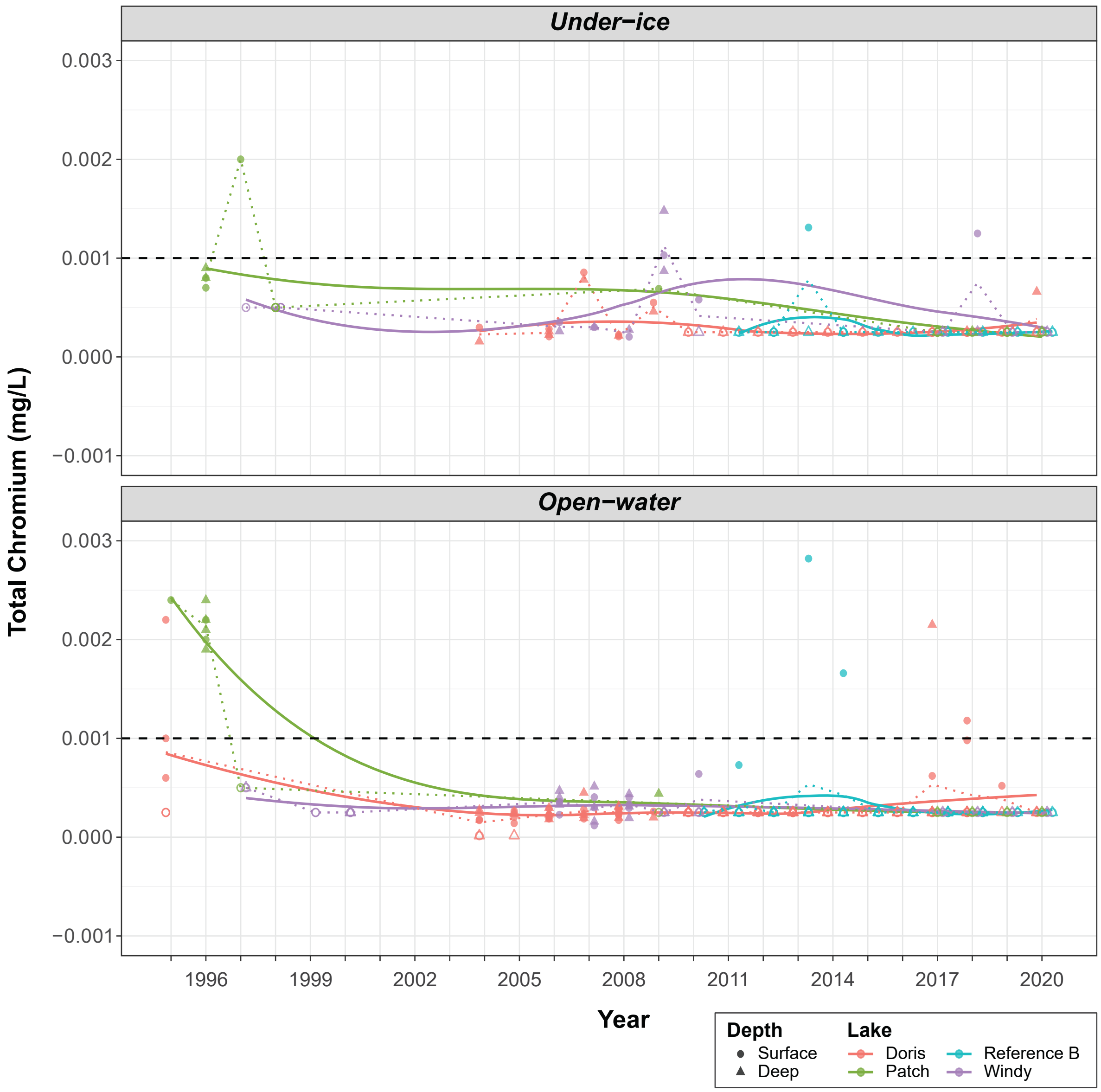
Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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 the CCME guideline.

Figure 3.3-12: Total Boron Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the minimum hardness-dependent CCME long-term guideline for cadmium of 0.00004 mg/L (for hardness as $CaCO_3$ of < 17 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-13: Total Cadmium Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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: Total Chromium Concentrations in Lakes, Hope Bay Project, 1995 to 2020

3.3.15 Total Copper

Under-ice and open-water total copper concentrations in Windy, Patch, and Doris lakes changed little over time (Figure 3.3-15). This was confirmed by the statistical analyses, which showed that there were no significant differences between baseline and 2020 mean total copper concentrations in Windy Lake ($p = 0.867$ for under ice, $p = 0.239$ for open water) and Patch Lake ($p = 0.792$ for under ice, $p = 0.422$ for open water), and the temporal trends in total copper concentrations in Doris Lake were not significantly different from a slope of zero ($p = 0.0935$ for under ice, $p = 0.977$ for open water). Thus, there was no indication that the Project adversely affected total copper concentrations in the exposure lakes.

The total copper concentration of 0.00236 mg/L measured in Patch Lake in April 2020 slightly exceeded the hardness-dependent CCME guideline for copper, and samples collected in Doris Lake (April and August) and Patch Lake (April) exceeded the low action level condition of 75% of the benchmark. However, 2020 copper concentrations did not trigger a low action level response because concentrations have not changed from baseline levels.

3.3.16 Total Iron

In 2020, under-ice concentrations of total iron were below the detection limit in Doris and Windy lakes (< 0.03 mg/L; no statistical analysis performed), and ranged from 0.050 to 0.057 mg/L in Patch Lake (Figure 3.3-16). The 2020 Patch Lake concentrations were within range of baseline under-ice concentrations, and the baseline mean was not significantly different from the 2020 mean ($p = 0.919$).

During the 2020 open-water season, total iron concentrations in Windy and Patch Lakes were similar to baseline concentrations (Figure 3.3-16), and the before-after analysis confirmed that baseline means were not significantly different from 2020 means (Windy Lake: $p = 0.558$; Patch Lake: $p = 0.209$). In Doris Lake, although August 2020 concentrations were within range of baseline concentrations, the regression analysis showed that there was a significant non-zero trend in total iron concentrations ($p < 0.0001$). It was not possible to compare trends between Doris Lake and Reference Lake B because of the high proportion of concentrations that were below detection limits in the reference lake dataset. However there was no evidence of an adverse Project effect on open-water season total iron concentrations in Doris Lake as there was no apparent increase in concentrations over time (Figure 3.3-16).

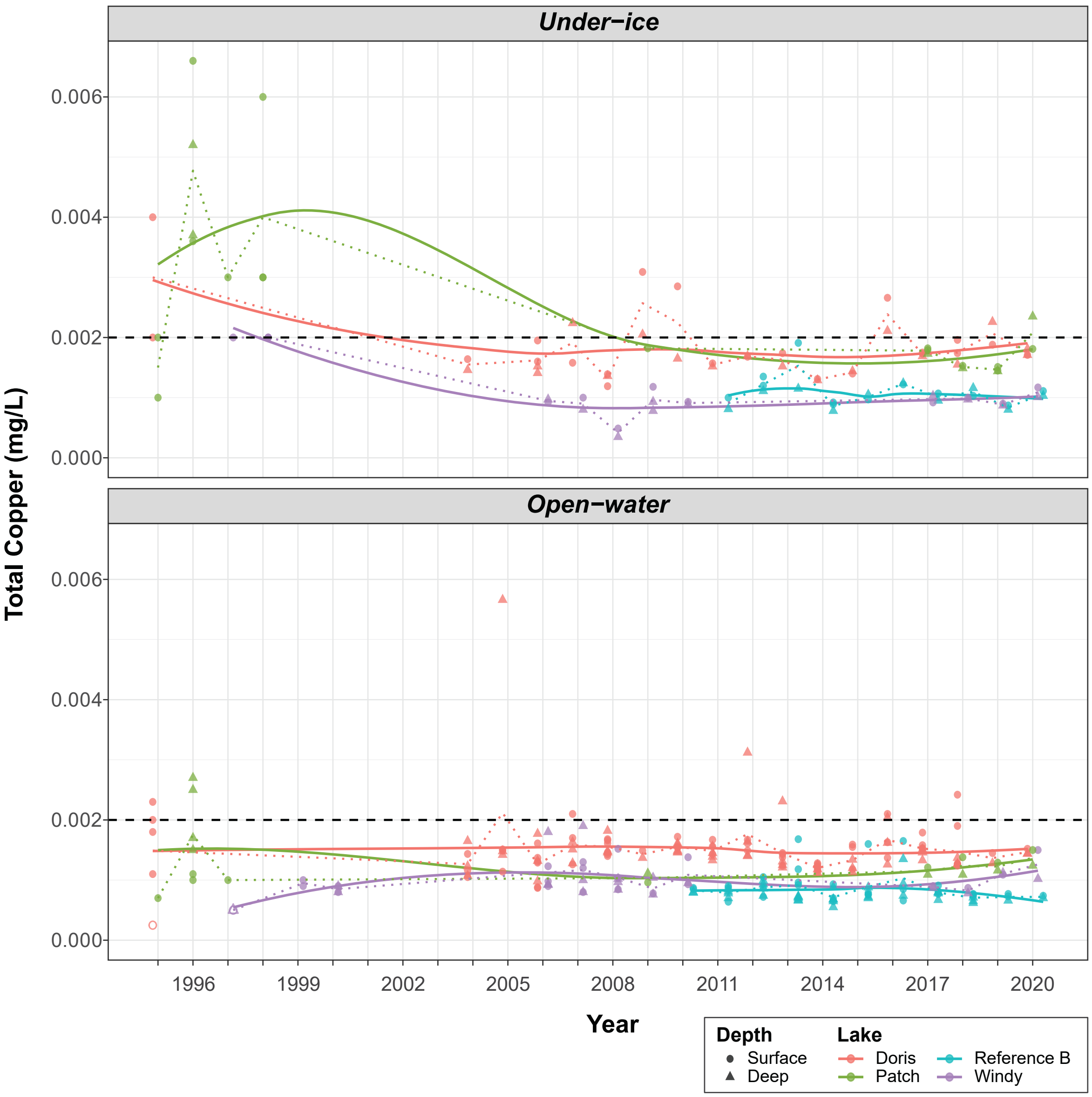
All 2020 total iron concentrations in the exposure lakes were below the CCME guideline of 0.3 mg/L and 75% of the water quality benchmark and a low action level response for total iron was not triggered.

3.3.17 Total Lead

All under-ice concentrations of total lead in the exposure lakes were below the detection limit (< 0.00005 mg/L) in 2020 (Figure 3.3-17). Therefore, there was no apparent Project effect on under-ice lead concentrations in any exposure lake.

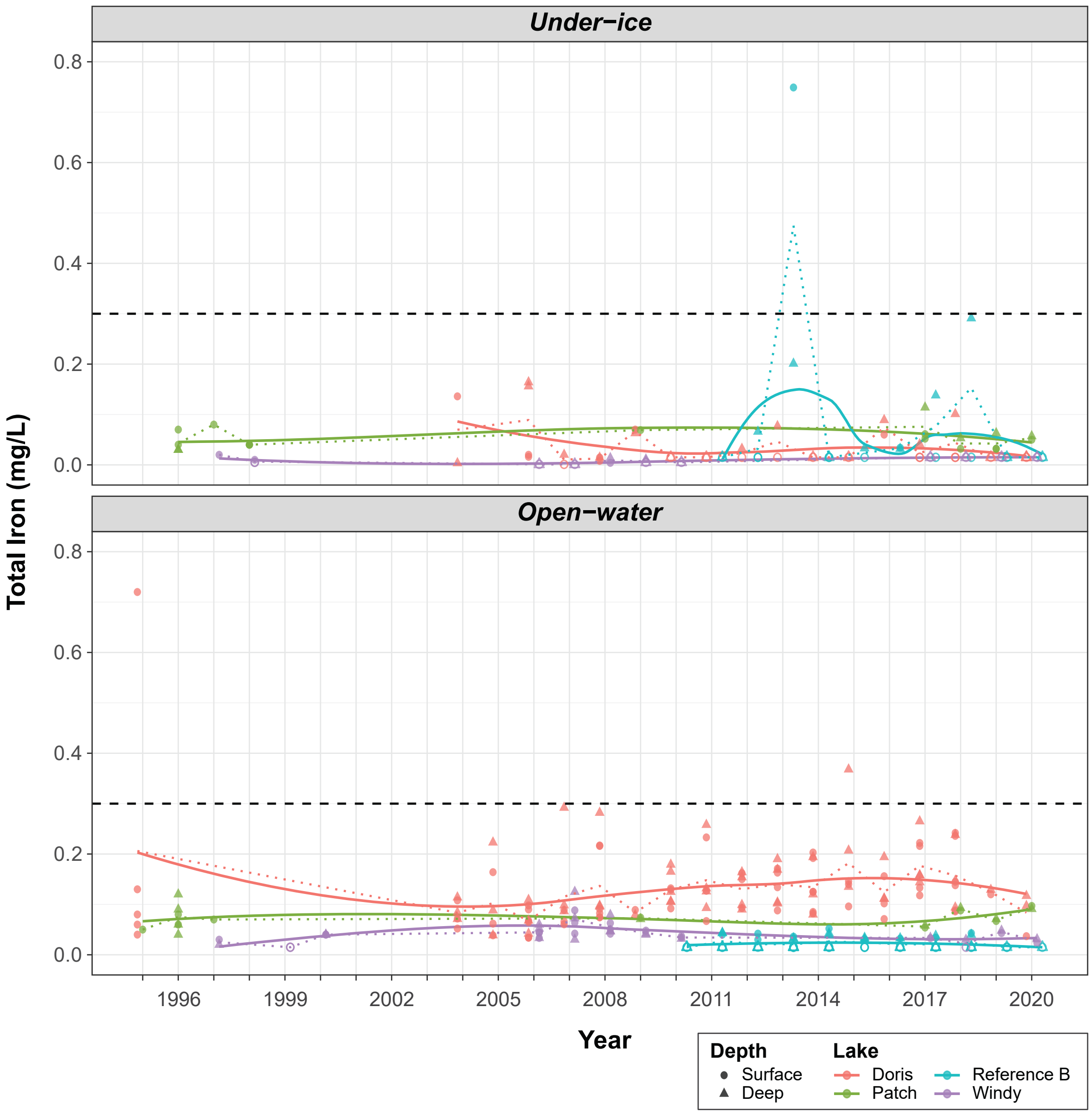
In the 2020 open-water season, all concentrations of total lead in Windy Lake were below the detection limit (< 0.00005 mg/L). In Patch Lake, August 2020 concentrations were within the range of baseline concentrations, and the before-after analysis showed that there was no statistically significant difference between baseline and 2020 means ($p = 0.814$). Similarly, August 2020 total lead concentrations in Doris Lake were consistent with baseline concentrations and the regression analysis showed that the trend in total lead concentrations was not significantly different from a slope of zero ($p = 0.111$).

All 2020 total lead concentrations in the exposure lakes were below the hardness-dependent CCME guideline and 75% of the water quality benchmark. Overall, there was no apparent Project-related increase in total lead concentrations in Windy, Patch, or Doris lakes, and a low action level response for total lead was not triggered.



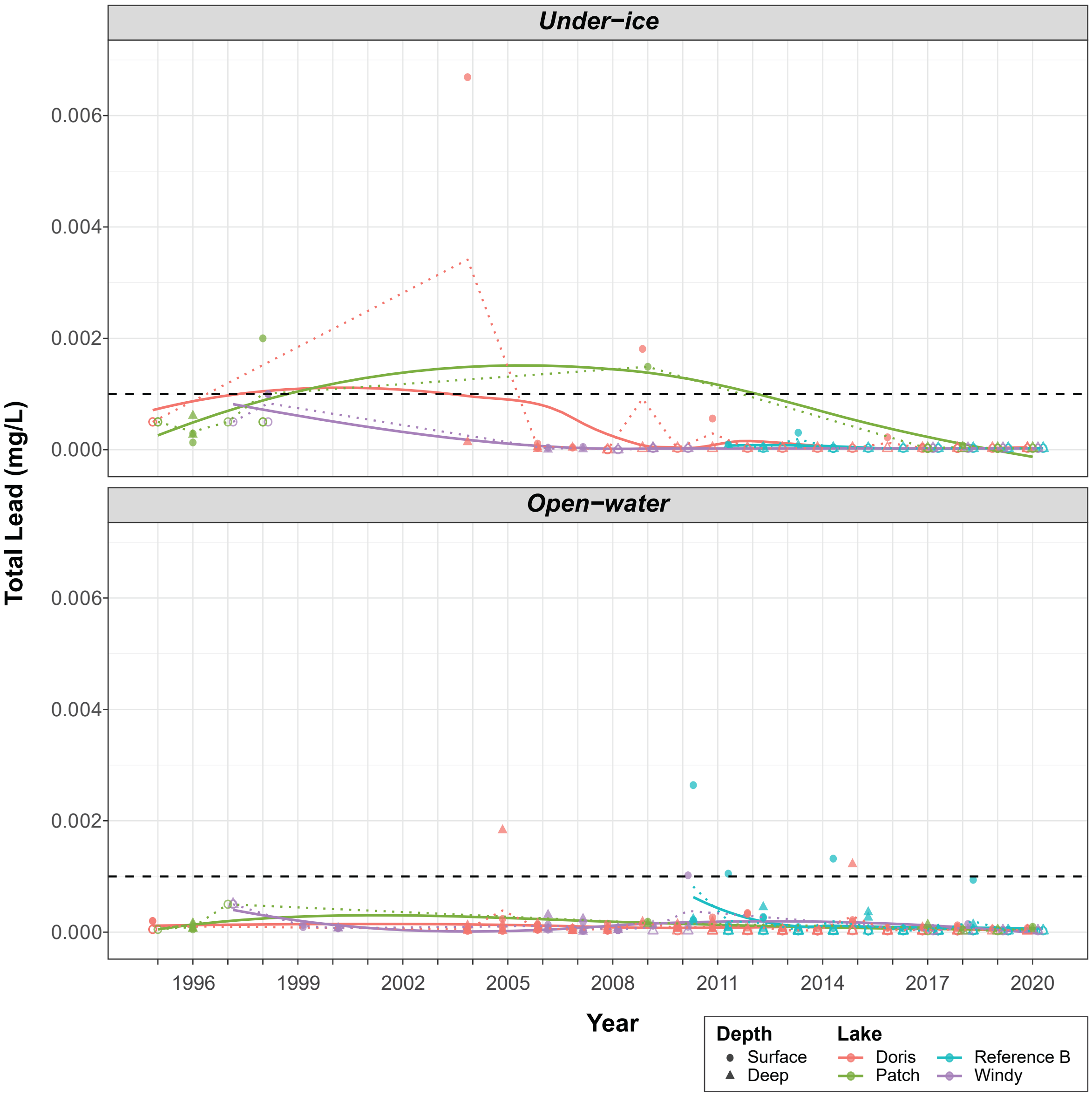
Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the minimum hardness-dependent CCME guideline for copper of 0.002 mg/L (for hardness as $CaCO_3$ of < 82 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-15: Total Copper Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME guideline for iron (0.3 mg/L).

Figure 3.3-16: Total Iron Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the minimum hardness-dependent CCME guideline for lead of 0.001 mg/L (for hardness as $CaCO_3$ of ≤ 60 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-17: Total Lead Concentrations in Lakes, Hope Bay Project, 1995 to 2020

3.3.18 Dissolved Manganese

Dissolved manganese was added to the list of evaluated water quality variables in 2020 due to the recent issuance of a CCME guideline for the protection of aquatic life for this variable (CCME 2019).

For the ice-covered season, the statistical analysis showed that there were no significant differences between the mean baseline and mean 2020 dissolved manganese concentrations in Windy Lake ($p = 0.933$) and Patch Lake ($p = 0.266$), and the fitted trend in dissolved manganese over time in Doris Lake was not significantly different from a slope of zero ($p = 0.695$). Under-ice dissolved manganese concentrations measured in Windy and Doris lakes in 2020 were consistent with baseline concentrations, while 2020 under-ice concentrations in Patch Lake were higher than the baseline range (Figure 3.3-18).

For the open-water season, dissolved manganese concentrations in all three exposure lakes were within the range of baseline concentrations. The before-after analysis showed that the mean baseline and mean 2020 concentrations in Windy Lake were not significantly different ($p = 0.453$); statistical analysis was not performed for Patch Lake open-water dissolved manganese concentrations because of the high proportion of censored data. In Doris Lake, the regression analysis showed that there was a significant non-zero slope in the fitted trend for dissolved manganese concentrations ($p < 0.0001$). A comparison of trends between Doris Lake and Reference Lake B could not be undertaken because of the high proportion of censored dissolved manganese concentrations in the reference lake dataset; however, there was no evidence that the non-zero trend in Doris Lake represented an increase in concentrations (Figure 3.3-18).

The variability between replicate dissolved manganese concentrations collected in Doris Lake in August 2020 was flagged in the QA/QC analysis (Appendix A; relative percent difference [RPD] of 44.6%) as exceeding the target RPD of 20%; however, the difference between replicates had a negligible effect on the evaluation of effects, as both concentrations were within the range of baseline concentrations.

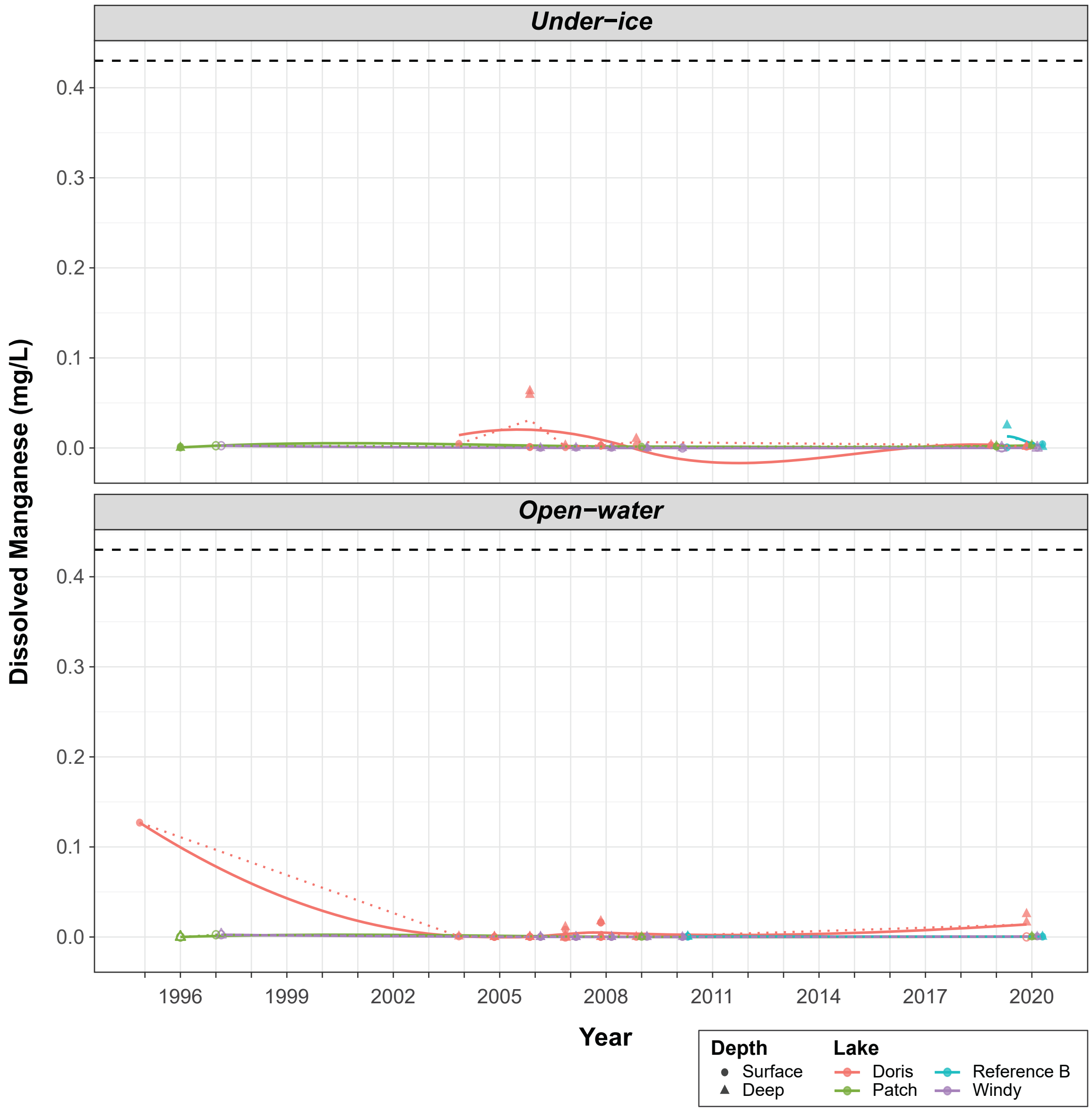
Overall, there was no evidence of an adverse change in dissolved manganese concentrations in any exposure lake due to the Project, and all dissolved manganese concentrations remained below the pH- and hardness-dependent CCME guideline as well as 75% of the benchmark concentrations. A low action level response was not triggered for dissolved manganese.

3.3.19 Total Mercury

Concentrations of total mercury in the exposure lakes were relatively consistent between 2007 and 2020, and variable prior to 2007 (Figure 3.3-19). All 2020 total mercury concentrations were within the range of baseline concentrations, and there was no apparent increase over time (Figure 3.3-19). Statistical analysis could not be performed for total mercury concentrations in Windy and Patch lakes because of the high proportion of censored data. For Doris Lake, the regression analysis showed that total mercury trends were not significantly different from a slope of zero ($p = 0.678$ for under ice, $p = 0.666$ for open water).

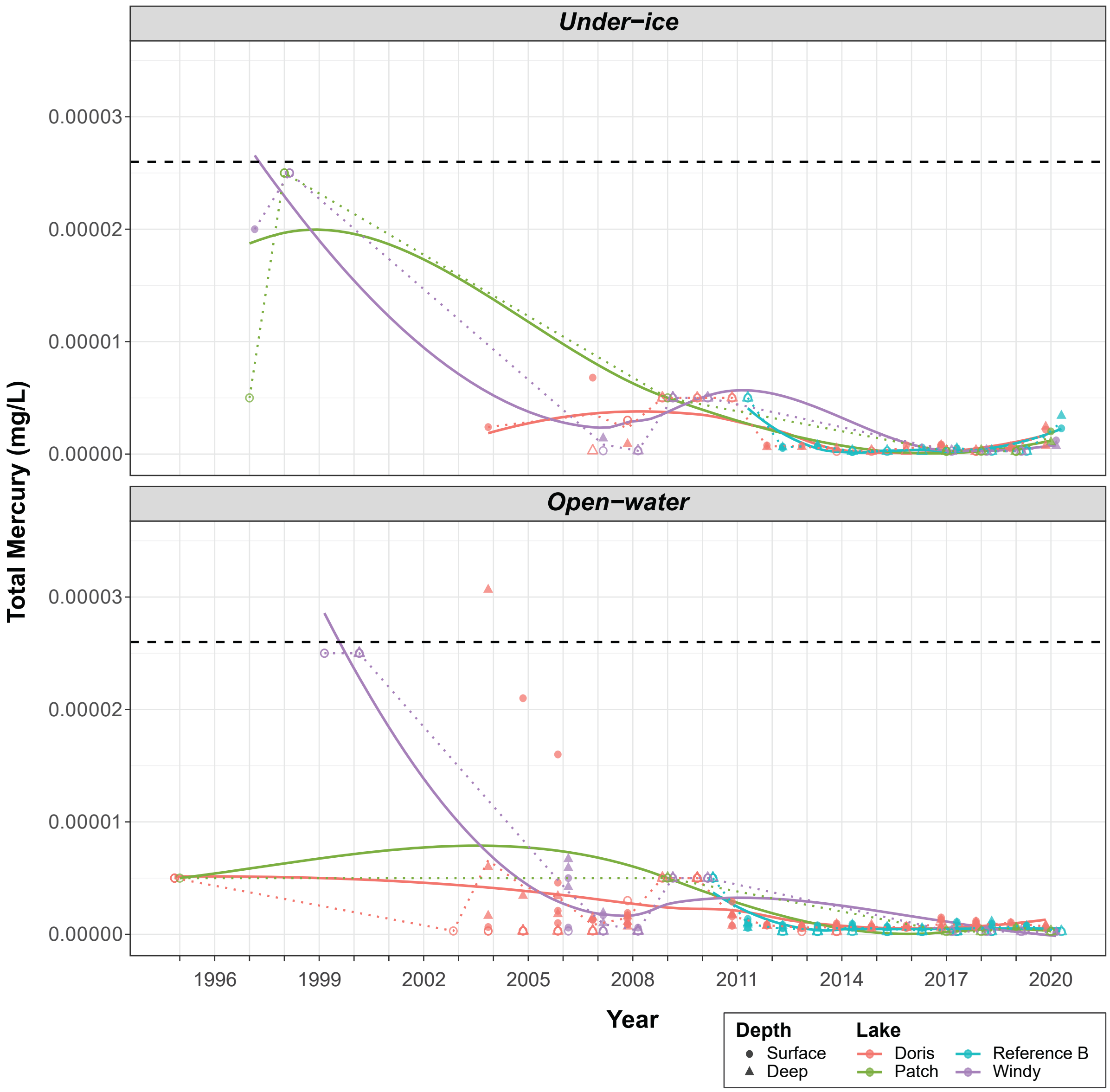
The total mercury concentrations in April blank samples were similar to the total mercury concentrations measured in exposure lake samples in April (Appendix A); however, there was no evidence of sample contamination as 2020 concentrations were not unusually high compared to historical concentrations. Therefore, potential mercury contamination likely had a negligible impact on the findings of the evaluation of effects.

Overall, there was no apparent Project effect on total mercury concentrations in the exposure lakes, and all concentrations were below the CCME guideline of 0.026 µg/L and 75% of the benchmark concentration. A low action level response was not triggered for total mercury.



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
The long-term CCME guideline for dissolved manganese is hardness- and pH-dependent; black dashed lines represent the dissolved manganese guideline of 0.43 mg/L for waters with a hardness of 50 mg $CaCO_3$/L and pH of 7.5.

Figure 3.3-18: Dissolved Manganese Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME guideline for mercury (0.000026 mg/L).

Figure 3.3-19: Total Mercury Concentrations in Lakes, Hope Bay Project, 1995 to 2020

3.3.20 Total Molybdenum

There were clear spatial differences in total molybdenum concentrations among the monitored lakes, with the highest concentrations in Windy Lake, lowest concentrations in Reference Lake B, and intermediate concentrations in Doris and Patch lakes (Figure 3.3-20). All 2020 total molybdenum concentrations in the monitored lakes remained below the CCME guideline of 0.073 mg/L.

In Windy and Patch lakes, both under-ice and open-water total molybdenum concentrations were relatively consistent over time (Figure 3.3-20), and the before-after analyses showed that baseline mean concentrations were not significantly different from 2020 means (Windy Lake: $p = 0.536$ for under ice, $p = 0.992$ for open water; Patch Lake: $p = 0.577$ for under ice, $p = 0.795$ for open water).

In Doris Lake, 2020 under-ice and open-water concentrations were within the range of baseline concentrations. However, for both the under-ice and open-water seasons, there was statistically significant non-zero trend over time ($p < 0.0001$ for under ice, $p = 0.0001$ for open water), with concentrations increasing slightly over time from baseline years to approximately 2017 or 2018 and decreasing in 2019 and 2020 (Figure 3.3-20). These trends could not be compared to the Reference Lake B trends because of the high proportion of concentrations that were below the detection limit in the reference lake dataset. Although the change in total molybdenum concentrations in Doris Lake is statistically significant, it is not considered to be an adverse change as 2020 concentrations remained within the baseline range for Doris Lake, and 2020 concentrations were more than 300 times lower than the CCME guideline for the protection of aquatic life. Total molybdenum concentrations observed in Doris Lake in 2020 were also more than three time lower than concentrations observed in Windy Lake and remained within the range of naturally occurring concentrations in Project area lakes (Figure 3.3-20).

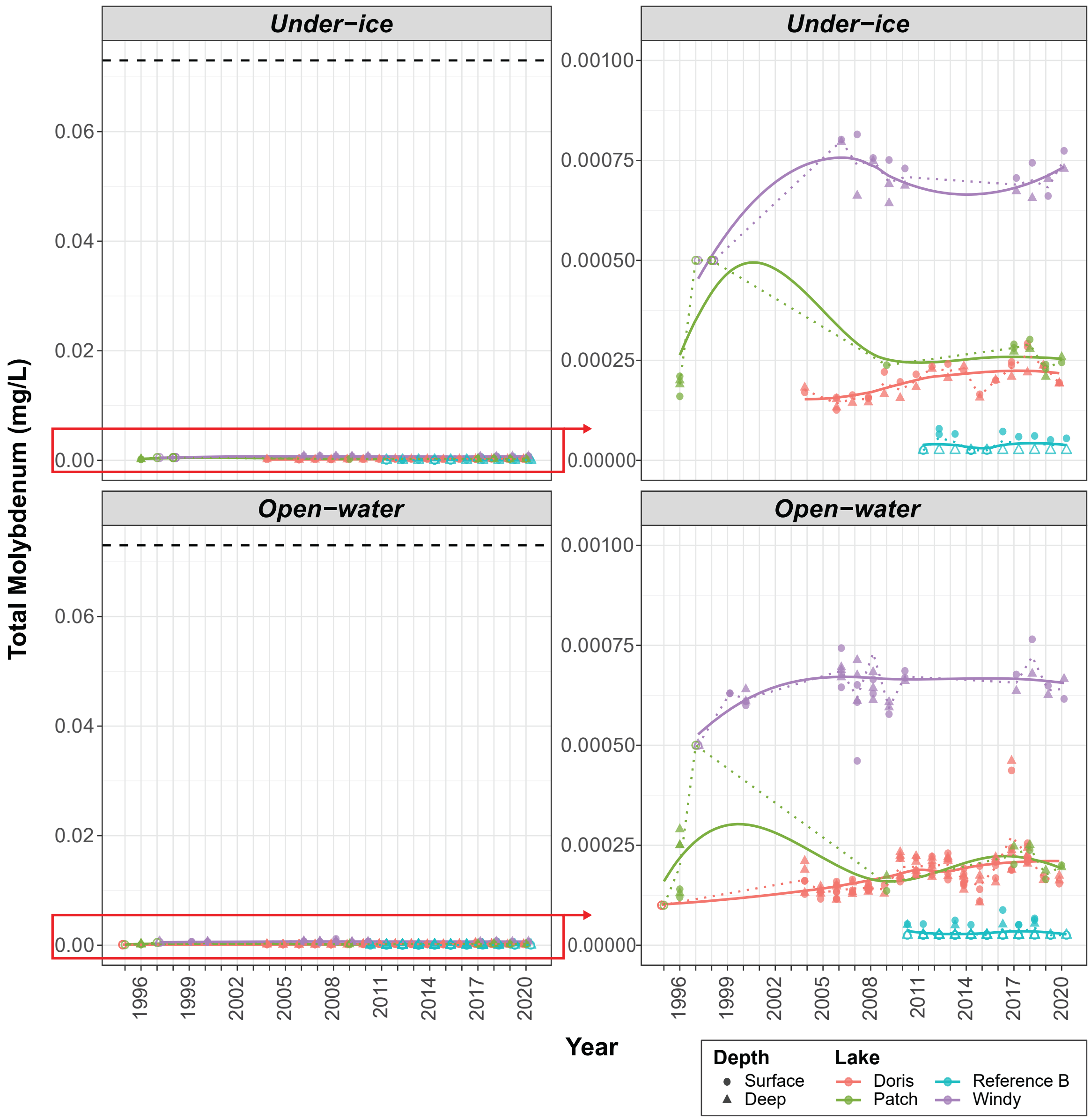
There was no adverse Project effect on total molybdenum concentrations in any exposure lake. A low action level response for molybdenum was not triggered since concentrations remained within the range of baseline concentrations and far below the low action level condition of 75% of the benchmark.

3.3.21 Total Nickel

Under-ice and open-water total nickel concentrations in Windy, Patch, and Doris lakes have changed little over time (Figure 3.3-21). This was confirmed by the statistical analyses, which showed that there were no significant differences between baseline and 2020 mean total nickel concentrations in Windy Lake ($p = 0.774$ for under ice, $p = 0.785$ for open water) and Patch Lake ($p = 0.520$ for under ice, $p = 0.790$ for open water), and the temporal trends in total nickel concentrations in Doris Lake were not significantly different from a slope of zero ($p = 0.403$ for under ice, $p = 0.262$ for open water). Thus, there was no indication that the Project adversely affected total nickel concentrations in the exposure lakes in 2020. All 2020 total nickel concentrations remained below the minimum hardness-dependent CCME guideline of 0.025 mg/L and 75% of the water quality benchmark and a low action level response for total nickel was not triggered.

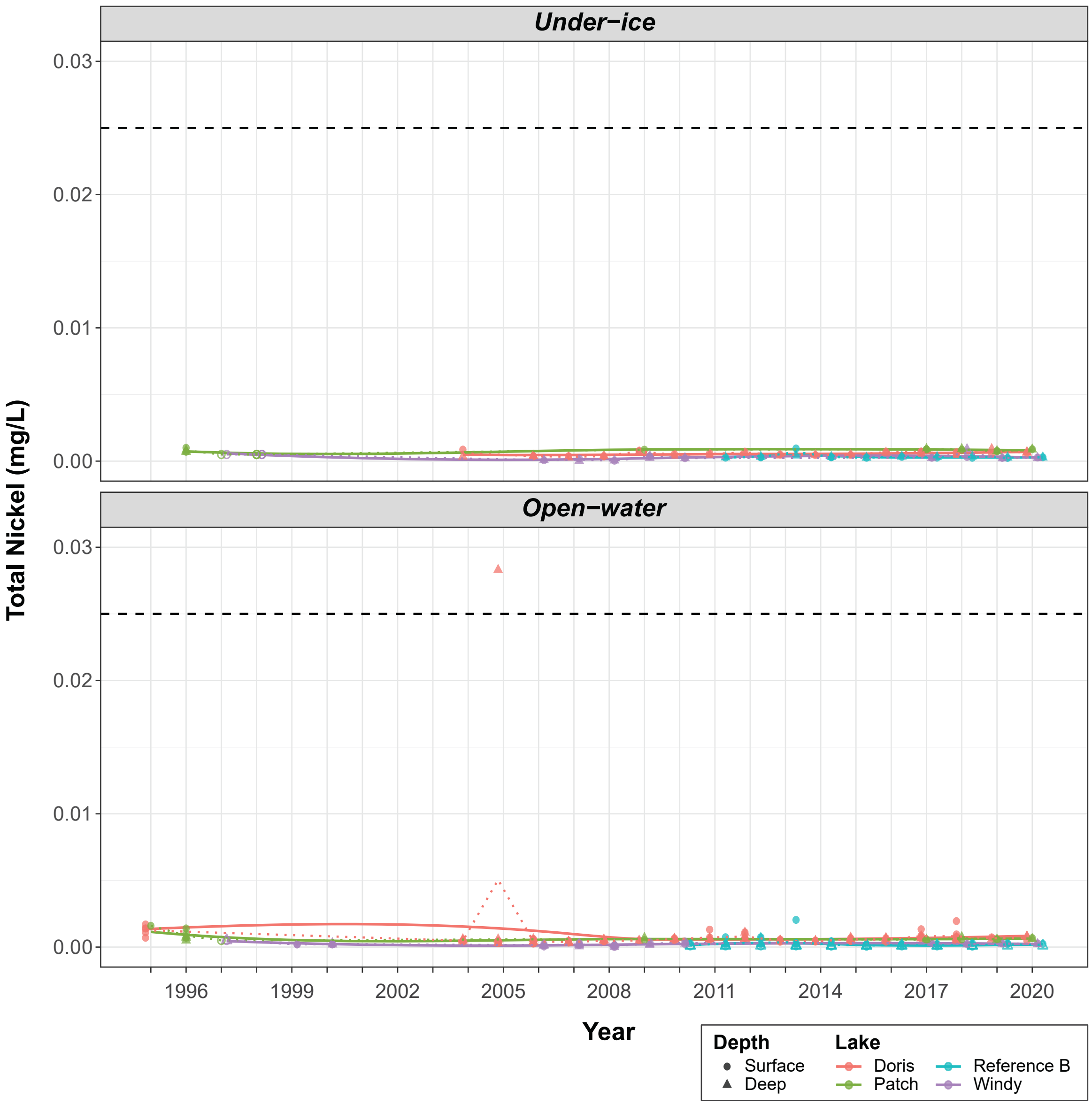
3.3.22 Total Selenium

All 2020 total selenium concentrations in Windy, Patch, and Doris lakes were below the analytical detection limit (< 0.00020 mg/L) and the CCME guideline of 0.001 mg/L (Figure 3.3-22). Statistical analysis of total selenium trends was not conducted; however, graphical analysis suggests that there was no increase in concentrations over time (Figure 3.3-22), and no evidence of a Project effect on total selenium concentrations in the exposure lakes. A low action level response for total selenium was not triggered.



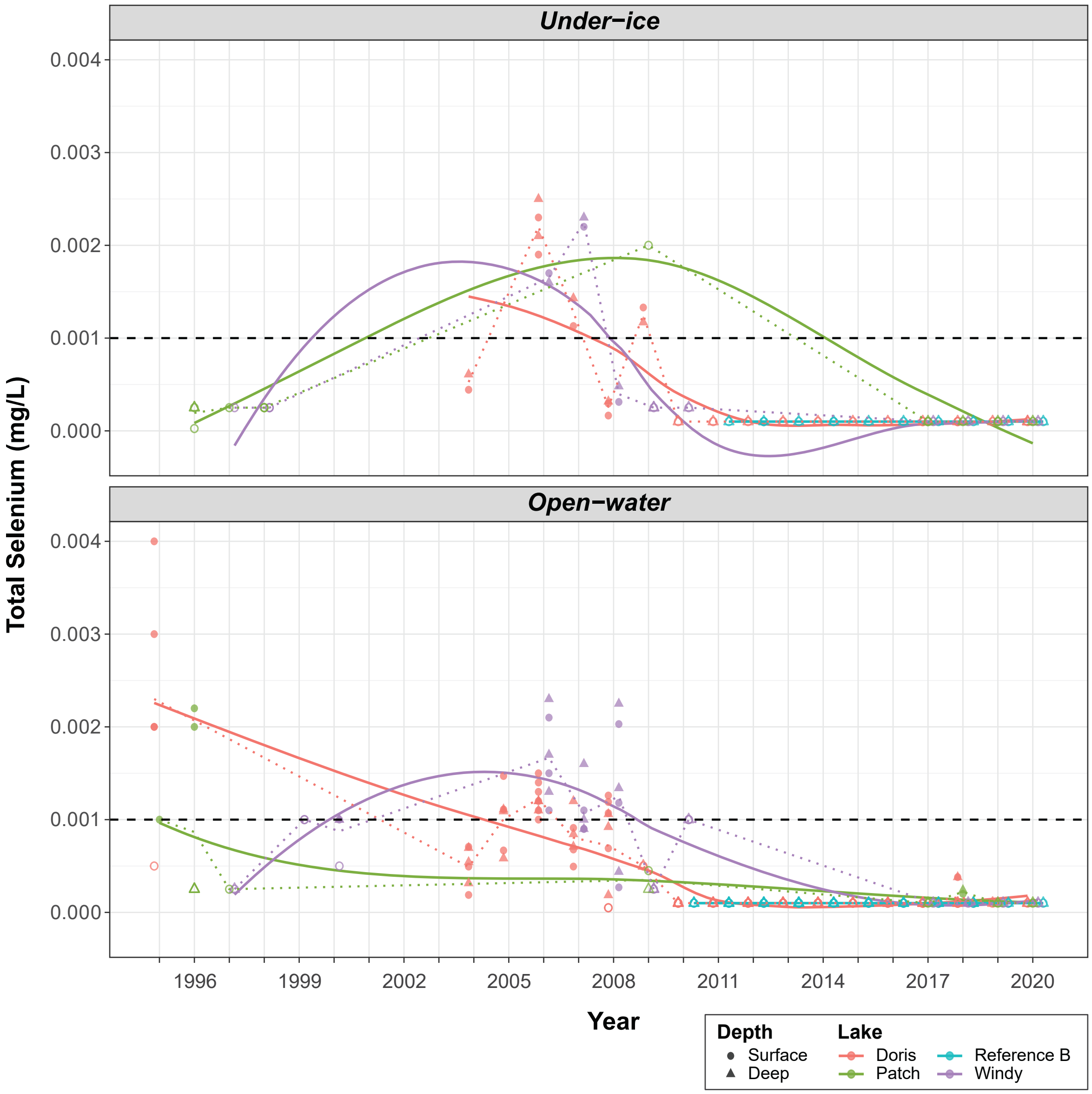
Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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 the CCME guideline.

Figure 3.3-20: Total Molybdenum Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the minimum hardness-dependent CCME guideline for nickel of 0.025 mg/L (for hardness as $CaCO_3$ of ≤ 60 mg/L); the CCME guideline increases with increasing hardness.

Figure 3.3-21: Total Nickel Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME guideline for selenium (0.001 mg/L).

Figure 3.3-22: Total Selenium Concentrations in Lakes, Hope Bay Project, 1995 to 2020

3.3.23 Total Silver

All 2020 total silver concentrations in Windy, Patch, and Doris lakes were below the analytical detection limit (< 0.000005 mg/L) and the CCME guideline of 0.00025 mg/L (Figure 3.3-23). Statistical analysis of total silver trends was not conducted; however, graphical analysis suggests that there was no increase in concentrations over time (Figure 3.3-23), and no evidence of a Project effect on total silver concentrations in the exposure lakes. A low action level response for total silver was not triggered.

3.3.24 Total Thallium

All 2020 total thallium concentrations in Windy, Patch, and Doris lakes were below the analytical detection limit (< 0.000005 mg/L or < 0.00005 mg/L) and the CCME guideline of 0.0008 mg/L (Figure 3.3-24). Statistical analysis of total thallium trends was not conducted; however, graphical analysis suggests that there was no increase in concentrations over time (Figure 3.3-24), and no evidence of a Project effect on total thallium concentrations in the exposure lakes. A low action level response for total thallium was not triggered.

3.3.25 Total Uranium

In Windy and Patch lakes, under-ice and open-water total uranium concentrations were relatively consistent over time (Figure 3.3-25), and the before-after analyses showed that baseline mean concentrations were not significantly different from 2020 means (Windy Lake: $p = 0.593$ for under ice, $p = 0.119$ for open water; Patch Lake: $p = 0.847$ for under ice, $p = 0.788$ for open water).

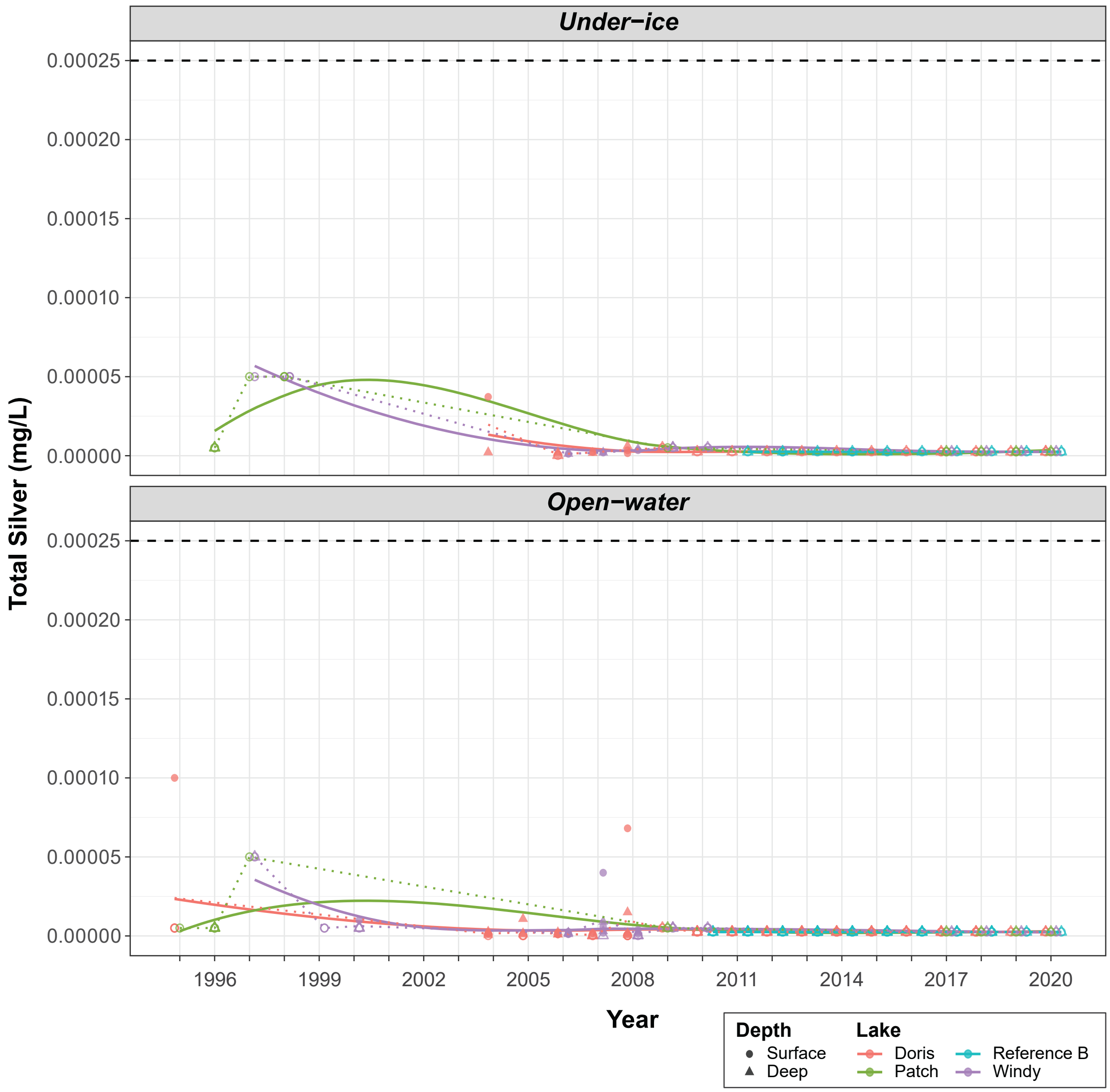
In Doris Lake, under-ice and open-water concentrations of total uranium were variable over time (Figure 3.3-25), and the regression analysis showed that there was a statistically significant non-zero trend in total uranium concentrations ($p < 0.0001$ for under ice, $p = 0.0027$ for open water). However, the comparison of total uranium trends between Doris Lake and Reference Lake B showed that the trends were similar over time, and there was no statistically significant difference in the trends between Doris Lake and Reference Lake B ($p = 0.268$ for under ice, $p = 0.876$ for open water).

All 2020 total uranium concentrations measured in exposure lakes were within the range of baseline concentrations, and below the CCME long-term guideline of 0.015 mg/L and 75% of the water quality benchmark. There was no evidence of a Project effect on total uranium concentrations in exposure lakes, and a low action level response was not triggered for this variable.

3.3.26 Dissolved Zinc

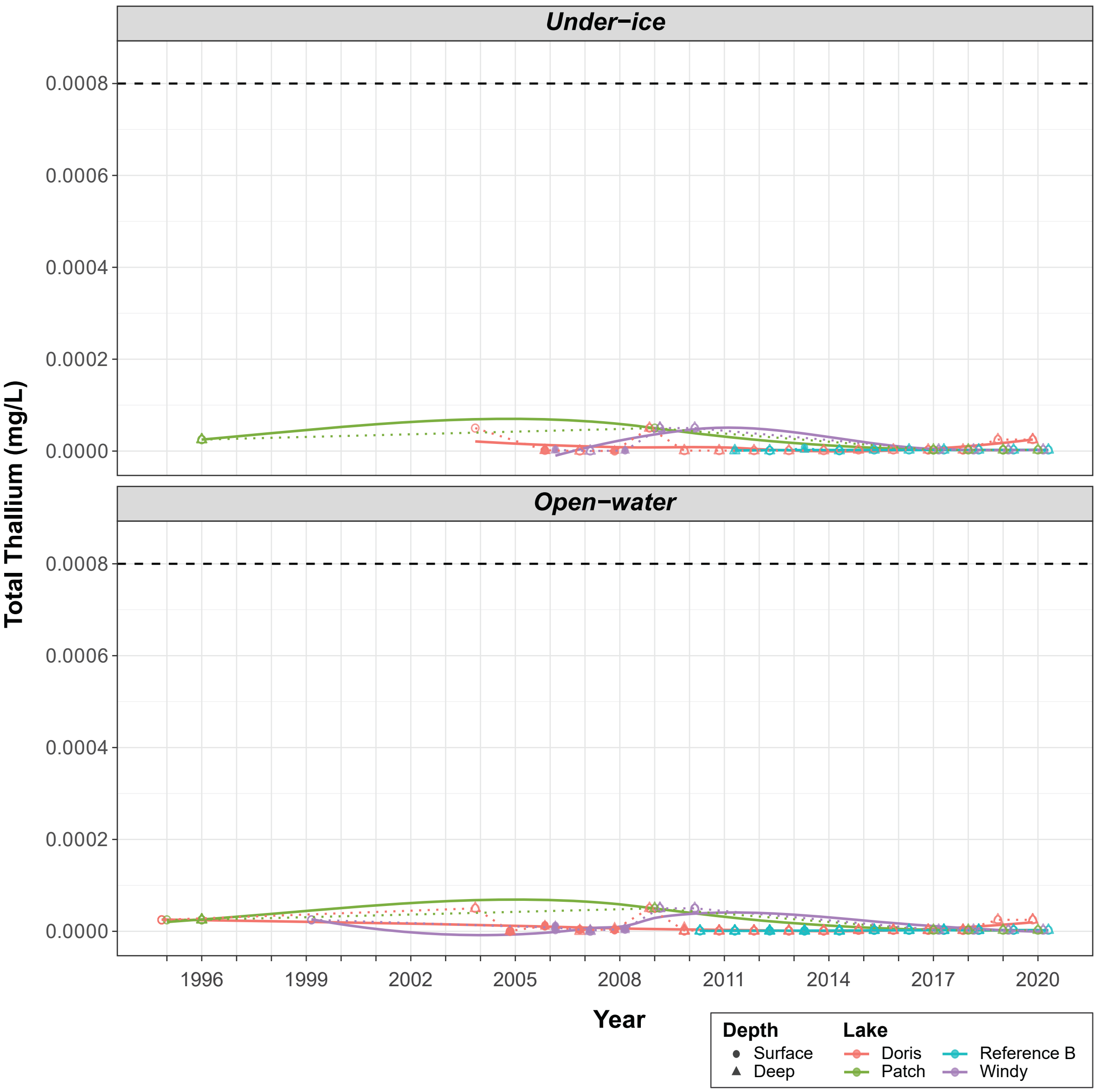
For the under-ice season, 2020 dissolved zinc concentrations were near or below the analytical detection limit in all exposure lakes, and within the range of baseline concentrations (Figure 3.3-26). Statistical analyses were not performed for Windy and Patch lakes because of the high proportion of censored data. For Doris Lake, the regression analysis showed that there was a statistically significant non-zero slope in the fitted trend of dissolved zinc concentrations over time ($p < 0.001$); however, this appears to be driven by higher and more variable baseline concentrations, and there was no evidence of an increase in concentrations over time (Figure 3.3-26).

The dissolved zinc concentration in the April field blank was similar to the dissolved zinc concentrations measured in exposure lake samples in April (Appendix A). However, there was no evidence of sample contamination as under-ice dissolved zinc concentrations in 2020 were within the range or lower than baseline concentrations. Therefore, potential dissolved zinc contamination likely had no impact on the findings of the evaluation of effects.



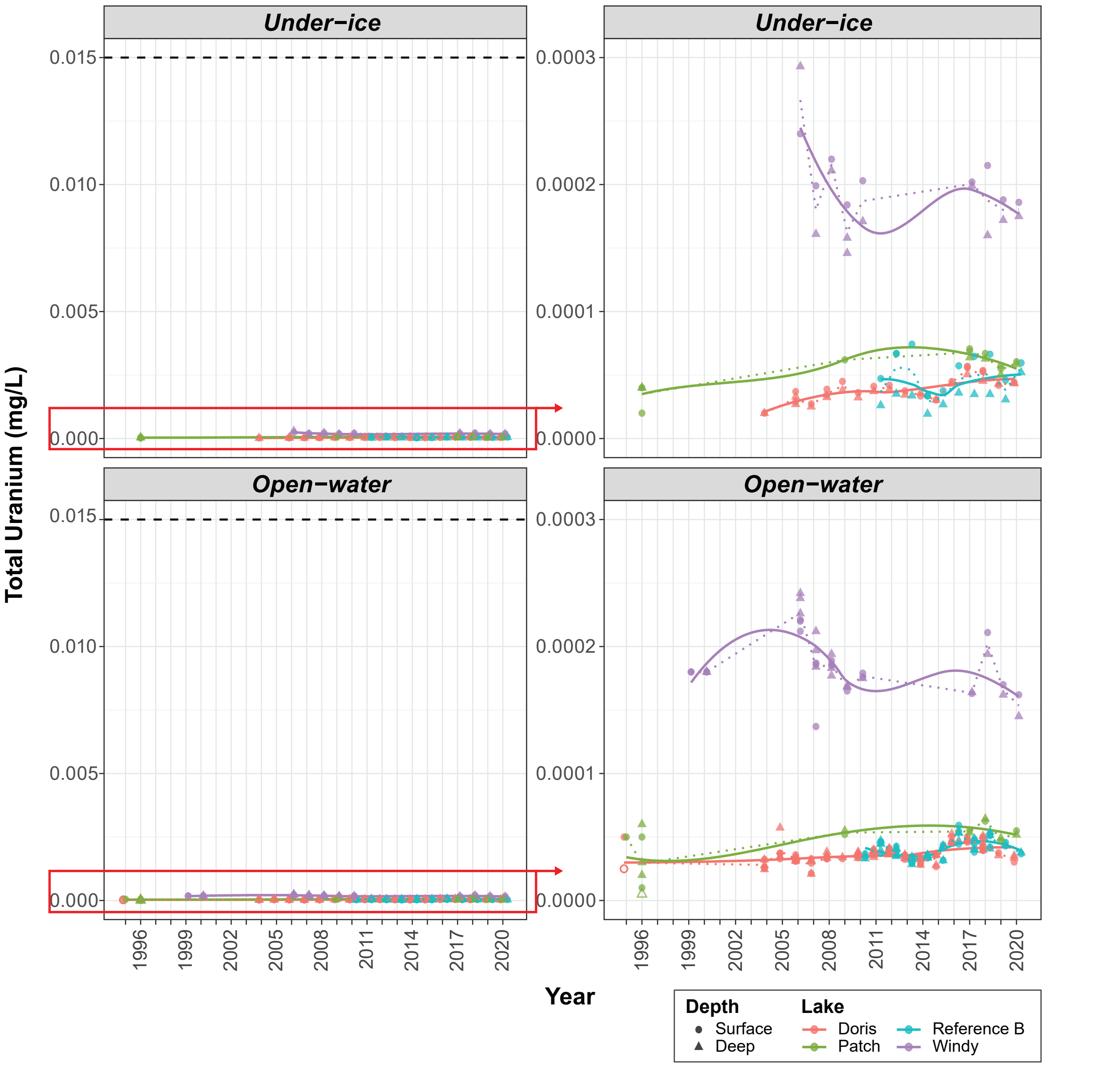
Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME long-term guideline for silver (0.00025 mg/L).

Figure 3.3-23: Total Silver Concentrations in Lakes, Hope Bay Project, 1995 to 2020



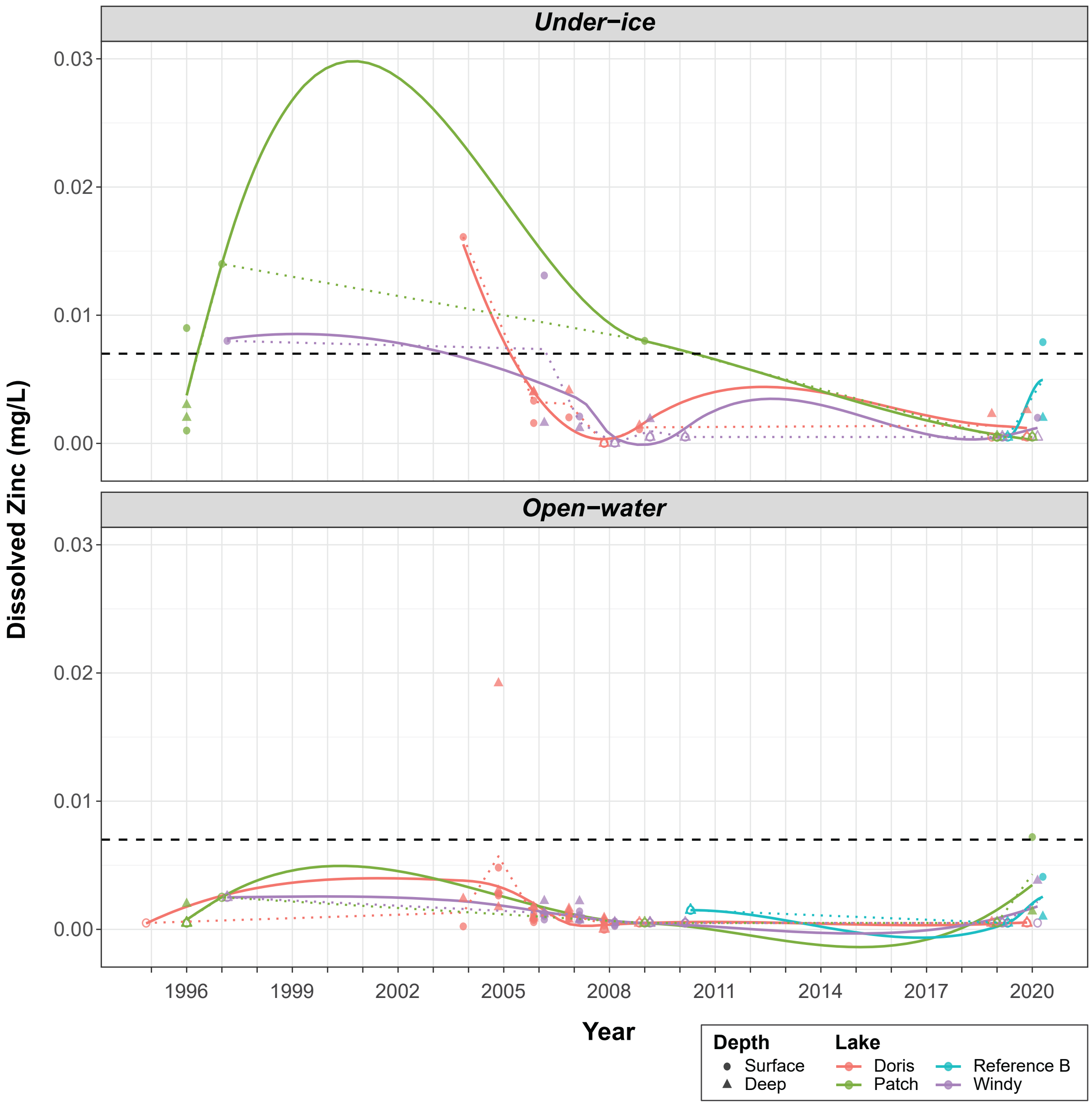
Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
Black dashed lines represent the CCME guideline for thallium (0.0008 mg/L).
1997 and 1998 concentrations below the unusually high detection limits of 0.1 and 0.2 were excluded from plots.

Figure 3.3-24: Total Thallium Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
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 the CCME guideline.

Figure 3.3-25: Total Uranium Concentrations in Lakes, Hope Bay Project, 1995 to 2020



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.
The long-term CCME guideline for dissolved zinc is hardness-, pH-, and dissolved organic carbon (DOC)-dependent; black dashed lines represent the dissolved zinc guideline of 0.007 mg/L for waters with a hardness of 50 mg $CaCO_3$/L, pH of 7.5, and DOC of 0.5 mg/L.

Figure 3.3-26: Dissolved Zinc Concentrations in Lakes, Hope Bay Project, 1995 to 2020

For the open-water season, all dissolved zinc concentrations in Doris Lake were below the detection limit and statistical analysis was not performed. In Windy and Patch lakes, one of two samples collected from each lake was higher than the baseline range; however, there was no apparent increasing trend in concentrations (Figure 3.3-26). A before-after analysis was not undertaken for concentrations in Patch Lake due to the high proportion of censored data; the statistical analysis for Windy Lake showed that the 2020 mean was not significantly different from the baseline mean ($p = 0.554$). Concentrations of dissolved zinc in Reference Lake B were also higher in 2020 compared to historical concentrations.

Overall, there was no evidence of a Project-related adverse change in dissolved zinc concentrations in Windy, Patch, or Doris lakes, and a low action level response for dissolved zinc was not triggered. All dissolved zinc concentrations were below the pH-, hardness- and dissolved organic carbon (DOC)-dependent CCME guideline and 75% of the water quality benchmark.

3.3.27 Water Quality Summary

Tables 3.3-1 to 3.3-3 provide summaries of the evaluation of effects for water quality for each exposure lake (Windy, Patch, and Doris lakes, respectively). The conclusions of the AEMP evaluation of effects feed into the Response Framework to identify potential Project effects that may require management action to prevent adverse environmental consequences. Table 3.3-4 presents a summary of the screening of the results of the evaluation of effects against the conditions that must be met to trigger a ‘low action level’ response under the Response Framework (as described in Section 2.2.3.1).

The evaluation of effects concluded that there were no Project-related changes in water quality in 2020 in both Windy (Table 3.3-1) and Patch lakes (Table 3.3-2). There was a potential Project-related increase in open-water turbidity in Doris Lake (Table 3.3-3); however, a low action level response was not triggered because the regression analysis showed that the apparent increasing trend in turbidity was not statistically significant (Table 3.3-4). At least one condition was not met for each evaluated lake/season/variable combination; therefore, no low action level responses were triggered for water quality during the 2020 assessment year (Table 3.3.4).

The FEIS water and load balance model predicted that some water quality variables could increase relative to baseline level during Project construction or operations phases; however, concentrations of water quality variables were not predicted to exceed water quality thresholds (TMAC 2017b). Variables that were predicted to increase relative to baseline levels included total mercury in Patch and Windy lakes during operations, and nearly all assessed variables (including total suspended solids) in Doris Creek during construction and operations (Doris Lake was not included as an assessment node in the water and load balance model as Doris Lake Outflow [TL-2] was included; TMAC 2017b). In 2020, there were no statistically significant Project-related increases in the concentrations of water quality variables beyond baseline ranges in Windy, Patch, and Doris lakes.

3.4 Phytoplankton Biomass

Phytoplankton are important primary producers in lakes, and phytoplankton biomass levels are estimated using the main photosynthetic pigment, chlorophyll *a*. Changes in chlorophyll *a* concentrations over time can be used as an indicator of changes in water quality and ecosystem health. The introduction of nutrients (e.g., phosphorus and nitrogen) through site runoff into lakes near Project infrastructure or activities could lead to increased primary production, while increases in certain water quality variables such as TSS, turbidity, or heavy metals could cause a decrease in primary production.

Table 3.3-1: Summary of Evaluation of Effects for Windy Lake Water Quality, Hope Bay Project, 2020

Variable	Statistical Analysis: BA or BACI Analysis				Graphical Analysis/Interpretation		Conclusion of Effect [c]	
	Under-ice		Open-water		Evidence of an Adverse [b] Change?			
	Within Lake Before-After Change (BA Analysis)? [a]	Difference in Before-After Trend Relative to Reference Lake (BACI Analysis)? [a]	Within Lake Before-After Change (BA Analysis)? [a]	Difference in Before-After Trend Relative to Reference Lake (BACI Analysis)? [a]	Under-ice	Open-water	Under-ice	Open-water
pH	No	☐	No	☐	No	No	No effect	No effect
Total Suspended Solids	◆	◆	◆	◆	No	No	No effect	No effect
Turbidity	No	☐	No	☐	No	No	No effect	No effect
Chloride	No	☐	No	☐	No	No	No effect	No effect
Fluoride	No	☐	No	☐	No	No	No effect	No effect
Total Ammonia	No	☐	No	☐	No	No	No effect	No effect
Nitrate	◆	◆	◆	◆	No	No	No effect	No effect
Nitrite	◆	◆	◆	◆	No	No	No effect	No effect
Total Phosphorus	No	☐	No	☐	No	No	No effect	No effect
Total Aluminum	No	☐	No	☐	No	No	No effect	No effect
Total Arsenic	No	☐	No	☐	No	No	No effect	No effect
Total Boron	No	☐	No	☐	No	No	No effect	No effect
Total Cadmium	◆	◆	◆	◆	No	No	No effect	No effect
Total Chromium	◆	◆	◆	◆	No	No	No effect	No effect
Total Copper	No	☐	No	☐	No	No	No effect	No effect
Total Iron	◆	◆	No	☐	No	No	No effect	No effect
Total Lead	◆	◆	◆	◆	No	No	No effect	No effect
Dissolved Manganese	No	☐	No	☐	No	No	No effect	No effect
Total Mercury	◆	◆	◆	◆	No	No	No effect	No effect
Total Molybdenum	No	☐	No	☐	No	No	No effect	No effect
Total Nickel	No	☐	No	☐	No	No	No effect	No effect
Total Selenium	◆	◆	◆	◆	No	No	No effect	No effect
Total Silver	◆	◆	◆	◆	No	No	No effect	No effect
Total Thallium	◆	◆	◆	◆	No	No	No effect	No effect
Total Uranium	No	☐	No	☐	No	No	No effect	No effect
Dissolved Zinc	◆	◆	No	☐	No	No	No effect	No effect

Notes:
BA = Before-After, BACI = Before-After/Control-Impact
[a] Statistically significant difference at $p < 0.05$
[b] For pH, any deviation from baseline levels is considered to be an adverse effect; for all remaining variables, only an increase from baseline levels is considered to be an adverse effect.
[c] Conclusion of effect is based on statistical analysis, graphical analysis, comparison to normal baseline range, 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 between before and after periods.

Table 3.3-2: Summary of Evaluation of Effects for Patch Lake Water Quality, Hope Bay Project, 2020

Variable	Statistical Analysis: BA or BACI Analysis				Graphical Analysis/Interpretation		Conclusion of Effect [c]	
	Under-ice		Open-water		Evidence of an Adverse [b] Change?			
	Within Lake Before-After Change (BA Analysis)? [a]	Difference in Before-After Trend Relative to Reference Lake (BACI Analysis)? [a]	Within Lake Before-After Change (BA Analysis)? [a]	Difference in Before-After Trend Relative to Reference Lake (BACI Analysis)? [a]	Under-ice	Open-water	Under-ice	Open-water
pH	No	☐	No	☐	No	No	No effect	No effect
Total Suspended Solids	◆	◆	No	☐	No	No	No effect	No effect
Turbidity	No	☐	No	☐	No	No	No effect	No effect
Chloride	No	☐	No	☐	No	No	No effect	No effect
Fluoride	No	☐	No	☐	No	No	No effect	No effect
Total Ammonia	No	☐	◆	◆	No	No	No effect	No effect
Nitrate	No	☐	◆	◆	No	No	No effect	No effect
Nitrite	◆	◆	◆	◆	No	No	No effect	No effect
Total Phosphorus	No	☐	No	☐	No	No	No effect	No effect
Total Aluminum	No	☐	No	☐	No	No	No effect	No effect
Total Arsenic	No	☐	No	☐	No	No	No effect	No effect
Total Boron	No	☐	No	☐	No	No	No effect	No effect
Total Cadmium	◆	◆	◆	◆	No	No	No effect	No effect
Total Chromium	◆	◆	◆	◆	No	No	No effect	No effect
Total Copper	No	☐	No	☐	No	No	No effect	No effect
Total Iron	No	☐	No	☐	No	No	No effect	No effect
Total Lead	◆	◆	No	☐	No	No	No effect	No effect
Dissolved Manganese	No	☐	◆	◆	No	No	No effect	No effect
Total Mercury	◆	◆	◆	◆	No	No	No effect	No effect
Total Molybdenum	No	☐	No	☐	No	No	No effect	No effect
Total Nickel	No	☐	No	☐	No	No	No effect	No effect
Total Selenium	◆	◆	◆	◆	No	No	No effect	No effect
Total Silver	◆	◆	◆	◆	No	No	No effect	No effect
Total Thallium	◆	◆	◆	◆	No	No	No effect	No effect
Total Uranium	No	☐	No	☐	No	No	No effect	No effect
Dissolved Zinc	◆	◆	◆	◆	No	No	No effect	No effect

Notes:
BA = Before-After, BACI = Before-After/Control-Impact
[a] Statistically significant difference at $p < 0.05$
[b] For pH, any deviation from baseline levels is considered to be an adverse effect; for all remaining variables, only an increase from baseline levels is considered to be an adverse effect.
[c] Conclusion of effect is based on statistical analysis, graphical analysis, comparison to normal baseline range, 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 between before and after periods.

Table 3.3-3: Summary of Evaluation of Effects for Doris Lake Water Quality, Hope Bay Project, 2020

Variable	Statistical Analysis: Linear Mixed Model or Tobit Regression				Graphical Analysis/Interpretation		Conclusion of Effect [c]	
	Under-ice		Open-water		Evidence of an Adverse [b] Change?			
	Different from slope 0? [a]	Different from Reference Lake B slope? [a]	Different from slope 0? [a]	Different from Reference Lake B slope? [a]	Under-ice	Open-water	Under-ice	Open-water
pH	Yes	No	Yes	Yes	No	No	No effect	No effect
Total Suspended Solids	Yes	◆	No	☐	No	No	No effect	No effect
Turbidity	No	☐	No	☐	No	Yes	No effect	Possible effect
Chloride	Yes	Yes	Yes	Yes	No	No	No effect	No effect
Fluoride	No	☐	No	☐	No	No	No effect	No effect
Total Ammonia	No	☐	No	☐	No	No	No effect	No effect
Nitrate	Yes	Yes	◆	◆	No	No	No effect	No effect
Nitrite	◆	◆	◆	◆	No	No	No effect	No effect
Total Phosphorus	No	☐	No	☐	No	No	No effect	No effect
Total Aluminum	No	☐	No	☐	No	No	No effect	No effect
Total Arsenic	Yes	No	Yes	No	No	No	No effect	No effect
Total Boron	Yes	◆	Yes	◆	No	No	No effect	No effect
Total Cadmium	◆	◆	◆	◆	No	No	No effect	No effect
Total Chromium	◆	◆	◆	◆	No	No	No effect	No effect
Total Copper	No	☐	No	☐	No	No	No effect	No effect
Total Iron	◆	◆	Yes	◆	No	No	No effect	No effect
Total Lead	◆	◆	No	☐	No	No	No effect	No effect
Dissolved Manganese	No	☐	Yes	◆	No	No	No effect	No effect
Total Mercury	No	☐	No	☐	No	No	No effect	No effect
Total Molybdenum	Yes	◆	Yes	◆	No	No	No effect	No effect
Total Nickel	No	☐	No	☐	No	No	No effect	No effect
Total Selenium	◆	◆	◆	◆	No	No	No effect	No effect
Total Silver	◆	◆	◆	◆	No	No	No effect	No effect
Total Thallium	◆	◆	◆	◆	No	No	No effect	No effect
Total Uranium	Yes	No	Yes	No	No	No	No effect	No effect
Dissolved Zinc	Yes	◆	◆	◆	No	No	No effect	No effect

Notes:

[a] *Statistically significant difference at $p < 0.05$*

[b] *For pH, any deviation from baseline levels is considered to be an adverse effect; for all remaining variables, only an increase from baseline levels is considered to be an adverse effect.*

[c] *Conclusion of effect is based on statistical analysis, graphical analysis, comparison to normal baseline range, and professional judgment.*

Diamond (◆) indicates that statistical analysis was not possible because of the high proportion of censored data, or in the case of dissolved manganese, too few data points to fit the model.

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.

Table 3.3-4: Comparison of Water Quality to Response Framework Conditions for Triggering a Low Action Level Response, Hope Bay Project, 2020

Exposure Lake:	Windy Lake			Windy Lake			Patch Lake			Patch Lake			Doris Lake			Doris Lake			Low Action Level Response Triggered for Any Lake?
Season:	Under-ice			Open-water			Under-ice			Open-water			Under-ice			Open-water			
Conditions for Low Action Level Response:	Conditions Met	Conditions Not Met	Conditions Not Evaluated [a]	Conditions Met	Conditions Not Met	Conditions Not Evaluated [a]	Conditions Met	Conditions Not Met	Conditions Not Evaluated [a]	Conditions Met	Conditions Not Met	Conditions Not Evaluated [a]	Conditions Met	Conditions Not Met	Conditions Not Evaluated [a]	Conditions Met	Conditions Not Met	Conditions Not Evaluated [a]	
Water Quality Variable																			
pH		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Total Suspended Solids		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Turbidity		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	2 (↑), 3	1	4	No
Chloride	3	1, 2	4	3	1, 2	4	3	1, 2	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Fluoride	3	1, 2	4		1, 2, 3	4	3	1, 2	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Total Ammonia		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Nitrate		2, 3	1, 4		2, 3	1, 4		1, 2, 3	4		2, 3	1, 4		1, 2, 3	4		2, 3	1, 4	No
Nitrite		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4	2 (↑)	3	1, 4		2, 3	1, 4	No
Total Phosphorus		1, 2	3, 4		1, 2	3, 4		1, 2	3, 4		1, 2	3, 4		1, 2	3, 4	2 (↓)	1	3, 4	No
Total Aluminum		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	3	1, 2	4		1, 2, 3	4		1, 2, 3	4	No
Total Arsenic		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	2 (↓)	1, 3	4		1, 2, 3	4	No
Total Boron		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Total Cadmium		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4	No
Total Chromium		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4	No
Total Copper		1, 2, 3	4		1, 2, 3	4	3	1, 2	4		1, 2, 3	4	3	1, 2	4	3	1, 2	4	No
Total Iron		2, 3	1, 4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		2, 3	1, 4		1, 2, 3	4	No
Total Lead		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		1, 2, 3	4		2, 3	1, 4		1, 2, 3	4	No
Dissolved Manganese		1, 2, 3	4		1, 2, 3	4	2 (↑)	1, 3	4		2, 3	1, 4		1, 2, 3	4		1, 2, 3	4	No
Total Mercury		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		1, 2, 3	4		1, 2, 3	4	No
Total Molybdenum		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Total Nickel		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Total Selenium		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4	2 (↓)	3	1, 4		2, 3	1, 4	No
Total Silver		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4	No
Total Thallium		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4		2, 3	1, 4	No
Total Uranium		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4		1, 2, 3	4	No
Dissolved Zinc		2, 3	1, 4	2 (↑)	1, 3	4		2, 3	1, 4	2 (↑)	3	1, 4		1, 2, 3	4		2, 3	1, 4	No

Notes:
Condition 1: identification of a statistically significant and potentially adverse change from baseline conditions.
Condition 2: the concentration of the water quality variable is outside of the normal range based on baseline concentration.
Condition 3: the concentration of the water quality variable exceeds 75% of a benchmark.
Condition 4: if a potentially adverse change is detected at the exposure site, the absence of a similar change at the reference site.
↑ and ↓ indicate that at least one replicate concentration was higher or lower that the baseline range, respectively. For Windy Lake, baseline data were from 1997 to 2018; for Patch Lake, baseline data were from 1995 to 2018; for Doris Lake, baseline data were from 1995 to 2009.
[a] Condition was not evaluated either because it was not necessary (i.e., at least one other condition was not met), or because there was not enough information for the evaluation (e.g., because of high proportion of censored data or absence of a water quality benchmark).

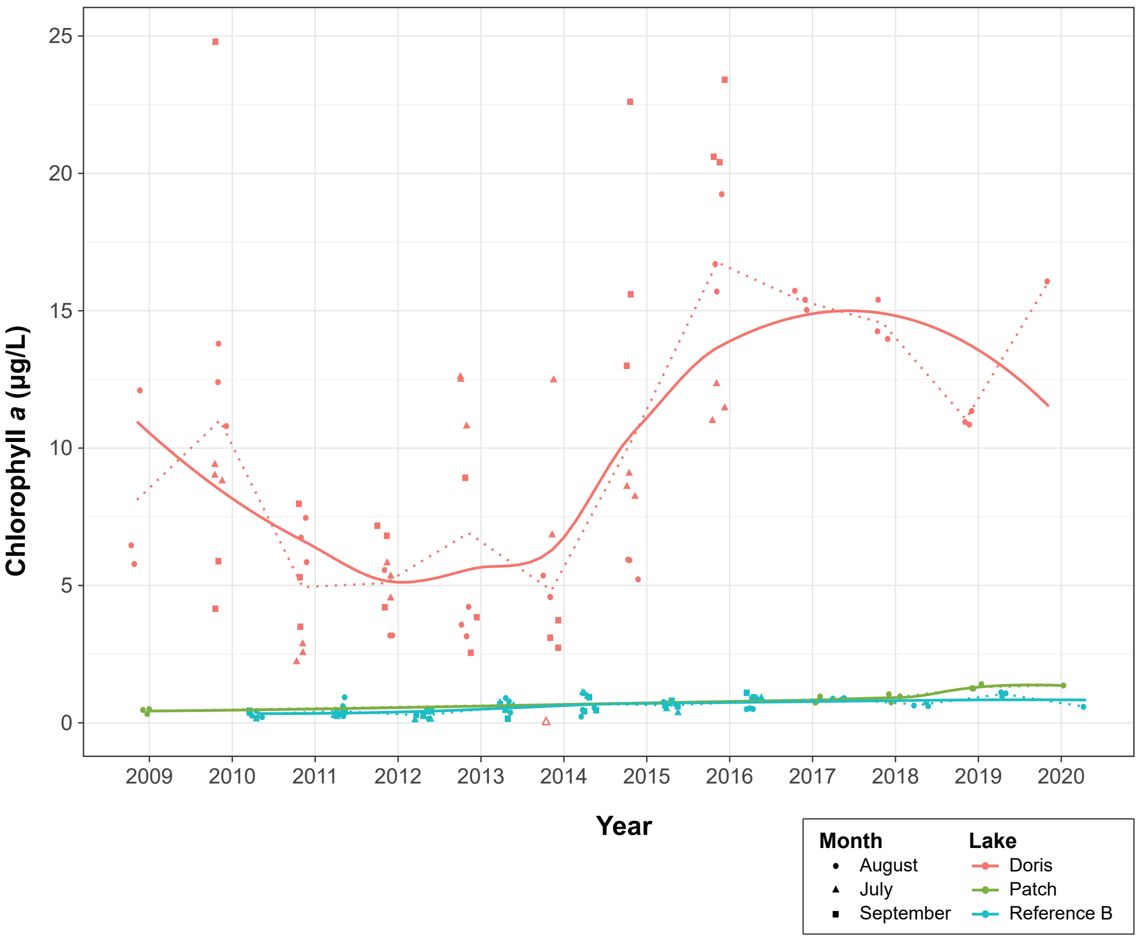
In August 2020, chlorophyll *a* samples were collected from the surface waters of two exposure lake sites (Doris Lake and Patch Lake) and one reference lake site (Reference Lake B) to estimate phytoplankton biomass levels. Due to a sampling error, only one sample was collected in the surface waters of each lake instead of three replicate samples; therefore, there is a higher level of uncertainty associated with the 2020 biomass levels compared to previous years. For Patch Lake, phytoplankton biomass data collected between 2009 and 2018 are considered to represent baseline conditions prior to the start to Madrid North construction activities in 2019. For Doris Lake, phytoplankton biomass data collected in 2009 are considered to represent baseline conditions prior to the start of Doris construction activities in 2010. Statistical and graphical analyses were used to determine if there were changes in phytoplankton biomass over time or in 2020 specifically 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.

Phytoplankton biomass data collected in 2020 are presented in Appendix A, and all statistical analysis results are presented in Appendix C.

3.4.1 Phytoplankton Biomass as Chlorophyll a

Chlorophyll *a* concentrations were markedly higher in Doris Lake than in either Patch Lake or Reference Lake B between 2009 and 2020 (Figure 3.4-1). Phytoplankton biomass was highly inter- and intra-annually variable in Doris Lake. Between 2009 and 2020, mean monthly chlorophyll *a* concentrations in Doris Lake 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 open-water season chlorophyll *a* concentrations ranged from 4.8 µg chl *a*/L (2014) to 16.8 µg chl *a*/L (2016). The 2020 August concentration of 16.1 µg chl *a*/L was at the higher end of the range of mean monthly and annual concentrations, and higher than concentrations measured during the single baseline year (2009; Figure 3.4-1).

The statistical analysis of phytoplankton biomass in Doris Lake indicated that the trend in chlorophyll *a* concentrations over time was significantly different from a slope of zero ($p < 0.0001$), and significantly different from the chlorophyll *a* trend in Reference Lake B ($p = 0.0149$). However, the 2009 to 2020 trend in biomass exhibits an oscillating or cyclical pattern over a decadal time scale rather than an increase or decrease over time (Figure 3.4-1). Mean annual chlorophyll *a* concentrations reached a minimum between 2012 and 2014, increased to a peak in 2016, and declined steadily from 2016 to 2019. The 2020 concentration of 16.1 µg chl *a*/L was an increase from recent years, which may represent a departure from the cyclical pattern. A Project-related increase in phytoplankton biomass would be expected to result from increased nutrient inputs to the lake; however, total phosphorus, nitrate, ammonia concentrations have been relatively constant over time, and 2020 nutrient concentrations were similar to baseline concentrations (Sections 3.3.6, 3.3.7, 3.3.9). Another explanation for the relatively high chlorophyll *a* concentration in 2020 in Doris Lake was the stronger than usual thermal stratification and higher water temperatures observed in August 2020 compared to previous years (Section 3.2.2). When the water column is stratified, surface phytoplankton biomass tends to be higher because phytoplankton spend more time in the well lit surface waters where high light levels stimulate photosynthesis. Conversely, in a well-mixed water column, phytoplankton are mixed vertically through the water column and spend relatively less time in a light regime that is optimal for growth and more time in deeper waters where light levels are reduced. Phytoplankton biomass has also been shown to increase with water temperature (Striebel et al. 2016), and August 2020 water temperatures in the upper 10 m of the water column were approximately 3 to 4°C warmer than the 2009 baseline year (i.e., the only baseline year for phytoplankton biomass; Figure 3.2-3b). Because nutrient levels did not increase in 2020, it is likely that phytoplankton biomass in Doris Lake in 2020 were at the upper end of the historical range and higher than baseline levels as a result of non-Project-related changes in temperature and stratification (Section 3.2.2). A Project-related increase in phytoplankton biomass would likely occur as a result of increased nutrient inputs from runoff of contact water. However, since there was no observed change in nutrients, the relatively high biomass in Doris Lake is likely a natural phenomenon related to water temperature and stratification.



Notes: Observations are slightly jittered along the x-axis for legibility.
Open symbols represent values below analytical detection limits, which are plotted at half the detection limit.
Dotted lines drawn through the scatter plots represent the annual means.
Solid lines drawn through the scatter plots represent LOESS smoothing curves.

Figure 3.4-1: Phytoplankton Biomass (as Chlorophyll *a*) in Lakes, Hope Bay Project, 2009 to 2020

Chlorophyll *a* concentrations in Patch Lake were generally consistent over time, and similar to those in Reference Lake B (annual means ranging from 0.43 to 1.36 µg chl *a*/L in Patch Lake and 0.27 to 1.05 µg chl *a*/L in Reference Lake B; Appendix C and Figure 3.4-1). Although the 2020 biomass of 1.36 µg chl *a*/L in Patch Lake was higher than the baseline range, the before-after analysis showed that the mean baseline and 2020 concentration were not significantly different ($p = 0.286$).

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 measured in the study lakes corresponds closely with what would be expected based on the total phosphorus concentrations in these lakes. Doris Lake would be classified as meso-eutrophic based on the mean total phosphorus concentration measured in this lake between 2004 and 2020 (0.027 mg/L; Section 3.3-9), and the 2020 chlorophyll *a* concentration in Doris Lake (16.1 µg chl *a*/L) is consistent with the ranges given in Table 3.4-1 for meso-eutrophic lakes. Based on the mean total phosphorus concentrations measured in Patch Lake from 1996 to 2020 (0.006 mg/L; Section 3.3-9) and Reference Lake B from 2010 to 2020 (0.004 mg/L; Section 3.3-9), these lakes would both be classified as oligo-mesotrophic according to the Vollenweider and Kerekes classification system (Table 3.4-1). The 2020 chlorophyll *a* concentrations in these lakes (1.36 µg chl *a*/L in Patch Lake and 0.58 µg chl *a*/L in Reference Lake B) also correspond with the levels expected for these trophic categories (Table 3.4-1).

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)

For Patch Lake, a low action level response was not triggered for phytoplankton biomass because there was no significant difference in means from baseline years to 2020. For Doris Lake, although a statistically significant change from baseline was detected, and there was no similar change at the reference site, a low action level response was not triggered because there is no evidence of increased nutrient inputs to the lake, and therefore no indication that the relatively high phytoplankton biomass is a Project effect. Rather, the high phytoplankton biomass is likely due to the stronger than usual stratification and the relatively high water column temperature in August 2020. While the 2020 phytoplankton biomass is elevated compared to the biomass estimates from the single baseline year of 2009, the chlorophyll concentration of 16.1 µg chl *a*/L remains consistent with the biomass level that would be expected in a meso-eutrophic lake such as Doris Lake (Table 3.4-1).

4. SUMMARY OF EFFECTS ANALYSIS

In 2020, physical profiles and water samples were collected from several exposure lakes and one reference lake to evaluate the potential for Project-related effects to the following components of the freshwater environment:

- fish habitat (water level and ice thickness);
- physical limnology (dissolved oxygen and water temperature);
- water quality; and
- phytoplankton biomass.

Physical, chemical, and biological data from 2020 (the fourth year of Doris operations and the second year of Madrid North construction/operations) were evaluated against historical data and reference site data to determine if there was any evidence of Project-related effects to the freshwater environment. The evaluation of effects was based on graphical and statistical analyses of trends over time both within each exposure lake and between exposure lakes and the reference lake, comparisons to baseline conditions, and professional judgement. Results of the evaluation of effects were then screened against the conditions that must be met to trigger a ‘low action level’ response under the Response Framework to identify potential Project effects that may require management action to prevent adverse environmental consequences.

No adverse Project-related effects to fish habitat (water level and ice thickness), under-ice dissolved oxygen concentrations, water temperature, or phytoplankton biomass were detected in the exposure lakes.

The evaluation of effects concluded that there was a potential Project-related increase in open-water turbidity in Doris Lake; however, a low action level response was not triggered because the statistical analysis showed that the apparent increasing trend in turbidity was not statistically significant. At least one condition was not met for each evaluated lake/season/variable combination; therefore, no low action level responses were triggered for water quality during the 2020 assessment year.

Table 4-1 presents a summary of the conclusions of the 2020 evaluation of effects.

Table 4-1: Summary of Evaluation of Effects for Hope Bay Project, 2020

Variable	Exposure Lakes Included in Evaluation of Effects	Conclusion of Effect	Low Action Level Triggered?
Fish Habitat			
Water level and ice thickness	Windy Lake, Glenn Lake, Patch Lake, Imniagut Lake, P.O. Lake, Ogama Lake, Doris Lake, Little Roberts Lake	No Effect	No
Physical Limnology			
Under-ice dissolved oxygen	Windy Lake, Patch Lake, Doris Lake	No Effect	No
Temperature		No Effect	No
Water Quality			
pH	Windy Lake, Patch Lake, Doris Lake	No Effect	No
Total Suspended Solids		No Effect	No
Turbidity		Possible Effect (Doris Lake, open-water season)	No
Chloride		No Effect	No
Fluoride		No Effect	No
Total Ammonia		No Effect	No
Nitrate		No Effect	No
Nitrite		No Effect	No
Total Phosphorus		No Effect	No
Total Aluminum		No Effect	No
Total Arsenic		No Effect	No
Total Boron		No Effect	No
Total Cadmium		No Effect	No
Total Chromium		No Effect	No
Total Copper		No Effect	No
Total Iron		No Effect	No
Total Lead		No Effect	No
Total Mercury		No Effect	No
Total Molybdenum		No Effect	No
Total Nickel		No Effect	No
Total Selenium		No Effect	No
Total Silver		No Effect	No
Total Thallium		No Effect	No
Total Uranium		No Effect	No
Dissolved Zinc		No Effect	No
Phytoplankton Biomass			
Chlorophyll *a*	Patch Lake, Doris Lake	No Effect	No

5. REFERENCES

Metal and Diamond Mining Effluent Regulations, SOR/2002-222.

CCME. 1999. Canadian water quality guidelines for the protection of aquatic life: Introduction. In: *Canadian Environmental Quality Guidelines*, 1999, Canadian Council of Ministers of the Environment. Winnipeg, MB.

CCME. 2007. *A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life 2007* Canadian Council of Ministers of the Environment: Winnipeg, MB.

CCME. 2019. *Canadian water quality guidelines for the protection of aquatic life: manganese. In: Canadian environmental quality guidelines, 1999*. Canadian Council of Ministers of the Environment: Winnipeg, MB.

CCME. 2020. Canadian Council of Ministers of the Environment. st-ts.ccme.ca/ (Canadian water quality guidelines for the protection of aquatic life: Summary table accessed October 2020).

Cott, P. A. 2007. Fisheries Related Impacts of Water Withdrawal from Ice-Covered Lakes. M.Sc. diss., University of Guelph.

ECCC. 2020a. Canadian Climate Normals 1981-2010 Station Data. Normals Data. https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=cambridge+bay&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=1786&dispBack=1 (accessed November 2020).

ECCC. 2020b. Daily Data Report for August 2020. https://climate.weather.gc.ca/climate_data/daily_data_e.html?hlyRange=2016-01-13%7C2020-10-12&dlyRange=2018-10-29%7C2020-10-12&mlyRange=%7C&StationID=54139&Prov=NU&urlExtension=_e.html&searchType=stnProx&optLimit=specDate&StartYear=1840&EndYear=2019&selRowPerPage=25&Line=0&txtRadius=25&optProxType=navLink&txtLatDecDeg=69.108055555556&txtLongDecDeg=-105.13722222222&timeframe=2&Day=28&Year=2020&Month=8 (accessed November 2020).

ECCC. 2020c. Daily Data Report for July 2020. https://climate.weather.gc.ca/climate_data/daily_data_e.html?hlyRange=2016-01-13%7C2020-10-12&dlyRange=2018-10-29%7C2020-10-12&mlyRange=%7C&StationID=54139&Prov=NU&urlExtension=_e.html&searchType=stnProx&optLimit=specDate&StartYear=1840&EndYear=2019&selRowPerPage=25&Line=0&txtRadius=25&optProxType=navLink&txtLatDecDeg=69.108055555556&txtLongDecDeg=-105.13722222222&timeframe=2&Day=28&Year=2020&Month=7 (accessed November 2020).

Environment Canada. 2004. *Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems*. Ecosystem Health: Science-based Solutions Report No. 1-8. National Guidelines and Standards Office, Water Policy and Coordination Directorate, Environment Canada. pp. 114:

ERM. 2015. *Doris North Project: 2014 Aquatic Effects Monitoring Program*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd. : Yellowknife, NT.

ERM. 2016. *Doris North Project: 2015 Aquatic Effects Monitoring Program Report*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd. : Yellowknife, NT.

ERM. 2017a. *Doris Project: 2016 Aquatic Effects Monitoring Program Report*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd. : Yellowknife, NT.

ERM. 2017b. *Hope Bay Project: 2017 Madrid-Boston Aquatic Baseline Report*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

ERM. 2018. *Doris Project: 2017 Aquatic Effects Monitoring Program Report*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

ERM. 2019a. *Doris Project: 2018 Aquatic Effects Monitoring Program Report*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

ERM. 2019b. *Hope Bay Project: 2018 Phase 2 Aquatic Baseline Report*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

ERM. 2020. *Hope Bay Project: 2019 Aquatic Effects Monitoring Program Report*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

ERM Rescan. 2014. *Doris North Project: 2013 Aquatic Effects Monitoring Program Report*. Prepared for TMAC Resources Inc. by ERM Rescan: Yellowknife, NT.

Golder Associates Ltd. 2005. *Doris North Project Aquatic Studies 2004*. Prepared for Miramar Hope Bay Ltd. by Golder Associates Ltd. Report No. 04-1373-009.

Golder Associates Ltd. 2006. *Doris North Project Aquatic Studies 2005*. Prepared for Miramar Hope Bay Ltd. by Golder Associates Ltd. Report No. 05-1373-014-F.

Golder Associates Ltd. 2007. *Doris North Project Aquatic Studies 2006*. Prepared for Miramar Hope Bay Ltd. by Golder Associates Ltd. Report No. 06-1373-026.

Golder Associates Ltd. 2008. *Doris North Project Aquatic Studies 2007*. Prepared for Miramar Hope Bay Ltd. by Golder Associates Ltd. Report No. 07-1373-0018D.

Golder Associates Ltd. 2009. *Hope Bay Gold Project 2008 Annual Aquatic Studies Report*. Prepared for Hope Bay Mining Ltd. by Golder Associates Ltd. Report No. 08-1373-0026-1000.

Klohn-Crippen Consultants Ltd. 1995. *Doris Lake Project, Northwest Territories: 1995 Environmental Study*. Prepared for BHP Minerals Canada Ltd. by Klohn-Crippen Consultants Ltd.

NOAA. 2020. July 2020 was record hot for N. Hemisphere, 2nd hottest for planet. https://www.noaa.gov/news/july-2020-was-record-hot-for-n-hemisphere-2nd-hottest-for-planet (accessed November 2020).

Patar, D. 2020. Nunavut's Eureka Weather Station experiences warmest July on record. *Nunatsiaq News, 13 August 2020*: https://nunatsiaq.com/stories/article/nunavuts-eureka-weather-station-experiences-warmest-july-on-record/ (accessed November 2020).

R Core Team. 2021. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. http://www.R-project.org/.

Rescan. 1997. *Environmental Baseline Studies Report 1996*. Prepared for BHP World Minerals by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 1998. *1997 Environmental Data Report*. Prepared for BHP World Minerals by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 1999. *1998 Environmental Data Report*. Prepared for BHP Diamonds Inc. by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 2001. *2000 Supplemental Environmental Baseline Data Report, Hope Bay Belt Project*. Prepared for Hope Bay Joint Venture by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 2010. *2009 Freshwater Baseline Report, Hope Bay Belt Project*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Yellowknife, NT.

Rescan. 2011. *Doris North Gold Mine Project: 2010 Aquatic Effects Monitoring Program Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012. *Doris North Gold Mine Project: 2011 Aquatic Effects Monitoring Program Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2013. *Doris North Gold Mine Project: 2012 Aquatic Effects Monitoring Program Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.: Vancouver, BC.

RL&L Environmental Services Ltd. / Golder Associates Ltd. 2003. *Doris North Project Aquatic Studies 2003*. Prepared for Miramar Hope Bay Ltd. by RL&L Environmental Services Ltd. and Golder Associates Ltd. Report No. 03-1370-007.

Striebel, M., S. Schabhüttl, D. Hodapp, P. Hingsamer, and H. Hillebrand. 2016. Phytoplankton responses to temperature increases are constrained by abiotic conditions and community composition. *Oecologia*, 182 (3): 815-27.

TMAC. 2017a. *Hope Bay Project: Madrid-Boston Aquatic Effects Monitoring Plan. Package P4-18, Volume 1 Annex V1-7 Type A Water Licence Applications, Madrid-Boston Final Environmental Impact Statement*. TMAC Resources Inc.: Toronto, ON.

TMAC. 2017b. *Madrid-Boston Project Final Environmental Impact Statement*. TMAC Resources Inc.: Toronto, ON.

TMAC. 2018. *Hope Bay Project: Aquatic Effects Monitoring Plan*. Prepared by TMAC Resources Inc.: Toronto, ON.

Vollenweider, R. A. and J. Kerekes. 1982. *Eutrophication of Waters. Monitoring Assessment and Control*. Organization for Economic Co-operation and Development (OECD), Paris. 156 pp.

Wetzel, R. G. 2001. *Limnology*. New York, NY: Academic Press.

APPENDIX A 2020 DATA REPORT

March 2021

HOPE BAY PROJECT

2020 Aquatic Effects Monitoring Program Report

Appendix A: 2020 Data Report

ERM Consultants Canada Ltd.
120 Adelaide Street West, Suite 2010
Toronto, ON
Canada M5H 1T1

T: +1 416 646 3608
F: +1 416 642 1269

CONTENTS

List of Annexes

List of Tables

List of Figures

Appendix A: 2020 Data Report

This data report presents the sampling methodology, the raw data, and summary figures and tables of the results of the 2020 Aquatic Effects Monitoring Program (AEMP) for the Hope Bay Project (the Project). Section A.1 presents the methodology, and Sections A.2 to A.5 present the 2020 data and summary tables and figures.

The 2020 AEMP was conducted according to the *Hope Bay Project: Aquatic Effects Monitoring Plan* (the Plan; TMAC 2018). The 2020 AEMP included the collection of the following data in lakes with the potential to be affected by Project activities (i.e., exposure lakes): water level, ice thickness, Secchi depth, temperature and dissolved oxygen profiles, water quality, and phytoplankton biomass. Sediment quality and the benthic invertebrate (benthos) community were last sampled in 2019, and were not sampled in 2020 according to the monitoring schedule outlined in the Plan. All methods and data relating to water level monitoring are presented in Appendix B, and are not repeated here. The evaluation of effects is provided in the main body of the AEMP 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 2020 AEMP, and Figures A.1-2 to A.1-5 show detailed maps of the sampling components and bathymetric contours in each sampled lake.

A.1.2 Sampling Program Summary

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

A.1.3 Ice Thickness

Ice thickness was measured between April 9 and 13 and between May 3 and May 4, 2020. April ice thickness data were collected at four lake sites (Windy Lake, Patch Lake, Doris Lake, and Reference Lake B) concurrently with water quality sampling and water profiling, and May ice thickness data were collected concurrently with water level surveys at all sites indicated in Figure A.1-1. A 25-cm diameter hole was drilled through the ice using a motorized auger; ice chips and snow were cleared from the surface, and the ice thickness was then measured using a metered rod.

A.1.3.1 Quality Assurance and Quality Control

Field crews were trained in the measurement of ice thickness so that measurement methods are reliable and consistent, and that data are comparable across years.

A.1.4 Physical Limnology

A.1.4.1 Ice-covered Season

During the ice-covered season (April), lake water at the sampling sites was accessed by drilling a 25-cm diameter hole through the ice using a motorized auger. The water column depth under the ice was measured using a depth sounder. Sampling dates are presented in Table A.1-2.

Table A.1-1: Sampling Program Summary, Hope Bay Project

Monitoring Component	Sampling Frequency	Sample Replication and Depths	Sampling Dates / Timing	Sampling Device
Ice Thickness				
Ice thickness measurement	1× per year[a]	n = 1 measurement/site	April or May	Metred rod
Physical Limnology				
Secchi depth; dissolved oxygen and temperature profiles	2× per year	n = 1 profile/site throughout water column	April (profiles only), August	Secchi disk, YSI ProODO optical dissolved oxygen and temperature probe
Water Quality				
Physical parameters, nutrients, metals	2× per year	n = 1 @ 1 m below the surface, n = 1 @ 2 m above water-sediment interface, + 10% replication per sampling event	April, August	Niskin or GO-FLO sampling bottle
Sediment Quality (not sampled in 2020)				
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[b]	August	GO-FLO sampling bottle, filtration equipment
Benthic Invertebrates (not sampled in 2020)				
Density and taxonomy	1× every 3 years	n = 5/site (3 composite subsamples/replicate)	August	Ekman grab, 500-µm sieve bag

[a] *Ice thickness measurements were collected twice in some lakes in 2020 (April and May).*
[b] *A single chlorophyll a sample was collected at 1 m below the surface at each site indicated in Figure A.1-1 instead of the usual three replicate samples due to an oversight.*

Temperature and dissolved oxygen (DO) measurements were collected using a YSI ProODO meter equipped with an optical DO sensor. Profiles extended from the bottom of the ice layer to approximately 1 m above the sediment surface to reduce suspension of bottom sediments. Depth was monitored using markings on the cable and data were recorded manually at 0.5-m intervals.

A.1.4.2 Open-water Season

Open-water season temperature and DO profiles were collected from a boat at the same sites as in the ice-covered season. Sampling dates are presented in Table A.1-2. Profiles were collected using a YSI ProODO meter, depth was monitored using markings on the cable and data were recorded manually at 0.5-m intervals as the probe was lowered into the water.

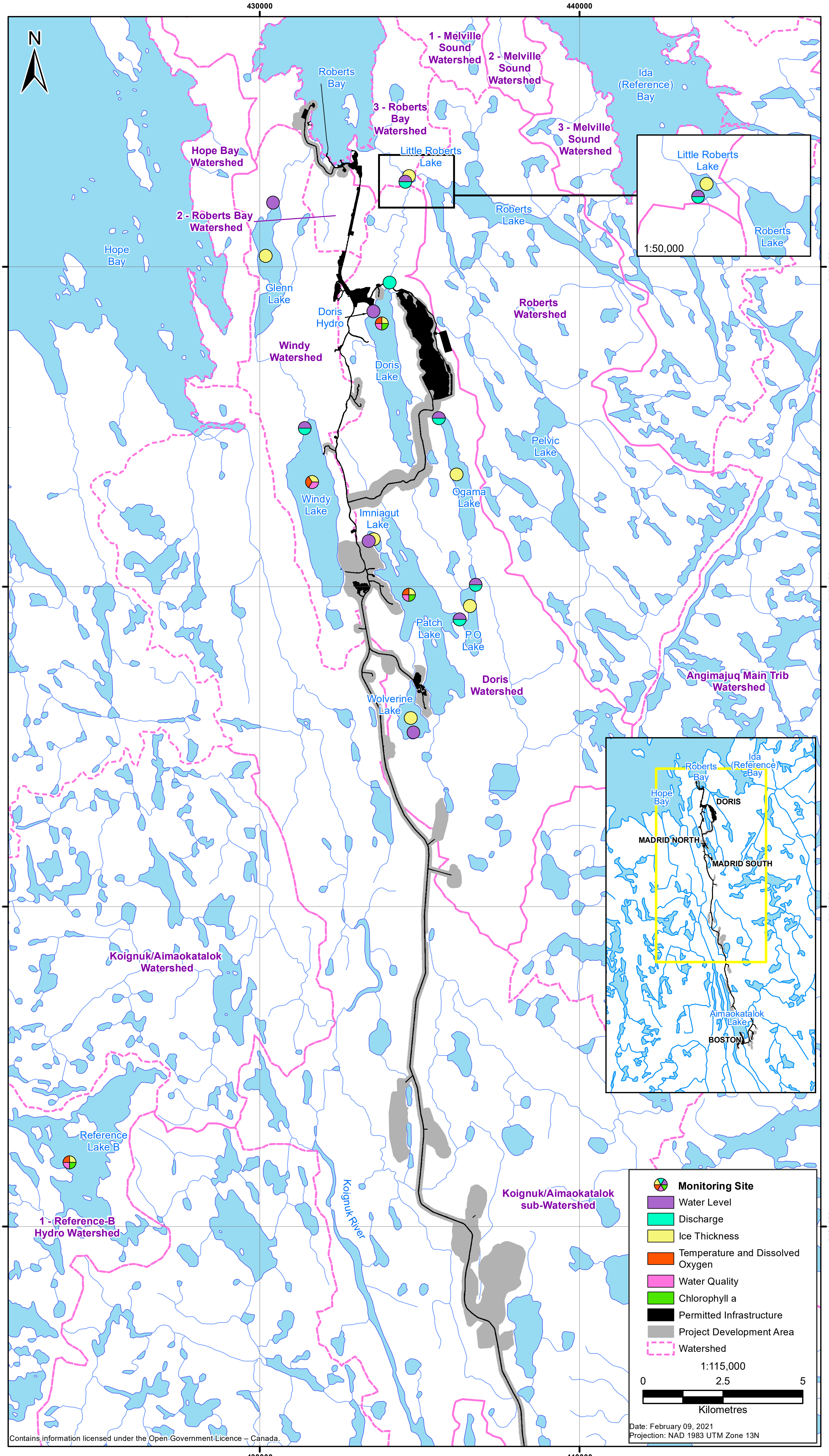


Figure A.1-1: AEMP Sampling Locations, Hope Bay Project, 2020

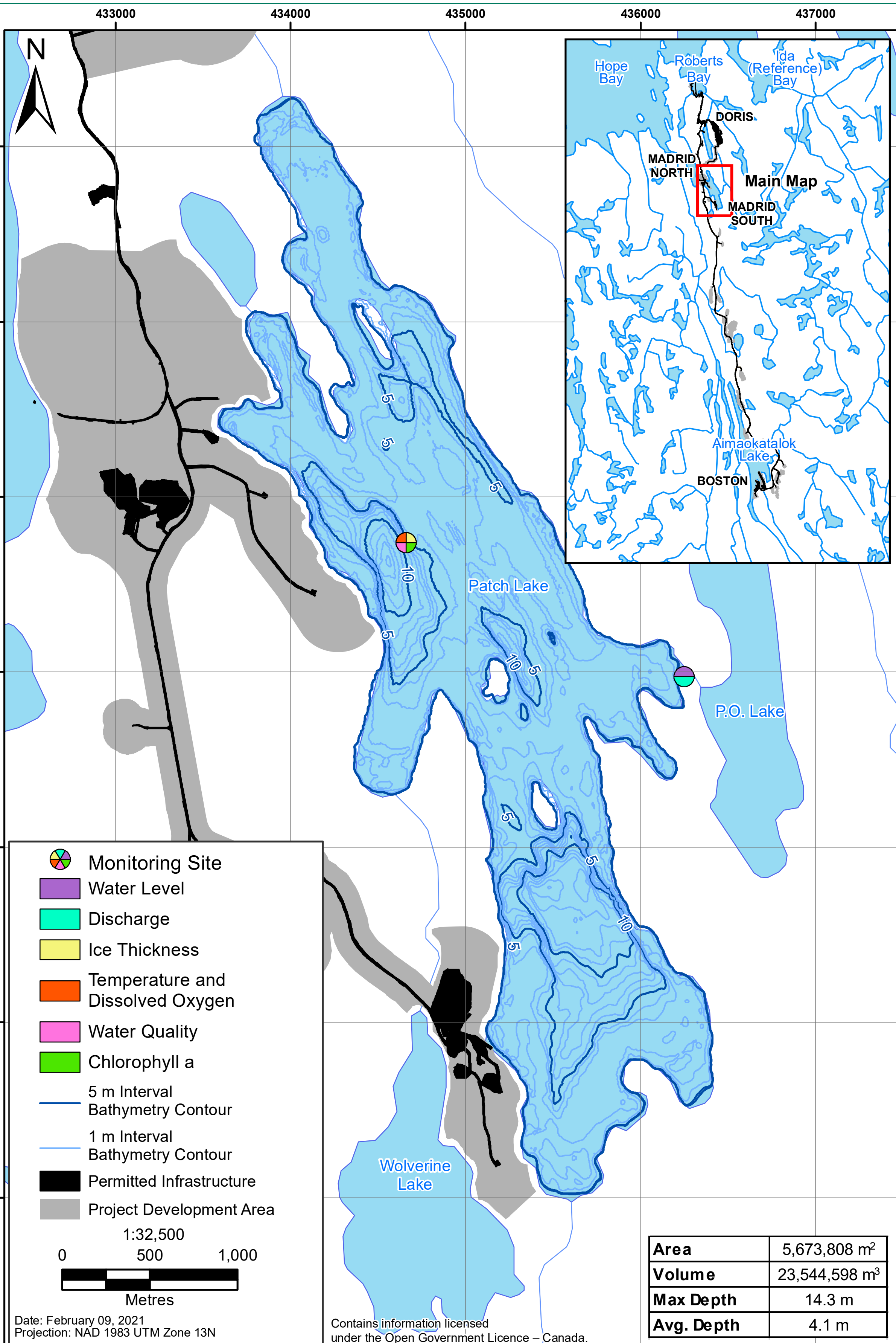
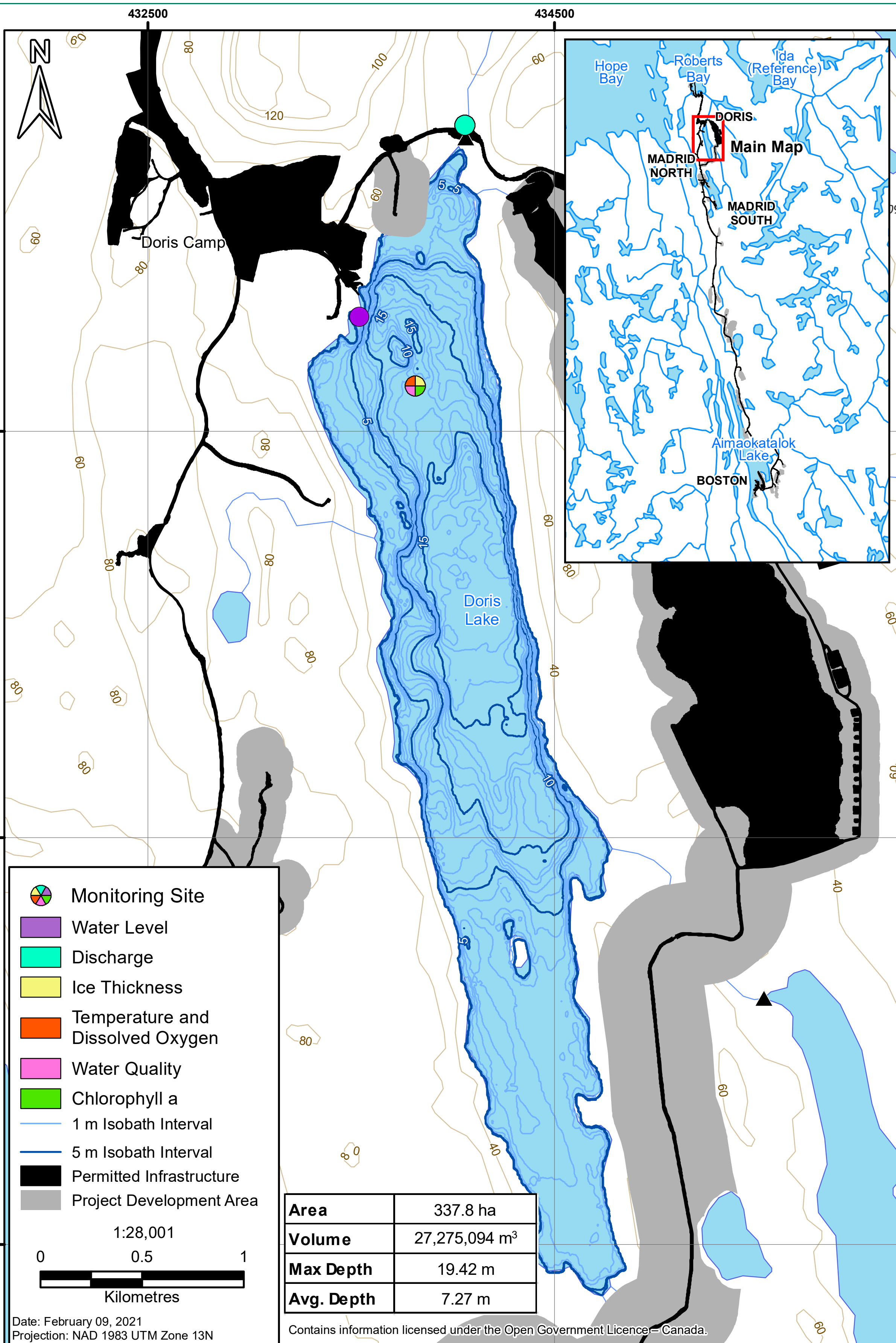


Figure A.1-2: Patch Lake AEMP Sampling Locations, Hope Bay Project, 2020



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

Figure A.1-3: Doris Lake AEMP Sampling Locations, Hope Bay Project, 2020

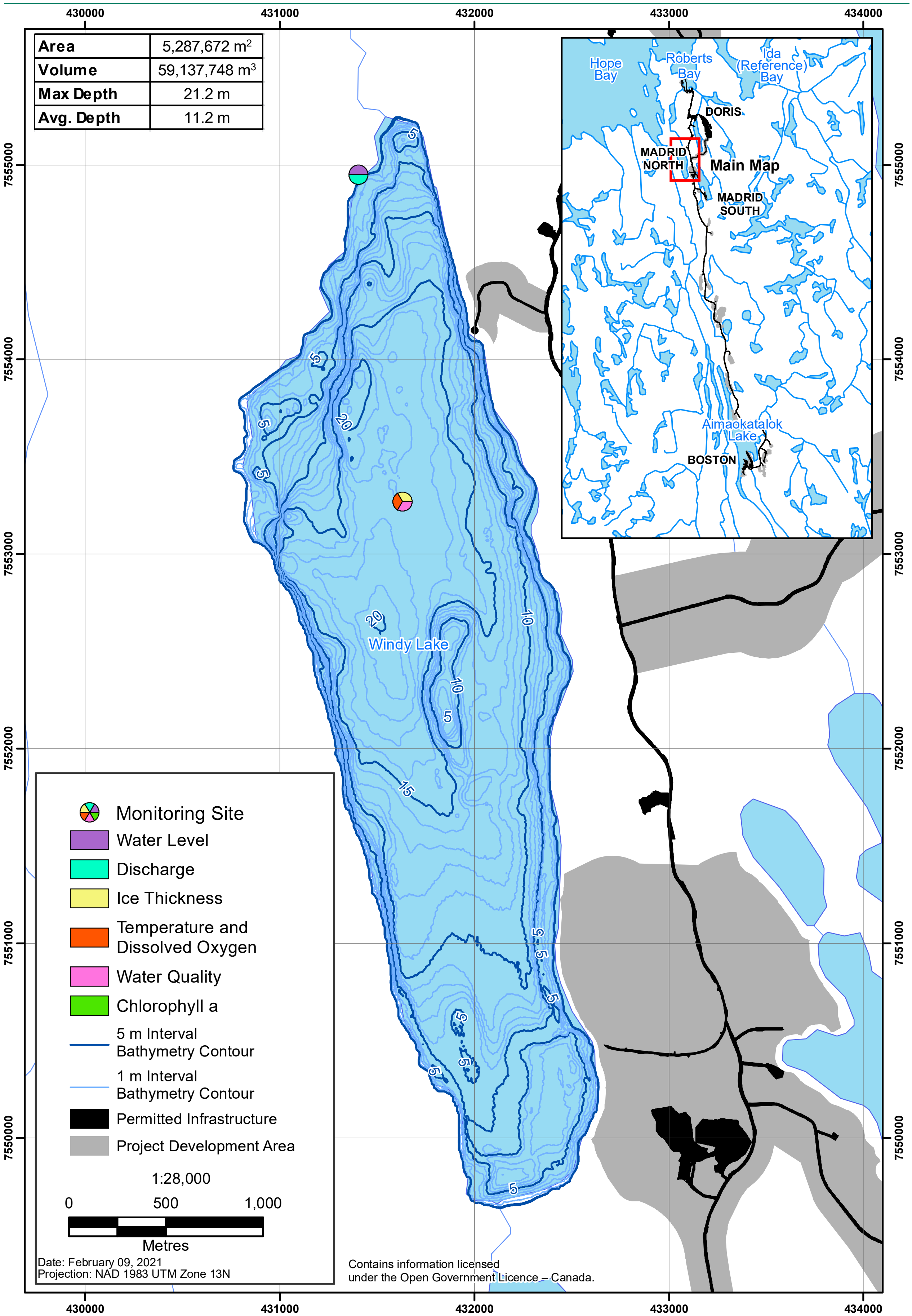


Figure A.1-4: Windy Lake AEMP Sampling Locations, Hope Bay Project, 2020

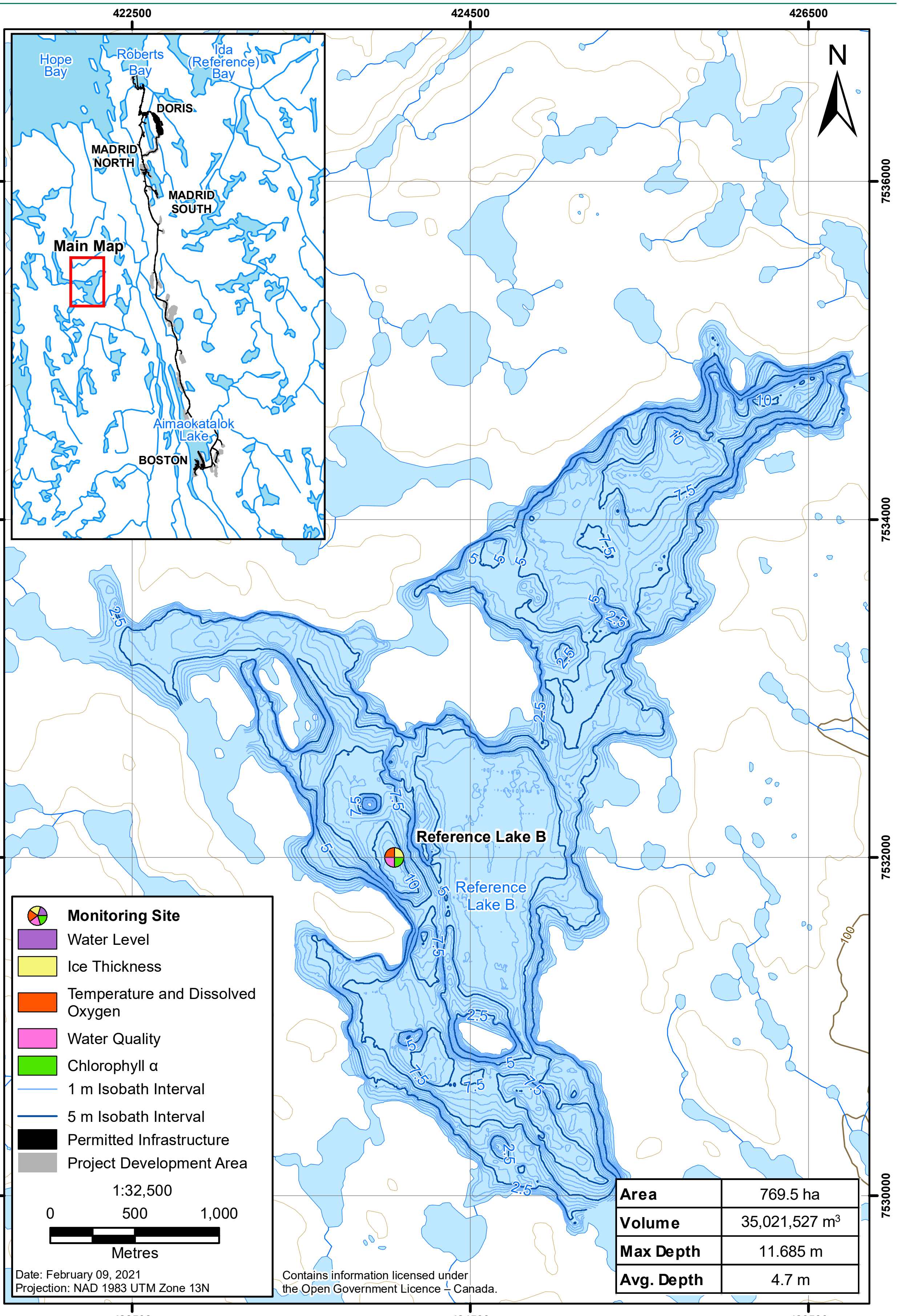


Figure A.1-5: Reference Lake B AEMP Sampling Location, Hope Bay Project, 2020

Table A.1-2: Physical Limnology and Water Quality Sampling Dates and Depths, Hope Bay Project, 2020

Site	Sampling Date	Physical Limnology Sampling Depths	Water Quality Sampling Depth(s) (m)
Windy Lake	13-Apr-2020	Throughout water column	3.0, 14
	12-Aug-2020	Throughout water column	1.0, 15
Patch Lake	9-Apr-2020	Throughout water column	2.5, 3.5
	17-Aug-2020	Throughout water column	1.0, 5.0
Doris Lake North	9-Apr-2020	Throughout water column	3.0, 10
	12-Aug-2020	Throughout water column	1.0, 12
Reference Lake B	12-Apr-2020	Throughout water column	3.0, 7.0
	25-Aug-2020	Throughout water column	1.0, 8.3

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. The disk was lowered further and then slowly raised until it once again became visible and this depth was also recorded. These depths were averaged to obtain an estimate of the Secchi depth (Ds). The 1% euphotic zone depth ($Z_{1\%}$) was computed by first calculating the light extinction coefficient (k) from Ds, and then calculating the 1% euphotic zone depth based on the appropriate light extinction coefficient. The 1% euphotic zone depth is the depth of the water column to which 1% of the surface irradiance reaches. It represents the depth at which the integrated gross water column photosynthetic production is equivalent to the integrated gross water column respiration; thus, there is net photosynthesis above this depth. The 1% euphotic zone depth is often referred to as the compensation depth, and is calculated as follows (Parsons, Takahashi, and Hargrave 1984):

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

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

A.1.4.3 Quality Assurance and Quality Control

The quality assurance and quality control (QA/QC) measures undertaken to verify the reliability of physical limnology data included calibrating the YSI ProODO meter prior to use, and reviewing the data for anomalous readings of water temperature or DO concentrations.

A.1.5 Water Quality

Water quality samples were collected at lake sites during the ice-covered season in April and the open-water season in August, 2020. The sampling dates and depths for all sites are presented in Table A.1-2 and the analyzed parameters are presented in Table A.1-3. Sampling locations are presented in Figure A.1-1.

Table A.1-3: Water Quality Parameters and Realized Detection Limits, Hope Bay Project, 2020

Parameter	Units	Realized Detection Limits		Parameter	Units	Realized Detection Limits	
Physical Tests				**Metals** *(cont'd)*		Total	Dissolved
Conductivity	µS/cm	2.0		Cobalt (Co)	mg/L	0.000050	-
Hardness (as $CaCO_3$)	mg/L	0.50 or 0.60		Copper (Cu)	mg/L	0.00050	-
pH	pH	0.10		Gallium (Ga)	mg/L	0.000050	-
Total Suspended Solids	mg/L	1.0		Iron (Fe)	mg/L	0.010 or 0.030	-
Turbidity	NTU	0.10		Lead (Pb)	mg/L	0.000050	-
Anions and Nutrients				Lithium (Li)	mg/L	0.00050	-
Alkalinity, Total (as $CaCO_3$)	mg/L	1.0		Magnesium (Mg)	mg/L	0.10	-
Ammonia, Total (as N)	mg/L	0.0050		Manganese (Mn)	mg/L	0.00020	0.00020
Bromide (Br)	mg/L	0.050		Mercury (Hg)	µg/L	0.00010 or 0.00050	-
Chloride (Cl)	mg/L	0.50		Molybdenum (Mo)	mg/L	0.000050	-
Fluoride (F)	mg/L	0.020		Nickel (Ni)	mg/L	0.00020	-
Nitrate (as N)	mg/L	0.0050		Phosphorus (P)	mg/L	0.30	-
Nitrite (as N)	mg/L	0.0010		Potassium (K)	mg/L	0.03 or 2.0	-
Orthophosphate (as P)	mg/L	0.0010		Rhenium (Re)	mg/L	0.000005	-
Total Phosphorus	mg/L	0.0020		Rubidium (Rb)	mg/L	0.000020	-
Sulphate (SO_4)	mg/L	0.30		Selenium (Se)	mg/L	0.00020	-
Organic Carbon				Silicon (Si)	mg/L	0.10	-
Dissolved Organic Carbon	mg/L	0.50		Silver (Ag)	mg/L	0.000005	-
Total Organic Carbon	mg/L	0.50		Sodium (Na)	mg/L	0.02 or 2.0	-
Metals		Total	Dissolved	Strontium (Sr)	mg/L	0.00020	-
Aluminum (Al)	mg/L	0.0030	-	Tellurium (Te)	mg/L	0.000050	-
Antimony (Sb)	mg/L	0.000030	-	Thallium (Tl)	mg/L	0.000005	-
Arsenic (As)	mg/L	0.000050	-	Thorium (Th)	mg/L	0.000005	-
Barium (Ba)	mg/L	0.00010	-	Tin (Sn)	mg/L	0.00020	-
Beryllium (Be)	mg/L	0.000005	-	Titanium (Ti)	mg/L	0.00020	-
Bismuth (Bi)	mg/L	0.000050	-	Tungsten (W)	mg/L	0.000010	-
Boron (B)	mg/L	0.010	-	Uranium (U)	mg/L	0.000002	-
Cadmium (Cd)	mg/L	0.000005	-	Vanadium (V)	mg/L	0.000050	-
Calcium (Ca)	mg/L	0.050	-	Yttrium (Y)	mg/L	0.000005	-
Cesium (Cs)	mg/L	0.000005	-	Zinc (Zn)	mg/L	0.0030	0.0010
Chromium (Cr)	mg/L	0.00050	-	Zirconium (Zr)	mg/L	0.000050	-

A.1.5.1 Under-ice Season

In April, the underlying water was accessed through an augured hole in the ice, following the collection of water column profiles. A 2.5-L Niskin bottle was used to collect water from under the ice layer. 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. Prior to the collection of water quality samples, the Niskin bottle was thoroughly rinsed with site-specific water as the Niskin was lowered into the water column in an open configuration allowing lake water to pass through the sampler.

Samples for the various water quality components (e.g., physical parameters, anions and nutrients, and total and dissolved metals) were drawn from the water sampler, with care taken not to bring the bottle or cap into contact with the plastic spigot or other possible sources of contamination. All samples were processed in the field (e.g., filtered, preserved) as appropriate for analysis by the analytical laboratory. Dissolved metals samples were decanted from the general parameters bottle and field filtered using clean syringe filters, the general parameters sample was then discarded and refilled with sample water.

All samples were kept cold and in the dark while in the field and were refrigerated at Doris Camp until the first available transport off-site. Samples were sent to ALS Laboratory Group (ALS) in Yellowknife and subsequently transferred to ALS Burnaby for analysis. The parameters analyzed and realized detection limits are summarized in Table A.1-3.

A.1.5.2 Open-water Season

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, terminally weighted to suspend the sampler vertically in the water column, and lowered to the appropriate sampling depth. It was then triggered close to collect a discrete water sample at that depth using a Teflon-coated brass messenger and brought aboard the boat for distribution of the collected water into sample containers.

Sample collection, processing, storage, and transportation off site to ALS for analysis followed the same methods as during the ice-covered season.

A.1.5.3 Quality Assurance and Quality Control

The QA/QC program for water quality sampling included the collection of replicates to account for within-site variability (~10% 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 (~25% 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, effect on sample data).

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 Biomass

Chlorophyll *a* samples were collected during the open-water season as an estimate of phytoplankton biomass to assess potential changes in phytoplankton standing stocks due to eutrophication (i.e., excess nutrients) or toxicity (i.e., presence of deleterious substances). Chlorophyll *a* samples were collected at each lake site between August 12 and 25, 2020. This sampling coincided with the physical limnology and water quality sampling. Chlorophyll *a* samples were collected in opaque, clean, 1-L sample bottles that were thoroughly rinsed with surface water at each site. For each chlorophyll *a* 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 from the sampler for chlorophyll *a* determination.

The sample water was kept cold and dark and transported to Doris Camp, where the samples were filtered using gentle vacuum filtration (hand pump). The chlorophyll *a* samples were filtered onto 47-mm diameter, 0.45-μm pore size nitrocellulose membrane filters until there was an observed colour change on the filter. The filters were folded carefully in half using forceps, and placed into a black plastic tube to prevent light penetration. 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 chlorophyll *a* sampling included the use of chain of custody forms to track samples.

A.2 Ice Thickness

Due to staffing shortages related to the COVID-19 pandemic, under-ice water quality and water profiling were collected in April 2020, while water level surveys were completed in May 2020 (theses are typically done at the same time, but this was not possible in 2020). As a result, ice thickness data were collected twice in 2020; April ice thickness data were collected concurrently with water quality sampling and water profiling, and May ice thickness data were collected concurrently with water level surveys. Table A.2-1 presents the ice thickness measurements recorded in 2020.

Table A.2-1: Ice Thickness Measurements, Hope Bay Project, 2020

Lake	Sampling Date	Measured Ice Thickness (m)
Windy Lake	April 13, 2020	1.79
	May 3, 2020	2.02
Glenn Lake	May 4, 2020	2.02
Wolverine Lake	May 3, 2020	1.94
Patch Lake	April 9, 2020	1.65
	May 3, 2020	1.96
Imniagut Lake	May 3, 2020	1.92
P.O. Lake	May 5, 2020	2.04
Ogama Lake	May 3, 2020	1.86
Doris Lake	April 9, 2020	1.82
	May 4, 2020	2.04
Little Roberts Lake	May 4, 2020	2.08
Reference Lake B	April 12, 2020	1.62

A.3 Physical Limnology

The Secchi depth data and physical profiles collected in 2020 are presented in this section.

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 in April and August 2020; Annex A.3-1 provides the profile data in tabular form.

Table A.3-1: Secchi Depths and Euphotic Zone Depths, Hope Bay Project, 2020

Lake Site	Sampling Date	Secchi Depth (Ds; m)	Euphotic Zone Depth 1% Light Level (m)	Bottom Depth (m)
Windy Lake	August 12, 2020	5.4	14.6	17.0
Patch Lake	August 17, 2020	2.3	6.3*	6.0
Doris Lake	August 12, 2020	1.5	3.9	14.0
Reference Lake B	August 25, 2020	6.1	16.6*	10.3

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

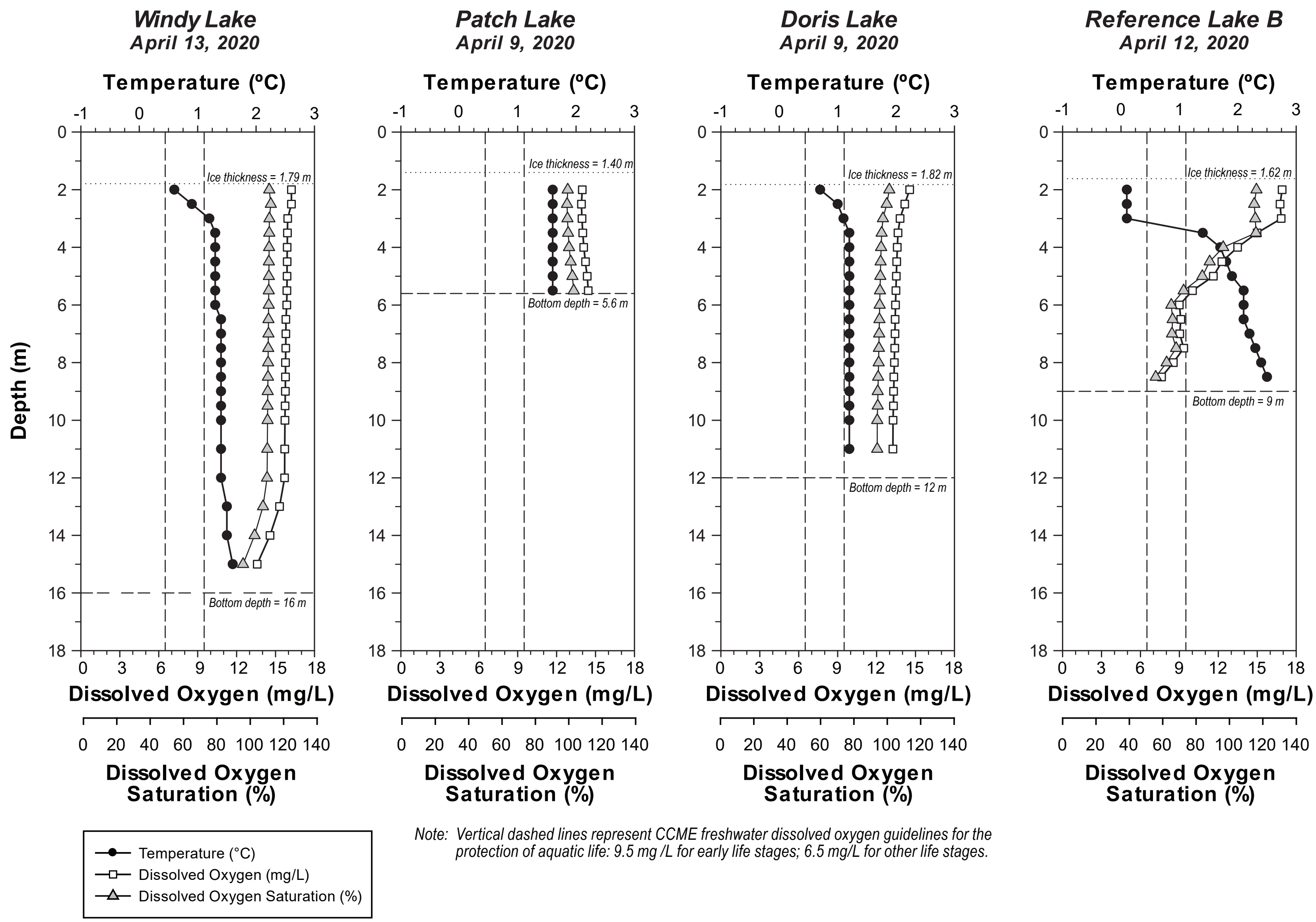
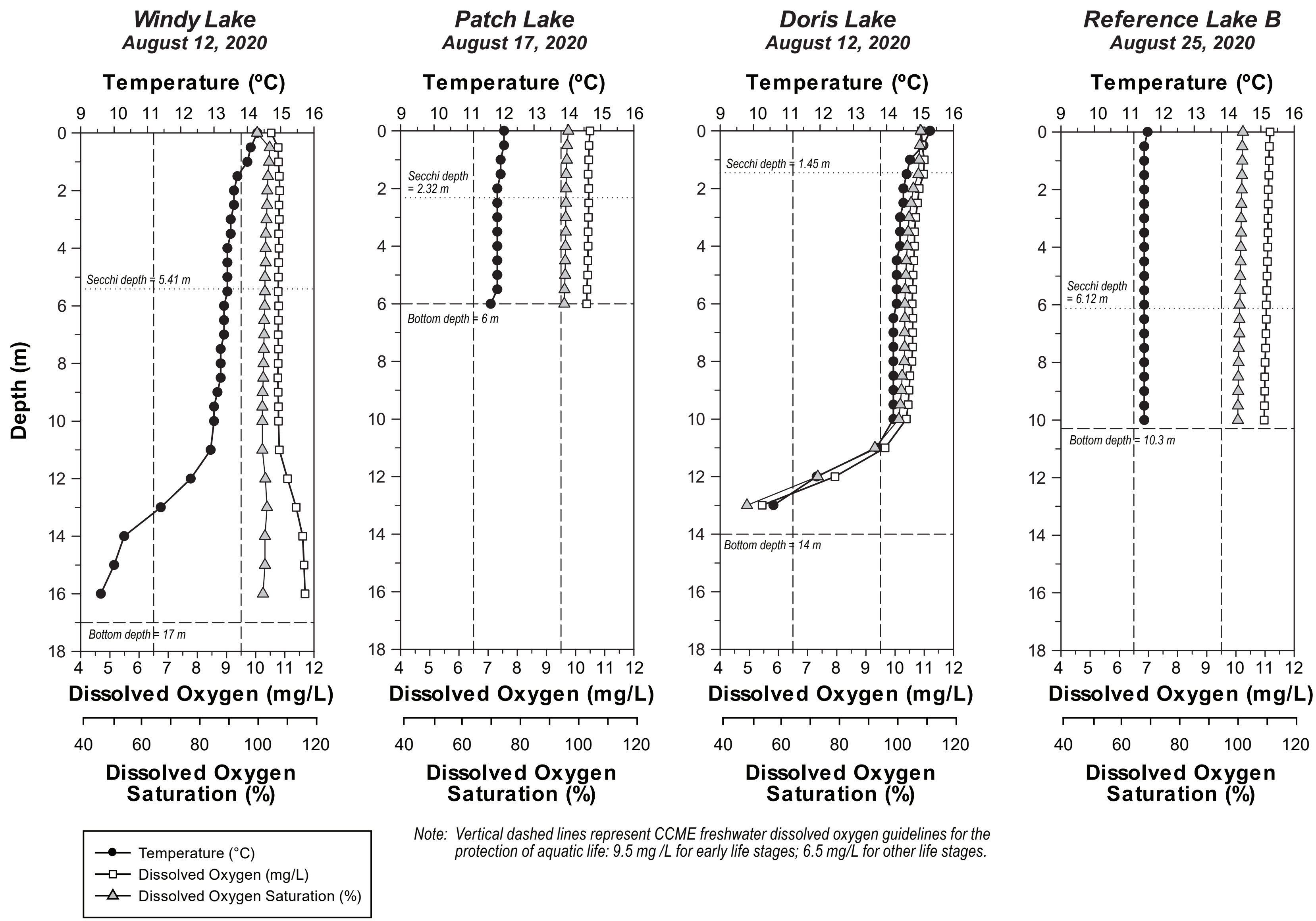


Figure A.3-1: Under-ice Temperature and Dissolved Oxygen Profiles, Hope Bay Project, April 2020



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

Figure A.3-2: Open-water Temperature and Dissolved Oxygen Profiles, Hope Bay Project, August 2020

Annex A.3-1: Temperature and Dissolved Oxygen Profiles, Hope Bay Project, 2020

Doris Lake North			
April 9, 2020			
Ice Thickness = 1.82 m			
Maximum Depth = 12 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2.0	0.7	14.55	101.0
2.5	1.0	14.17	99.4
3.0	1.1	13.81	97.2
3.5	1.2	13.65	96.4
4.0	1.2	13.59	96.1
4.5	1.2	13.55	95.8
5.0	1.2	13.52	95.6
5.5	1.2	13.49	95.4
6.0	1.2	13.46	95.2
6.5	1.2	13.44	95.1
7.0	1.2	13.42	94.9
7.5	1.2	13.40	94.8
8.0	1.2	13.37	94.6
8.5	1.2	13.33	94.3
9.0	1.2	13.31	94.1
9.5	1.2	13.30	94.1
10	1.2	13.27	93.8
11	1.2	13.26	93.8

Patch Lake			
April 9, 2020			
Ice Thickness = 1.40 m			
Maximum Depth = 5.6 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2.0	1.6	13.98	100.0
2.5	1.6	13.92	99.6
3.0	1.6	13.96	99.8
3.5	1.6	14.02	100.2
4.0	1.6	14.09	100.8
4.5	1.6	14.23	101.8
5.0	1.6	14.36	102.8
5.5	1.6	14.44	103.6

Annex A.3-1: Temperature and Dissolved Oxygen Profiles, Hope Bay Project, 2020

Windy Lake			
April 13, 2020			
Ice Thickness = 1.79 m			
Maximum Depth = 16 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2.0	0.6	16.23	112.9
2.5	0.9	16.23	113.8
3.0	1.2	15.94	113.0
3.5	1.3	15.92	112.9
4.0	1.3	15.90	112.8
4.5	1.3	15.90	112.7
5.0	1.3	15.89	112.7
5.5	1.3	15.88	112.6
6.0	1.3	15.87	112.6
6.5	1.4	15.80	112.4
7.0	1.4	15.80	112.4
7.5	1.4	15.79	112.3
8.0	1.4	15.77	112.2
8.5	1.4	15.77	112.1
9.0	1.4	15.76	112.0
9.5	1.4	15.74	111.9
10	1.4	15.73	111.9
11	1.4	15.71	111.7
12	1.4	15.70	111.6
13	1.5	15.31	109.2
14	1.5	14.58	104.1
15	1.6	13.59	97.2

Reference Lake B			
April 12, 2020			
Ice Thickness = 1.62 m			
Maximum Depth = 9.0 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2.0	0.1	16.92	116.2
2.5	0.1	16.76	114.9
3.0	0.1	16.85	115.5
3.5	1.4	14.99	115.9
4.0	1.7	13.49	96.3
4.5	1.8	12.28	88.2
5.0	1.9	11.62	83.8
5.5	2.1	10.01	72.6
6.0	2.1	9.00	65.2
6.5	2.1	9.11	66.0
7.0	2.2	9.03	65.6
7.5	2.3	9.34	68.1
8.0	2.4	8.54	62.4
8.5	2.5	7.63	55.9

Annex A.3-1: Temperature and Dissolved Oxygen Profiles, Hope Bay Project, 2020

Doris Lake North			
August 12, 2020			
Secchi Depth = 1.45 m			
Maximum Depth = 14 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.0	15.3	10.90	108.8
0.5	15.1	10.93	108.5
1.0	14.7	11.00	108.3
1.5	14.6	10.98	108.0
2.0	14.5	10.83	106.3
2.5	14.5	10.77	105.5
3.0	14.4	10.71	104.8
3.5	14.4	10.67	104.5
4.0	14.4	10.67	104.2
4.5	14.3	10.64	103.9
5.0	14.3	10.62	103.7
5.5	14.3	10.60	103.5
6.0	14.3	10.59	103.4
6.5	14.2	10.61	103.4
7.0	14.2	10.60	103.3
7.5	14.2	10.60	103.3
8.0	14.2	10.58	103.2
8.5	14.2	10.51	102.4
9.0	14.2	10.48	102.2
9.5	14.2	10.45	101.8
10	14.2	10.39	101.3
11	13.7	9.66	93.1
12	11.9	7.94	73.5
13	10.6	5.44	49.2

Windy Lake			
August 12, 2020			
Secchi Depth = 5.41 m			
Maximum Depth = 17 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.0	14.3	10.53	100.5
0.5	14.1	10.77	104.8
1.0	14.0	10.78	104.6
1.5	13.7	10.81	104.2
2.0	13.6	10.82	104.0
2.5	13.6	10.8	103.9
3.0	13.5	10.81	103.7
3.5	13.5	10.79	103.5
4.0	13.4	10.8	103.4
4.5	13.4	10.79	103.4
5.0	13.4	10.78	103.2
5.5	13.4	10.77	103.2
6.0	13.3	10.79	103.1
6.5	13.3	10.78	102.9
7.0	13.3	10.77	102.9
7.5	13.2	10.78	102.8
8.0	13.2	10.77	102.7
8.5	13.2	10.76	102.6
9.0	13.1	10.77	102.4
9.5	13	10.78	102.3
10	13	10.78	102.3
11	12.9	10.81	102.3
12	12.3	11.09	103.3
13	11.4	11.39	103.9
14	10.3	11.61	103.2
15	10	11.66	103.2
16	9.6	11.69	102.5

Annex A.3-1: Temperature and Dissolved Oxygen Profiles, Hope Bay Project, 2020

Patch Lake			
August 17, 2020			
Secchi Depth = 2.32 m			
Maximum Depth = 6.0 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.0	12.1	10.49	97.5
0.5	12.1	10.46	97.1
1.0	12.0	10.45	97.0
1.5	12.0	10.43	96.8
2.0	11.9	10.45	96.7
2.5	11.9	10.45	96.7
3.0	11.9	10.44	96.6
3.5	11.9	10.43	96.6
4.0	11.9	10.43	96.5
4.5	11.9	10.42	96.4
5.0	11.9	10.41	96.4
5.5	11.9	10.39	96.2
6.0	11.7	10.38	96.1

Reference Lake B			
August 25, 2020			
Secchi Depth = 6.12 m			
Maximum Depth = 10.3 m			
Depth (m)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.0	11.6	11.17	102.4
0.5	11.5	11.15	102.2
1.0	11.5	11.14	102.2
1.5	11.5	11.13	102.1
2.0	11.5	11.11	102.0
2.5	11.5	11.11	101.9
3.0	11.5	11.10	101.8
3.5	11.5	11.10	101.8
4.0	11.5	11.09	101.7
4.5	11.5	11.08	101.6
5.0	11.5	11.07	101.5
5.5	11.5	11.06	101.5
6.0	11.5	11.04	101.3
6.5	11.5	11.04	101.2
7.0	11.5	11.03	101.2
7.5	11.5	11.02	101.0
8.0	11.5	11.00	100.9
8.5	11.5	10.99	100.8
9.0	11.5	10.99	100.8
9.5	11.5	10.98	100.7
10	11.5	10.97	100.7

A.4 Water Quality

This section presents the water quality data collected in April and August 2020, as well as the findings of the QA/QC program for water quality. Only the parameters that were subjected to an evaluation of effects (see main body of the report) are shown graphically. All water quality parameters were screened against Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 2020). CCME guidelines are included in all graphs and annexes.

At each monitoring site, water quality data were collected from the surface (1 m) and approximately 2 m from the bottom in AEMP lakes. Samples were collected in April (ice-covered season) and August (open-water season) 2020. Figures A.4-1 to A.4-7 show seasonal and spatial trends for each evaluated water quality parameter. Annex A.4-1 presents the full 2020 lake water quality dataset.

A.4.1 Quality Assurance/Quality Control Data

A.4.1.1 Field QA/QC

Relative Percent Difference Calculations

Field sample variability was accounted for by collecting two field duplicates at Doris Lake, one in April and one in August. Relative percent difference (RPD) calculations for duplicate water quality samples are presented in Annex A.4-2. A total of 48 RPD calculations were made. The majority (43 out of 48) of the calculated RPD values were below 20%, and there were no RPD values greater than 50%, indicating that there was no evidence of substantial contamination or lack of sample representativeness.

For the duplicate samples collected in April in Doris Lake, the only RPD greater than 20% was for the concentration of total yttrium (20.7% RPD between duplicates). Yttrium is not an evaluated parameter in the AEMP; therefore, the slightly elevated RPD had no impact on the findings of the AEMP evaluation of effects.

For the duplicate samples collected in August in Doris Lake, four RPDs were greater than 20% but less than 50%: total suspended solids (23.3%), total phosphorus (38.6%), total manganese (23.3%), and dissolved manganese (44.6%). Of these, all but total manganese are evaluated parameters in the AEMP. The variability between replicates was considered in the evaluation of effects presented in the main report. Overall, 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.

There was a small subset of parameters for which concentrations were detectable above analytical detection limits in at least one equipment, field, or travel blank: total alkalinity, nitrate, nitrite, total aluminum, total boron, total mercury, total silver, total vanadium, and dissolved zinc. These parameters were assessed to determine if the potential contamination introduced by sampling equipment, sample handling, storage, and/or transportation could have biased the concentrations and influenced the findings of the evaluation of effects.

Total alkalinity and total vanadium concentrations in August blank samples were only slightly above detection limits, and neither of these parameters are evaluated parameters in the AEMP. Therefore, these elevated blank concentrations had no impact on the results of the AEMP evaluation of effects.

Nitrate concentrations were detectable above the detection limit of 0.005 mg/L in two blank samples: the April field blank (0.0063 mg/L) and the August equipment blank (0.0428 mg/L). The April field blank concentration is not of concern as 0.0063 mg/L is only slightly higher than the detection limit and lower than all lake concentrations (except Windy Lake where nitrate concentrations were below the detection limit). The August equipment blank concentration of 0.0428 mg/L is high compared to typical lake concentrations, which could indicate that the sampling equipment was an important source of nitrate contamination. However, the GO-FLO sampler is rinsed thoroughly with site-specific water before a sample is collected, and all August nitrate concentrations in lake samples were below the detection limit except for the detectable concentration of 0.0116 mg/L in the surface waters of Doris Lake. While it is possible that the nitrate concentration in this Doris Lake sample could have been elevated due to contamination introduced from the sampling equipment, the potential contamination likely had a negligible impact on the evaluation of effects (Section 3.3.7 of main report).

The nitrite concentration measured in the April equipment blank was 0.0013 mg/L. Nitrite concentrations measured in lakes in April ranged from below the detection limit (<0.001 mg/L) to 0.0030 mg/L, with most concentrations in the 0.001 to 0.002 mg/L range. The equipment blank nitrite concentration is similar to the concentrations measured in lakes; therefore, sampling equipment contamination could have influenced the 2020 under-ice nitrite concentrations in lakes. This potential contamination is discussed in the AEMP evaluation of effects for nitrite (Section 3.3.8 of main report).

The total boron concentration in the August field blank was 0.036 mg/L, which is similar to the total boron concentrations measured in exposure lake samples in August (ranging from 0.019 to 0.047 mg/L). This potential contamination is discussed in the AEMP evaluation of effects for total boron (Section 3.3.12 of main report)

The total mercury concentrations of 0.00087 µg/L and 0.00208 µg/L in April blank samples are similar to the total mercury concentrations measured in exposure lake samples in April (ranging from 0.00072 to 0.00244 mg/L). This potential contamination is discussed in the AEMP evaluation of effects for total mercury (Section 3.3.19 of main report).

Despite the detectable total silver concentration of 0.0000071 mg/L in the August field blank, there was no evidence of contamination in the lake samples as all total silver concentrations measured in exposure lakes in 2020 were below the analytical detection limit of 0.000005 mg/L.

The dissolved zinc concentration of 0.0012 mg/L in the April field blank is similar to the dissolved zinc concentrations measured in exposure lake samples in April (ranging from <0.0010 to 0.0026 mg/L). This potential contamination is discussed in the AEMP evaluation of effects for dissolved zinc (Section 3.3.26 of main report).

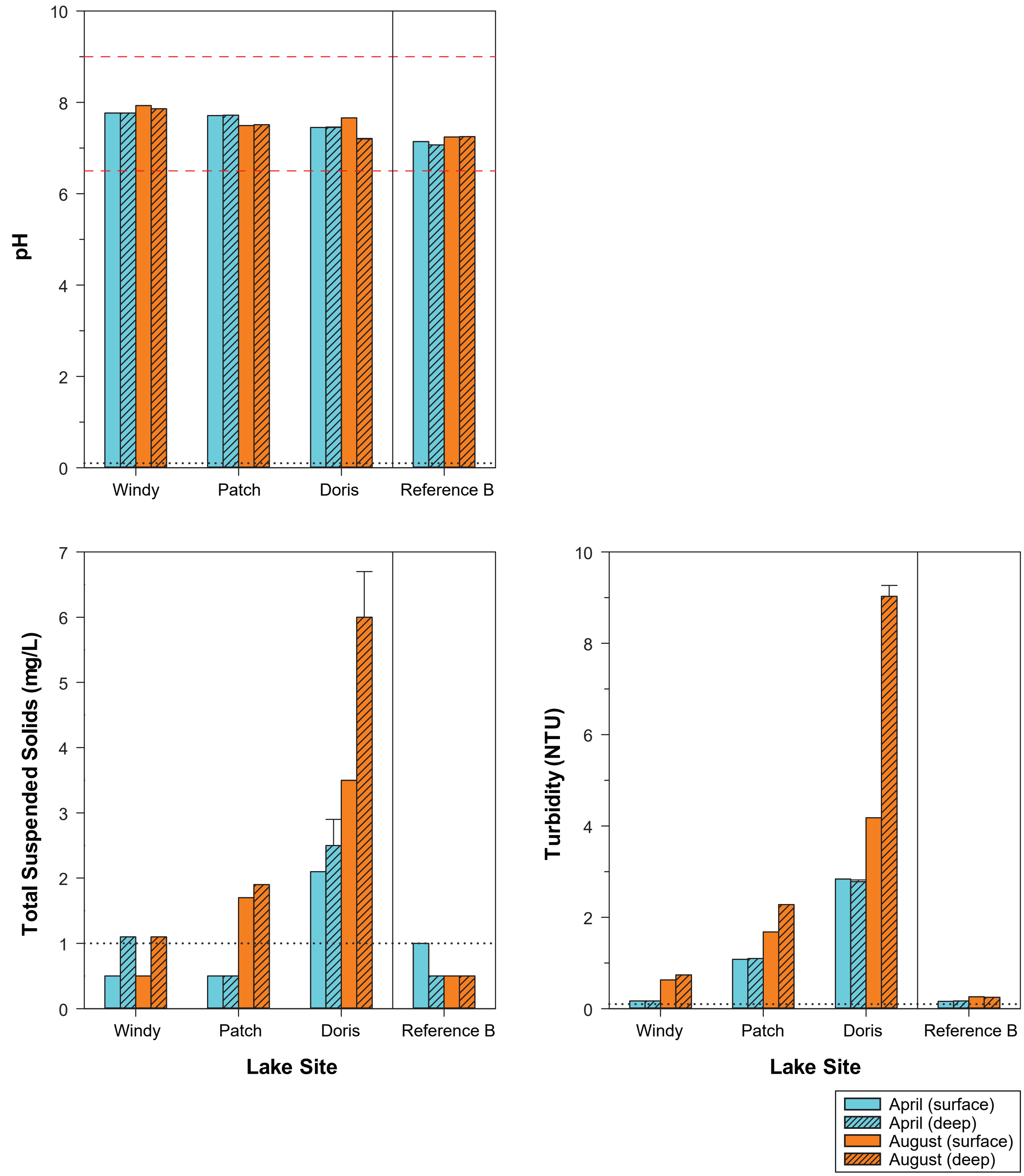
A.4.1.2 Laboratory QA/QC

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) during both sampling sessions (April and August), as well as for total suspended solids during the August sampling session (Annex A.4-4). Recommended hold times for these parameters range from 15 minutes for pH to 7 days for total suspended solids, with the remaining parameters having a 3-day recommended holding time. These recommended holding times are often unattainable when sampling in remote environments and having to ship samples long distances from the study area to the analytical laboratory.

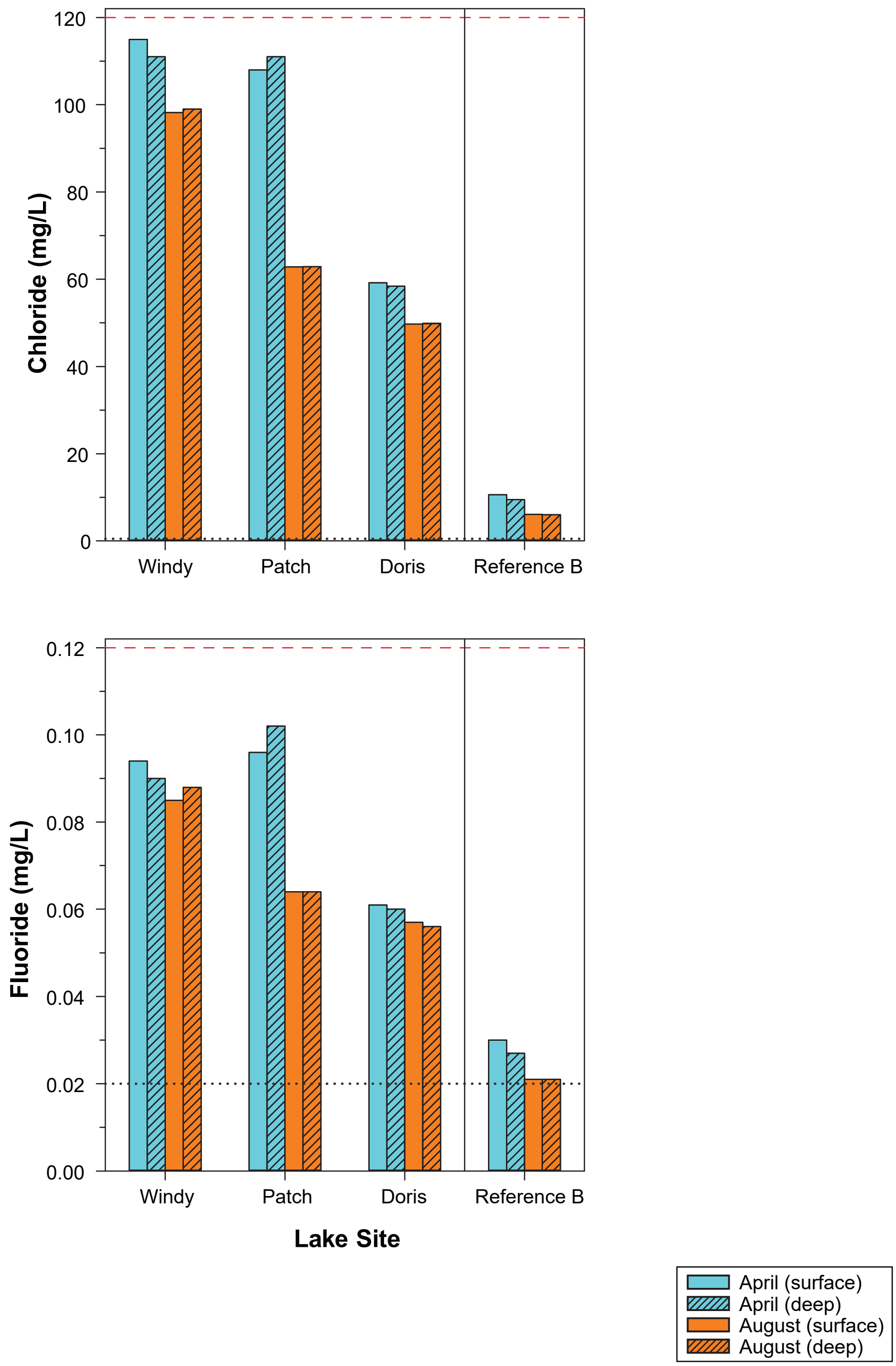
The method blank for total vanadium in ALS work order L2436487 and the method blank for total calcium in ALS work order L2495714 exceeded the ALS DQOs; therefore, associated sample results that are within five times the method blank are not considered reliable. Total vanadium and total calcium are not evaluated parameters in the AEMP, but if these data are used in the future, this should be considered.

In some cases, matrix spikes did not achieve DQOs and analytical detection limits had to be raised.



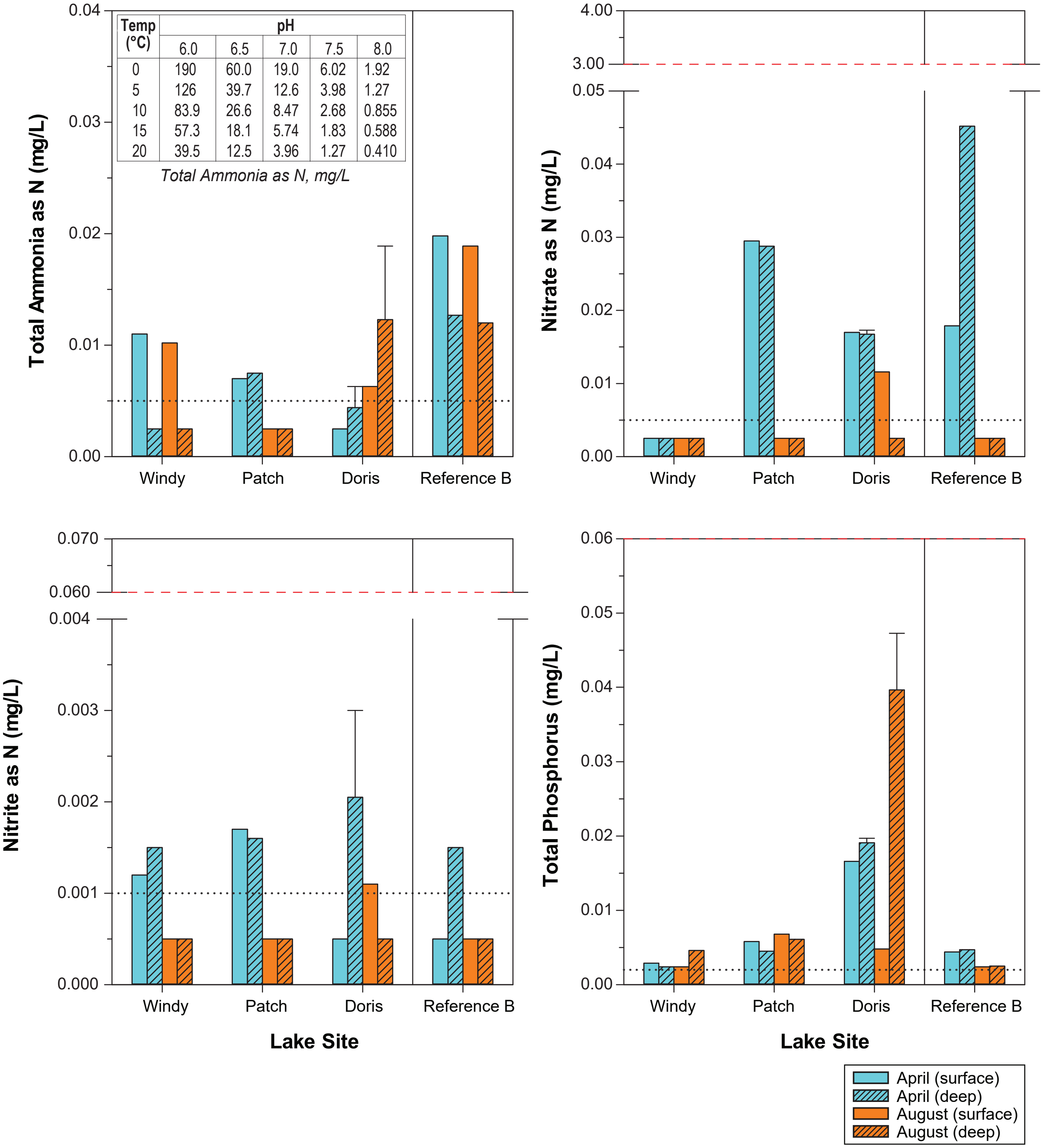
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guideline pH range (6.5–9.0).
The CCME guidelines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

Figure A.4-1: pH, Total Suspended Solids, and Turbidity in Lakes, Hope Bay Project, 2020



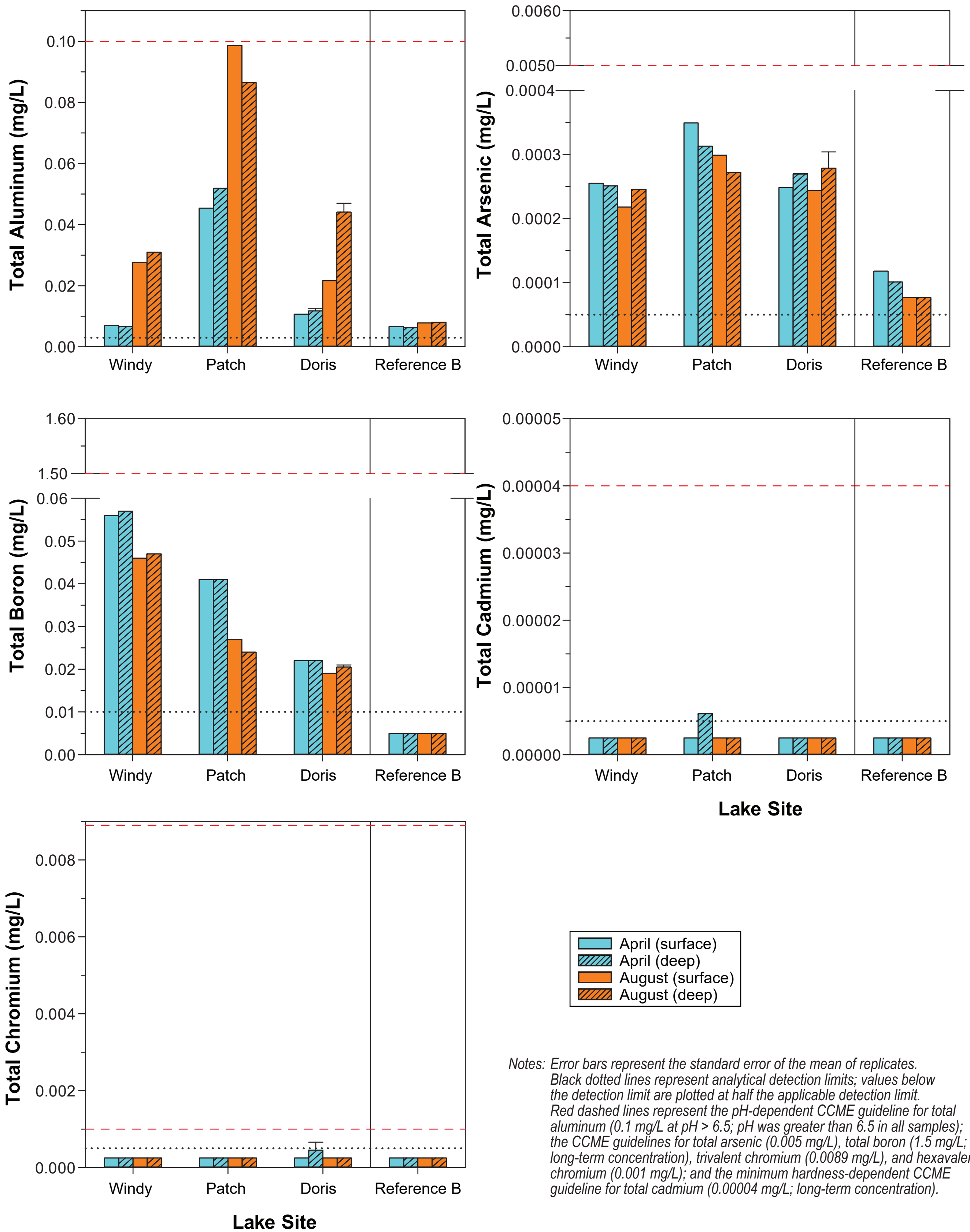
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent CCME guidelines for chloride (120 mg/L; long-term concentration)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

Figure A.4-2: Chloride and Fluoride Concentrations in Lakes, Hope Bay Project, 2020



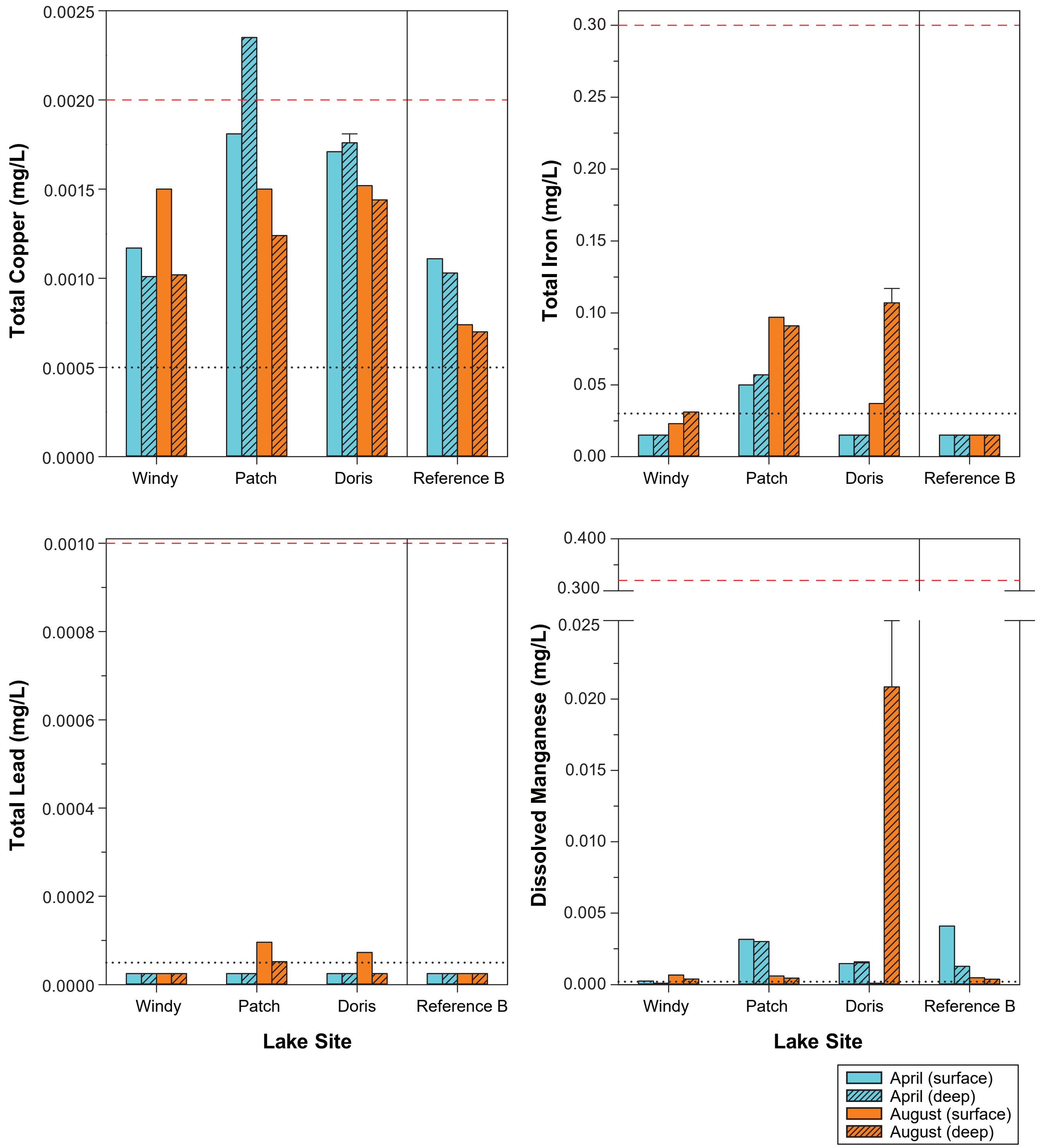
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Inset table shows the pH- and temperature-dependent CCME guideline for total ammonia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

Figure A.4-3: Ammonia, Nitrate, Nitrite, and Phosphorus Concentrations in Lakes, Hope Bay Project, 2020



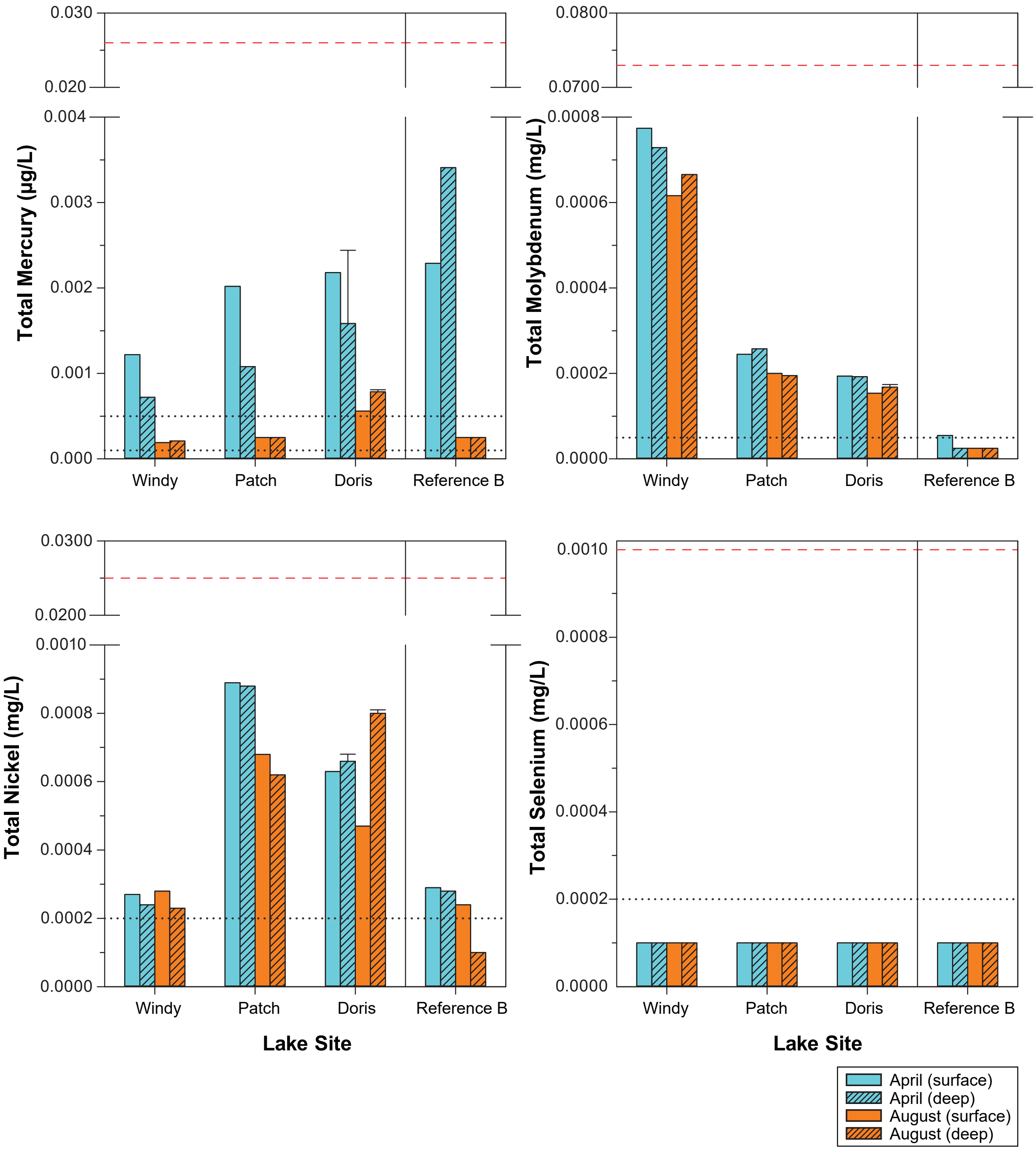
Notes: Error bars represent the standard error of the mean of replicates. Black dotted lines represent analytical detection limits; values below the detection limit are plotted at half the applicable detection limit. Red dashed lines represent the pH-dependent CCME guideline for total aluminum (0.1 mg/L at pH > 6.5; pH was greater than 6.5 in all samples); the CCME guidelines for total arsenic (0.005 mg/L), total boron (1.5 mg/L; long-term concentration), trivalent chromium (0.0089 mg/L), and hexavalent chromium (0.001 mg/L); and the minimum hardness-dependent CCME guideline for total cadmium (0.00004 mg/L; long-term concentration).

Figure A.4-4: Aluminum, Arsenic, Boron, Cadmium, and Chromium Concentrations in Lakes, Hope Bay Project, 2020



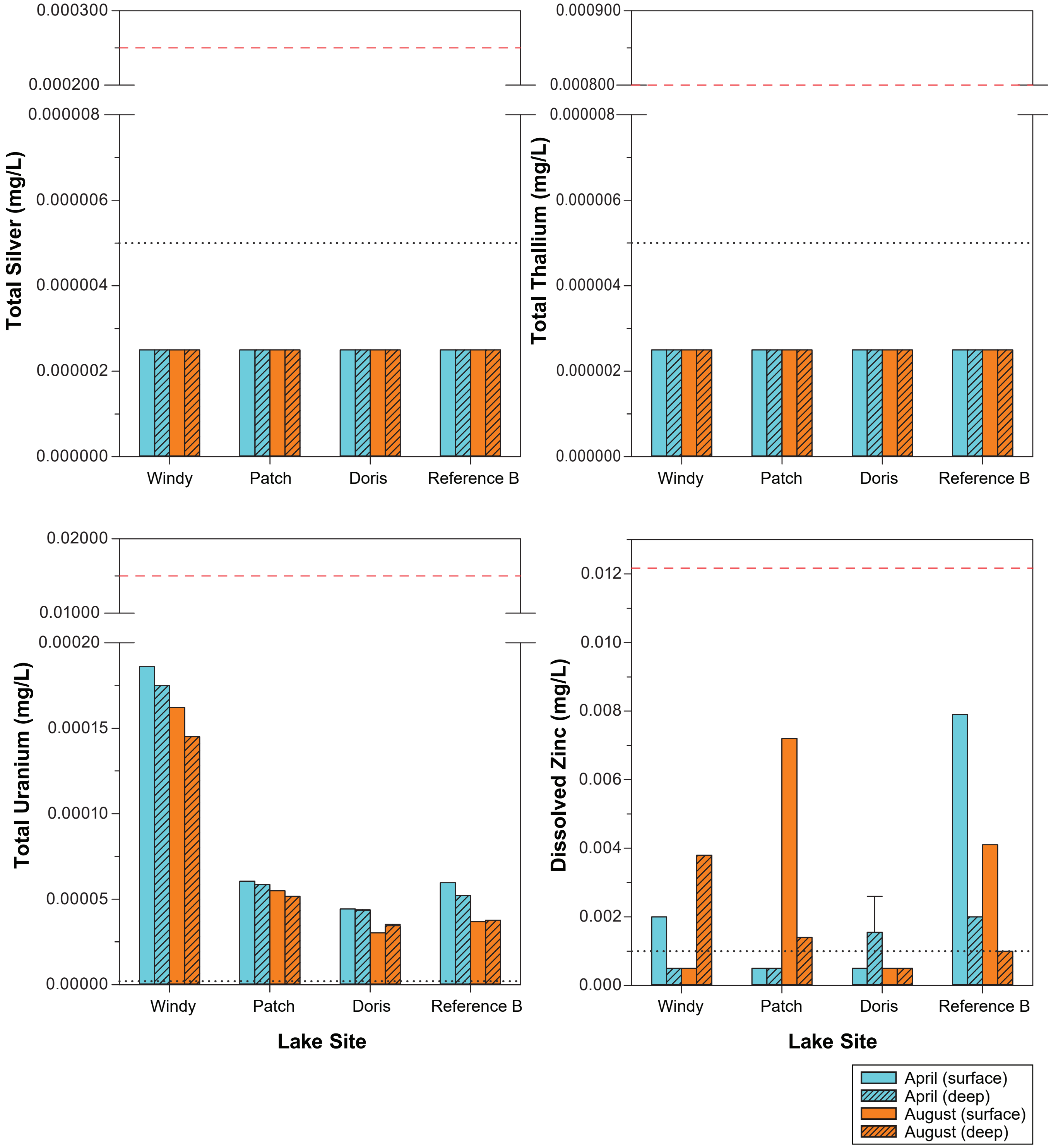
Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Red dashed lines represent the CCME guidelines for total iron (0.3 mg/L), the minimum hardness-dependent CCME guidelines for total copper (0.002 mg/L) and total lead (0.001 mg/L), and the minimum pH- and hardness-dependent guideline for dissolved manganese for the range of pH and hardness measured in exposure lakes in 2020 (0.320 mg/L; long-term guideline).

Figure A.4-5: Copper, Iron, Lead, and Manganese Concentrations in Lakes, Hope Bay Project, 2020



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 CCME guidelines for total inorganic mercury (0.026 g/L) and total selenium (0.001 mg/L), the interim CCME guideline for total molybdenum (0.073 mg/L), and the minimum hardness-dependent CCME guideline for total nickel (0.025 mg/L).

Figure A.4-6: Mercury, Molybdenum, Nickel, and Selenium Concentrations in Lakes, Hope Bay Project, 2020



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 total silver (0.00025 mg/L; long-term concentration), total thallium (0.0008 mg/L), total uranium (0.015 mg/L; long-term concentration), and the minimum pH-, DOC-, and hardness-dependent guideline for dissolved zinc for the range of pH, DOC, and hardness measured in exposure lakes in 2020 (0.0122 mg/L; long-term concentration).

Figure A.4-7: Silver, Thallium, Uranium, and Zinc Concentrations in Lakes, Hope Bay Project, 2020

Annex A.4-1: Water Quality Data, Hope Bay Project, 2020

Lake:	Units	CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	Doris Lake			Patch Lake		Reference Lake B		Windy Lake	
Replicate:				1	1	2	1	1	1	1	1	1
Depth Sampled (m):				3.0	10	10	2.5	3.5	3.0	7.0	3.0	14
Date Sampled:				9-Apr-2020	9-Apr-2020	9-Apr-2020	9-Apr-2020	9-Apr-2020	12-Apr-2020	12-Apr-2020	13-Apr-2020	13-Apr-2020
ALS Sample ID:				L2436487-1	L2436487-2	L2436487-3	L2436487-4	L2436487-5	L2436698-1	L2436698-2	L2436698-3	L2436698-4
Physical Tests												
Conductivity	uS/cm		2.0	272	274	273	487	487	81.2	75.2	527	514
Hardness (as $CaCO_3$)	mg/L		0.50	47.3	46.9	46.8	86.0	86.7	21.6	19.4	85.3	83.0
pH	pH	6.5 to 9.0	0.10	7.45	7.45	7.46	7.71	7.72	7.14	7.07	7.77	7.77
Total Suspended Solids	mg/L	dependent on background levels	1.0	2.1	2.9	2.1	<1.0	<1.0	1.0	<1.0	<1.0	1.1
Turbidity	NTU	dependent on background levels	0.10	2.84	2.74	2.82	1.08	1.10	0.16	0.17	0.17	0.17
Anions and Nutrients												
Alkalinity, Total (as $CaCO_3$)	mg/L		1.0	34.2	33.6	34.2	59.8	60.2	19.8	16.3	61.0	60.5
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	<0.0050	0.0063	<0.0050	0.0070	0.0075	0.0198	0.0127	0.011	<0.0050
Bromide (Br)	mg/L		0.050	0.174	0.175	0.181	0.324	0.336	<0.050	<0.050	0.428	0.413
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.50	59.2	58.4	58.4	108	111	10.6	9.5	115	111
Fluoride (F)	mg/L	0.12[b]	0.020	0.061	0.060	0.060	0.096	0.102	0.030	0.027	0.094	0.090
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.0050	0.0170	0.0173	0.0162	0.0295	0.0288	0.0179	0.0452	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.0010	<0.0010	0.0011	0.0030	0.0017	0.0016	<0.0010	0.0015	0.0012	0.0015
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
Phosphorus (P)-Total	mg/L	Trigger ranges from guidance framework[c]	0.0020	0.0166	0.0185	0.0197	0.0058	0.0045	0.0044	0.0047	0.0029	0.0024
Sulphate (SO_4)	mg/L		0.30	2.80	2.79	2.76	4.04	4.13	2.79	2.58	10.00	9.68
Organic/Inorganic Carbon												
Dissolved Organic Carbon	mg/L		0.50	6.79	6.81	6.88	7.69	7.83	4.27	3.90	2.43	2.17
Total Organic Carbon	mg/L		0.50	7.22	7.11	7.02	7.90	7.83	4.02	3.82	2.24	2.30
Total Metals												
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0107	0.0125	0.0110	0.0454	0.0519	0.0066	0.0064	0.0070	0.0066
Antimony (Sb)	mg/L		0.000030	<0.000030	<0.000030	<0.000030	0.000033	0.000034	<0.000030	<0.000030	0.000083	0.000077
Arsenic (As)	mg/L	0.005	0.000050	0.000248	0.000269	0.000270	0.000349	0.000313	0.000118	0.000101	0.000255	0.000251
Barium (Ba)	mg/L		0.00010	0.00249	0.00257	0.00253	0.00397	0.00408	0.00261	0.00251	0.00274	0.00246
Beryllium (Be)	mg/L		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
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.010	0.022	0.022	0.022	0.041	0.041	<0.010	<0.010	0.056	0.057
Cadmium (Cd)	mg/L	short-term: 0.00011 to 0.00770; long-term: 0.00004 to 0.00037[d]	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000061	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	7.71	7.54	7.67	14.1	14.4	5.08	4.50	14.0	13.9
Cesium (Cs)	mg/L		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	0.00066	<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	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002 to 0.004[e]	0.00050	0.00171	0.00171	0.00181	0.00181	0.00235	0.00111	0.00103	0.00117	0.00101
Gallium (Ga)	mg/L		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	<0.030	0.050	0.057	<0.030	<0.030	<0.030	<0.030
Lead (Pb)	mg/L	0.001 to 0.007[f]	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00050	0.00317	0.00316	0.00320	0.00672	0.00672	<0.00050	<0.00050	0.00330	0.00333
Magnesium (Mg)	mg/L		0.10	6.82	6.81	6.70	12.3	12.3	2.17	1.97	12.2	11.7
Manganese (Mn)	mg/L		0.00020	0.00287	0.00300	0.00308	0.00580	0.00634	0.0010	0.0020	0.00077	0.00078
Mercury (Hg)	µg/L	Inorganic Hg: 0.026	0.00050	0.00218	0.00244	0.00073	0.00202	0.00108	0.00229	0.00341	0.00122	0.00072
Molybdenum (Mo)	mg/L	0.073[b]	0.000050	0.000194	0.000192	0.000193	0.000245	0.000258	0.000055	<0.000050	0.000774	0.000729
Nickel (Ni)	mg/L	0.025 to 0.15[g]	0.00020	0.00063	0.00068	0.00064	0.00089	0.00088	0.00029	0.00028	0.00027	0.00024
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.5	2.6	2.6	4.5	4.5	<2.0	<2.0	5.1	4.9
Rhenium (Re)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

Annex A.4-1: Water Quality Data, Hope Bay Project, 2020

Lake:	Units	CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	Doris Lake			Patch Lake		Reference Lake B		Windy Lake	
Replicate:				1	1	2	1	1	1	1	1	1
Depth Sampled (m):				3.0	10	10	2.5	3.5	3.0	7.0	3.0	14
Date Sampled:				9-Apr-2020	9-Apr-2020	9-Apr-2020	9-Apr-2020	9-Apr-2020	12-Apr-2020	12-Apr-2020	13-Apr-2020	13-Apr-2020
ALS Sample ID:				L2436487-1	L2436487-2	L2436487-3	L2436487-4	L2436487-5	L2436698-1	L2436698-2	L2436698-3	L2436698-4
Total Metals *(cont'd)*												
Rubidium (Rb)	mg/L		0.000020	0.00155	0.00156	0.00155	0.00234	0.00230	0.00122	0.00111	0.00230	0.00224
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
Silicon (Si)	mg/L		0.10	1.23	1.23	1.25	0.87	0.85	0.25	0.39	0.43	0.46
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
Sodium (Na)	mg/L		2.0	31.1	31.9	32.8	57.5	60.0	6.3	5.6	67.2	64.6
Strontium (Sr)	mg/L		0.00020	0.0422	0.0406	0.0409	0.0813	0.0856	0.0278	0.0251	0.0741	0.0704
Tellurium (Te)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
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
Thorium (Th)	mg/L		0.0000050	0.0000177	0.0000166	0.0000172	0.0000206	0.0000240	0.0000103	0.0000101	<0.0000050	<0.0000050
Tin (Sn)	mg/L		0.00020	<0.00020	<0.00020	0.00021	<0.00020	0.00095	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	<0.00020	<0.00020	<0.00020	0.00091	0.00104	<0.00020	<0.00020	0.00034	0.00021
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	0.000015	0.000015	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000443	0.0000434	0.0000438	0.0000605	0.0000585	0.0000596	0.0000521	0.000186	0.000175
Vanadium (V)	mg/L		0.000050	0.000137	0.000155	0.000140	0.000172	0.000184	0.000091	0.000093	0.000140	0.000133
Yttrium (Y)	mg/L		0.0000050	0.0000218	0.0000283	0.0000230	0.0000351	0.0000396	0.0000221	0.0000228	0.0000051	0.0000058
Zinc (Zn)	mg/L		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	0.000059	0.000057	0.000059	0.000061	0.000068	0.000055	<0.000050	<0.000050	<0.000050
Dissolved Metals (Field-filtered)												
Manganese (Mn)	mg/L	short-term: hardness-dependent; long-term: pH- and hardness-dependent[h]	0.00020	0.00146	0.00144	0.00160	0.00317	0.00301	0.00410	0.00127	0.00024	<0.00020
Zinc (Zn)	mg/L	pH-, hardness-, and DOC-dependent[i]	0.0010	<0.0010	<0.0010	0.0026	<0.0010	<0.0010	0.0079	0.0020	0.0020	<0.0010

Notes:

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

[a] *Canadian water quality guidelines (CWQG) for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment (CCME 2020)*

[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 <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 ≤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 ≤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 short-tern benchmark for dissolved manganese is hardness dependent (hardness as $CaCO_3$) and is calculated using the equation: CWQG = $e^{(0.878[\ln(\text{hardness})] + 4.76)}$; this equation is valid between hardness 25 and 250 mg/L. The long-term benchmark for dissolved manganese is pH and hardness dependent, and is determined using the look-up table provided in CCME (2019).*

[i] *The dissolved zinc water quality guideline is calculated from the pH, hardness, and dissolved organic carbon (DOC) concentration. The short-term benchmark is calculated using the equation: CWQG (mg/L) = $0.001*e^{\{0.833[\ln(\text{hardness})] +0.240[\ln(\text{DOC})] + 0.526\}}$; this equation is valid between hardness 13.8 and 250.5 mg $CaCO_3$/L and DOC 0.3 and 17.3 mg/L. The long-term benchmark is calculated using the equation: CWQG (mg/L) = $0.001*e^{0.947[\ln(\text{hardness})] - 0.815[pH] + 0.398[\ln(\text{DOC})] + 4.625\}}$; this equation is valid between hardness 23.4 and 399 mg $CaCO_3$/L, pH 6.5 and 8.13, and DOC 0.3 to 22.9 mg/L.*

Annex A.4-1: Water Quality Data, Hope Bay Project, 2020

Lake:	Units	CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	Doris Lake			Windy Lake		Patch Lake		Reference Lake B	
Replicate:				1	1	2	1	1	1	1	1	1
Depth Sampled (m):				1.0	12	12	1.0	15	1.0	5.0	1.0	8.3
Date Sampled:				12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	25-Aug-2020	25-Aug-2020
ALS Sample ID:				VA20B2888-001	VA20B2888-002	VA20B2888-003	VA20B2888-005	VA20B2888-006	L2490479-1	L2490479-2	L2495714-1	L2495714-2
Physical Tests												
Conductivity	uS/cm		2.0	221	221	221	430	434	293	293	47.4	47.8
Hardness (as $CaCO_3$)	mg/L		0.50	40.2	42.8	41.9	74.1	73.7	50.7	49.3	12.6	12.2
pH	pH	6.5 to 9.0	0.10	7.66	7.21	7.19	7.93	7.86	7.49	7.51	7.24	7.25
Total Suspended Solids	mg/L	dependent on background levels	1.0	3.5	5.3	6.7	<1.0	1.1	1.7	1.9	<1.0	<1.0
Turbidity	NTU	dependent on background levels	0.10	4.18	8.79	9.27	0.63	0.74	1.68	2.28	0.26	0.25
Anions and Nutrients												
Alkalinity, Total (as $CaCO_3$)	mg/L		1.0	25.3	25.4	25.5	47	46.5	34.1	34.4	10.1	10.3
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	0.0063	0.0189	0.0057	0.0102	<0.0050	<0.0050	<0.0050	0.0189	0.012
Bromide (Br)	mg/L		0.050	0.198	0.206	0.202	0.416	0.413	0.196	0.200	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.50	49.7	49.7	49.9	98.2	99	62.8	62.9	6.07	6.03
Fluoride (F)	mg/L	0.12[b]	0.020	0.057	0.056	0.056	0.085	0.088	0.064	0.064	0.021	0.021
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.0050	0.0116	<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	0.0011	<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
Phosphorus (P)-Total	mg/L	Trigger ranges from guidance framework[c]	0.0020	0.0048	0.032	0.0473	0.0024	0.0046	0.0068	0.0061	0.0024	0.0025
Sulphate (SO_4)	mg/L		0.30	2.35	2.35	2.36	8.73	8.78	2.36	2.37	1.58	1.58
Organic/Inorganic Carbon												
Dissolved Organic Carbon	mg/L		0.50	6.14	5.65	5.98	1.92	2.17	5.09	4.86	2.78	2.75
Total Organic Carbon	mg/L		0.50	5.90	5.81	5.91	1.80	1.85	5.04	4.92	3.41	3.05
Total Metals												
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0216	0.0412	0.0470	0.0276	0.0310	0.0986	0.0865	0.0078	0.0081
Antimony (Sb)	mg/L		0.000030	<0.000030	<0.000030	<0.000030	0.00007	0.00007	0.000089	0.000044	<0.000030	<0.000030
Arsenic (As)	mg/L	0.005	0.000050	0.000244	0.000253	0.000304	0.000218	0.000246	0.000299	0.000272	0.000077	0.000077
Barium (Ba)	mg/L		0.00010	0.00225	0.00299	0.00287	0.00224	0.00237	0.00279	0.00256	0.00168	0.00139
Beryllium (Be)	mg/L		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
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.010	0.019	0.021	0.020	0.046	0.047	0.027	0.024	<0.010	<0.010
Cadmium (Cd)	mg/L	short-term: 0.00011 to 0.00770; long-term: 0.00004 to 0.00037[d]	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	7.06	7.39	7.43	12.1	12.3	8.87	8.04	3.00	2.90
Cesium (Cs)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000051	0.0000072	0.0000085	<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
Cobalt (Co)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000052	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002 to 0.004[e]	0.00050	0.00152	0.00144	0.00144	0.00150	0.00102	0.00150	0.00124	0.00074	0.00070
Gallium (Ga)	mg/L		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	0.037	0.097	0.117	0.023	0.031	0.097	0.091	<0.030	<0.030
Lead (Pb)	mg/L	0.001 to 0.007[f]	0.000050	0.000073	<0.000050	<0.000050	<0.000050	<0.000050	0.000096	0.000052	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00050	0.00295	0.00316	0.00313	0.00288	0.00297	0.00417	0.00385	<0.00050	<0.00050
Magnesium (Mg)	mg/L		0.10	5.49	5.92	5.68	10.6	10.4	6.94	7.11	1.25	1.20
Manganese (Mn)	mg/L		0.00020	0.00735	0.0399	0.0504	0.00154	0.00178	0.0055	0.0048	0.00167	0.00154
Mercury (Hg)	µg/L	Inorganic Hg: 0.026	0.00050	0.00056	0.00081	0.00076	0.00019	0.00021	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.073[b]	0.000050	0.000154	0.000174	0.000162	0.000616	0.000666	0.000200	0.000195	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.025 to 0.15[g]	0.00020	0.00047	0.00081	0.00079	0.00028	0.00023	0.00068	0.00062	0.00024	<0.00020
Phosphorus (P)	mg/L		0.30	<0.050	0.052	0.058	<0.050	<0.050	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.03	2.15	2.12	3.97	4.01	2.5	2.4	<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

Annex A.4-1: Water Quality Data, Hope Bay Project, 2020

Lake:	Units	CCME Guideline for the Protection of Aquatic life[a]	Realized Detection Limit	Doris Lake			Windy Lake		Patch Lake		Reference Lake B	
Replicate:				1	1	2	1	1	1	1	1	1
Depth Sampled (m):				1.0	12	12	1.0	15	1.0	5.0	1.0	8.3
Date Sampled:				12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020	25-Aug-2020	25-Aug-2020
ALS Sample ID:				VA20B2888-001	VA20B2888-002	VA20B2888-003	VA20B2888-005	VA20B2888-006	L2490479-1	L2490479-2	L2495714-1	L2495714-2
Total Metals *(cont'd)*												
Rubidium (Rb)	mg/L		0.000020	0.00134	0.00143	0.00144	0.00195	0.00204	0.00164	0.00158	0.000773	0.000759
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
Silicon (Si)	mg/L		0.10	1.02	1.21	1.2	0.42	0.44	0.41	0.39	0.13	0.12
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
Sodium (Na)	mg/L		2.0	25.4	25.9	25.2	53.1	53.4	31.9	32.0	3.7	3.8
Strontium (Sr)	mg/L		0.00020	0.0349	0.0349	0.0356	0.0612	0.0609	0.0486	0.0470	0.0156	0.0156
Tellurium (Te)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
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
Thorium (Th)	mg/L		0.0000050	0.0000119	0.0000154	0.0000159	0.0000101	0.0000232	0.0000398	0.0000249	<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
Titanium (Ti)	mg/L		0.00020	0.00048	0.00097	<0.00120	0.00118	0.00157	0.00388	0.00368	<0.00020	<0.00020
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000020	0.000014	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000303	0.0000336	0.0000353	0.000162	0.000145	0.0000549	0.0000517	0.0000368	0.0000377
Vanadium (V)	mg/L		0.000050	0.000154	0.000208	0.000222	0.000167	0.000172	0.000276	0.000277	0.000062	0.000065
Yttrium (Y)	mg/L		0.0000050	0.0000152	0.0000287	0.0000275	0.0000144	0.0000157	0.0000359	0.0000293	0.0000100	0.0000078
Zinc (Zn)	mg/L		0.0030	<0.0030	0.004	<0.0030	<0.0030	<0.0030	0.0058	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.000050	<0.000050	0.000059	0.000064	<0.000050	<0.000050	0.000055	0.000057	<0.000050	<0.000050
Dissolved Metals (Field-filtered)												
Manganese (Mn)	mg/L	short-term: hardness-dependent; long-term: pH- and hardness-dependent[h]	0.00020	<0.00020	0.0162	0.0255	0.00067	0.00039	0.00060	0.00045	0.00047	0.00037
Zinc (Zn)	mg/L	pH-, hardness-, and DOC-dependent[i]	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0038	0.0072	0.0014	0.0041	0.0010

Notes:

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

[a] *Canadian water quality guidelines (CWQG) for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment (CCME 2020)*

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

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

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

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

[h] *The short-tern benchmark for dissolved manganese is hardness dependent (hardness as $CaCO_3$) and is calculated using the equation: CWQG = $e^{(0.878[ln(hardness)] + 4.76)}$; this equation is valid between hardness 25 and 250 mg/L. The long-term benchmark for dissolved manganese is pH and hardness dependent, and is determined using the look-up table provided in CCME (2019).*

[i] *The dissolved zinc water quality guideline is calculated from the pH, hardness, and dissolved organic carbon (DOC) concentration. The short-term benchmark is calculated using the equation: CWQG (mg/L) = $0.001*e^{\{0.833[ln(hardness)] +0 .240[ln(DOC)] + 0.526\}}$; this equation is valid between hardness 13.8 and 250.5 mg $CaCO_3$/L and DOC 0.3 and 17.3 mg/L. The long-term benchmark is calculated using the equation: CWQG (mg/L) = $0.001*e^{0.947[ln(hardness)] - 0.815[pH] + 0.398[ln(DOC)] + 4.625}$; this equation is valid between hardness 23.4 and 399 mg $CaCO_3$/L, pH 6.5 and 8.13, and DOC 0.3 to 22.9 mg/L.*

Annex A.4-2: Relative Percent Difference Calculations for Duplicate Water Quality Samples, Hope Bay Project, 2020

Lake:	Units	Realized Detection Limit	5x Realized Detection Limit	Doris Lake			Doris Lake B		
Replicate:				1	2		1	2	
Depth Sampled (m):				10			12		
Date Sampled:				9-Apr-2020			12-Aug-2020		
ALS Sample ID:				L2436487-2	L2436487-3	RPD (%)	VA20B2888-002	VA20B2888-003	RPD (%)
Physical Tests									
Conductivity	µS/cm	2.0	10.0	274	273	0.4	221	221	0
Hardness (as $CaCO_3$)	mg/L	0.50	2.50	46.9	46.8	0.2	42.8	41.9	2.1
pH	pH	0.10	0.50	7.45	7.46	0.1	7.21	7.19	0.3
Total Suspended Solids	mg/L	1.0	5.0	2.90	2.10	n/a	5.30	6.70	**23.3**
Turbidity	NTU	0.10	0.50	2.74	2.82	2.9	8.79	9.27	5.3
Anions and Nutrients									
Alkalinity, Total (as $CaCO_3$)	mg/L	1.0	5.0	33.6	34.2	1.8	25.4	25.5	0.4
Ammonia, Total (as N)	mg/L	0.005	0.025	0.0063	<0.0050	n/a	0.0189	0.0057	n/a
Bromide (Br)	mg/L	0.050	0.250	0.175	0.181	n/a	0.206	0.202	n/a
Chloride (Cl)	mg/L	0.50	2.50	58.4	58.4	0	49.7	49.9	0.4
Fluoride (F)	mg/L	0.020	0.100	0.06	0.06	n/a	0.056	0.056	n/a
Nitrate (as N)	mg/L	0.0050	0.0250	0.0173	0.0162	n/a	<0.0050	<0.0050	n/a
Nitrite (as N)	mg/L	0.0010	0.0050	0.0011	0.0030	n/a	<0.0010	<0.0010	n/a
Orthophosphate, Dissolved (as P)	mg/L	0.0010	0.0050	<0.0010	<0.0010	n/a	<0.0010	<0.0010	n/a
Phosphorus, Total (as P)	mg/L	0.0020	0.0100	0.0185	0.0197	6.3	0.0320	0.0473	**38.6**
Sulphate (SO_4)	mg/L	0.30	1.50	2.79	2.76	1.1	2.35	2.36	0.4
Organic Carbon									
Dissolved Organic Carbon	mg/L	0.50	2.50	6.81	6.88	1.0	5.65	5.98	5.7
Total Organic Carbon	mg/L	0.50	2.50	7.11	7.02	1.3	5.81	5.91	1.7
Total Metals									
Aluminum (Al)	mg/L	0.0030	0.0150	0.0125	0.011	n/a	0.0412	0.0470	13.2
Antimony (Sb)	mg/L	0.000030	0.000150	<0.000030	<0.000030	n/a	<0.000030	<0.000030	n/a
Arsenic (As)	mg/L	0.000050	0.000250	0.000269	0.000270	0.4	0.000253	0.000304	18.3
Barium (Ba)	mg/L	0.00010	0.00050	0.00257	0.00253	1.6	0.00299	0.00287	4.1
Beryllium (Be)	mg/L	0.0000050	0.0000250	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Bismuth (Bi)	mg/L	0.000050	0.000250	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a
Boron (B)	mg/L	0.010	0.050	0.022	0.022	n/a	0.021	0.020	n/a
Cadmium (Cd)	mg/L	0.0000050	0.0000250	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Calcium (Ca)	mg/L	0.050	0.250	7.54	7.67	1.7	7.39	7.43	0.5
Cesium (Cs)	mg/L	0.0000050	0.0000250	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Chromium (Cr)	mg/L	0.00050	0.00250	0.00066	<0.00050	n/a	<0.00050	<0.00050	n/a

Annex A.4-2: Relative Percent Difference Calculations for Duplicate Water Quality Samples, Hope Bay Project, 2020

Lake:	Units	Realized Detection Limit	5x Realized Detection Limit	Doris Lake			Doris Lake B		
Replicate:				1	2		1	2	
Depth Sampled (m):				10			12		
Date Sampled:				9-Apr-2020			12-Aug-2020		
ALS Sample ID:				L2436487-2	L2436487-3	RPD (%)	VA20B2888-002	VA20B2888-003	RPD (%)
Total Metals *(cont'd)*									
Cobalt (Co)	mg/L	0.000050	0.000250	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a
Copper (Cu)	mg/L	0.00050	0.00250	0.00171	0.00181	n/a	0.00144	0.00144	n/a
Gallium (Ga)	mg/L	0.000050	0.000250	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a
Iron (Fe)	mg/L	0.030	0.150	<0.030	<0.030	n/a	0.097	0.117	n/a
Lead (Pb)	mg/L	0.000050	0.000250	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a
Lithium (Li)	mg/L	0.00050	0.00250	0.00316	0.00320	1.3	0.00316	0.00313	1.0
Magnesium (Mg)	mg/L	0.10	0.50	6.81	6.70	1.6	5.92	5.68	4.1
Manganese (Mn)	mg/L	0.00020	0.00100	0.00300	0.00308	2.6	0.0399	0.0504	**23.3**
Mercury (Hg)	µg/L	0.00050	0.00250	0.00244	0.00073	n/a	0.00081	0.00076	n/a
Molybdenum (Mo)	mg/L	0.000050	0.000250	0.000192	0.000193	n/a	0.000174	0.000162	n/a
Nickel (Ni)	mg/L	0.00020	0.00100	0.00068	0.00064	n/a	0.00081	0.00079	n/a
Phosphorus (P)	mg/L	0.30	1.50	<0.30	<0.30	n/a	0.052	0.058	n/a
Potassium (K)	mg/L	2.0	10.0	2.6	2.6	n/a	2.15	2.12	n/a
Rhenium (Re)	mg/L	0.0000050	0.0000250	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Rubidium (Rb)	mg/L	0.000020	0.000100	0.00156	0.00155	0.6	0.00143	0.00144	0.7
Selenium (Se)	mg/L	0.00020	0.00100	<0.00020	<0.00020	n/a	<0.00020	<0.00020	n/a
Silicon (Si)	mg/L	0.10	0.50	1.23	1.25	1.6	1.21	1.20	0.8
Silver (Ag)	mg/L	0.0000050	0.0000250	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Sodium (Na)	mg/L	2.0	10.0	31.9	32.8	2.8	25.9	25.2	2.7
Strontium (Sr)	mg/L	0.00020	0.00100	0.0406	0.0409	0.7	0.0349	0.0356	2.0
Tellurium (Te)	mg/L	0.000050	0.000250	<0.000050	<0.000050	n/a	<0.000050	<0.000050	n/a
Thallium (Tl)	mg/L	0.0000050	0.0000250	<0.0000050	<0.0000050	n/a	<0.0000050	<0.0000050	n/a
Thorium (Th)	mg/L	0.0000050	0.0000250	0.0000166	0.0000172	n/a	0.0000154	0.0000159	n/a
Tin (Sn)	mg/L	0.00020	0.00100	<0.00020	0.00021	n/a	<0.00020	<0.00020	n/a
Titanium (Ti)	mg/L	0.00020	0.00100	<0.00020	<0.00020	n/a	0.00097	<0.00120	n/a
Tungsten (W)	mg/L	0.000010	0.000050	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Uranium (U)	mg/L	0.0000020	0.0000100	0.0000434	0.0000438	0.9	0.0000336	0.0000353	4.9
Vanadium (V)	mg/L	0.000050	0.000250	0.000155	0.000140	n/a	0.000208	0.000222	n/a
Yttrium (Y)	mg/L	0.0000050	0.0000250	0.0000283	0.0000230	**20.7**	0.0000287	0.0000275	4.3
Zinc (Zn)	mg/L	0.0030	0.0150	<0.0030	<0.0030	n/a	0.004	<0.0030	n/a
Zirconium (Zr)	mg/L	0.000050	0.000250	0.000057	0.000059	n/a	0.000059	0.000064	n/a

Annex A.4-2: Relative Percent Difference Calculations for Duplicate Water Quality Samples, Hope Bay Project, 2020

Lake:	Units	Realized Detection Limit	5x Realized Detection Limit	Doris Lake			Doris Lake B		
Replicate:				1	2		1	2	
Depth Sampled (m):				10			12		
Date Sampled:				9-Apr-2020			12-Aug-2020		
ALS Sample ID:				L2436487-2	L2436487-3	RPD (%)	VA20B2888-002	VA20B2888-003	RPD (%)
Dissolved Metals (Field-filtered)									
Manganese (Mn)	mg/L	0.00020	0.00100	0.00144	0.00160	10.5	0.0162	0.0255	**44.6**
Zinc (Zn)	mg/L	0.0010	0.0050	<0.0010	0.0026	n/a	<0.0010	<0.0010	n/a

Notes:

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

Relative percent difference (RPD) is only calculated if at least one duplicate concentration is greater than five times the detection limit.

Bold and highlighted values indicate a RPD of greater than 20% but less than 50%.

No RPD values exceeded 50%.

Annex A.4-3: Blank Data for Water Quality Sampling, Hope Bay Project, 2020

Blank Type:	Units	Equipment Blank	Field Blank	Travel Blank	Field Blank	Equipment Blank	Travel Blank
Date Sampled:		9-Apr-2020	9-Apr-2020	9-Apr-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020
ALS Sample ID:		L2436487-6	L2436487-7	L2436487-8	VA20B2888-004	VA20B2888-007	VA20B2888-008
Physical Tests							
Conductivity	µS/cm	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (as $CaCO_3$)	mg/L	<0.50	<0.50	<0.50	<0.60	<0.60	<0.60
pH	pH	5.45	5.33	5.26	5.40	5.79	5.50
Total Suspended Solids	mg/L	<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
Anions and Nutrients							
Alkalinity, Total (as $CaCO_3$)	mg/L	<1.0	<1.0	<1.0	<1.0	**1.1**	<1.0
Ammonia, Total (as N)	mg/L	<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
Chloride (Cl)	mg/L	<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
Nitrate (as N)	mg/L	<0.0050	**0.0063**	<0.0050	<0.0050	**0.0428**	<0.0050
Nitrite (as N)	mg/L	**0.0013**	<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	-
Phosphorus (P)-Total	mg/L	<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
Organic Carbon							
Dissolved Organic Carbon	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	-
Total Organic Carbon	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Metals							
Aluminum (Al)	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Antimony (Sb)	mg/L	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030	<0.000030
Arsenic (As)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Barium (Ba)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Beryllium (Be)	mg/L	<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
Boron (B)	mg/L	<0.010	<0.010	<0.010	**0.036**	<0.010	<0.010
Cadmium (Cd)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L	<0.050	<0.050	<0.050	<0.020	<0.020	<0.020
Cesium (Cs)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	<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	<0.000050
Copper (Cu)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Gallium (Ga)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050

Annex A.4-3: Blank Data for Water Quality Sampling, Hope Bay Project, 2020

Blank Type:	Units	Equipment Blank	Field Blank	Travel Blank	Field Blank	Equipment Blank	Travel Blank
Date Sampled:		9-Apr-2020	9-Apr-2020	9-Apr-2020	12-Aug-2020	12-Aug-2020	12-Aug-2020
ALS Sample ID:		L2436487-6	L2436487-7	L2436487-8	VA20B2888-004	VA20B2888-007	VA20B2888-008
Total Metals *(cont'd)*							
Iron (Fe)	mg/L	<0.030	<0.030	<0.030	<0.010	<0.010	<0.010
Lead (Pb)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Magnesium (Mg)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese (Mn)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Mercury (Hg)	µg/L	**0.00087**	**0.00208**	-	<0.00010	<0.00010	<0.00010
Molybdenum (Mo)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Nickel (Ni)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Phosphorus (P)	mg/L	<0.30	<0.30	<0.30	<0.050	<0.050	<0.050
Potassium (K)	mg/L	<2.0	<2.0	<2.0	<0.030	<0.030	<0.030
Rhenium (Re)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Selenium (Se)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silver (Ag)	mg/L	<0.0000050	<0.0000050	<0.0000050	**0.0000071**	<0.0000050	<0.0000050
Sodium (Na)	mg/L	<2.0	<2.0	<2.0	<0.020	<0.020	<0.020
Strontium (Sr)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tellurium (Te)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Thallium (Tl)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Thorium (Th)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Tin (Sn)	mg/L	<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
Tungsten (W)	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Vanadium (V)	mg/L	<0.000050	<0.000050	<0.000050	**0.000053**	<0.000050	<0.000050
Yttrium (Y)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Zinc (Zn)	mg/L	<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
Dissolved Metals (Field-filtered)							
Manganese (Mn)	mg/L	<0.00020	<0.00020	-	<0.00020	<0.00020	-
Zinc (Zn)	mg/L	<0.0010	**0.00120**	-	<0.0010	<0.0010	-

Notes:

Bold and highlighted values represent concentrations that are higher than analytical detection limits (pH was excluded from this screening).

"-" indicates paramerter not analyzed

Annex A.4-4: Laboratory QA/QC Results, Hope Bay Project, 2020

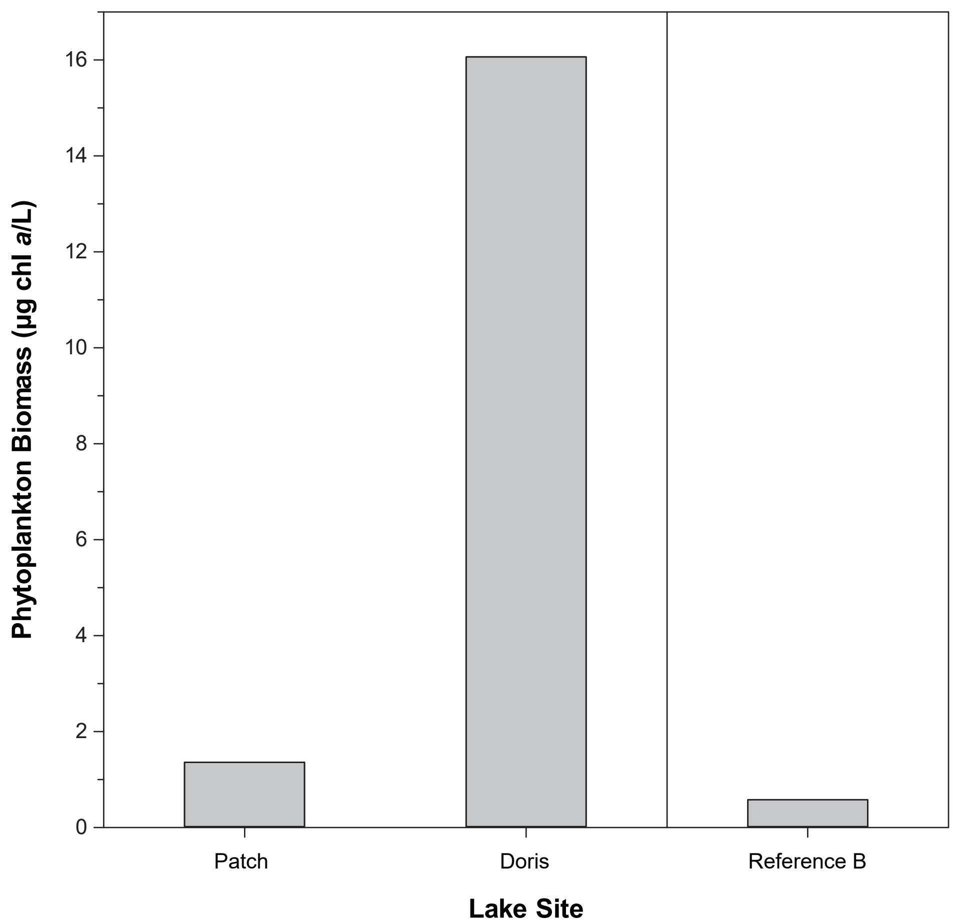
Sampling Month	ALS Work Order Number	QC Lot Did Not Meet ALS Hold Time Recommendations	Method Blank Exceeded ALS Data Quality Objective	Matrix Spike Recovery Could Not be Accurately Calculated due to High Analyte Background in Sample
April	L2436487	pH, turbidity, nitrate-N, nitrite-N, orthophosphate-P	Total vanadium	Dissolved organic carbon, total calcium, total magnesium, total sodium, total strontium
April	L2436698	pH, turbidity, nitrate-N, nitrite-N, orthophosphate-P		
August	L2490479	pH, total suspended solids, turbidity, nitrate-N, nitrite-N, orthophosphate-P		
August	L2495714	pH, turbidity, nitrate-N, nitrite-N, orthophosphate-P	Total calcium	Total magnesium, total sodium
August	VA20B2888	pH, turbidity, nitrate-N, nitrite-N, orthophosphate-P		

A.5 Phytoplankton Biomass

This section presents the phytoplankton biomass (chlorophyll *a*) data collected in August 2020 at the AEMP lake sites. Due to an oversight, only one chlorophyll *a* sample was collected in the surface waters of each AEMP lake site in 2020 instead of the usual three replicates. Table A.5-1 and Figure A.5-1 present the phytoplankton biomass measured in Patch Lake, Doris Lake, and Reference Lake B in 2020.

Table A.5-1: Phytoplankton Biomass Data, Hope Bay Project, 2020

Lake	Replicate #	Date Sampled	Depth Sampled (m)	ALS Sample ID	Phytoplankton Biomass (µg chl *a*/L)
Doris Lake	1	12-Aug-2020	1	VA20B2888-001	16.1
Patch Lake	1	12-Aug-2020	1	L2490479-1	1.36
Reference Lake B	1	25-Aug-2020	1	L2495714-1	0.58



Note: All chlorophyll a concentrations were above analytical detection limits.

Figure A.5-1: Phytoplankton Biomass (as Chlorophyll *a*), Hope Bay Project, August 2020

A.6 References

CCME. 2019. *Canadian water quality guidelines for the protection of aquatic life: manganese. In: Canadian environmental quality guidelines, 1999*. Canadian Council of Ministers of the Environment: Winnipeg, MB.

CCME. 2020. Canadian Council of Ministers of the Environment. st-ts.ccme.ca/ (Canadian water quality guidelines for the protection of aquatic life: Summary table accessed October 2020).

Clark, M. J. R. (editor) 2003. *British Columbia Field Sampling Manual. 2013 edition.* Water, Air and Climate Change Branch, Ministry of Water, Land and Air Protection: Victoria, BC.

Parsons, T. R., M. Takahashi, and B. Hargrave. 1984. *Biological Oceanographic Processes*. Oxford, UK: Pergamon Press.

TMAC. 2018. *Hope Bay Project: Aquatic Effects Monitoring Plan*. Prepared by TMAC Resources Inc.: Toronto, ON.

APPENDIX B 2020 HYDROLOGY COMPLIANCE MONITORING SUMMARY

ERM

120 Adelaide Street West, Suite 2010
Toronto, ON
Canada M5H 1T1

Telephone: +1 416 646 3608
Fax: +1 416 642 1269

www.erm.com

Memo

To	Agnico Eagle Mines Limited – Hope Bay
From	Patricia House and Cameron Evans
Cc	Nicole Bishop
Date	March 16, 2021
Reference	0510704-0003
Subject	2020 Hydrology Compliance Monitoring Summary

1. INTRODUCTION

The Hope Bay Project (the Project) is a gold mining development in the West Kitikmeot region of mainland Nunavut. The Project property is approximately 153 km southwest of Cambridge Bay on the southern shore of Melville Sound and contains a greenstone belt (the Belt) that runs 80 km in a north-south direction varying in width between 7 km and 20 km. The Project continued to be operated by TMAC Resources Inc. (TMAC) in 2020. On February 2, 2021 TMAC was purchased by Agnico Eagle Mines Ltd. (Agnico Eagle) but TMAC continues to exist as a legal entity and is now a wholly owned subsidiary of Agnico Eagle.

This memorandum provides a summary of the hydrology compliance monitoring program performed for the Hope Bay Project (the Project) in 2020. Compliance requirements for hydrometric monitoring, listed below, are set out in the Project Certificate (NIRB No. 003, amended September 23, 2016), the Type A and B Water License (NWB License No. 2AM-DOH1335 Type A, amended December 7, 2018, and NWB License No. 2BE-HOP1222 Type B, renewed June 31, 2012), and the Hope Bay Project Aquatic Effects Monitoring Plan (AEMP).

The Fisheries Authorization NU-02-0117.3 does not explicitly state a monitoring requirement of Roberts Lake outflow. However, monitoring outflows of this lake is necessary, as it is considered a critical component for evaluating the success of the Roberts Lake Outflow Fish Habitat Compensation Monitoring Program. Monitoring of Roberts Lake also provides a control with which to compare the AEMP monitored lakes.

The Type A Water License (No. 2AM DOH1335) sets out the following requirements applying to aquatic effects monitoring:

- Part I. Item 3: The Licensee shall undertake the Monitoring Program provided in Tables 1, 2, and 3 of Schedule I. Table 3 outlines the requirement for monitoring Doris Outflow (TL-2) during Operations upon commencement of mining in or beneath the Doris Lake Talik and monitoring Doris Lake (ST-12) water levels during Operations and Closure.

The Type B Water License (No. 2BE-HOP1222) sets out the following requirements:

- Part J. Item 9: The Licensee shall monitor water levels in Windy Lake during open water, in order to verify that additional water withdrawal for dust suppression activities does not result in drawdown beyond naturally occurring levels.

The New Project Certificate (NIRB No. 009) sets out the following requirements:

- New Term and Condition 10: the Proponent shall:
  a. monitor the effects of Project activities and infrastructure on surface water quality conditions;
  b. ensure the monitoring data is sufficient to compare the impact predictions made for the Project with actual monitoring results;
  c. ensure that the sampling locations and frequency of monitoring is consistent with and reflects the requirements of the Aquatic Effects Monitoring Plan, and Water Management Plan; and
  d. on an annual basis, compare monitoring results with the impact assessment predictions in the FEIS and will identify any significant discrepancies between impact predictions and monitoring results

The Project Aquatic Effects Monitoring Plan prescribes monitoring requirements based on project development phases. In 2020, the Doris development was in the operations phase and Madrid North was in the construction and operations phase, which triggered water level monitoring at Glenn and Imniagut lakes, as well as water level and outflow monitoring at Doris, Little Roberts, Ogama, Patch, PO, and Windy lakes. Tables 3.1-1 and 3.2-1 of the AEMP (TMAC 2018) outline these requirements.

Due to the COVID pandemic, the ability to collect data as per previous years was difficult due to limited staffing and travel restrictions. As a result, for all stations requiring helicopter access, pressure transducers were installed near the end of June and removed at the end of August, with no manual discharge measurements performed. Only Doris Lake and Doris Creek (TL-2) were monitored in line with past years. Data were collected to the best that conditions permitted to continue the comparison with past monitoring data and the predicted project effects, however due to the shortened monitoring period and limited manual measurements, there is greater uncertainty in the 2020 data than with previous years of monitoring.

The following section consists of 2020 monitoring data and results. These results are based on the comparison of 2020 monitoring data with past monitoring data and the predicted project effects from the Madrid-Boston Project Final Environmental Impact Statement (FEIS; TMAC 2017).

2. MONITORING STATIONS

The 2020 compliance monitoring program consisted of 10 hydrometric monitoring stations, as presented in Tables 2-1 and 2-2. Water level surveys and manual discharge measurements are typically conducted at these stations throughout the open water season, however, due to the limitations caused by COVID-19, only stations accessible by road (Doris Lake and TL-2) were visited during the open water season. At all other stations, only water level surveys were performed during installation in June and demobilization in August. Hydrometric stations monitored either Lake Level, Lake Outflow (discharge) or both. Most hydrometric stations are operated seasonally (during the open water season); however, Doris Lake-2 and Roberts Hydro-2 are operated year round.

Table 2-1: Station Types

Station	Station Type	Monitoring Period
Windy Outflow	Discharge and Water Level	Seasonal
Glenn Lake	Lake Level Only	Seasonal
Imniagut Lake	Lake Level Only	Seasonal
Patch Outflow	Discharge and Water Level	Seasonal
PO Outflow	Discharge and Water Level	Seasonal
Ogama Outflow	Discharge and Water Level	Seasonal
Doris Lake-2	Lake Level Only	Year Round
Doris Creek TL-2	Discharge Only	Seasonal
Roberts Hydro-2	Discharge and Water Level	Year Round
Little Roberts Outflow	Discharge and Water Level	Seasonal

Table 2-2: 2020 Station Locations

Station	Easting[1]	Northing[1]	Watershed Area (km^2)	Lake Coverage (%)
Windy Outflow	431404	7554948	13.73	41
Glenn Lake	430410	7562001	20.59	13
Imniagut Lake	433403	7551421	1.31	12
Patch Outflow	436248	7548973	32.16	23
PO Outflow	436749	7550055	35.30	23
Ogama Outflow	435595	7555262	74.93	18
Doris Lake-2	433547	7558601	90.29	19
Doris Creek TL-2	434059	7559504	90.29	19
Roberts Hydro-2	435231	7562674	97.83	18
Little Roberts Outflow	434548	7562652	194.15	18

[1] UTM Zone 13W

Seasonal stations consist of an INW PT2X vented pressure transducer placed on the lake or streambed in a weighted assembly, recording water level readings every 15 minutes. The Doris Lake-2 station consists of two Solinst Leveloggers, unvented pressure transducers, installed at depths of approximately 7 metres to monitor lake level year round. The Roberts Hydro-2 station consists of one Levelogger installed at approximately 2 m depth. The Leveloggers are coupled with a Solinst Barologger, located at Doris Camp, to compensate for changes in atmospheric pressure.

Water level surveys were performed using an engineer’s level and stadia rod using a minimum of three local benchmarks at each station. All benchmarks are tied to geodetic elevation.

Manual discharge measurements were performed using the velocity area method with an OTT MF Pro electromagnetic current meter. The Doris North Project 2013 Hydrology Compliance Monitoring Report (ERM 2014) describes the details of the standard methods used for installation of hydrometric stations, development of stage-discharge rating equations, and daily flow hydrographs for the Project.

3. 2020 ANALYSIS AND RESULTS

Tables 3-1 to 3-8 present the 2020 compliance monitoring results that include stage-discharge measurements, observed lake levels, rating equations, annual runoff, peak and low flows, and monthly runoff. Appendix A and Appendix B present the lake level graphs and the daily flow hydrographs, respectively. Appendix C and Appendix D present the mean daily lake level and the mean daily discharges, respectively.

Table 3-1: Summary of 2020 Stage and Discharge Measurements

Station	Date	Stage (m)	Discharge (m^3/s)	Measurement Made By
Windy Outflow	6/19/2020	18.409	n/a[1]	TMAC
	6/27/2020	18.410	n/a[1]	TMAC
	8/27/2020	18.280	n/a[1]	TMAC
Glenn Lake	6/20/2020	10.101	n/a[2]	TMAC
	6/27/2020	9.913	n/a[2]	TMAC
	8/27/2020	9.579	n/a[2]	TMAC
Imniagut Lake	6/19/2020	27.372	n/a[2]	TMAC
	6/27/2020	27.413	n/a[2]	TMAC
	8/27/2020	27.280	n/a[2]	TMAC
Patch Outflow	6/19/2020	26.541	n/a[1]	TMAC
	6/27/2020	26.502	n/a[1]	TMAC
	8/27/2020	26.222	n/a[1]	TMAC
PO Outflow	6/20/2020	26.478	n/a[1]	TMAC
	6/27/2020	26.396	n/a[1]	TMAC
	8/28/2020	26.108	n/a[1]	TMAC
Ogama Outflow	6/18/2020	24.032	n/a[1]	TMAC
	6/26/2020	24.444	n/a[1]	TMAC
	8/28/2020	24.024	n/a[1]	TMAC
Doris Lake-2	6/19/2020	22.220	n/a[1]	TMAC
	8/1/2020	21.856	n/a[1]	TMAC
	9/9/2020	21.755	n/a[1]	TMAC
	10/1/2020	21.761	n/a[1]	TMAC

Station	Date	Stage (m)	Discharge (m^3/s)	Measurement Made By
Doris Creek (TL-2)	6/18/2020	22.073	2.234	TMAC
	6/26/2020	21.744	n/a[1]	TMAC
	7/9/2020	21.955	n/a[1]	TMAC
Doris Creek (TL-2)	8/4/2020	21.744	0.564	TMAC
	8/23/2020	21.693	0.254	TMAC
Roberts Hydro-2	6/18/2020	6.717	n/a[1]	TMAC
	8/28/2020	6.315	n/a[1]	TMAC
Little Roberts Outflow	6/18/2020	5.253	n/a[1]	TMAC
	6/27/2020	5.157	n/a[1]	TMAC
	8/28/2020	4.587	n/a[1]	TMAC

[1] *Not measured due to time constraints, access limitations, or staffing limitations due to COVID.*

[2] *Lake Level only measured.*

TMAC staff performed an under-ice water level measurement in April and May. Due to COVID-19 restrictions, monitoring during the open water season was more limited than in previous years. Monitoring at helicopter access stations was limited to two water level surveys in late-June during station installations and one in August during station demobilization. Road access station Doris Creek (TL-2) was monitored throughout the open water season from June to October, and lake level station Doris Lake-2 was monitored year round, consistent with previous years.

3.1 Stage Discharge Measurements

TMAC personnel conducted open water season water level and discharge measurements from June to September where access was possible due to staffing limitations due to COVID and helicopter availability.

3.2 Hydrographs

Seasonal stations were re-installed in late-June and were demobilized in late-August. Discharge at TL-2 was modelled using linear regression with the Doris Lake-2 year round monitoring station for open water periods that were not recorded by the seasonal station. Discharge during the open water season that was not monitored at the other stations was modelled using a linear regression with TL-2. For the periods where ice was known or suspected to have impacted flow, discharge was estimated using exponential growth/decay curves.

For the open water period outside of the observed data, lake levels were back calculated using the station rating curves for the periods when discharge had been modeled. For stations with no discharge monitoring, lake level was modeled using a linear regression with Doris Lake-2. For the periods where ice was known or suspected to have impacted flow, lake level was estimated using exponential growth/decay curves, stabilizing at the level surveyed during the April water level survey. In cases where the winter water level survey appeared significantly too high or low in relation to the open water surveys, lake level was assumed to stabilize on the last day of modeled data.

Year round stations operated from January 1 to December 31, however the last data download at Roberts Hydro-2 was performed on June 18, and as a result, the discharge and the lake level could not be determined at the time of writing.

Table 3-2 and Table 3-3 present the estimated discharge and the lake level, respectively. Appendix A and B provide the Lake Level Graphs and Hydrographs for each monitored station in 2020. Appendix C and D provide the Mean Daily Lake Level Tables and the Mean Daily Discharge Tables. Appendix E and F provide historical lake level graphs and hydrographs for comparing 2020 with previous years.

Table 3-2: 2020 Observed, Modelled and Estimated Discharge

Station	Observed	Modelled	Estimated
Windy Outflow	Jun 19 – Aug 27	Jun 16 – Jun 19 Aug 28 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9
Patch Outflow	Jun 29 – Aug 27	Jun 16 – Jun 28 Aug 28 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9
PO Outflow	Jun 29 – Aug 28	Jun 16 – Jun 28 Aug 28 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9
Ogama Outflow	Jun 28 – Aug 28	Jun 16 – Jun 27 Aug 29 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9
Doris Creek TL-2	Jun 28 – Oct 8	Jun 16 – Jun 28 Oct 9 – Oct 10	Jun 10 – 15 Oct 10 – Nov 9
Roberts Hydro-2	Jan 1 – Jun 18	n/a	n/a
Little Roberts Outflow	Jun 28 – Aug 28	Jun 16 – Jun 27 Aug 29 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9

Table 3-3: 2020 Observed, Modelled and Estimated Lake Levels

Station	Observed	Modelled	Estimated
Windy Outflow	Jun 19 – Aug 27	Jun 16 – Jun 19 Aug 28 – Oct 9	Jun 10 – 15 Oct 10 – Dec 31
Glenn Lake	Jun 29 –Aug 27	Jun 16 – Jun 28 Aug 27 – Oct 9	Jan 1 – Jun 15 Oct 10 – Dec 31
Imniagut Lake	Jun 29 –Aug 27	Jun 16 – Jun 28 Aug 27 – Oct 9	Jan 1 – Jun 15 Oct 10 – Dec 31
Patch Outflow	Jun 29 – Aug 27	Jun 16 – Jun 28 Aug 28 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9
PO Outflow	Jun 29 – Aug 28	Jun 16 – Jun 28 Aug 28 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9
Ogama Outflow	Jun 28 – Aug 28	Jun 16 – Jun 27 Aug 29 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9

Station	Observed	Modelled	Estimated
Doris Lake-2	Jan 1 – Dec 31	n/a	n/a
Roberts Hydro-2	Jan 1 – Jun 18	n/a	n/a
Little Roberts Outflow	Jun 28 – Aug 28	Jun 16 – Jun 27 Aug 29 – Oct 9	Jun 10 – 15 Oct 10 – Nov 9

Flow was predicted to have started on June 10, based on site photos taken every 3 to 5 days and a minimum of 7 consecutive days of air temperature above 0°C, and ended on November 9, based on the Doris Lake water level no longer dropping. The lake outflows are estimated to have been free of snow or ice starting June 16, based on site photos, and have ice formation impact outflow on October 11 based on ice cover forming across Doris Lake.

Table 3-4 presents monthly mean, maximum and minimum lake levels, along with the maximum water level fluctuation during the open water season, and over the full calendar year. These monthly statistics include observed, modelled and estimated data.

Table 3-5 presents the stage-discharge rating curves from the seven hydrometric stations that record discharges. Rating curves are empirical equations unique to each monitoring station that convert stage data recorded by the monitoring station to discharge and are developed using concurrent manual measurements of stage (water level) and discharge. Measurements dating back to 2017 were used in the development of the rating curves. Measurements made prior to 2017 did not align with measurements that are more recent and were excluded from the rating development process. This adjustment is common as erosion and aggradation of the channel changes the stage discharge relationship over time.

3.3 Rating Curves

No updates were made to rating curves in 2020 as no stage-discharge measurements were collected due to limitations caused by COVID-19 restrictions. The exception to this was monitoring station TL-2 where measurements collected in 2020 were in line with the existing rating equation. Stage data collected in 2020 was converted to discharge using the equations listed in Table 3-5

3.4 Hydrologic Indices

Table 3-6 presents the 2020 hydrologic indices such as runoff, peak flows and 7-day low flows. Table 3-7 presents the monthly runoff distributions from the seven hydrometric stations that record discharges.

Annual runoff is the volume of streamflow over the year normalized by drainage area and reported as depth and is useful index for comparing the hydrologic responses of basins of different sizes. Estimates of annual runoff were calculated from the available data and interpolated using the equation:

$$Ro = \frac{(Q * t)}{A}$$

where: runoff (Ro; units = mm) is calculated as streamflow (Q; units = m^3/s) multiplied by time (t; units = seconds) divided by basin area (A; units = km^2).

Table 3-4: Summary of 2020 Lake Levels

Station	Parameter	2020 Monthly Lake Level[1] (m)												Lake Level Fluctuation[2]	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jun-Sep	Annual
Windy Outflow	Mean	18.318	18.318	18.318	18.318	18.318	18.370	18.381	18.321	18.292	18.308	18.293	18.293	0.135	0.135
	Max	18.318	18.318	18.318	18.318	18.318	18.416	18.404	18.365	18.303	18.401	18.293	18.293		
	Min	18.318	18.318	18.318	18.318	18.318	18.318	18.364	18.282	18.281	18.289	18.293	18.293		
Glenn Lake	Mean	9.527	9.527	9.527	9.527	9.527	9.760	9.774	9.630	9.593	9.588	9.583	9.582	0.334	0.388
	Max	9.527	9.527	9.527	9.527	9.527	9.915	9.859	9.703	9.605	9.610	9.583	9.582		
	Min	9.527	9.527	9.527	9.527	9.527	9.527	9.711	9.588	9.581	9.583	9.582	9.582		
Imniagut Lake	Mean	27.249	27.249	27.249	27.249	27.249	27.339	27.350	27.294	27.286	27.286	27.285	27.285	0.171	0.171
	Max	27.249	27.249	27.249	27.249	27.249	27.420	27.390	27.311	27.288	27.289	27.286	27.285		
	Min	27.249	27.249	27.249	27.249	27.249	27.249	27.314	27.282	27.285	27.286	27.285	27.285		
Patch Outflow	Mean	26.287	26.287	26.287	26.287	26.287	26.426	26.397	26.258	26.223	26.218	26.191	26.190	0.312	0.362
	Max	26.287	26.287	26.287	26.287	26.287	26.552	26.483	26.316	26.233	26.236	26.201	26.190		
	Min	26.287	26.287	26.287	26.287	26.287	26.287	26.325	26.219	26.214	26.202	26.190	26.190		
PO Outflow	Mean	26.307	26.307	26.307	26.307	26.307	26.352	26.283	26.164	26.132	26.124	26.077	26.068	0.291	0.341
	Max	26.307	26.307	26.307	26.307	26.307	26.409	26.364	26.227	26.142	26.147	26.105	26.068		
	Min	26.307	26.307	26.307	26.307	26.307	26.307	26.231	26.118	26.123	26.106	26.068	26.068		

Station	Parameter	2020 Monthly Lake Level[1] (m)												Lake Level Fluctuation[2]	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jun-Sep	Annual
Ogama Outflow	Mean	24.058	24.058	24.058	24.058	24.058	24.266	24.230	24.058	24.034	24.036	24.039	24.040	0.443	0.427
	Max	24.058	24.058	24.058	24.058	24.058	24.467	24.381	24.111	24.041	24.045	24.040	24.040		
	Min	24.058	24.058	24.058	24.058	24.058	24.058	24.114	24.024	24.027	24.032	24.037	24.040		
Doris Lake-2	Mean	21.726	21.713	21.692	21.666	21.652	21.961	21.965	21.765	21.734	21.744	21.760	21.802	0.498	0.580
	Max	21.748	21.729	21.715	21.690	21.659	22.222	22.120	21.832	21.744	21.760	21.789	21.819		
	Min	21.712	21.698	21.675	21.644	21.642	21.647	21.839	21.727	21.724	21.725	21.740	21.774		
Roberts Hydro – 2[3]	Mean	6.507	6.447	6.448	6.416	6.394	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Max	6.572	6.494	6.466	6.448	6.429	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	Min	6.465	6.419	6.427	6.390	6.365	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Little Roberts Outflow	Mean	4.501	4.501	4.501	4.501	4.501	4.858	4.881	4.647	4.597	4.575	4.505	4.501	0.604	0.683
	Max	4.501	4.501	4.501	4.501	4.501	5.184	5.083	4.738	4.613	4.620	4.528	4.501		
	Min	4.501	4.501	4.501	4.501	4.501	4.501	4.746	4.591	4.580	4.531	4.501	4.501		

[1] *Water levels include observed, modelled and estimated data*

[2] *Change in lake level refers to the difference between the highest June and lowest July to September lake levels*

[3] *Roberts Hydro – 2 appears to have been damaged by ice during the spring melt, data collected after June was deemed unreliable*

Table 3-5: Stage-Discharge Rating Equations for Madrid Hydrometric Stations in 2020

Station	Rating Equation[1] Q = C (h-a)b	Number of Measurements Used[2]	Root Mean Square – Error (m^3/s)	Year Rating Equation Developed[3]
Windy Outflow	$Q = 7.096\ (h - 18.15)^{2.401}$	6	7.8	2019 [2]
Patch Outflow	$Q = 2.975\ (h - 26.105)^{1.706}$; $h < 26.395$ $Q = 5.706\ (h - 26.155)^{1.936}$; $h > 26.395$	12	8.5	2019 [2]
PO Outflow	$Q = 2.703\ (h - 25.9)^{1.897}$; $h < 26.27$ $Q = 5.839\ (h - 26)^{2.029}$; $h > 26.27$	7	4.8	2019 [2]
Ogama Outflow	$Q = 3.966\ (h - 23.855)^{2.065}$; $h < 24.31$ $Q = 8.145\ (h - 23.95)^{2.296}$; $h > 24.31$	11	4.3	2019 [2]
Doris Creek TL-2	$Q = 5.068\ (h - 21.511)^{1.665}$; $h < 22.00$ $Q = 8.545\ (h - 21.611)^{1.815}$; $h > 22.00$	21	9.3	2019 [3]
Roberts Outflow-2	$Q = 7.125\ (h - 6.104)^{2.042}$; $h < 6.49$ $Q = 13.281\ (h - 6.168)^{2.265}$; $h > 6.49$	12	7.3	2019 [2]
Little Roberts Outflow	$Q = 2.756\ (h - 4.02)^{2.206}$	5	1.8	2019 [2]

[1] *Equation $Q = C(h - a)^b$: Q is the discharge (m^3/s), C and b are dimensionless coefficients, h is the stage (m), and a is the approximate stage at zero flow (m).*

[2] *The 2019 stage-discharge rating equations were developed using measurements from 2017 to 2019 where available.*

[3] *No changes were made to the 2019 rating equation with addition of 2020 stage/discharge data.*

Peak daily flows are the highest mean daily flow during the year and typically occur during freshet. The lowest seven-day averaged flow during the open water season typically occurs during late summer or early fall. Annual low flows are zero and are not reported as the streams freeze solid in winter. Breaking runoff down by month shows the majority of flow occurs during and shortly after freshet, with much less water flowing during late summer and fall. This flow distribution is typical of arctic streams.

Table 3-6: Summary of 2020 Annual Runoff, Peak Flows and Low Flows

Station	Annual Runoff (mm)	Annual Peak Daily Flows[1]		7 – Day Low Flows[2]	
		Peak Flow (m^3/s)	Date	7- Day Low Flow (m^3/s)	Date
Windy Outflow	107	0.30	June 22	0.07	Aug 27
Patch Outflow	82	0.78	June 22	0.06	Aug 28
PO Outflow	102	0.90	June 27	0.08	Sept 15
Ogama Outflow	58	1.79	June 22	0.12	Aug 28
Doris Creek TL-2	75	2.05	June 22	0.29	Sept 2
Roberts Outflow-2	N/A	N/A	N/A	N/A	N/A
Little Roberts Outflow	83	3.86	June 22	0.84	Aug 27

[1] *Peak flows refer to peak daily discharges in 2020 and are based on estimated and observed data.*

[2] *7-day low flows are based on observed data only.*

Table 3-7: Summary of 2020 Monthly Runoff Distributions

Station	2020 Monthly Runoff (mm)							
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Windy Outflow	0	27	41	21	12	6	0	0
Patch Outflow	0	30	33	10	6	3	0	0
PO Outflow	0	32	36	17	12	5	0	0
Ogama Outflow	0	27	20	5	4	2	0	0
Doris Creek TL-2	0	27	28	9	8	3	0	0
Roberts Outflow-2	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*
Little Roberts Outflow	0	27	28	14	11	5	0	0

* *Roberts Outflow-2 appears to have been damaged by ice during freshet*

3.5 Ice Measurements

TMAC conducted under-ice water surface measurements in April at the same time as the under-ice aquatic sampling; however, due to COVID, RTK system surveys were conducted approximately 3 weeks later than the under-ice aquatic sampling. Table 3-8 presents surveyed water level, ice thickness, and water gap[1] for each monitored lake. The RTK system has a lower accuracy than the water level surveys made during the open water season. The lower accuracy leads to some discrepancies in the results, such as PO Lake having a higher reported water level than Patch Lake despite being downstream, and Little Roberts Outflow having a reported water level higher than all open water season water levels.

[1] Water gap is the space between the ice and the under-ice water

Table 3-8: Summary of 2020 Under-Ice Lake Level Surveys with Under-Ice Volumes of Monitored Lakes with Bathymetry Information

Station	2020			
	Water Surface Elevation [1] (masl)	Ice Thickness (m)	Water Gap (m)	Under-Ice Volume (Mm^3)
Windy Outflow	15.636*	2.02	0.15	46.22*
Glenn Lake	9.582	1.94	0.1	N/A[3]
Wolverine Lake	26.19	1.96	0.13	N/A[3]
Imniagut Lake	24.46	1.92	0.15	0.03
Patch Outflow	23.572*	1.96	0.13	9.52
PO Outflow	26.068*	2.04	0.16	0.24*
Ogama Outflow	21.36*	1.86	0.1	0.42*
Doris Lake-2	21.763	2.04	0.16	21.54
Little Roberts Outflow	5.565 *	2.08	0.16	N/A[4]

[1] *UTM Zone 13W.*

[2] *Surveyed in May 2020.*

** Discrepancy in surveyed winter water surface elevation, greater uncertainty exists in the volume estimate.*

[3] *No bathymetric data available.*

[4] *Winter water surface elevation too great to provide reasonable.*

Bathymetric survey information collected in 2006 and 2008 was used to create subsurface contours for Windy, Imniagut, Patch, PO, Ogama, Doris and Little Roberts Lakes. The geodetic water surface at the time of survey was given for some of the lakes; however, where the elevation was not specifically identified it was compared to discharge at the likely time of the survey being done (i.e., approximately Aug 1 of 2006 or 2008), the discharge was then compared to lake levels at that discharge. The lake elevations are expected to be within approximately 0.15 m of what was the likely elevation at the time of the survey based on comparison of those with known elevations. Establishing the surface elevation for the bathymetry, a contour elevation was able to be re-calculated to the geodetic reference. The under-ice water elevation less the ice thickness and water gap, was then identified up on the GIS developed bathymetric tables to provide the under-ice water volume estimates (Table 3-8). The bathymetry resolution is to 0.25 m contours, as a result, a 0.125 m value rounding up or down when selecting a contour can create bias in the under-ice volume estimate due to the lake shape sub-surface (i.e., steeper versus flatter sides at a contour change). A single contour change could results in a 10% water volume difference.

4. DISCUSSION AND COMPARISON WITH FEIS PREDICTIONS

4.1 Precipitation Influence

Table 4-1 presents the precipitation at the Hope Bay meteorological station for the 2020 hydrologic year (October 2019 to September 2020). A total of 178 mm of precipitation was measured during the 2020 hydrologic year, however approximately half the data are missing for both October and November 2019. Assuming the true precipitation for October and November 2019 was close to the expected mean monthly precipitation, 24 mm and 16 mm respectively, the total precipitation would be 190 mm..

Table 4-1: Doris Hydrometric Station Precipitation October 2019 – September 2020

Month	Total Rainfall (mm)	Total Snowfall (SWE, mm)	Total Precipitation (mm)	Expected Mean Monthly Precipitation
Oct-19	2.2*	9.4*	11.6*	24
Nov-19	0.0*	15.6*	15.6*	16
Dec-19	0.0	9.7	9.7	11
Jan-20	0.0	21.3	21.3	10
Feb-20	0.0	13.3	13.3	9
Mar-20	0.0	0.0	0.0	11
Apr-20	0.0	17.4	17.4	11
May-20	0.0	17.6	17.6	14
Jun-20	7.5	3.2	10.6	18
Jul-20	12.7	0.0	12.7	29
Aug-20	27.8	0.0	27.8	31
Sep-20	8.9	10.9	19.8	26
Total	56.9	93.4	178.4	210
Total Precipitation Including Assumed Average October and November 2019			**190**	**-**

** Incomplete data set.*

Sources: Nunami Stantec 2019-2020, Package P5-2 (Table 5) of the Hope Bay FEIS (SRK 2017).

Table 4-2 presents the precipitation return periods used in the Climate and Hydrological Parameters Summary Report, Package P5-2 of the Hope Bay FEIS (SRK 2017). It indicates that 190 mm of precipitation corresponds to a dryer than average year with a return period less than 5 years, while 178 mm corresponds to between a 5 and 10 year dry year. The 2020 hydrologic year was likely close to a 5 year dry year.

Table 4-2: Hope Bay Extreme Precipitation Depths

Return Period	Annual Precipitation (mm)
200 Wet	324
100 Wet	311
50 Wet	297
25 Wet	282
20 Wet	277
10 Wet	261
5 Wet	243
Average (MAP)	210
2 Wet	210
3 Dry	195
5 Dry	182
10 Dry	168
20 Dry	158
25 Dry	155
50 Dry	147
100 Dry	140
200 Dry	134

Note: Annual precipitation values are based on calendar year totals. While the hydrologic year is October to September, total precipitation statistics will be comparable when using a large data set.

Source: Package P5-2 (Table 6) of the Hope Bay FEIS (SRK 2017).

4.2 Runoff

A portion of the precipitation is converted to runoff, which enters the lakes and streams, resulting in streamflow. Table 4-3 presents the comparison of the 2020 runoff with historical baseline data collected between 2004 and 2015, as well as the 2019 monitoring data. Runoff in 2020 was lower than in 2019 and the 2004-2015 average. Patch Outflow was consistent with the average predicted runoff.

Table 4-4 presents the modelled impact to the 2020 annual outflow predicted by the FEIS. Effects to Doris Lake are predicted due to direct water withdrawal and mine dewatering activities that could cause the Doris Lake water level drawdown. This water level drawdown could result in downstream effects to Little Roberts Outflow. Effects to Windy Lake are predicted due to the withdrawal of water from Windy Lake.

Table 4-3: Comparison of 2020 Runoff with Historical Averages and Predicted Values

Station	Monitored Runoff (mm)			FEIS Predicted Runoff[1]		
	2019	2020	2004-2015 Average[1]	Predicted Average Runoff	Predicted 20y Dry Runoff	Predicted 20y Wet Runoff
Windy Outflow	174	107	130	58	21	119
Patch Outflow	189	82	112	77	40	137
PO Outflow	222	102	153	80	41	143
Ogama Outflow	167	58	117	100	46	199
Doris Creek TL-2	191	75	110	101	48	213
Roberts Outflow-2	156	N/A	112	n/a	n/a	n/a
Little Roberts Outflow	175	83	93	161	64	347

[1] Data Source: V5-S1 (Table 1.2-7, 1.5-7 to 1.5-12) of the Hope Bay FEIS (TMAC 2017).

Table 4-4: Predicted Impact due to Annual Outflow from Monitored Lakes

Station	FEIS Predicted Impact[1] to Annual Flow in 2020 Under Average Climate Conditions (% Change)
Windy Outflow	-6.7
Patch Outflow	0
PO Outflow	0
Ogama Outflow	0
Doris Creek TL-2	-13.4
Little Roberts Outflow	-7.8
Glenn Outflow	-2.0

[1] *Project Phase "Existing and Permitted Projects".*
Source: V5-S1 (Table 1.2-7, 1.5-7 to 1.5-12) of the Hope Bay FEIS (TMAC 2017).

Drawdown to the Doris Lake water level was not detected in 2020. The 2020 hydrologic year experienced a generally drier than normal year, as shown in Table 4-1 and Table 4-2, with corresponding lower than average runoff values, as shown in Table 4-3. Drawdown due to mine dewatering would be expected to reduce water levels in water levels Doris Lake during the winter when there are no inflows to the lake; however, water levels remain stable during the winter, as shown in Table 3-5. Since there is no effects observed in Doris Lake; therefore, there is no downstream effects to Little Roberts Lake either.

Water withdrawal from Windy Lake did not cause a detectable impact in 2020, possibly in part due to rainfall prior to freeze-up. In 2020, no detectable impact caused by the Hope Bay project were observed to lake levels or lake outflow rates as part of the compliance monitoring.

5. CLOSING

We trust that the monitoring summaries and recommendations for improvement are sufficient for your needs. Please contact us if you have any questions.

Prepared by:

Patricia House, P.Eng.
ERM

Cameron Evans B.A.Sc.
ERM

REFERENCES

ERM Rescan. 2014. *Doris North Project: 2013 Hydrology Compliance Monitoring Report*. Prepared for TMAC Resources Inc. by ERM Rescan: Yellowknife, NT.

Golder Associates Ltd. 2007. *Doris North Project Aquatic Studies 2006*. Prepared for Miramar Hope Bay Ltd. by Golder Associates Ltd. Report No. 06-1373-026:

Rescan. 2010. *2009 Freshwater Baseline Report, Hope Bay Belt Project*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Yellowknife, NT.

SRK 2017. *Climate and Hydrological Parameters Summary Report, Hope Bay Project.* Prepared for TMAC Resources Inc. November 2017.

TMAC. 2017. *Madrid-Boston Project Final Environmental Impact Statement.* TMAC Resources Inc.: Toronto, ON.

TMAC. 2018. *Hope Bay Project: Aquatic Effects Monitoring Plan.* Prepared by TMAC Resources Inc.: Toronto, ON.

Nunami Stantec 2019. *Winter 2018-2019 Atmospheric Compliance Monitoring Program Report,* September 2019. Prepared for TMAC Resources Inc.

Nunami Stantec 2020. *Summer 2019-2020 Atmospheric Compliance Monitoring Program Report,* (In Preparation).

APPENDIX A LAKE LEVELS GRAPHS

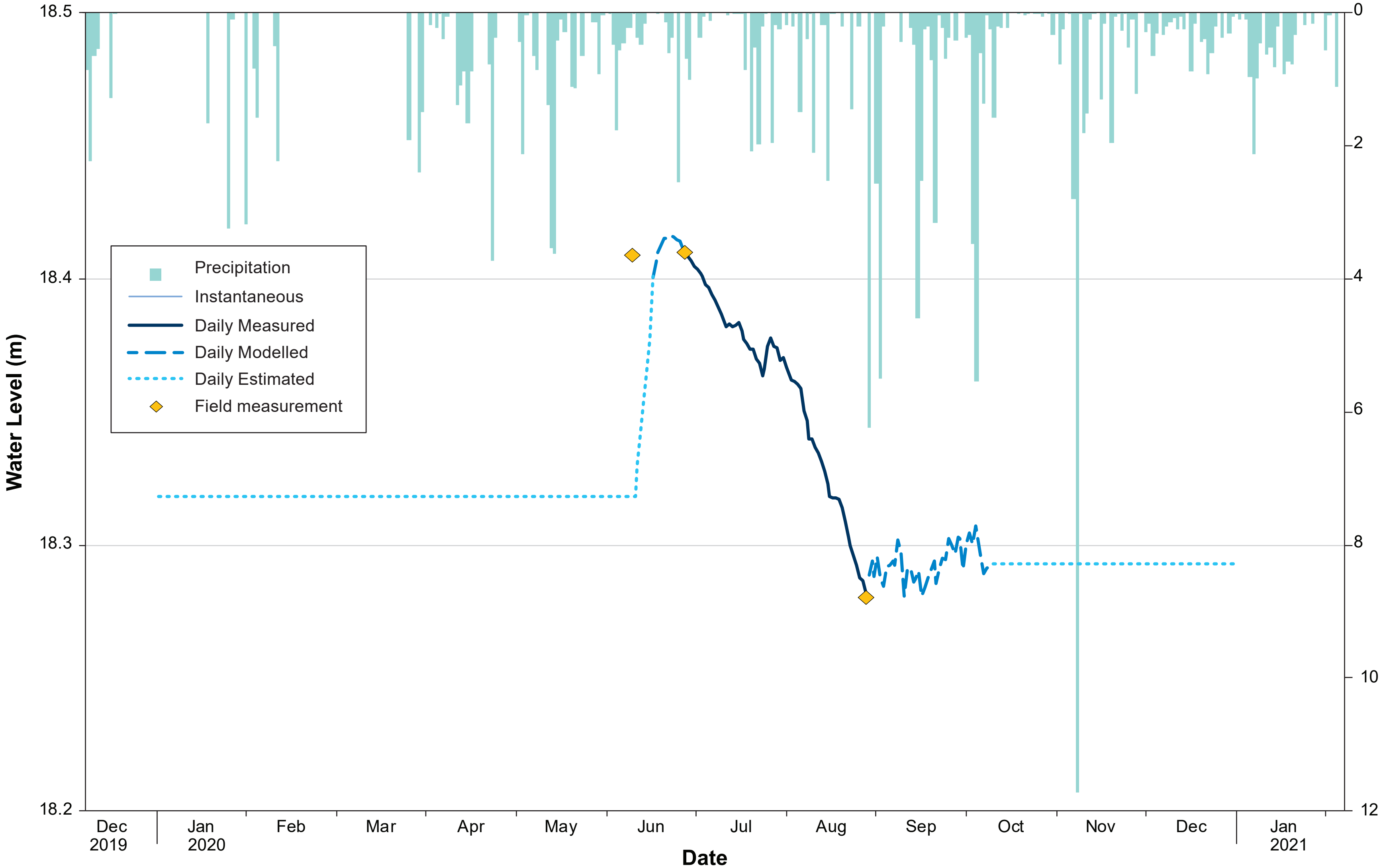


Figure A1: 2020 Mean Daily Lake Level for Monitoring Station Windy Outflow

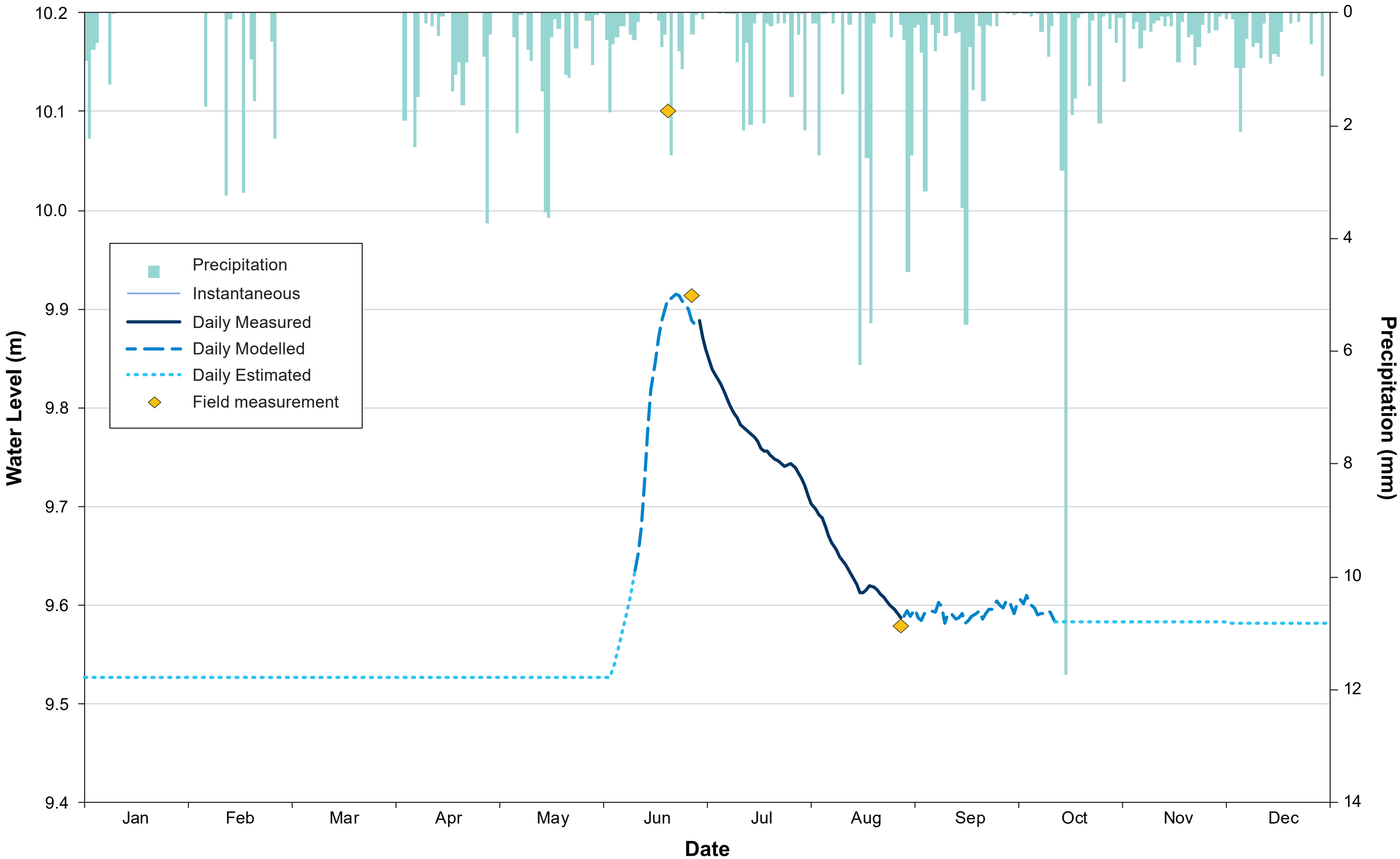


Figure A2: 2020 Mean Daily Lake Level for Monitoring Station Glenn Lake

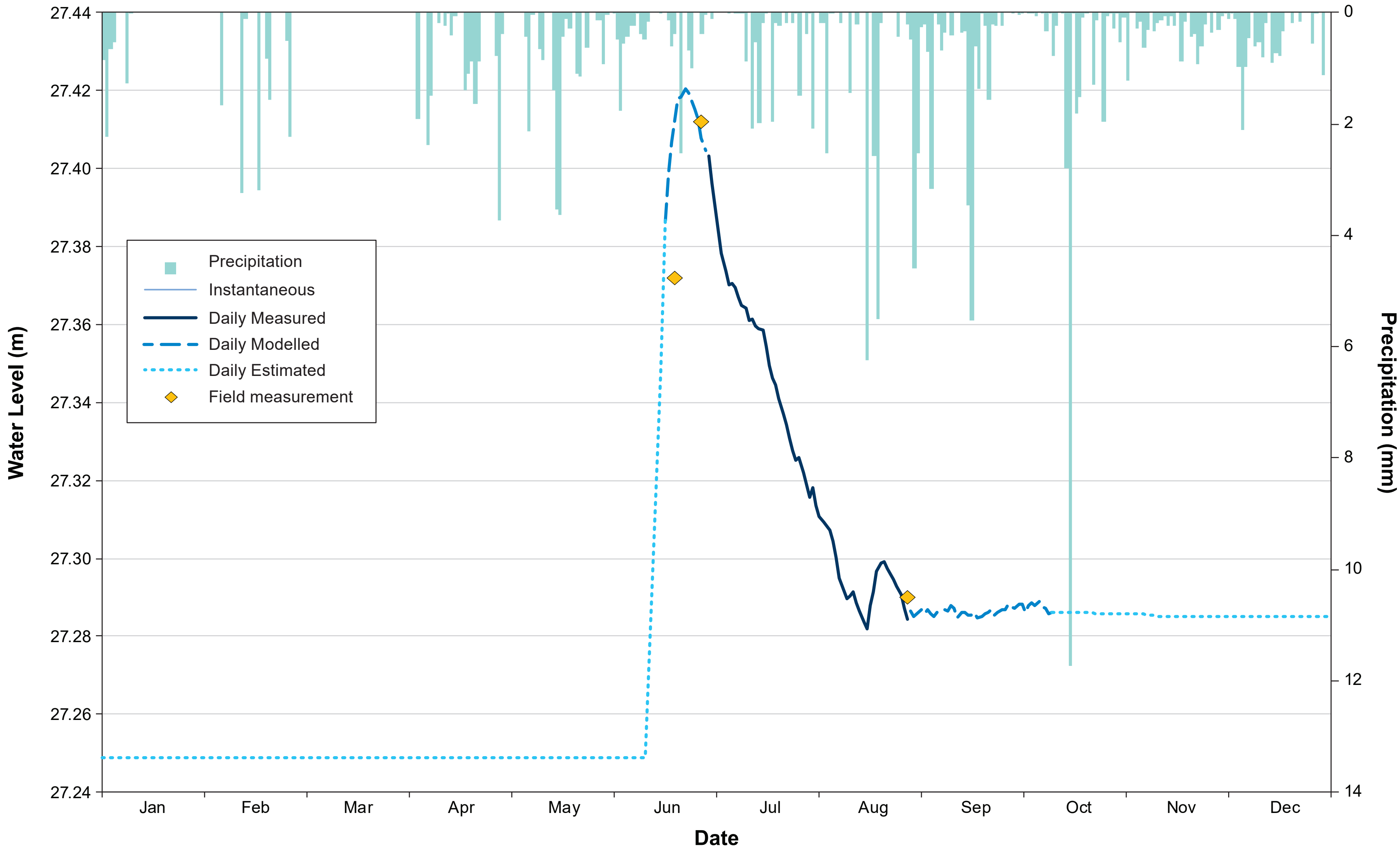


Figure A3: 2020 Mean Daily Lake Level for Monitoring Station Imniagut Lake

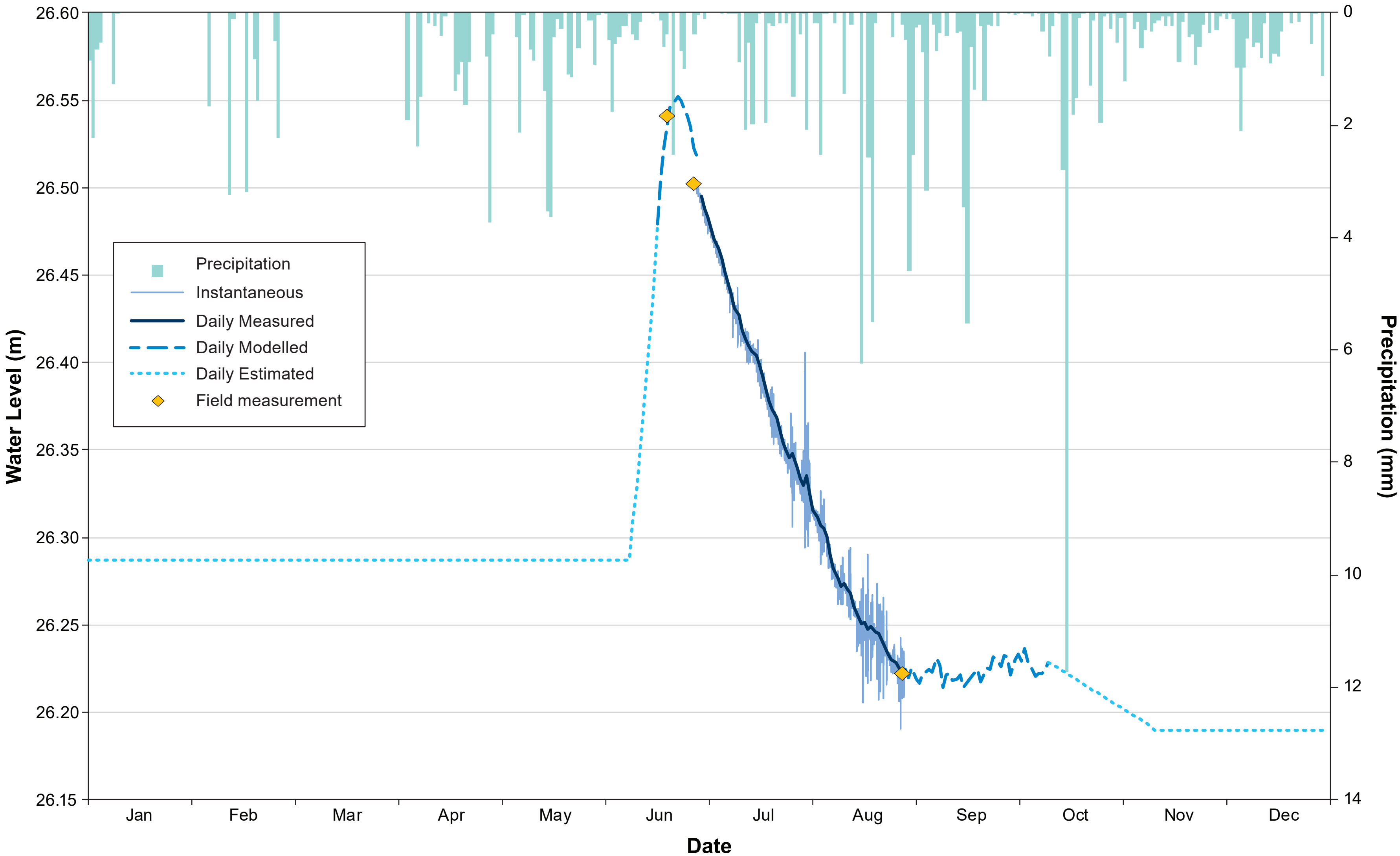


Figure A4: 2020 Mean Daily Lake Level for Monitoring Station Patch Outflow

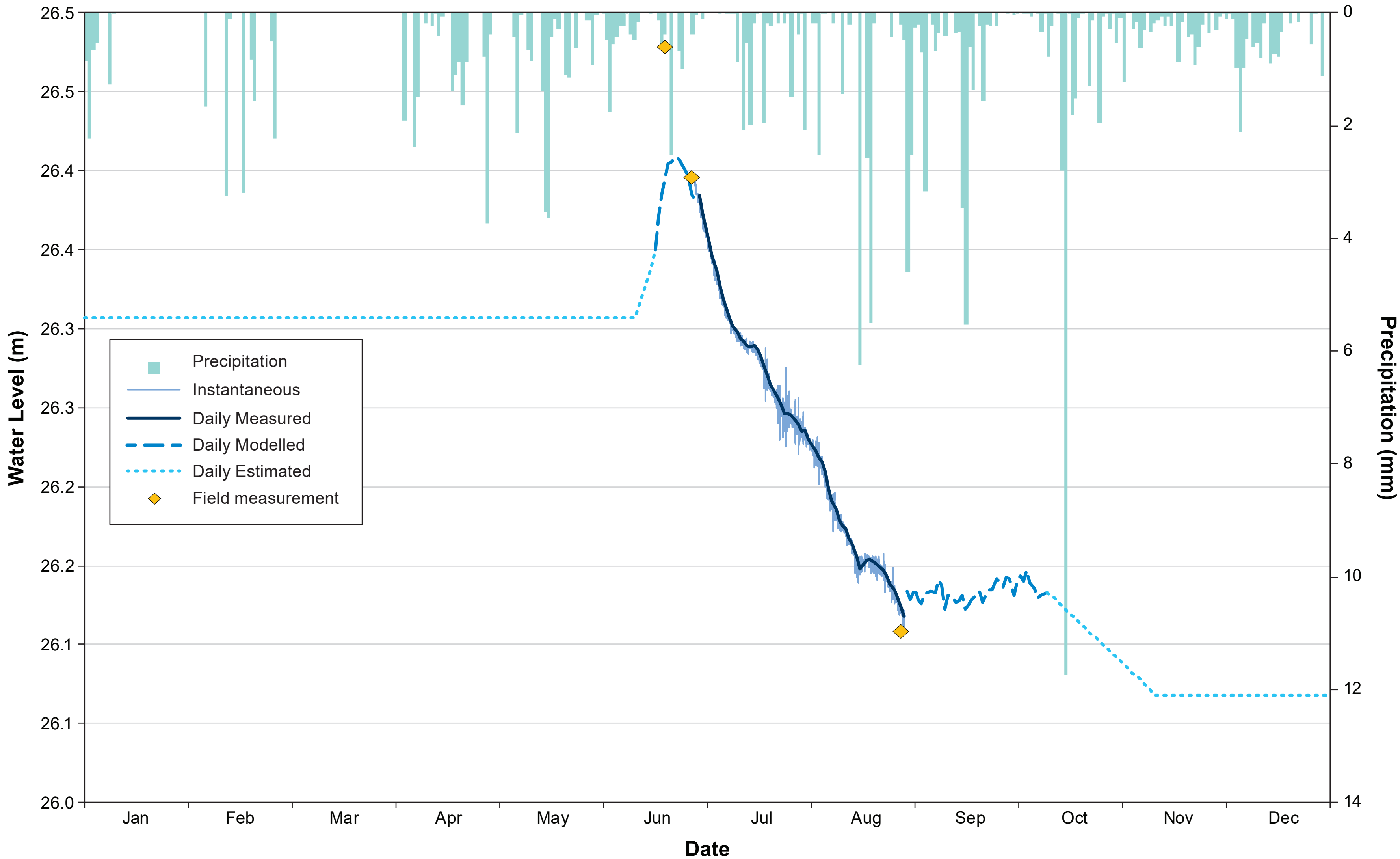


Figure A5: 2020 Mean Daily Lake Level for Monitoring Station PO Outflow

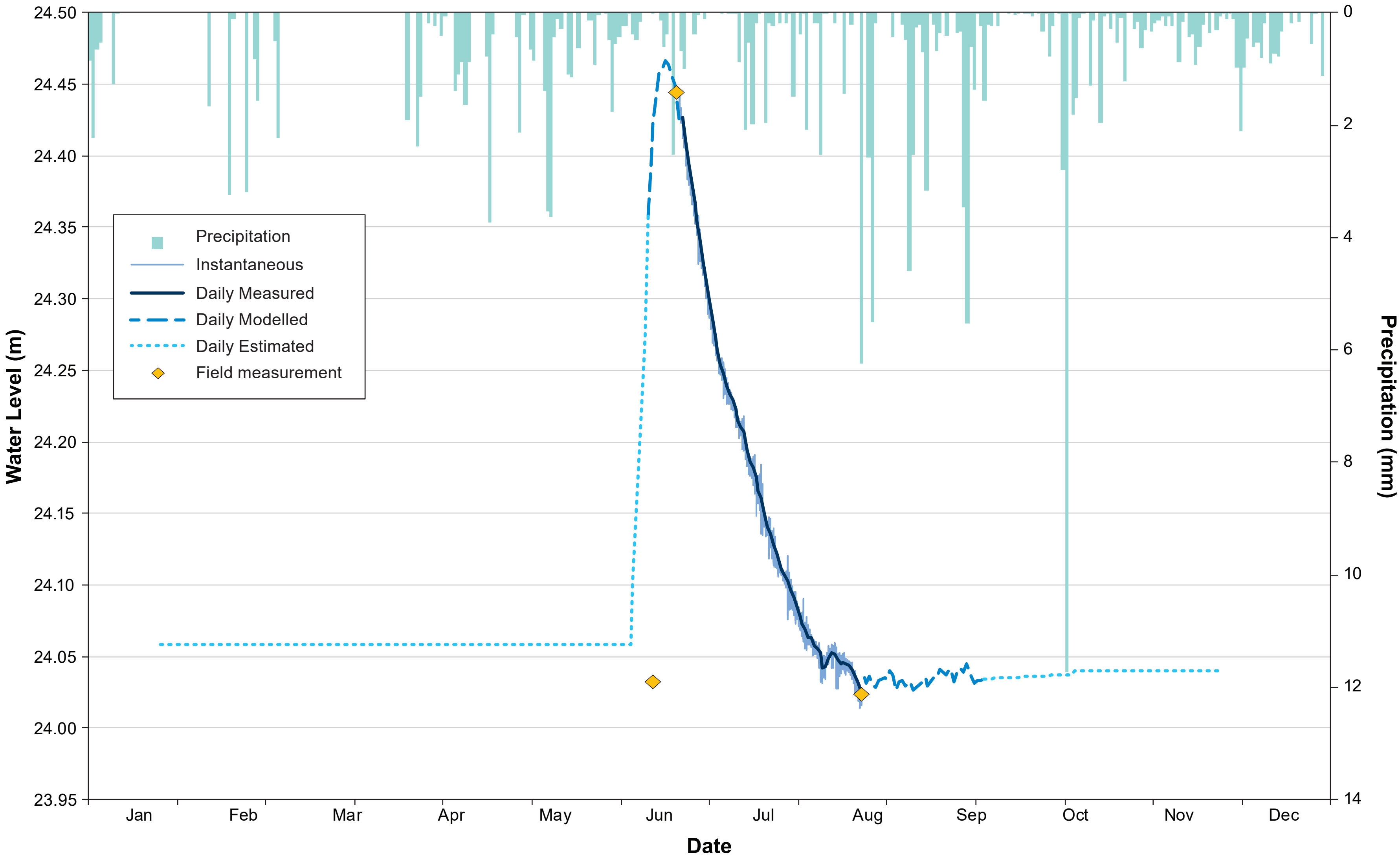


Figure A6: 2020 Mean Daily Lake Level for Monitoring Station Ogama Outflow

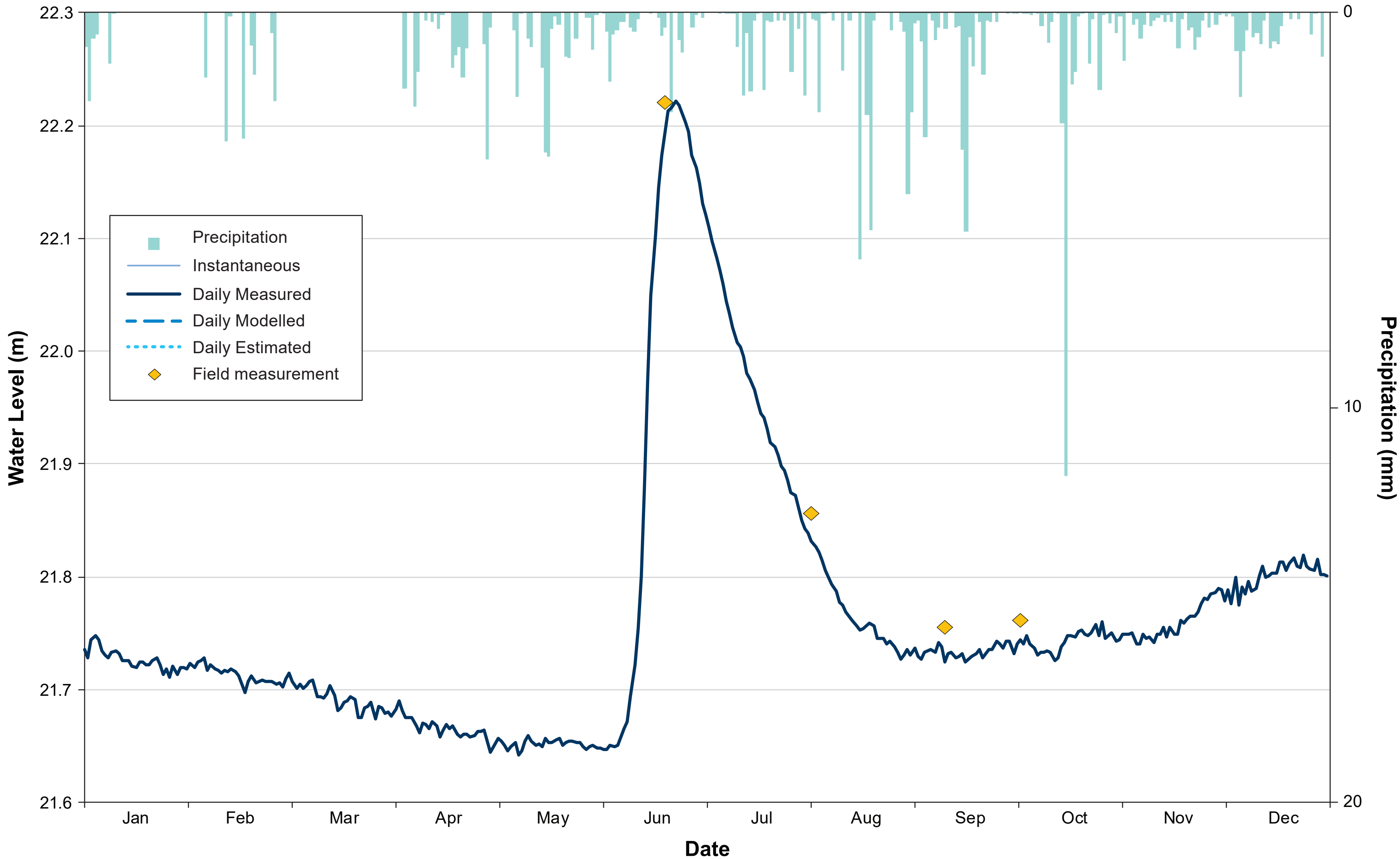


Figure A7: 2020 Mean Daily Lake Level for Monitoring Station Doris Lake-2

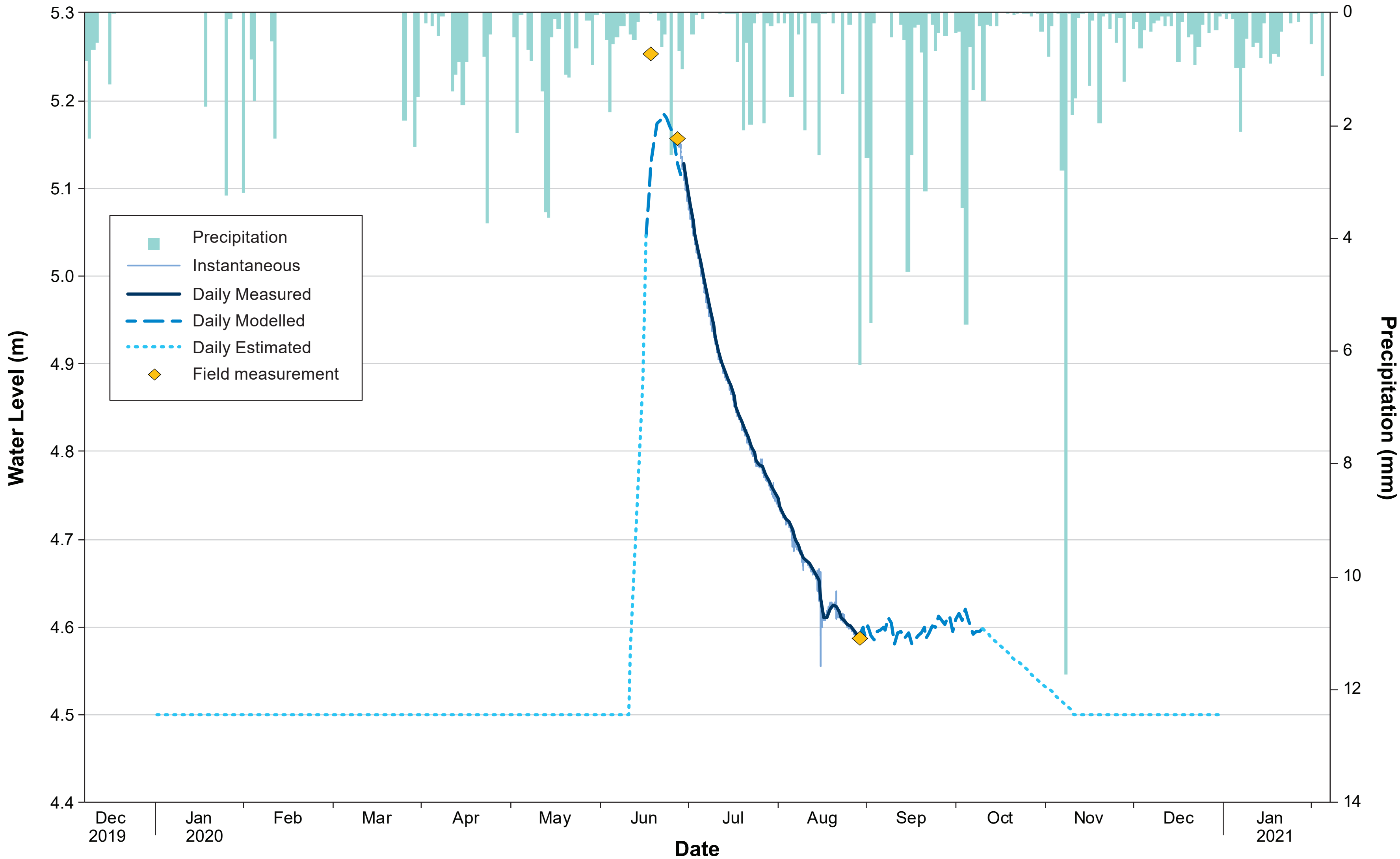


Figure A8: 2020 Mean Daily Lake Level for Monitoring Station Little Roberts Outflow

APPENDIX B HYDROGRAPHS

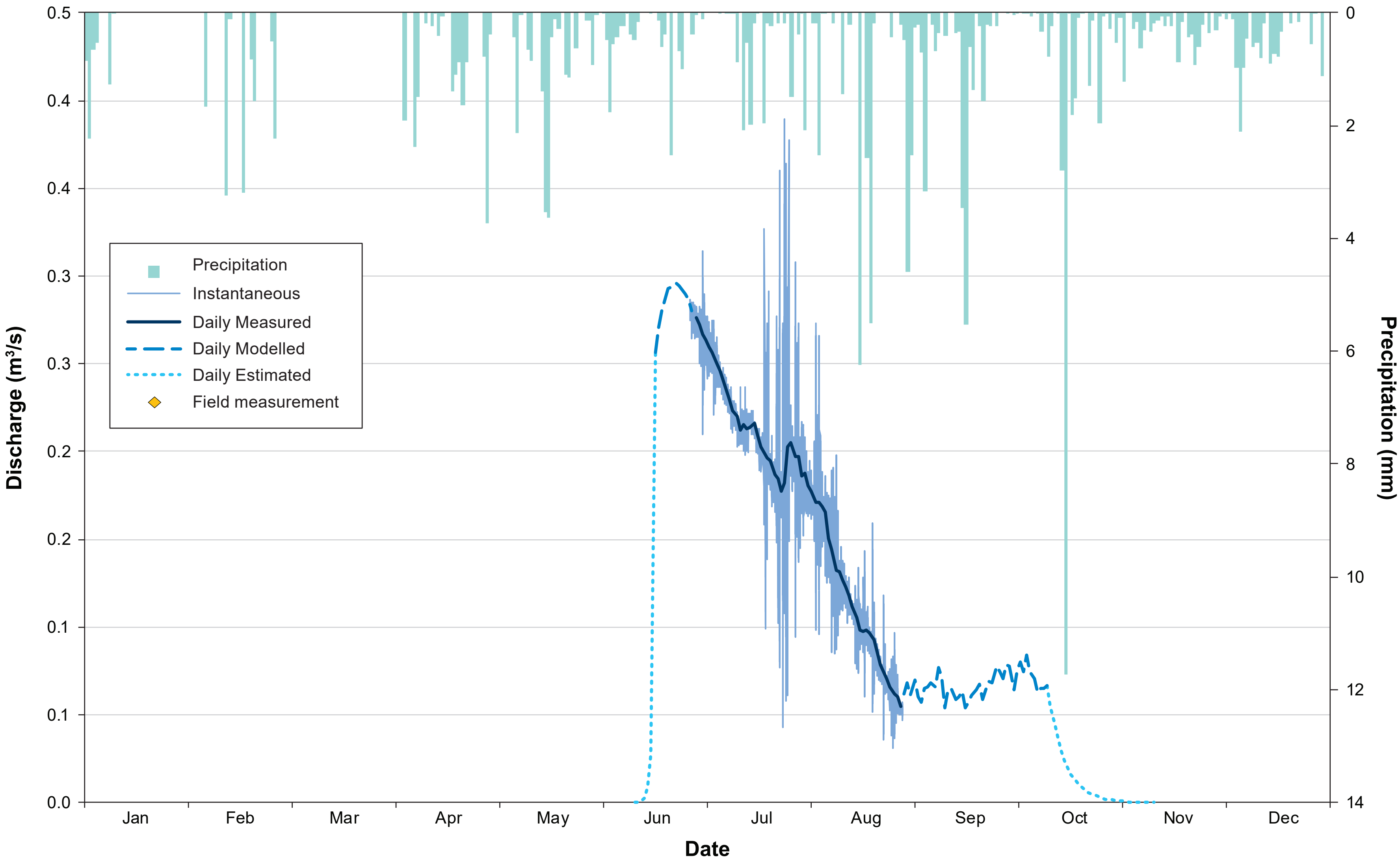


Figure B1: 2020 Mean Daily Hydrograph at Monitoring Station Windy Lake Outtflow

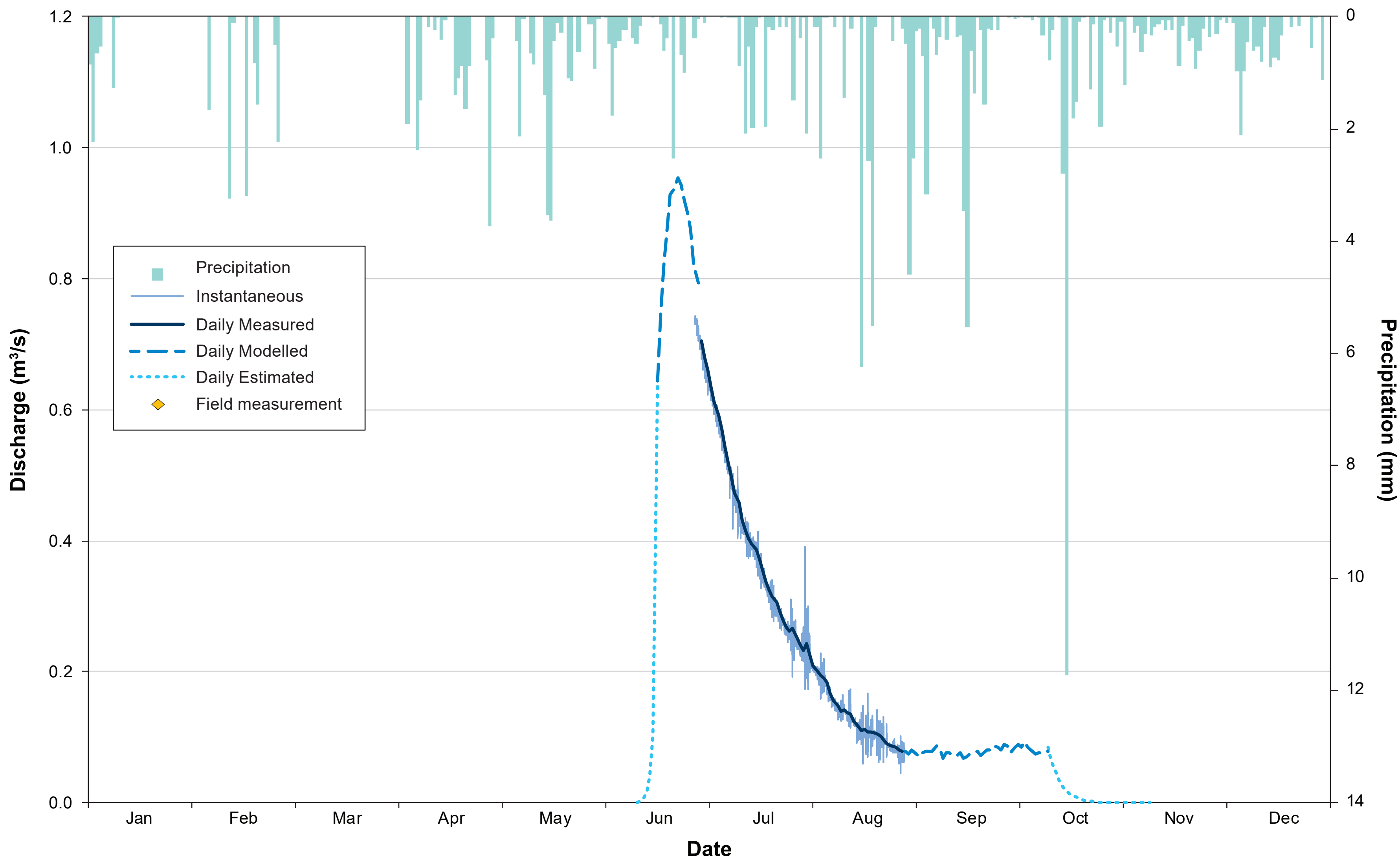


Figure B2: 2020 Mean Daily Hydrograph at Monitoring Station Patch Outflow

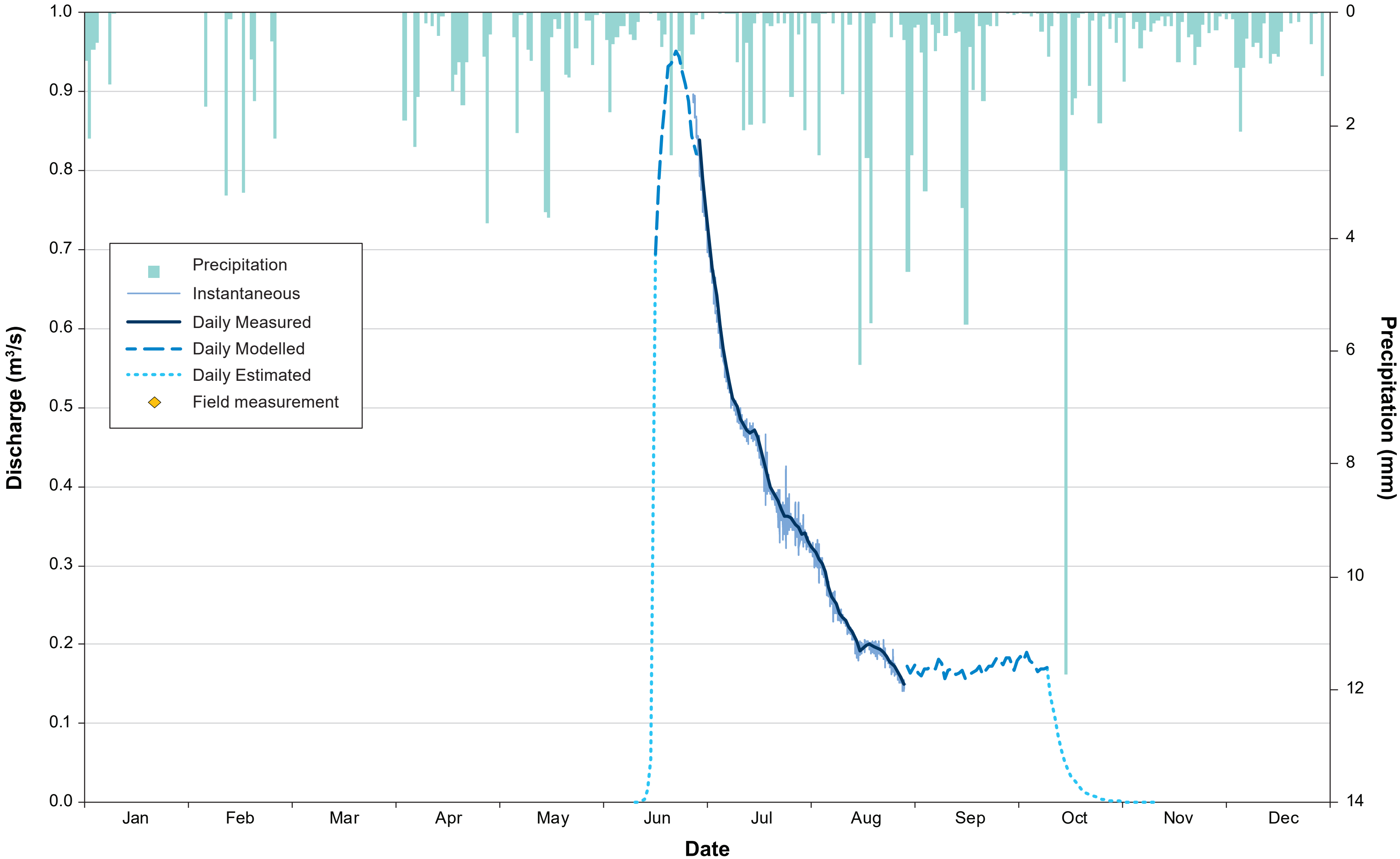


Figure B3: 2020 Mean Daily Hydrograph at Monitoring Station PO Outflow

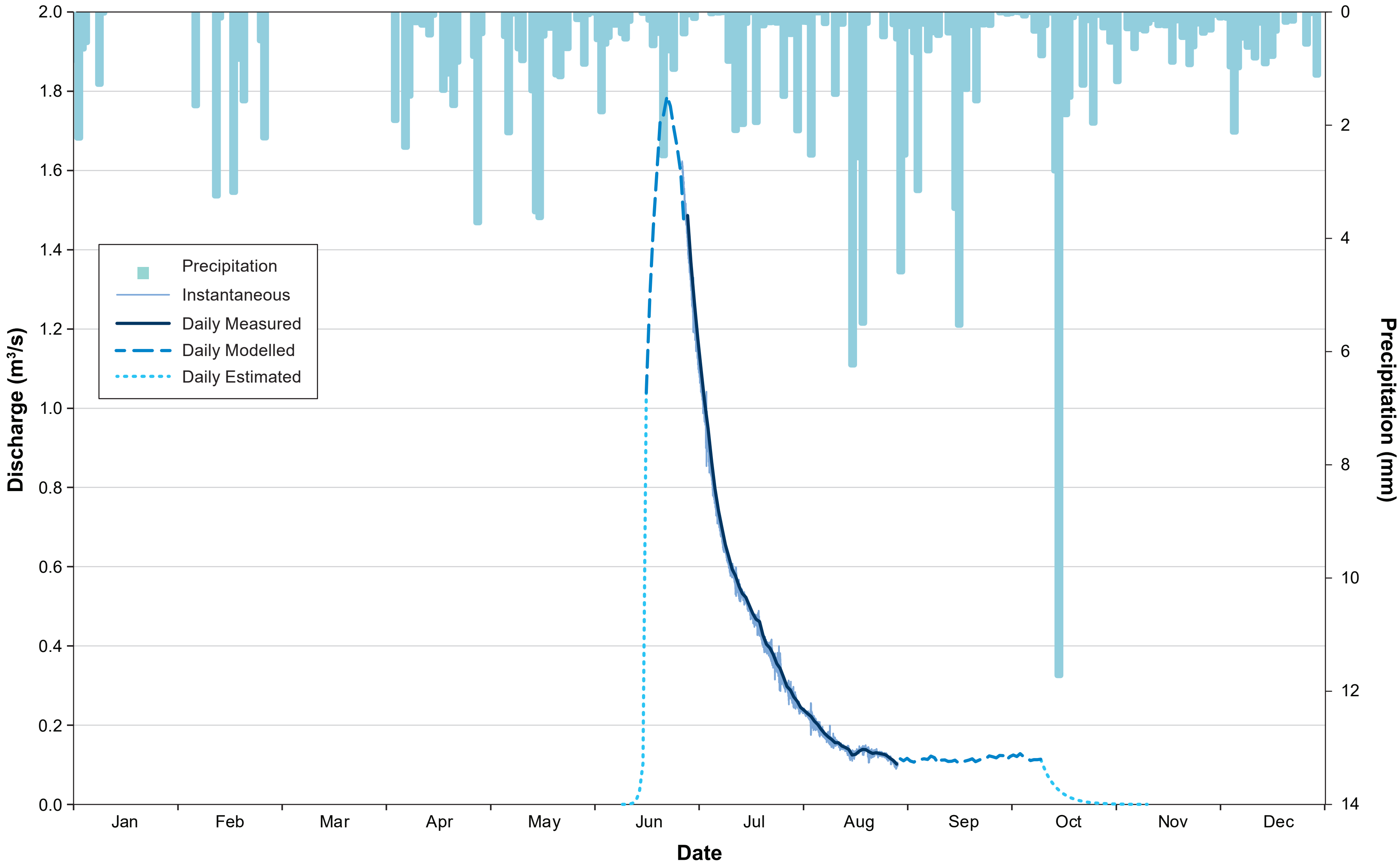


Figure B4: 2020 Mean Daily Hydrograph at Monitoring Station Ogama Outflow

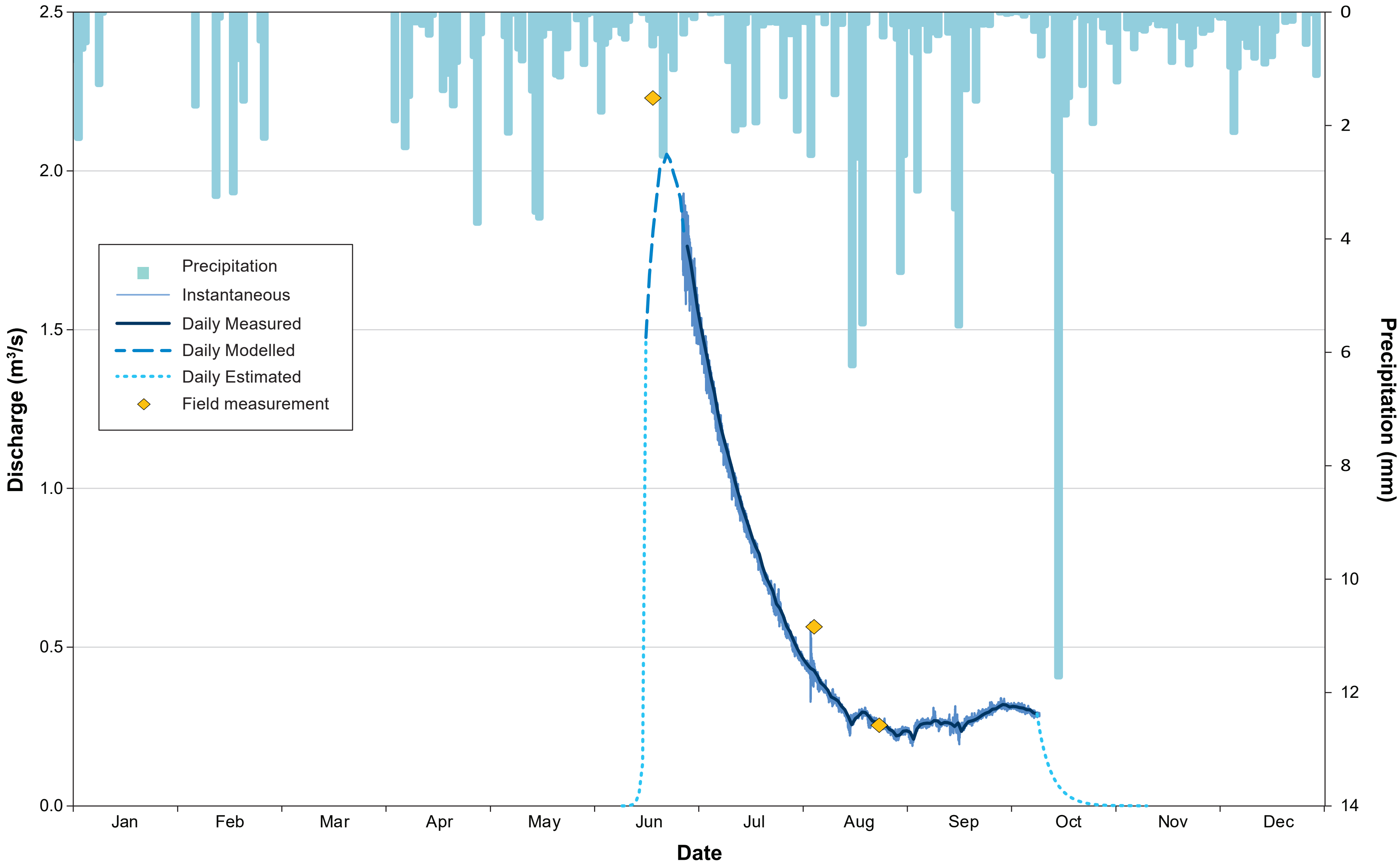


Figure B5: 2020 Mean Daily Hydrograph at Monitoring Station Doris Creek

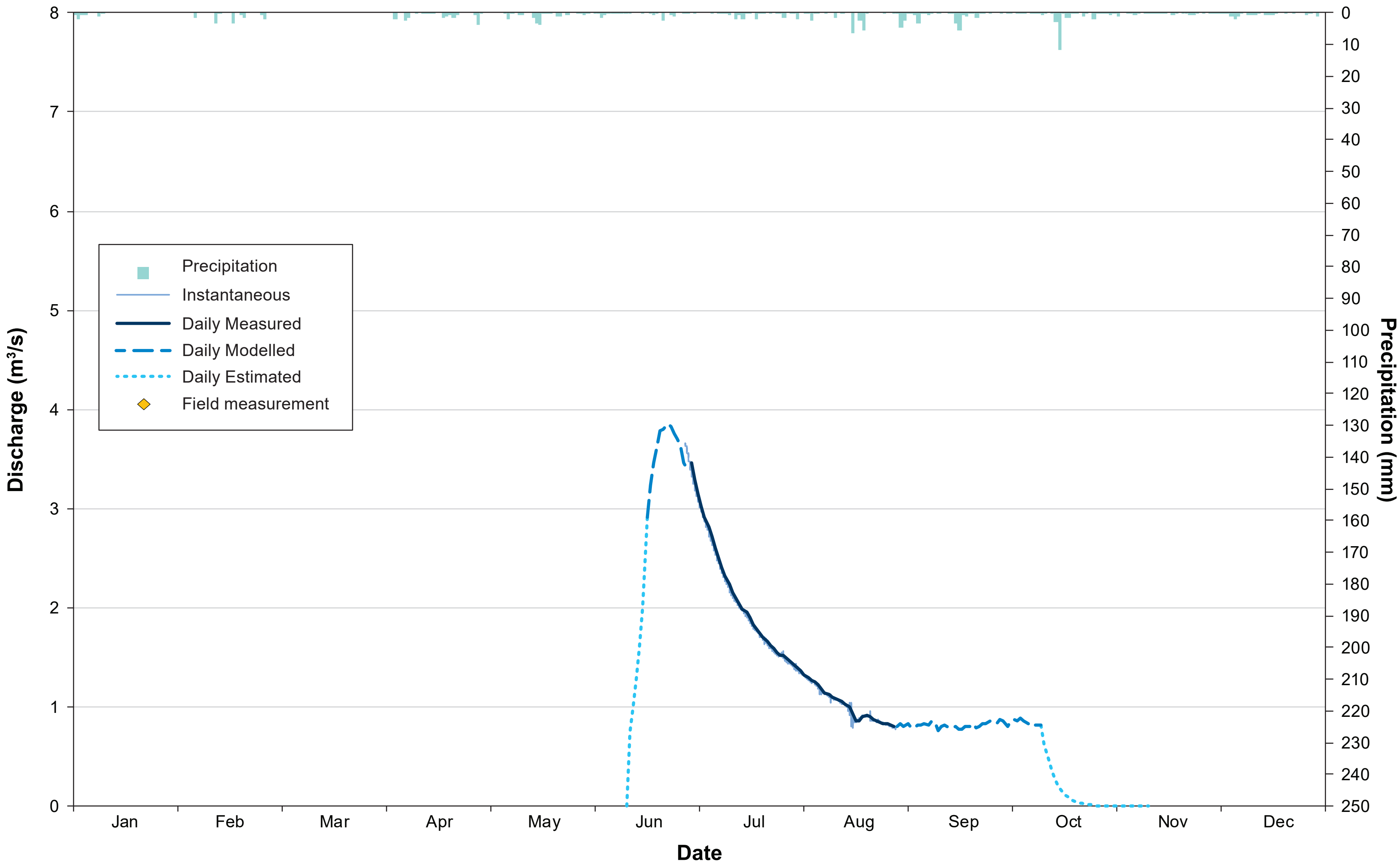


Figure B6: 2020 Mean Daily Hydrograph at Monitoring Station Little Roberts Outflow

APPENDIX C MEAN DAILY LAKE LEVEL TABLES

Summary of Mean Daily Water Level (m) at Hydrometric Station Windy Outflow, 2020

Drainage Area = 13.73 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.404	18.365	*18.287*	*18.304*	*18.293*	*18.293*
2	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.402	18.362	*18.284*	*18.300*	*18.293*	*18.293*
3	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.401	18.361	*18.292*	*18.307*	*18.293*	*18.293*
4	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.398	18.360	*18.293*	*18.300*	*18.293*	*18.293*
5	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.397	18.359	*18.294*	*18.296*	*18.293*	*18.293*
6	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.394	18.351	*18.292*	*18.289*	*18.293*	*18.293*
7	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.392	18.347	*18.302*	*18.291*	*18.293*	*18.293*
8	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.389	18.340	*18.297*	*18.292*	*18.293*	*18.293*
9	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.387	18.340	*18.281*	*18.293*	*18.293*	*18.293*
10	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	18.385	18.337	*18.291*	*18.293*	*18.293*	*18.293*
11	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.330*	18.382	18.334	*18.291*	*18.293*	*18.293*	*18.293*
12	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.342*	18.383	18.331	*18.286*	*18.293*	*18.293*	*18.293*
13	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.354*	18.382	18.327	*18.287*	*18.293*	*18.293*	*18.293*
14	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.365*	18.382	18.323	*18.291*	*18.293*	*18.293*	*18.293*
15	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.377*	18.383	18.318	*18.281*	*18.293*	*18.293*	*18.293*
16	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.401*	18.380	18.318	*18.284*	*18.293*	*18.293*	*18.293*
17	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.406*	18.377	18.318	*18.288*	*18.293*	*18.293*	*18.293*
18	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.410*	18.376	18.317	*18.291*	*18.293*	*18.293*	*18.293*
19	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.413*	18.374	18.314	*18.294*	*18.293*	*18.293*	*18.293*
20	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.415*	18.373	18.309	*18.285*	*18.293*	*18.293*	*18.293*
21	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.415*	18.370	18.303	*18.291*	*18.293*	*18.293*	*18.293*
22	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.416*	18.368	18.300	*18.295*	*18.293*	*18.293*	*18.293*
23	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.416*	18.364	18.296	*18.295*	*18.293*	*18.293*	*18.293*
24	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.415*	18.366	18.293	*18.302*	*18.293*	*18.293*	*18.293*
25	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.414*	18.375	18.288	*18.300*	*18.293*	*18.293*	*18.293*
26	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.413*	18.378	18.287	*18.297*	*18.293*	*18.293*	*18.293*
27	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.410*	18.375	18.282	*18.303*	*18.293*	*18.293*	*18.293*
28	*18.318*	*18.318*	*18.318*	*18.318*	*18.318*	*18.409*	18.374	18.289	*18.303*	*18.293*	*18.293*	*18.293*
29	*18.318*	18.318	*18.318*	*18.318*	*18.318*	18.407	18.369	*18.294*	*18.291*	*18.293*	*18.293*	*18.293*
30	*18.318*		*18.318*	*18.318*	*18.318*	18.405	18.370	*18.288*	*18.301*	*18.293*	*18.293*	*18.293*
31	*18.318*		*18.318*		*18.318*		18.367	*18.296*		*18.293*		*18.293*
Mean	18.318	18.318	18.318	18.318	18.318	18.370	18.381	18.321	18.292	18.294	18.293	18.293
Max	18.318	18.318	18.318	18.318	18.318	18.416	18.404	18.365	18.303	18.307	18.293	18.293
Min	18.318	18.318	18.318	18.318	18.318	18.318	18.364	18.282	18.281	18.289	18.293	18.293

Note: Estimated and modelled values are italicized.

Summary of Mean Daily Water Level (m) at Hydrometric Station Glenn Lake, 2020

Drainage Area = 20.59 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	9.859	9.703	*9.588*	*9.606*	*9.583*	*9.582*
2	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	9.848	9.697	*9.585*	*9.601*	*9.583*	*9.582*
3	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	9.839	9.692	*9.592*	*9.610*	*9.583*	*9.582*
4	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.540*	9.831	9.689	*9.593*	*9.601*	*9.583*	*9.582*
5	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.554*	9.825	9.680	*9.595*	*9.597*	*9.583*	*9.582*
6	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.567*	9.819	9.670	*9.593*	*9.590*	*9.583*	*9.582*
7	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.581*	9.811	9.663	*9.603*	*9.592*	*9.583*	*9.582*
8	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.594*	9.804	9.656	*9.598*	*9.592*	*9.583*	*9.582*
9	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.608*	9.796	9.649	*9.581*	*9.594*	*9.583*	*9.582*
10	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.635*	9.790	9.645	*9.591*	*9.593*	*9.583*	*9.582*
11	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.652*	9.783	9.641	*9.592*	*9.583*	*9.583*	*9.582*
12	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.679*	9.780	9.635	*9.586*	*9.583*	*9.583*	*9.582*
13	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.724*	9.777	9.629	*9.587*	*9.583*	*9.583*	*9.582*
14	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.776*	9.774	9.621	*9.591*	*9.583*	*9.583*	*9.582*
15	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.818*	9.770	9.612	*9.582*	*9.583*	*9.583*	*9.582*
16	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.848*	9.765	9.613	*9.585*	*9.583*	*9.583*	*9.582*
17	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.872*	9.760	9.615	*9.588*	*9.583*	*9.583*	*9.582*
18	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.888*	9.756	9.619	*9.591*	*9.583*	*9.583*	*9.582*
19	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.899*	9.756	9.618	*9.595*	*9.583*	*9.583*	*9.582*
20	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.910*	9.752	9.615	*9.586*	*9.583*	*9.583*	*9.582*
21	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.911*	9.748	9.611	*9.591*	*9.583*	*9.583*	*9.582*
22	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.915*	9.746	9.608	*9.596*	*9.583*	*9.582*	*9.582*
23	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.913*	9.743	9.604	*9.595*	*9.583*	*9.582*	*9.582*
24	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.909*	9.741	9.600	*9.604*	*9.583*	*9.582*	*9.582*
25	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.905*	9.742	9.596	*9.601*	*9.583*	*9.582*	*9.582*
26	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.900*	9.744	9.592	*9.597*	*9.583*	*9.582*	*9.582*
27	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.888*	9.739	9.588	*9.605*	*9.583*	*9.582*	*9.582*
28	*9.527*	*9.527*	*9.527*	*9.527*	*9.527*	*9.882*	9.734	9.589	*9.604*	*9.583*	*9.582*	*9.582*
29	*9.527*	9.527	*9.527*	*9.527*	*9.527*	*9.888*	9.728	*9.595*	*9.591*	*9.583*	*9.582*	*9.582*
30	*9.527*		*9.527*	*9.527*	*9.527*	9.871	9.721	*9.589*	*9.602*	*9.583*	*9.582*	*9.582*
31	*9.527*		*9.527*		*9.527*	9.859	9.711	*9.596*		*9.583*		*9.582*
Mean	9.527	9.527	9.527	9.527	9.527	9.760	9.774	9.630	9.593	9.588	9.583	9.582
Max	9.527	9.527	9.527	9.527	9.527	9.915	9.859	9.703	9.605	9.610	9.583	9.582
Min	9.527	9.527	9.527	9.527	9.527	9.527	9.711	9.588	9.581	9.583	9.582	9.582

Note: Estimated and modelled values are italicized.

Summary of Mean Daily Water Level (m) at Hydrometric Station Imniagut, 2020

Drainage Area = 1.31 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.390	27.311	*27.286*	*27.286*	*27.286*	*27.285*
2	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.384	27.309	*27.287*	*27.288*	*27.286*	*27.285*
3	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.378	27.308	*27.286*	*27.288*	*27.286*	*27.285*
4	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.374	27.307	*27.285*	*27.288*	*27.286*	*27.285*
5	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.370	27.304	*27.286*	*27.289*	*27.286*	*27.285*
6	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.370	27.300	*27.286*	*27.288*	*27.286*	*27.285*
7	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.369	27.295	*27.287*	*27.287*	*27.286*	*27.285*
8	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.367	27.292	*27.286*	*27.286*	*27.286*	*27.285*
9	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.365	27.290	*27.288*	*27.286*	*27.285*	*27.285*
10	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	27.364	27.290	*27.287*	*27.286*	*27.285*	*27.285*
11	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.269*	27.361	27.291	*27.285*	*27.286*	*27.285*	*27.285*
12	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.289*	27.361	27.289	*27.286*	*27.286*	*27.285*	*27.285*
13	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.308*	27.360	27.286	*27.286*	*27.286*	*27.285*	*27.285*
14	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.328*	27.359	27.284	*27.285*	*27.286*	*27.285*	*27.285*
15	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.348*	27.359	27.282	*27.286*	*27.286*	*27.285*	*27.285*
16	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.387*	27.354	27.288	*27.286*	*27.286*	*27.285*	*27.285*
17	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.399*	27.349	27.291	*27.285*	*27.286*	*27.285*	*27.285*
18	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.407*	27.346	27.297	*27.285*	*27.286*	*27.285*	*27.285*
19	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.412*	27.345	27.299	*27.286*	*27.286*	*27.285*	*27.285*
20	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.418*	27.341	27.299	*27.286*	*27.286*	*27.285*	*27.285*
21	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.419*	27.337	27.297	*27.287*	*27.286*	*27.285*	*27.285*
22	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.420*	27.334	27.296	*27.285*	*27.286*	*27.285*	*27.285*
23	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.419*	27.331	27.294	*27.286*	*27.286*	*27.285*	*27.285*
24	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.417*	27.328	27.293	*27.287*	*27.286*	*27.285*	*27.285*
25	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.415*	27.325	27.291	*27.287*	*27.286*	*27.285*	*27.285*
26	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.413*	27.326	27.287	*27.288*	*27.286*	*27.285*	*27.285*
27	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.408*	27.322	27.284	*27.288*	*27.286*	*27.285*	*27.285*
28	*27.249*	*27.249*	*27.249*	*27.249*	*27.249*	*27.405*	27.319	27.286	*27.287*	*27.286*	*27.285*	*27.285*
29	*27.249*	27.249	*27.249*	*27.249*	*27.249*	*27.403*	27.316	*27.285*	*27.288*	*27.286*	*27.285*	*27.285*
30	*27.249*		*27.249*	*27.249*	*27.249*	27.396	27.318	*27.286*	*27.288*	*27.286*	*27.285*	*27.285*
31	*27.249*		*27.249*		*27.249*		27.314	*27.287*		*27.286*		*27.285*
Mean	27.249	27.249	27.249	27.249	27.249	27.339	27.350	27.294	27.286	27.286	27.285	27.285
Max	27.249	27.249	27.249	27.249	27.249	27.420	27.390	27.311	27.288	27.289	27.286	27.285
Min	27.249	27.249	27.249	27.249	27.249	27.249	27.314	27.282	27.285	27.286	27.285	27.285

Note: Estimated and modelled values are italicized.

Summary of Mean Daily Water Level (m) at Hydrometric Station Patch Outflow, 2020

Drainage Area = 32.16 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.483	26.316	*26.217*	*26.229*	*26.201*	*26.190*
2	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.477	26.311	*26.222*	*26.236*	*26.199*	*26.190*
3	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.471	26.307	*26.223*	*26.229*	*26.198*	*26.190*
4	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.465	26.305	*26.224*	*26.226*	*26.197*	*26.190*
5	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.459	26.301	*26.223*	*26.220*	*26.196*	*26.190*
6	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.452	26.290	*26.231*	*26.222*	*26.195*	*26.190*
7	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.445	26.283	*26.227*	*26.222*	*26.193*	*26.190*
8	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	26.439	26.277	*26.214*	*26.224*	*26.192*	*26.190*
9	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.308*	26.431	26.272	*26.222*	*26.229*	*26.190*	*26.190*
10	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.330*	26.427	26.273	*26.222*	*26.228*	*26.190*	*26.190*
11	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.351*	26.418	26.270	*26.218*	*26.226*	*26.190*	*26.190*
12	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.372*	26.414	26.268	*26.219*	*26.225*	*26.190*	*26.190*
13	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.393*	26.410	26.261	*26.221*	*26.224*	*26.190*	*26.190*
14	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.415*	26.407	26.254	*26.214*	*26.223*	*26.190*	*26.190*
15	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.436*	26.404	26.250	*26.216*	*26.221*	*26.190*	*26.190*
16	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.479*	26.399	26.251	*26.219*	*26.220*	*26.190*	*26.190*
17	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.505*	26.392	26.248	*26.222*	*26.219*	*26.190*	*26.190*
18	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.522*	26.385	26.249	*26.224*	*26.218*	*26.190*	*26.190*
19	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.534*	26.378	26.246	*26.217*	*26.217*	*26.190*	*26.190*
20	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.547*	26.373	26.245	*26.221*	*26.215*	*26.190*	*26.190*
21	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.548*	26.368	26.241	*26.225*	*26.214*	*26.190*	*26.190*
22	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.552*	26.361	26.237	*26.225*	*26.213*	*26.190*	*26.190*
23	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.550*	26.354	26.233	*26.231*	*26.212*	*26.190*	*26.190*
24	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.545*	26.350	26.230	*26.229*	*26.210*	*26.190*	*26.190*
25	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.541*	26.345	26.228	*26.226*	*26.209*	*26.190*	*26.190*
26	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.535*	26.348	26.225	*26.232*	*26.208*	*26.190*	*26.190*
27	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.522*	26.340	26.223	*26.232*	*26.207*	*26.190*	*26.190*
28	*26.287*	*26.287*	*26.287*	*26.287*	*26.287*	*26.516*	26.334	26.224	*26.222*	*26.206*	*26.190*	*26.190*
29	*26.287*	26.287	*26.287*	*26.287*	*26.287*	*26.495*	26.330	*26.220*	*26.230*	*26.204*	*26.190*	*26.190*
30	*26.287*		*26.287*	*26.287*	*26.287*	26.488	26.335	*26.226*	*26.233*	*26.203*	*26.190*	*26.190*
31	*26.287*		*26.287*		*26.287*		26.325	*26.219*		*26.202*		*26.190*
Mean	26.287	26.287	26.287	26.287	26.287	26.426	26.397	26.258	26.223	26.218	26.191	26.190
Max	26.287	26.287	26.287	26.287	26.287	26.552	26.483	26.316	26.233	26.236	26.201	26.190
Min	26.287	26.287	26.287	26.287	26.287	26.287	26.325	26.219	26.214	26.202	26.190	26.190

Note: Estimated and modelled values are italicized.

Summary of Mean Daily Water Level (m) at Hydrometric Station PO Outflow 2020

Drainage Area = 35.3 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.364	26.227	*26.128*	*26.144*	*26.086*	*26.068*
2	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.355	26.223	*26.126*	*26.140*	*26.084*	*26.068*
3	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.346	26.218	*26.132*	*26.147*	*26.082*	*26.068*
4	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.337	26.215	*26.133*	*26.139*	*26.080*	*26.068*
5	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.327	26.209	*26.134*	*26.136*	*26.078*	*26.068*
6	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.319	26.199	*26.132*	*26.130*	*26.076*	*26.068*
7	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.313	26.191	*26.141*	*26.132*	*26.074*	*26.068*
8	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.307	26.186	*26.137*	*26.132*	*26.072*	*26.068*
9	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.301	26.179	*26.123*	*26.133*	*26.068*	*26.068*
10	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	26.298	26.175	*26.131*	*26.131*	*26.068*	*26.068*
11	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.313*	26.293	26.173	*26.131*	*26.129*	*26.068*	*26.068*
12	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.319*	26.292	26.167	*26.127*	*26.127*	*26.068*	*26.068*
13	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.326*	26.289	26.164	*26.128*	*26.125*	*26.068*	*26.068*
14	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.332*	26.288	26.156	*26.131*	*26.123*	*26.068*	*26.068*
15	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.338*	26.289	26.148	*26.123*	*26.121*	*26.068*	*26.068*
16	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.350*	26.287	26.150	*26.125*	*26.119*	*26.068*	*26.068*
17	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.371*	26.282	26.153	*26.128*	*26.117*	*26.068*	*26.068*
18	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.385*	26.276	26.154	*26.131*	*26.115*	*26.068*	*26.068*
19	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.395*	26.271	26.152	*26.134*	*26.113*	*26.068*	*26.068*
20	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.405*	26.265	26.151	*26.126*	*26.111*	*26.068*	*26.068*
21	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.406*	26.260	26.149	*26.131*	*26.109*	*26.068*	*26.068*
22	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.409*	26.256	26.147	*26.135*	*26.107*	*26.068*	*26.068*
23	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.407*	26.251	26.143	*26.134*	*26.105*	*26.068*	*26.068*
24	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.403*	26.246	26.139	*26.142*	*26.103*	*26.068*	*26.068*
25	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.400*	26.246	26.135	*26.139*	*26.101*	*26.068*	*26.068*
26	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.395*	26.246	26.130	*26.136*	*26.098*	*26.068*	*26.068*
27	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.385*	26.242	26.124	*26.142*	*26.096*	*26.068*	*26.068*
28	*26.307*	*26.307*	*26.307*	*26.307*	*26.307*	*26.380*	26.239	26.118	*26.142*	*26.094*	*26.068*	*26.068*
29	*26.307*	26.307	*26.307*	*26.307*	*26.307*	*26.384*	26.235	26.134	*26.131*	*26.092*	*26.068*	*26.068*
30	*26.307*		*26.307*	*26.307*	*26.307*	26.373	26.236	*26.129*	*26.140*	*26.090*	*26.068*	*26.068*
31	*26.307*		*26.307*		*26.307*		26.231	*26.135*		*26.088*		*26.068*
Mean	26.307	26.307	26.307	26.307	26.307	26.352	26.283	26.164	26.132	26.118	26.071	26.068
Max	26.307	26.307	26.307	26.307	26.307	26.409	26.364	26.227	26.142	26.147	26.086	26.068
Min	26.307	26.307	26.307	26.307	26.307	26.307	26.231	26.118	26.123	26.088	26.068	26.068

Note: Estimated and modelled values are italicized.

Summary of Mean Daily Water Level (m) at Hydrometric Station Ogama, 2020

Drainage Area = 74.93 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.381	24.111	*24.031*	*24.042*	*24.037*	*24.040*
2	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.367	24.107	*24.029*	*24.039*	*24.037*	*24.040*
3	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.354	24.103	*24.033*	*24.045*	*24.037*	*24.040*
4	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.342	24.096	*24.034*	*24.039*	*24.037*	*24.040*
5	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.326	24.091	*24.035*	*24.037*	*24.037*	*24.040*
6	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.313	24.084	*24.034*	*24.032*	*24.037*	*24.040*
7	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.299	24.078	*24.040*	*24.033*	*24.037*	*24.040*
8	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.287	24.073	*24.037*	*24.033*	*24.038*	*24.040*
9	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.273	24.069	*24.027*	*24.034*	*24.040*	*24.040*
10	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	24.264	24.064	*24.033*	*24.034*	*24.040*	*24.040*
11	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.101*	24.253	24.063	*24.033*	*24.035*	*24.040*	*24.040*
12	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.143*	24.248	24.058	*24.030*	*24.035*	*24.040*	*24.040*
13	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.186*	24.239	24.056	*24.030*	*24.035*	*24.040*	*24.040*
14	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.229*	24.233	24.052	*24.033*	*24.035*	*24.040*	*24.040*
15	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.272*	24.230	24.042	*24.027*	*24.035*	*24.040*	*24.040*
16	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.358*	24.223	24.043	*24.029*	*24.035*	*24.040*	*24.040*
17	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.397*	24.215	24.049	*24.031*	*24.035*	*24.040*	*24.040*
18	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.423*	24.210	24.052	*24.033*	*24.035*	*24.040*	*24.040*
19	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.441*	24.208	24.052	*24.035*	*24.035*	*24.040*	*24.040*
20	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.459*	24.195	24.048	*24.029*	*24.036*	*24.040*	*24.040*
21	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.461*	24.186	24.045	*24.033*	*24.036*	*24.040*	*24.040*
22	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.467*	24.182	24.046	*24.036*	*24.036*	*24.040*	*24.040*
23	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.463*	24.175	24.045	*24.035*	*24.036*	*24.040*	*24.040*
24	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.456*	24.166	24.044	*24.041*	*24.036*	*24.040*	*24.040*
25	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.450*	24.161	24.041	*24.039*	*24.036*	*24.040*	*24.040*
26	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.441*	24.151	24.036	*24.037*	*24.036*	*24.040*	*24.040*
27	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.423*	24.140	24.032	*24.041*	*24.036*	*24.040*	*24.040*
28	*24.058*	*24.058*	*24.058*	*24.058*	*24.058*	*24.427*	24.136	24.024	*24.041*	*24.036*	*24.040*	*24.040*
29	*24.058*	24.058	*24.058*	*24.058*	*24.058*	24.410	24.128	24.035	*24.033*	*24.037*	*24.040*	*24.040*
30	*24.058*		*24.058*	*24.058*	*24.058*	24.394	24.122	*24.031*	24.040	*24.037*	*24.040*	*24.040*
31	*24.058*		*24.058*		*24.058*		24.114	*24.036*		*24.037*		*24.040*
Mean	24.058	24.058	24.058	24.058	24.058	24.266	24.230	24.058	24.034	24.036	24.039	24.040
Max	24.058	24.058	24.058	24.058	24.058	24.467	24.381	24.111	24.041	24.045	24.040	24.040
Min	24.058	24.058	24.058	24.058	24.058	24.058	24.114	24.024	24.027	24.032	24.037	24.040

Note: Estimated and modelled values are italicized.

Summary of Mean Daily Water Level (m) at Hydrometric Station DorisLake-2, 2020

Drainage Area = 90.29 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.735	21.723	21.715	21.682	21.657	21.647	22.120	21.832	21.729	21.745	21.749	21.788
2	21.728	21.720	21.707	21.690	21.655	21.647	22.109	21.826	21.727	21.741	21.749	21.776
3	21.744	21.725	21.701	21.681	21.651	21.650	22.097	21.822	21.733	21.748	21.750	21.799
4	21.748	21.726	21.704	21.675	21.646	21.649	22.083	21.814	21.734	21.741	21.740	21.774
5	21.744	21.729	21.701	21.676	21.649	21.650	22.072	21.806	21.735	21.737	21.740	21.791
6	21.734	21.717	21.704	21.676	21.654	21.658	22.060	21.799	21.734	21.731	21.750	21.785
7	21.731	21.722	21.707	21.668	21.642	21.666	22.044	21.794	21.742	21.733	21.746	21.796
8	21.729	21.719	21.709	21.662	21.646	21.672	22.033	21.788	21.738	21.733	21.746	21.787
9	21.733	21.717	21.694	21.671	21.654	21.694	22.022	21.778	21.724	21.734	21.742	21.790
10	21.734	21.715	21.694	21.669	21.659	21.722	22.007	21.775	21.732	21.734	21.750	21.801
11	21.732	21.717	21.693	21.665	21.655	21.754	22.003	21.769	21.733	21.725	21.749	21.809
12	21.725	21.716	21.696	21.671	21.651	21.801	21.995	21.766	21.728	21.728	21.755	21.799
13	21.726	21.718	21.704	21.668	21.652	21.881	21.981	21.761	21.729	21.738	21.747	21.800
14	21.725	21.716	21.695	21.658	21.649	21.973	21.975	21.756	21.732	21.741	21.755	21.804
15	21.721	21.713	21.681	21.664	21.656	22.049	21.966	21.753	21.724	21.748	21.750	21.804
16	21.719	21.705	21.683	21.670	21.653	22.102	21.955	21.754	21.727	21.748	21.750	21.813
17	21.724	21.698	21.688	21.666	21.654	22.145	21.944	21.756	21.730	21.747	21.762	21.814
18	21.725	21.708	21.690	21.668	21.656	22.174	21.941	21.759	21.732	21.752	21.759	21.806
19	21.722	21.712	21.694	21.661	21.657	22.193	21.931	21.756	21.735	21.753	21.763	21.812
20	21.722	21.706	21.691	21.658	21.650	22.213	21.919	21.746	21.728	21.749	21.765	21.817
21	21.726	21.707	21.675	21.661	21.653	22.215	21.915	21.745	21.732	21.747	21.765	21.809
22	21.728	21.708	21.675	21.661	21.654	22.222	21.908	21.745	21.736	21.750	21.769	21.808
23	21.722	21.707	21.684	21.657	21.654	22.219	21.898	21.741	21.736	21.757	21.776	21.819
24	21.714	21.707	21.686	21.659	21.653	22.210	21.894	21.743	21.743	21.748	21.782	21.809
25	21.718	21.707	21.689	21.663	21.653	22.204	21.885	21.739	21.740	21.760	21.779	21.806
26	21.712	21.704	21.675	21.663	21.649	22.194	21.874	21.733	21.737	21.746	21.784	21.805
27	21.721	21.706	21.685	21.665	21.647	22.174	21.873	21.727	21.744	21.747	21.786	21.815
28	21.713	21.702	21.684	21.654	21.649	22.163	21.861	21.731	21.743	21.751	21.789	21.802
29	21.720	21.710	21.680	21.644	21.651	22.150	21.850	21.735	21.732	21.743	21.788	21.802
30	21.720		21.680	21.652	21.648	22.130	21.843	21.730	21.741	21.744	21.779	21.801
31	21.718		21.677		21.648		21.839	21.737		21.750		21.805
Mean	21.726	21.713	21.692	21.666	21.652	21.961	21.965	21.765	21.734	21.744	21.760	21.802
Max	21.748	21.729	21.715	21.690	21.659	22.222	22.120	21.832	21.744	21.760	21.789	21.819
Min	21.712	21.698	21.675	21.644	21.642	21.647	21.839	21.727	21.724	21.725	21.740	21.774

Note: Estimated and modelled values are italicized.

Summary of Mean Daily Water Level (m) at Hydrometric Station Liitle Roberts, 2020

Drainage Area = 194.15 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	5.083	4.738	*4.590*	*4.615*	*4.528*	*4.501*
2	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	5.064	4.730	*4.585*	*4.608*	*4.525*	*4.501*
3	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	5.047	4.724	*4.595*	*4.620*	*4.522*	*4.501*
4	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	5.030	4.720	*4.597*	*4.608*	*4.519*	*4.501*
5	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	5.014	4.712	*4.599*	*4.602*	*4.516*	*4.501*
6	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	4.996	4.700	*4.597*	*4.592*	*4.513*	*4.501*
7	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	4.977	4.692	*4.611*	*4.595*	*4.510*	*4.501*
8	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	4.961	4.687	*4.604*	*4.596*	*4.507*	*4.501*
9	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	4.945	4.679	*4.580*	*4.598*	*4.501*	*4.501*
10	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	4.930	4.675	*4.594*	*4.595*	*4.501*	*4.501*
11	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.575*	4.915	4.672	*4.595*	*4.592*	*4.501*	*4.501*
12	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.650*	4.902	4.666	*4.587*	*4.588*	*4.501*	*4.501*
13	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.726*	4.893	4.660	*4.589*	*4.585*	*4.501*	*4.501*
14	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.804*	4.883	4.654	*4.594*	*4.582*	*4.501*	*4.501*
15	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*4.883*	4.876	4.633	*4.581*	*4.579*	*4.501*	*4.501*
16	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.045*	4.864	4.610	*4.585*	*4.576*	*4.501*	*4.501*
17	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.095*	4.852	4.611	*4.590*	*4.573*	*4.501*	*4.501*
18	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.128*	4.841	4.621	*4.594*	*4.570*	*4.501*	*4.501*
19	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.151*	4.834	4.625	*4.599*	*4.567*	*4.501*	*4.501*
20	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.174*	4.825	4.624	*4.587*	*4.564*	*4.501*	*4.501*
21	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.177*	4.817	4.616	*4.594*	*4.561*	*4.501*	*4.501*
22	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.184*	4.806	4.611	*4.601*	*4.558*	*4.501*	*4.501*
23	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.180*	4.799	4.608	*4.600*	*4.555*	*4.501*	*4.501*
24	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.171*	4.789	4.603	*4.612*	*4.552*	*4.501*	*4.501*
25	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.163*	4.785	4.601	*4.607*	*4.549*	*4.501*	*4.501*
26	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.152*	4.784	4.597	*4.603*	*4.546*	*4.501*	*4.501*
27	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.128*	4.773	4.592	*4.613*	*4.543*	*4.501*	*4.501*
28	*4.501*	*4.501*	*4.501*	*4.501*	*4.501*	*5.116*	4.767	4.591	*4.612*	*4.540*	*4.501*	*4.501*
29	*4.501*	4.501	*4.501*	*4.501*	*4.501*	*5.128*	4.760	*4.599*	*4.594*	*4.537*	*4.501*	*4.501*
30	*4.501*		*4.501*	*4.501*	*4.501*	5.104	4.754	*4.591*	*4.609*	*4.534*	*4.501*	*4.501*
31	*4.501*		*4.501*		*4.501*		4.746	*4.601*		*4.531*		*4.501*
Mean	4.501	4.501	4.501	4.501	4.501	4.858	4.881	4.647	4.597	4.575	4.505	4.501
Max	4.501	4.501	4.501	4.501	4.501	5.184	5.083	4.738	4.613	4.620	4.528	4.501
Min	4.501	4.501	4.501	4.501	4.501	4.501	4.746	4.591	4.580	4.531	4.501	4.501

Note: Estimated and modelled values are italicized.

APPENDIX D MEAN DAILY DISCHARGE TABLES

Summary of Daily Discharge [Q, m^3/s] at Hydrometric Station Windy Outflow, 2020

Drainage Area = 13.73 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	0.267	0.180	*0.070*	*0.075*	*0.001*	-
2	-	-	-	-	-	-	0.263	0.177	*0.061*	*0.080*	*0.001*	-
3	-	-	-	-	-	-	0.260	0.171	*0.057*	*0.075*	*0.001*	-
4	-	-	-	-	-	-	0.257	0.171	*0.065*	*0.084*	*0.000*	-
5	-	-	-	-	-	-	0.250	0.169	*0.066*	*0.075*	*0.000*	-
6	-	-	-	-	-	-	0.246	0.165	*0.068*	*0.070*	*0.000*	-
7	-	-	-	-	-	-	0.240	0.150	*0.066*	*0.062*	*0.000*	-
8	-	-	-	-	-	-	0.235	0.144	*0.077*	*0.065*	*0.000*	-
9	-	-	-	-	-	-	0.229	0.132	*0.072*	*0.065*	*0.000*	-
10	-	-	-	-	-	-	0.223	0.132	*0.054*	*0.067*	*0.000*	-
11	-	-	-	-	-	*0.000*	0.220	0.126	*0.064*	*0.054*	-	-
12	-	-	-	-	-	*0.000*	0.212	0.123	*0.065*	*0.044*	-	-
13	-	-	-	-	-	*0.001*	0.215	0.118	*0.059*	*0.036*	-	-
14	-	-	-	-	-	*0.003*	0.213	0.112	*0.060*	*0.030*	-	-
15	-	-	-	-	-	*0.009*	0.213	0.105	*0.064*	*0.024*	-	-
16	-	-	-	-	-	*0.027*	0.216	0.098	*0.054*	*0.020*	-	-
17	-	-	-	-	-	*0.256*	0.209	0.098	*0.057*	*0.016*	-	-
18	-	-	-	-	-	*0.270*	0.202	0.098	*0.061*	*0.013*	-	-
19	-	-	-	-	-	*0.280*	0.199	0.097	*0.064*	*0.011*	-	-
20	-	-	-	-	-	*0.286*	0.197	0.093	*0.068*	*0.009*	-	-
21	-	-	-	-	-	*0.293*	0.195	0.086	*0.058*	*0.007*	-	-
22	-	-	-	-	-	*0.294*	0.187	0.078	*0.064*	*0.006*	-	-
23	-	-	-	-	-	*0.296*	0.184	0.075	*0.069*	*0.005*	-	-
24	-	-	-	-	-	*0.295*	0.178	0.070	*0.068*	*0.004*	-	-
25	-	-	-	-	-	*0.292*	0.182	0.066	*0.077*	*0.003*	-	-
26	-	-	-	-	-	*0.290*	0.203	0.061	*0.074*	*0.003*	-	-
27	-	-	-	-	-	*0.287*	0.205	0.060	*0.071*	*0.002*	-	-
28	-	-	-	-	-	*0.280*	0.197	0.055	*0.078*	*0.002*	-	-
29	-		-	-	-	0.276	0.197	*0.062*	*0.078*	*0.001*	-	-
30	-		-	-	-	0.272	0.186	*0.068*	*0.064*	*0.001*	-	-
31	-		-		-		0.188	*0.061*		*0.001*		-
Mean	0.000	0.000	0.000	0.000	0.000	0.200	0.215	0.110	0.066	0.033	0.000	#DIV/0!
Max	0.000	0.000	0.000	0.000	0.000	0.296	0.267	0.180	0.078	0.084	0.001	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.178	0.055	0.054	0.001	0.000	0.000

Note: Estimated and modelled values are italicized

Summary of Daily Discharge [Q, m^3/s] at Hydrometric Station Patch Outflow, 2020

Drainage Area = 32.16 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	0.679	0.225	*0.073*	*0.090*	*0.000*	-
2	-	-	-	-	-	-	0.660	0.209	*0.071*	*0.085*	*0.000*	-
3	-	-	-	-	-	-	0.636	0.201	*0.077*	*0.093*	*0.000*	-
4	-	-	-	-	-	-	0.612	0.194	*0.078*	*0.085*	*0.000*	-
5	-	-	-	-	-	-	0.590	0.191	*0.079*	*0.081*	*0.000*	-
6	-	-	-	-	-	-	0.570	0.184	*0.078*	*0.075*	*0.000*	-
7	-	-	-	-	-	-	0.542	0.168	*0.087*	*0.077*	*0.000*	-
8	-	-	-	-	-	-	0.520	0.156	*0.082*	*0.077*	*0.000*	-
9	-	-	-	-	-	-	0.498	0.147	*0.068*	*0.078*	*0.000*	-
10	-	-	-	-	-	-	0.473	0.140	*0.076*	*0.084*	-	-
11	-	-	-	-	-	*0.001*	0.458	0.143	*0.077*	*0.063*	-	-
12	-	-	-	-	-	*0.003*	0.431	0.138	*0.072*	*0.047*	-	-
13	-	-	-	-	-	*0.006*	0.416	0.135	*0.073*	*0.035*	-	-
14	-	-	-	-	-	*0.016*	0.404	0.125	*0.076*	*0.026*	-	-
15	-	-	-	-	-	*0.040*	0.395	0.116	*0.068*	*0.020*	-	-
16	-	-	-	-	-	*0.101*	0.387	0.111	*0.070*	*0.015*	-	-
17	-	-	-	-	-	*0.644*	0.372	0.112	*0.073*	*0.011*	-	-
18	-	-	-	-	-	*0.747*	0.354	0.108	*0.076*	*0.008*	-	-
19	-	-	-	-	-	*0.821*	0.339	0.109	*0.079*	*0.006*	-	-
20	-	-	-	-	-	*0.874*	0.325	0.105	*0.072*	*0.005*	-	-
21	-	-	-	-	-	*0.929*	0.316	0.104	*0.076*	*0.003*	-	-
22	-	-	-	-	-	*0.934*	0.306	0.099	*0.080*	*0.003*	-	-
23	-	-	-	-	-	*0.953*	0.292	0.094	*0.080*	*0.002*	-	-
24	-	-	-	-	-	*0.943*	0.278	0.090	*0.087*	*0.001*	-	-
25	-	-	-	-	-	*0.920*	0.269	0.086	*0.085*	*0.001*	-	-
26	-	-	-	-	-	*0.902*	0.262	0.084	*0.082*	*0.001*	-	-
27	-	-	-	-	-	*0.876*	0.266	0.080	*0.088*	*0.001*	-	-
28	-	-	-	-	-	*0.821*	0.252	0.078	*0.088*	*0.000*	-	-
29	-		-	-	-	*0.794*	0.241	*0.079*	*0.076*	*0.000*	-	-
30	-		-	-	-	0.705	0.233	*0.074*	*0.085*	*0.000*	-	-
31	-		-		-		0.244	*0.081*		*0.000*		-
Mean	0.000	0.000	0.000	0.000	0.000	0.602	0.407	0.128	0.078	0.035	0.000	n/a
Max	0.000	0.000	0.000	0.000	0.000	0.953	0.679	0.225	0.088	0.093	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.001	0.233	0.074	0.068	0.000	0.000	0.000

Note: Estimated and modelled values are italicized

Summary of Daily Discharge [Q, m^3/s] at Hydrometric Station PO Outflow, 2020

Drainage Area = 35.3 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	0.790	0.331	*0.174*	*0.180*	*0.001*	-
2	-	-	-	-	-	-	0.751	0.324	*0.164*	*0.186*	*0.001*	-
3	-	-	-	-	-	-	0.714	0.316	*0.160*	*0.180*	*0.001*	-
4	-	-	-	-	-	-	0.678	0.308	*0.169*	*0.190*	*0.001*	-
5	-	-	-	-	-	-	0.643	0.303	*0.170*	*0.180*	*0.000*	-
6	-	-	-	-	-	-	0.606	0.292	*0.172*	*0.175*	*0.000*	-
7	-	-	-	-	-	-	0.576	0.273	*0.170*	*0.166*	*0.000*	-
8	-	-	-	-	-	-	0.553	0.260	*0.182*	*0.168*	*0.000*	-
9	-	-	-	-	-	-	0.530	0.251	*0.176*	*0.169*	*0.000*	-
10	-	-	-	-	-	-	0.513	0.240	*0.156*	*0.171*	*0.000*	-
11	-	-	-	-	-	*0.000*	0.501	0.234	*0.168*	*0.135*	-	-
12	-	-	-	-	-	*0.000*	0.485	0.230	*0.168*	*0.107*	-	-
13	-	-	-	-	-	*0.001*	0.479	0.222	*0.162*	*0.085*	-	-
14	-	-	-	-	-	*0.004*	0.472	0.216	*0.163*	*0.067*	-	-
15	-	-	-	-	-	*0.016*	0.468	0.204	*0.167*	*0.053*	-	-
16	-	-	-	-	-	*0.056*	0.471	0.192	*0.156*	*0.042*	-	-
17	-	-	-	-	-	*0.696*	0.463	0.195	*0.160*	*0.033*	-	-
18	-	-	-	-	-	*0.782*	0.448	0.199	*0.164*	*0.027*	-	-
19	-	-	-	-	-	*0.844*	0.430	0.201	*0.168*	*0.021*	-	-
20	-	-	-	-	-	*0.887*	0.415	0.198	*0.172*	*0.017*	-	-
21	-	-	-	-	-	*0.932*	0.399	0.196	*0.162*	*0.013*	-	-
22	-	-	-	-	-	*0.936*	0.389	0.193	*0.167*	*0.010*	-	-
23	-	-	-	-	-	*0.952*	0.381	0.190	*0.173*	*0.008*	-	-
24	-	-	-	-	-	*0.944*	0.372	0.185	*0.173*	*0.007*	-	-
25	-	-	-	-	-	*0.925*	0.362	0.178	*0.183*	*0.005*	-	-
26	-	-	-	-	-	*0.910*	0.362	0.173	*0.179*	*0.004*	-	-
27	-	-	-	-	-	*0.889*	0.361	0.166	*0.175*	*0.003*	-	-
28	-	-	-	-	-	*0.844*	0.352	0.158	*0.184*	*0.003*	-	-
29	-		-	-	-	*0.821*	0.348	0.150	*0.183*	*0.002*	-	-
30	-		-	-	-	0.838	0.340	*0.172*	*0.168*	*0.002*	-	-
31	-		-		-		0.341	*0.165*		*0.001*		-
Mean	0.000	0.000	0.000	0.000	0.000	0.614	0.484	0.223	0.170	0.078	0.000	0.000
Max	0.000	0.000	0.000	0.000	0.000	0.952	0.790	0.331	0.184	0.190	0.001	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.340	0.150	0.156	0.001	0.000	0.000

Note: Estimated and modelled values are italicized

Summary of Daily Discharge [Q, m^3/s] at Hydrometric Station Ogama, 2020

Drainage Area = 74.93 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	1.265	0.245	*0.116*	*0.121*	*0.001*	-
2	-	-	-	-	-	-	1.178	0.237	*0.109*	*0.125*	*0.001*	-
3	-	-	-	-	-	-	1.093	0.229	*0.107*	*0.121*	*0.001*	-
4	-	-	-	-	-	-	1.017	0.222	*0.113*	*0.128*	*0.000*	-
5	-	-	-	-	-	-	0.948	0.211	*0.114*	*0.120*	*0.000*	-
6	-	-	-	-	-	-	0.865	0.202	*0.115*	*0.117*	*0.000*	-
7	-	-	-	-	-	-	0.797	0.190	*0.114*	*0.111*	*0.000*	-
8	-	-	-	-	-	-	0.741	0.179	*0.122*	*0.113*	*0.000*	-
9	-	-	-	-	-	-	0.699	0.170	*0.118*	*0.113*	*0.000*	-
10	-	-	-	-	-	*0.000*	0.656	0.164	*0.104*	*0.114*	*0.000*	-
11	-	-	-	-	-	*0.000*	0.627	0.156	*0.112*	*0.092*	-	-
12	-	-	-	-	-	*0.001*	0.593	0.156	*0.113*	*0.074*	-	-
13	-	-	-	-	-	*0.003*	0.577	0.147	*0.108*	*0.059*	-	-
14	-	-	-	-	-	*0.010*	0.551	0.144	*0.109*	*0.047*	-	-
15	-	-	-	-	-	*0.032*	0.532	0.139	*0.112*	*0.038*	-	-
16	-	-	-	-	-	*0.103*	0.523	0.125	*0.104*	*0.030*	-	-
17	-	-	-	-	-	*1.040*	0.503	0.126	*0.107*	*0.024*	-	-
18	-	-	-	-	-	*1.281*	0.482	0.134	*0.110*	*0.020*	-	-
19	-	-	-	-	-	*1.459*	0.468	0.139	*0.112*	*0.016*	-	-
20	-	-	-	-	-	*1.588*	0.461	0.138	*0.115*	*0.013*	-	-
21	-	-	-	-	-	*1.726*	0.428	0.133	*0.108*	*0.010*	-	-
22	-	-	-	-	-	*1.740*	0.404	0.129	*0.112*	*0.008*	-	-
23	-	-	-	-	-	*1.788*	0.395	0.130	*0.116*	*0.007*	-	-
24	-	-	-	-	-	*1.763*	0.378	0.128	*0.116*	*0.005*	-	-
25	-	-	-	-	-	*1.705*	0.355	0.127	*0.123*	*0.004*	-	-
26	-	-	-	-	-	*1.659*	0.344	0.124	*0.120*	*0.003*	-	-
27	-	-	-	-	-	*1.594*	0.320	0.117	*0.117*	*0.003*	-	-
28	-	-	-	-	-	*1.459*	0.298	0.111	*0.124*	*0.002*	-	-
29	-		-	-	-	1.486	0.288	0.101	*0.123*	*0.002*	-	-
30	-		-	-	-	1.369	0.271	*0.115*	*0.112*	*0.001*	-	-
31	-		-		-		0.260	*0.110*		*0.001*		-
Mean	0.000	0.000	0.000	0.000	0.000	1.038	0.591	0.154	0.113	0.053	0.000	#DIV/0!
Max	0.000	0.000	0.000	0.000	0.000	1.788	1.265	0.245	0.124	0.128	0.001	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.260	0.101	0.104	0.001	0.000	0.000

Note: Estimated and modelled values are italicized

Summary of Daily Discharge [Q, m^3/s] at Hydrometric Station Doris Creek, 2020

Drainage Area = 90.29 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	1.641	0.479	0.237	0.312	*0.001*	-
2	-	-	-	-	-	-	1.569	0.462	0.233	0.313	*0.001*	-
3	-	-	-	-	-	-	1.509	0.445	0.211	0.313	*0.001*	-
4	-	-	-	-	-	-	1.457	0.433	0.242	0.309	*0.001*	-
5	-	-	-	-	-	-	1.403	0.427	0.256	0.308	*0.000*	-
6	-	-	-	-	-	-	1.343	0.410	0.260	0.303	*0.000*	-
7	-	-	-	-	-	-	1.299	0.388	0.261	0.302	*0.000*	-
8	-	-	-	-	-	-	1.233	0.378	0.260	0.293	*0.000*	-
9	-	-	-	-	-	-	1.185	0.365	0.269	0.290	*0.000*	-
10	-	-	-	-	-	*0.000*	1.143	0.344	0.268	*0.228*	*0.000*	-
11	-	-	-	-	-	*0.000*	1.106	0.338	0.258	*0.179*	-	-
12	-	-	-	-	-	*0.001*	1.064	0.331	0.263	*0.140*	-	-
13	-	-	-	-	-	*0.004*	1.020	0.314	0.262	*0.110*	-	-
14	-	-	-	-	-	*0.012*	0.981	0.303	0.259	*0.087*	-	-
15	-	-	-	-	-	*0.040*	0.943	0.281	0.250	*0.068*	-	-
16	-	-	-	-	-	*0.134*	0.910	0.256	0.262	*0.053*	-	-
17	-	-	-	-	-	*1.475*	0.879	0.275	0.235	*0.042*	-	-
18	-	-	-	-	-	*1.673*	0.843	0.283	0.253	*0.033*	-	-
19	-	-	-	-	-	*1.811*	0.817	0.296	0.265	*0.026*	-	-
20	-	-	-	-	-	*1.907*	0.794	0.294	0.268	*0.020*	-	-
21	-	-	-	-	-	*2.008*	0.755	0.282	0.272	*0.016*	-	-
22	-	-	-	-	-	*2.018*	0.721	0.268	0.278	*0.013*	-	-
23	-	-	-	-	-	*2.052*	0.699	0.264	0.285	*0.010*	-	-
24	-	-	-	-	-	*2.035*	0.676	0.258	0.292	*0.008*	-	-
25	-	-	-	-	-	*1.993*	0.637	0.252	0.295	*0.006*	-	-
26	-	-	-	-	-	*1.959*	0.623	0.253	0.305	*0.005*	-	-
27	-	-	-	-	-	*1.912*	0.599	0.241	0.306	*0.004*	-	-
28	-	-	-	-	-	*1.811*	0.566	0.235	0.313	*0.003*	-	-
29	-		-	-	-	1.763	0.548	0.220	0.319	*0.002*	-	-
30	-		-	-	-	1.713	0.521	0.224	0.318	*0.002*	-	-
31	-		-		-		0.499	0.236		*0.001*		-
Mean	0.000	0.000	0.000	0.000	0.000	1.253	0.967	0.317	0.269	0.123	0.000	#DIV/0!
Max	0.000	0.000	0.000	0.000	0.000	2.052	1.641	0.479	0.319	0.313	0.001	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.499	0.220	0.211	0.001	0.000	0.000

Note: Estimated and modelled values are italicized

Summary of Daily Discharge [Q, m^3/s] at Hydrometric Station Little Roberts, 2020

Drainage Area = 194.15 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	3.293	1.362	*0.833*	*0.857*	*0.002*	-
2	-	-	-	-	-	-	3.154	1.327	*0.796*	*0.877*	*0.001*	-
3	-	-	-	-	-	-	3.030	1.295	*0.783*	*0.855*	*0.001*	-
4	-	-	-	-	-	-	2.921	1.270	*0.814*	*0.893*	*0.001*	-
5	-	-	-	-	-	-	2.818	1.254	*0.819*	*0.854*	*0.001*	-
6	-	-	-	-	-	-	2.717	1.223	*0.826*	*0.836*	*0.000*	-
7	-	-	-	-	-	-	2.610	1.177	*0.818*	*0.804*	*0.000*	-
8	-	-	-	-	-	-	2.502	1.148	*0.863*	*0.813*	*0.000*	-
9	-	-	-	-	-	-	2.410	1.129	*0.841*	*0.815*	*0.000*	-
10	-	-	-	-	-	-	2.319	1.097	*0.768*	*0.821*	*0.000*	-
11	-	-	-	-	-	*0.000*	2.241	1.083	*0.810*	*0.620*	-	-
12	-	-	-	-	-	*0.751*	2.157	1.074	*0.813*	*0.468*	-	-
13	-	-	-	-	-	*0.994*	2.091	1.053	*0.790*	*0.353*	-	-
14	-	-	-	-	-	*1.281*	2.041	1.031	*0.794*	*0.266*	-	-
15	-	-	-	-	-	*1.612*	1.992	1.007	*0.810*	*0.201*	-	-
16	-	-	-	-	-	*1.993*	1.954	0.929	*0.769*	*0.152*	-	-
17	-	-	-	-	-	*2.913*	1.897	0.862	*0.781*	*0.114*	-	-
18	-	-	-	-	-	*3.233*	1.835	0.864	*0.797*	*0.086*	-	-
19	-	-	-	-	-	*3.459*	1.784	0.896	*0.810*	*0.065*	-	-
20	-	-	-	-	-	*3.617*	1.752	0.910	*0.826*	*0.049*	-	-
21	-	-	-	-	-	*3.783*	1.707	0.907	*0.788*	*0.037*	-	-
22	-	-	-	-	-	*3.799*	1.669	0.882	*0.810*	*0.028*	-	-
23	-	-	-	-	-	*3.856*	1.620	0.864	*0.831*	*0.021*	-	-
24	-	-	-	-	-	*3.826*	1.587	0.853	*0.829*	*0.016*	-	-
25	-	-	-	-	-	*3.758*	1.546	0.838	*0.866*	*0.012*	-	-
26	-	-	-	-	-	*3.702*	1.525	0.832	*0.852*	*0.009*	-	-
27	-	-	-	-	-	*3.625*	1.520	0.820	*0.838*	*0.007*	-	-
28	-	-	-	-	-	*3.459*	1.474	0.804	*0.870*	*0.005*	-	-
29	-		-	-	-	*3.374*	1.447	*0.802*	*0.867*	*0.004*	-	-
30	-		-	-	-	3.457	1.417	*0.826*	*0.811*	*0.003*	-	-
31	-		-		-		1.392	*0.799*		*0.002*		-
Mean	0.000	0.000	0.000	0.000	0.000	2.825	2.078	1.007	0.818	0.353	0.001	0.000
Max	0.000	0.000	0.000	0.000	0.000	3.856	3.293	1.362	0.870	0.893	0.002	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	1.392	0.799	0.768	0.002	0.000	0.000

Note: Estimated and modelled values are italicized

APPENDIX E HISTORICAL LAKE LEVEL COMPARISON GRAPHS

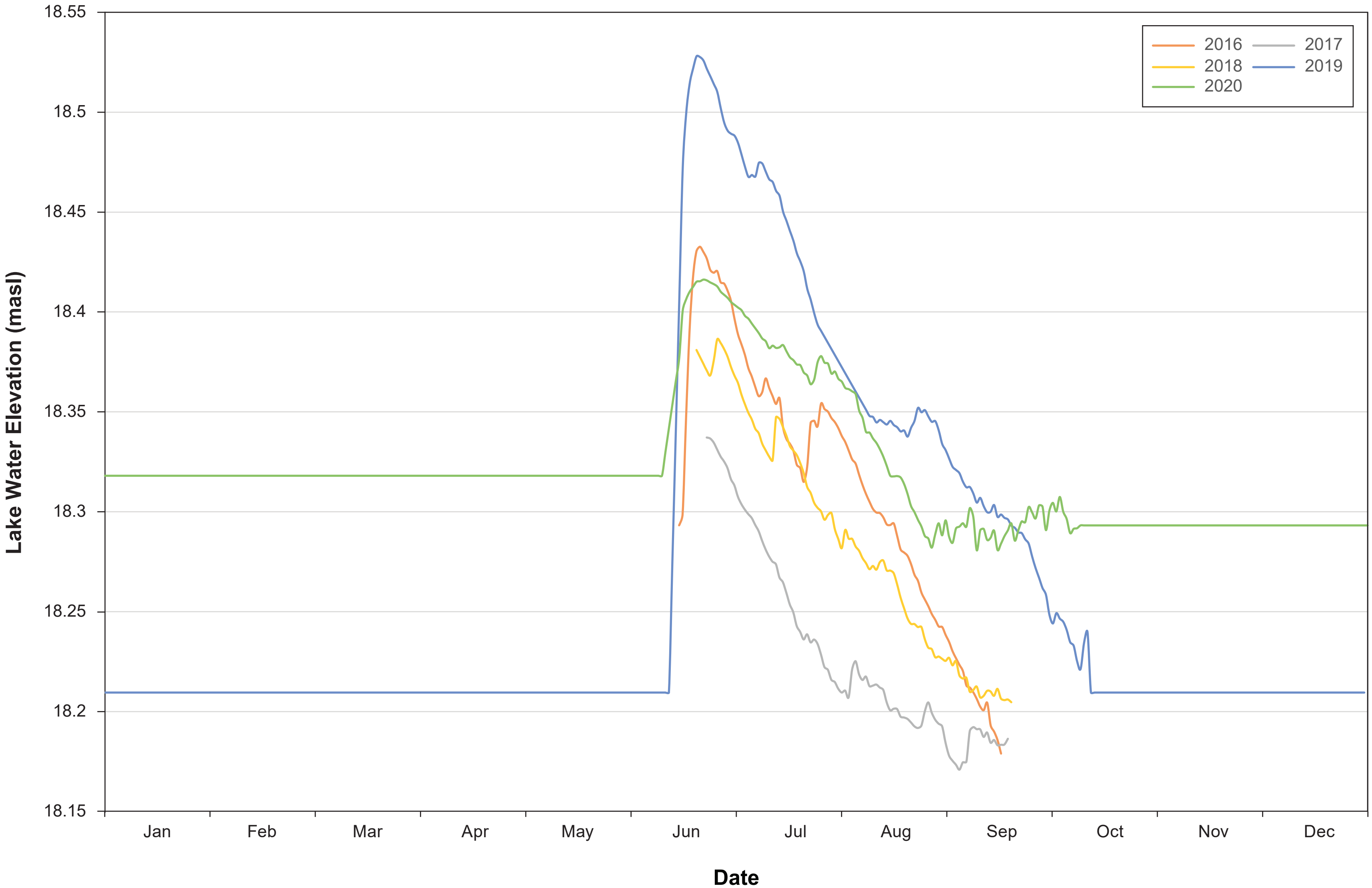


Figure E1: Historical Mean Daily Lake Level for Monitoring Station Windy Outflow

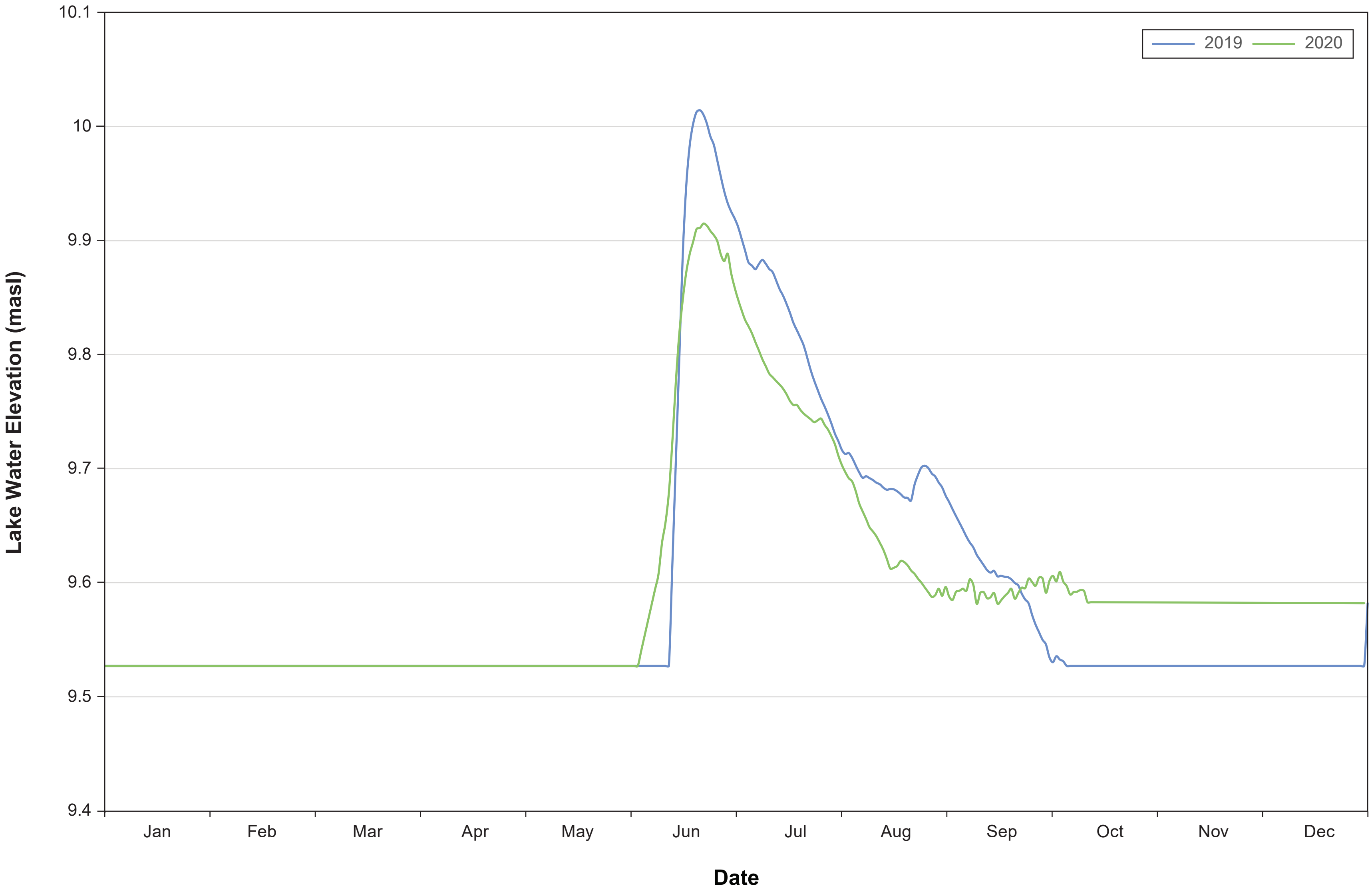


Figure E2: Historical Mean Daily Lake Level for Monitoring Station Glenn Lake

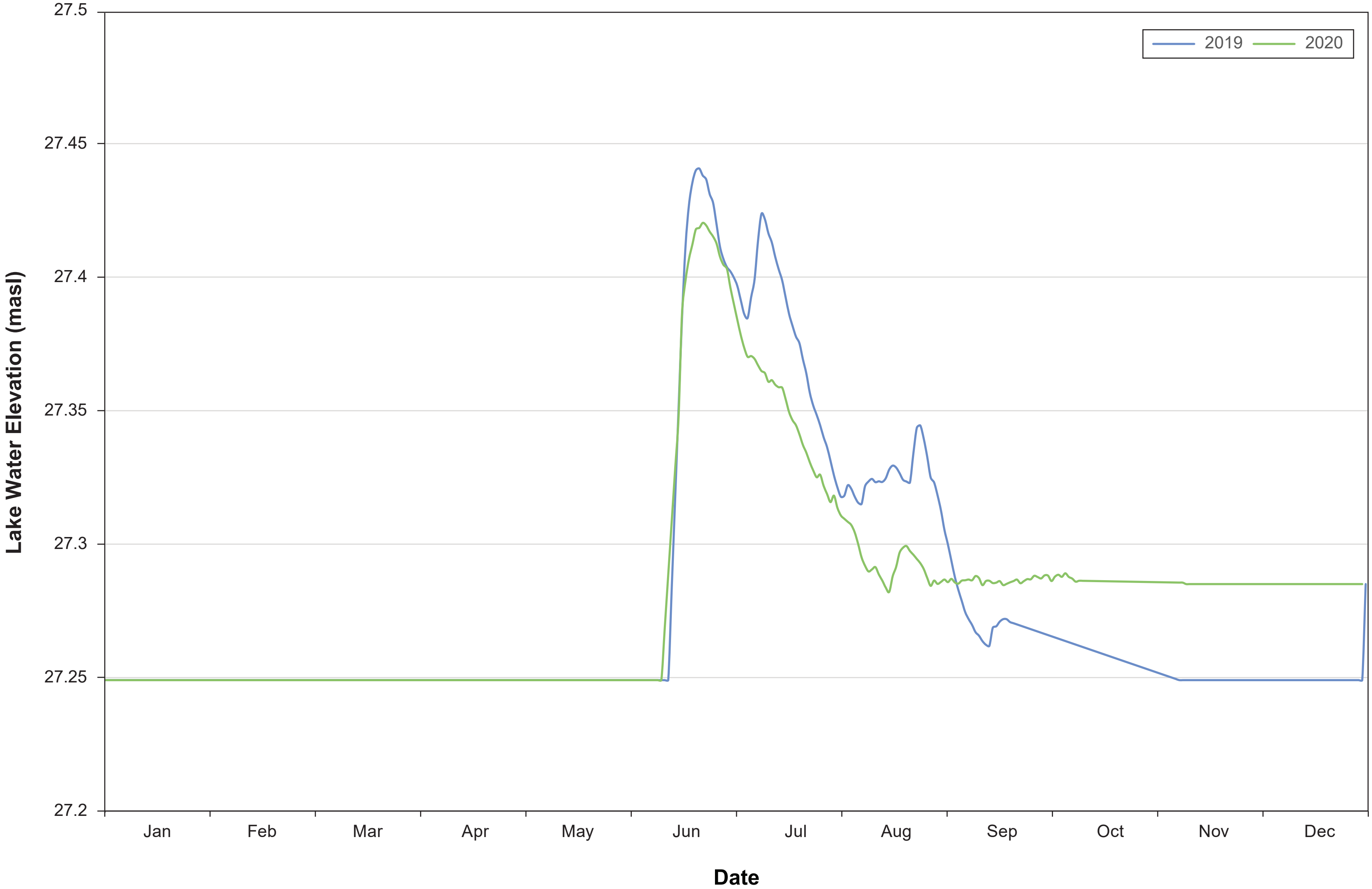


Figure E3: Historical Mean Daily Lake Level for Monitoring Station Imniagut Lake

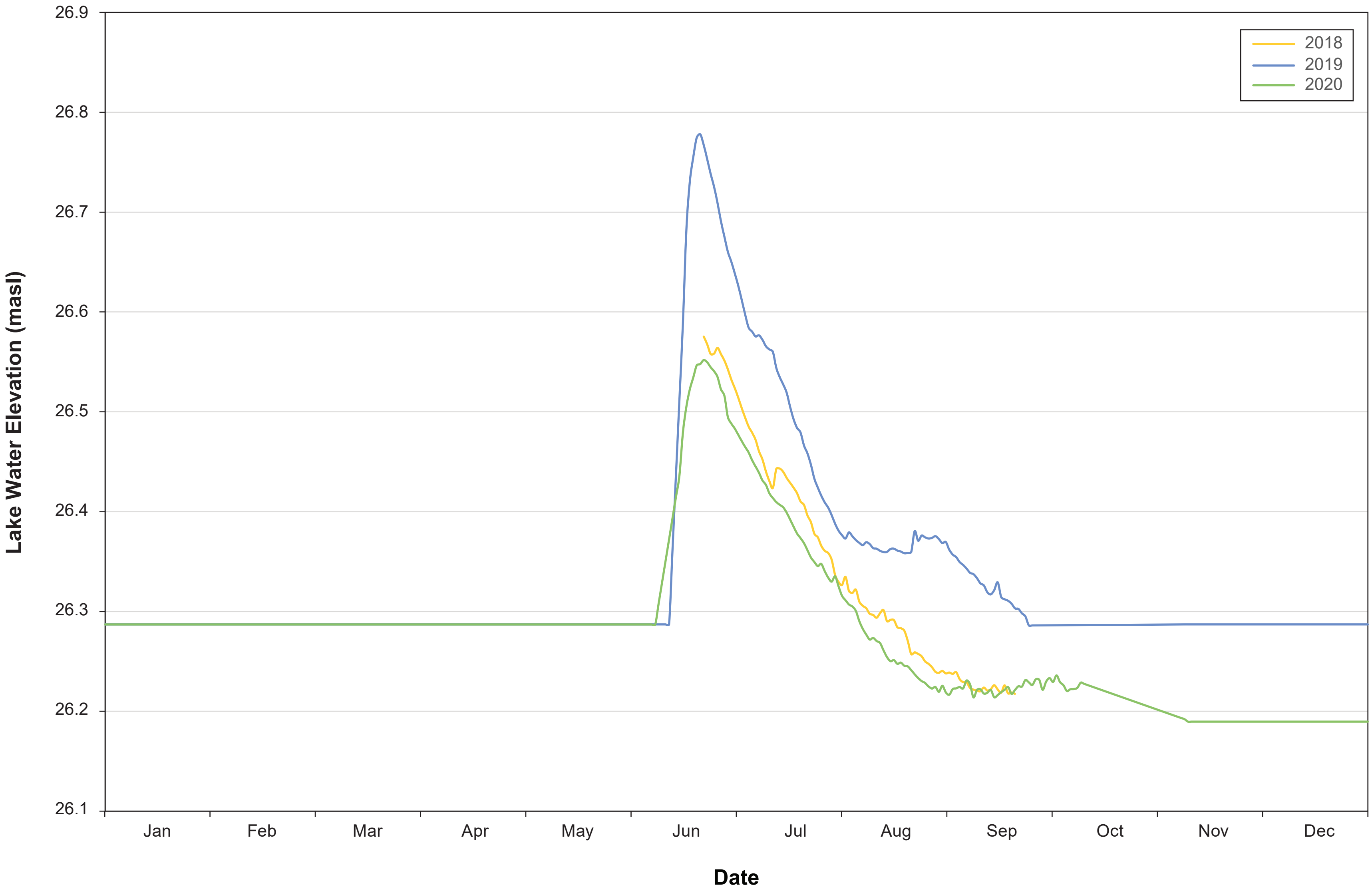


Figure E4: Historical Mean Daily Lake Level for Monitoring Station Patch Outflow

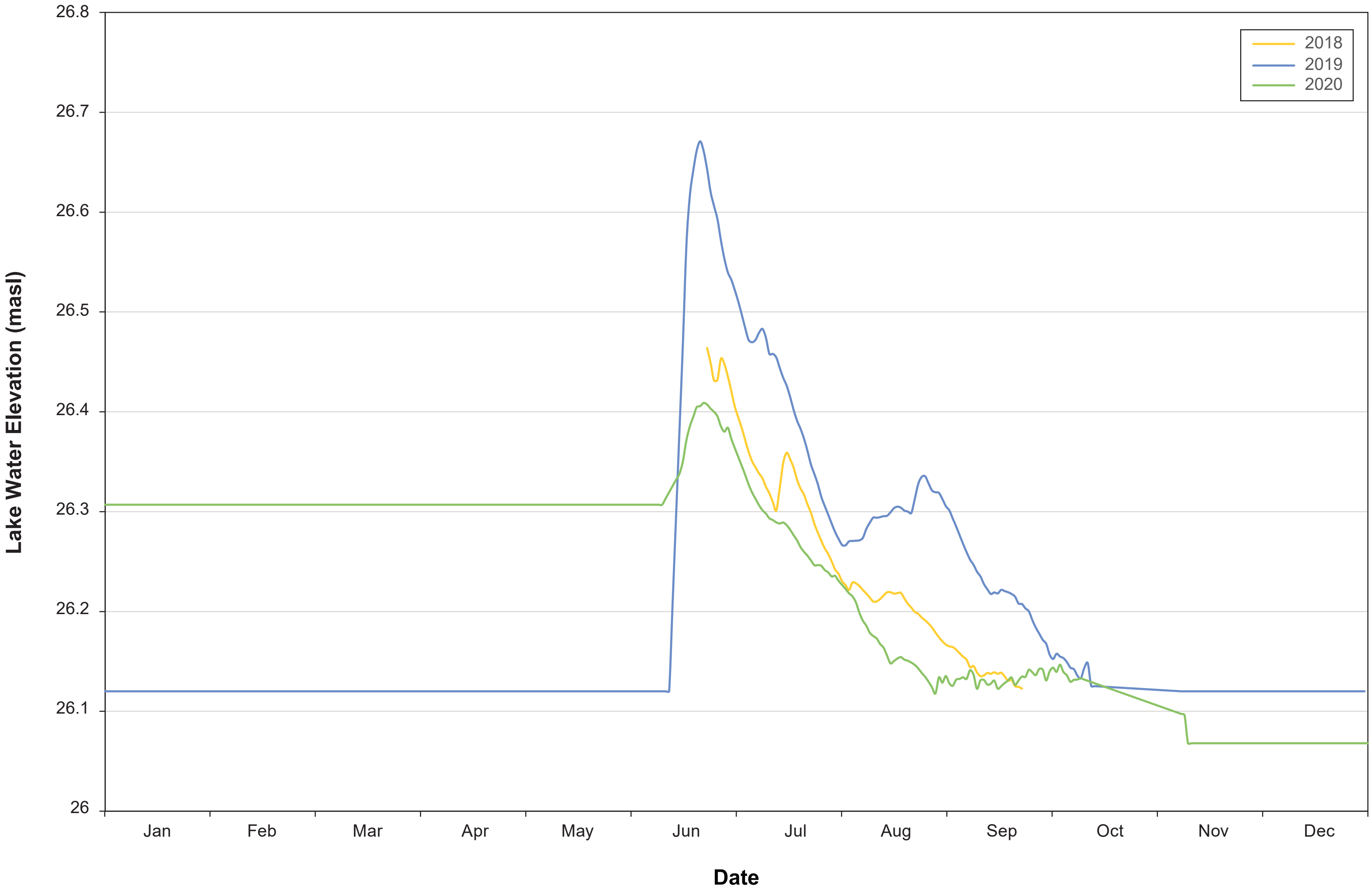


Figure E5: Historical Mean Daily Lake Level for Monitoring Station PO Outflow

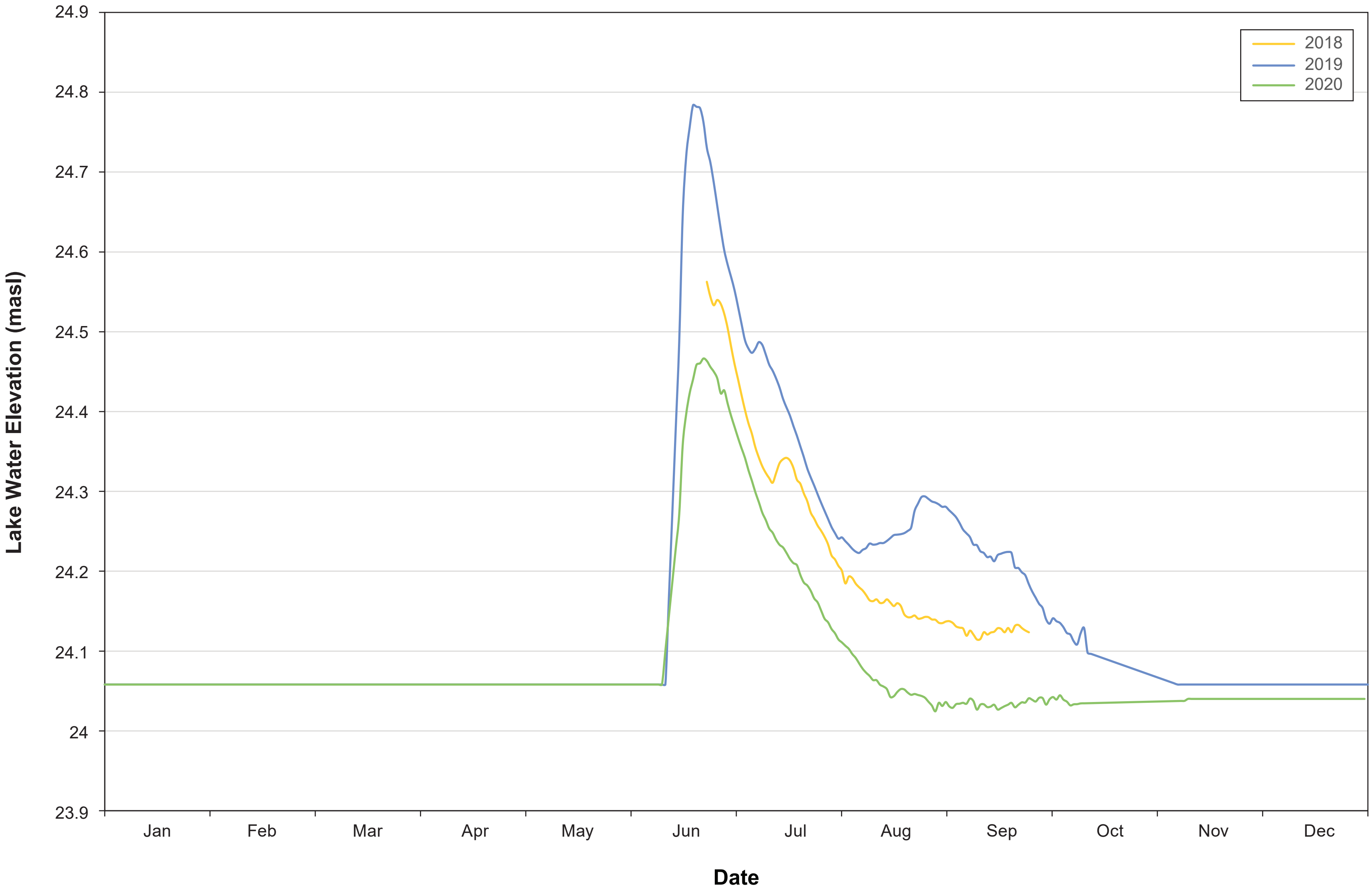


Figure E6: Historical Mean Daily Lake Level for Monitoring Station Ogama Outflow

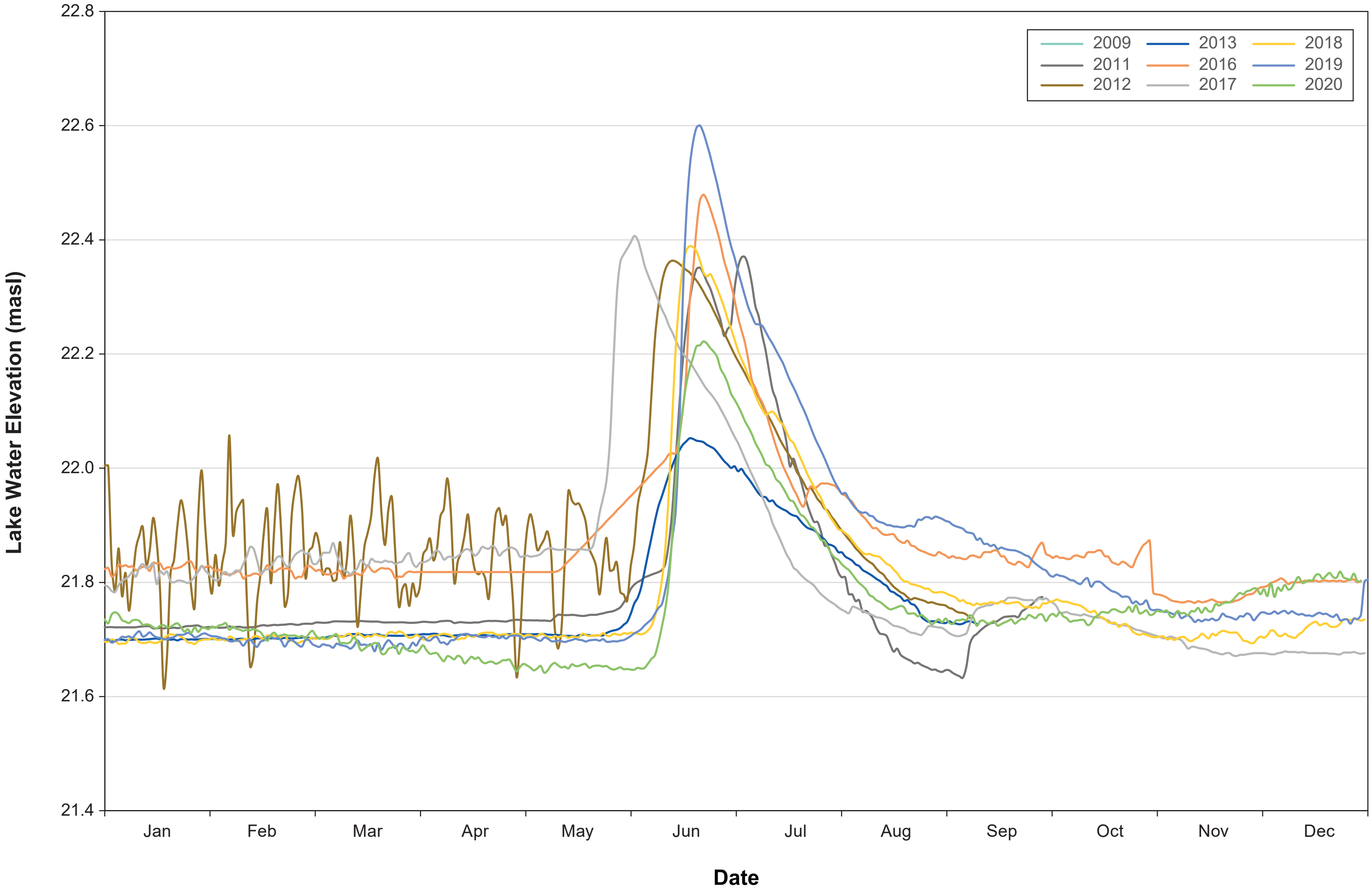


Figure E7: Historical Mean Daily Lake Level for Monitoring Station Doris Lake

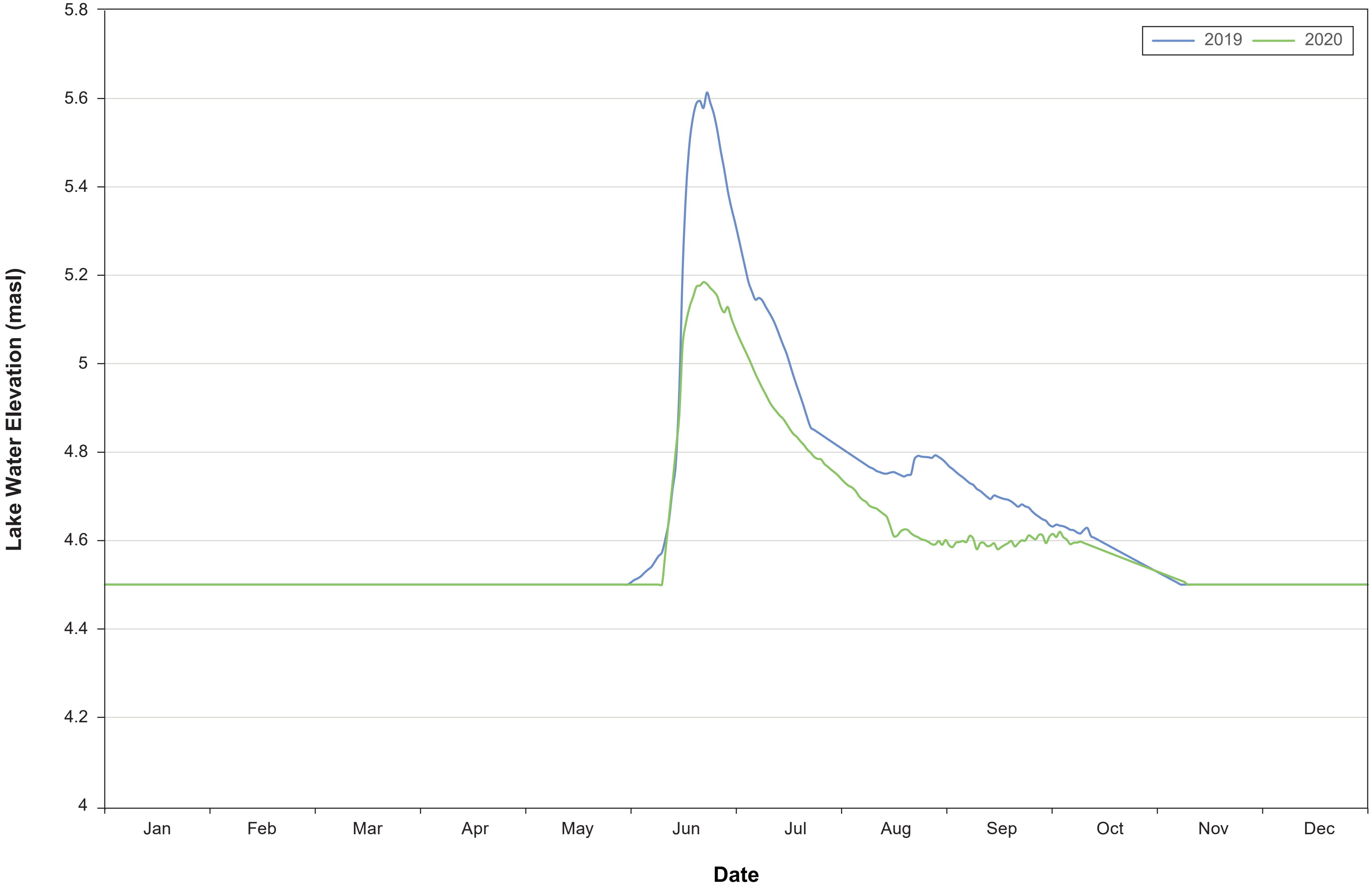


Figure E8: Historical Mean Daily Lake Level for Monitoring Station Little Roberts Outflow

APPENDIX F HISTORICAL MEAN DAILY DISCHARGE COMPARISON GRAPHS

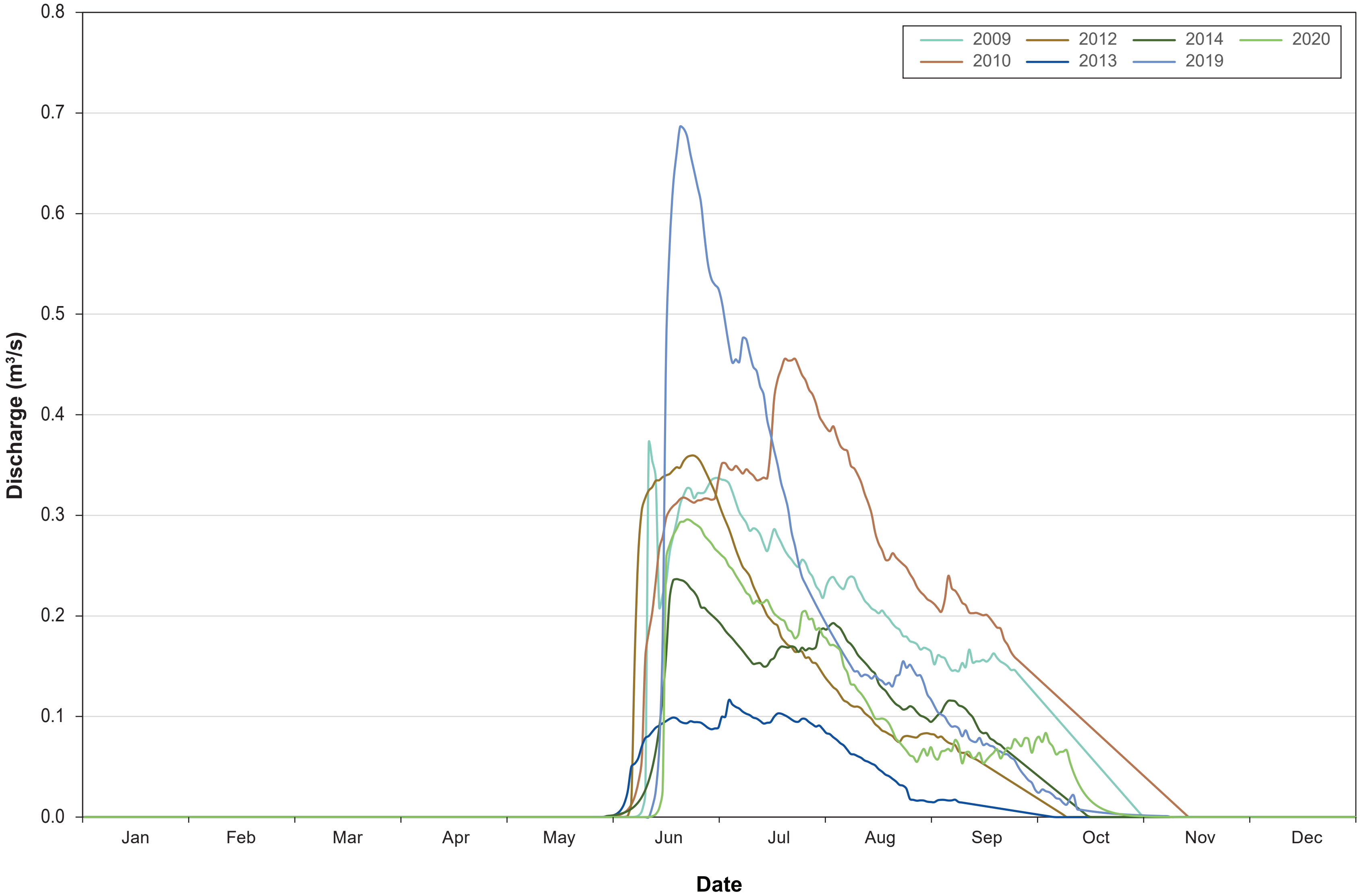


Figure F1: Historical Mean Daily Discharge for Monitoring Station Windy Outflow

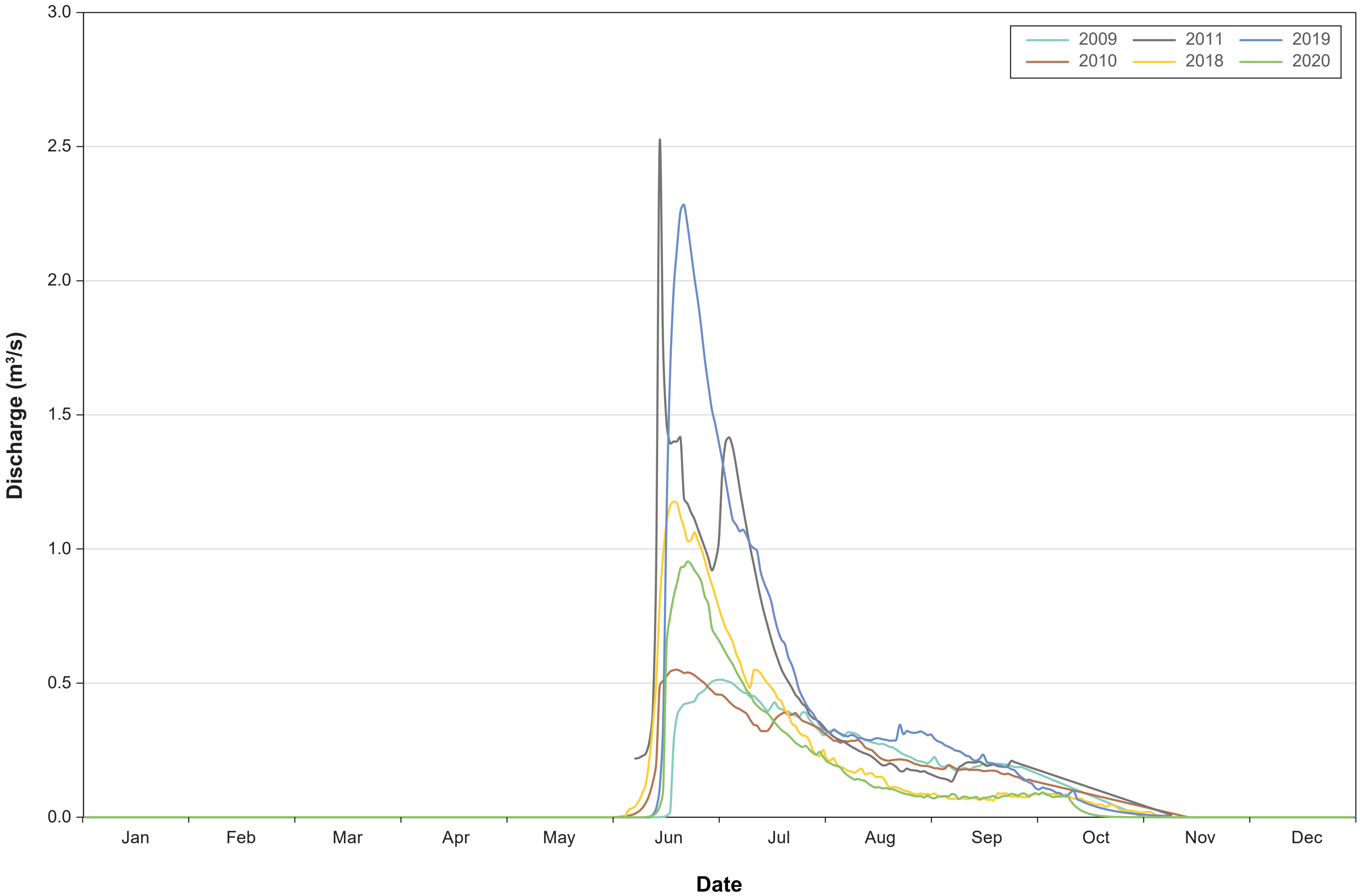


Figure F2: Historical Mean Daily Discharge for Monitoring Station Patch Outflow

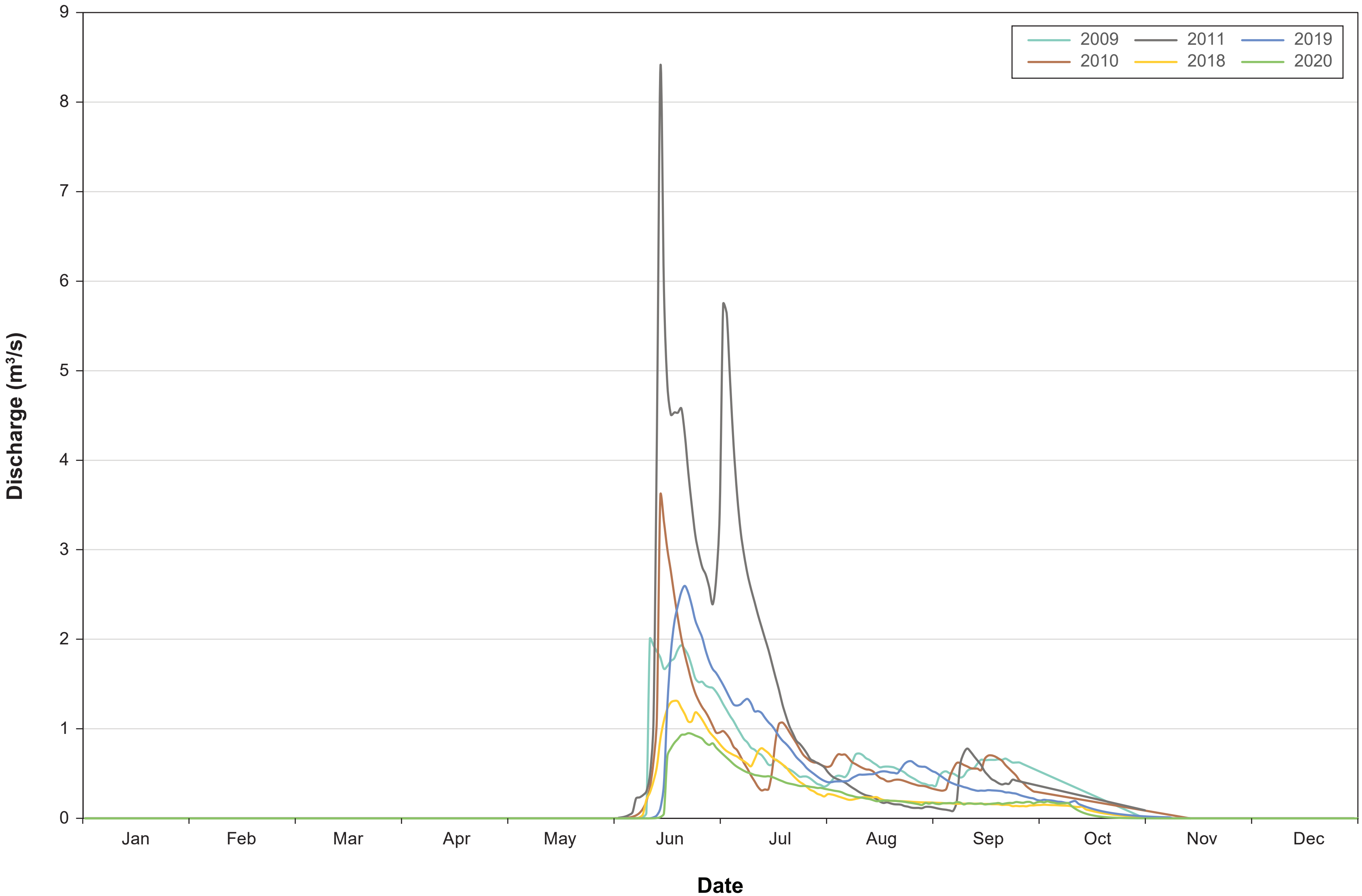


Figure F3: Historical Mean Daily Discharge for Monitoring Station PO Outflow

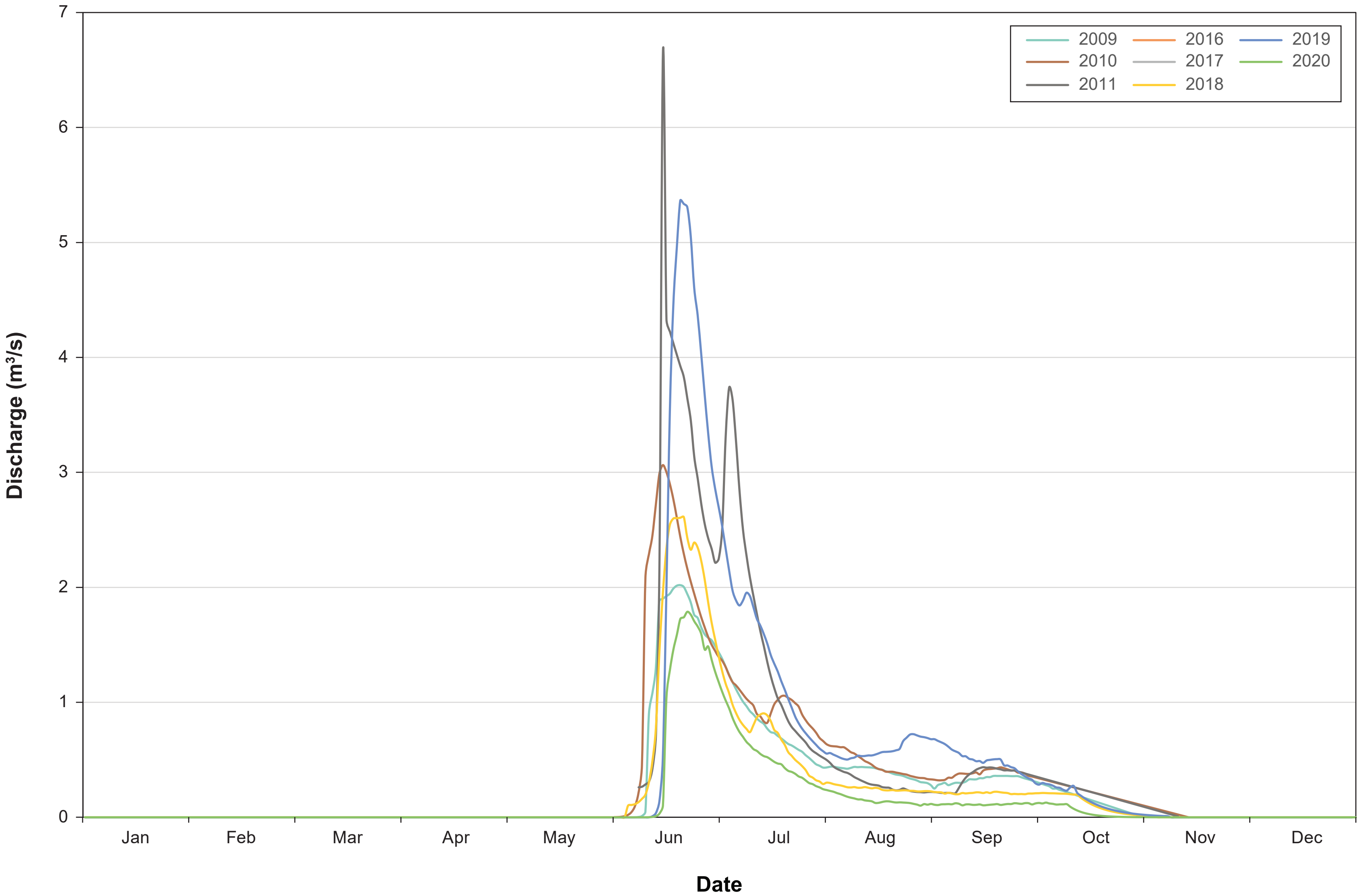


Figure F4: Historical Mean Daily Discharge for Monitoring Station Ogama Outflow

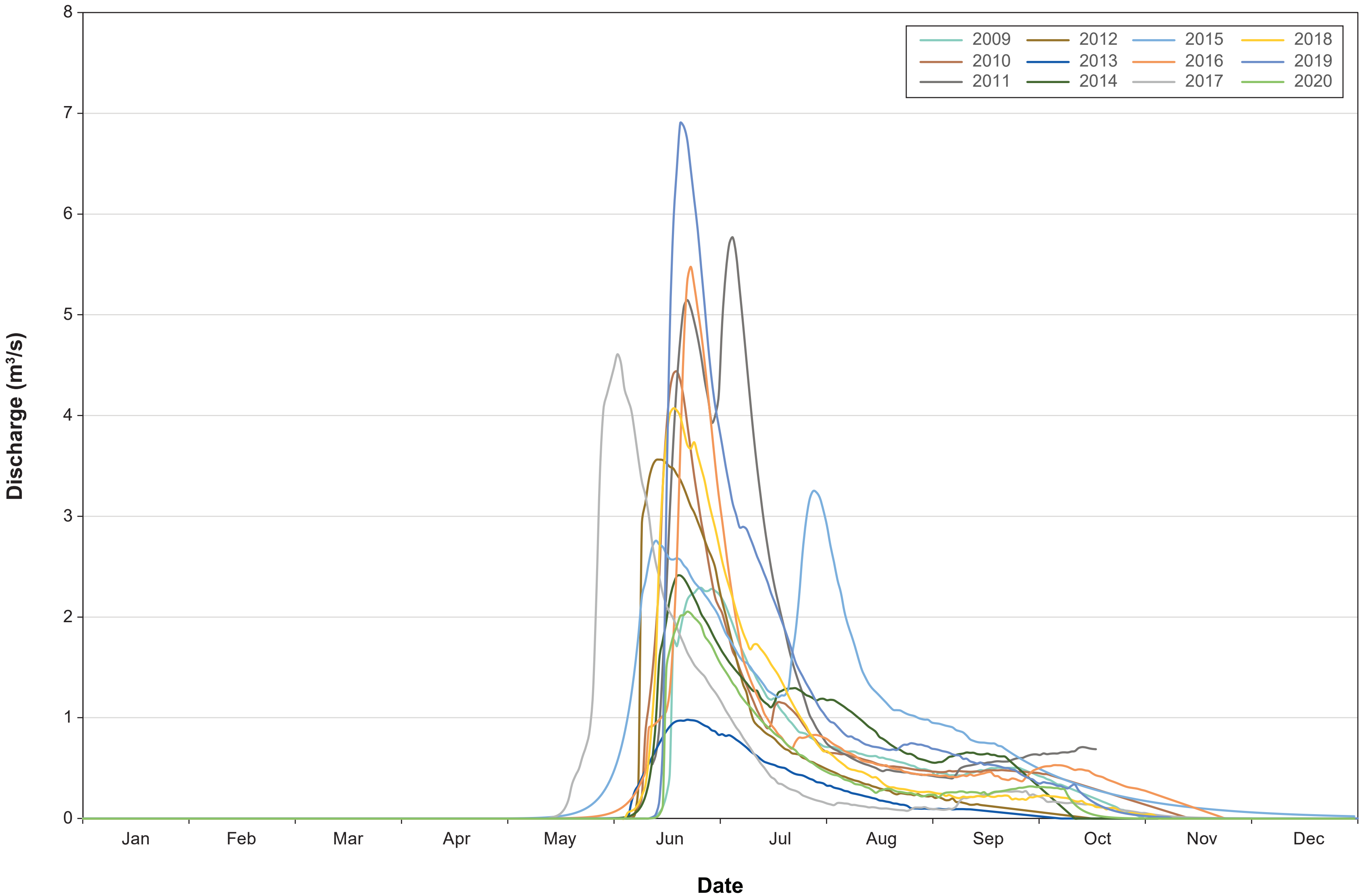


Figure F5: Historical Mean Daily Discharge for Monitoring Station Doris Creek TL-2

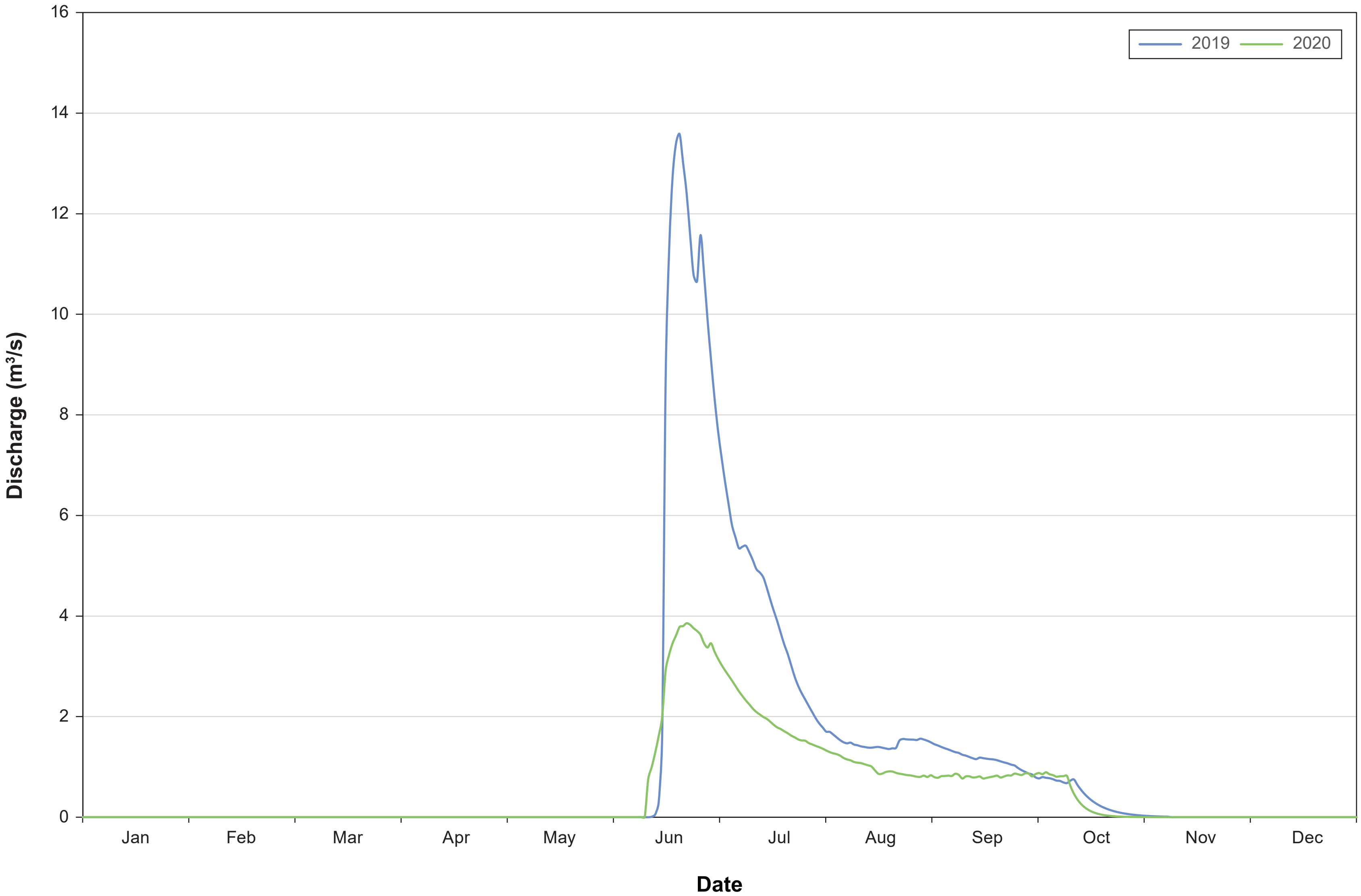


Figure F6: Historical Mean Daily Discharge for Monitoring Station Little Roberts Outflow

APPENDIX C 2020 EVALUATION OF EFFECTS SUPPORTING INFORMATION

March 2021

HOPE BAY PROJECT

2020 Aquatic Effects Monitoring Program Report

Appendix C: 2020 Evaluation of Effects Supporting Information

ERM Consultants Canada Ltd.
120 Adelaide Street West, Suite 2010
Toronto, ON
Canada M5H 1T1

T: +1 416 646 3608
F: +1 416 642 1269

CONTENTS

List of Tables

Appendix C: 2020 Evaluation of Effects Supporting Information

C.1 Historical Data Selection Rationale for Evaluation of Effects

The tables in this section present a summary of the historical physical limnology (temperature and dissolved oxygen), water quality, and phytoplankton biomass data collected at the AEMP lake sites, as well as the rationale for the exclusion of certain historical data from the 2020 evaluation of effects.

C.1.1 Temperature and Dissolved Oxygen Profiles

Table C.1-1 presents a summary of the historical temperature and dissolved oxygen profile data collected at AEMP lake sites, and the rationale for the exclusion of certain historical data from the 2020 evaluation of effects. The selection of historical data to include in the temperature and dissolved oxygen evaluation of effects was based on similarity of historical sampling locations to 2020 AEMP sampling locations.

Table C.1-1: Historical Data Selection Rationale for Temperature and Dissolved Oxygen Evaluation of Effects, Hope Bay Project, 2020

Sampling Sites	Years Sampled	Months Sampled	Data Included in Graphs and Analyses	Data Excluded from Graphs and Analyses	Rationale for Exclusion
Doris Lake	1995	August	Data from northern end of the lake	Data from southern end of the lake	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	1996	April, August	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	1997	April, July, August	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	1998	April	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	2000	August	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.

Sampling Sites	Years Sampled	Months Sampled	Data Included in Graphs and Analyses	Data Excluded from Graphs and Analyses	Rationale for Exclusion
Doris Lake *(cont'd)*	2003	July, August, September	August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2004	June, July, August, September	June and August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2005	July, August, September	August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2006, 2007, 2008	May, July, August, September	May and August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2009	April, August	Data collected at "Doris North" sampling location	Data collected at "Doris South" sampling location	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	Annually from 2010 to 2016	April, July, August, September	April and August data collected at "Doris North" sampling location	All data collected at "Doris South" sampling location; all July and September data	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake. Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2017, 2018	April, July, August, September	April and August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2019	April, August	All	None	

Sampling Sites	Years Sampled	Months Sampled	Data Included in Graphs and Analyses	Data Excluded from Graphs and Analyses	Rationale for Exclusion
Patch Lake	1995	August	All	None	
	1996	April, August	All	None	Note: Data were estimated from plots of the profiles.
	1997	April, July	April data	July data	Profiles for the 2020 open-water season were collected in August, so historical data collected in July were excluded. Note: April data were estimated from plots of the profiles.
	1998	April	All	None	
	2006	June, July, and September	None	All	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake.
	2007, 2008	May, July, August, September	None	All	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake.
	2009	April, August	Data collected at "Patch North" sampling location	Data collected at "Patch South" sampling location	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake.
	2017, 2018, 2019	April, August	All	None	
Windy Lake	1995	August	None	All	Excluded data collected from southern end of Windy Lake, as current AEMP sampling site is at northern end of the lake.
	1996	August	None	All	Excluded data collected from southern end of Windy Lake, as current AEMP sampling site is at northern end of the lake.
	1997	April, July	April data	July data	Profiles for the 2020 open-water season were collected in August, so historical data collected in July were excluded. Note: April data were estimated from plots of the profiles.

Sampling Sites	Years Sampled	Months Sampled	Data Included in Graphs and Analyses	Data Excluded from Graphs and Analyses	Rationale for Exclusion
Windy Lake *(cont'd)*	1998	April	All	None	
	2006	June, July, August, September	June and August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2007 and 2008	May, July, August, September	May and August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2009, 2010, 2017, 2018, 2019	April, August	All	None	.
Reference Lake B	2009	May, August	None	All	Excluded data collected from northeastern end of Reference Lake B, as current AEMP sampling site is in the central basin of the lake.
	2010	April, July, August September	August data	April, July, and September data	Excluded data collected from April and July as these were collected from northeastern end of the lake. Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	Annually from 2011 to 2018	April, July, August, September	April and August data	July and September data	Profiles for the 2020 open-water season were collected in August, so historical data collected in August were included and July and September data were excluded.
	2019	April, August	All	None	

C.1.2 Water Quality

Table C.1-2 presents a summary of the historical water quality data collected at AEMP lake sites, and the rationale for the exclusion of certain historical data from the 2020 evaluation of effects. The selection of historical data to include in the water quality evaluation of effects was based on similarity of historical sampling locations to 2020 AEMP sampling locations and sampling methodology.

Table C.1-2: Historical Data Selection Rationale for Water Quality Evaluation of Effects, Hope Bay Project, 2020

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	Data from northern end of the lake	Data from southern end of the lake, and all shoreline grab samples	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake; excluded shoreline grabs, which are not comparable to samples collected from a boat over deep areas of the lake.
	1996	April, August	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	1997	April, July, August	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	1998	April	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	2000	July, August	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	2003	July, August, September	All	None	
	2004	June, July, August, September	All	None	
	2005	July, August, September	All	None	
	2006, 2007, 2008	May, 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
Doris Lake *(cont'd)*	2009	April, August	Data collected at "Doris" sampling location	Data collected at "Doris South" sampling location	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	Annually from 2010 to 2016	April, July, August, September	Data collected at "Doris" sampling location	Data collected at "Doris South" sampling location	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.
	2017 and 2018	April, July, August, September	All	None	
	2019	April, August	All	None	
Patch Lake	1995	May, June, July, August	Data from northern end of the lake	Data from southern end of the lake, and all shoreline grab samples	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake; excluded shoreline grabs, which are not comparable to samples collected from a boat over deep areas of the lake.
	1996	April, August	All	None	.
	1997	April, July	All	None	.
	1998	April	All	None	
	2006	June, July, August, September	None	All	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake.
	2007 and 2008	May, July, August, September	None	All	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake.
	2009	April, August	Data collected at "Patch" sampling location	Data collected at "Patch South" sampling location	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake.
	2017, 2018, 2019	April, August	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
Windy Lake	1995	May, June, July, August	None	All	Excluded data collected from southern end of Windy Lake, as current AEMP sampling site is at northern end of the lake; excluded shoreline grabs, which are not comparable to samples collected from a boat over deep areas of the lake.
	1996	August	None	All	Excluded data collected from southern end of Windy Lake, as current AEMP sampling site is at northern end of the lake.
	1997	April, July	All	None	
	1998	April	All	None	
	1999	July	Samples collected from boat	All shoreline grab samples	Some samples were shoreline grabs, which are not comparable to samples collected from a boat over deep areas of the lake.
	2000	July	All	None	
	2006	June, July, August, September	All	None	
	2007, 2008	May, July, August, September	All	None	
	2009, 2010, 2017, 2018, 2019	April, August	All	None	.
Reference Lake B	2009	May, August	None	All	Excluded data collected from northeastern end of Reference Lake B, as current AEMP sampling site is in the central basin of the lake.

Sampling Sites	Years Sampled	Months Sampled	Data Included in Graphs and Statistical Analyses	Data Excluded from Graphs and Statistical Analyses	Rationale for Exclusion
Reference Lake B *(cont'd)*	2010	April, July, August September	August and September data	April and July data	Excluded data collected from April and July, as these were collected from northeastern end of the lake. The August and September samples were collected at the current AEMP sampling site.
	Annually from 2011 to 2018	April, July, August, September	All	None	
	2019	April, August	All	None	

C.1.3 Phytoplankton Biomass

Table C.1-3 presents a summary of the historical phytoplankton biomass (as chlorophyll *a*) data collected at AEMP lake sites, and the rationale for the exclusion of certain historical data from the 2020 evaluation of effects. The main criteria for the selection of historical biomass data for inclusion in the evaluation of effect were the proximity of historical sampling sites to 2020 AEMP sampling sites, the timing of sample collection, and comparability of sampling methodology.

Table C.1-3: Historical Data Selection Rationale for Phytoplankton Biomass (as Chlorophyll *a*) Evaluation of Effects, Hope Bay Project, 2020

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	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake. Potential issue with sample integrity, as samples were lost and then found and analyzed more than one year after sample collection.
	2000	July	None	All	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake.

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 *(cont'd)*	2003	July, August, September	None	All	Excluded because of methodological differences, as samples consisted of a composite of subsamples collected throughout the euphotic zone (not comparable to discrete surface samples collected in 2020).
	2006	September	None	All	Methodology not described. Assumed to be a composite sample from throughout euphotic zone.
	2007, 2008	July, August, September	None	All	Excluded because of methodological differences, as samples consisted of a composite of subsamples collected throughout the euphotic zone (not comparable to discrete surface samples collected in 2020).
	2009	April, August	August data collected at "Doris" sampling location	All April data and August data collected at "Doris South" sampling location	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake; only open-water season chlorophyll *a* data included in the 2020 evaluation of effects, so excluded historical under-ice data.
	Annually from 2010 to 2016	April, July, August, September	July, August, September data collected at "Doris" sampling location	April data and all data collected at "Doris South" sampling location	Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake; only open-water season chlorophyll *a* data included in the 2020 evaluation of effects, so excluded historical under-ice data.
	2017, 2018, 2019	August	All	None	
Patch Lake	1997	July	None	All	Potential issue with sample integrity, as samples were lost and then found and analyzed more than one year after sample collection.

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
Patch Lake *(cont'd)*	2006	September	None	All	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake.
	2007, 2008	July, August, September	None	All	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake; excluded because of methodological differences, as samples consisted of a composite of subsamples collected throughout the euphotic zone (not comparable to discrete surface samples collected in 2020).
	2009	April, August	August data collected at "Patch" sampling location	All April data and August data collected at "Patch South" sampling location	Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake; only open-water season chlorophyll *a* data included in the 2020 evaluation of effects, so excluded historical under-ice data.
	2017, 2018	April, August	August data	April data	Only open-water season chlorophyll *a* data included in the 2020 evaluation of effects, so excluded historical under-ice data.
	2019	August	All	None	
Reference Lake B	2009	August	None	All	Excluded data collected from northeastern end of Reference Lake B, as current AEMP sampling site is in the central basin of the lake.
	2010	April, July, August, September	August, September data	April, July data	Excluded April and July data collected from northeastern end of Reference Lake B, as current AEMP sampling site is in the central basin of the lake; only open-water season chlorophyll *a* data included in the 2020 evaluation of effects, so excluded historical under-ice data.

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
Reference Lake B *(cont'd)*	Annually from 2011 to 2016	April, July, August, September	July, August, September data	April data	Only open-water season chlorophyll *a* data included in the 2020 evaluation of effects, so excluded historical under-ice data.
	2017	April, August	August data	April data	Only open-water season chlorophyll *a* data included in the 2020 evaluation of effects, so excluded historical under-ice data.
	2018, 2019	August	All	None	

C.2 Statistical Methodology for Evaluation of Effects

The general statistical methodology is described in Sections C.2.1 and C.2.2. Variations in methodology specific to each monitoring component and analysis are described in Sections C.2.3 and C.2.4.

C.2.1 Lakes with ≥ 10 Continuous Years of Continuous Historical Data

Regression models were used to assess data from lakes with 10 or more years of continuous historical data available for most variables (i.e., Doris Lake) and examine any time trends over the monitoring period. Hypothesis tests were conducted to assess time trends for particular variables. If there was a significant change over time, the time trend in the exposure lake was compared to the time trend in the reference lake (Reference Lake B). For comparisons between exposure and reference lakes, only years in which both lakes were sampled were included in the analysis. All the observed and fitted data are presented graphically to support the interpretation of results.

C.2.1.1 Non-detects

If all data in the current assessment year (2020) were below the detection limit, no regression analysis was performed for that variable. If a large amount of data (> 50% of the dataset) from a lake was 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 data was removed, it was not possible to make comparisons between exposure and reference lakes, and inference about the exposure lake was based on the within-lake regression analysis and 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 exposure lake. Tobit regression was used when a moderate amount of data (between 10 and 50%) 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.

C.2.1.2 Linear Mixed Effects (LME) Regression

Model Form

Let y denote a 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 or more 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

For water variables, 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. For phytoplankton biomass, all observations from the same lake on the same date were averaged.

Random Variation

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

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

or mathematically:

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

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

Assessing Model Fit and Outliers

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

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

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

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

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

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

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

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

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

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

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

Pseudoreplication

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

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

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 $a = b = \bar{y}$.

C.2.1.4 Hypothesis Testing

Once the LME or Tobit regression models were fit, hypothesis tests were performed to determine if there was evidence that the mean variable values in the exposure lake (E) 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 exposure lake was compared to the reference lake (R) to determine if there was a parallel trend over time at the exposure and reference lakes. For comparisons between exposure and reference lakes, only years in which both lakes were sampled were included in the analysis.

Test 1: Comparison within Exposure Lake

The fitted pattern of means in the exposure 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:

$H_0: \beta_{kE} = 0$ for k = 1 … K.

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

Rejection of the null hypothesis provides evidence that the mean variable value in the exposure 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 over time, the fitted patterns of means in the exposure lake were compared to the reference lake. Only years in which both lakes were sampled were included in the analysis

The hypotheses of these tests were:

$H_0: \beta_{kE} = \beta_{kR}$ for k = 1 … K.

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

Rejection of the null hypothesis provided evidence that the time trend in the mean variable value in the exposure 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 detection limit were plotted at half the detection limit 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.

C.2.2 Lakes with < 10 Continuous Years of Historical Data

C.2.2.1 Statistical Modelling – Before-After Control-Impact Design

When there was less than 10 years of continuous years of historical data available (i.e., Patch and Windy lakes), a Before-After (BA) analysis was used to compare the mean measurements for all baseline years to the mean for 2020 in the exposure site. If the change in means was found to be significant, this change was then compared to the change in means at Reference B using a Before-After Control-Impact (BACI) analysis. For the BACI analysis, only years in which both lakes were sampled were included in the analysis. Each site and evaluated variable was treated independently. Section C.2.4 describes modifications to the general methodology for specific variables.

Non-detects

Observations below analytical detection limits were considered censored. Censored data can potentially bias statistical analyses because of violation of underlying mathematical assumptions. For a particular variable, a site was removed from the analysis if more than 50% of observations for the site were censored.

If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results. If censored data were included in the analyses, the data were assumed to be equal to half the analytical detection limit.

Data Transformations

Initial model assessment was carried out to determine if data transformation was appropriate.
The general approach was to compare the normalized residuals and overall model performance for the basic linear model (Equation X) using both untransformed and natural log-transformed data. Plots of standardized residuals, fitted values and normal Q-Q plots were examined to establish the most appropriate choice of transformation. A data transformation was conducted if it produced a more uniform random distribution of residuals and a closer distribution along the 1:1 reference line on the Q-Q plot.

Outliers

The standardized residuals from the model fit were examined and outliers were identified as standardized residuals greater than 3. The outliers (if any) were flagged to caution interpretation of results but not removed from the model.

Model Form – Before-After Design

Regression models were constructed for each exposure site based on a Before-After (BA) design.
A model was constructed for each exposure site and season. The models follow the general form given in Equation X.

(X) $y = period$ + Year-R +Error-R

This model identifies variation associated with different components, where:

period describes the differences between the before and after periods,

or mathematically:

$$E[y_p] = \beta_0 + \beta_p$$

where:

- $\mathrm{E}[y_p]$ represents the expected mean value of the variable in period *p*;
- β_0 represents the intercept; and
- β_p represents the expected difference in the variable between the before and after periods.

Model Form – Before-After Control-Impact Design

LME models were constructed for each exposure site based on a BACI. The models follow the general form given below:

$$y = site\ class + period + site\ class\!:\!period.$$

This model identifies variation associated with different components, where:

site class describes the differences between the reference and exposure sites;

period describes the differences between the before and after periods across all sites (reference and exposure); and

site class:period is the interaction term describing reference and exposure site-specific differences between periods (the BACI term).

The *site class:period* term is the key statistical term that describes differential changes to the exposure site during the period of potential mine effects relative to changes at the reference sites.

Let $y_{i\,sc\,p}$ denote observation *i* at site *sc* in period *p*, where period is before or after. The basic regression model specifies:

$$E(y_{i\,sc\,p}) = \beta_0 + \beta_{sc} + \beta_p + \beta_{sc:p}$$

where β_0 is the intercept, β_{sc} is the expected difference between reference and exposure site effects, β_p is the expected period effect, and $\beta_{sc:p}$ is a vector of expected site specific period effects.

Pseudoreplication

All observations from the same site and season were presented in the plots of the observed data and modelled values. However, repeated observations from each lake in each season were collected from similar locations at similar times and the variability between these observations may not reflect the true variation between random replicates from the entire lake in the given season. Analyzing these measurements as independent observations may underestimate the true variability and lead to overly sensitive statistical tests. Thus, LME models were used to incorporate random effects for site and year, and improve error variance modelling.

Random Variation

Random effects were included in the model to control for natural inter-annual variation (*year*) and natural site to site variation. Including random effects for site, year, and the interaction between site and year provided an adjustment for dependence among observations in a given season, at a specific site, and in a given year.

The model can be represented as:

$$E(y_{isp}) = \beta_0 + \beta_{sc} + \beta_p + \beta_{sc:p} + \varepsilon_s + \varepsilon_y + \varepsilon_{s:y}$$

where β_0 is the intercept, β_{sc} is the expected value for site class *sc*, β_p is the expected value for period *p*, $\beta_{sc:p}$ is the expected value for site class *sc* in period *p*, and $\varepsilon_s + \varepsilon_y + \varepsilon_{s:y}$ are the predicted random component for site *s* and year *y*.

C.2.2.2 Hypothesis Testing

Test 1: BA Analysis - Comparison within Exposure Lake

A Project-related effect would be expected to result in a significant difference between the before-after change observed at the exposure site. The period term describes the change from the before period to the after period. For each exposure site, the period effect was assessed using an F-test.

The hypothesis of this test was:

$H_0: \beta_p = 0$

$H_a: \beta_p \neq 0$

If the p-value for this *period* hypothesis test was less than α = 0.05, then it was concluded that a significant difference between the before and after periods was observed in the exposure site and the analysis proceeded to a BACI analysis.

Test 2: BACI Analysis - Comparison of Exposure and Reference Lake

A Project-related effect would be expected to result in a significant difference between the before-after change observed at the exposure sites and the reference sites. For BACI comparisons, only years in which both lakes were sampled were included in the analysis. The *site class:period* term describes the site class-specific variability in the change from the before period to the after period.

The hypothesis of this test was:

$H_0: \beta_{sc:p} = 0$

$H_a: \beta_{sc:p} \neq 0$

For each exposure site, the overall *site class:period* effect was assessed using an F-test. If the p-value for this *site class:period* hypothesis test was less than α = 0.05, then it was concluded that a significant site class-specific difference between the before and after periods was observed.

Confidence Intervals for Contrast Terms

Contrasts were calculated to compare the difference between the change at the exposure site and reference sites. In this approach, any contrast substantially different from zero would represent a differential before/after effect between the exposure site and the reference site currently being contrasted. For the contrasts, 95% confidence intervals were calculated to support the interpretation and, in turn, support the identification of significant site-specific differences. If the confidence interval for a contrast did not cover zero, it was concluded that a significant site-specific difference between the *before* and *after* periods was observed between the exposure site and that particular reference site.

C.2.2.3 Plots of Observed Data and Modelled Values

Plots of the observed data for each site in each year were plotted for each variable to visualize the variation between sites. Symbols show the observed values of the variable for each site in each year. Given sufficient data above detection limit, LME model predictions and approximate 95% confidence intervals were obtained and plotted as vertical lines. Observations below analytical detection limits were substituted with half the analytical detection limit for the calculation of annual site specific means.

C.2.3 Variations in Methodology – Doris Lake

C.2.3.1 Water Quality

Water quality samples were collected during the under-ice (April, May, or June) and open-water (July, August, and/or 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:

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

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.

Hypothesis Testing

Test 1: Comparison within Exposure Lake

For season *j* in exposure lake *E*, the hypothesis tests were:

$H_0: \beta_{kEj} = 0$ for *k* = 1 … *K*.

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

If there was enough evidence to suggest the variable changed across time in the exposure lake in season *j*, the time trend in the exposure lake was compared to the reference lake in season *j* using Test 2.
For comparisons between exposure and reference lakes, only years in which both lakes were sampled were included in the analysis.

Test 2: Comparison against Reference Lake

The hypotheses of the tests were:

$H_0: \beta_{kEj} = \beta_{kRj}$ for k = 1 … K.

$H_a: \beta_{kEj} \neq \beta_{kRj}$ 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 exposure lake differed from the time trend in the reference lake in season *j*.

C.2.3.2 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 + s(Year) + Lake*s(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 C.2.1.4.

C.2.4 Variations in methodology – Patch and Windy Lake

C.2.4.1 Water Quality

Water quality samples were collected during the under-ice and open-water 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. The regression models for the BA and BACI water quality data were as follows:

y = depth + period + Year-R + Error-R

or mathematically:

$$E[y_{dp}] = \beta_0 + \beta_{\mathrm{d}} + \beta_{\mathrm{p}} ,$$

and

y = depth + site class + *period* + *site class:period* + Year-R + Error-R,

or mathematically:

$$E\left[y_{dp\ sc}\right] = \beta_0 + \beta_{\mathrm{d}} + \beta_{\mathrm{sc}} + \beta_{\mathrm{p}} + \beta_{\mathrm{sc:p}} ,$$

where:

- $\mathrm{E}[y_{dp\ sc}]$ represents the expected mean value of the variable*;*
- β_0 represents the intercept*;*
- β_d represents the expected value for depth *d*;
- β_{sc} represents the expected value for site class *sc*; and
- $\beta_{sc:p}$ represents the expected value for site class *sc* in period *p*.

Hypothesis testing procedures followed that outlined in section C.2.2.2.

C.2.4.2 Phytoplankton Biomass

Phytoplankton biomass data were collected in one month at one depth, hence the model form and hypothesis testing procedure followed that outlined in section C.2.2.1 and C.2.2.2.

C.2.5 Computing

All steps of the analysis were performed using the statistical computing package R version 4.0.2.
The following versions of packages were used for the analyses:

- dplyr (1.0.0);
- stringr (1.4.0);
- tidyr (1.1.0);
- lubridate (1.7.9);
- ggplot2 (3.3.2);
- knitr (1.29);
- survival (3.2-3); and
- lme4 (1.1-23).

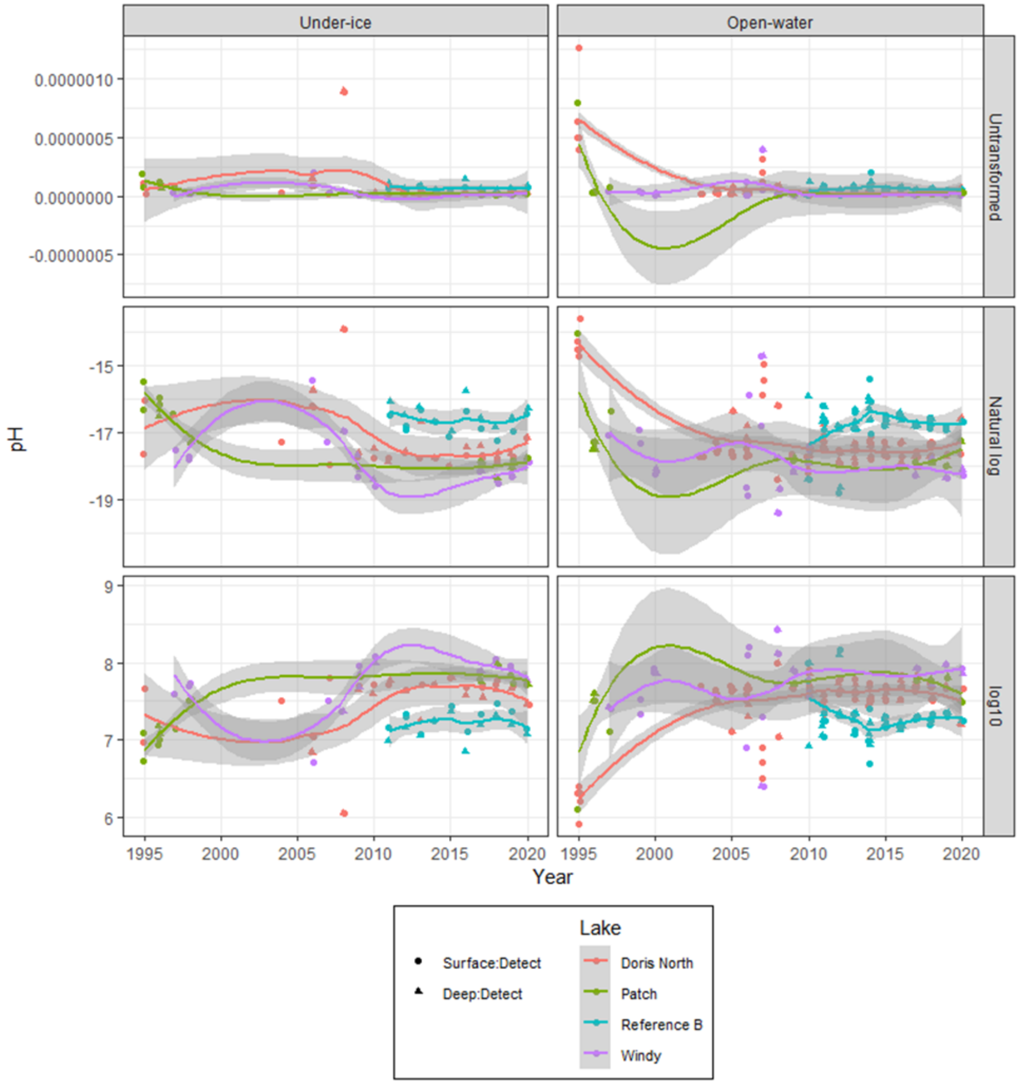
C.3 Statistical Results for Evaluation of Effects

C.3.1 Water Quality

C.3.1.1 pH

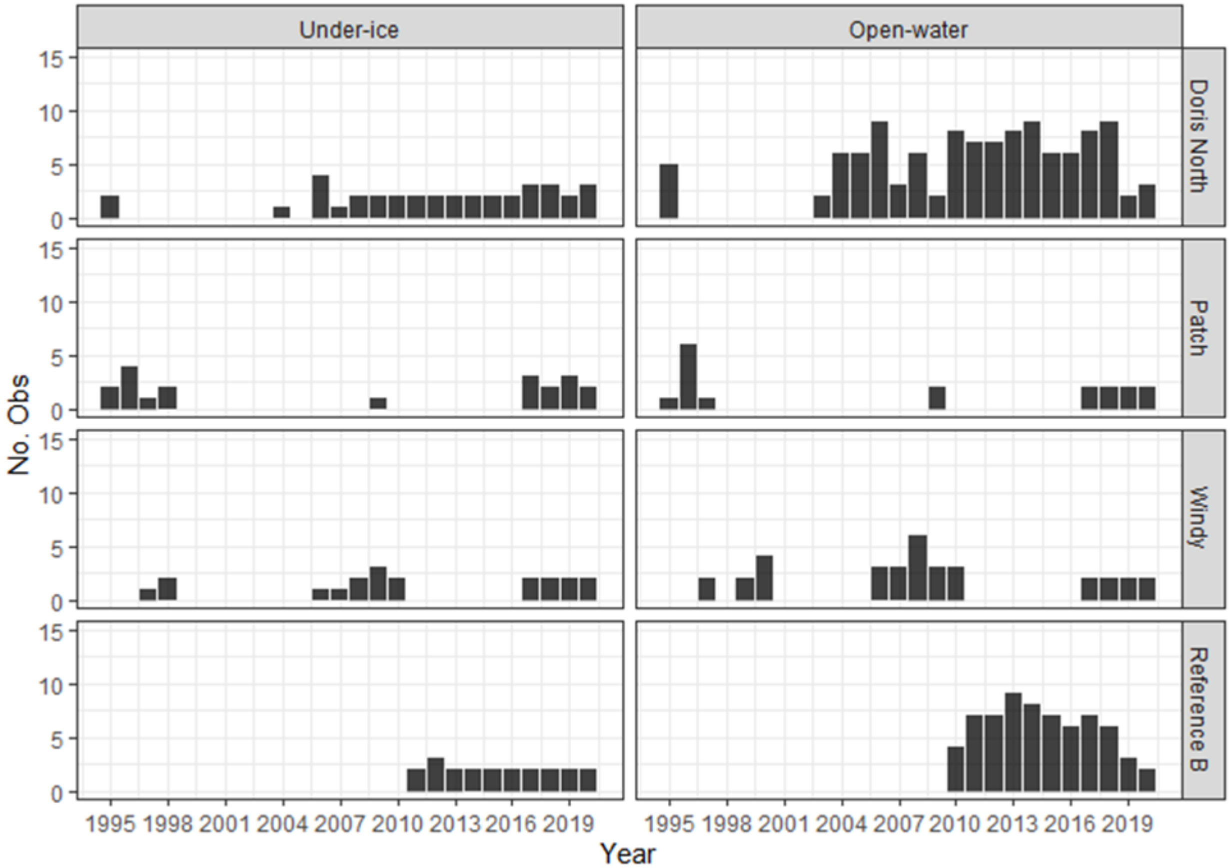
Observed Data

The following plots show all the observed data on untransformed, natural log scale, and log (base 10) scales. For analysis of untransformed and natural log transformed pH, pH values were first converted to the concentration of hydrogen ions ([H+] = 10^{-pH}). For the log (base 10) transformation, raw pH values are presented, since pH = -log10[H+]. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines.
The lines drawn through the scatter plots represent the annual means. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

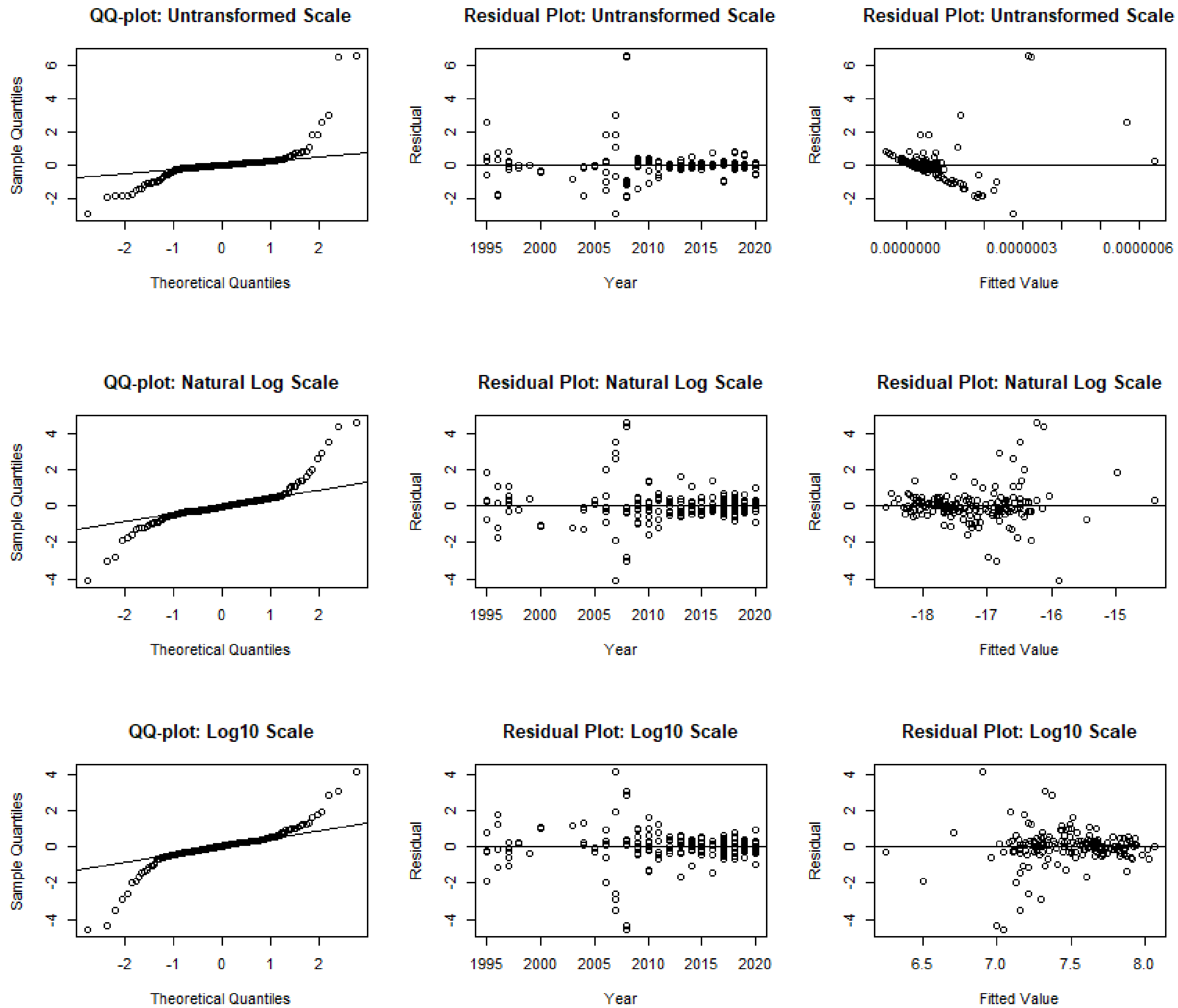
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	37	0	0	0	0.0000000
Doris North	Open-water	112	0	0	0	0.0000000
Patch	Under-ice	20	0	0	0	0.0000000
Patch	Open-water	18	0	0	0	0.0000000
Reference B	Under-ice	21	0	0	0	0.0000001
Reference B	Open-water	66	0	0	0	0.0000001
Windy	Under-ice	20	0	0	0	0.0000000
Windy	Open-water	34	0	0	0	0.0000000

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris	2008	Under-ice	Deep	0.0000009	0	6.495
Doris	2008	Under-ice	Surface	0.0000009	0	6.572

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2007	Under-ice	Surface	0.0000000	-15.887	-4.136
Doris North	2008	Under-ice	Deep	0.0000009	-16.110	4.349
Doris North	2008	Under-ice	Surface	0.0000009	-16.227	4.581
Windy	2007	Open-water	Deep	0.0000004	-16.487	3.492
Windy	2008	Open-water	Deep	0.0000000	-16.865	-3.040

Outliers on log10 scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual

Doris North	2007	Under-ice	Surface	0.0000000	6.900	4.136
Doris North	2008	Under-ice	Deep	0.0000009	6.997	-4.349
Doris North	2008	Under-ice	Surface	0.0000009	7.047	-4.581
Windy	2007	Open-water	Deep	0.0000004	7.160	-3.492
Windy	2008	Open-water	Deep	0.0000000	7.324	3.040

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

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was compared to the trend in Reference B (including comparable years only). This contrast does not test for differences in intercepts between lakes.

Under-ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	17.348	4	0.0017
Compare to Reference B	3.741	4	0.4422

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

Open-water

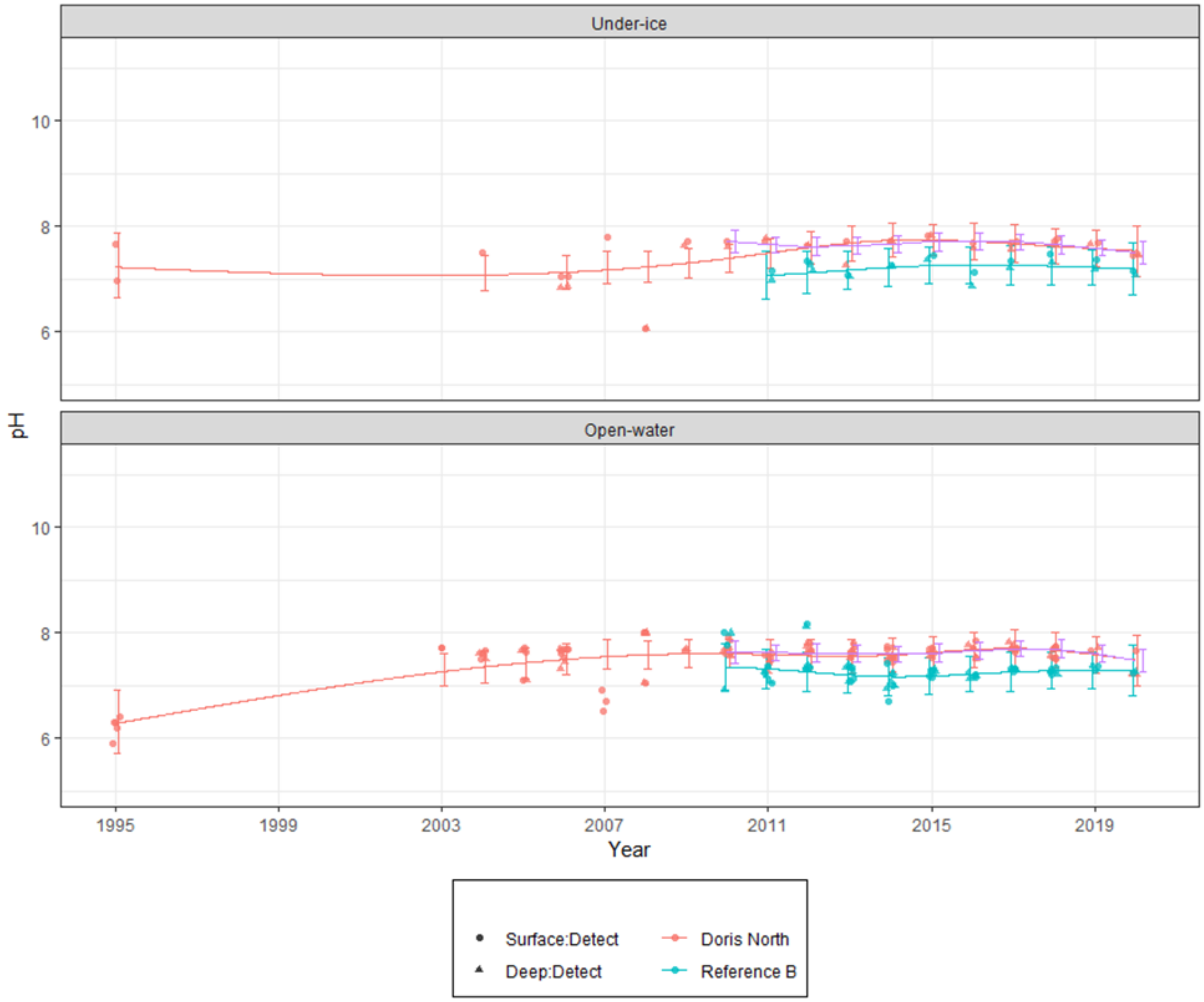
Analysis	Chi.sq	DF	P.value
Compare to slope 0	27.178	4	0.0000
Compare to Reference B	9.551	4	0.0487

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

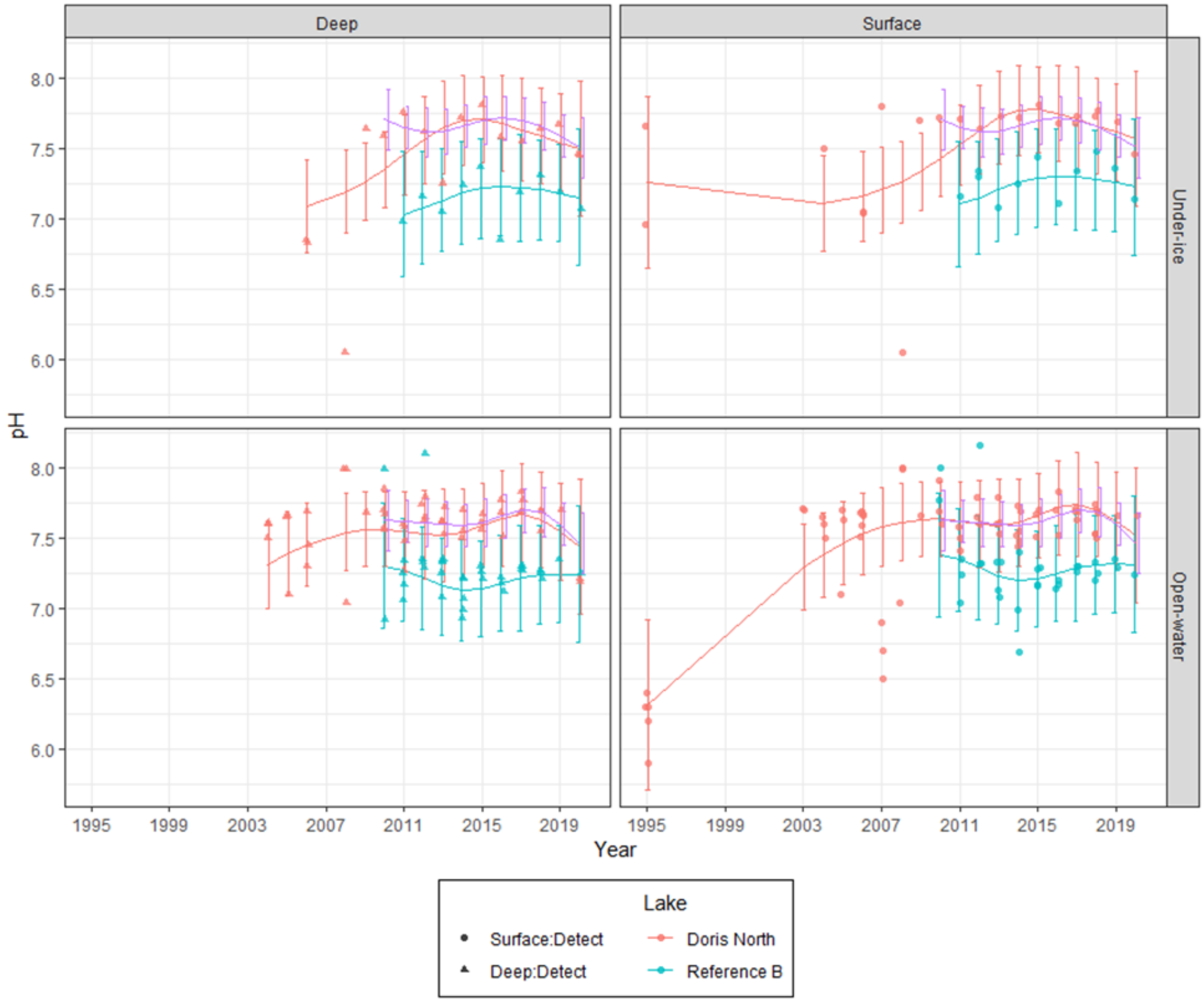
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data; solid purple lines show fitted curves through comparable years of data for comparisons between Doris Lake and Reference B Lake data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in pH from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in pH from before to after periods between Reference B and Patch over comparable years of data. Models were fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.2574	0.4521	5.956	0.5693	0.5900	not sig.

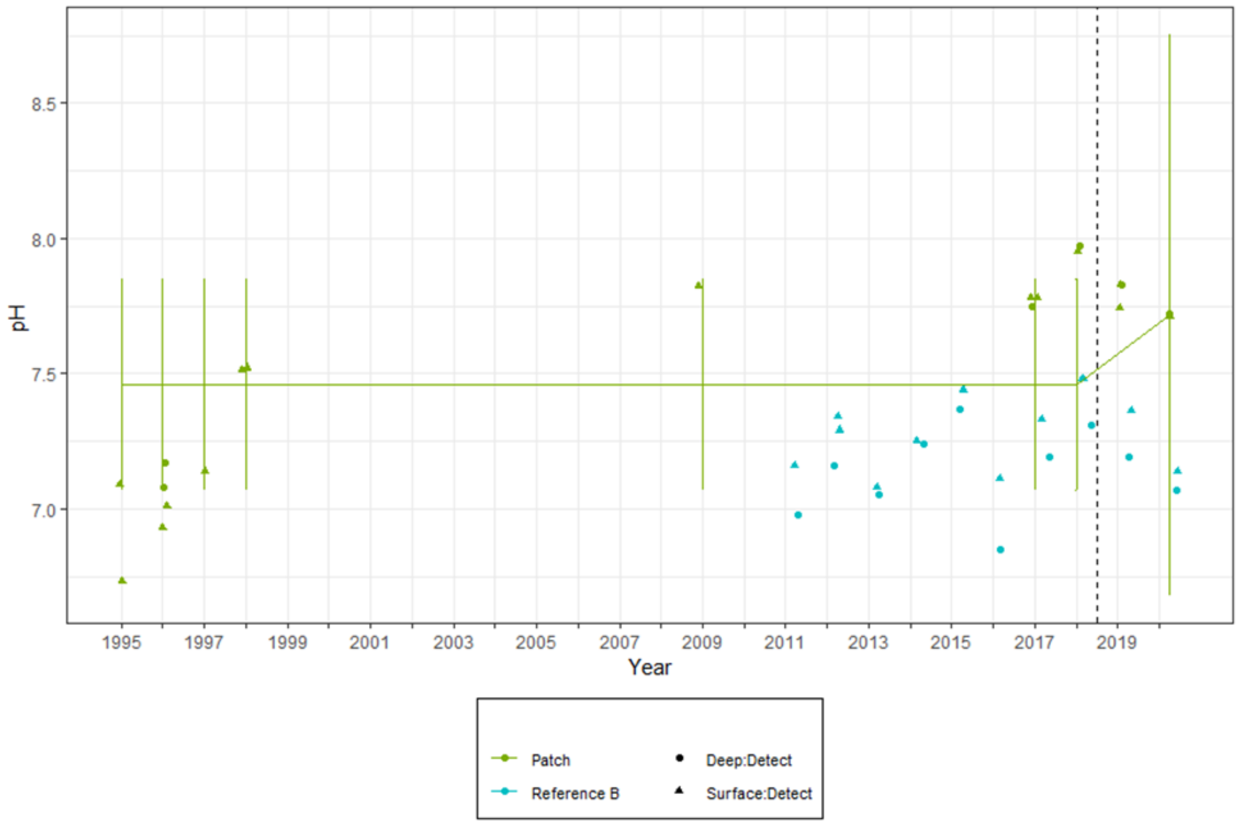
Conclusion:

The change in pH in Patch Lake from before to after was not significantly ($p = 0.5900$) different.

BACI analysis not performed.

Under-ice 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. The symbols represent the observed data values (x's represent annual observed means). Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.1623	0.7044	4.994	0.2304	0.8269	not sig.

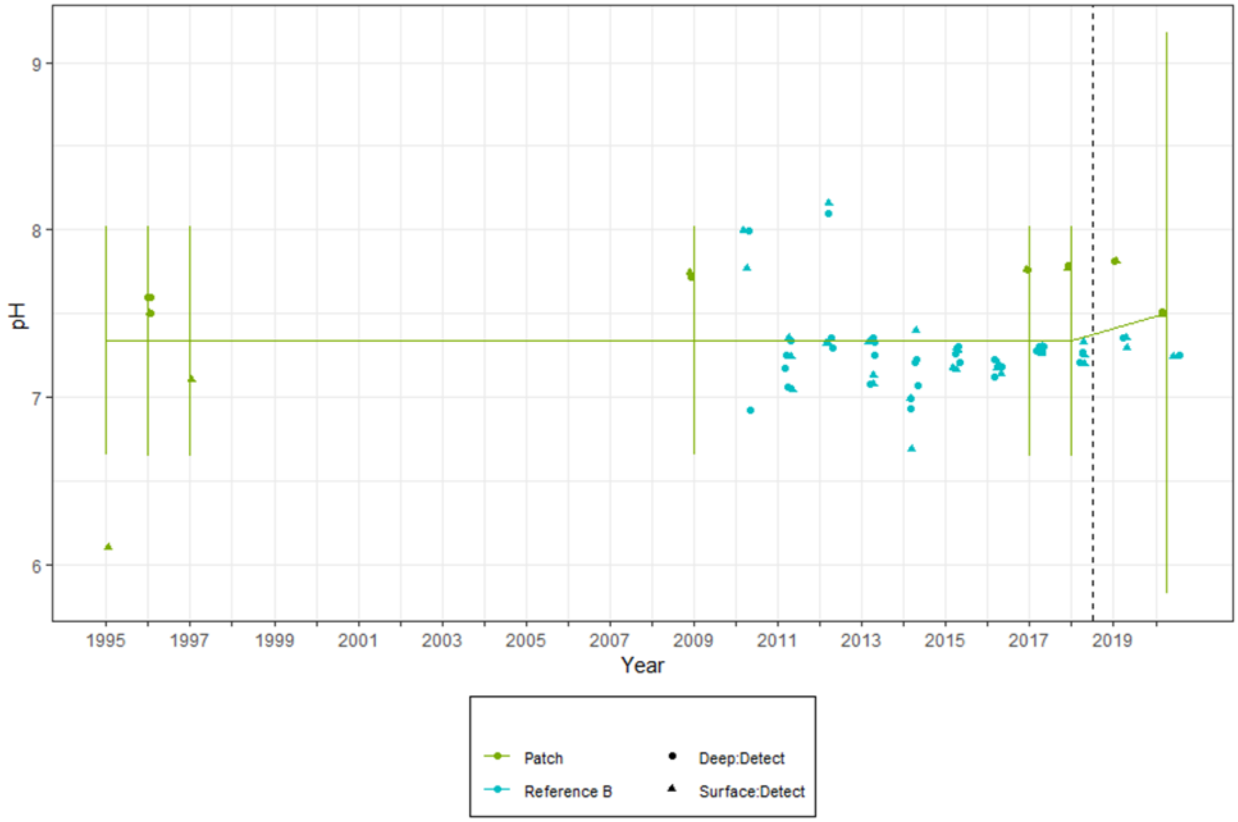
Conclusion:

The change in pH in Patch Lake from *before* to *after* was not significantly (p = 0.8269) different.

BACI analysis not performed.

Open-water 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. The symbols represent the observed data values (x's represent annual observed means). Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in pH from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in pH from before to after periods between Reference B and Windy over comparable years of data. Models were fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.1493	0.4477	7.912	0.3336	0.7474	not sig.

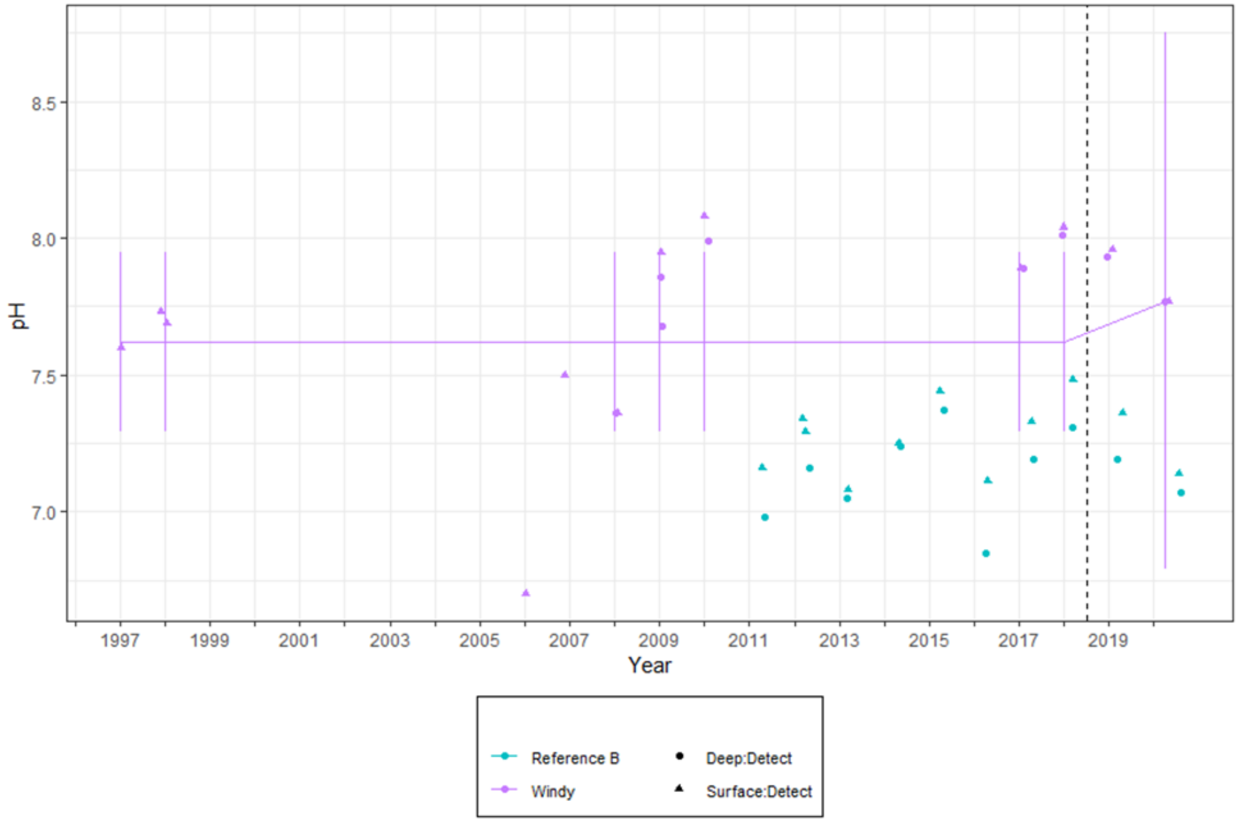
Conclusion:

The change in pH in Windy Lake from before to after was not significantly ($p = 0.7474$) different.

BACI analysis not performed.

Under-ice 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. The symbols represent the observed data values (x's represent annual observed means). Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.3147	0.4635	8.987	0.6789	0.5143	not sig.

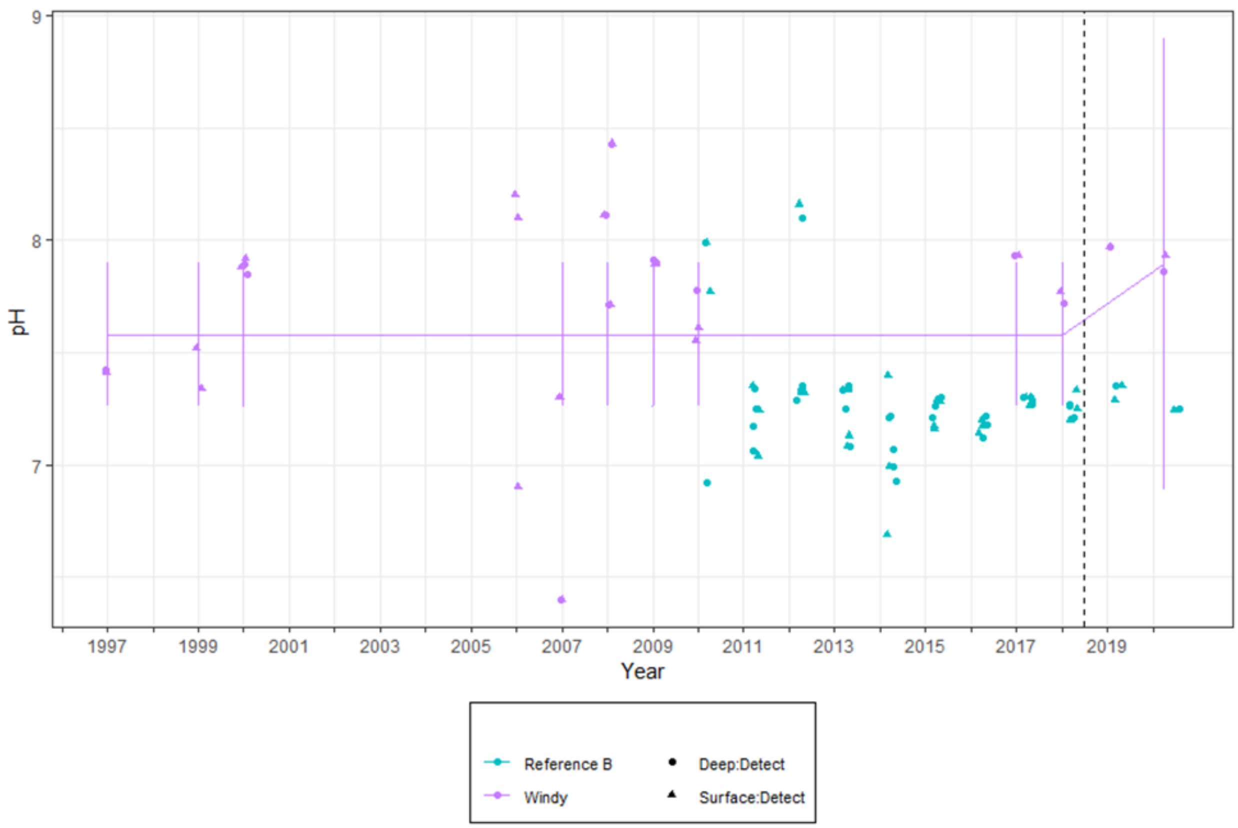
Conclusion:

The change in pH in Windy Lake from *before* to *after* was not significantly (p = 0.5143) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

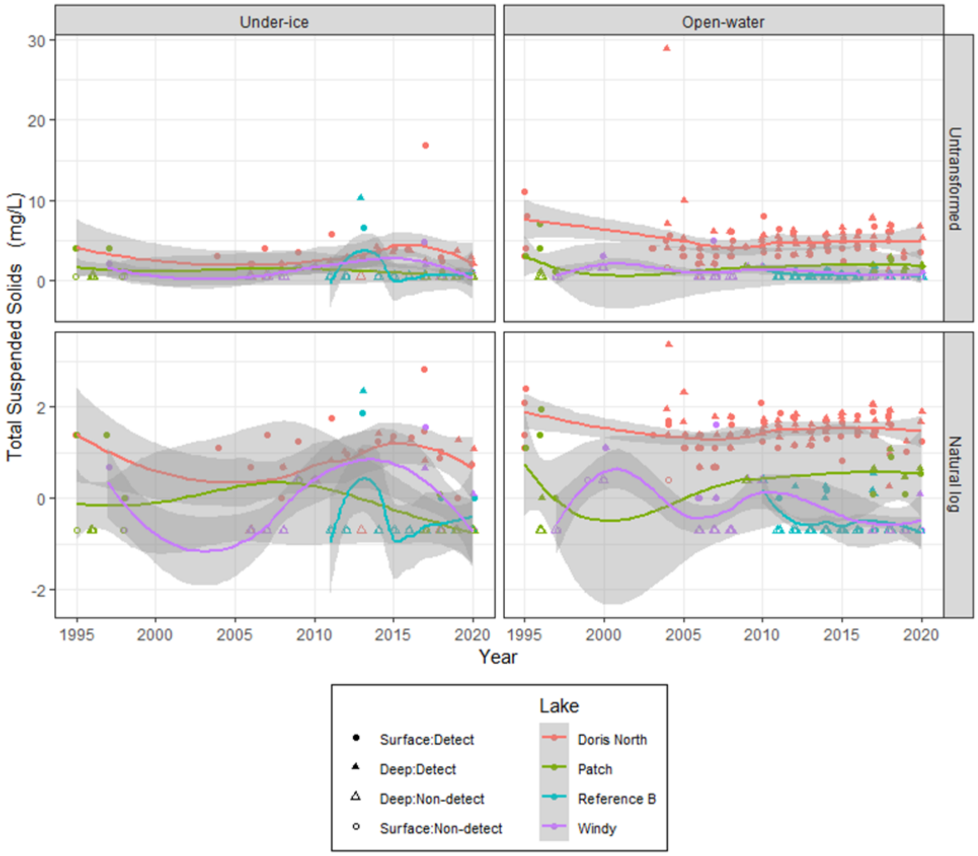
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values (x's represent annual observed means). Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.2 Total Suspended Solids

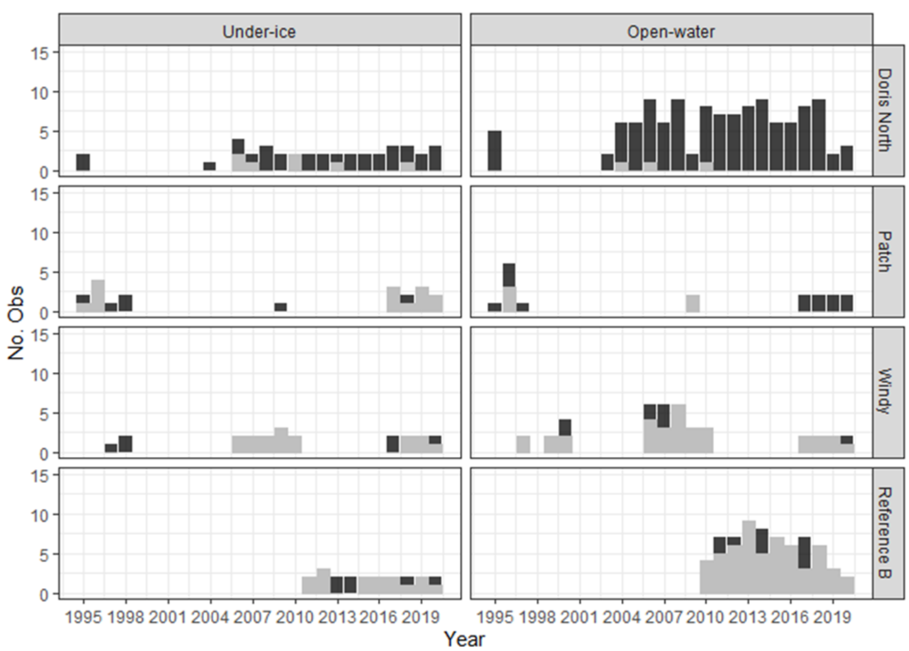
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

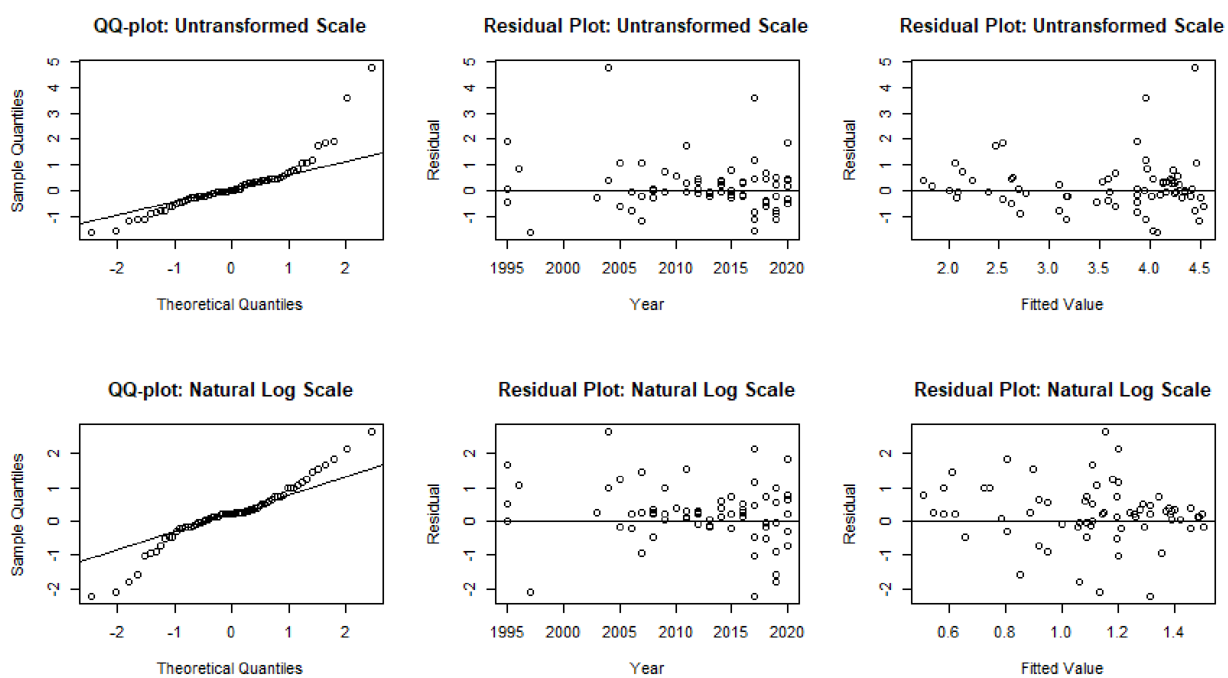
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	39	8	0.21	0.0	2.80
Doris North	Open-water	118	3	0.03	0.0	4.35
Patch	Under-ice	20	16	0.80	1.0	1.00
Patch	Open-water	18	5	0.28	0.0	1.80
Reference B	Under-ice	21	17	0.81	0.5	1.00
Reference B	Open-water	66	56	0.85	1.0	1.00
Windy	Under-ice	22	17	0.77	0.5	1.00
Windy	Open-water	40	32	0.80	0.5	1.00

More than 50% of data under detection limit in Patch under-ice, Reference B under-ice, Reference B open-water, Windy under-ice, and Windy open-water. Data from those site-season groupings will be removed from the analysis. Doris under-ice and Patch open-water exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris. The analysis proceeds with linear mixed effects regression for Patch.

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 fitted model 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
Doris	2004	Open-water	Deep	13.33	4.452	4.774
Doris	2017	Under-ice	Surface	10.60	3.960	3.570

Outliers on natural log scale: None

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

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	15.62	4	0.0036

Doris Lake appears to show significant deviation from no trend.

Open-water

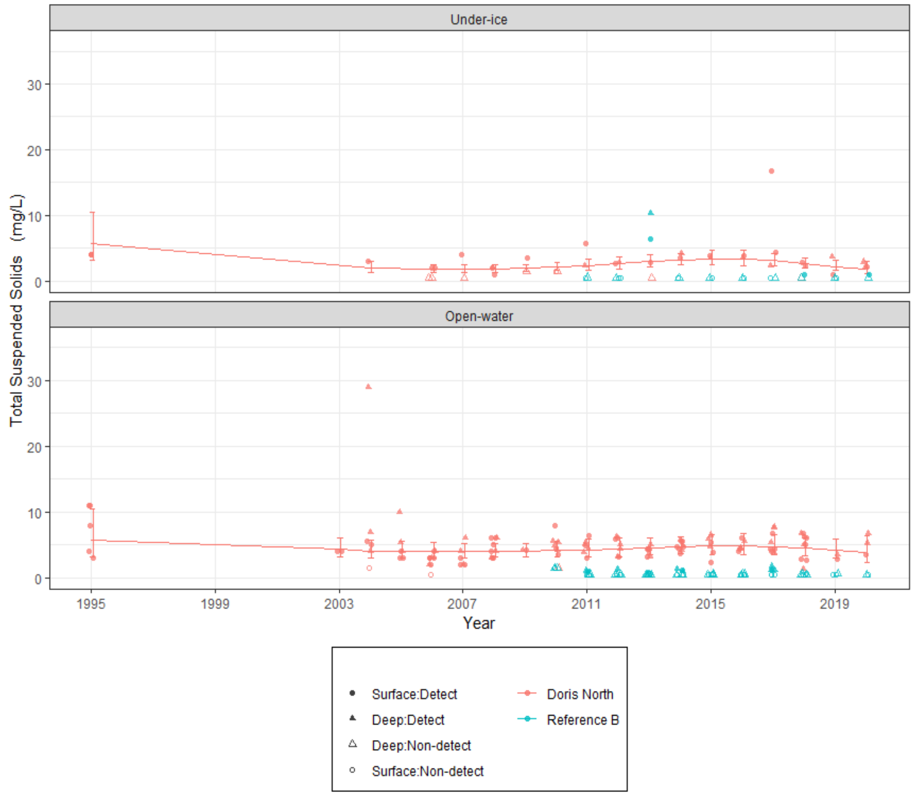
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.572	4	0.8138

Doris Lake does not exhibit significant deviation from no trend.

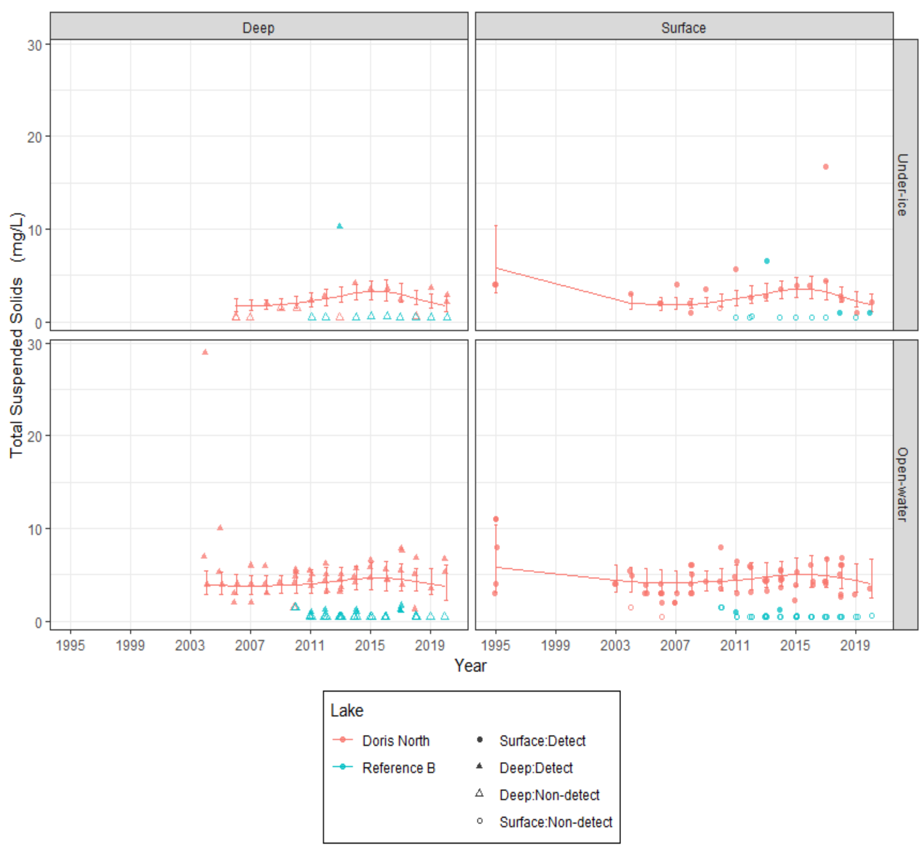
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.223	0.4832	9	0.0462	0.9642	not sig.

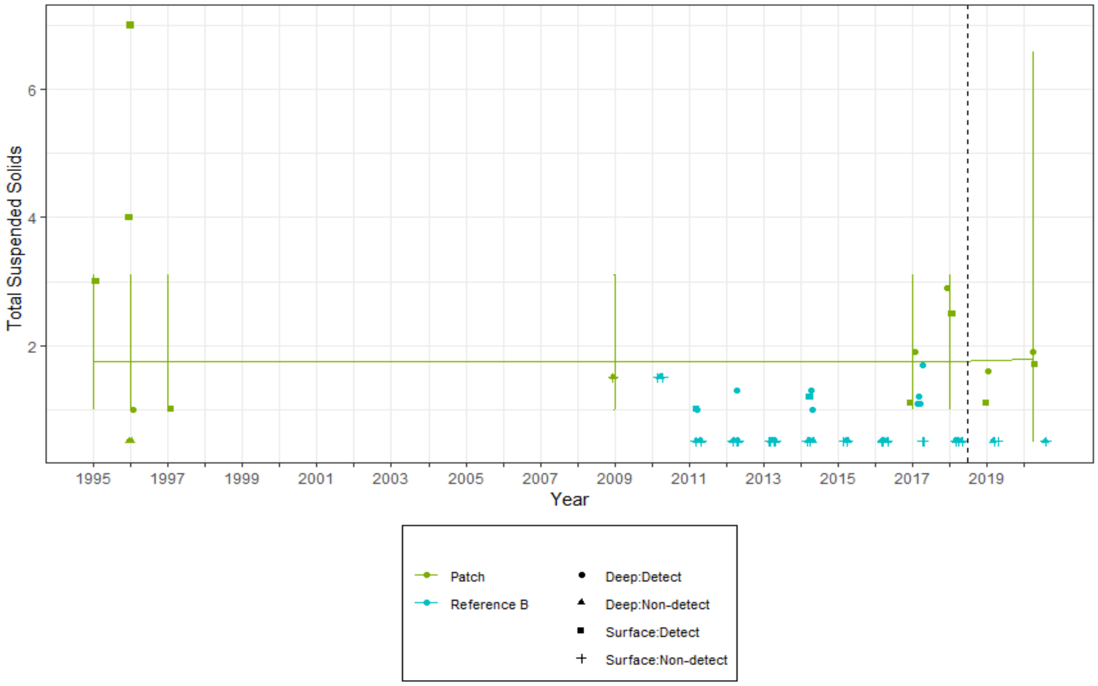
Conclusion:

The change in total suspended solids concentrations in Patch Lake from *before* to *after* was not significantly ($p = 0.9642$) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

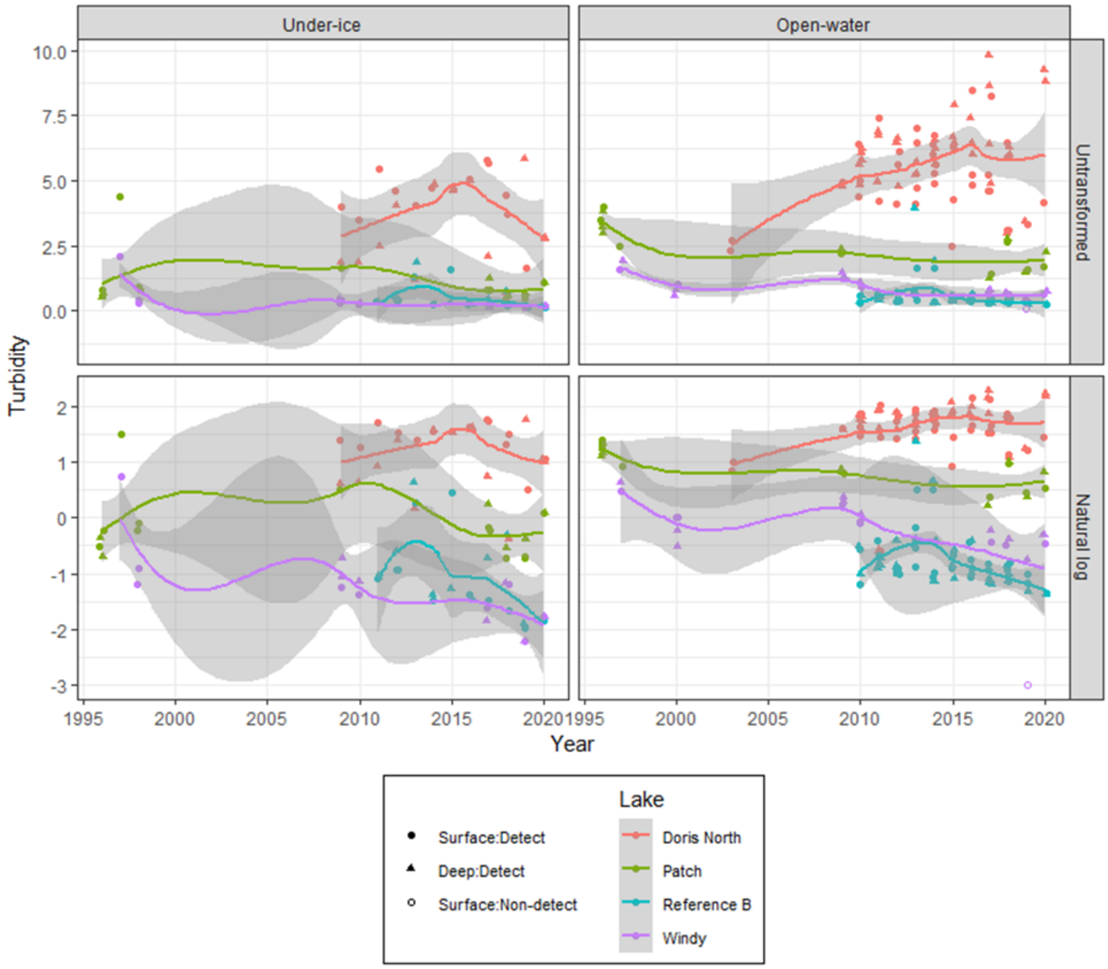
Open-water Before-vs-After Analysis

Analysis not performed.

C.3.1.3 Turbidity

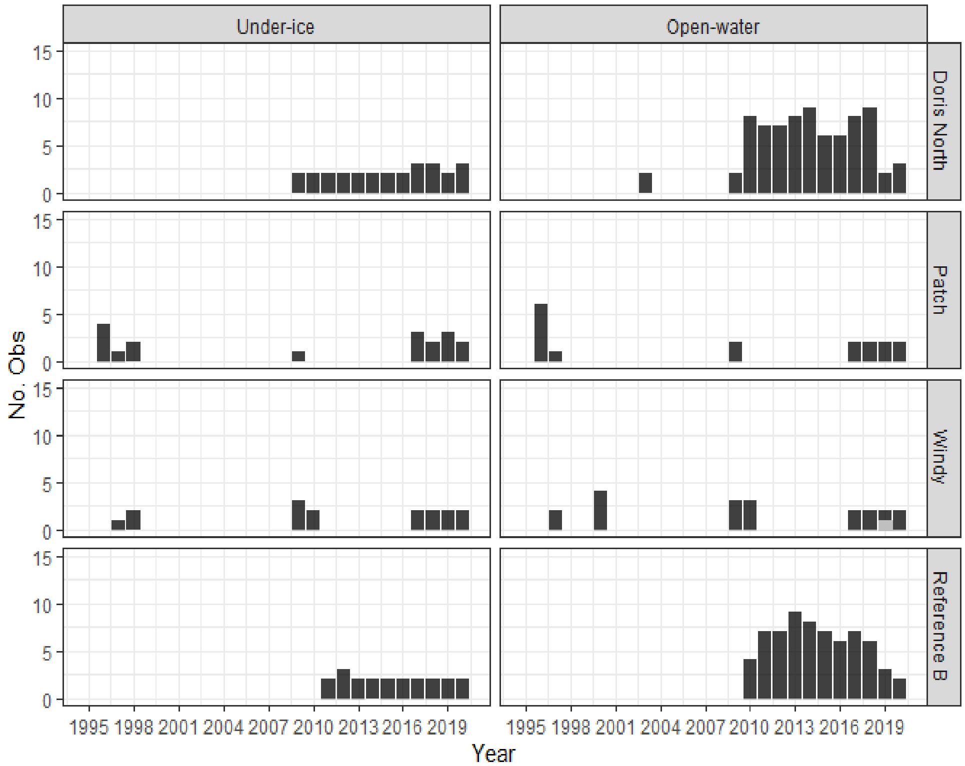
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

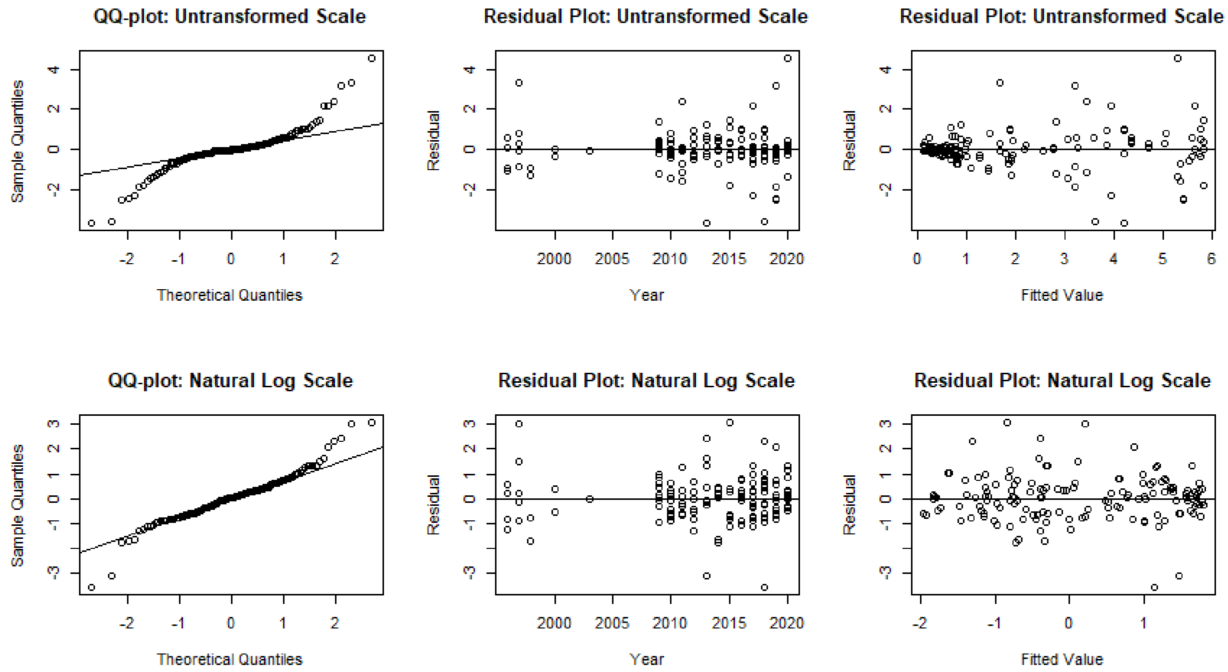
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	27	0	0.00	0	4.050
Doris North	Open-water	77	0	0.00	0	5.750
Patch	Under-ice	18	0	0.00	0	0.795
Patch	Open-water	17	0	0.00	0	2.500
Reference B	Under-ice	21	0	0.00	0	0.280
Reference B	Open-water	66	0	0.00	0	0.405
Windy	Under-ice	16	0	0.00	0	0.295
Windy	Open-water	20	1	0.05	0	0.855

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris North	2013	Under-ice	Deep	1.18	4.197	-3.670
Doris North	2018	Under-ice	Deep	0.69	3.603	-3.543
Doris North	2019	Under-ice	Deep	5.82	3.198	3.190
Doris North	2020	Open-water	Deep	9.03	5.295	4.544
Patch	1997	Under-ice	Surface	4.40	1.681	3.308

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2013	Under-ice	Deep	1.18	1.464	-3.071
Doris North	2018	Under-ice	Deep	0.69	1.143	-3.580
Patch	1997	Under-ice	Surface	4.40	0.210	3.006
Reference B	2015	Under-ice	Surface	1.59	-0.836	3.073

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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	6.082	4	0.1931

Doris Lake does not exhibit significant deviation from no trend.

Open-water

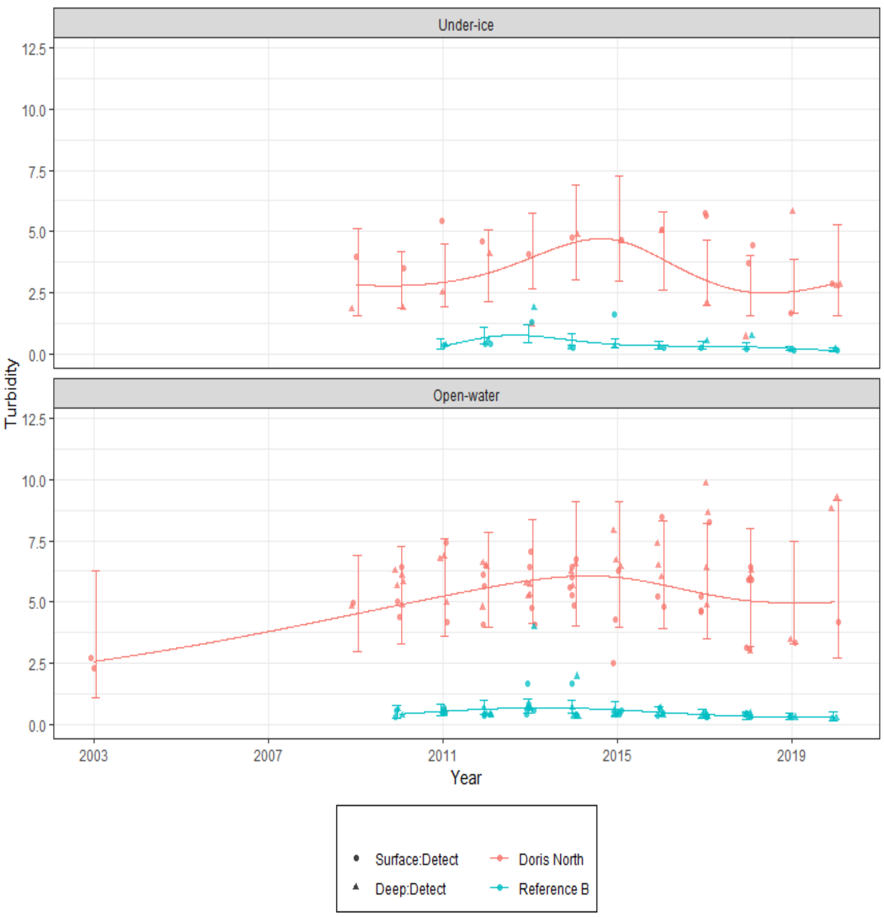
Analysis	Chi.sq	DF	P.value
Compare to slope 0	4.188	4	0.3811

Doris Lake does not exhibit significant deviation from no trend.

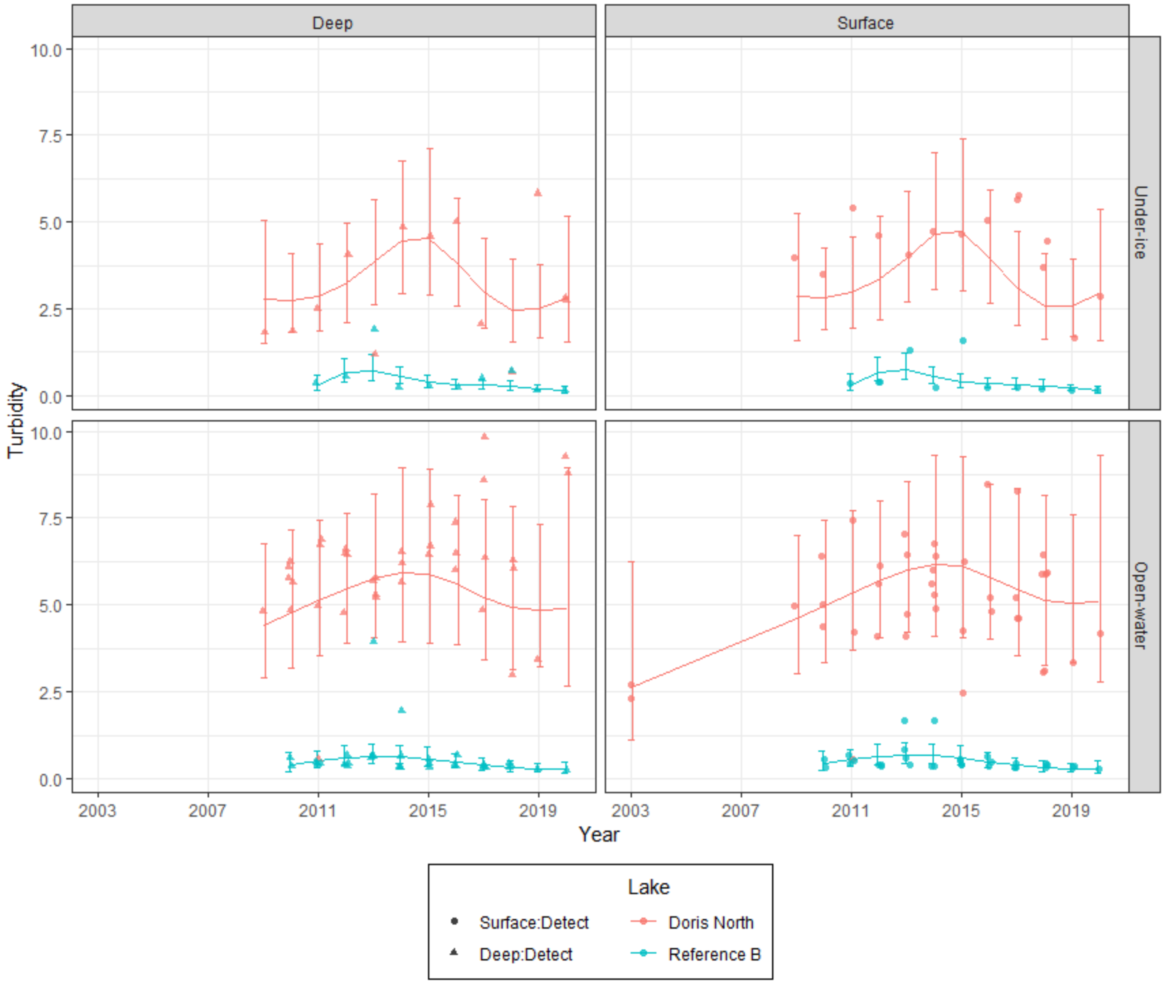
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.0598	0.8435	4.801	-0.071	0.9463	not sig.

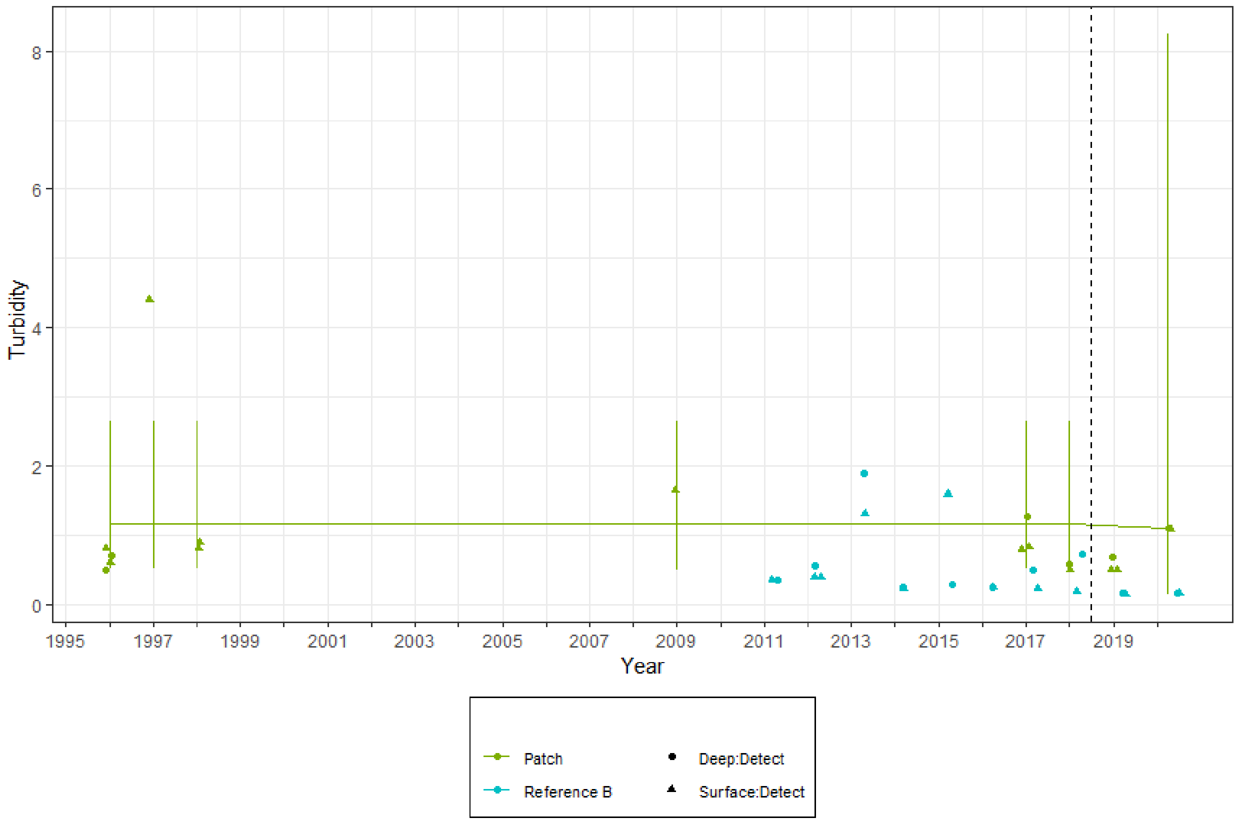
Conclusion:

The change in turbidity at the Patch site from *before* to *after* was not significantly (p = 0.9463) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.1886	0.394	4.009	-0.4786	0.6572	not sig.

Conclusion:

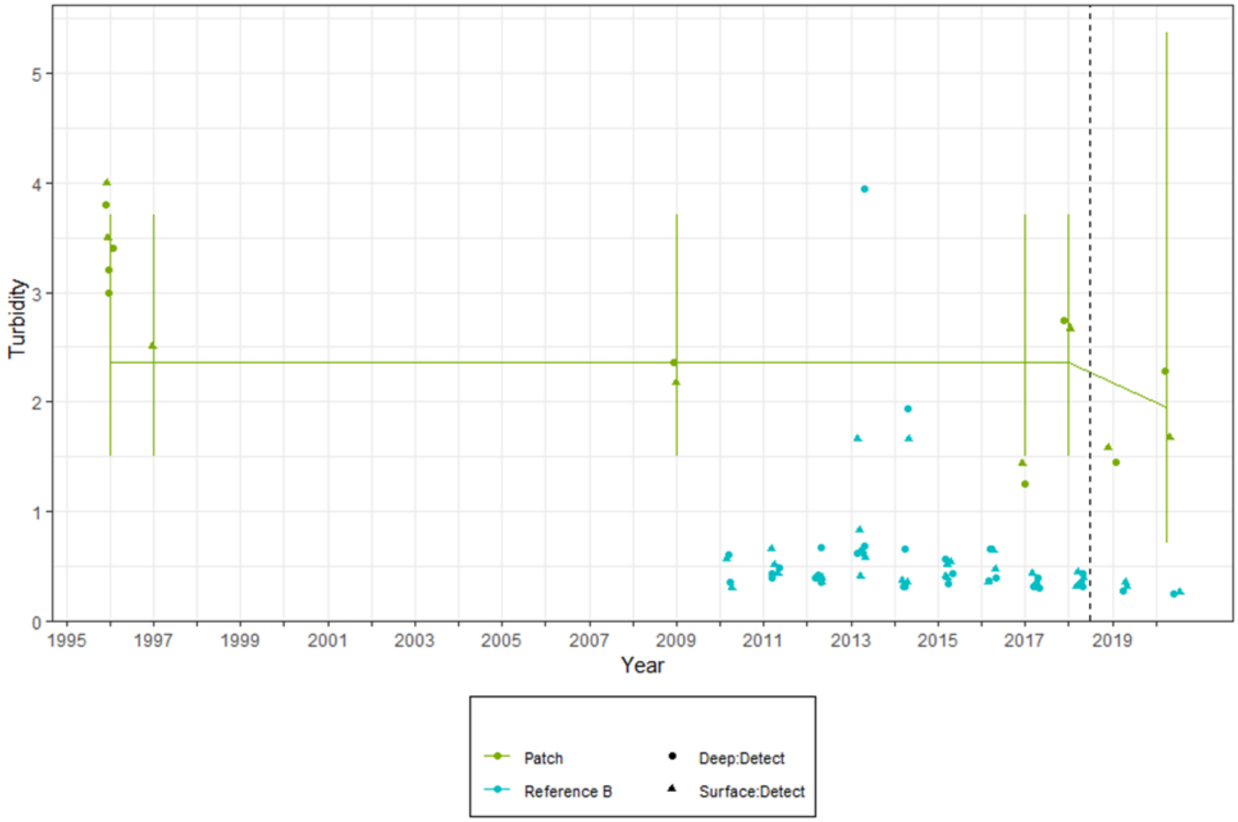
The change in turbidity in Patch Lake from *before* to *after* was not significantly (p = 0.6572) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.8575	0.9254	4.847	-0.9266	0.3979	not sig.

Conclusion:

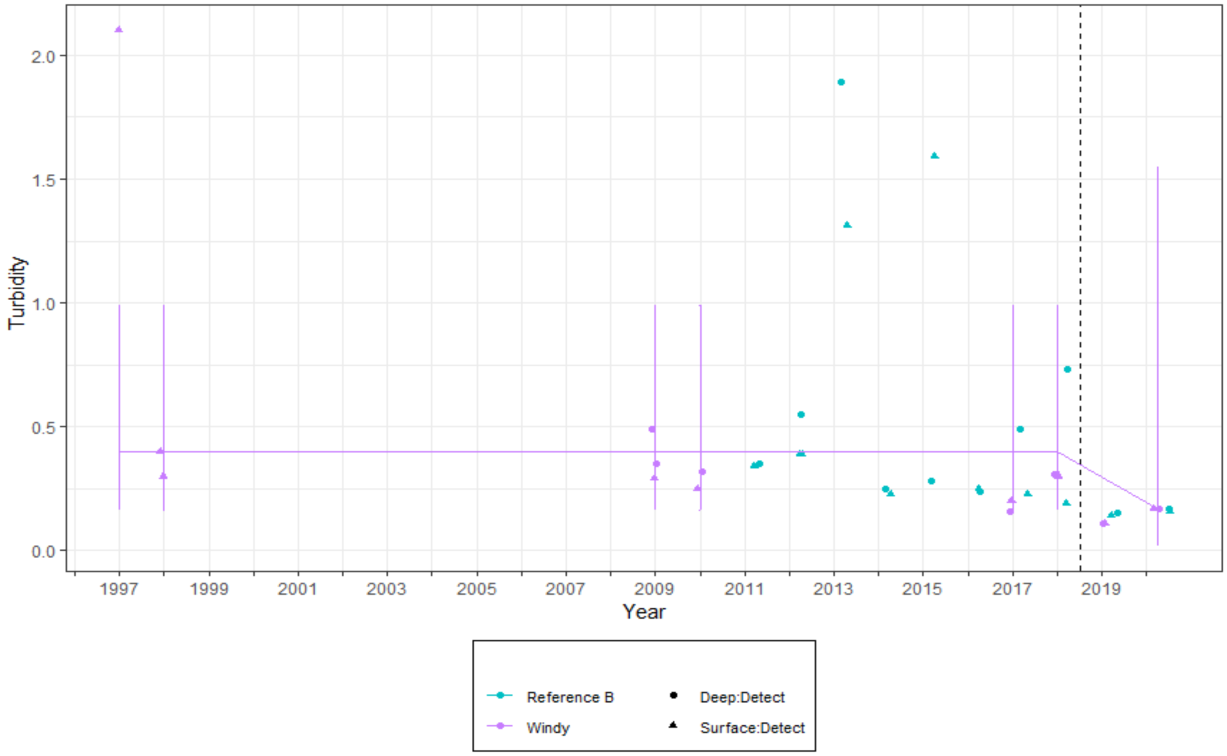
The change in turbidity in Windy Lake from *before* to *after* was not significantly (p = 0.3979) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars

indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.3605	0.4106	5	-0.8781	0.4201	not sig.

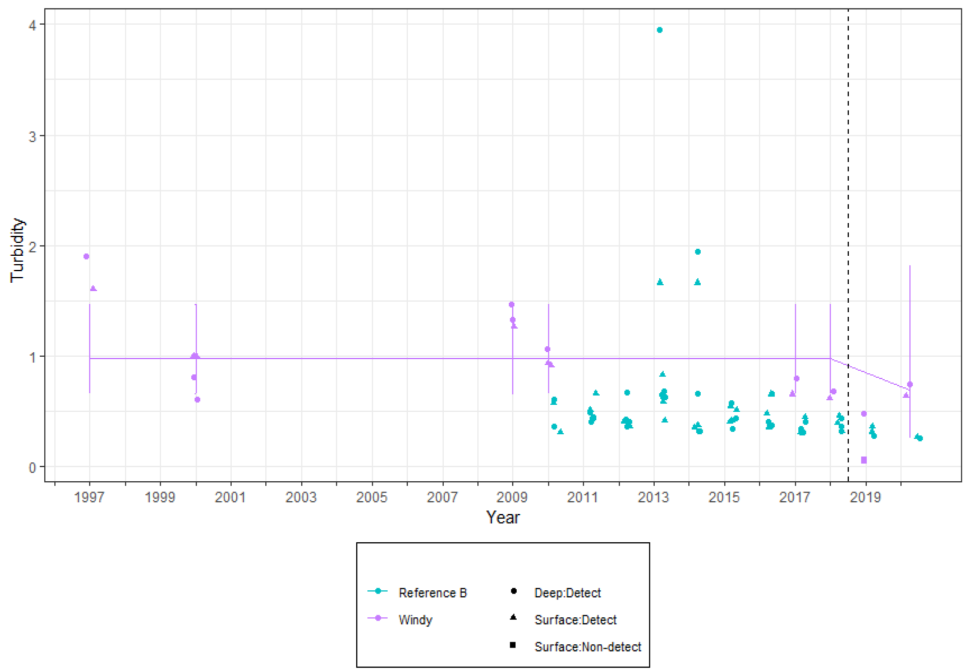
Conclusion:

The change in turbidity in Windy Lake from *before* to *after* was not significantly (p = 0.4201) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

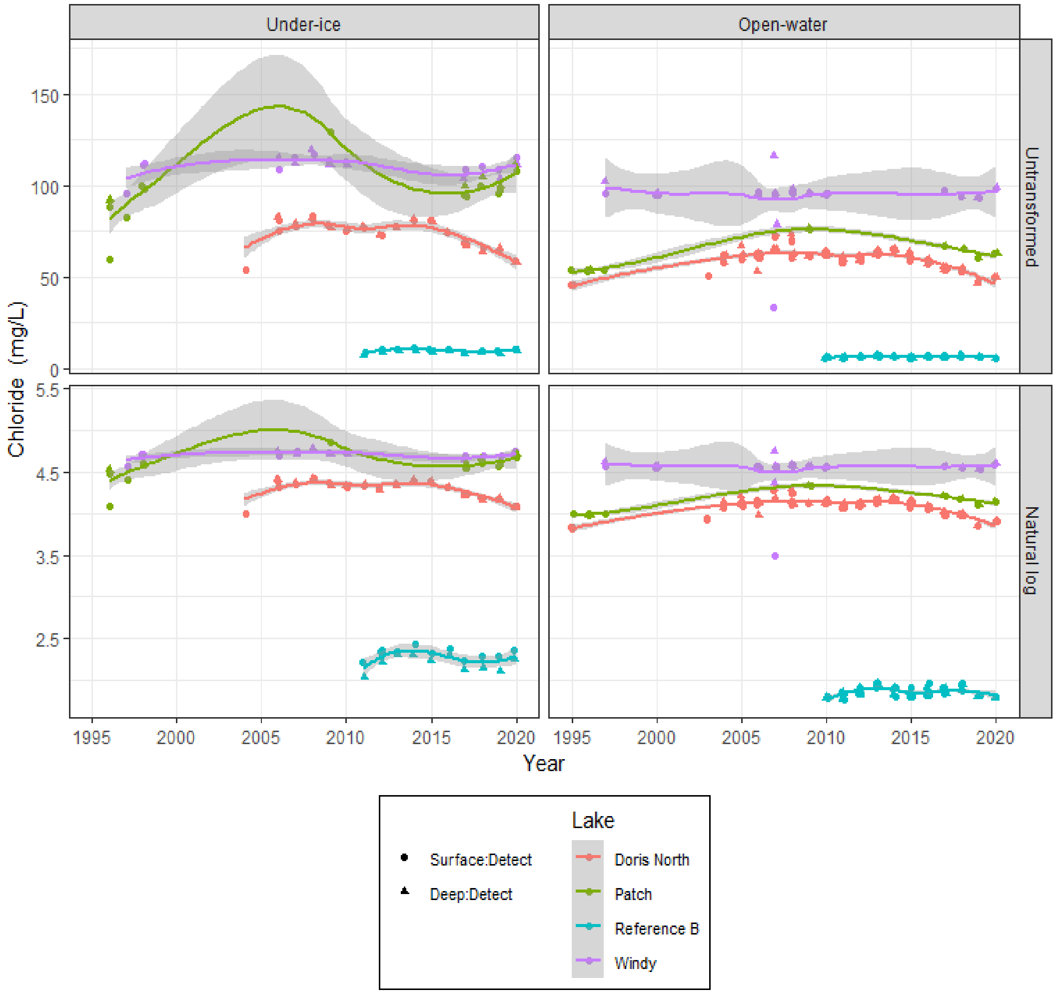
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.4 Chloride

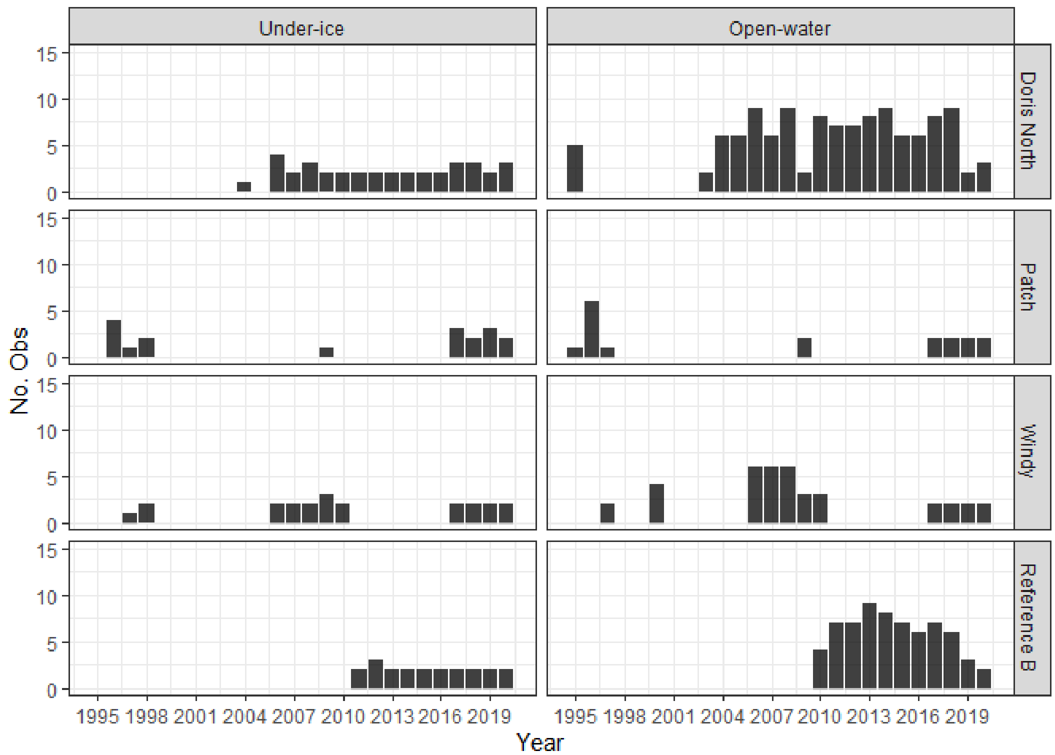
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

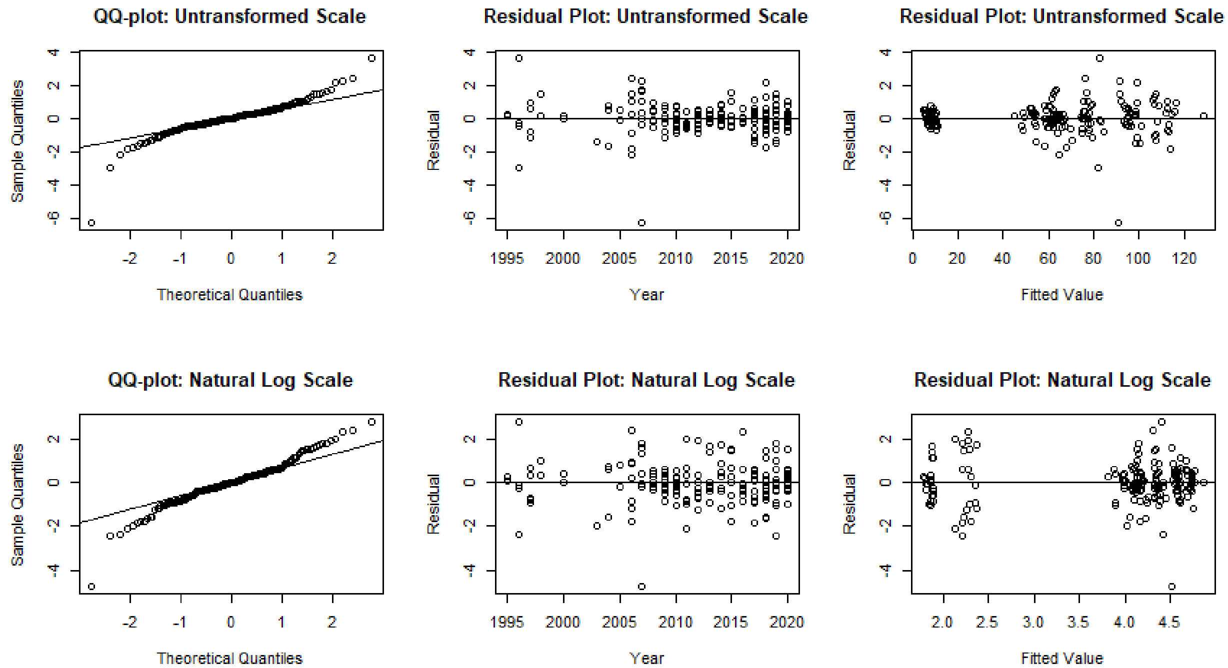
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	37	0	0	0	76.000
Doris North	Open-water	118	0	0	0	61.050
Patch	Under-ice	18	0	0	0	97.950
Patch	Open-water	18	0	0	0	60.600
Reference B	Under-ice	21	0	0	0	9.890
Reference B	Open-water	66	0	0	0	6.395
Windy	Under-ice	22	0	0	0	111.000
Windy	Open-water	38	0	0	0	95.700

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Patch	1996	Under-ice	Deep	91.65	82.37	3.627
Patch	1996	Under-ice	Surface	74.10	81.78	-3.004
Windy	2007	Open-water	Surface	74.57	90.69	-6.302

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Windy	2007	Open-water	Surface	74.57	4.513	-4.756

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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	70.55	4	0.0000
Compare to Reference B	70.97	4	0.0000

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

Open-water

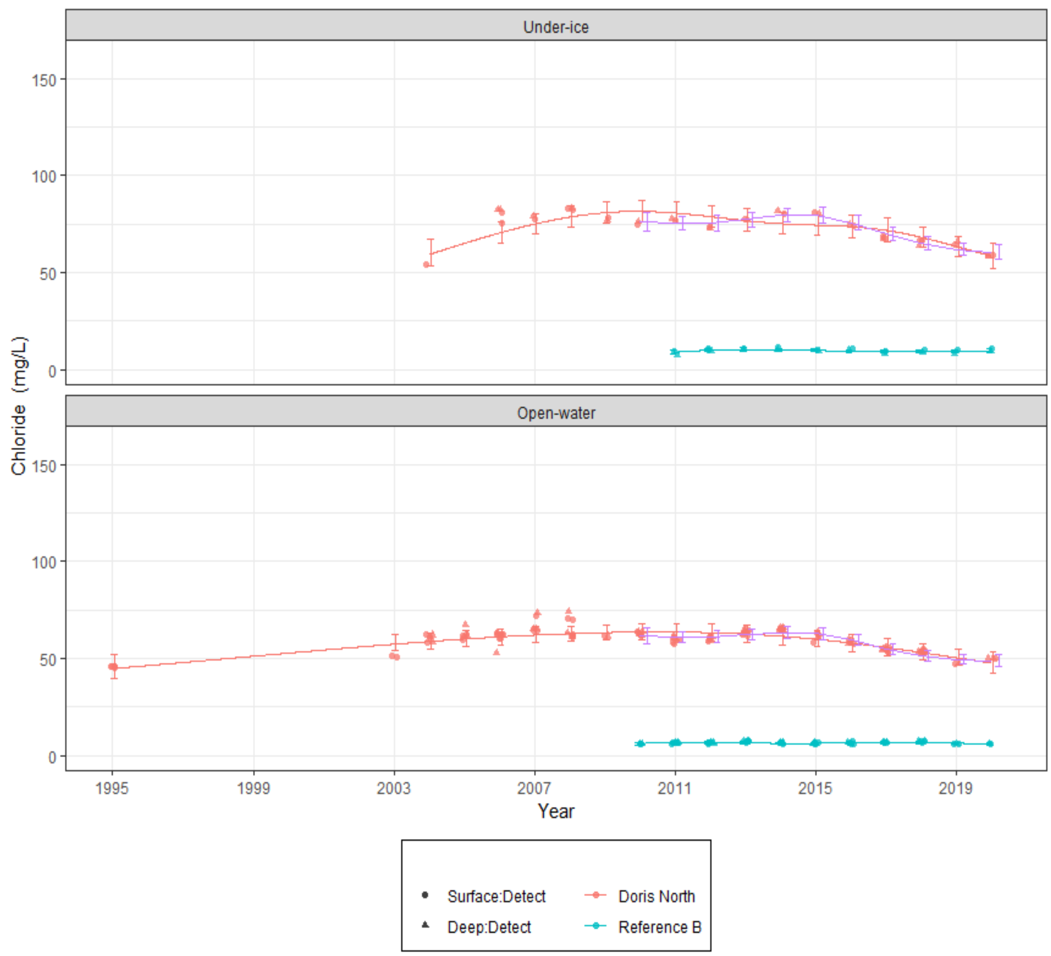
Analysis	Chi.sq	DF	P.value
Compare to slope 0	69.01	4	0.0000
Compare to Reference B	70.42	4	0.0000

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

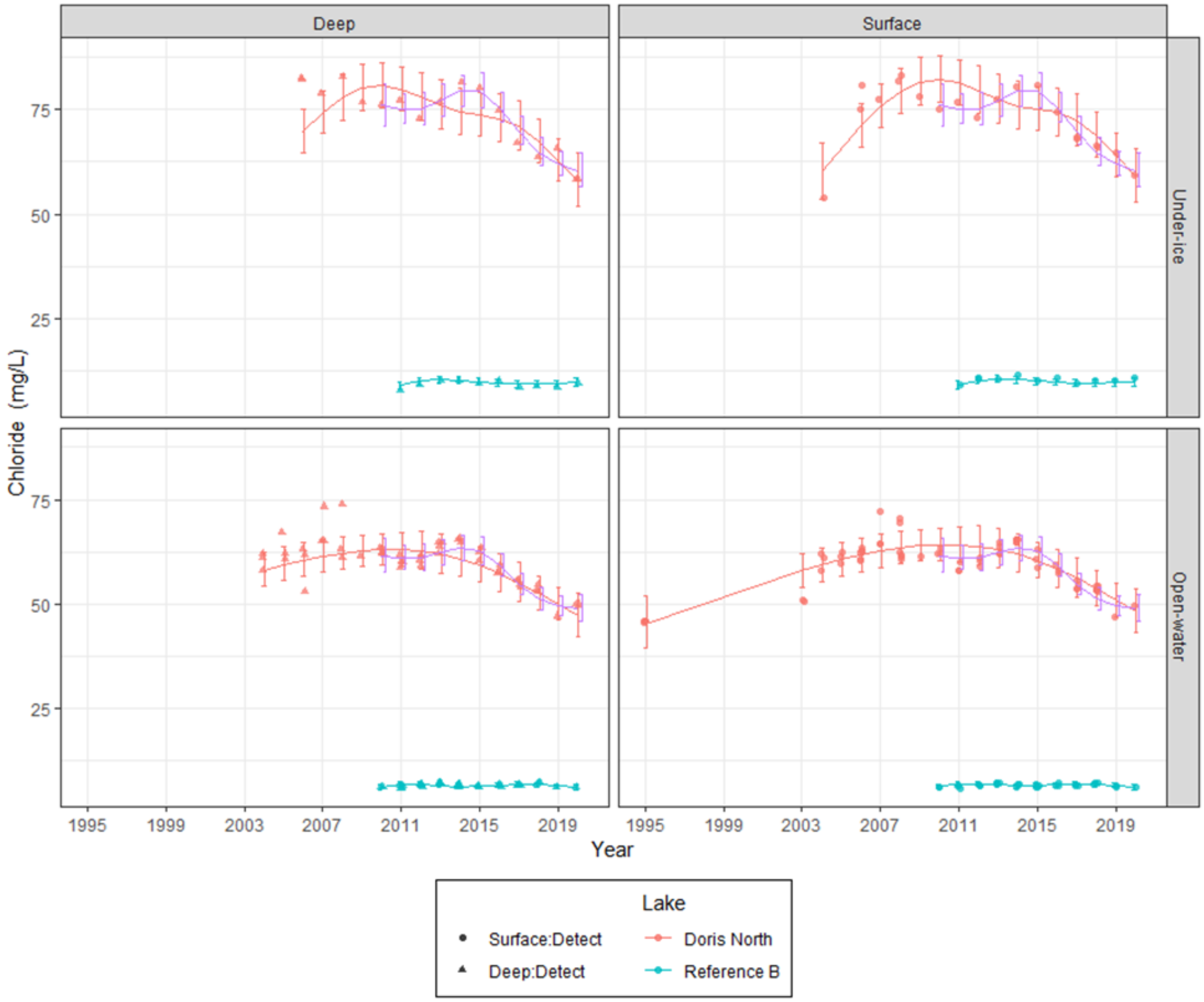
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data; solid purple lines show fitted curves through comparable years of data for comparisons between Doris Lake and Reference B Lake data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0972	0.1829	4.564	0.5323	0.6194	not sig.

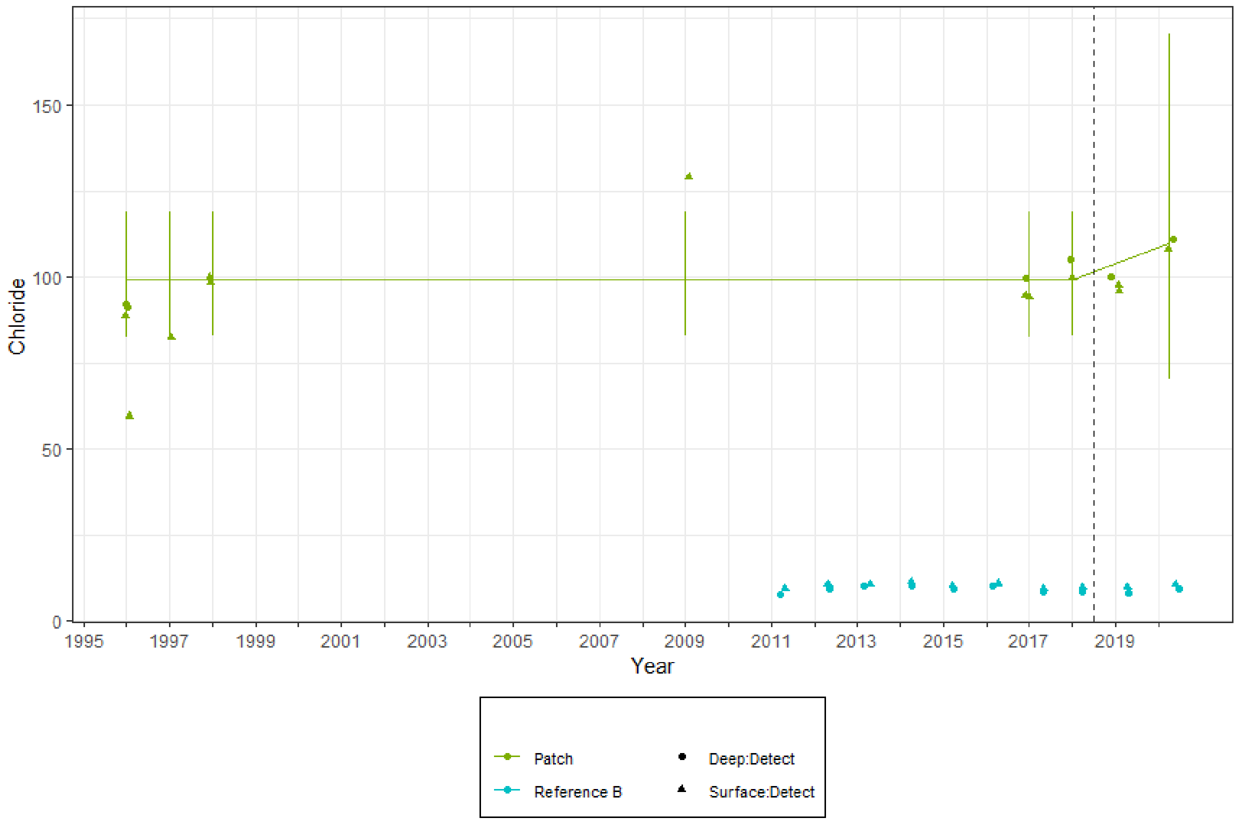
Conclusion:

The change in chloride concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.6194) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0283	0.1595	5	0.1771	0.8664	not sig.

Conclusion:

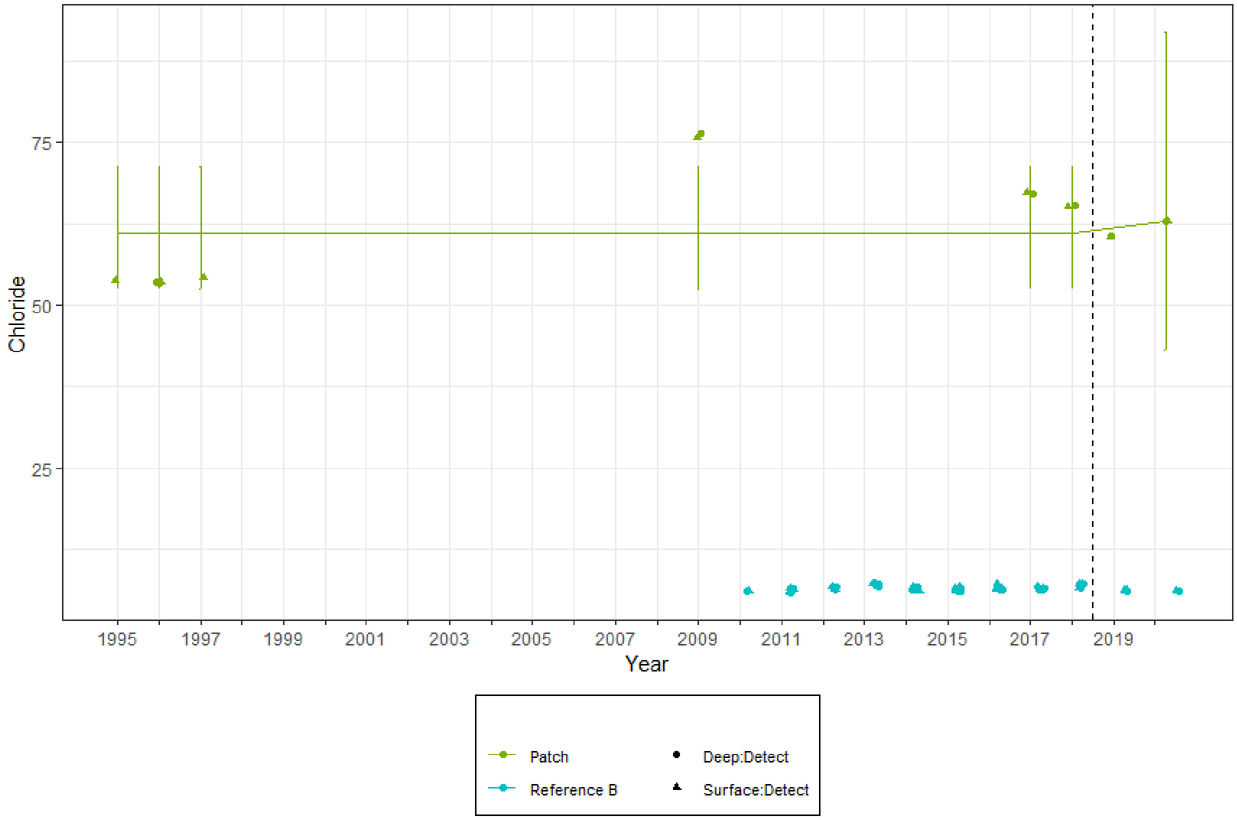
The change in chloride concentrations in Patch Lake from *before* to *after* was not significantly ($p = 0.8664$) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars

indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0291	0.0604	6.925	0.4811	0.6453	not sig.

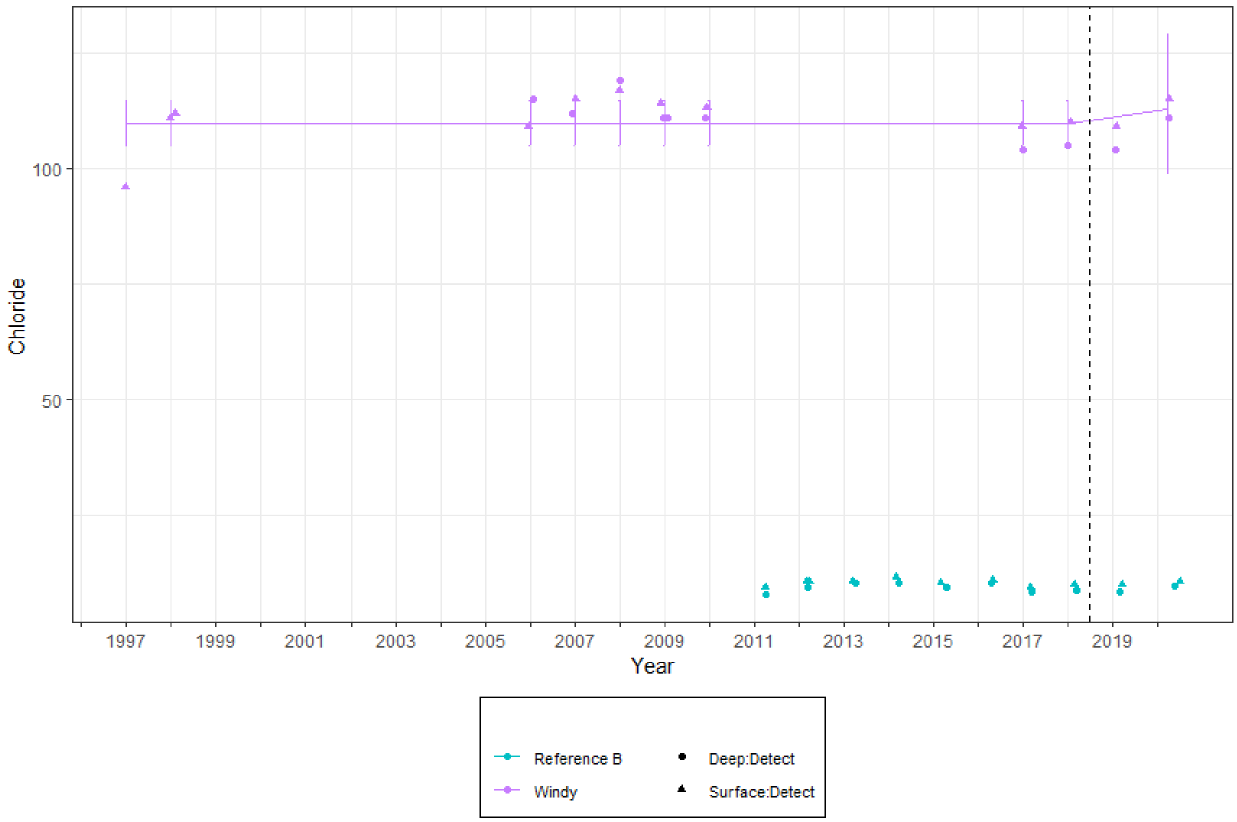
Conclusion:

The change in chloride concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.6453) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0403	0.0453	8	0.8901	0.3994	not sig.

Conclusion:

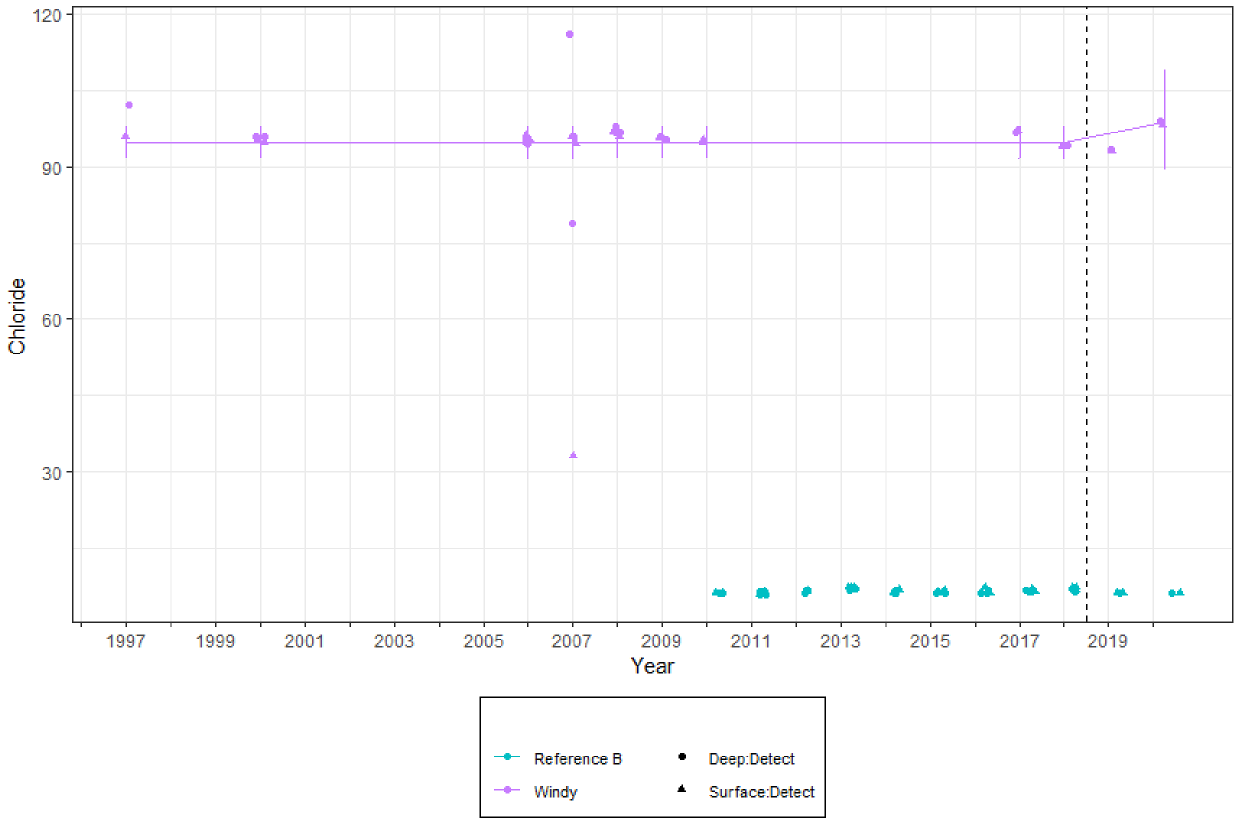
The change in chloride concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.3994) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars

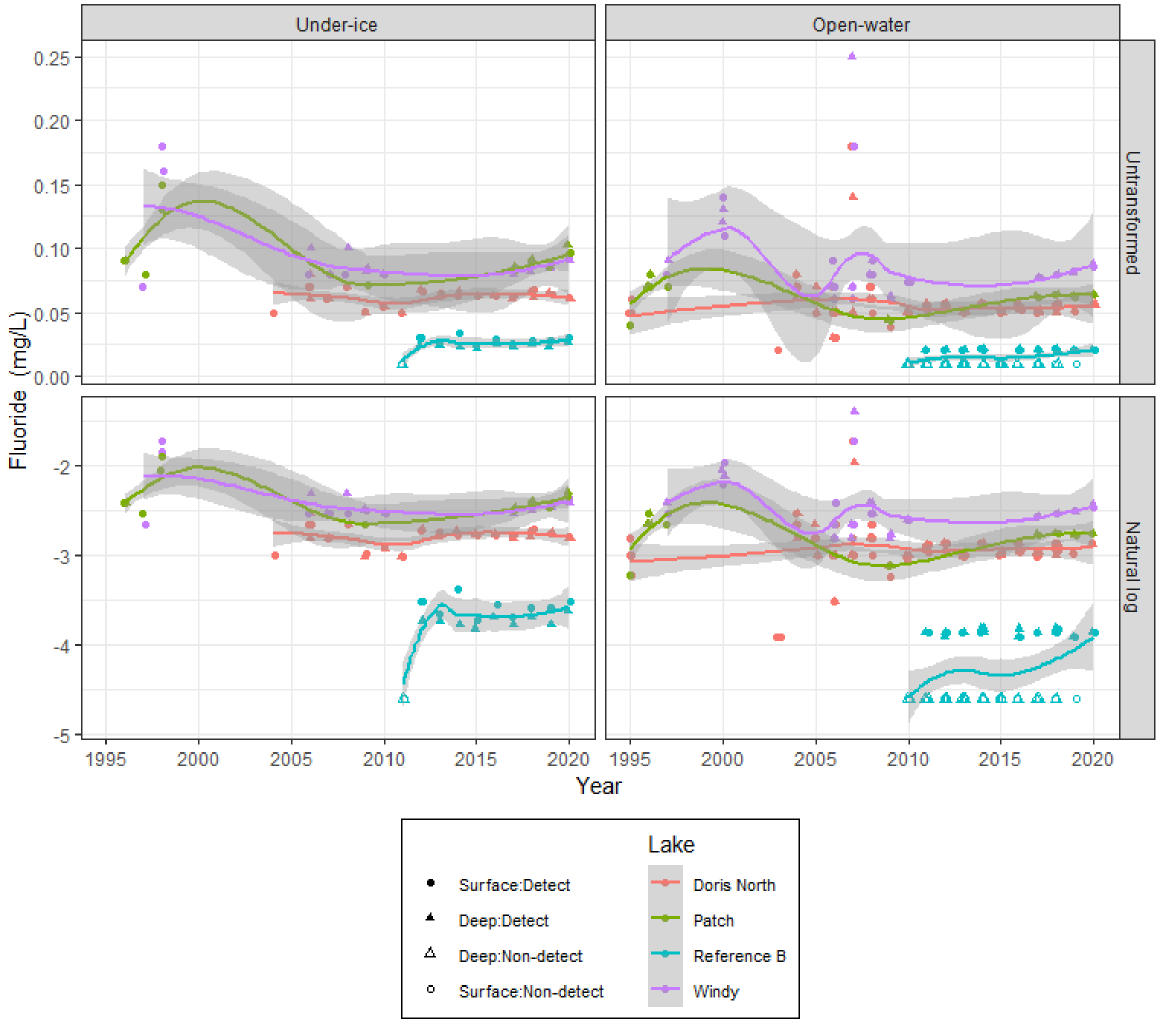
indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.5 Fluoride

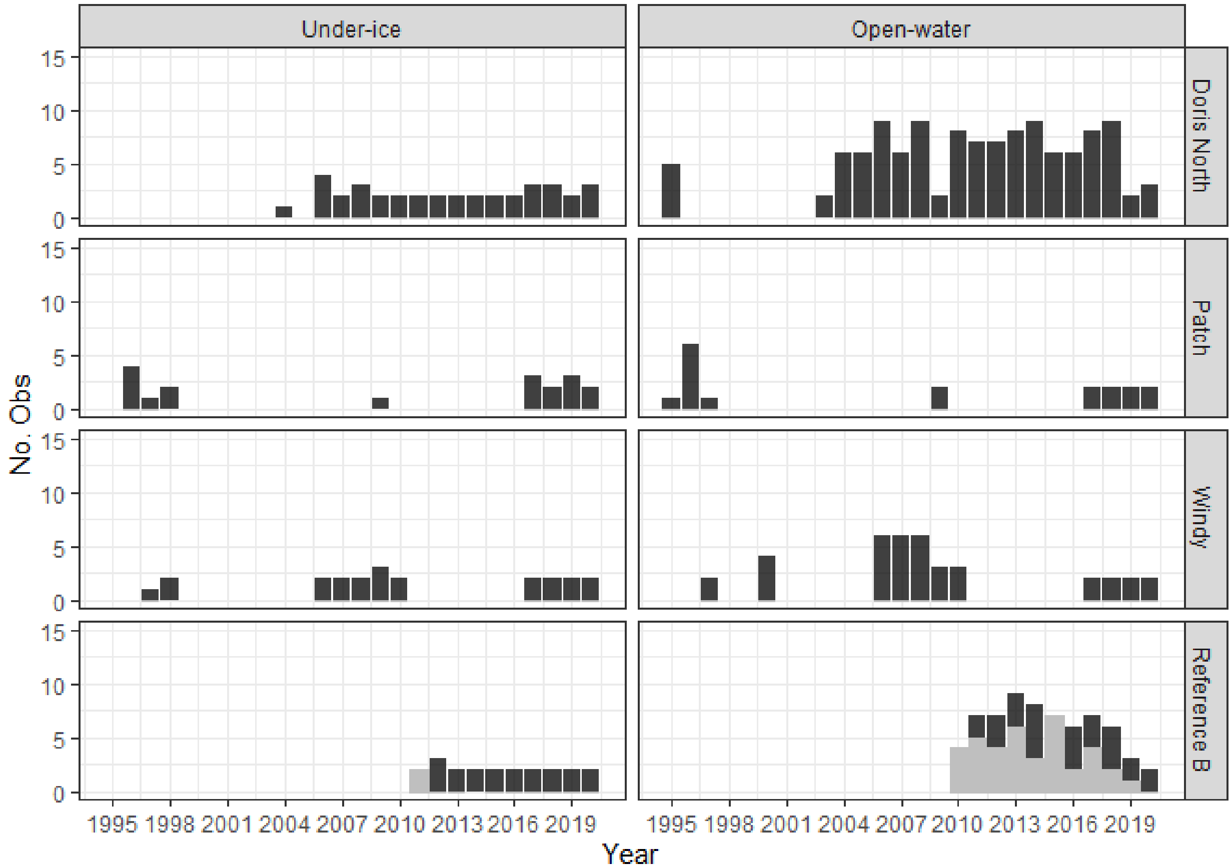
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

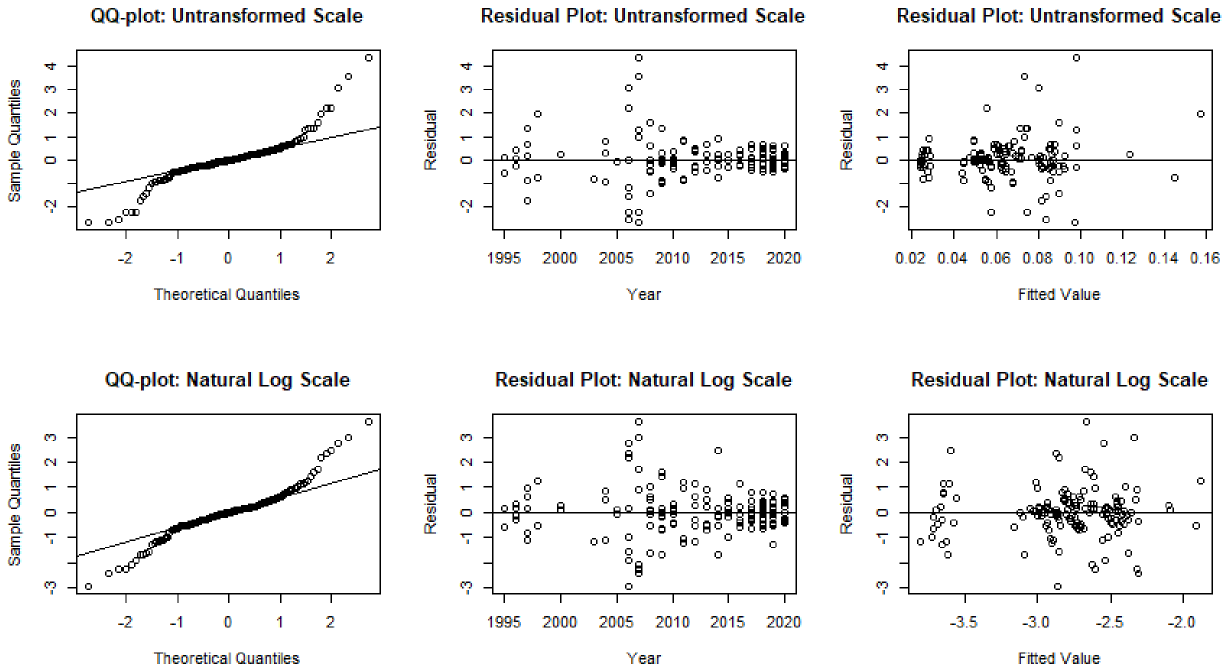
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	37	0	0.00	0	0.0630
Doris North	Open-water	118	0	0.00	0	0.0530
Patch	Under-ice	18	0	0.00	0	0.0900
Patch	Open-water	18	0	0.00	0	0.0640
Reference B	Under-ice	21	2	0.10	0	0.0250
Reference B	Open-water	66	38	0.58	0	0.0200
Windy	Under-ice	22	0	0.00	0	0.0830
Windy	Open-water	38	0	0.00	0	0.0795

More than 50% of data under detection limit in Reference B open-water. Data from those site-season groupings will be removed from the analysis. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris North	2007	Open-water	Surface	0.0967	0.074	3.550
Windy	2006	Under-ice	Deep	0.1000	0.080	3.078
Windy	2007	Open-water	Deep	0.1267	0.098	4.379

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2007	Open-water	Surface	0.0967	-2.666	3.605

The natural log-transformed data 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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	6.771	4	0.1485

Doris Lake does not exhibit significant deviation from no trend.

Open-water

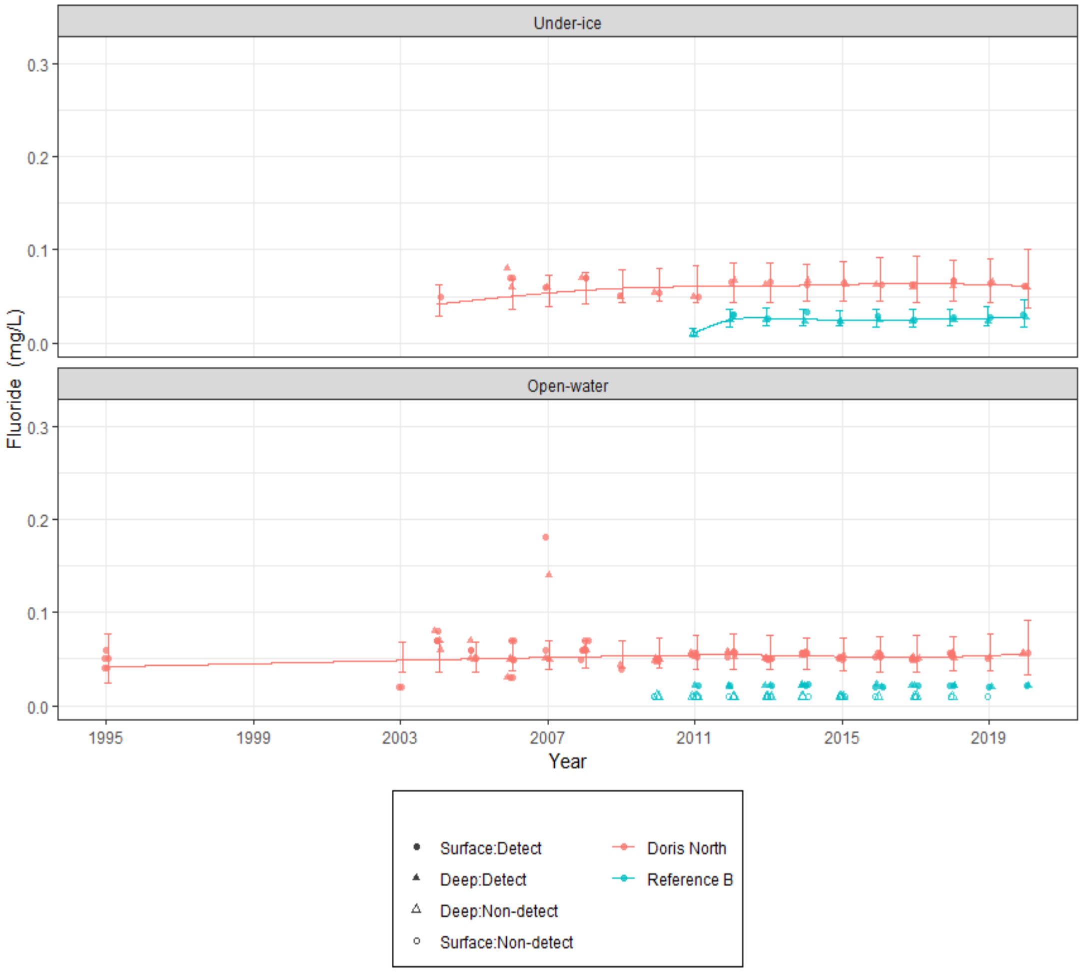
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.24	4	0.8715

Doris Lake does not exhibit significant deviation from no trend.

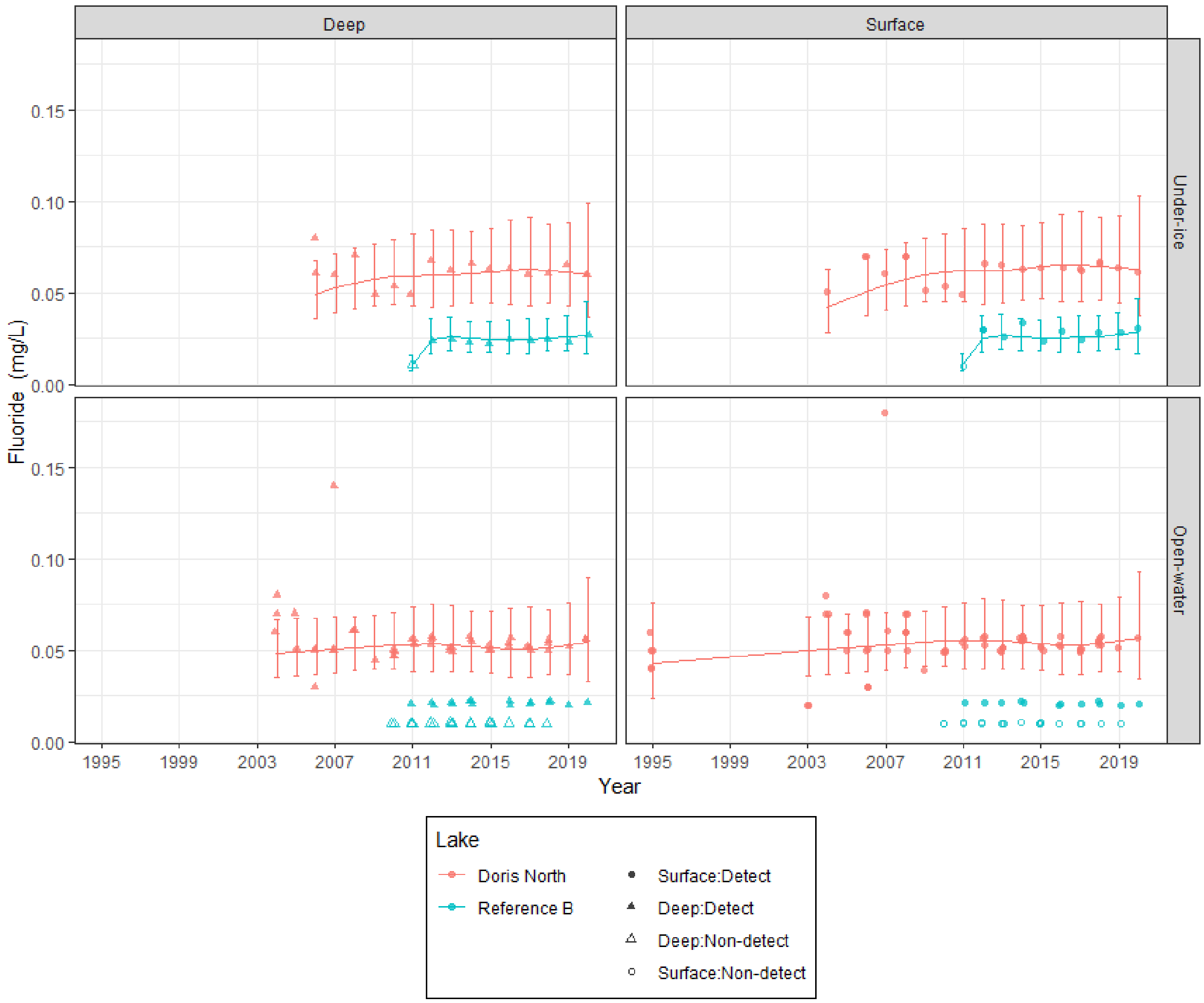
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of observed and fitted data averaged over depth.


Under-ice
Open-water
Fluoride (mg/L)
0.0
0.1
0.2
0.3
1995
1999
2003
2007
2011
2015
2019
Year
Surface:Detect
Deep:Detect
Deep:Non-detect
Surface:Non-detect
Doris North
Reference B

Plot of observed and fitted data separated by depth.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0833	0.2513	4.974	0.3317	0.7536	not sig.

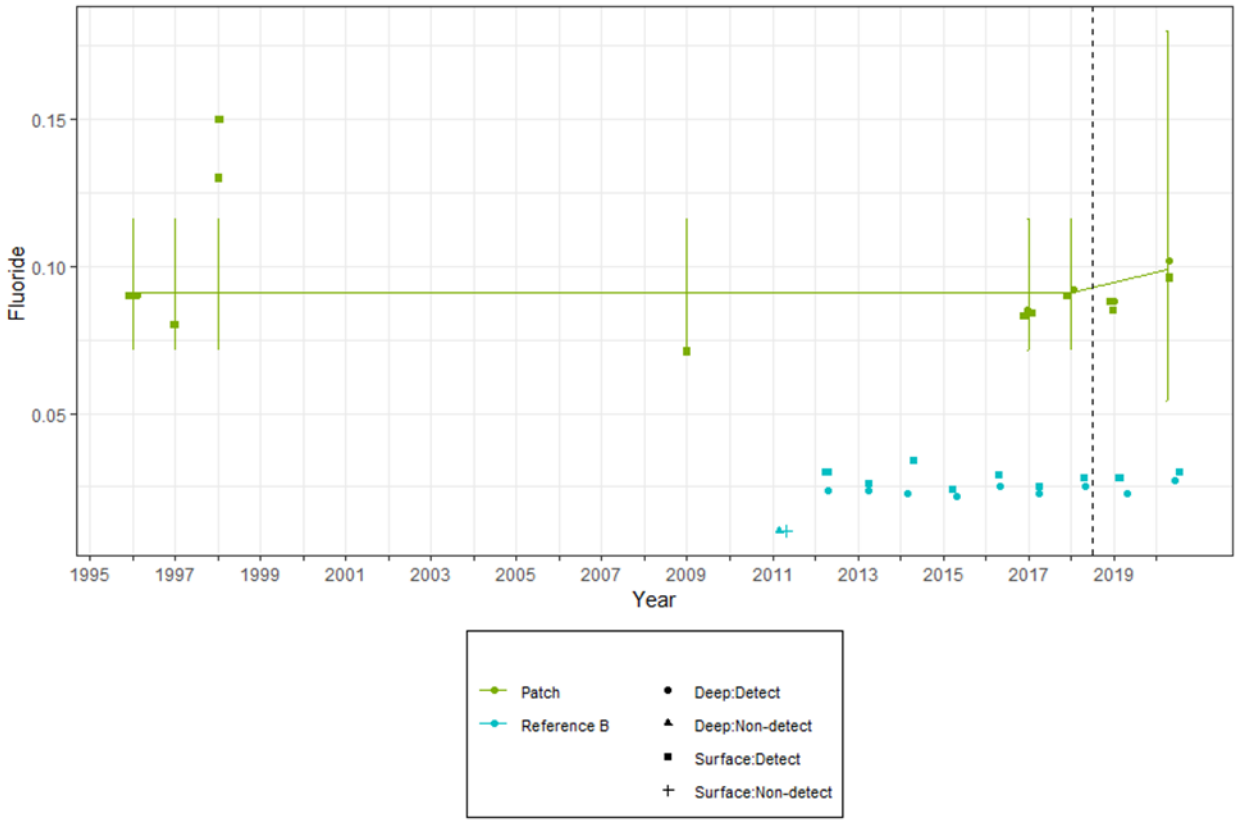
Conclusion:

The change in fluoride concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.7536) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.1067	0.2744	4.994	0.389	0.7133	not sig.

Conclusion:

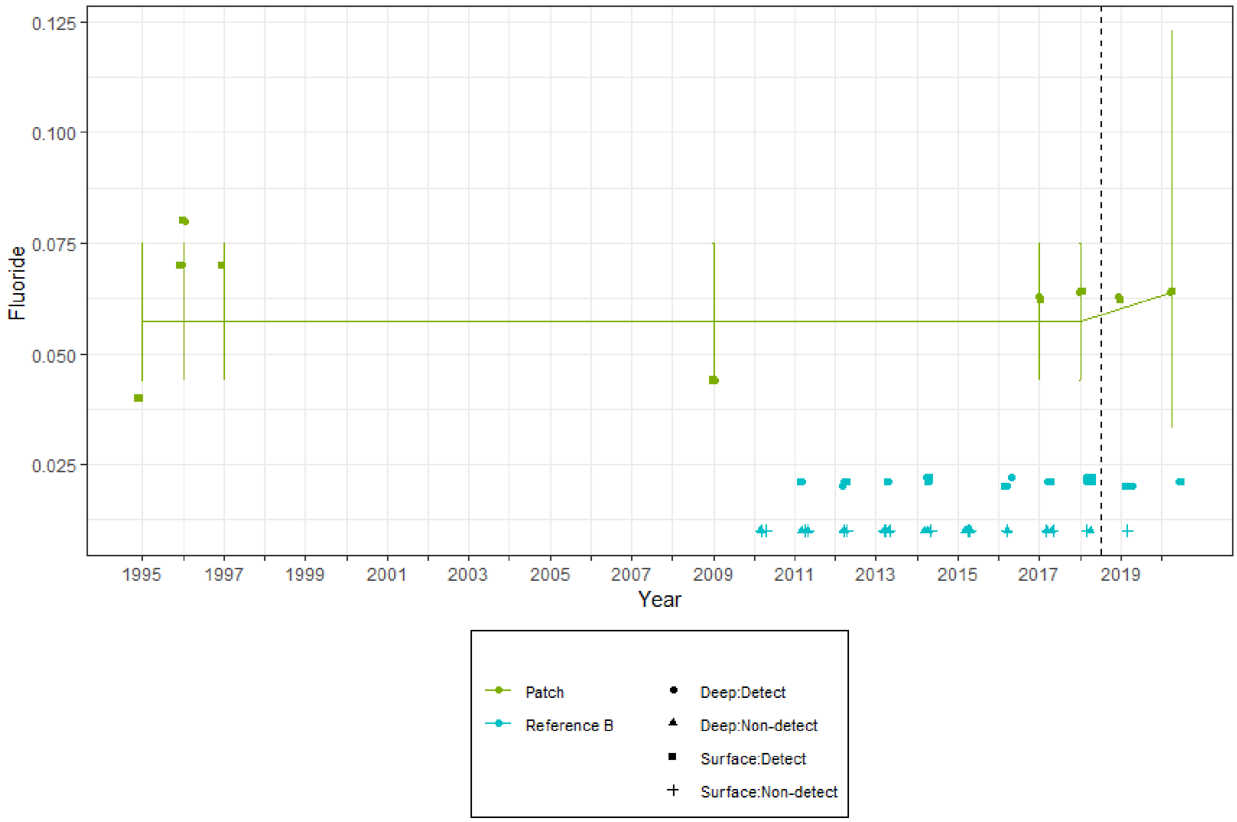
The change in fuoride concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.7133) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars

indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0333	0.2583	7.044	0.1289	0.901	not sig.

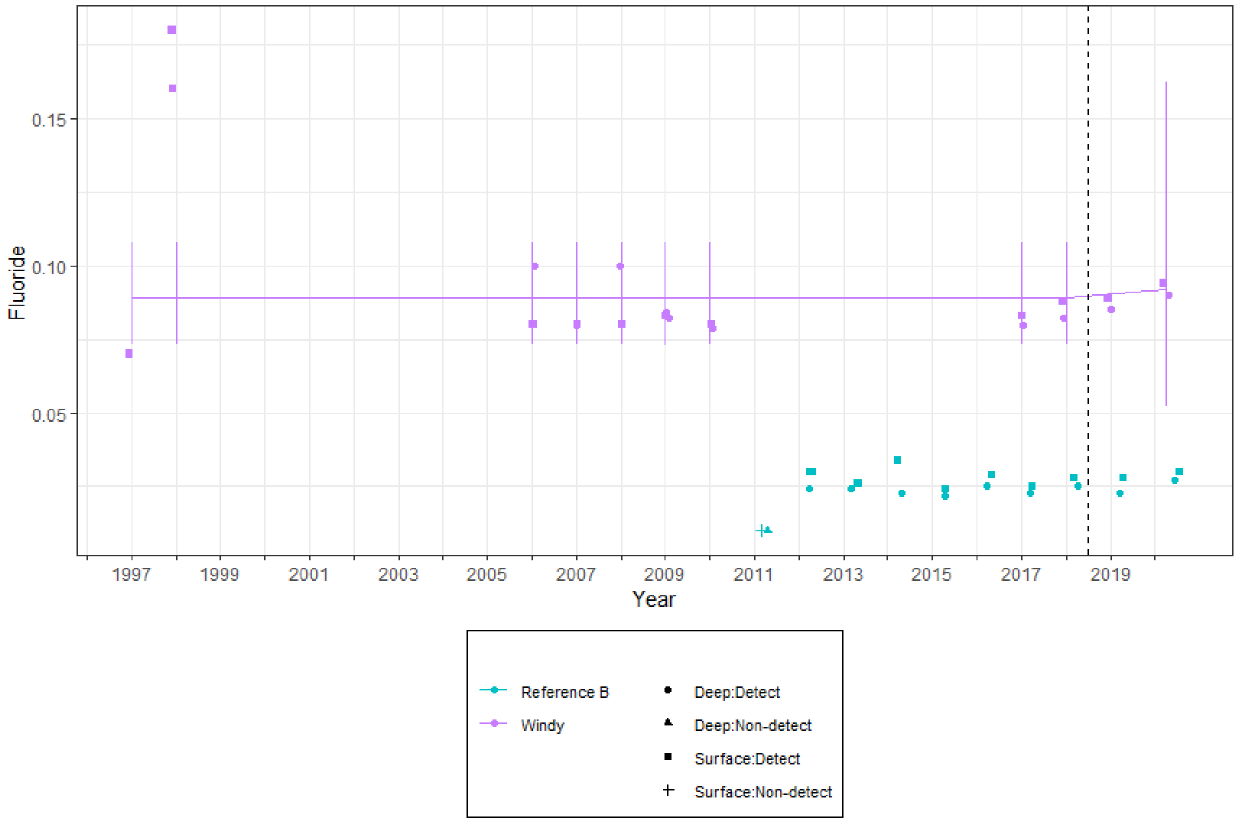
Conclusion:

The change in fluoride concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.901) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0317	0.2414	8	0.1311	0.8989	not sig.

Conclusion:

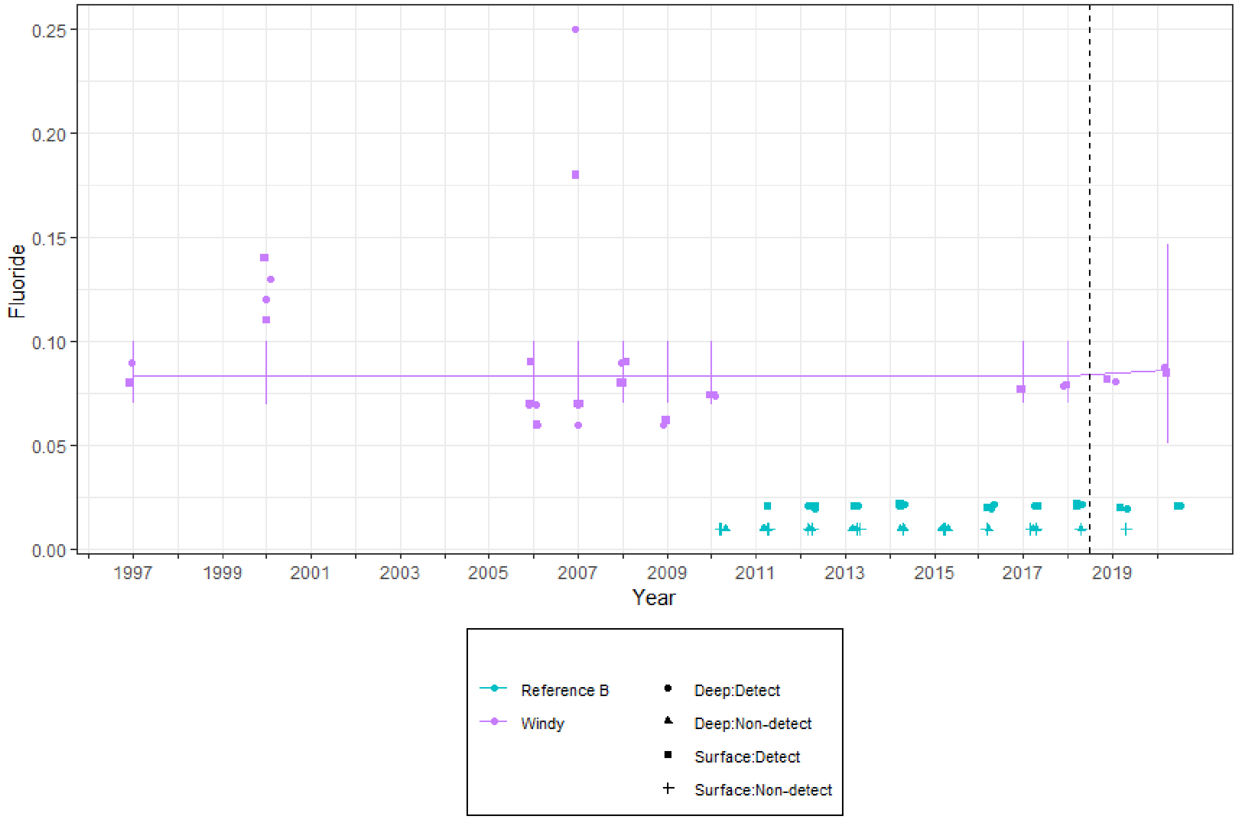
The change in fluoride concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.8989) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

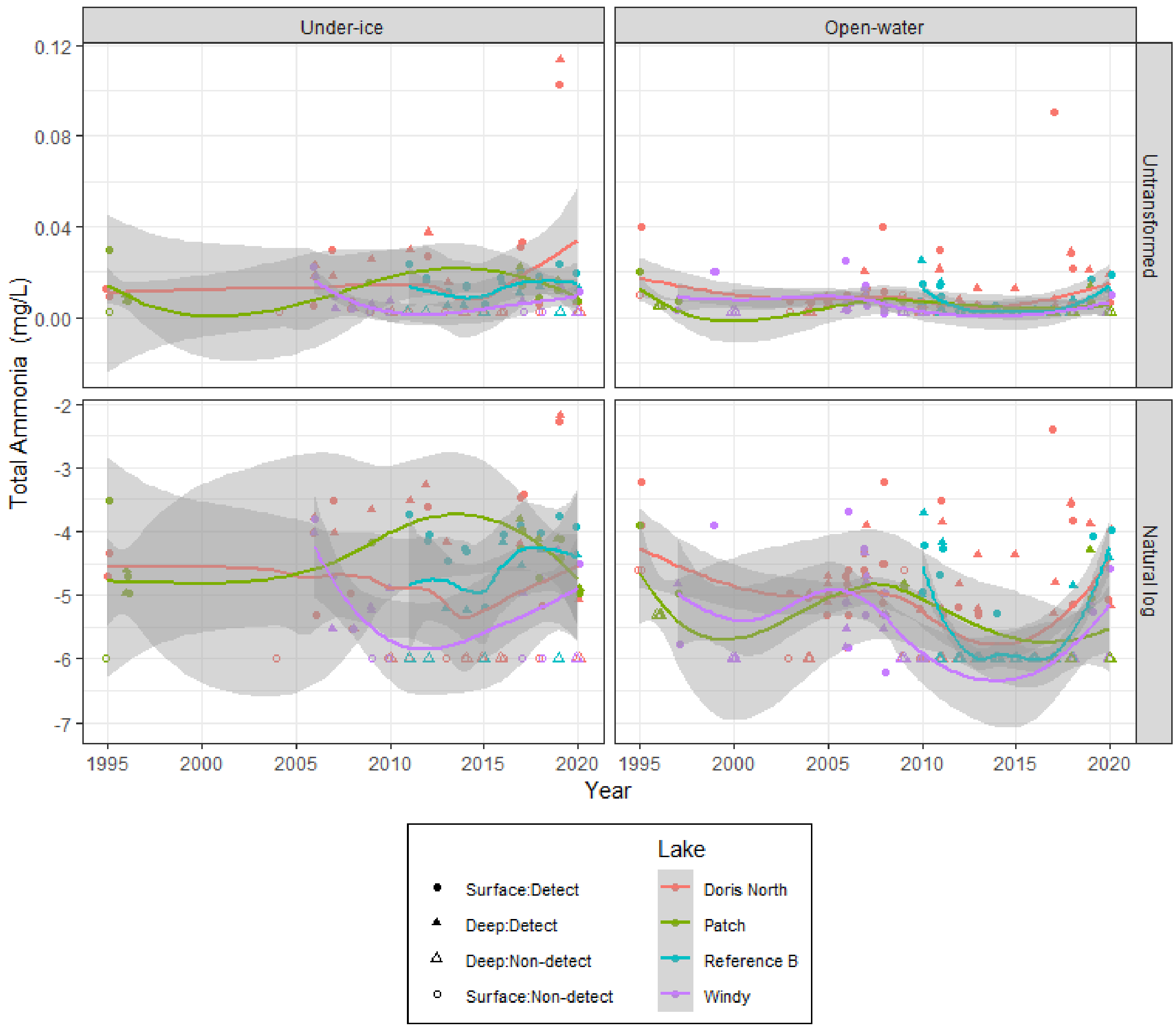
after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.6 *Total Ammonia*

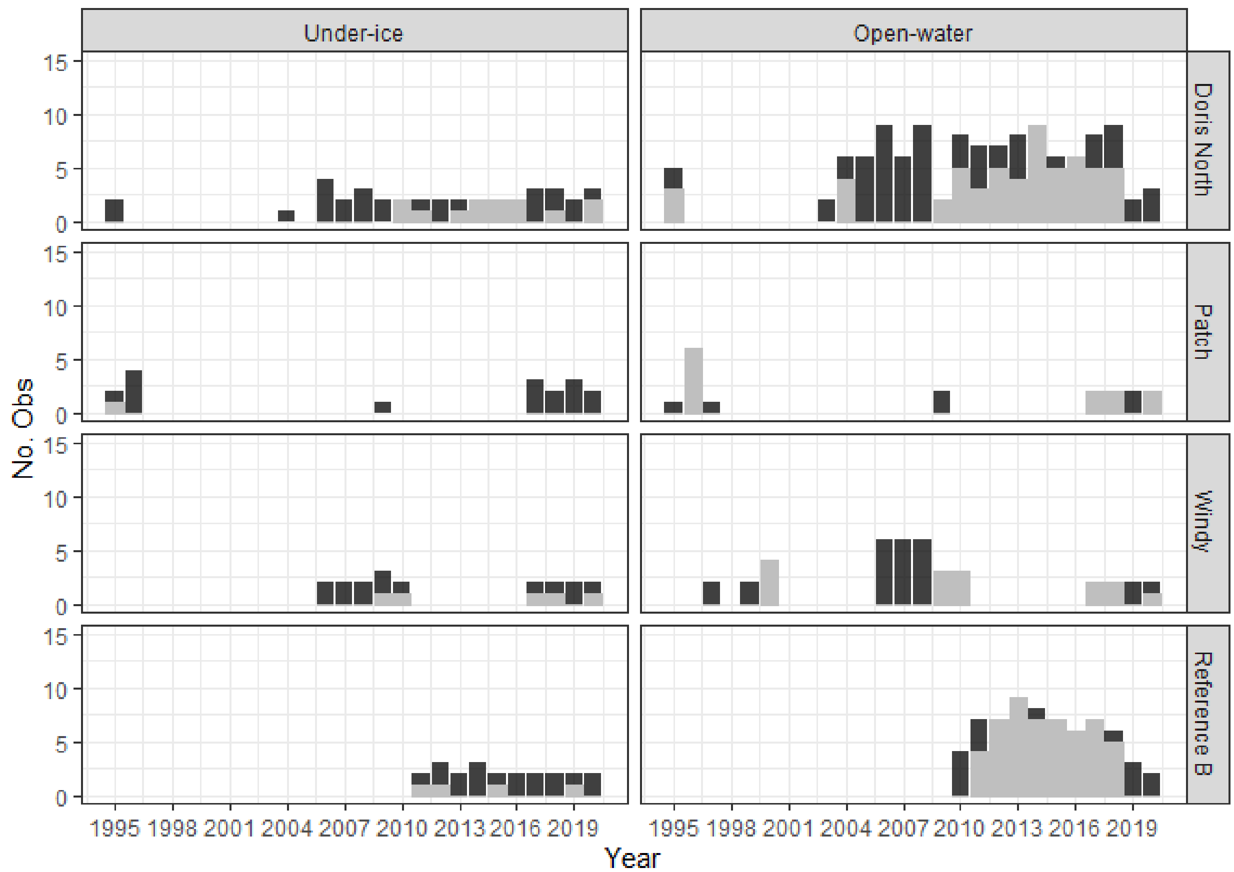
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

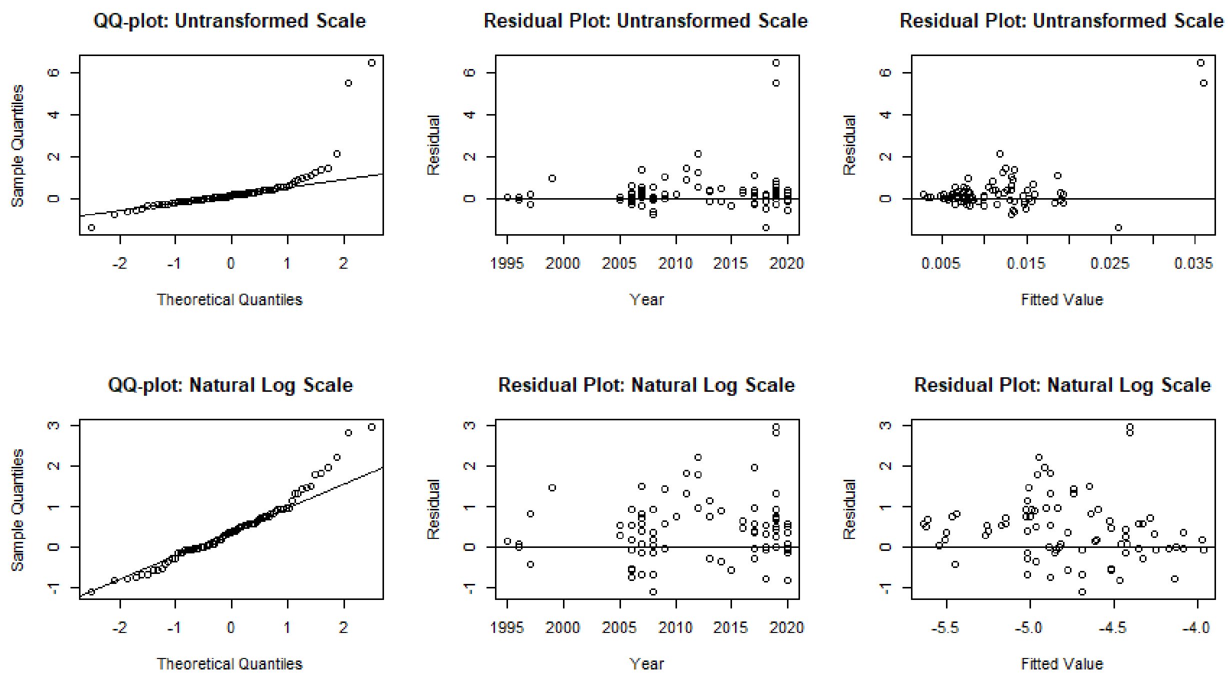
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	39	15	0.38	0.67	0.0063
Doris North	Open-water	118	57	0.48	0.00	0.0050
Patch	Under-ice	17	1	0.06	0.00	0.0122
Patch	Open-water	18	12	0.67	1.00	0.0078
Reference B	Under-ice	22	4	0.18	0.00	0.0136
Reference B	Open-water	66	52	0.79	0.00	0.0050
Windy	Under-ice	19	5	0.26	0.50	0.0056
Windy	Open-water	40	15	0.38	0.50	0.0050

More than 50% of data under detection limit Patch open-water and Reference B open-water. Data from those site-season groupings will be removed from the analysis. Doris under-ice, Doris open-water, Reference B under-ice, Windy under-ice, and Windy open-water exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris. The analysis proceeds with linear mixed effects regression for Patch and Windy.

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 fitted model 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
Doris North	2019	Under-ice	Deep	0.114	0.036	6.492
Doris North	2019	Under-ice	Surface	0.103	0.036	5.549

Outliers on natural log scale: None

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

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	2.279	4	0.6846

Doris Lake does not exhibit significant deviation from no trend.

Open-water

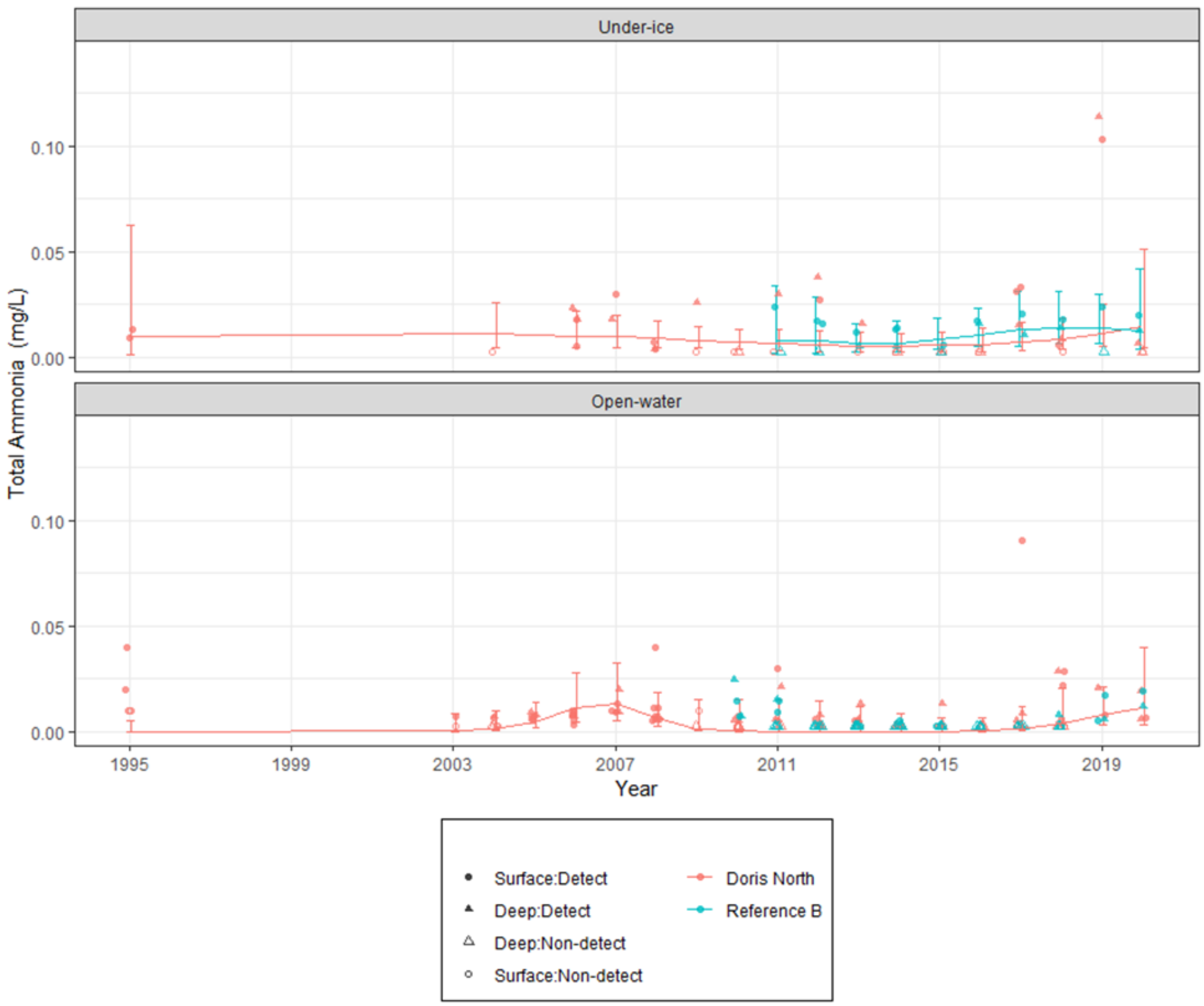
Analysis	Chi.sq	DF	P.value
Compare to slope 0	4.854	4	0.3026

Doris Lake does not exhibit significant deviation from no trend.

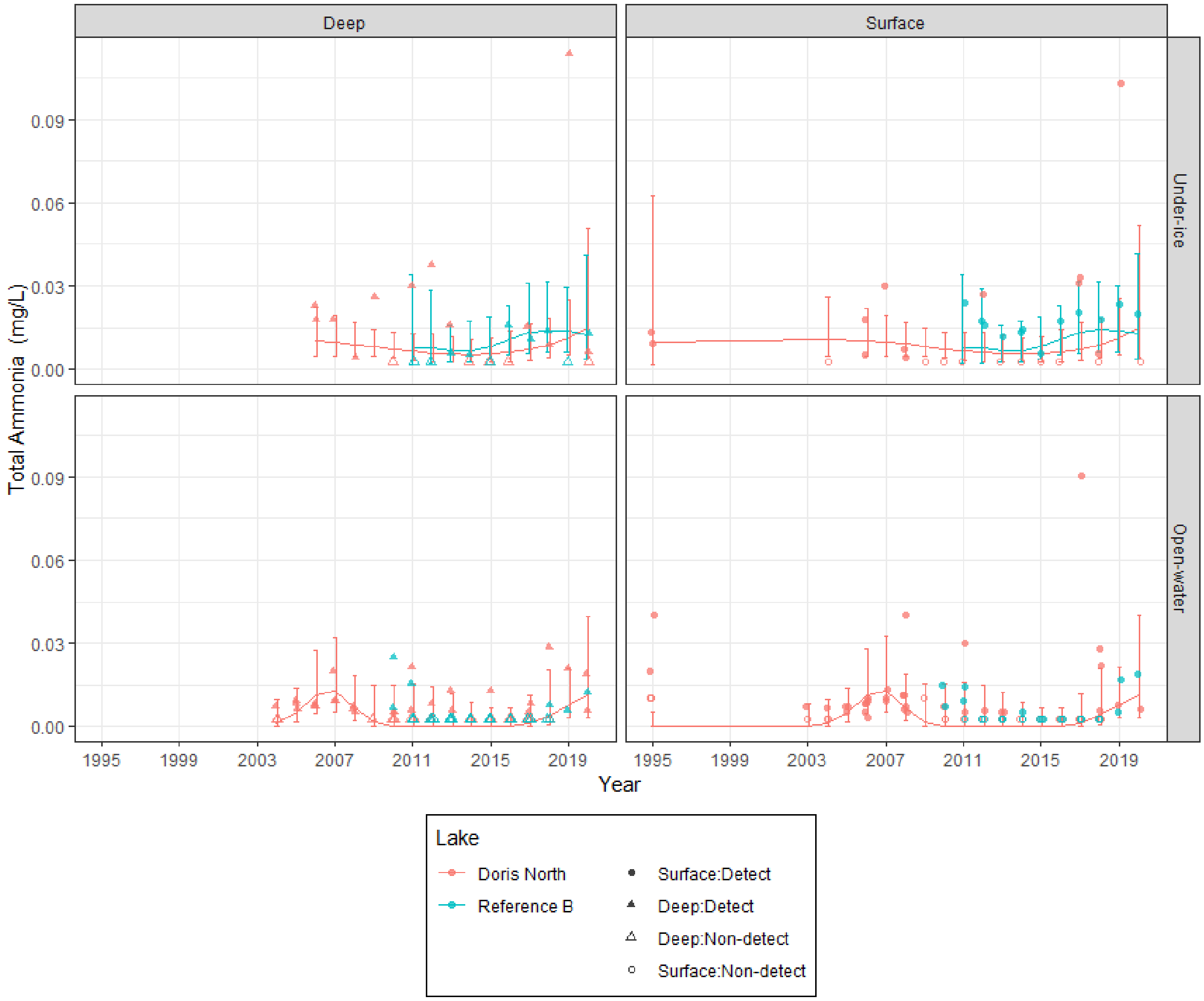
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.667	0.3973	3.843	-1.679	0.1714	not sig.

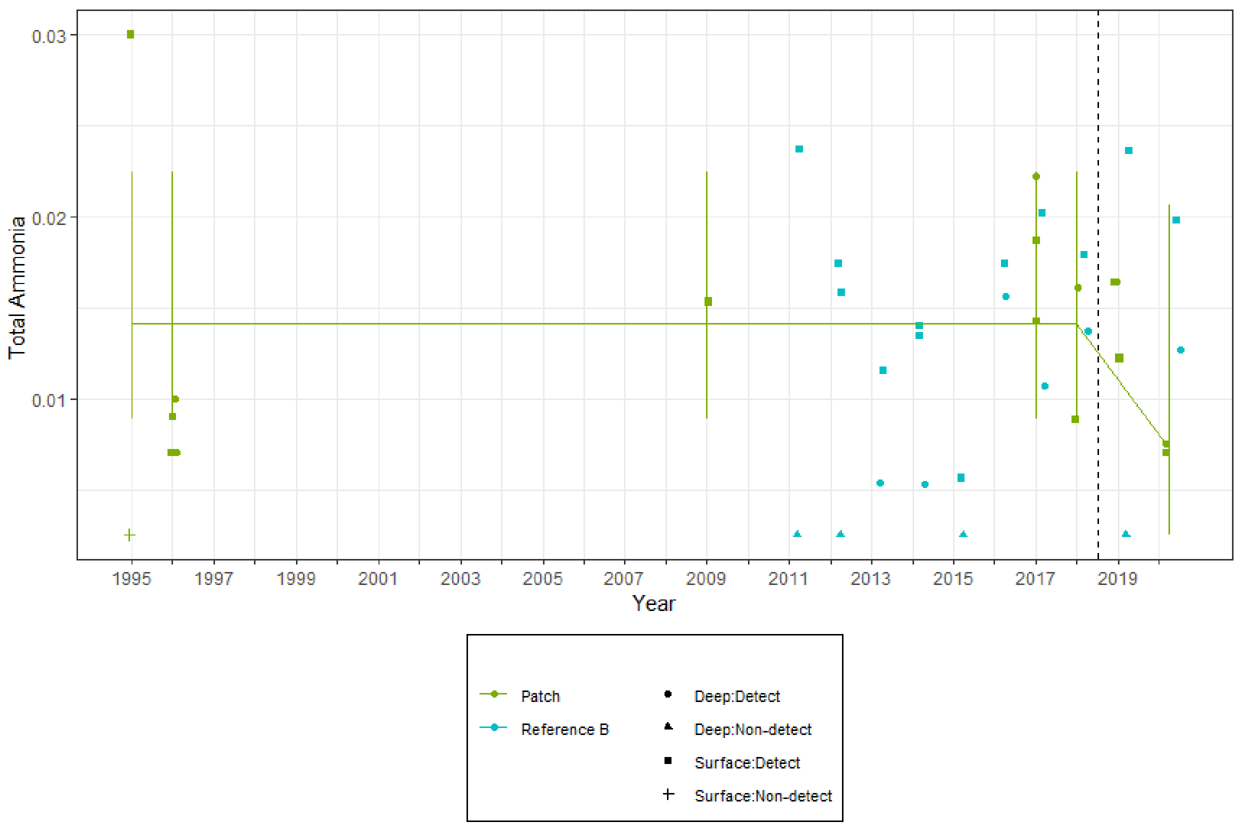
Conclusion:

The change in total Ammonia concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.1714) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Analysis not performed.

Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.0427	0.6303	6	-0.0678	0.9482	not sig.

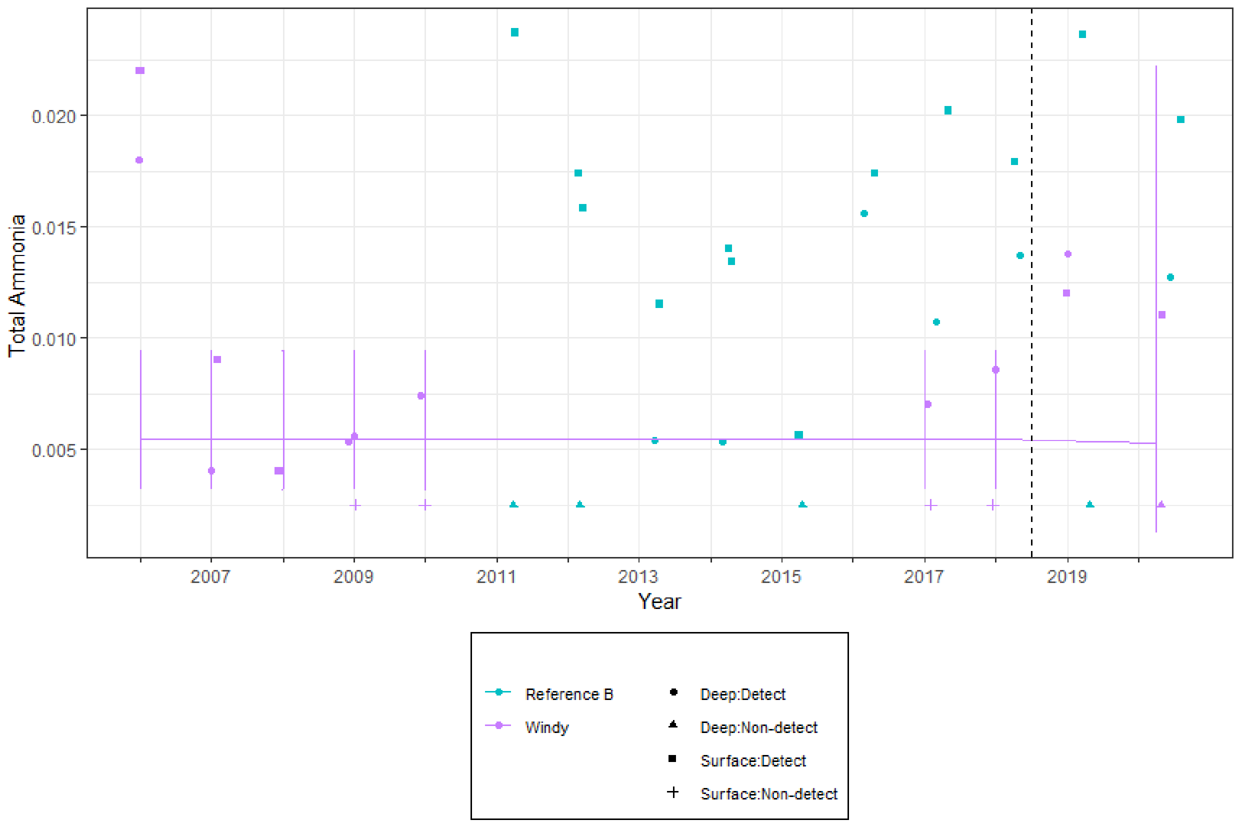
Conclusion:

The change in total ammonia concentrations in Windy Lake from *before* to *after* was not significantly ($p = 0.9482$) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.1594	0.68	7.334	0.2344	0.8211	not sig.

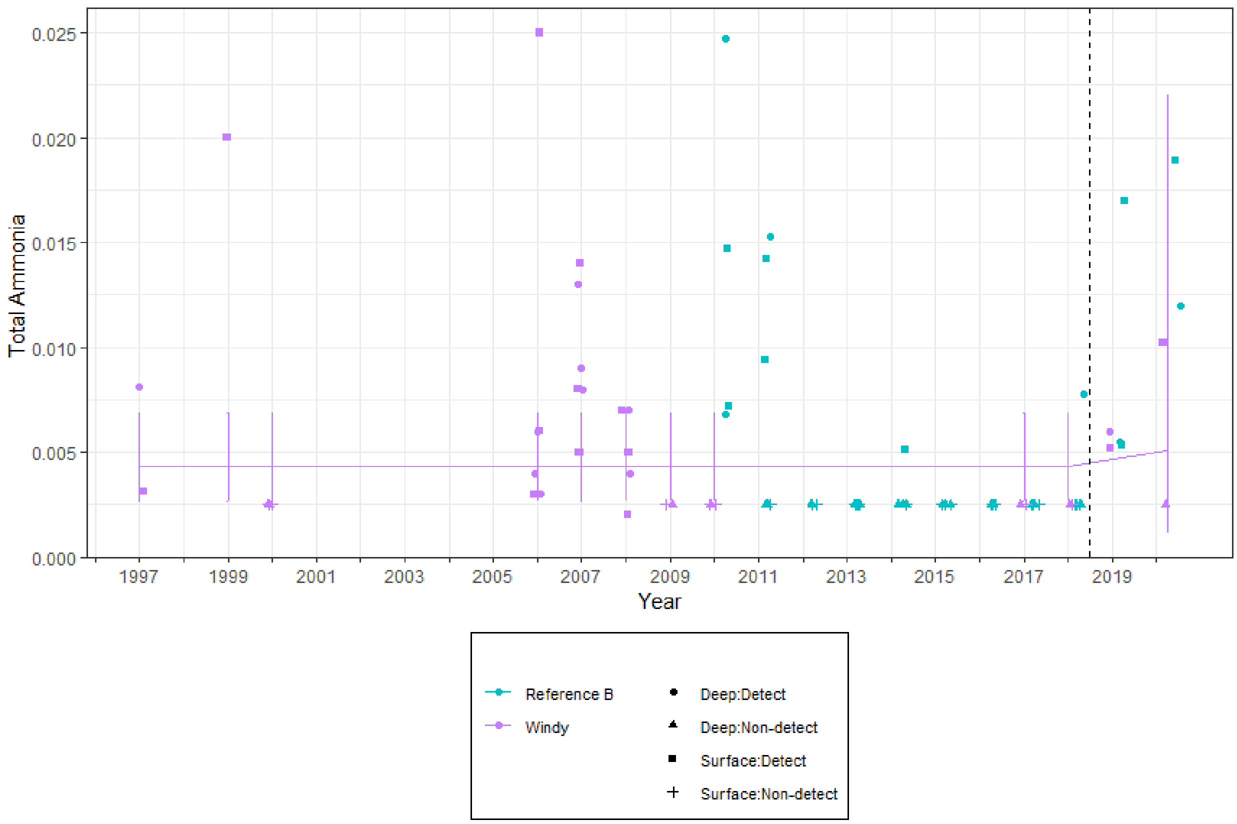
Conclusion:

The change in total ammonia concentrations in Windy Lake from *before* to *after* was not significantly ($p = 0.8211$) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

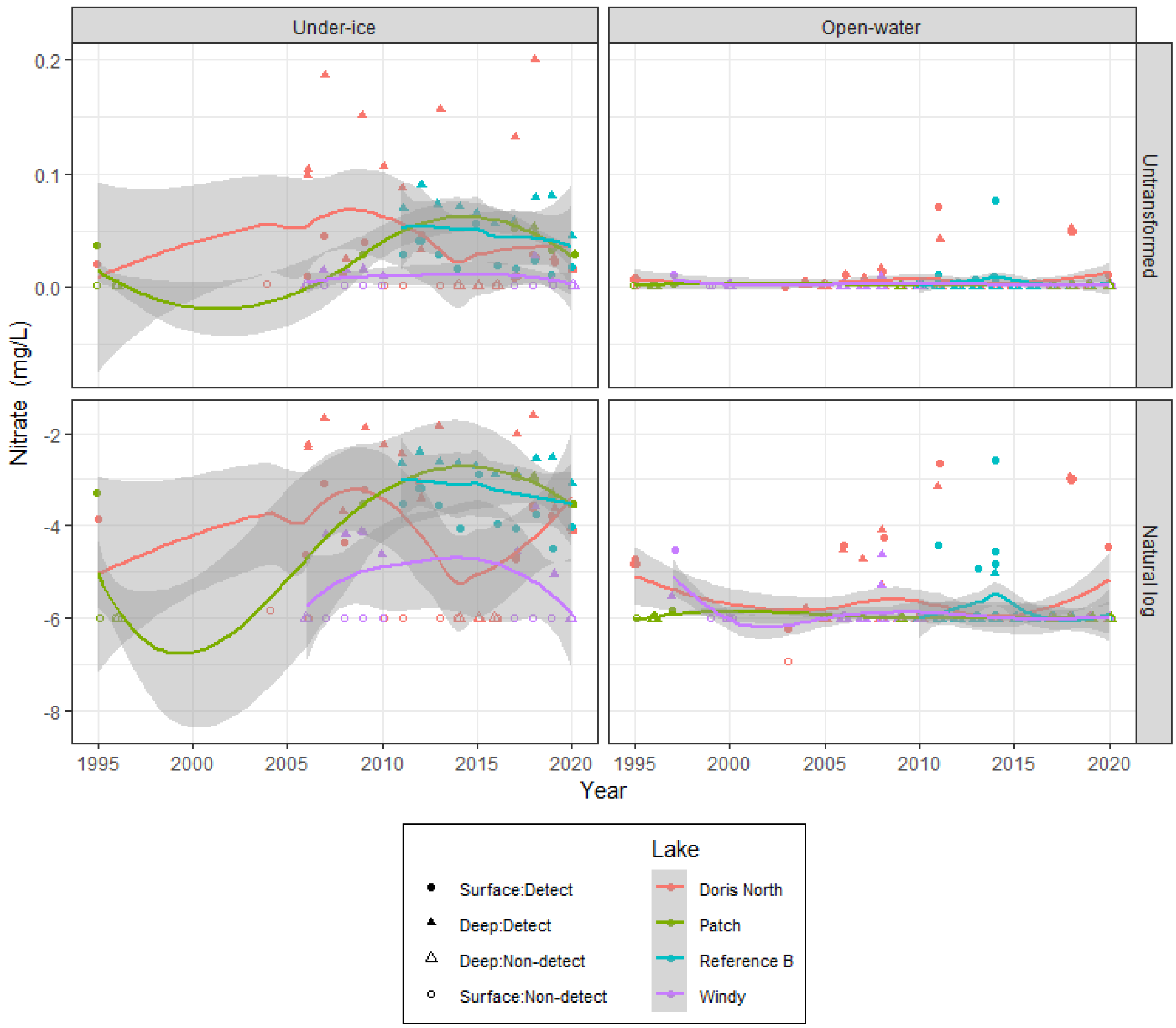
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.7 Nitrate

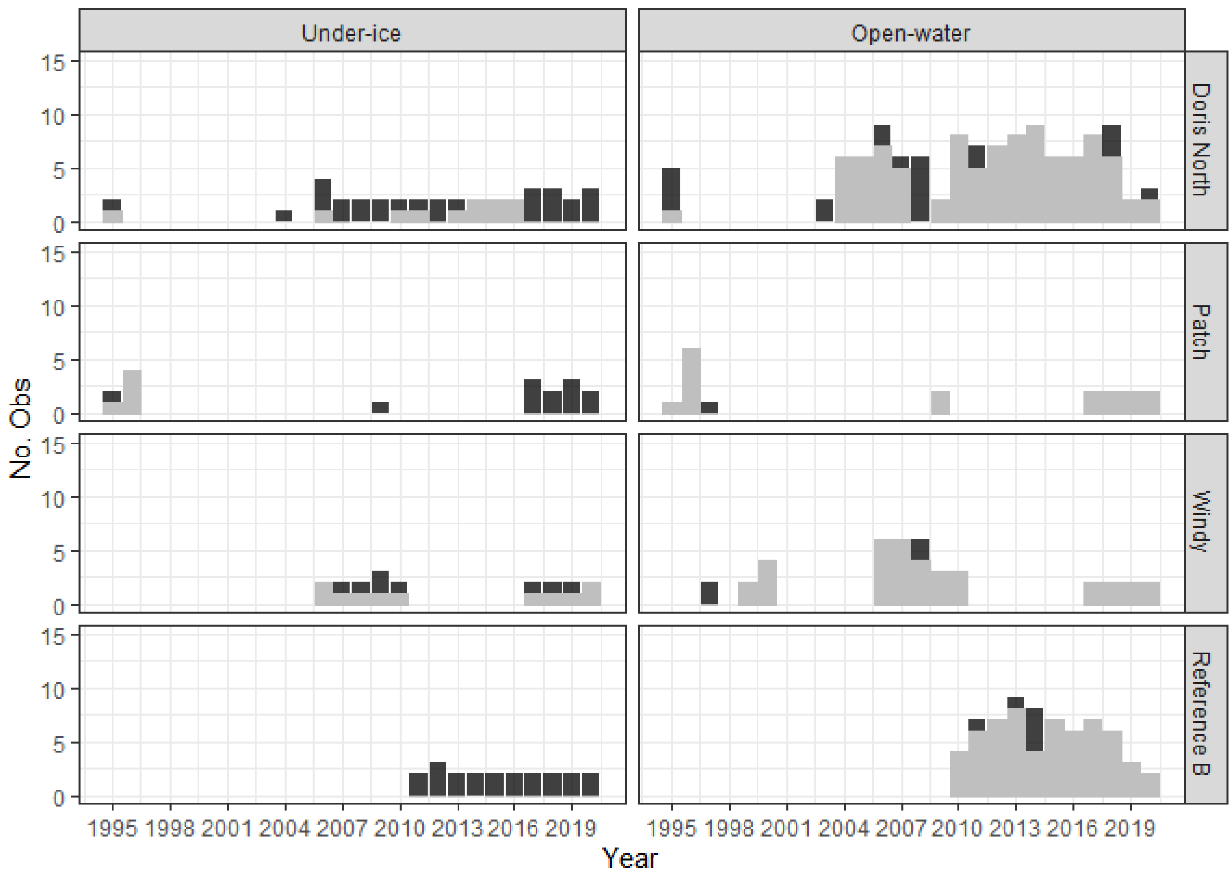
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

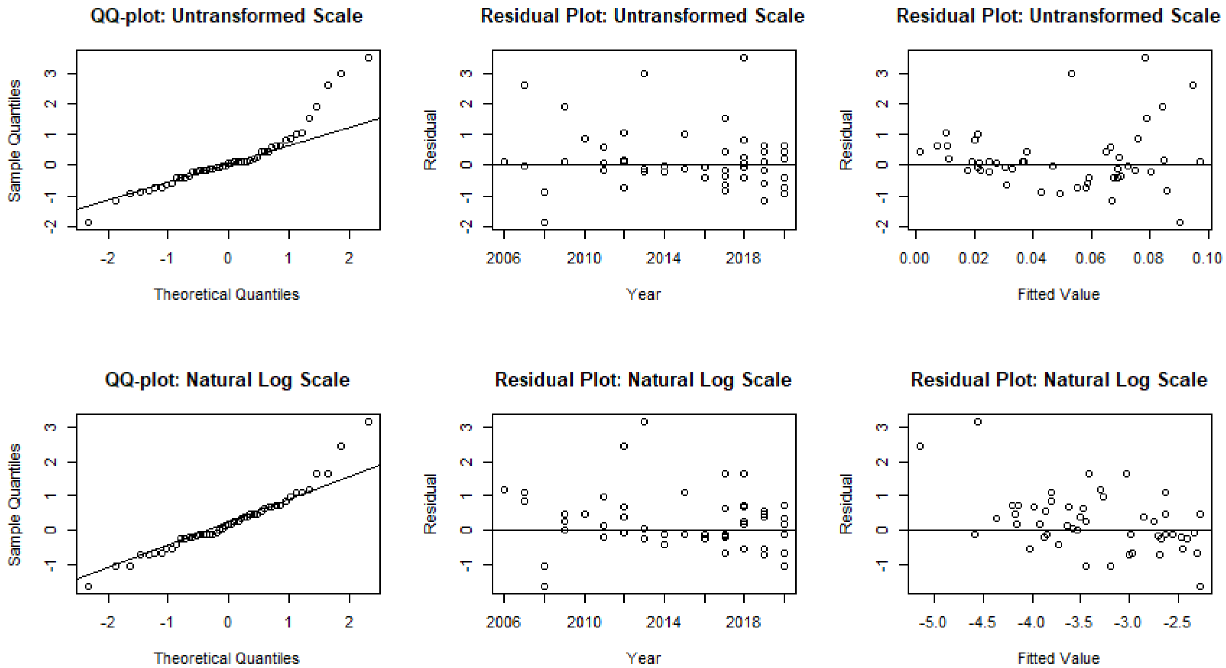
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	12	0.32	0.00	0.0192
Doris North	Open-water	115	98	0.85	0.67	0.0050
Patch	Under-ice	17	5	0.29	0.00	0.0331
Patch	Open-water	18	17	0.94	1.00	0.0050
Reference B	Under-ice	21	0	0.00	0.00	0.0452
Reference B	Open-water	66	60	0.91	1.00	0.0050
Windy	Under-ice	19	11	0.58	1.00	0.0050
Windy	Open-water	40	36	0.90	1.00	0.0050

More than 50% of data under detection limit in Doris open-water, Patch open-water, Reference B open-water, Windy under-ice, and Windy open-water. Data from those site-season groupings will be removed from the analysis. Doris under-ice and Patch under-ice exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris. The analysis proceeds with linear mixed effects regression for Patch.

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 fitted model 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
Doris	2018	Under-ice	Deep	0.201	0.078	3.493

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris	2013	Under-ice	Deep	0.157	-4.551	3.169

The natural log-transformed data 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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	19.70	4	0.0006
Compare to Reference B	25.11	4	0.0000

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

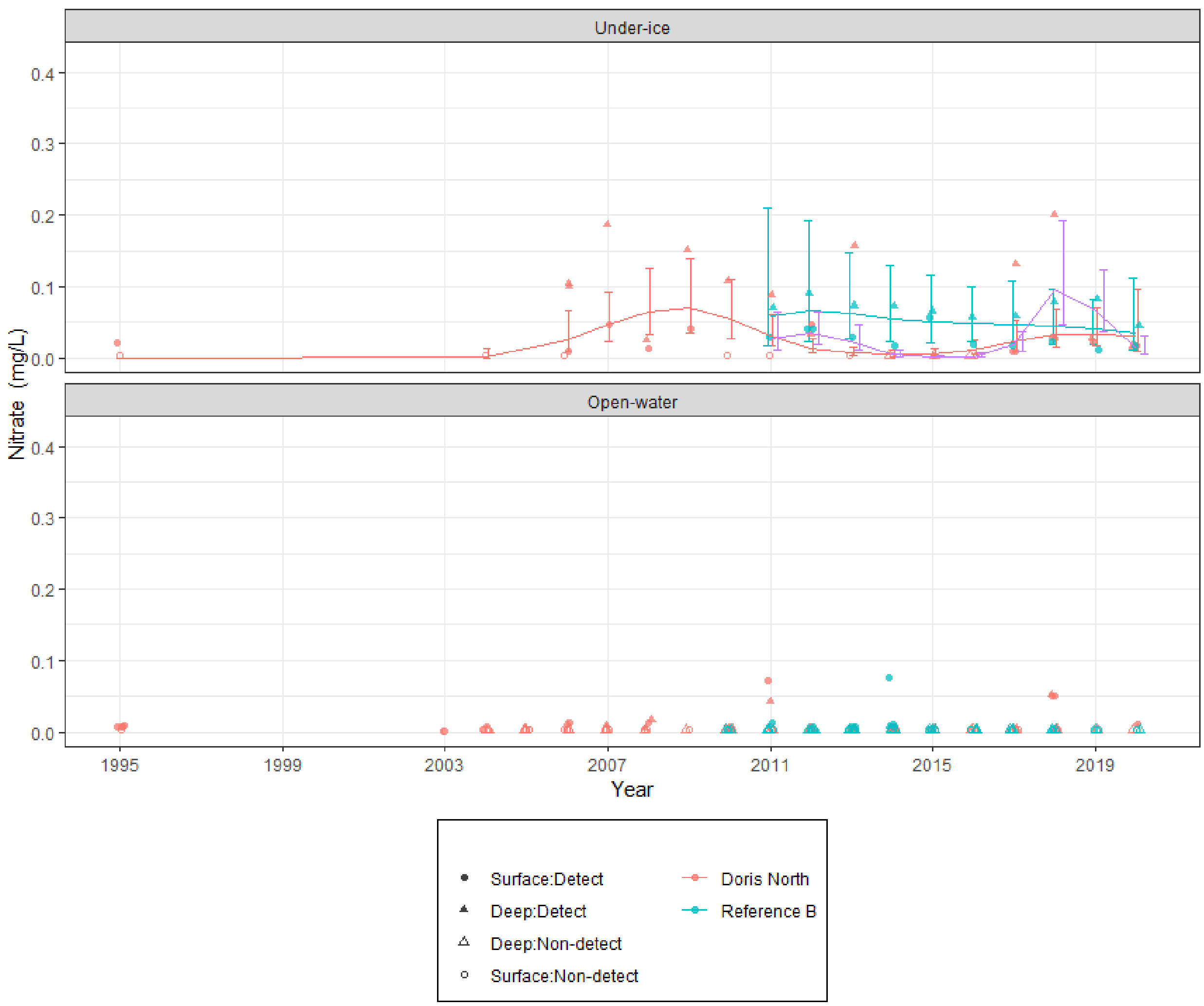
Open-water

All data from Doris open-water removed from the analysis. No analysis performed.

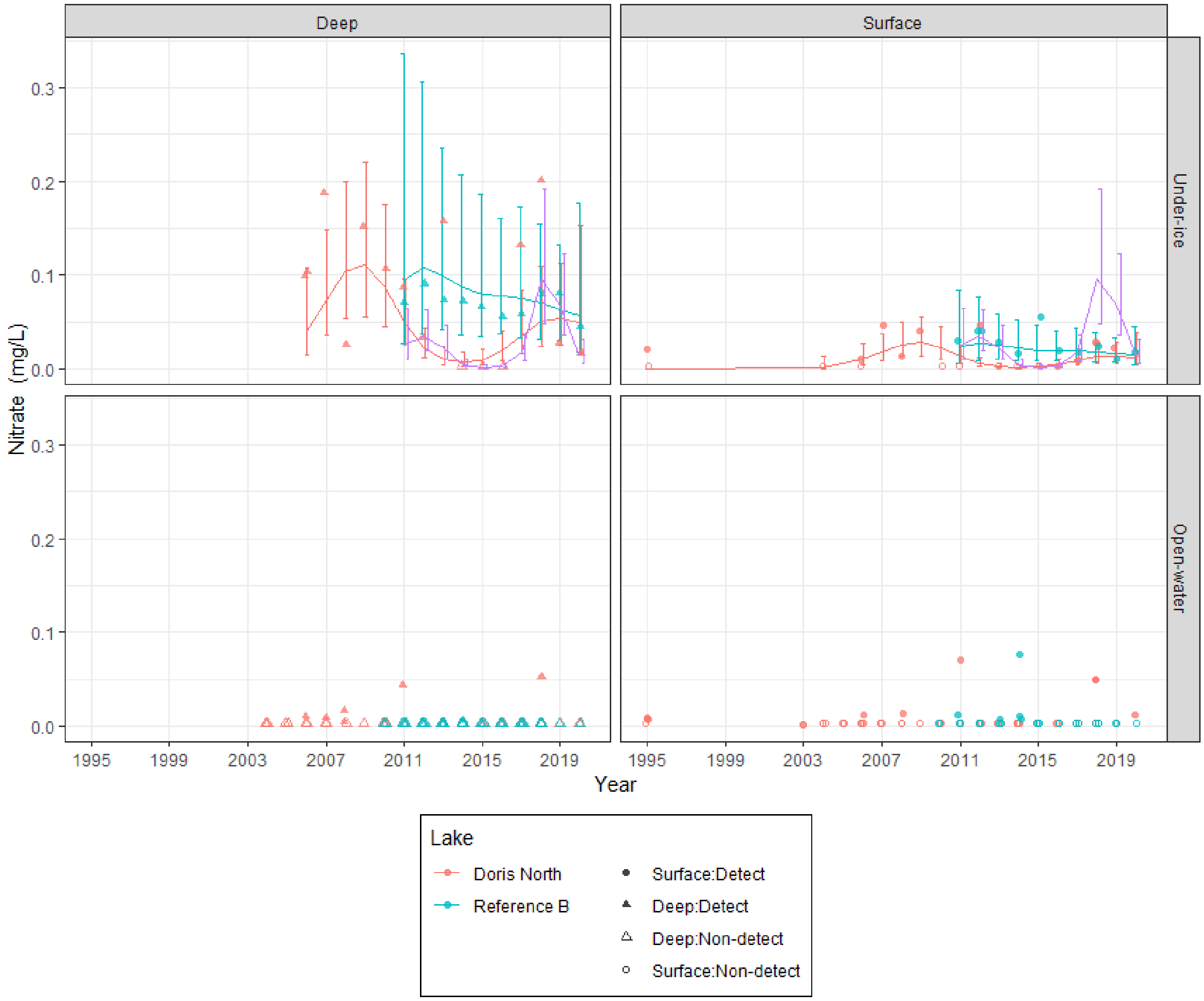
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data; solid purple lines show fitted curves through comparable years of data for comparisons between Doris Lake and Reference B Lake data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.3224	1.382	4	0.2334	0.8269	not sig.

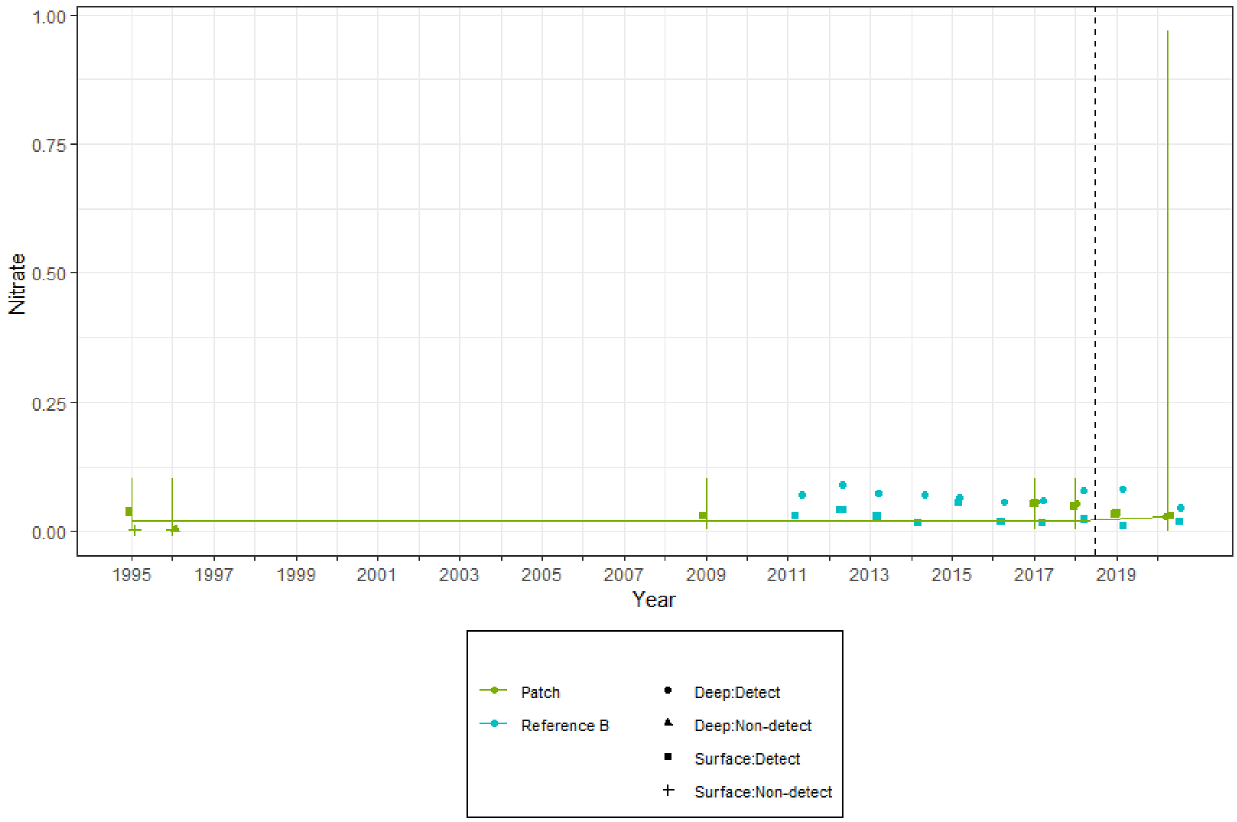
Conclusion:

The change in nitrate concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.8269) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Analysis not performed.

Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

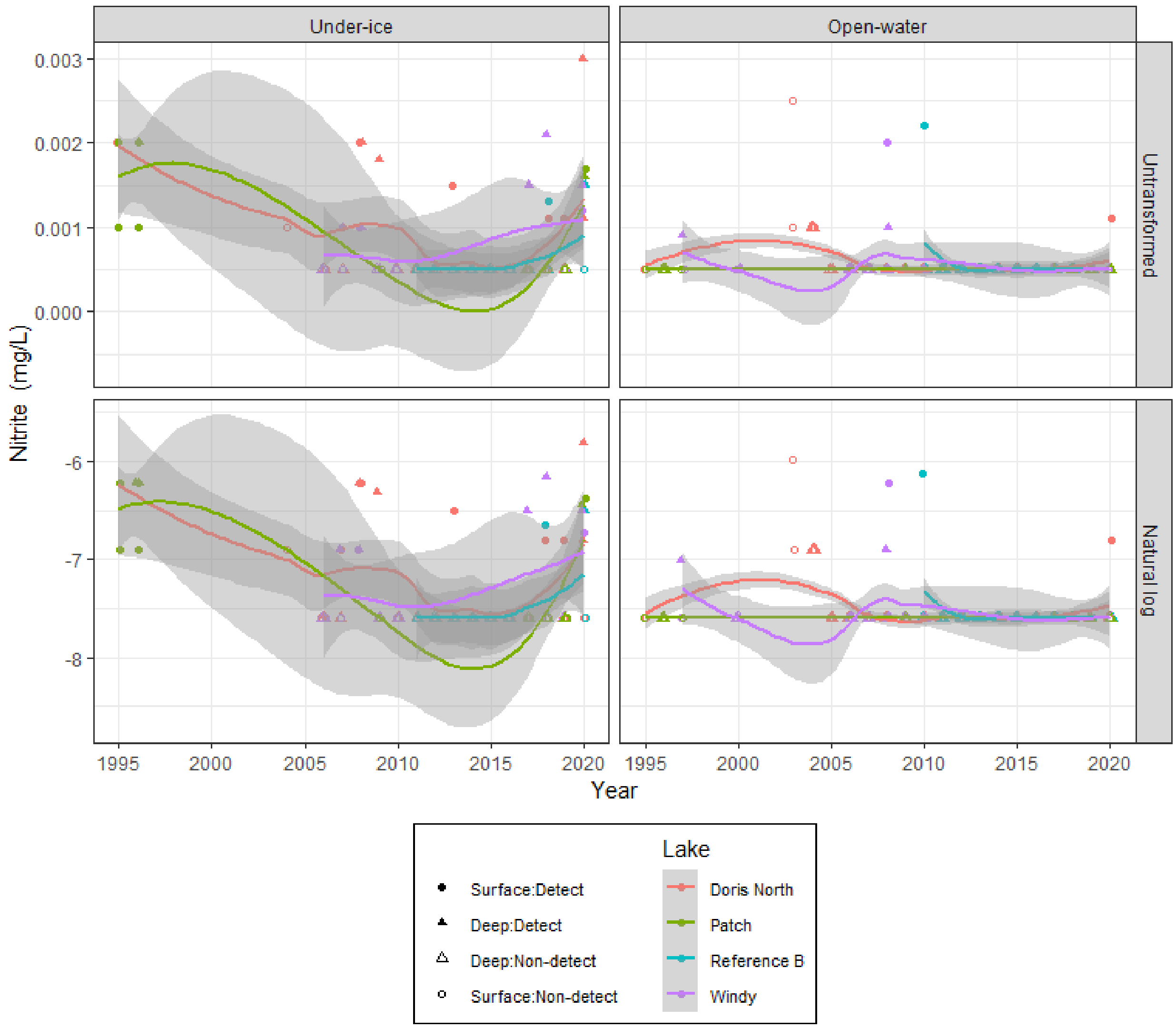
Open-water Before-vs-After Analysis

Analysis not performed.

C.3.1.8 Nitrite

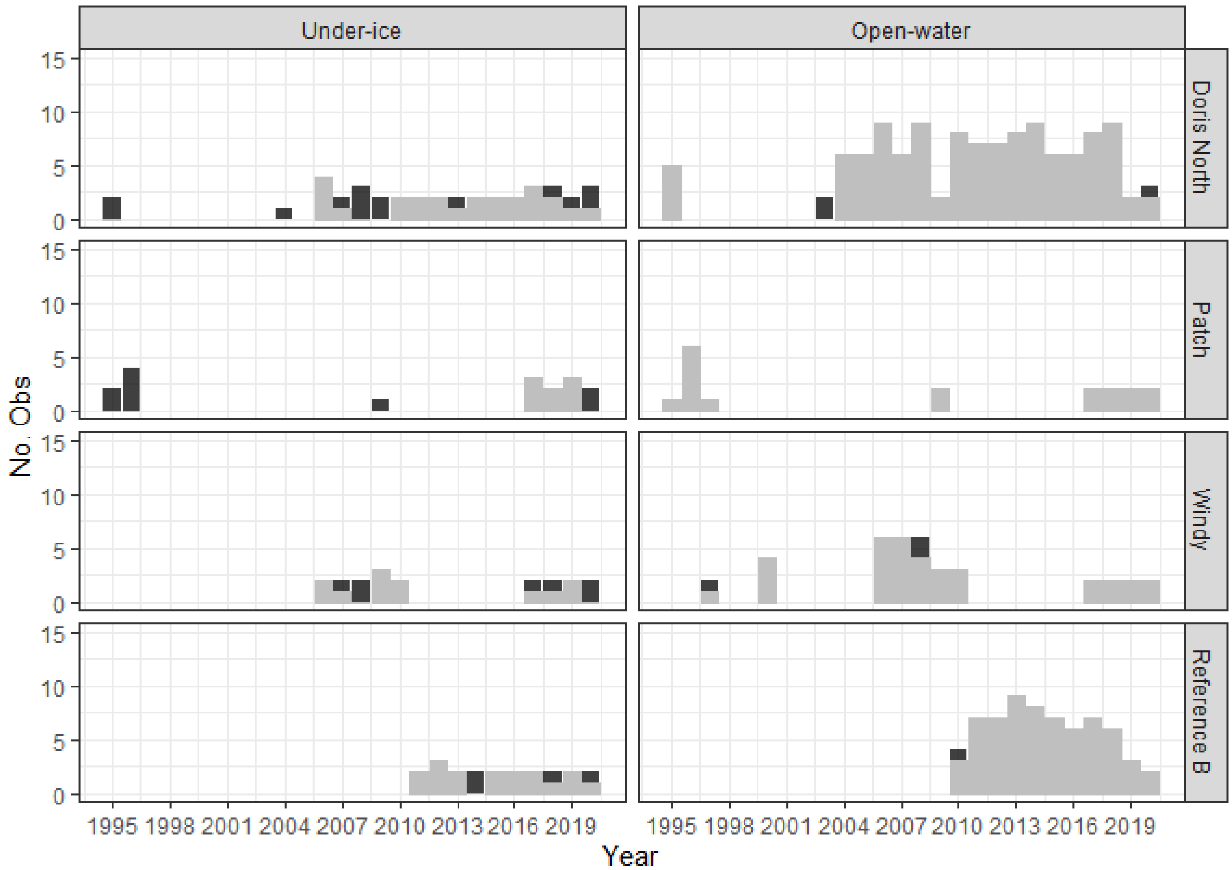
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

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

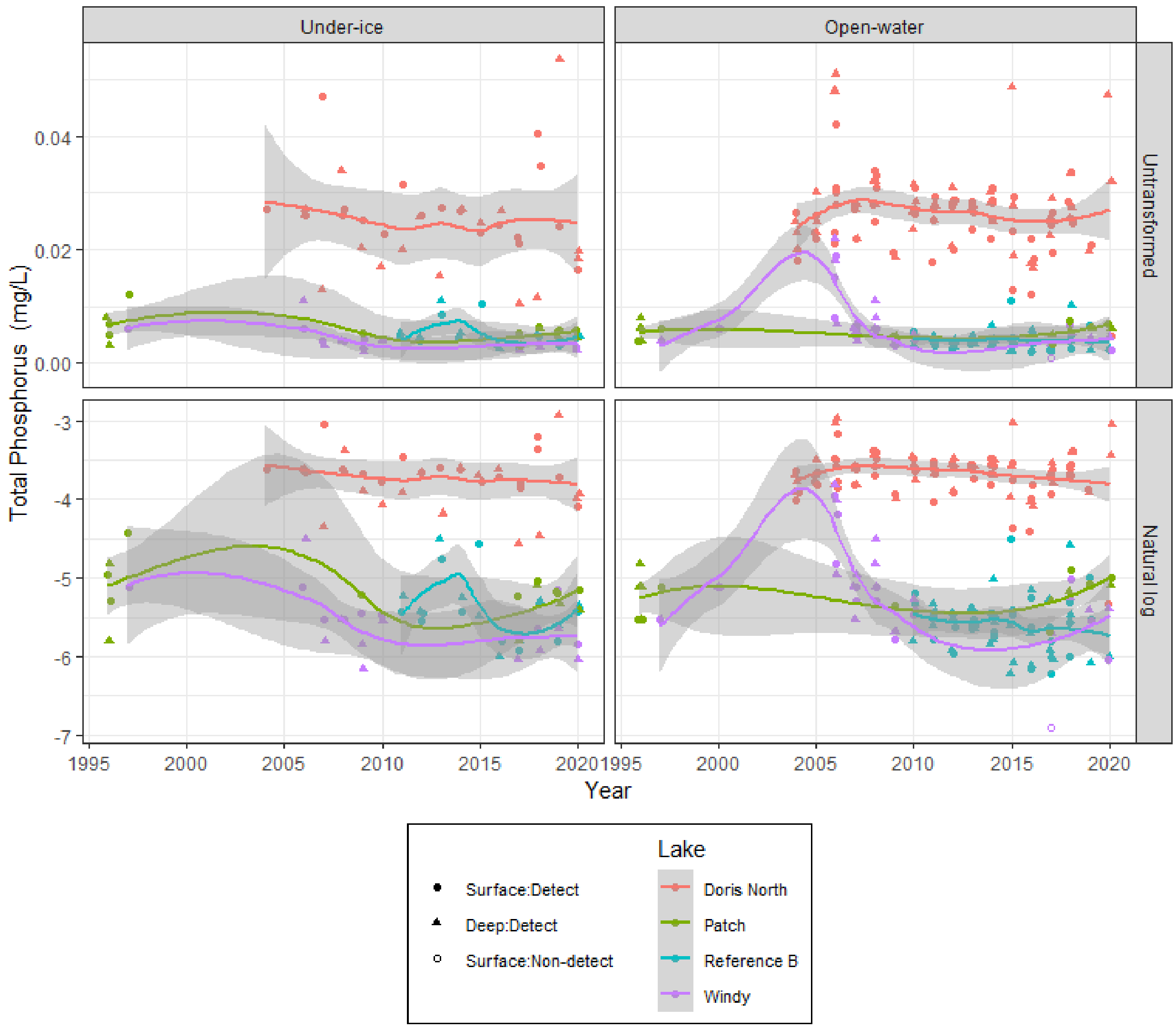
Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	39	27	0.69	0.33	0.001
Doris North	Open-water	118	117	0.99	0.67	0.001
Patch	Under-ice	17	9	0.53	0.00	0.001
Patch	Open-water	18	18	1.00	1.00	0.001
Reference B	Under-ice	21	19	0.90	0.50	0.001
Reference B	Open-water	66	65	0.98	1.00	0.001
Windy	Under-ice	19	12	0.63	0.00	0.001
Windy	Open-water	38	35	0.92	1.00	0.001

Greater than 50% of observations from all site-season groupings were censored and no statistical analyses were performed.

C.3.1.9 Total Phosphorus

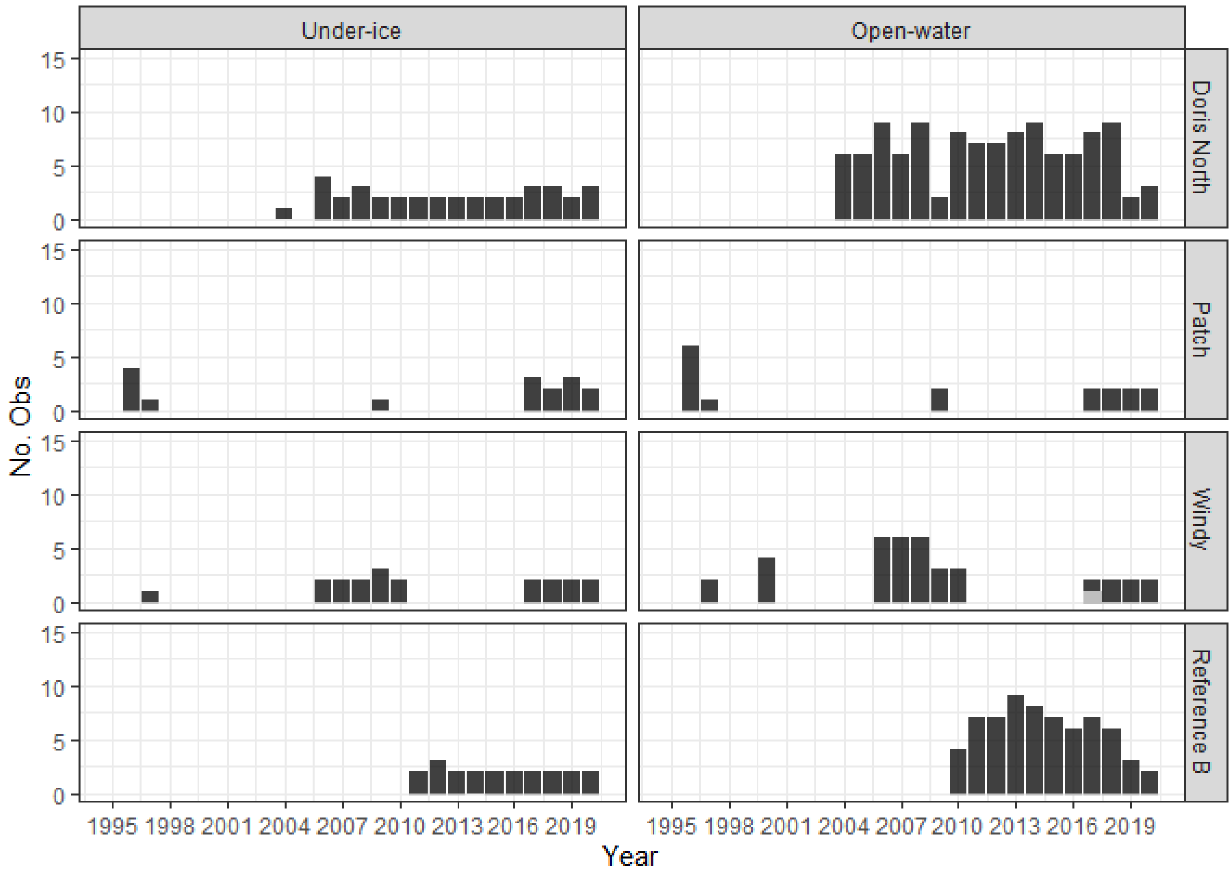
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

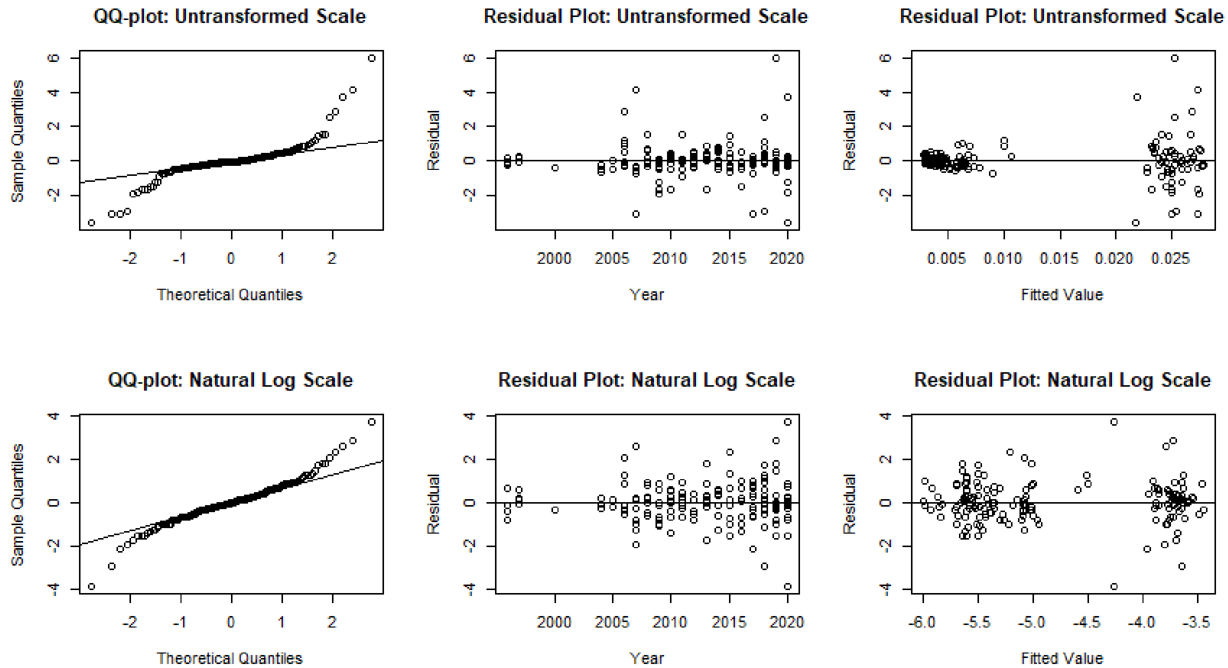
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	37	0	0.00	0	0.0258
Doris North	Open-water	111	0	0.00	0	0.0268
Patch	Under-ice	16	0	0.00	0	0.0054
Patch	Open-water	17	0	0.00	0	0.0060
Reference B	Under-ice	21	0	0.00	0	0.0044
Reference B	Open-water	66	0	0.00	0	0.0038
Windy	Under-ice	20	0	0.00	0	0.0037
Windy	Open-water	38	1	0.03	0	0.0056

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris North	2007	Under-ice	Deep	0.0130	0.027	-3.017
Doris North	2007	Under-ice	Surface	0.0470	0.027	4.139
Doris North	2017	Under-ice	Deep	0.0105	0.025	-3.061
Doris North	2019	Under-ice	Deep	0.0537	0.025	5.964
Doris North	2020	Open-water	Deep	0.0397	0.022	3.735
Doris North	2020	Open-water	Surface	0.0048	0.022	-3.583

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2020	Open-water	Deep	0.0397	-4.266	3.748
Doris North	2020	Open-water	Surface	0.0048	-4.256	-3.908

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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	1.205	4	0.8772

Doris Lake does not exhibit significant deviation from no trend.

Open-water

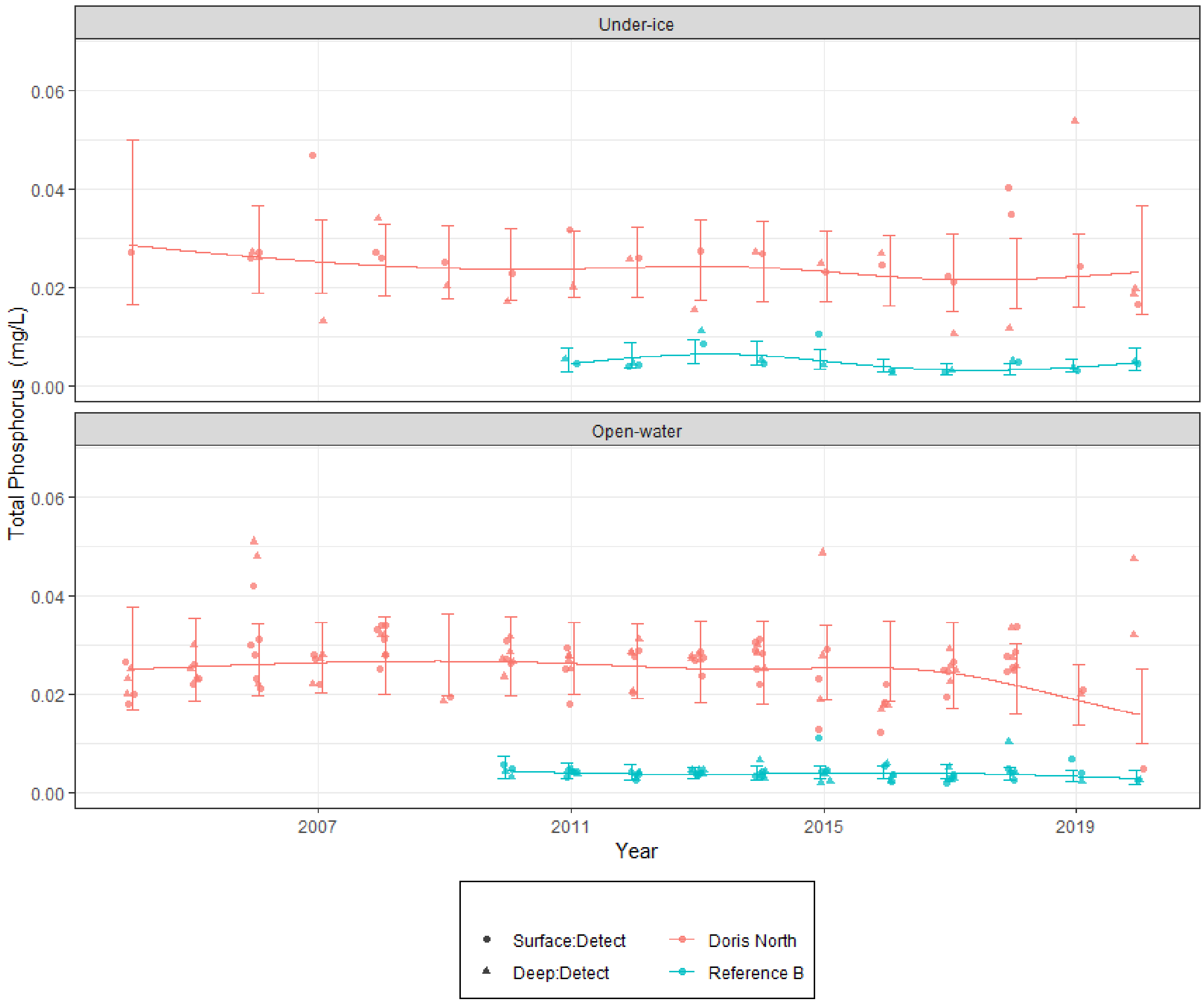
Analysis	Chi.sq	DF	P.value
Compare to slope 0	6.43	4	0.1693

Doris Lake does not exhibit significant deviation from no trend.

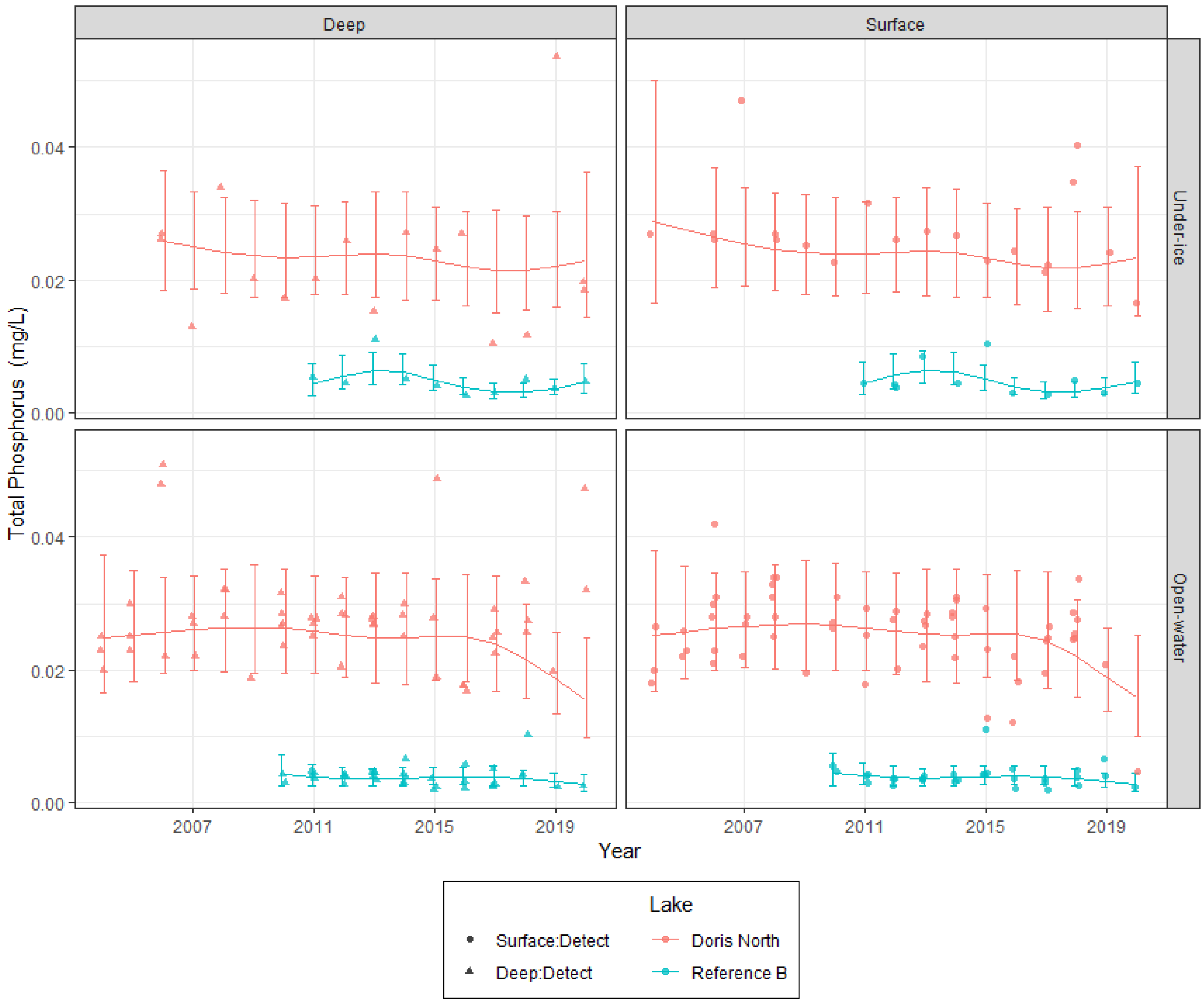
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.1338	0.4459	3.877	-0.3001	0.7795	not sig.

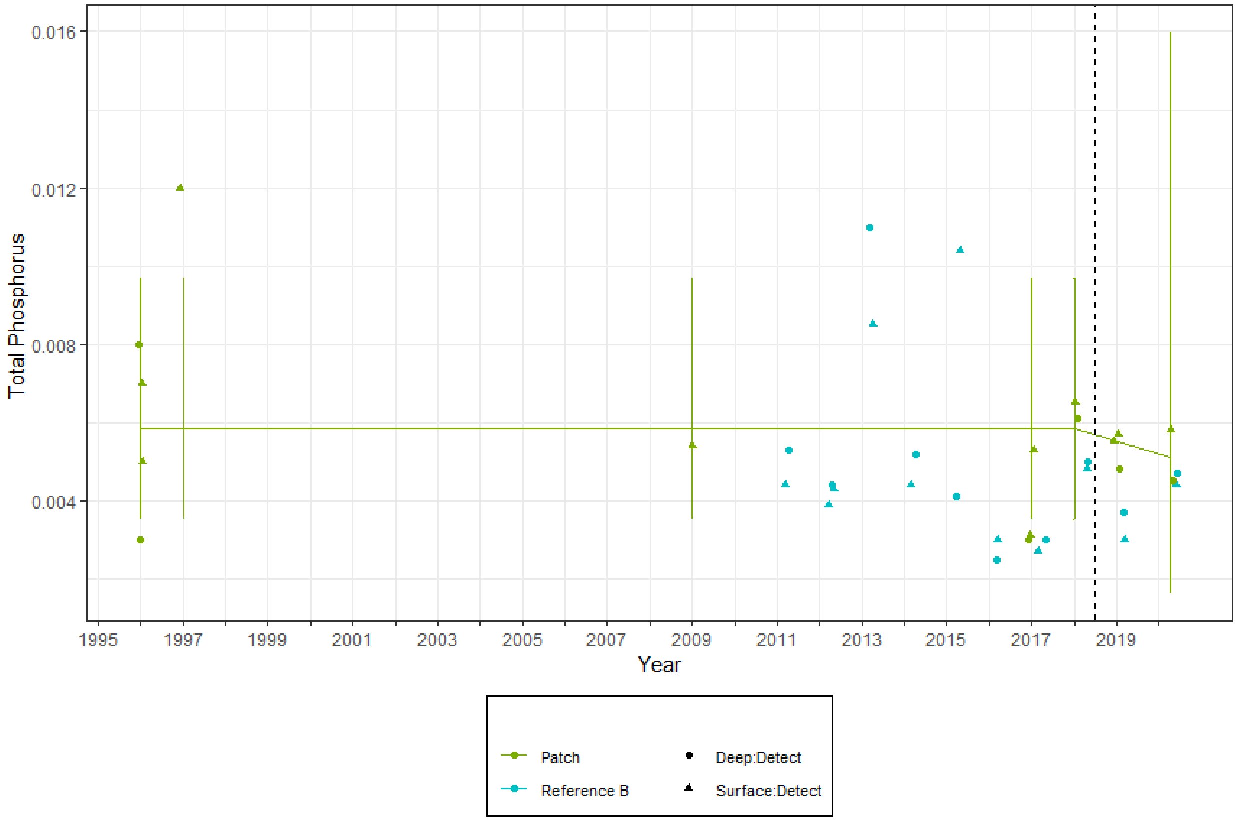
Conclusion:

The change in total phosphorus concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.7795) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.2294	0.2096	3.597	1.095	0.3415	not sig.

Conclusion:

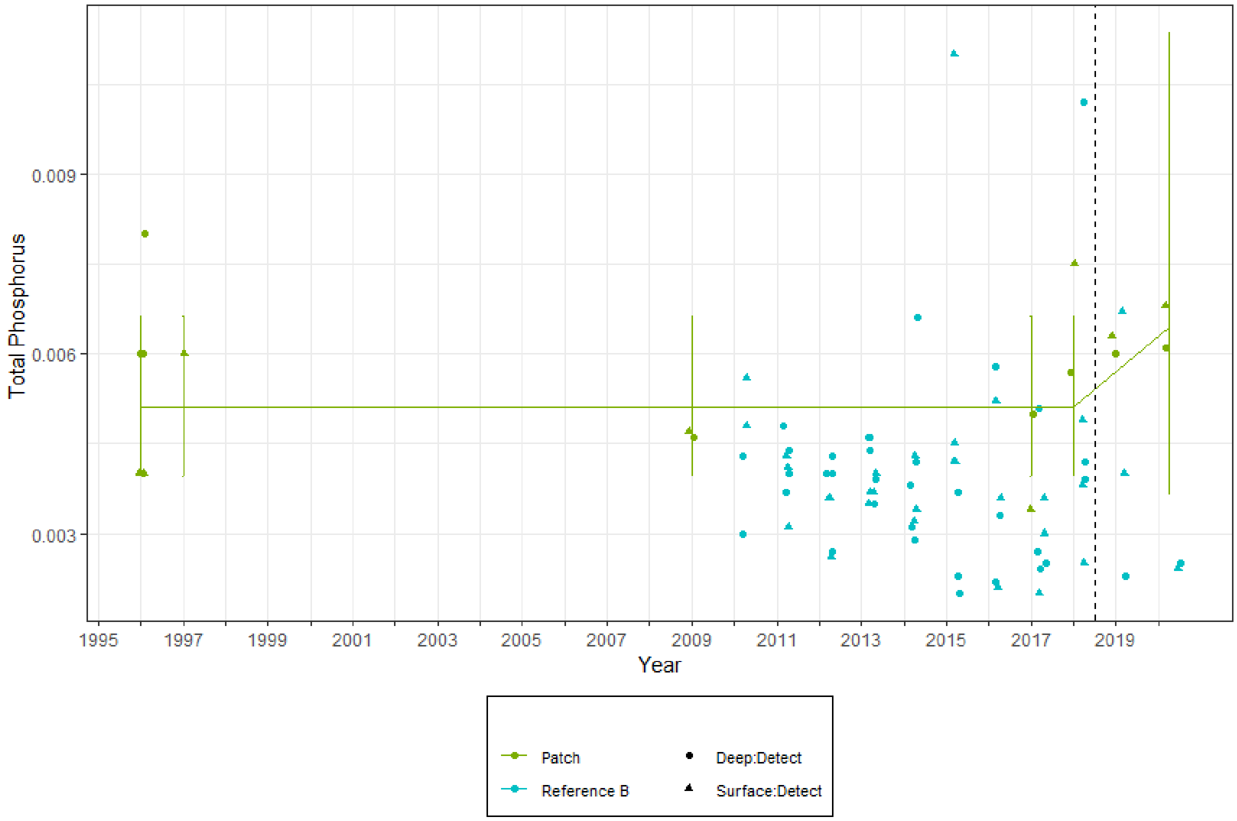
The change in total phosphorus concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.3415) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.4185	0.3729	6.749	-1.122	0.3001	not sig.

Conclusion:

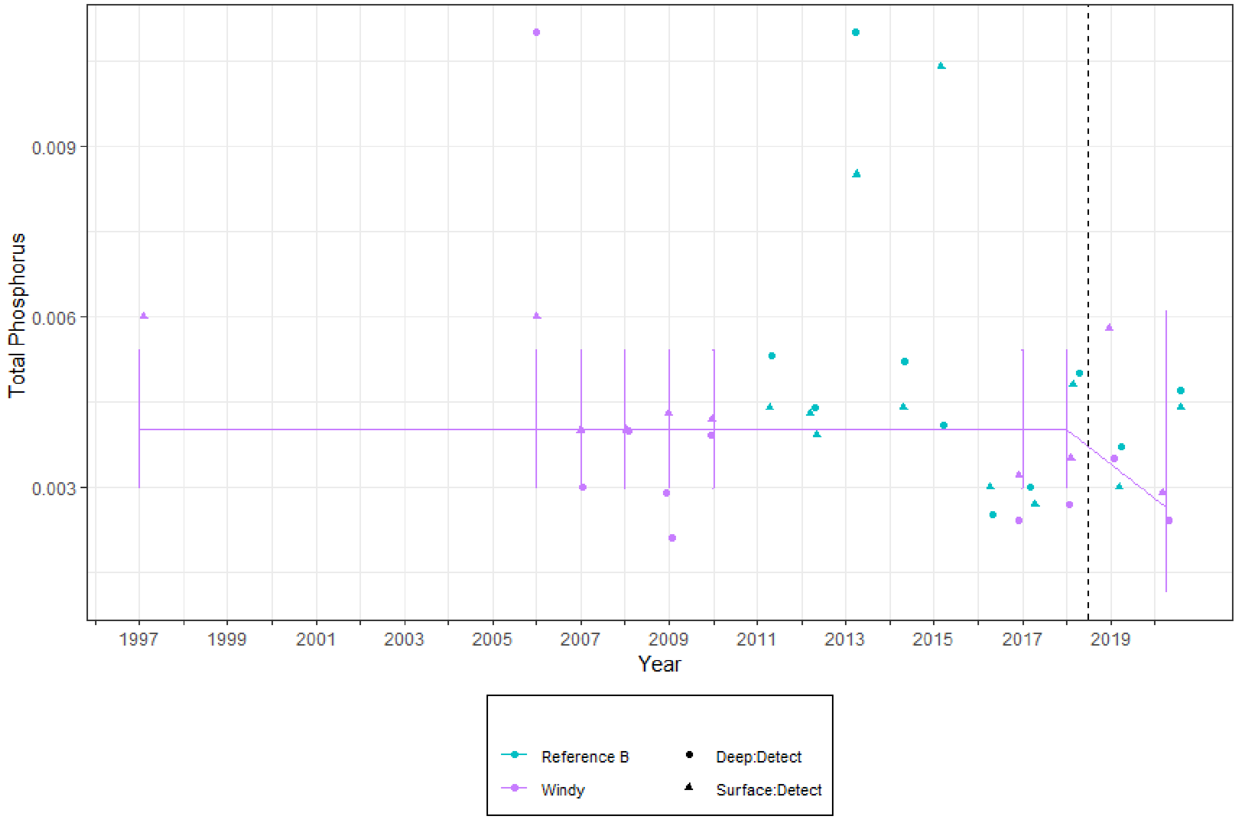
The change in total phosphorus concentrations in Windy Lake from *before* to *after* was not significantly ($p = 0.3001$) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.4211	0.6022	8	-0.6993	0.5042	not sig.

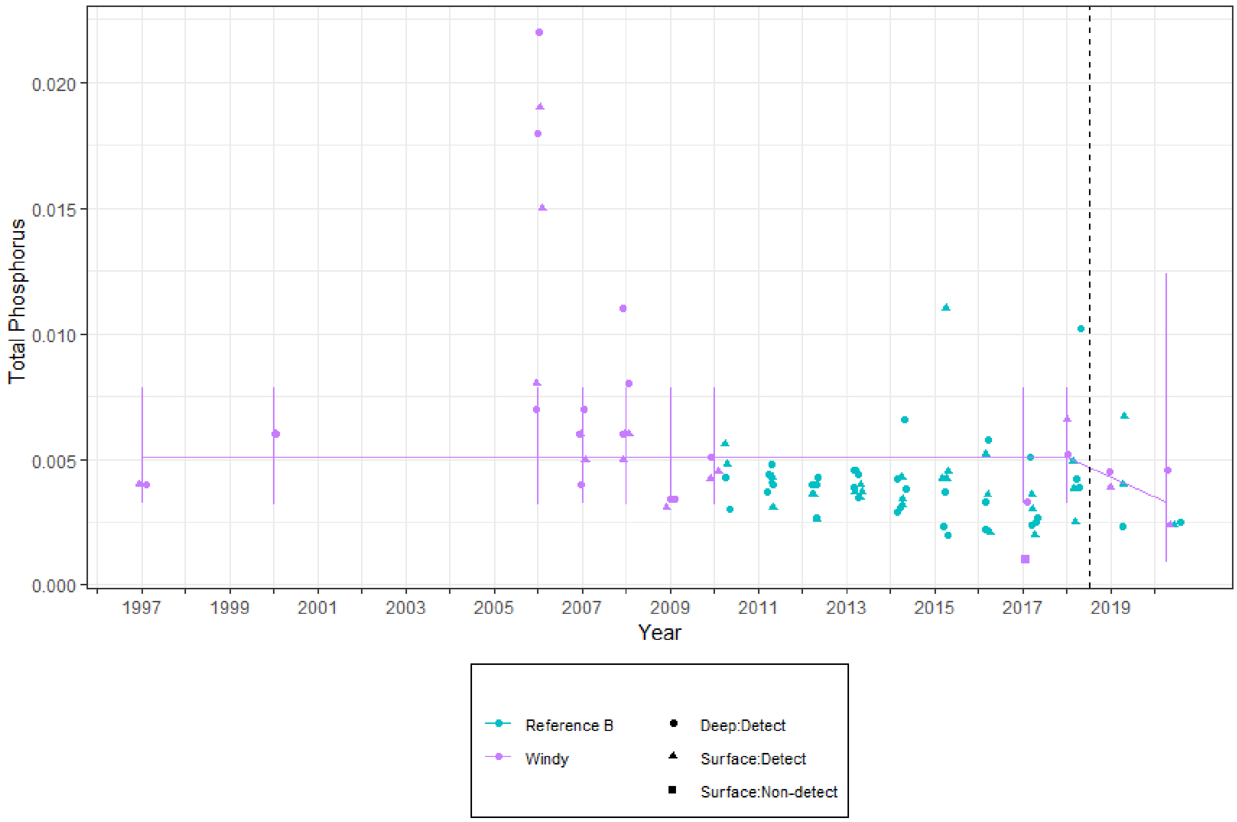
Conclusion:

The change in total phosphorus concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.5042) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

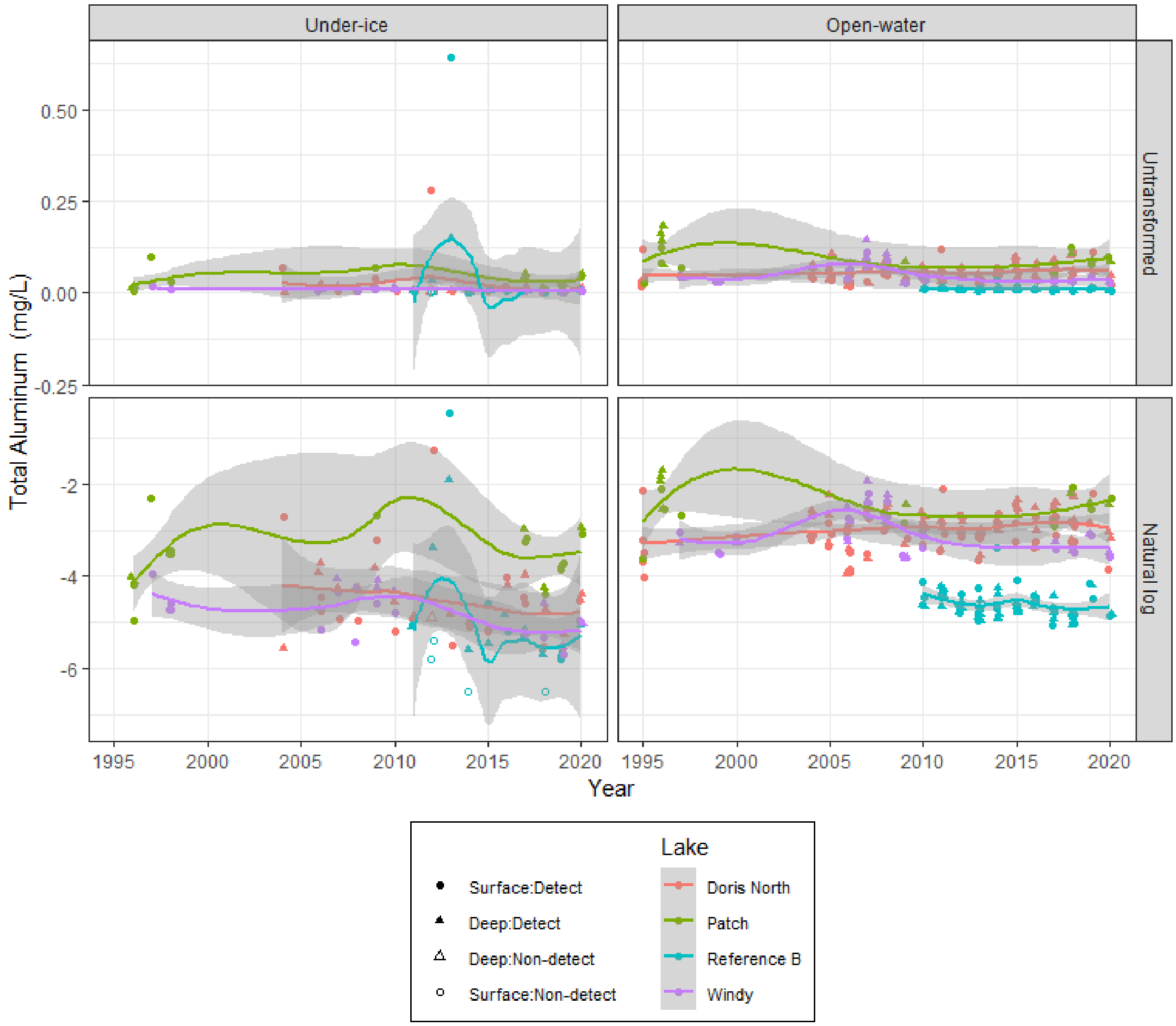
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.10 *Total Aluminum*

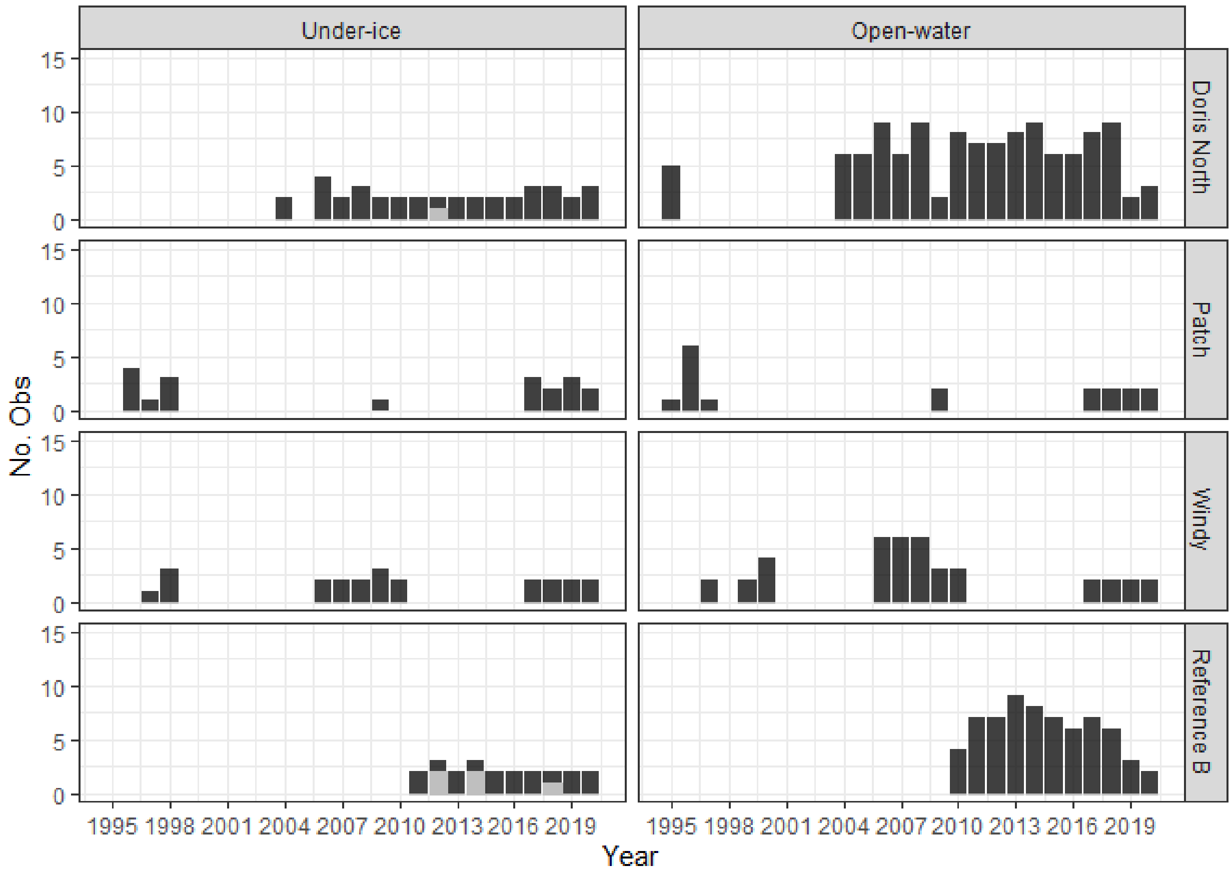
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

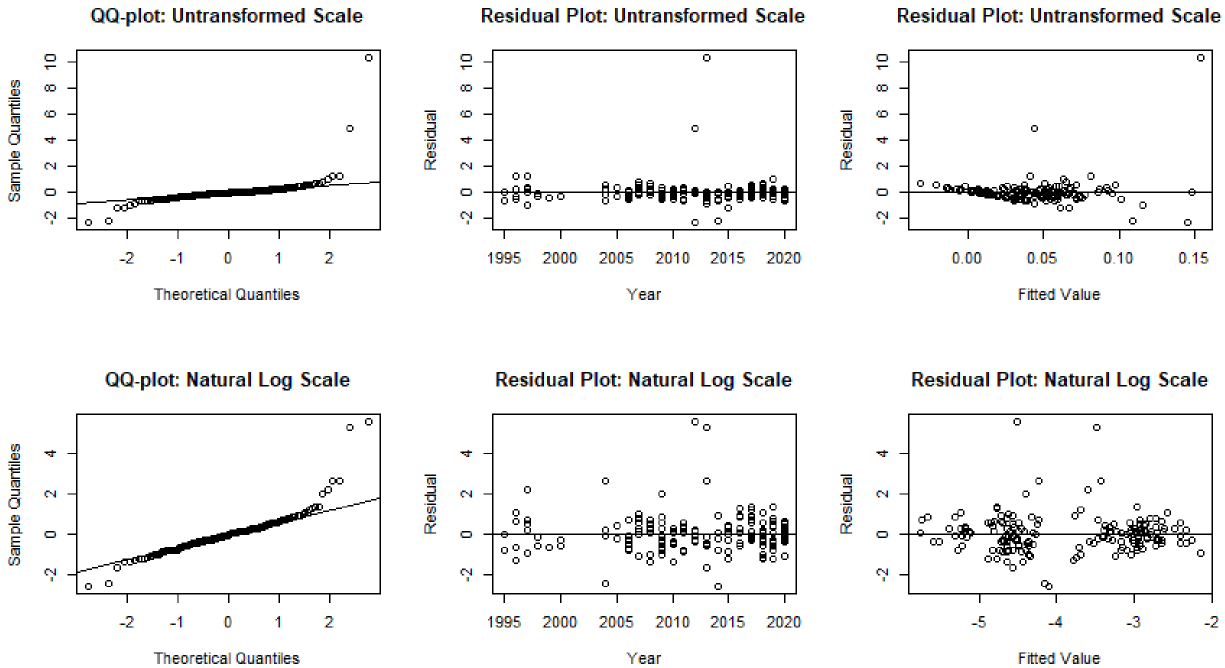
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	1	0.03	0	0.0096
Doris North	Open-water	116	0	0.00	0	0.0533
Patch	Under-ice	19	0	0.00	0	0.0300
Patch	Open-water	18	0	0.00	0	0.0867
Reference B	Under-ice	22	5	0.23	0	0.0059
Reference B	Open-water	66	0	0.00	0	0.0095
Windy	Under-ice	23	0	0.00	0	0.0090
Windy	Open-water	40	0	0.00	0	0.0436

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris	2012	Under-ice	Surface	0.280	0.045	4.935
Reference B	2013	Under-ice	Surface	0.644	0.153	10.281

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris	2012	Under-ice	Surface	0.280	-4.502	5.603
Reference B	2013	Under-ice	Surface	0.644	-3.492	5.295

The natural log-transformed data 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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	3.552	4	0.4700

Doris Lake does not exhibit significant deviation from no trend.

Open-water

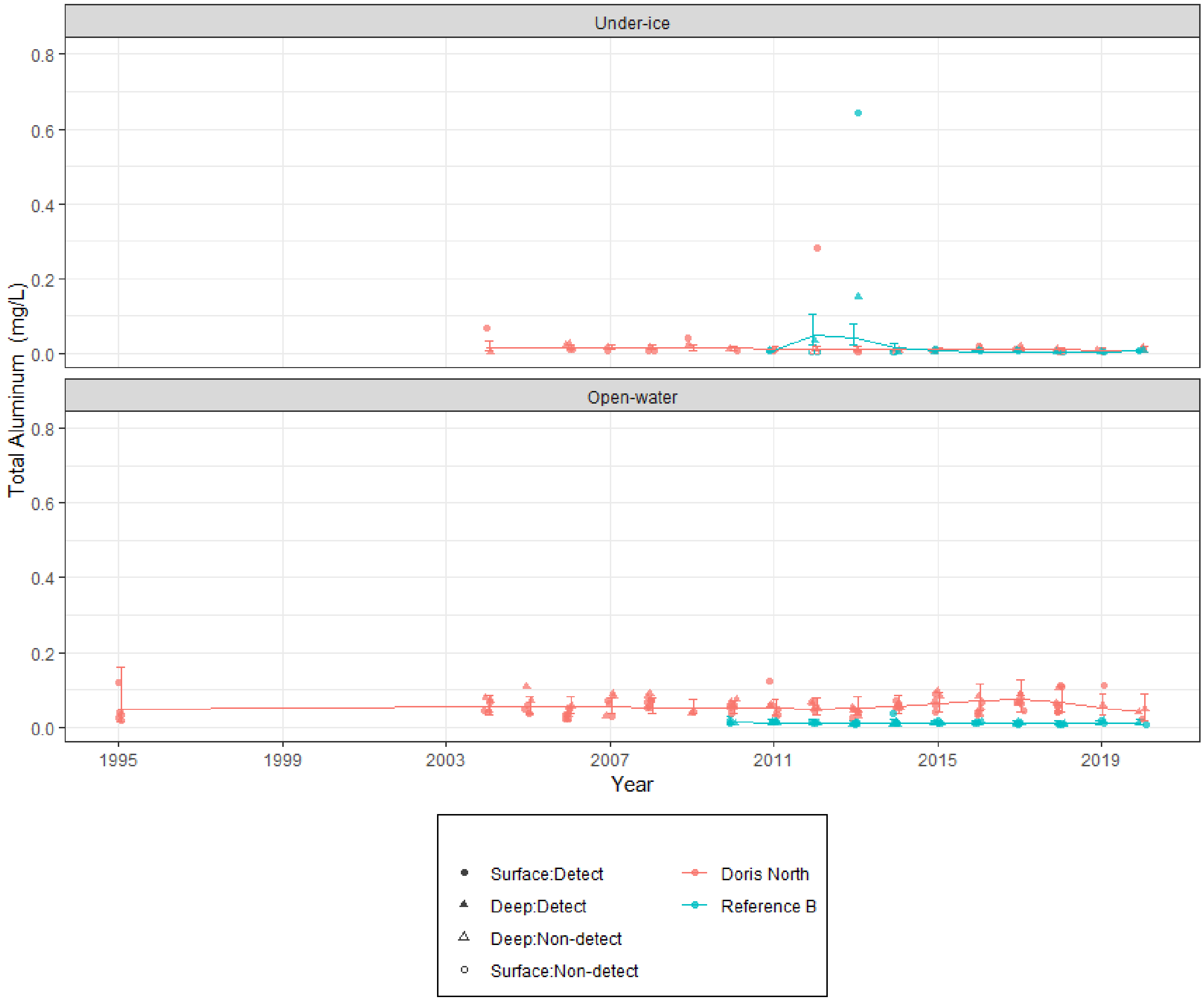
Analysis	Chi.sq	DF	P.value
Compare to slope 0	1.46	4	0.8336

Doris Lake does not exhibit significant deviation from no trend.

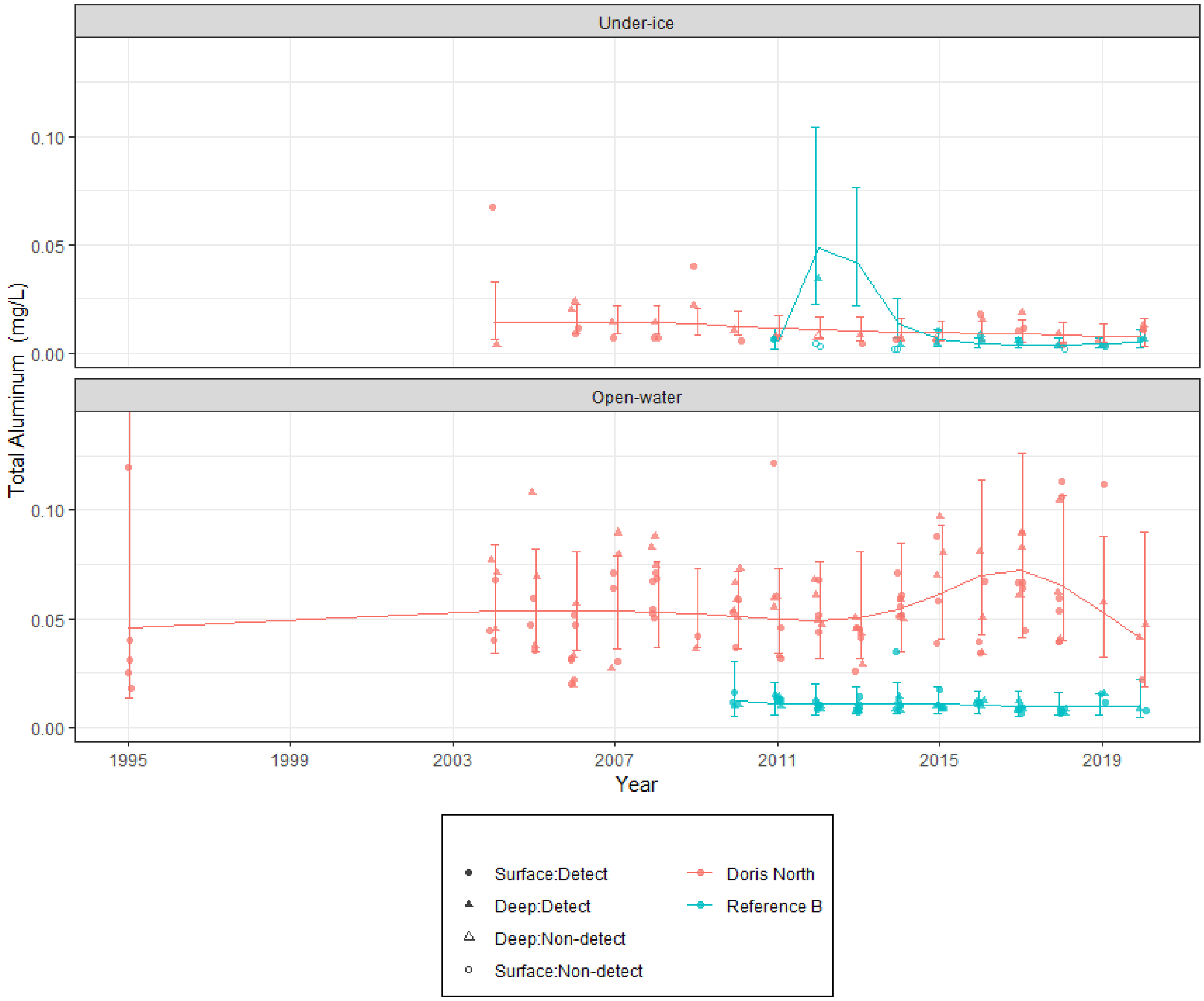
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

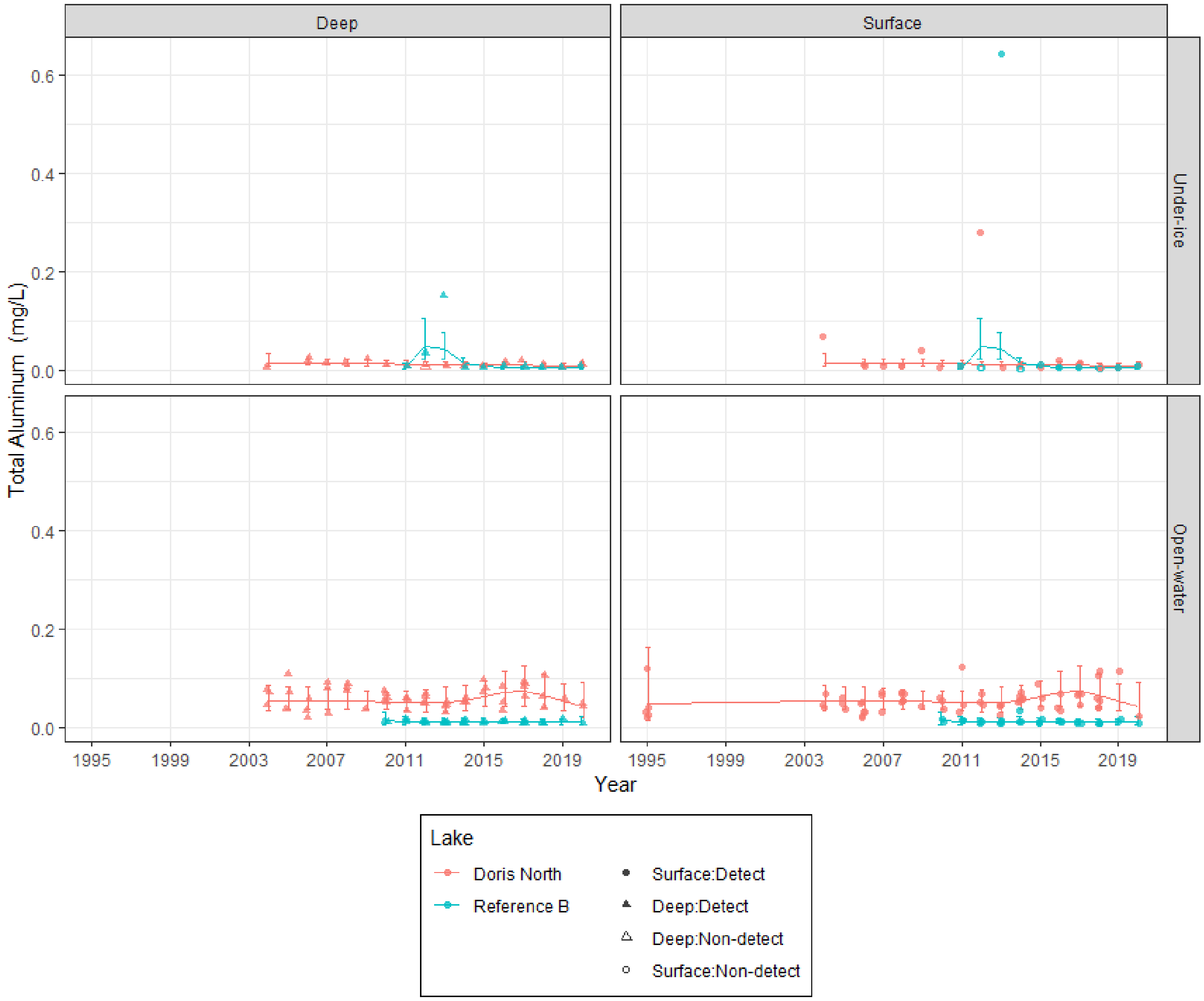
Plot of observed and fitted data averaged over depth.


Under-ice
Open-water
Total Aluminum (mg/L)
0.0
0.2
0.4
0.6
0.8
1995
1999
2003
2007
2011
2015
2019
Year
Surface:Detect
Deep:Detect
Deep:Non-detect
Surface:Non-detect
Doris North
Reference B

Zoom-in:


Under-ice
Open-water
0.10
0.05
0.00
Total Aluminum (mg/L)
1995
1999
2003
2007
2011
2015
2019
Year
Surface:Detect
Deep:Detect
Deep:Non-detect
Surface:Non-detect
Doris North
Reference B

Plot of observed and fitted data separated by depth.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.2806	0.9518	4.964	0.2948	0.7801	not sig.

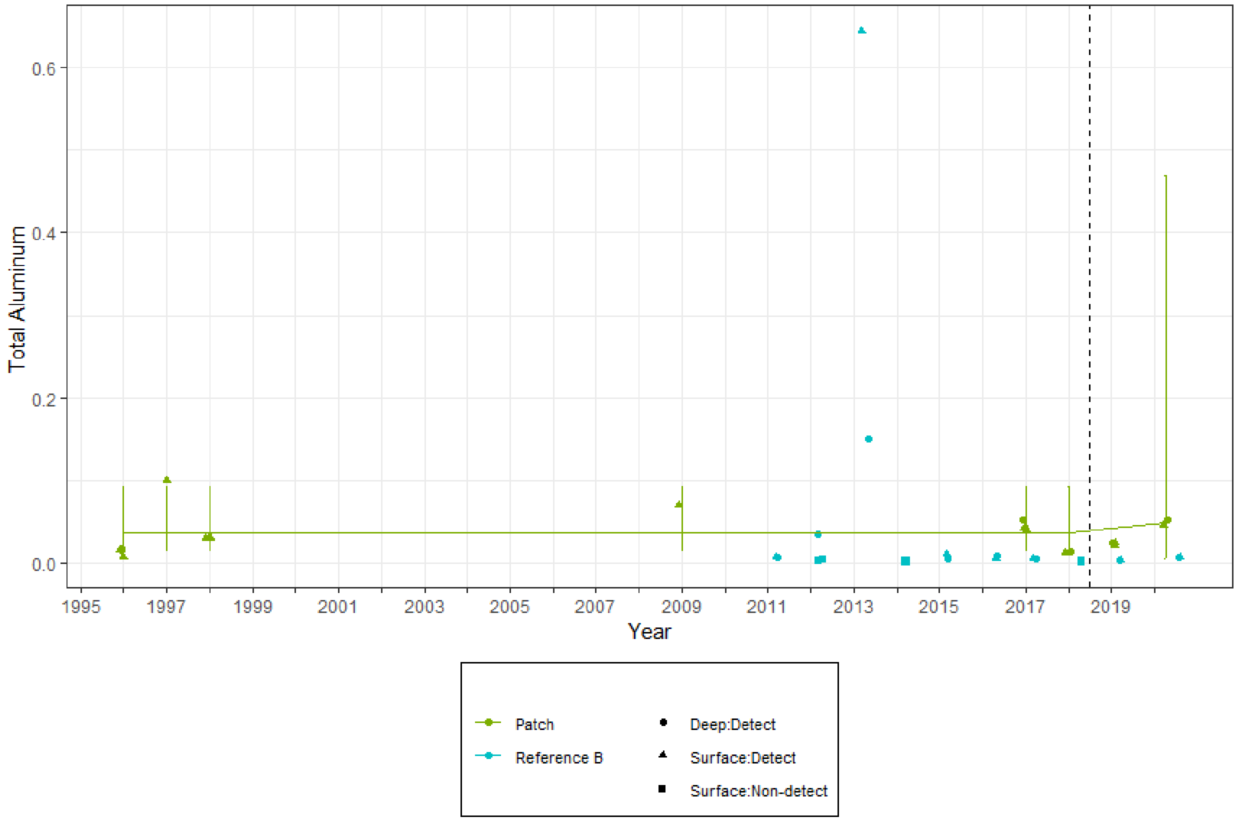
Conclusion:

The change in total aluminum concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.7801) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.2685	0.5597	4.655	0.4798	0.6531	not sig.

Conclusion:

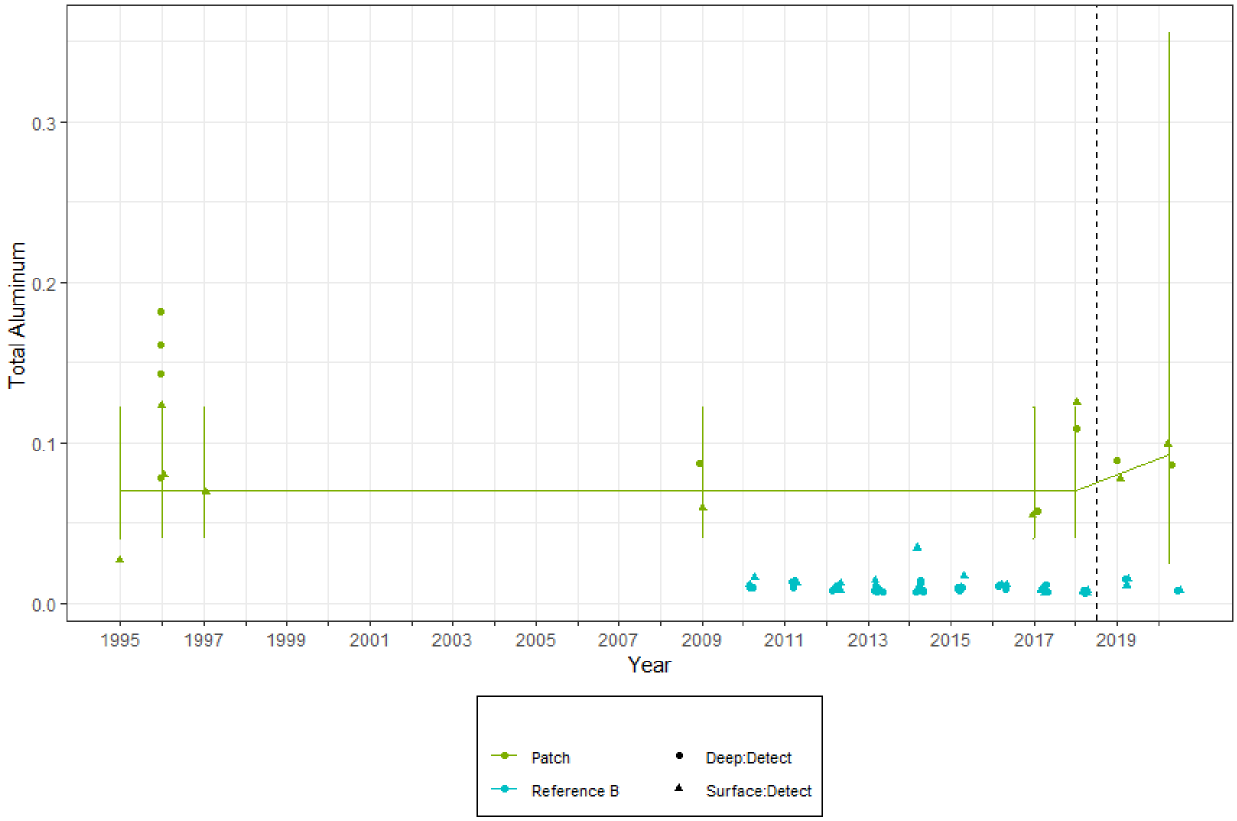
The change in total aluminum concentrations in Patch Lake from *before* to *after* was not significantly ($p = 0.6531$) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.3737	0.455	6.785	-0.8213	0.4394	not sig.

Conclusion:

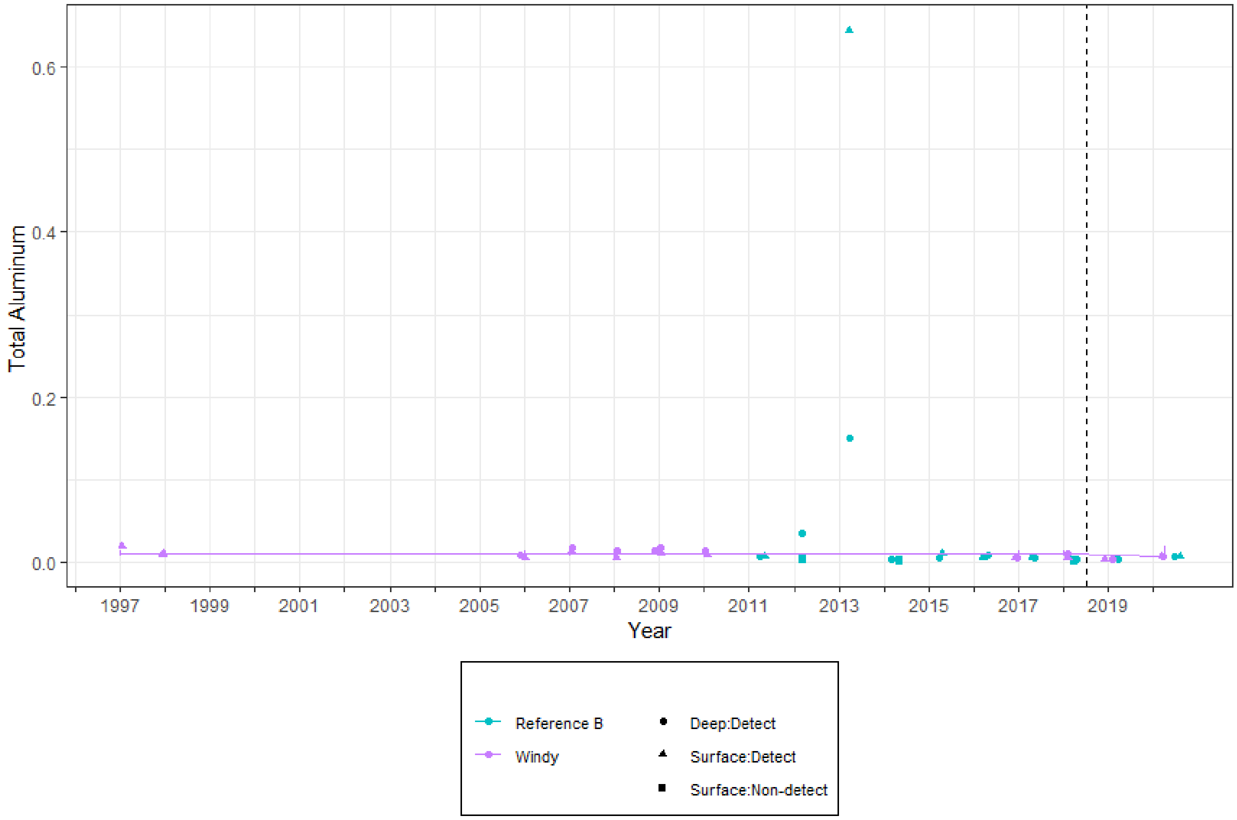
The change in total aluminum concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.4394) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.4204	0.435	8.969	-0.9664	0.3592	not sig.

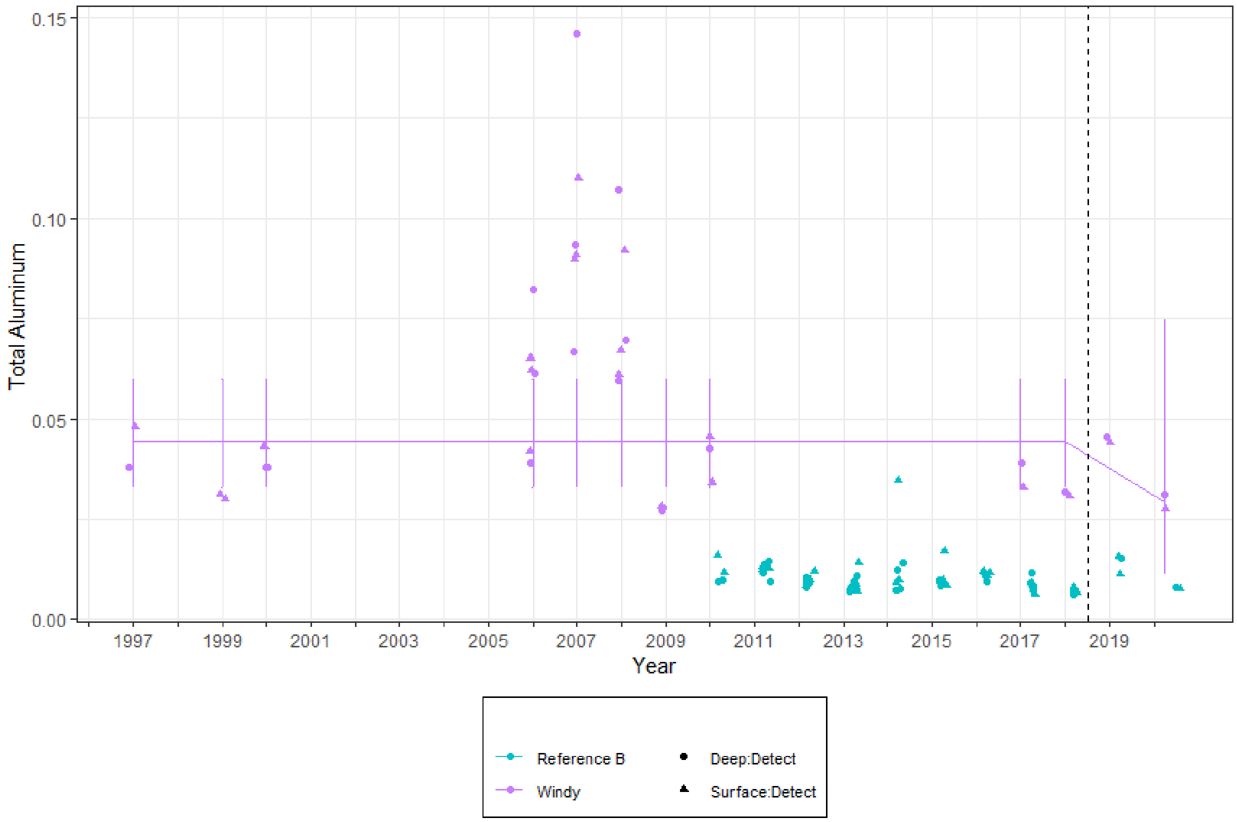
Conclusion:

The change in total aluminum concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.3592) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

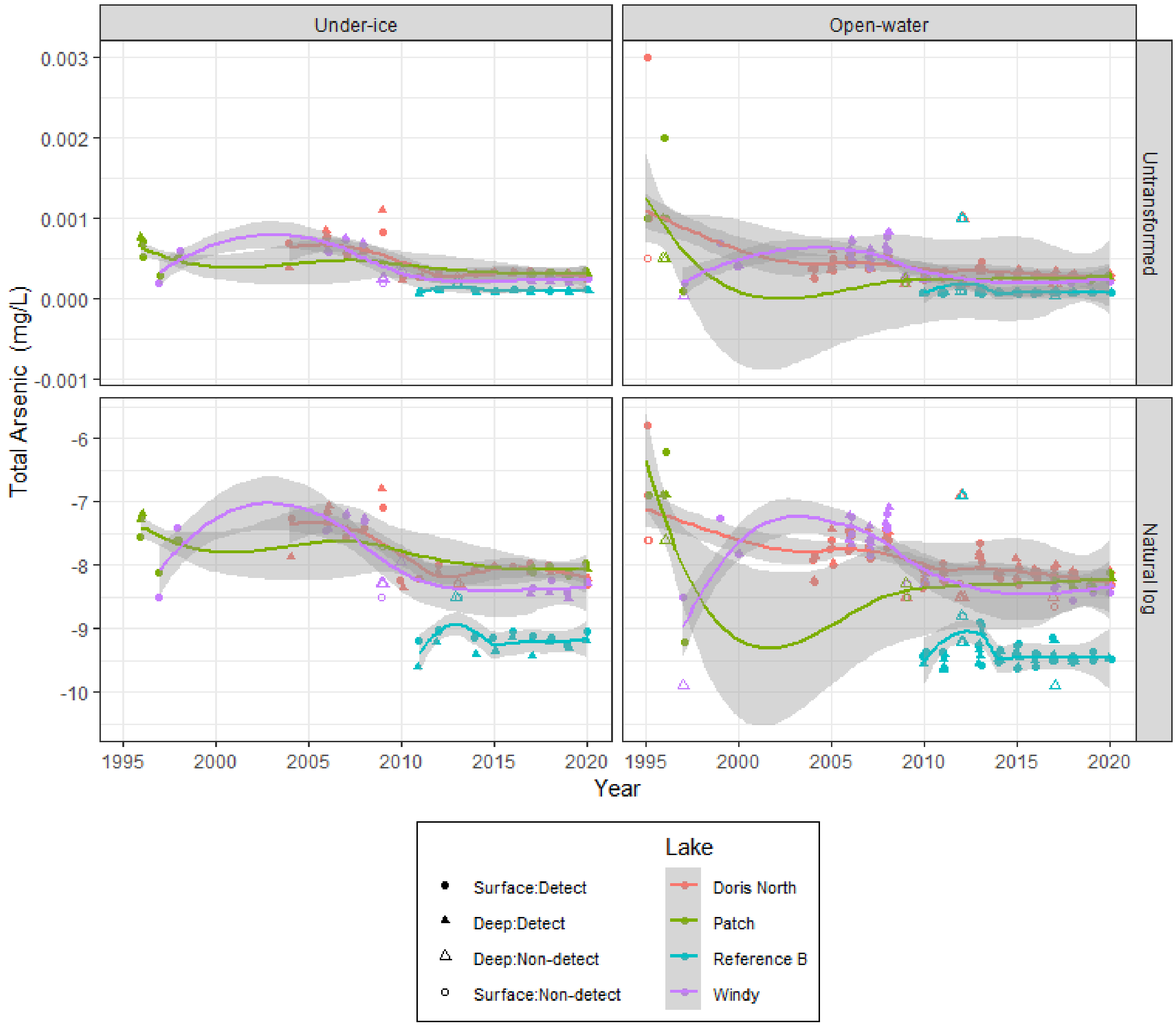
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.11 *Total Arsenic*

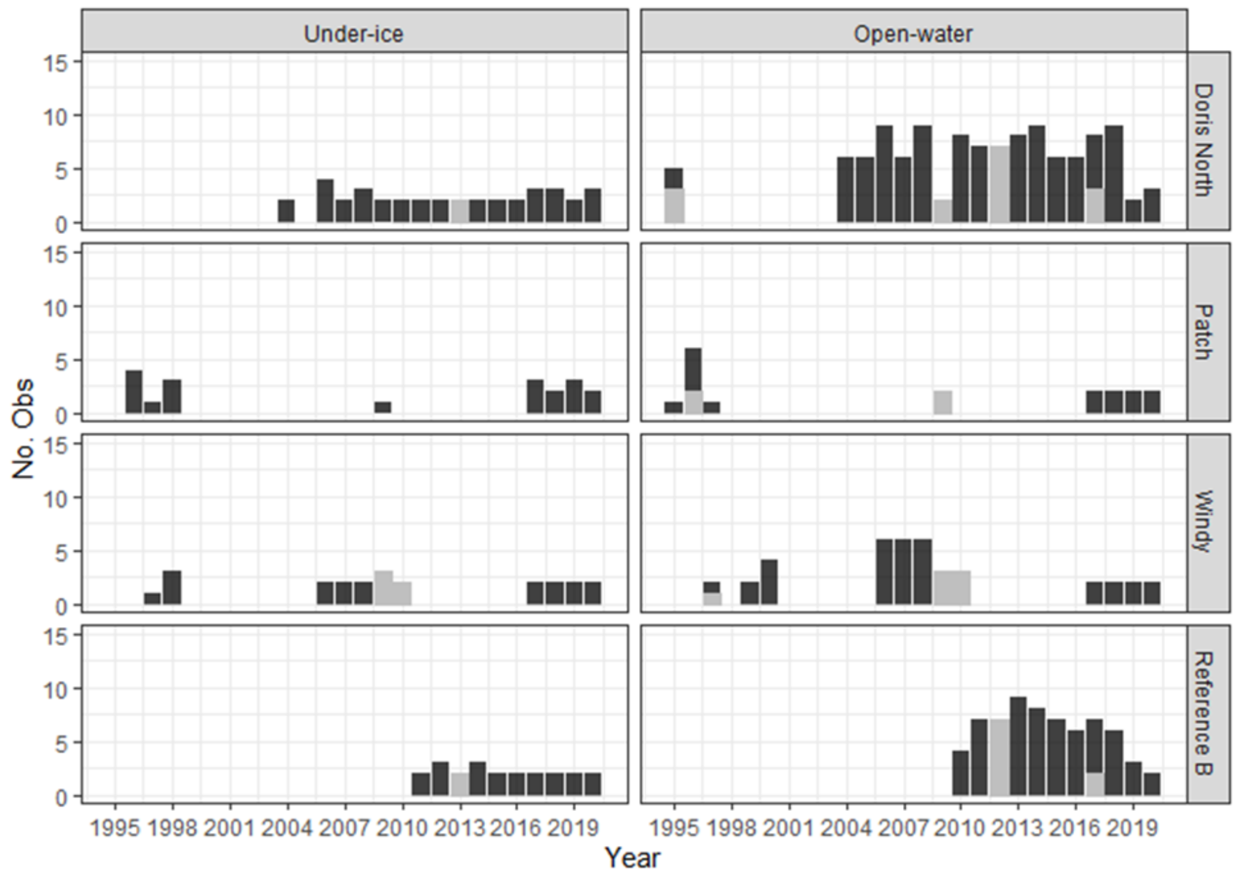
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

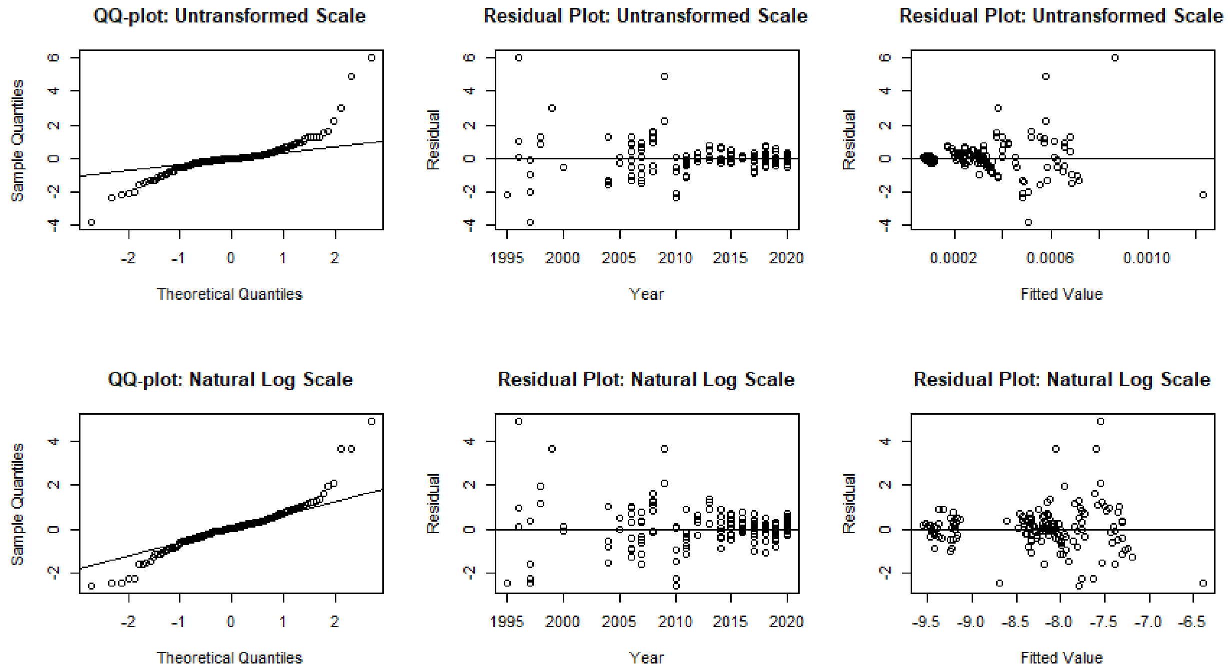
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	2	0.05	0	0.0003
Doris North	Open-water	116	15	0.13	0	0.0003
Patch	Under-ice	19	1	0.05	0	0.0003
Patch	Open-water	18	4	0.22	0	0.0003
Reference B	Under-ice	22	2	0.09	0	0.0001
Reference B	Open-water	66	9	0.14	0	0.0001
Windy	Under-ice	23	5	0.22	0	0.0005
Windy	Open-water	40	7	0.17	0	0.0005

None of the sites exhibited greater than 50% of data less than the detection limit. Doris open-water, Patch open-water, Reference B open-water, Windy under-ice, and Windy open-water exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris. The analysis proceeds with linear mixed effects regression for Patch and Windy.

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 fitted model 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
Doris North	2009	Under-ice	Deep	0.0011	0.001	4.920
Patch	1996	Open-water	Surface	0.0015	0.001	6.010
Patch	1997	Open-water	Surface	0.0001	0.001	-3.835

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris	2009	Under-ice	Deep	0.0011	-7.593	3.660
Patch	1996	Open-water	Surface	0.0015	-7.548	4.903
Windy	1999	Open-water	Surface	0.0007	-8.049	3.680

The natural log-transformed data 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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	86.289	4	0.0000
Compare to Reference B	8.614	4	0.0715

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

Open-water

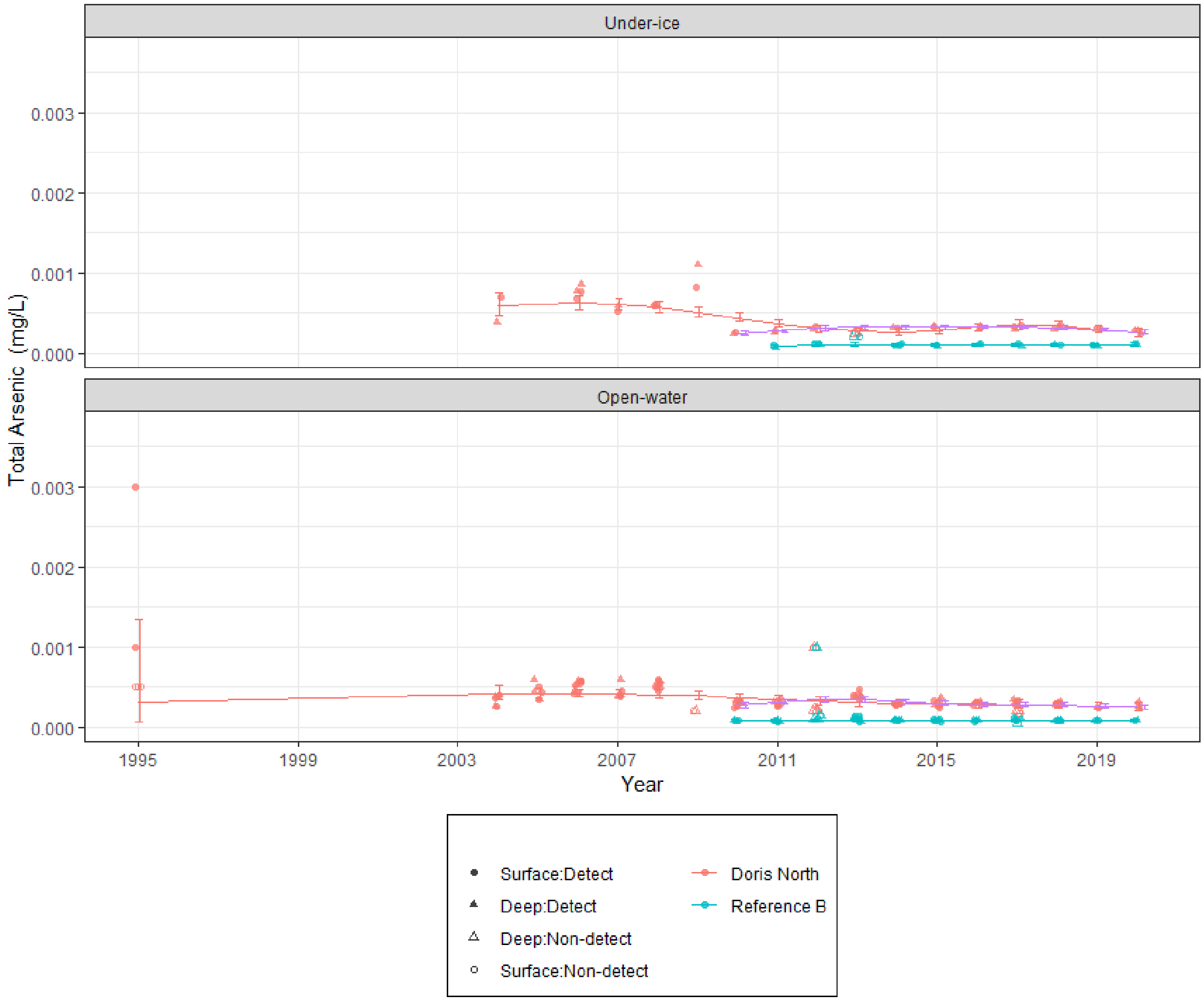
Analysis	Chi.sq	DF	P.value
Compare to slope 0	30.993	4	0.0000
Compare to Reference B	3.468	4	0.4828

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

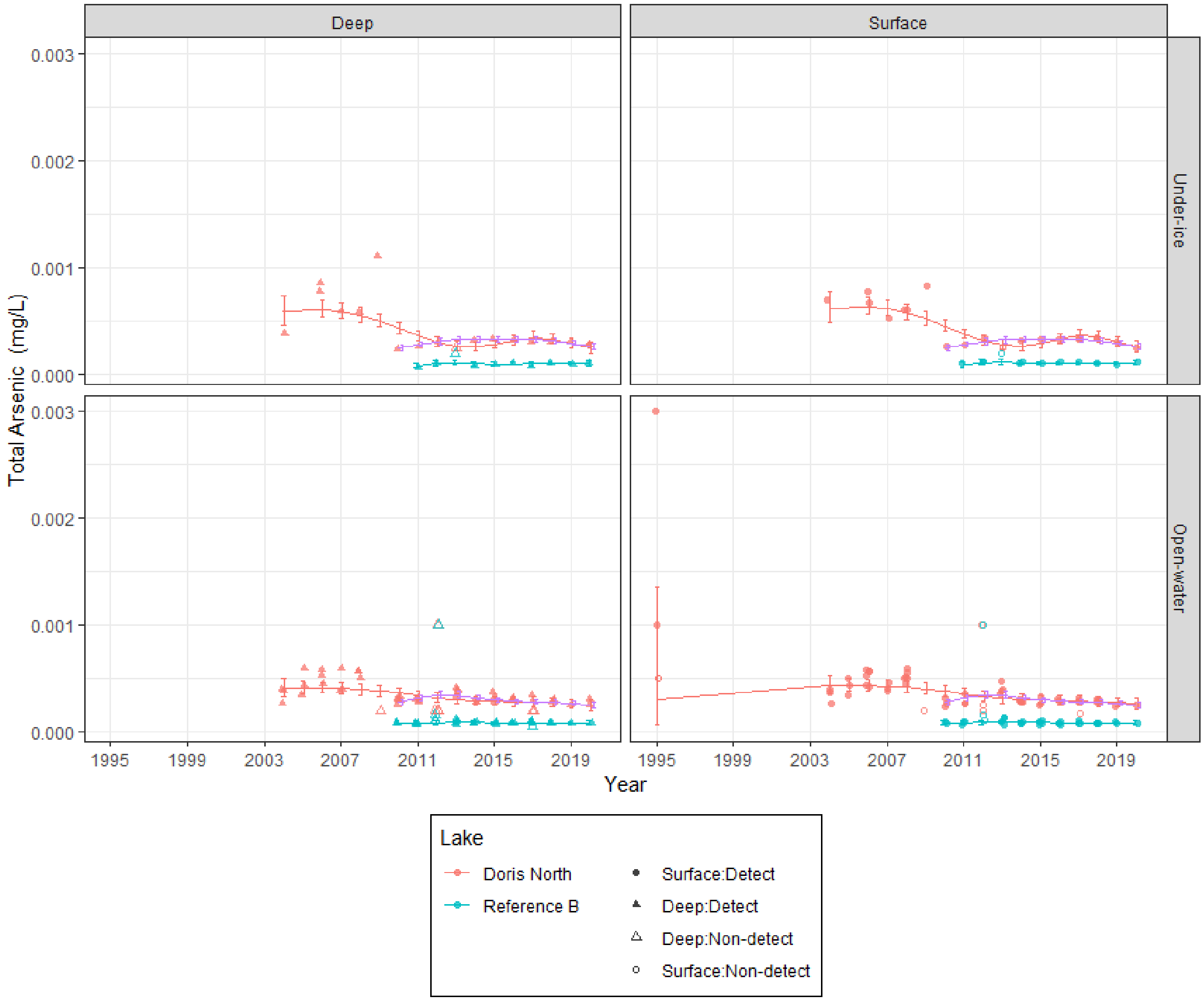
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data; solid purple lines show fitted curves through comparable years of data for comparisons between Doris Lake and Reference B Lake data. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of observed and fitted data averaged over depth.


Under-ice
Open-water
Total Arsenic (mg/L)
0.000
0.001
0.002
0.003
1995
1999
2003
2007
2011
2015
2019
Year
Surface:Detect
Deep:Detect
Deep:Non-detect
Surface:Non-detect
Doris North
Reference B

Plot of observed and fitted data separated by depth.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.2101	0.3468	4.955	-0.6057	0.5714	not sig.

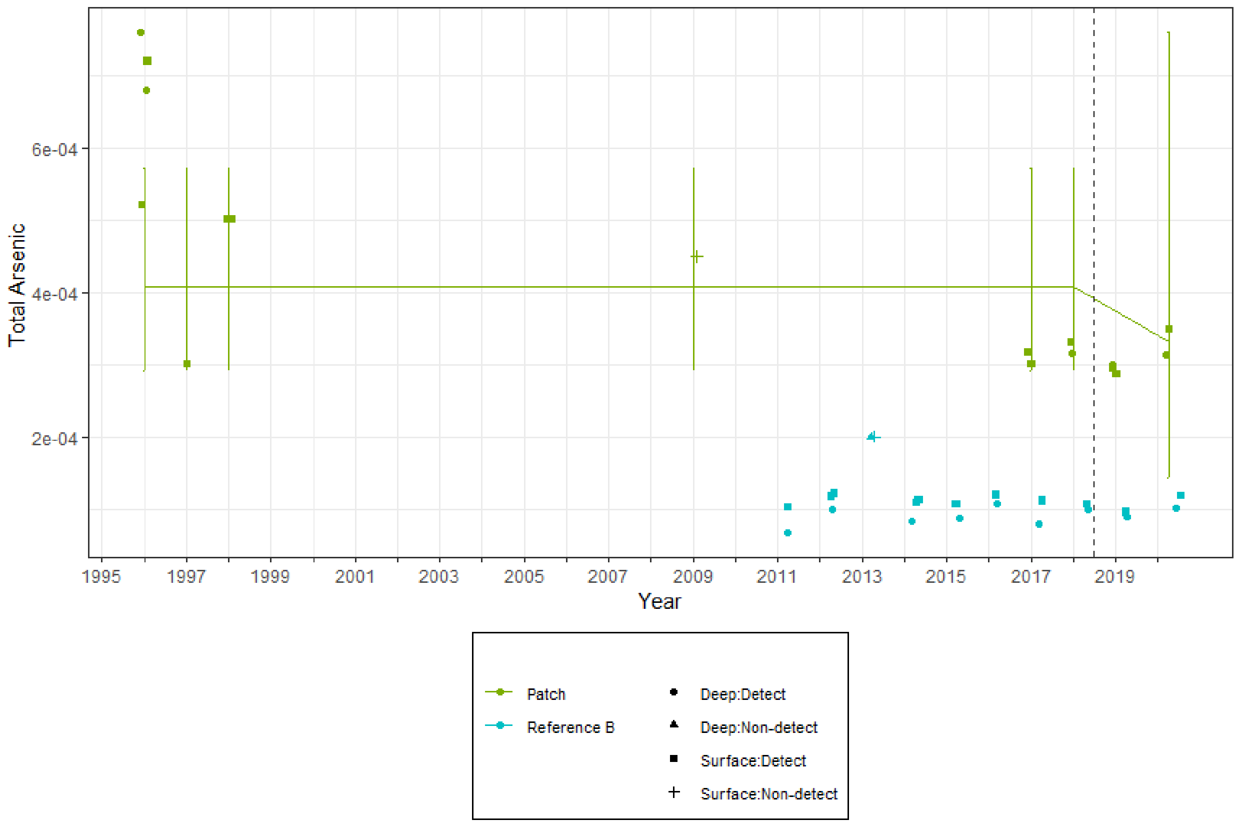
Conclusion:

The change in total arsenic concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.5714) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.1589	0.9901	4.816	-0.1605	0.879	not sig.

Conclusion:

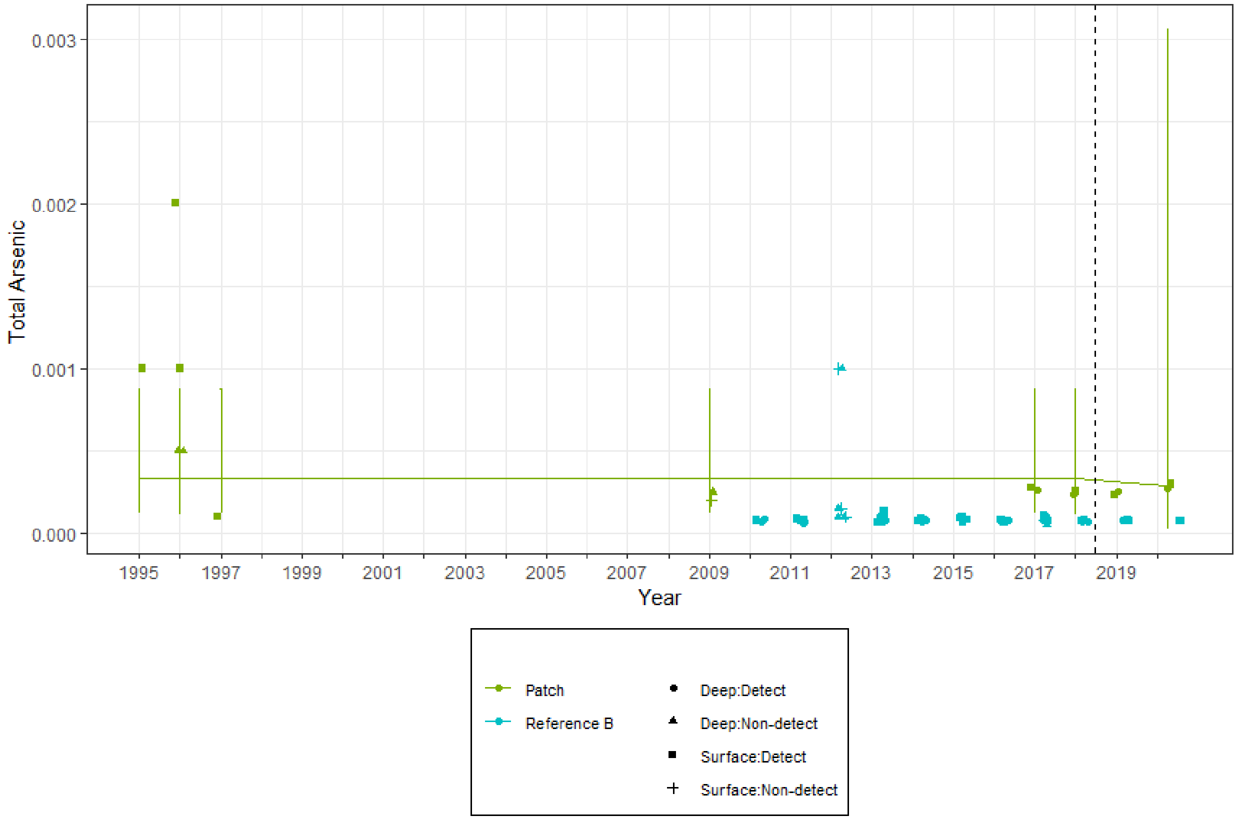
The change in total arsenic concentrations at the Patch site from *before* to *after* was not significantly ($p = 0.879$) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.388	0.5641	7.953	-0.6878	0.5111	not sig.

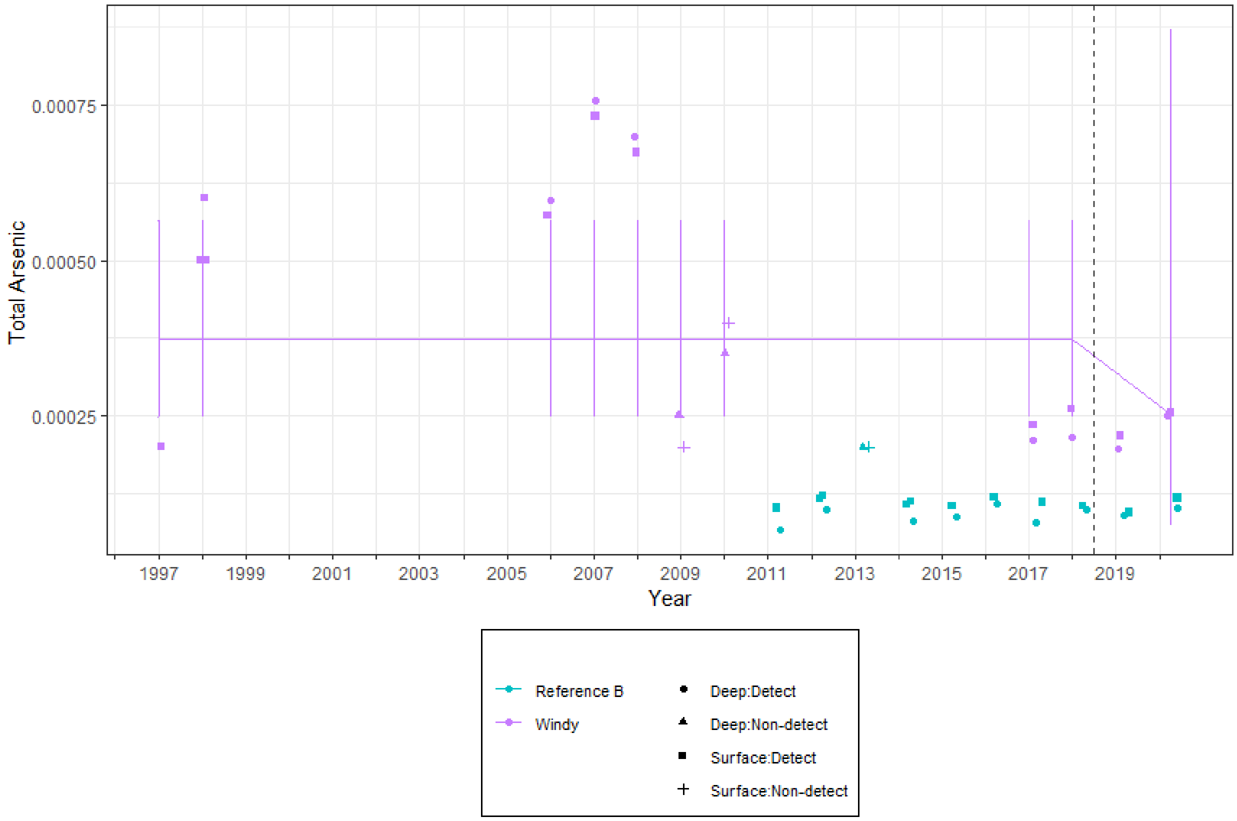
Conclusion:

The change in total arsenic concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.5111) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.357	0.6359	8.711	-0.5613	0.5887	not sig.

Conclusion:

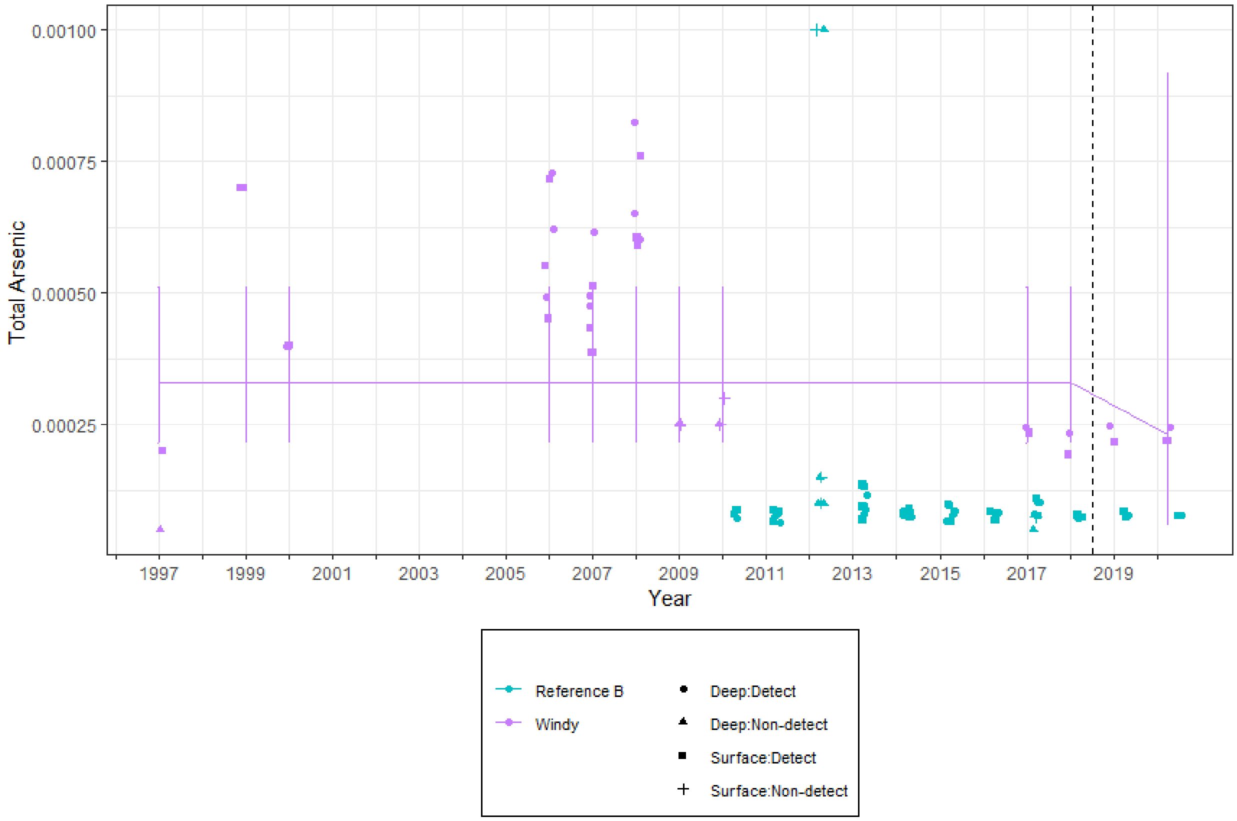
The change in total arsenic concentrations in Windy Lake from *before* to *after* was not significantly ($p = 0.5887$) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

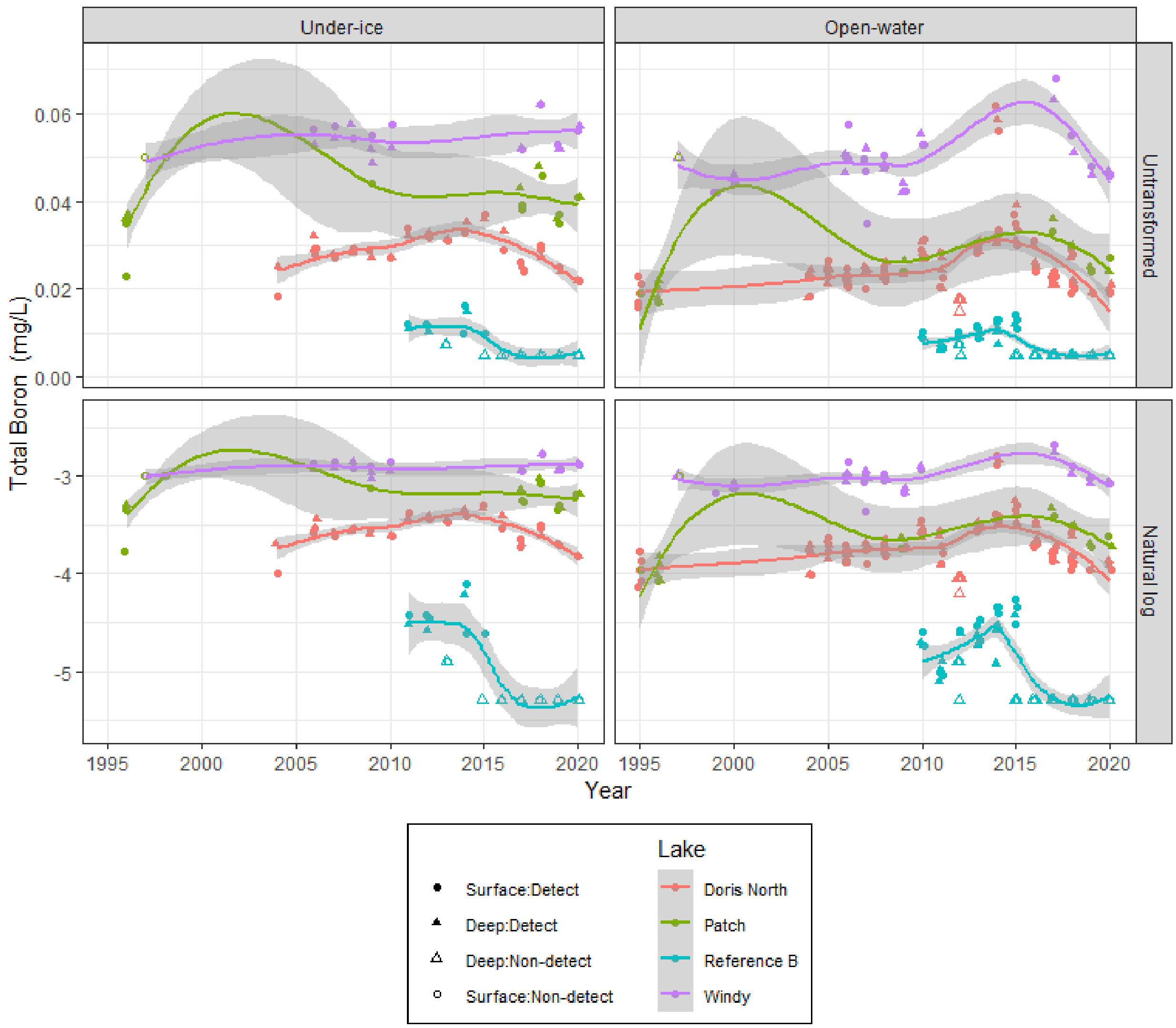
after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.12 Total Boron

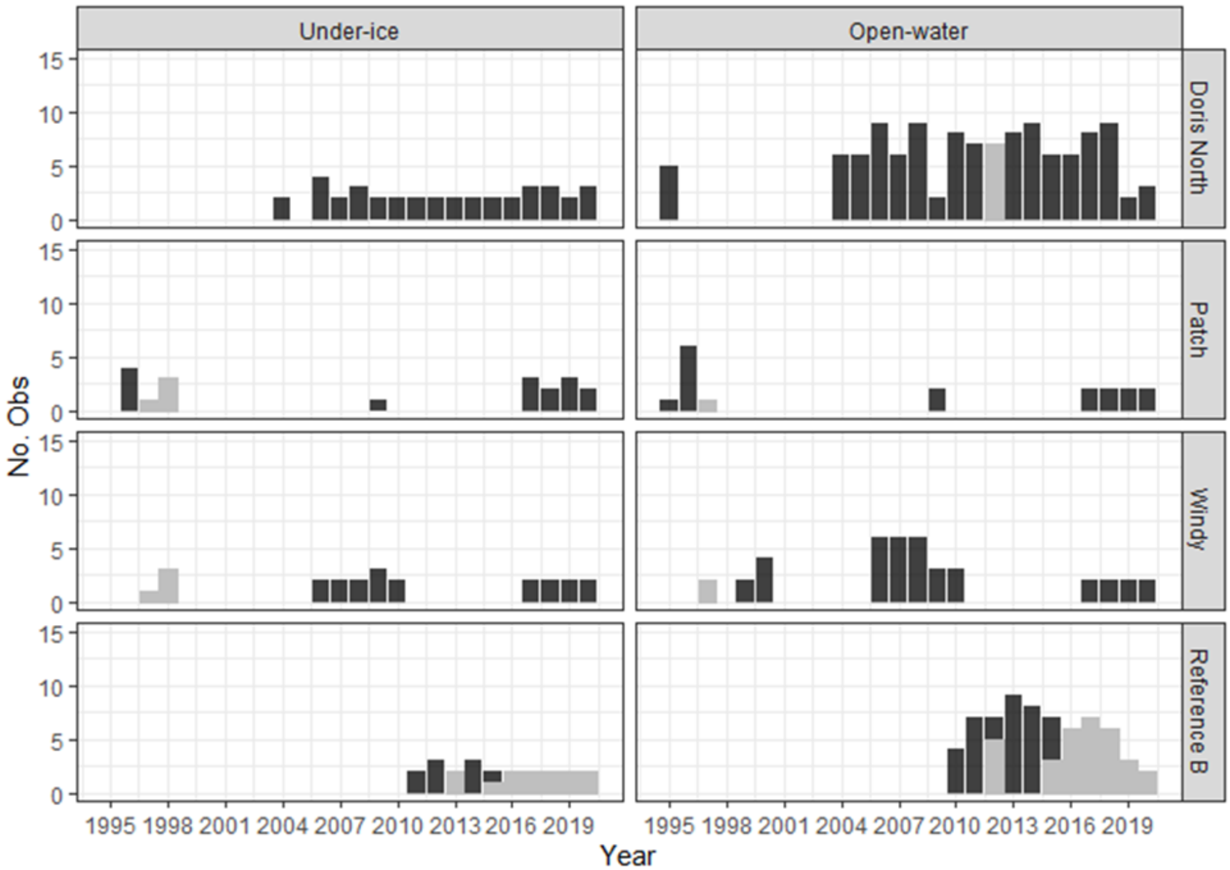
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

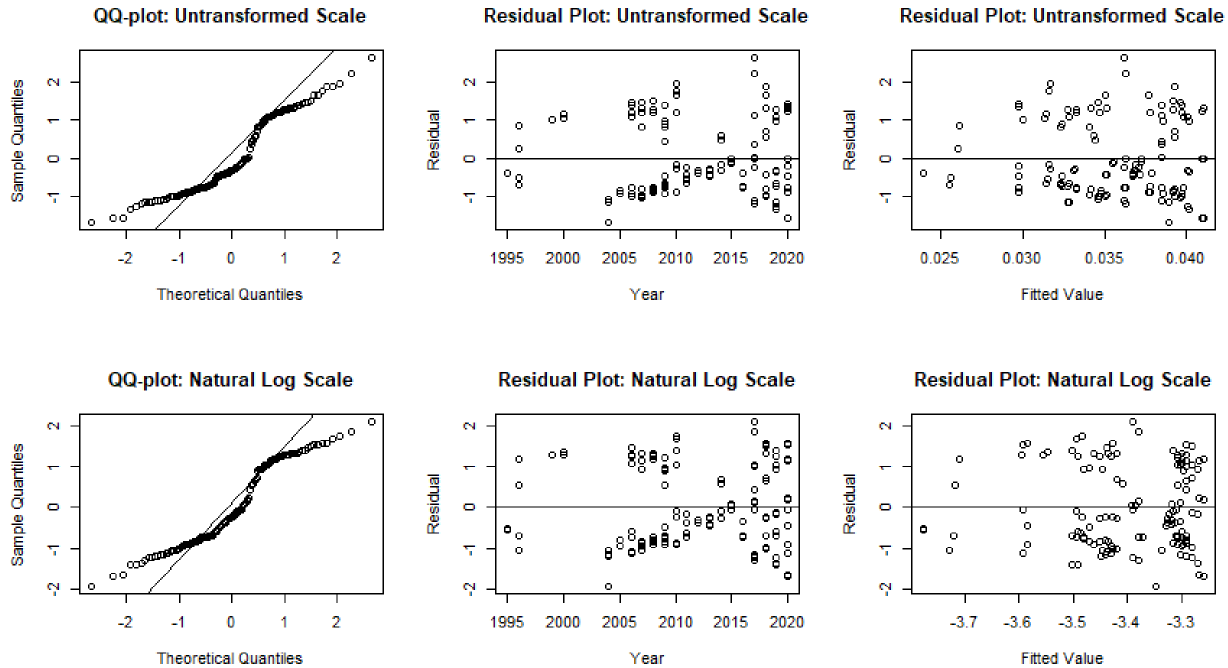
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	0	0.00	0	0.0288
Doris North	Open-water	116	7	0.06	0	0.0243
Patch	Under-ice	19	4	0.21	0	0.0410
Patch	Open-water	18	1	0.06	0	0.0240
Reference B	Under-ice	22	13	0.59	1	0.0100
Reference B	Open-water	66	32	0.48	1	0.0100
Windy	Under-ice	23	4	0.17	0	0.0560
Windy	Open-water	40	2	0.05	0	0.0482

More than 50% of data under detection limit in Reference B under-ice. Data from those site-season groupings will be removed from the analysis. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	51.06	4	0.0000

Doris Lake appears to show significant deviation from no trend.

Open-water

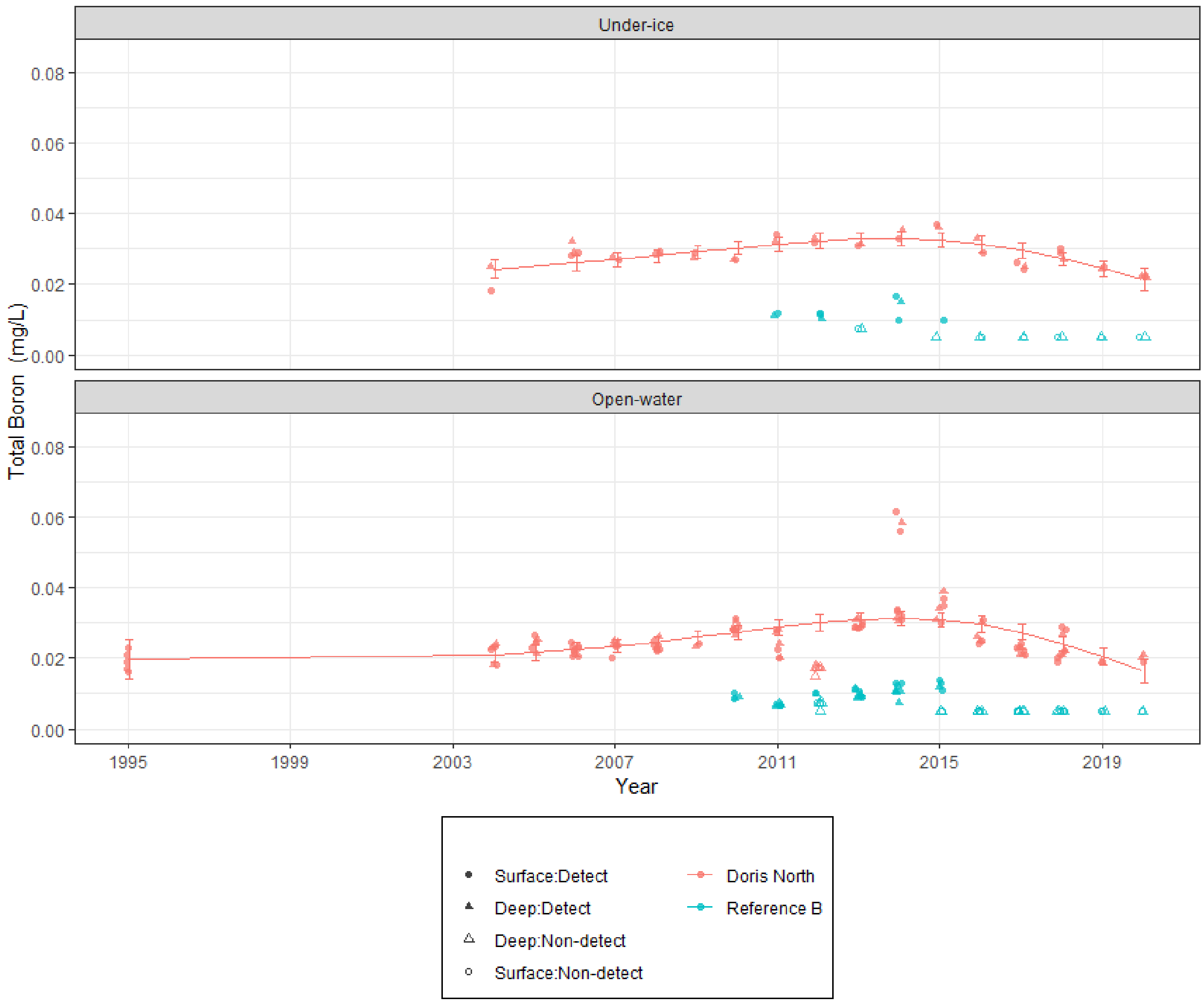
Analysis	Chi.sq	DF	P.value
Compare to slope 0	69.44	4	0.0000

Doris Lake appears to show significant deviation from no trend.

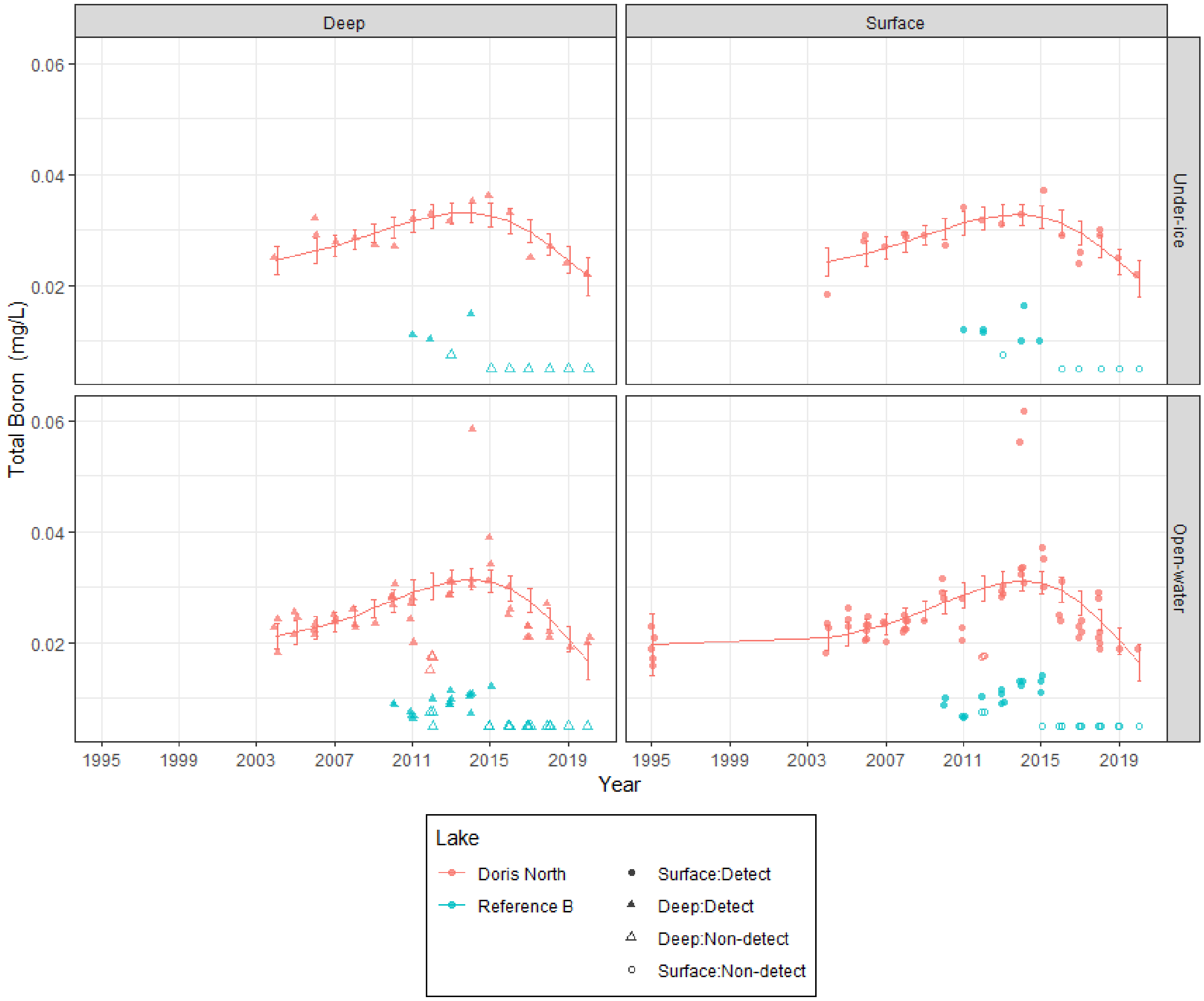
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.0037	0.0078	4.796	-0.4812	0.6515	not sig.

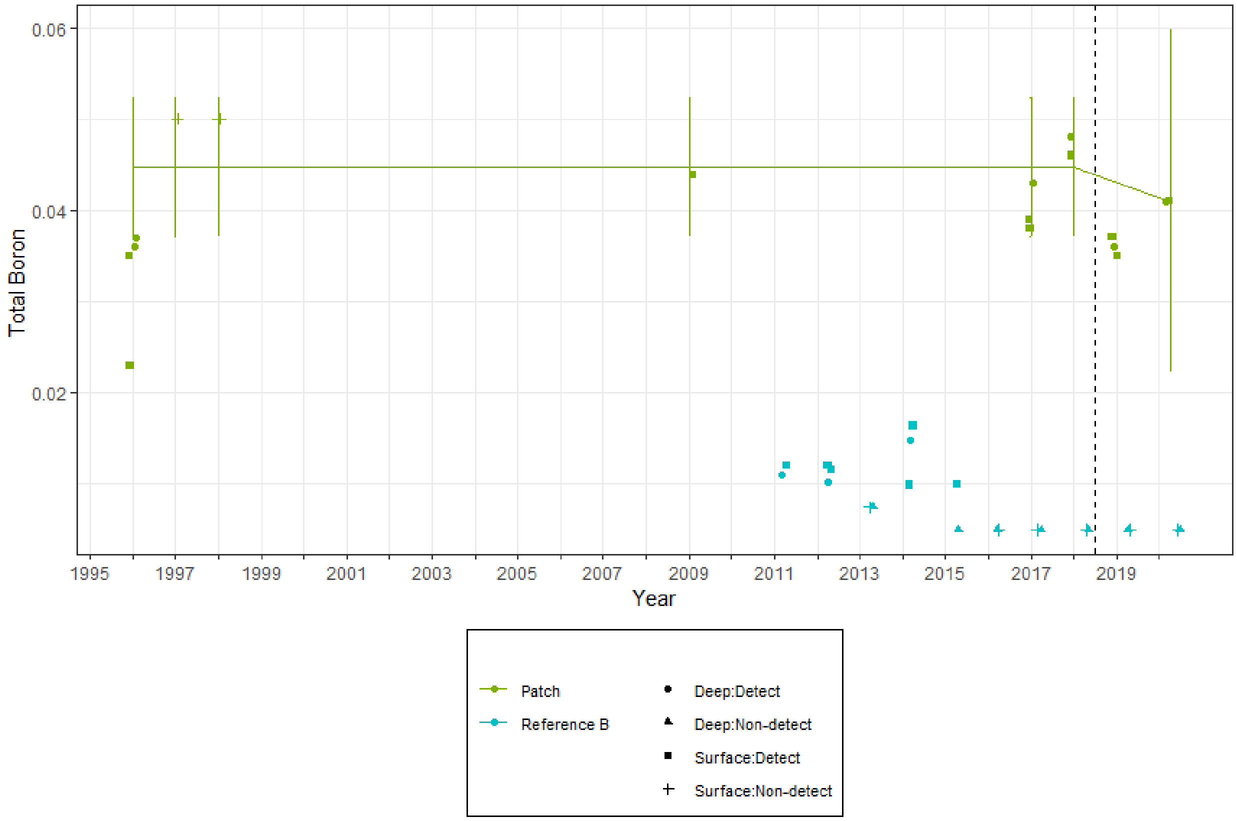
Conclusion:

The change in total boron concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.6515) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.0041	0.0128	4.919	-0.321	0.7614	not sig.

Conclusion:

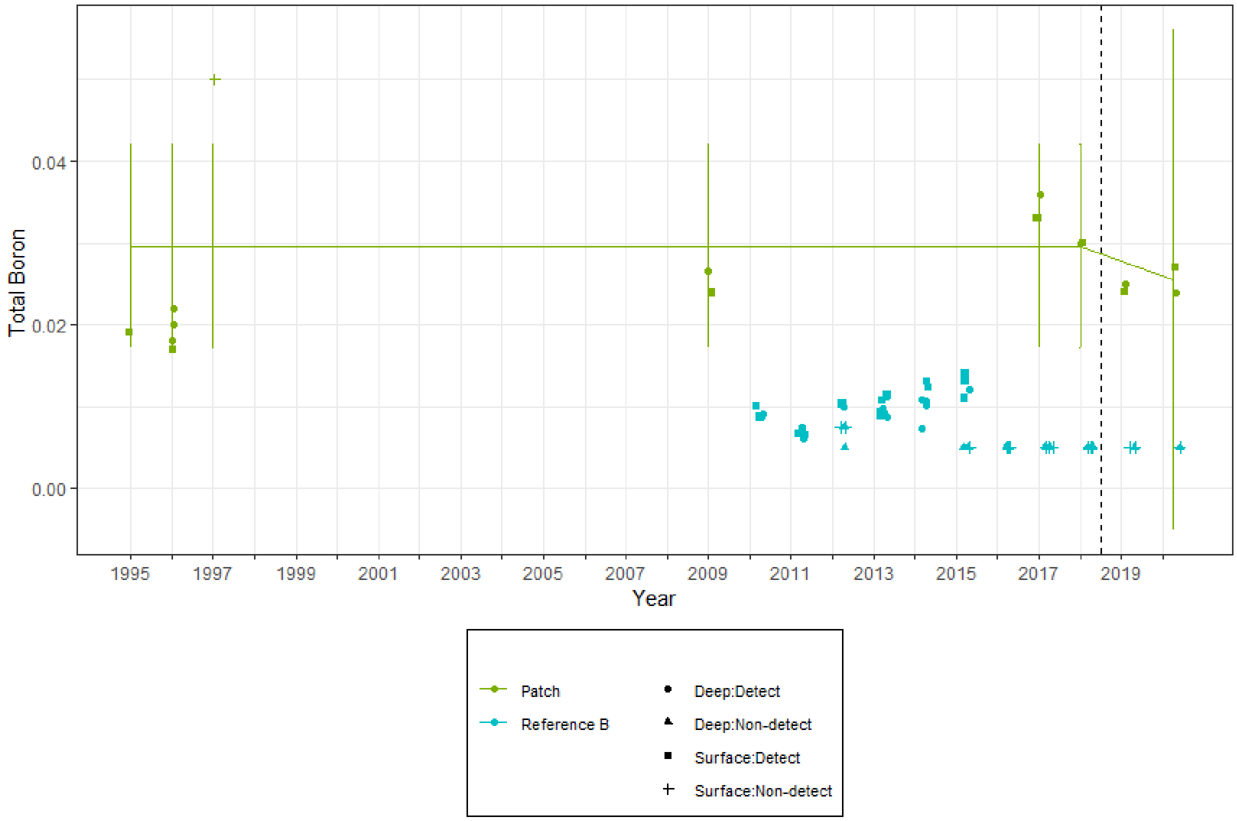
The change in total boron concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.7614) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0023	0.0039	7.091	0.5839	0.5774	not sig.

Conclusion:

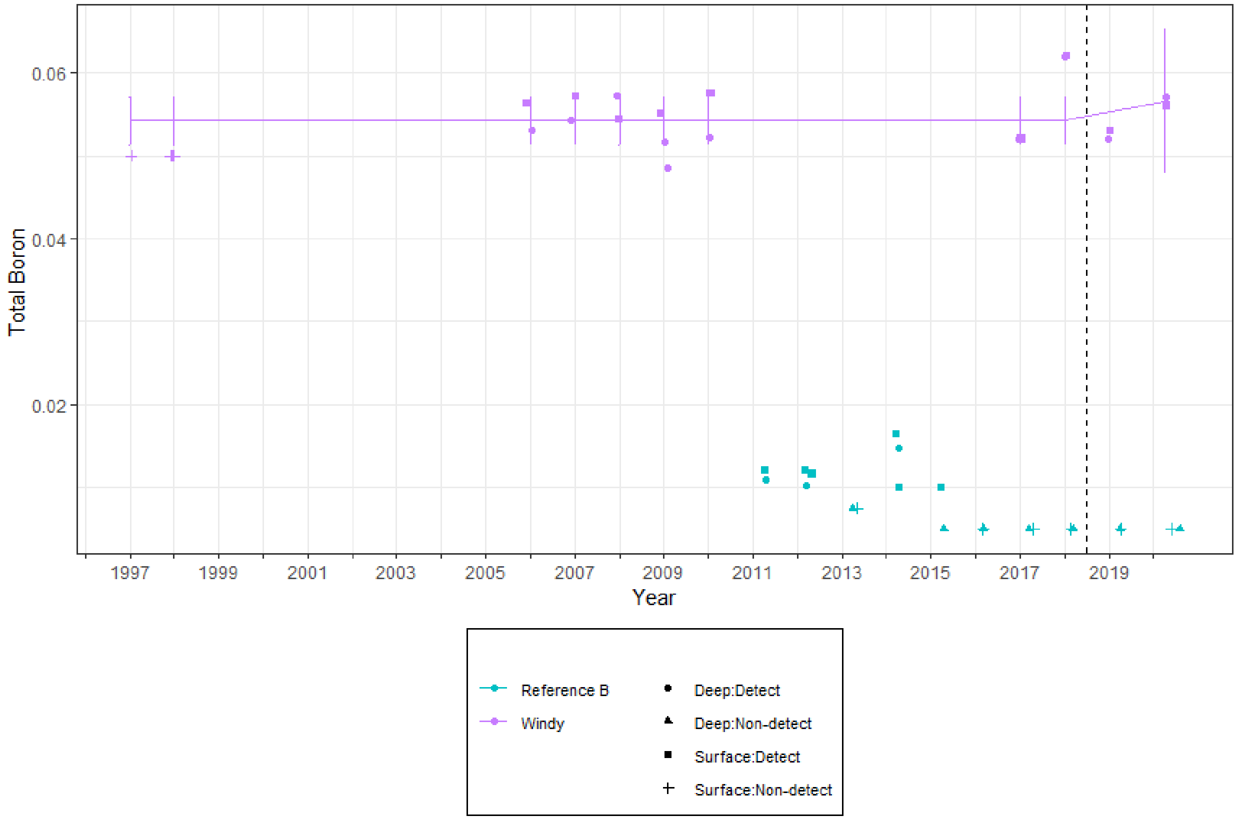
The change in total boron concentrations in Windy ake from *before* to *after* was not significantly (p = 0.5774) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.0033	0.0072	8.861	-0.4649	0.6532	not sig.

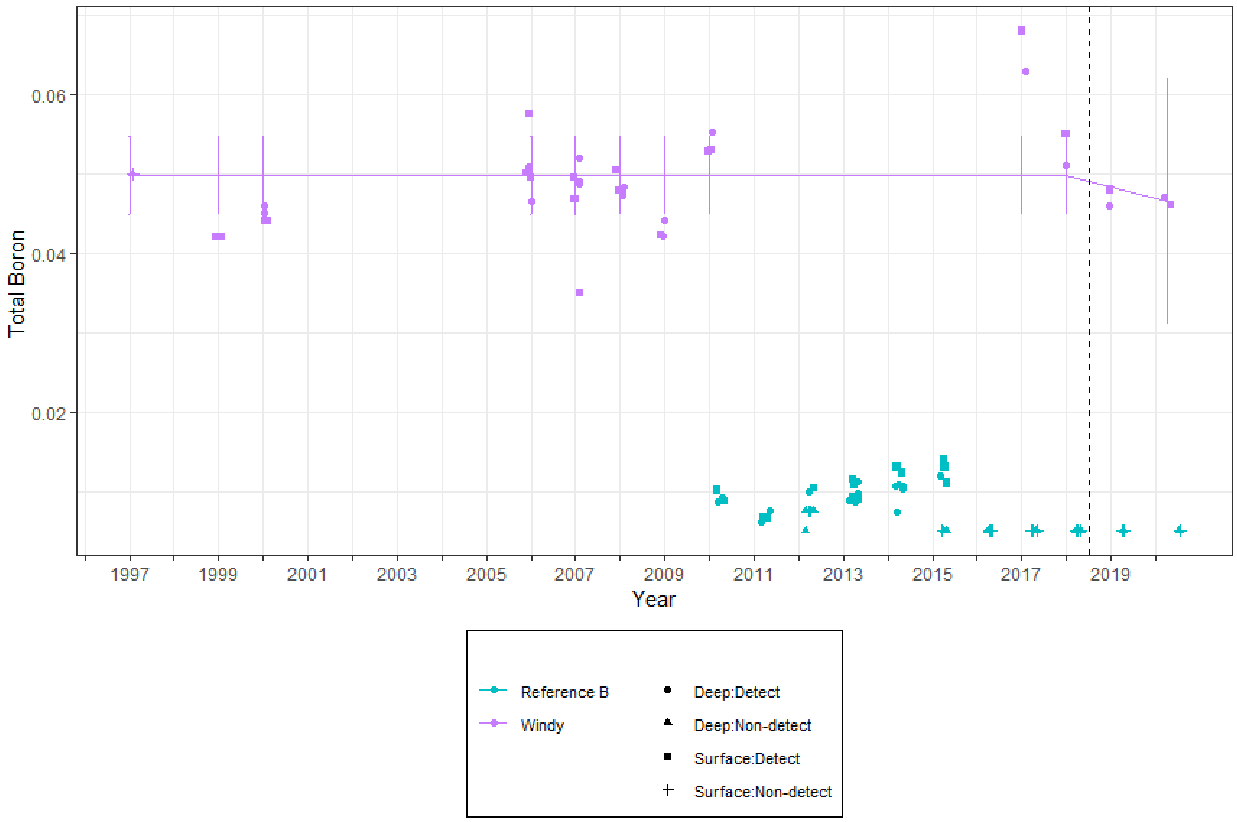
Conclusion:

The change in total boron concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.6532) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

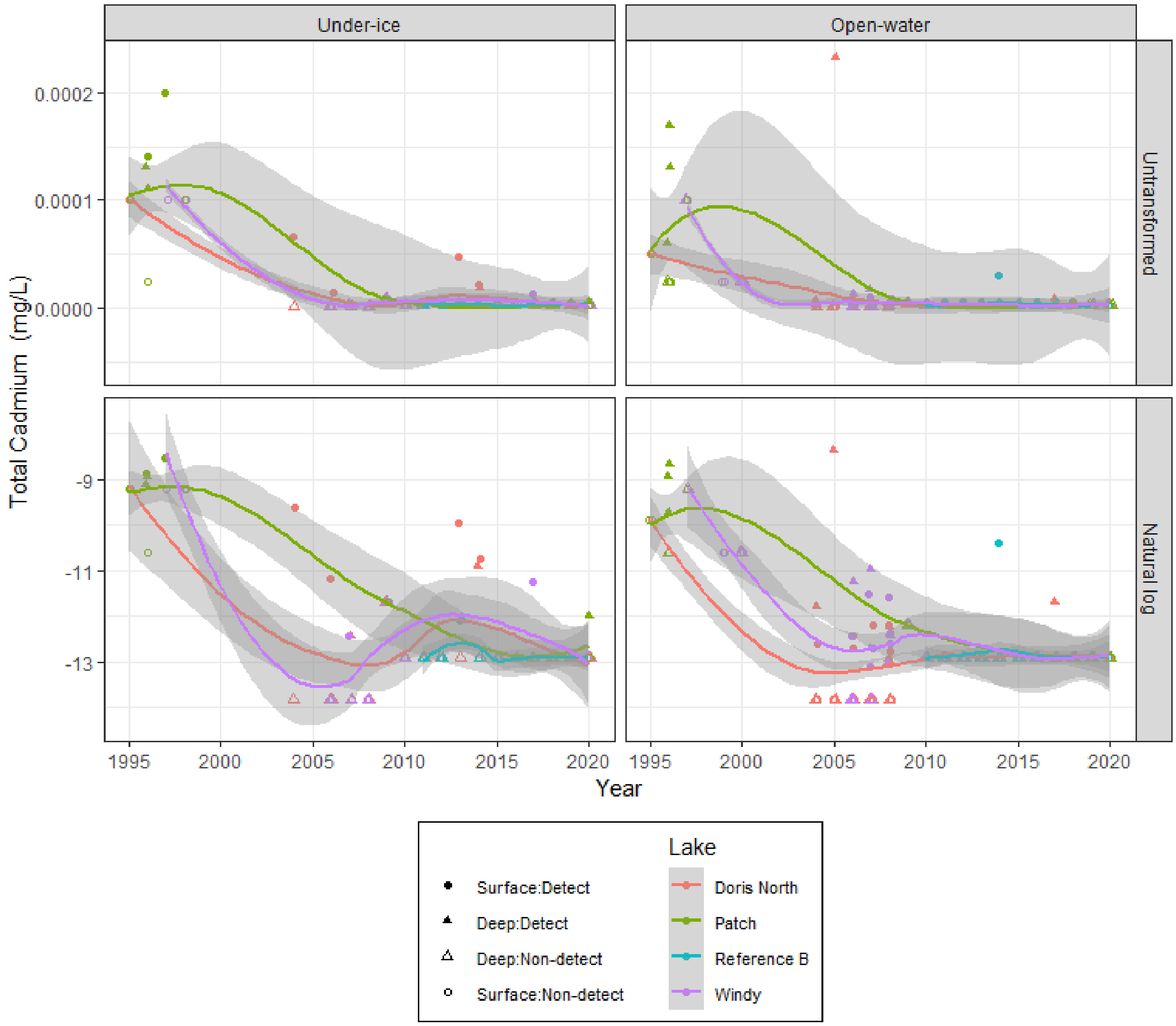
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.13 *Total Cadmium*

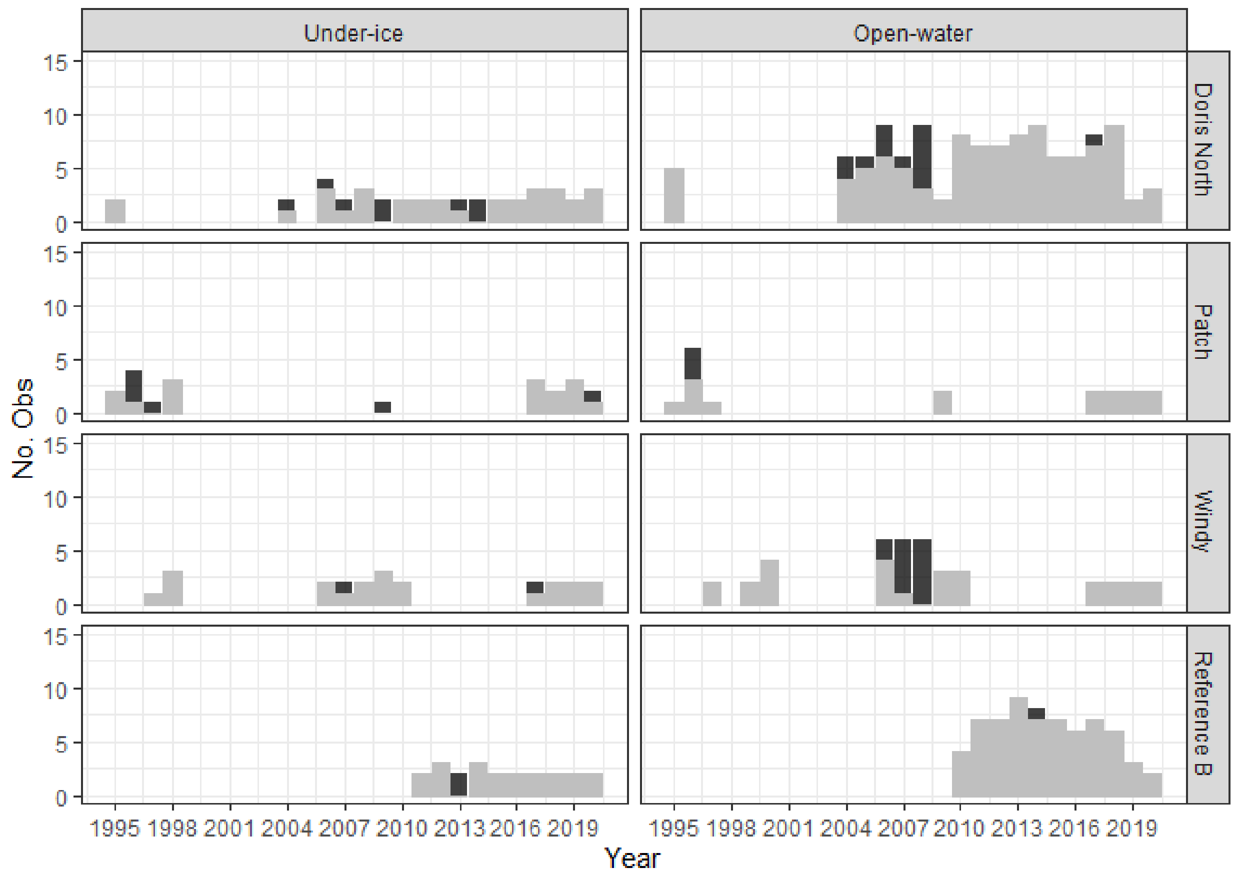
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

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

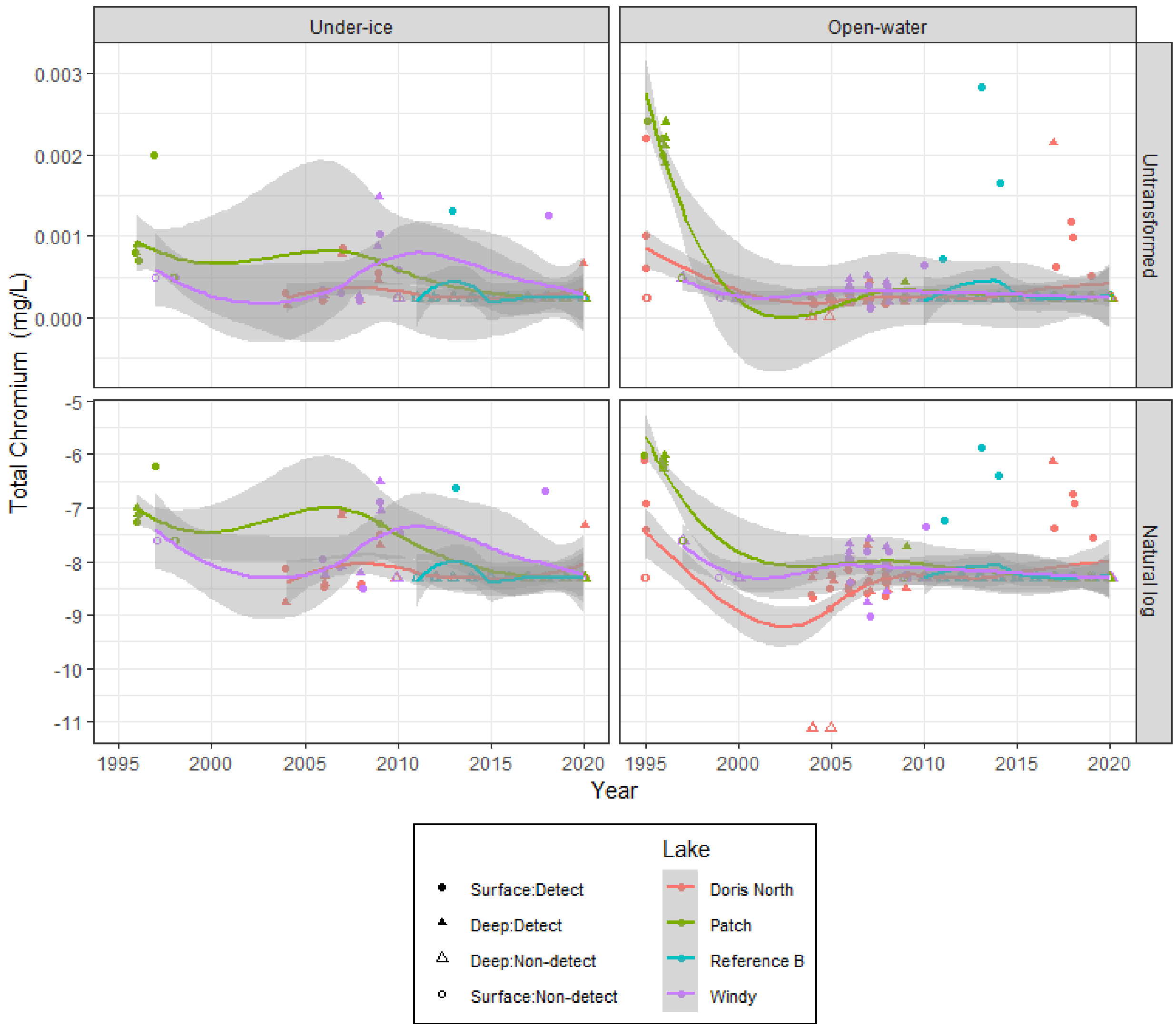
Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	40	34	0.85	1.0	0
Doris North	Open-water	116	102	0.88	1.0	0
Patch	Under-ice	21	16	0.76	0.5	0
Patch	Open-water	18	15	0.83	1.0	0
Reference B	Under-ice	22	20	0.91	1.0	0
Reference B	Open-water	66	65	0.98	1.0	0
Windy	Under-ice	23	21	0.91	1.0	0
Windy	Open-water	40	27	0.68	1.0	0

Greater than 50% of observations from all site-season groupings were censored. All data removed from the analysis and no statistical analyses were performed.

C.3.1.14 Total Chromium

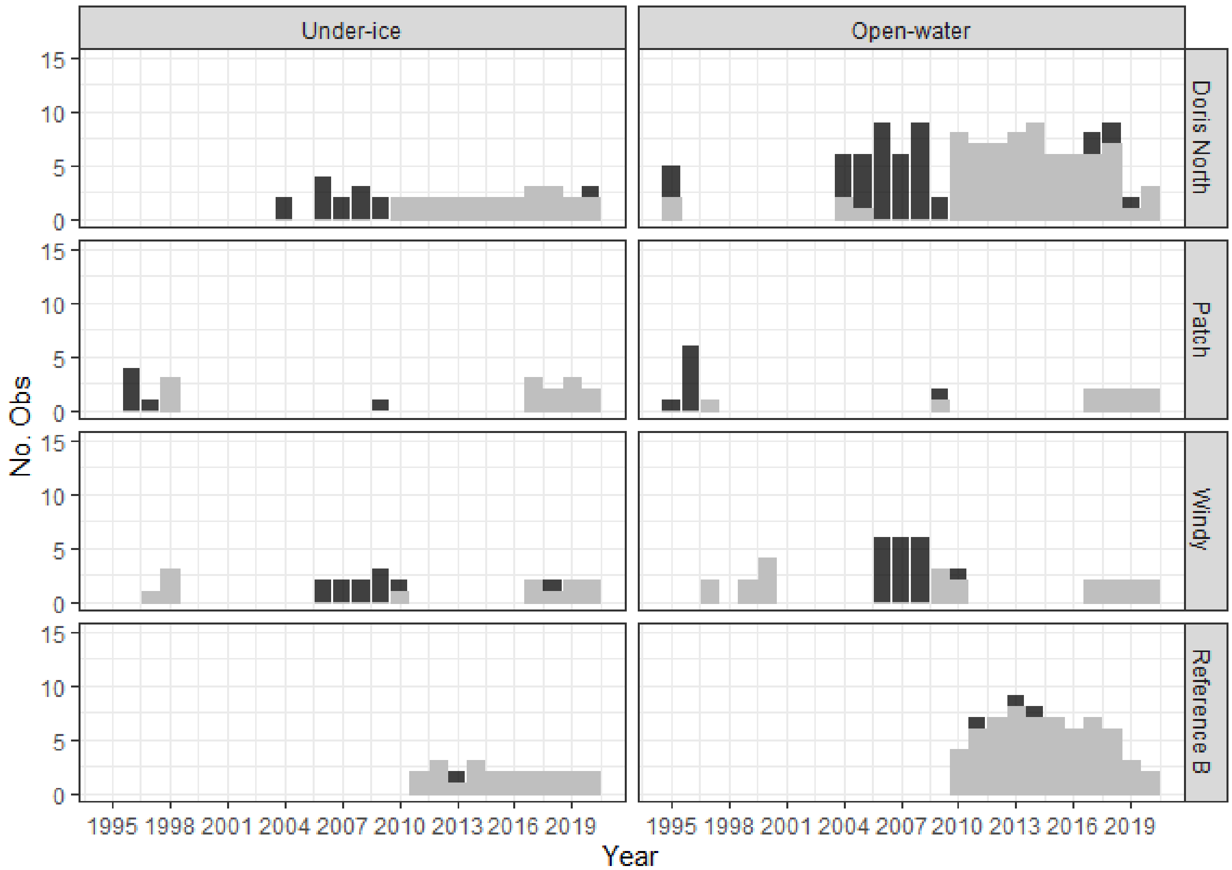
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

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

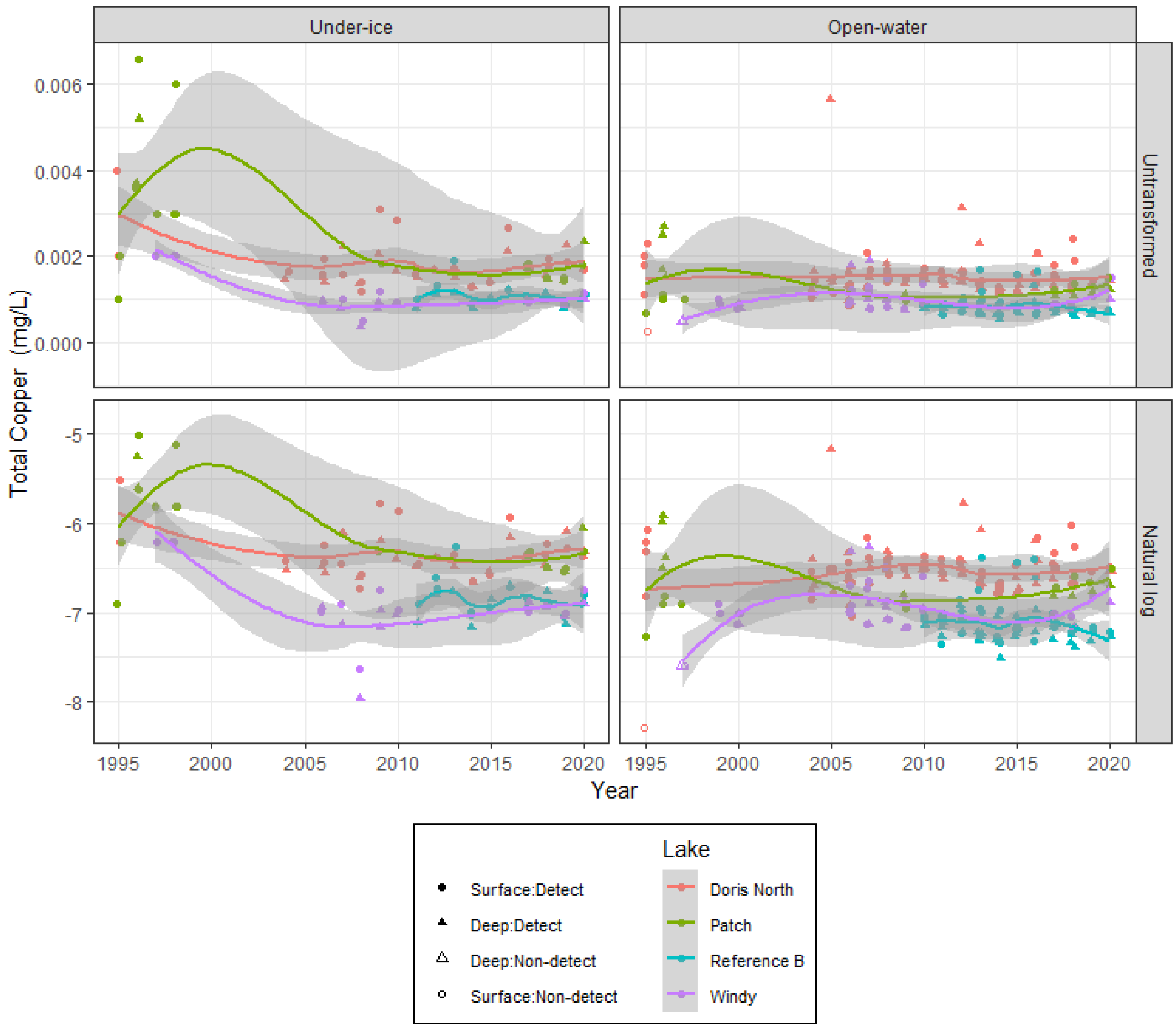
Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	24	0.63	0.67	0.0005
Doris North	Open-water	116	73	0.63	1.00	0.0005
Patch	Under-ice	19	13	0.68	1.00	0.0005
Patch	Open-water	18	10	0.56	1.00	0.0005
Reference B	Under-ice	22	21	0.95	1.00	0.0005
Reference B	Open-water	66	63	0.95	1.00	0.0005
Windy	Under-ice	23	12	0.52	1.00	0.0005
Windy	Open-water	40	21	0.52	1.00	0.0005

Greater than 50% of observations from all site-season groupings were censored. All data removed from the analysis and no statistical analyses were performed.

C.3.1.15 Total Copper

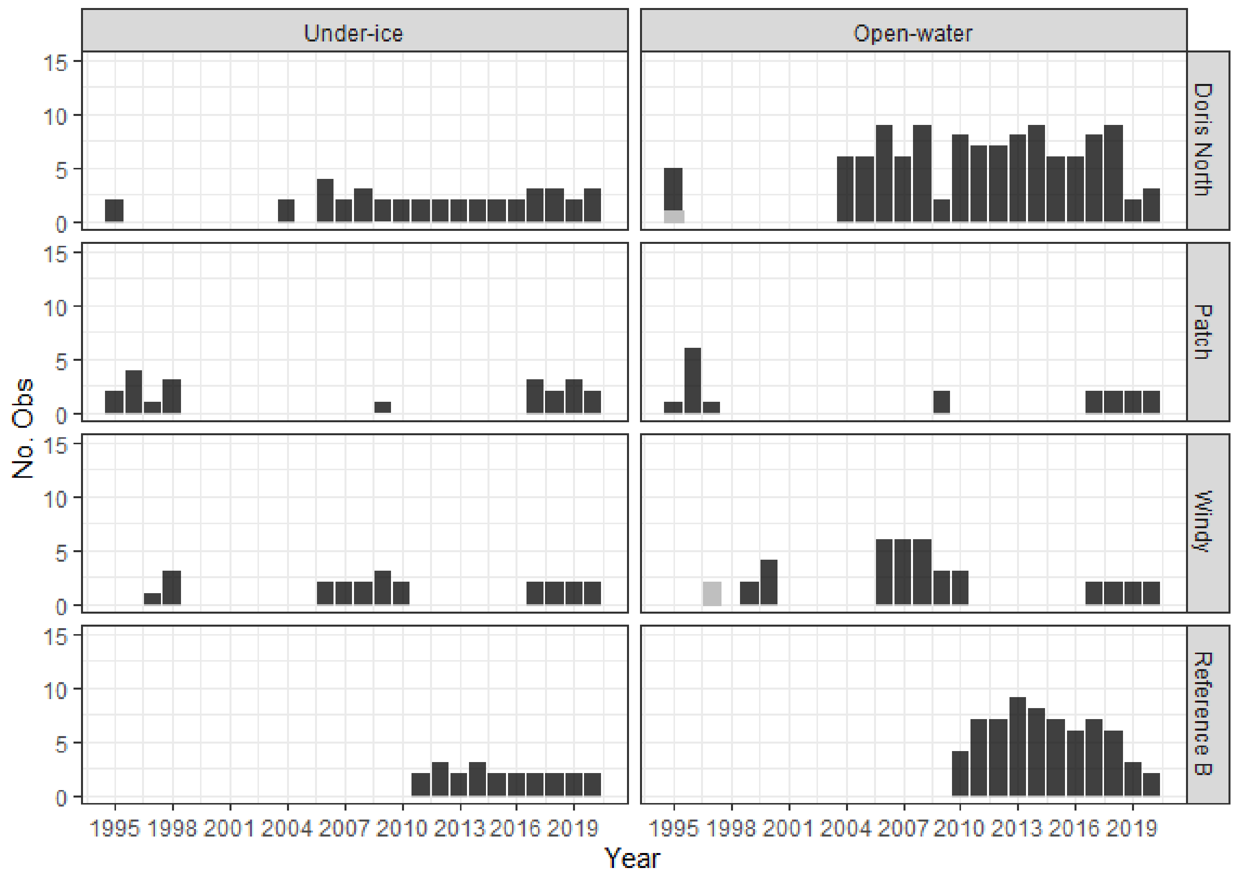
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

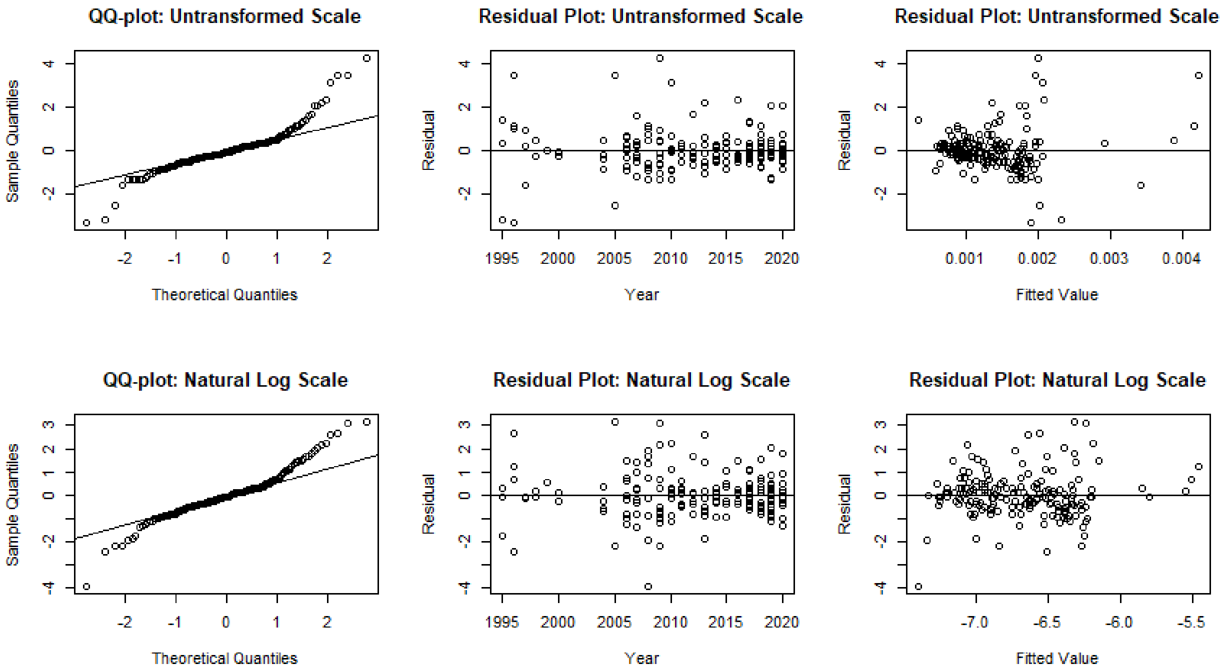
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	40	0	0.00	0	0.0017
Doris North	Open-water	116	1	0.01	0	0.0014
Patch	Under-ice	21	0	0.00	0	0.0018
Patch	Open-water	18	0	0.00	0	0.0012
Reference B	Under-ice	22	0	0.00	0	0.0010
Reference B	Open-water	66	0	0.00	0	0.0008
Windy	Under-ice	23	0	0.00	0	0.0010
Windy	Open-water	40	2	0.05	0	0.0010

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris North	2005	Open-water	Deep	0.0029	0.002	3.493
Doris North	2009	Under-ice	Surface	0.0031	0.002	4.261
Doris North	2010	Under-ice	Surface	0.0029	0.002	3.132
Patch	1995	Under-ice	Surface	0.0015	0.002	-3.233
Patch	1996	Under-ice	Surface	0.0051	0.004	3.483
Patch	1996	Open-water	Surface	0.0011	0.002	-3.360

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2005	Open-water	Deep	0.0029	-6.320	3.145
Doris North	2009	Under-ice	Surface	0.0031	-6.234	3.102
Windy	2008	Under-ice	Deep	0.0003	-7.394	-3.926

The natural log-transformed data 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.

Doris Lake

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

Under-ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	7.949	4	0.0935

Doris Lake does not exhibit significant deviation from no trend.

Open-water

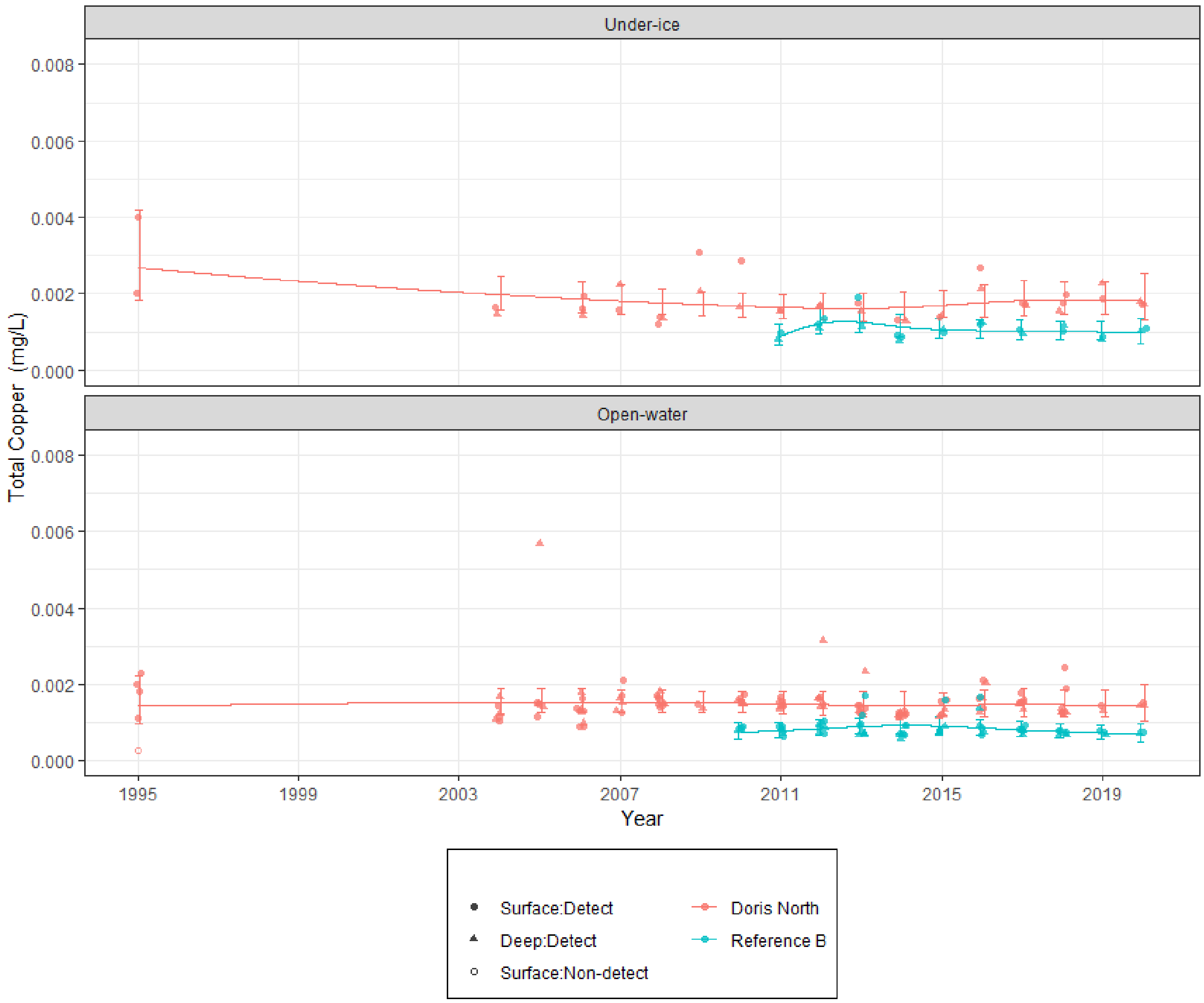
Analysis	Chi.sq	DF	P.value
Compare to slope 0	0.46	4	0.9773

Doris Lake does not exhibit significant deviation from no trend.

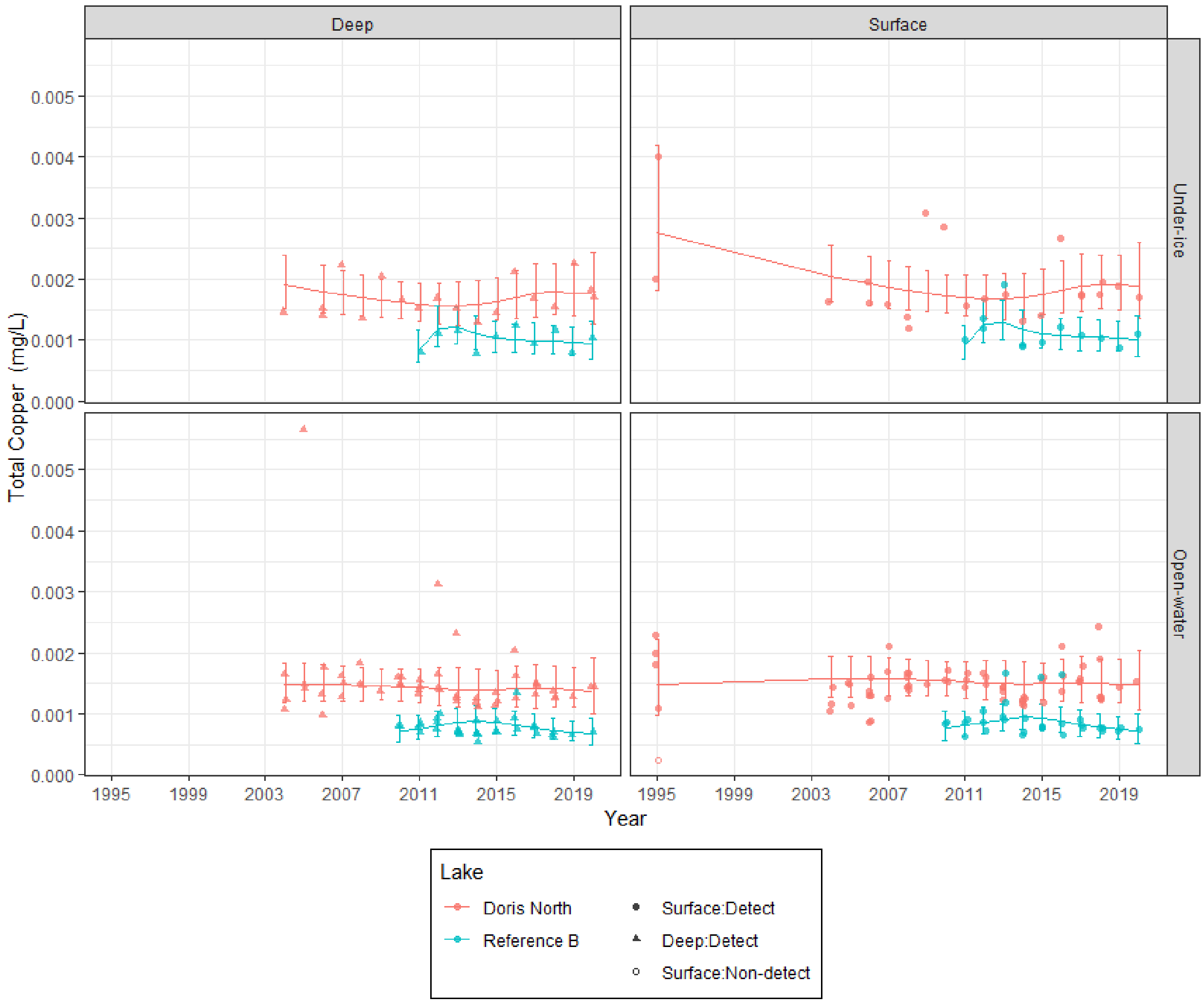
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.1413	0.5132	5.893	-0.2754	0.7924	not sig.

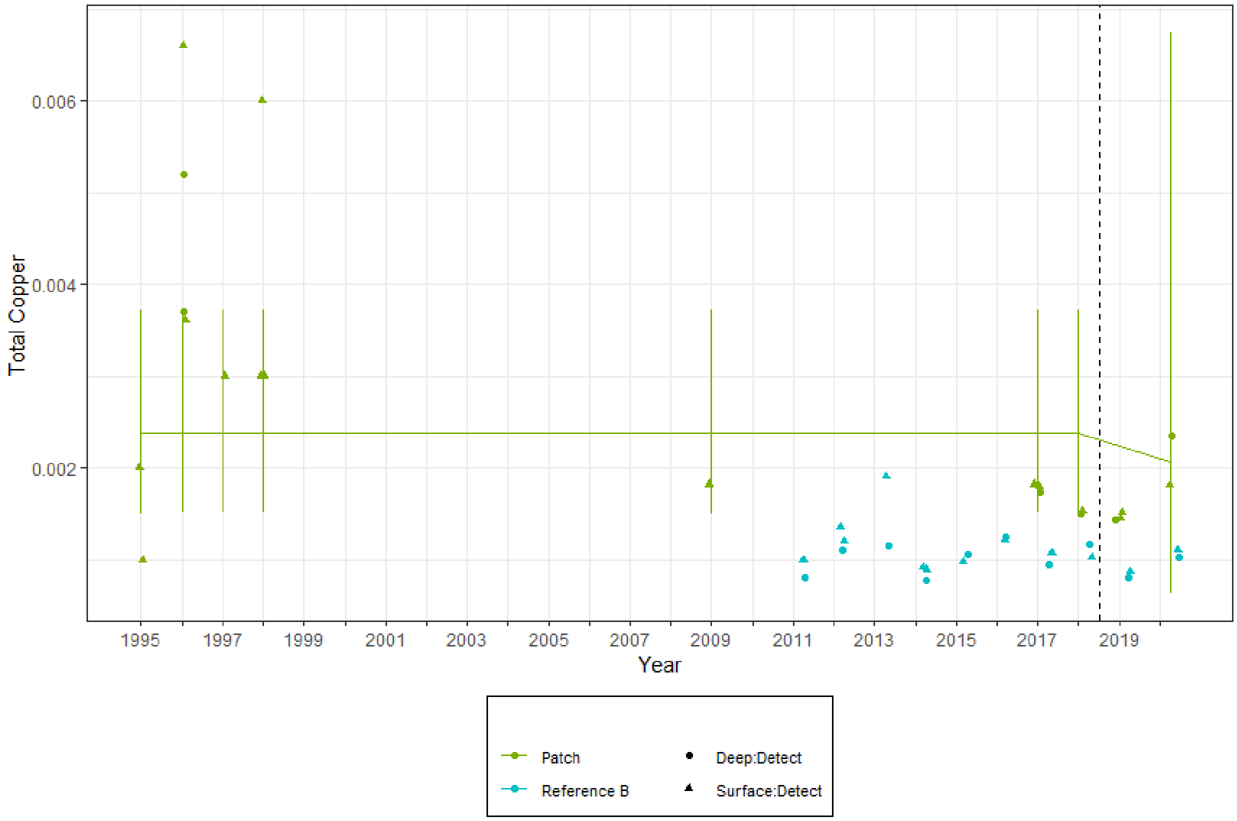
Conclusion:

The change in total copper concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.7924) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.1765	0.2097	9	0.8416	0.4218	not sig.

Conclusion:

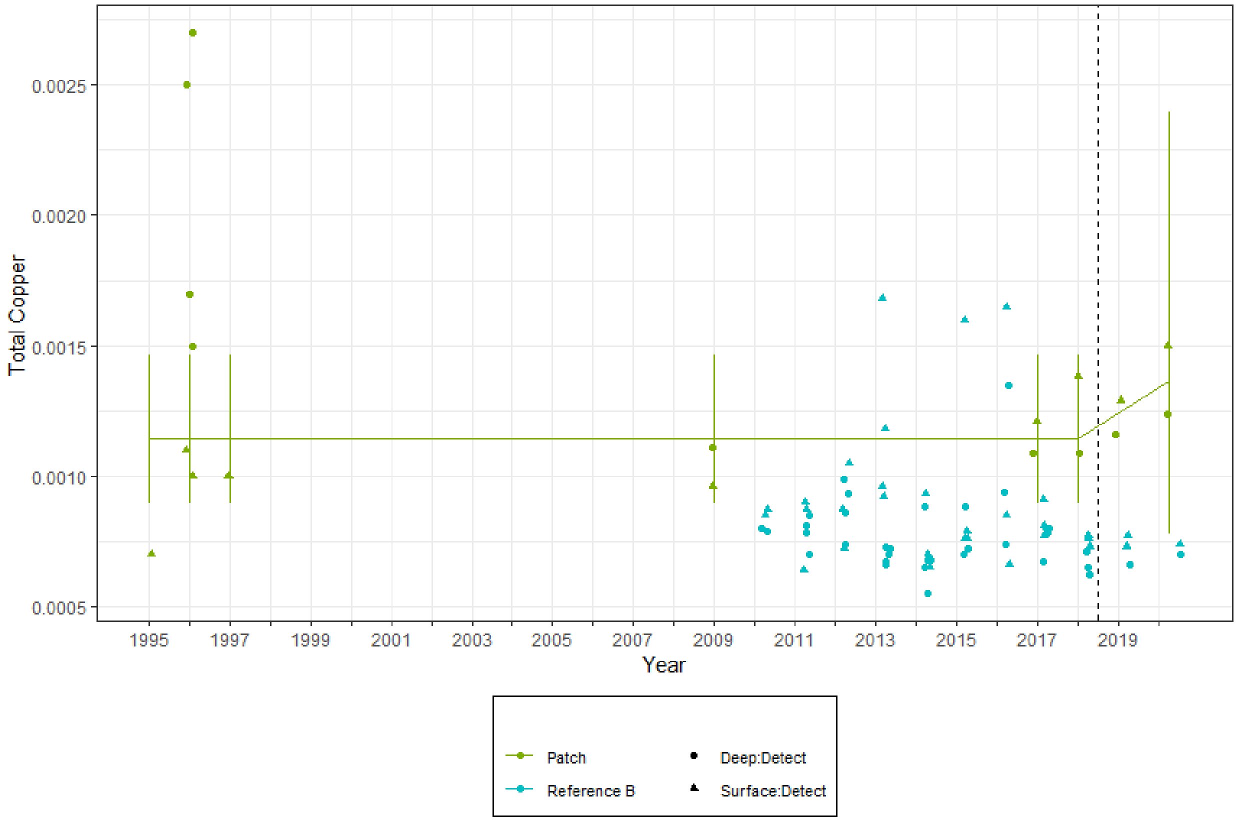
The change in total copper concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.4218) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0811	0.4668	7.671	0.1737	0.8666	not sig.

Conclusion:

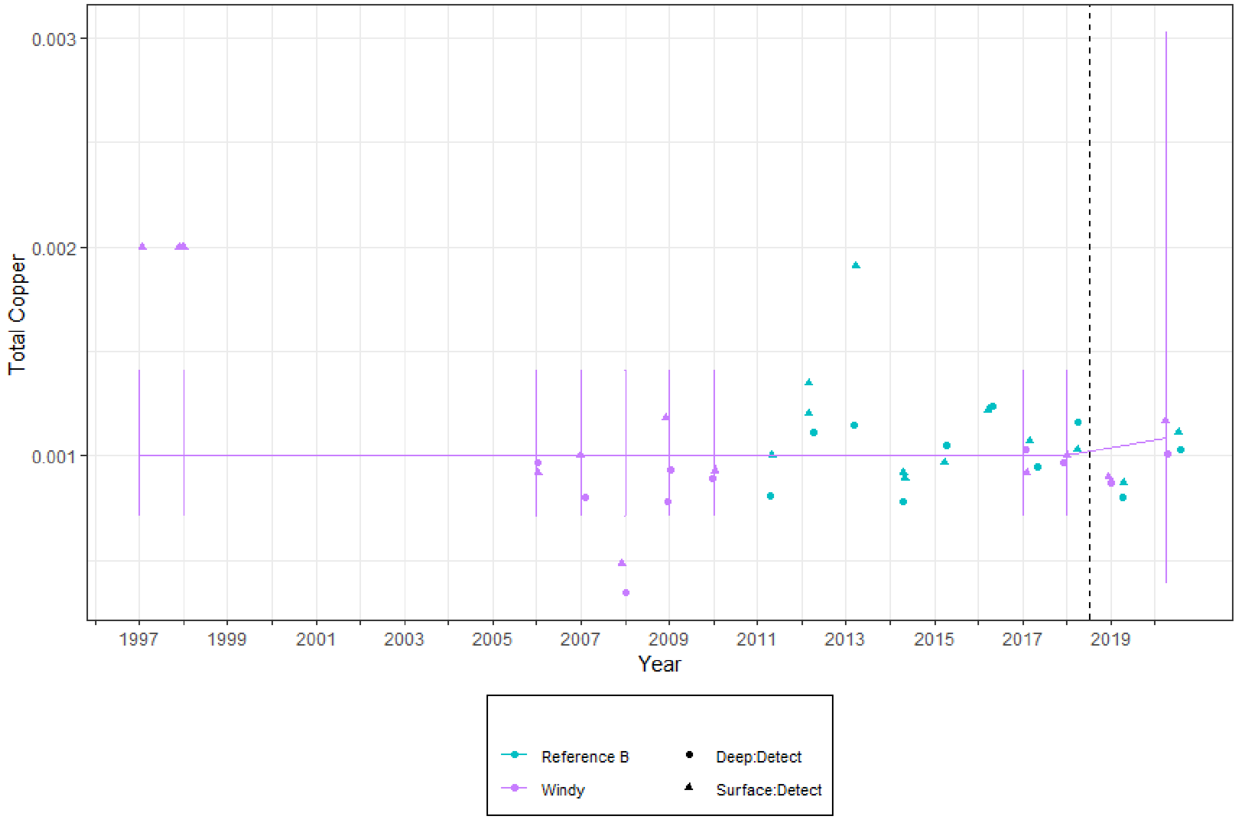
The change in total copper concentrations in Windy Lake from *before* to *after* was not significantly ($p = 0.8666$) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.3206	0.2539	9.001	1.262	0.2385	not sig.

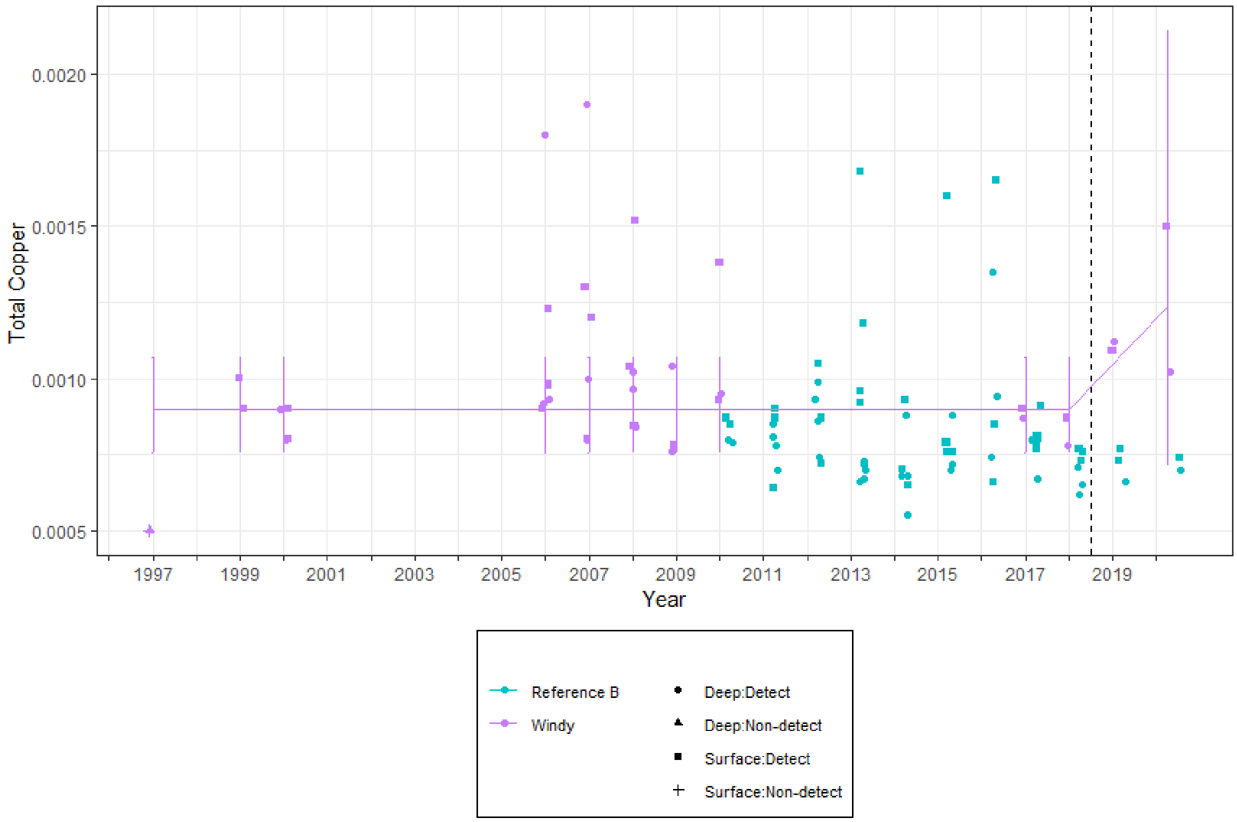
Conclusion:

The change in total copper concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.2385) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

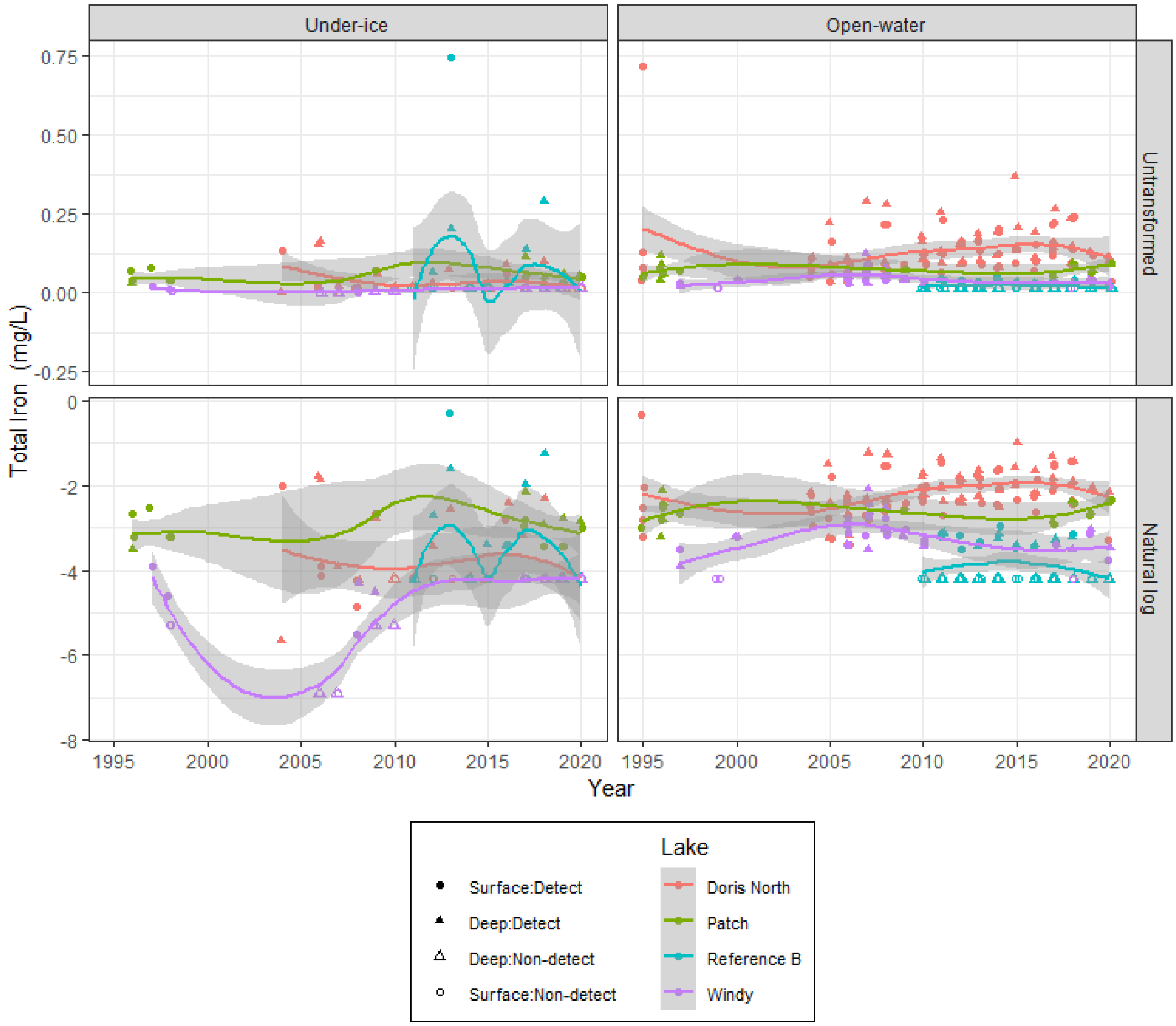
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.16 Total Iron

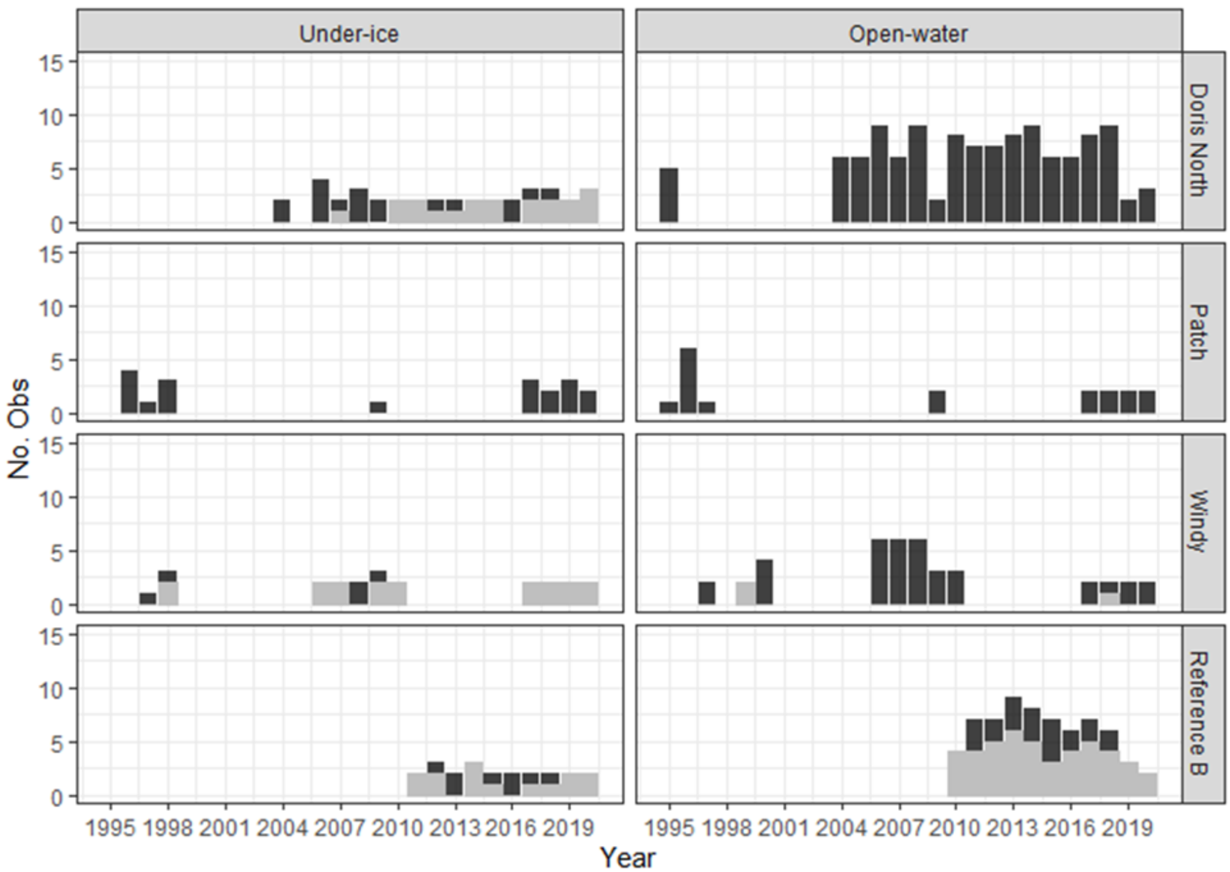
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

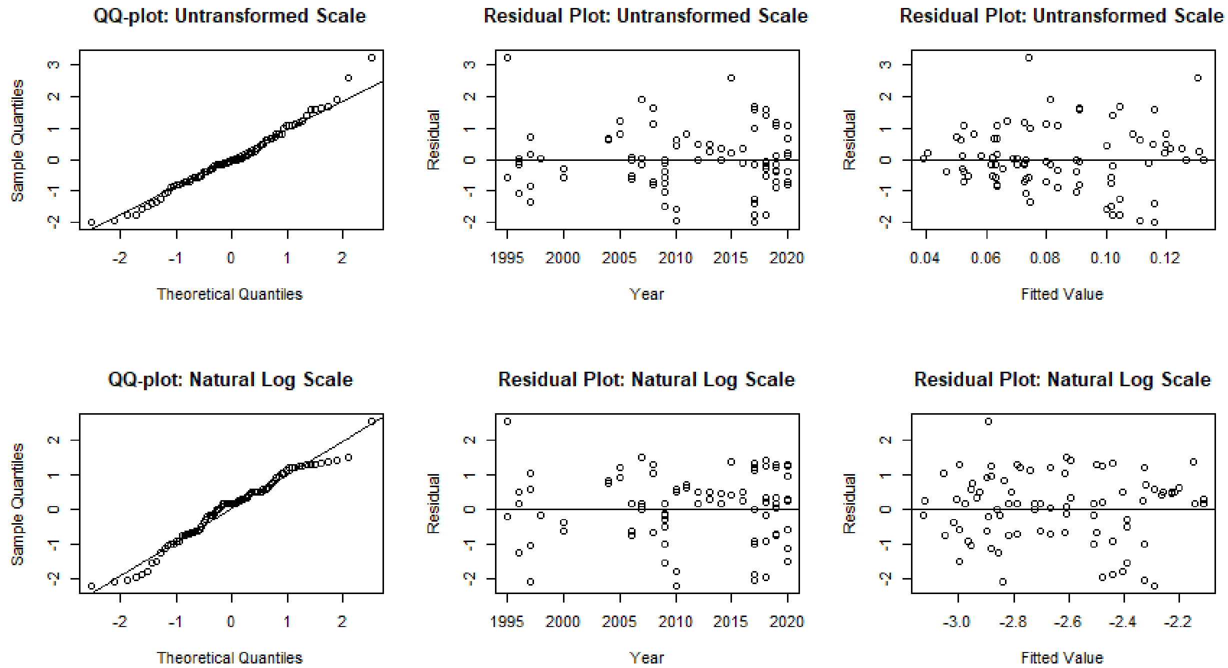
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	20	0.53	1	0.030
Doris North	Open-water	116	0	0.00	0	0.113
Patch	Under-ice	19	0	0.00	0	0.050
Patch	Open-water	18	0	0.00	0	0.071
Reference B	Under-ice	22	14	0.64	1	0.030
Reference B	Open-water	66	45	0.68	1	0.030
Windy	Under-ice	23	18	0.78	1	0.010
Windy	Open-water	40	3	0.07	0	0.040

More than 50% of data under detection limit in Doris under-ice, Reference B under-ice, Reference B open-water, and Windy under-ice. Data from those site-season groupings will be removed from the analysis. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris	1995	Open-water	Surface	0.206	0.074	3.233

Outliers on natural log scale: None

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

Doris Lake

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

Under-ice

All data from Doris under-ice removed from the analysis. No analysis performed.

Open-water

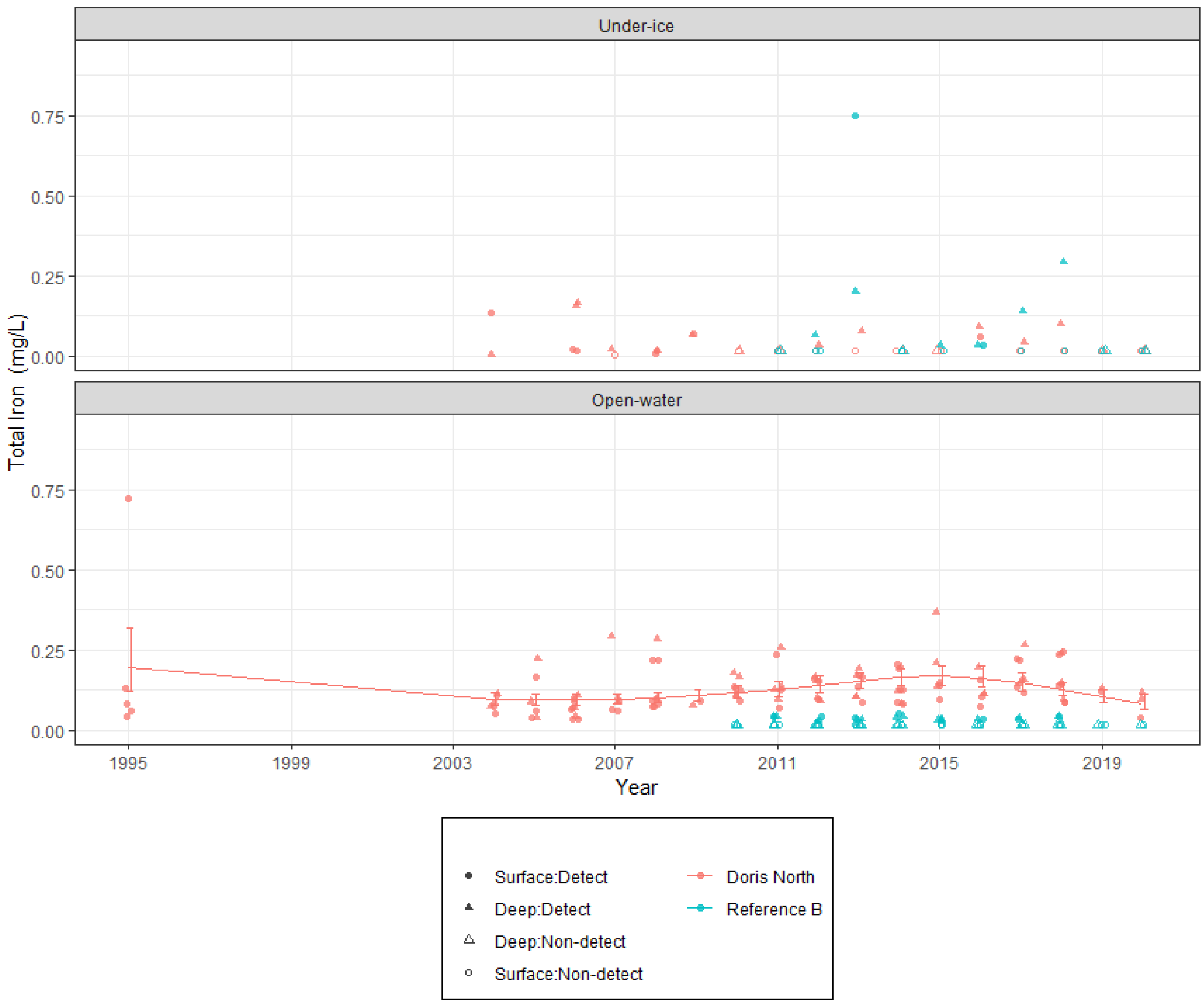
Analysis	Chi.sq	DF	P.value
Compare to slope 0	33.7	4	0.0000

Doris Lake appears to show significant deviation from no trend.

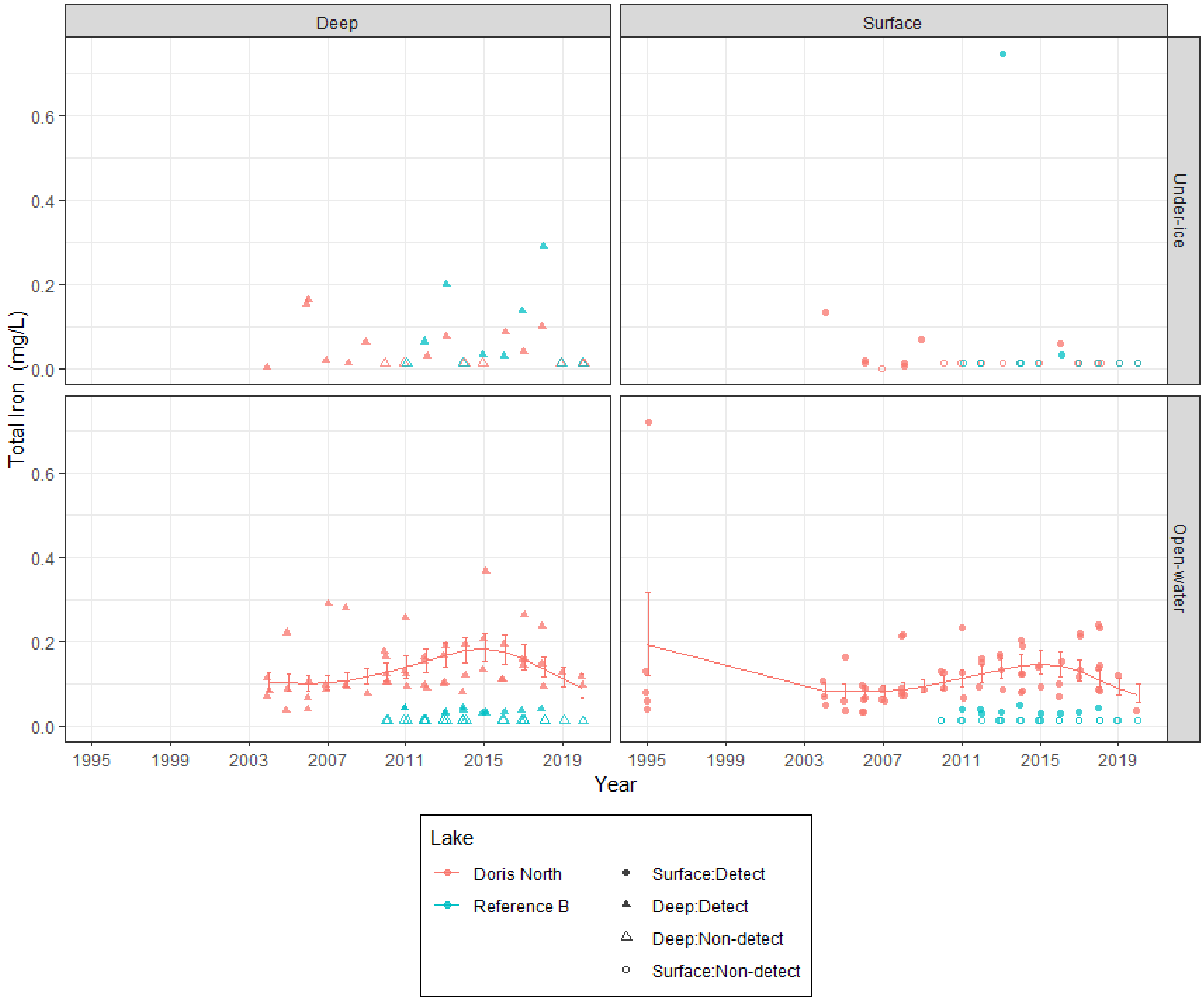
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.0407	0.3751	3.871	-0.1084	0.9191	not sig.

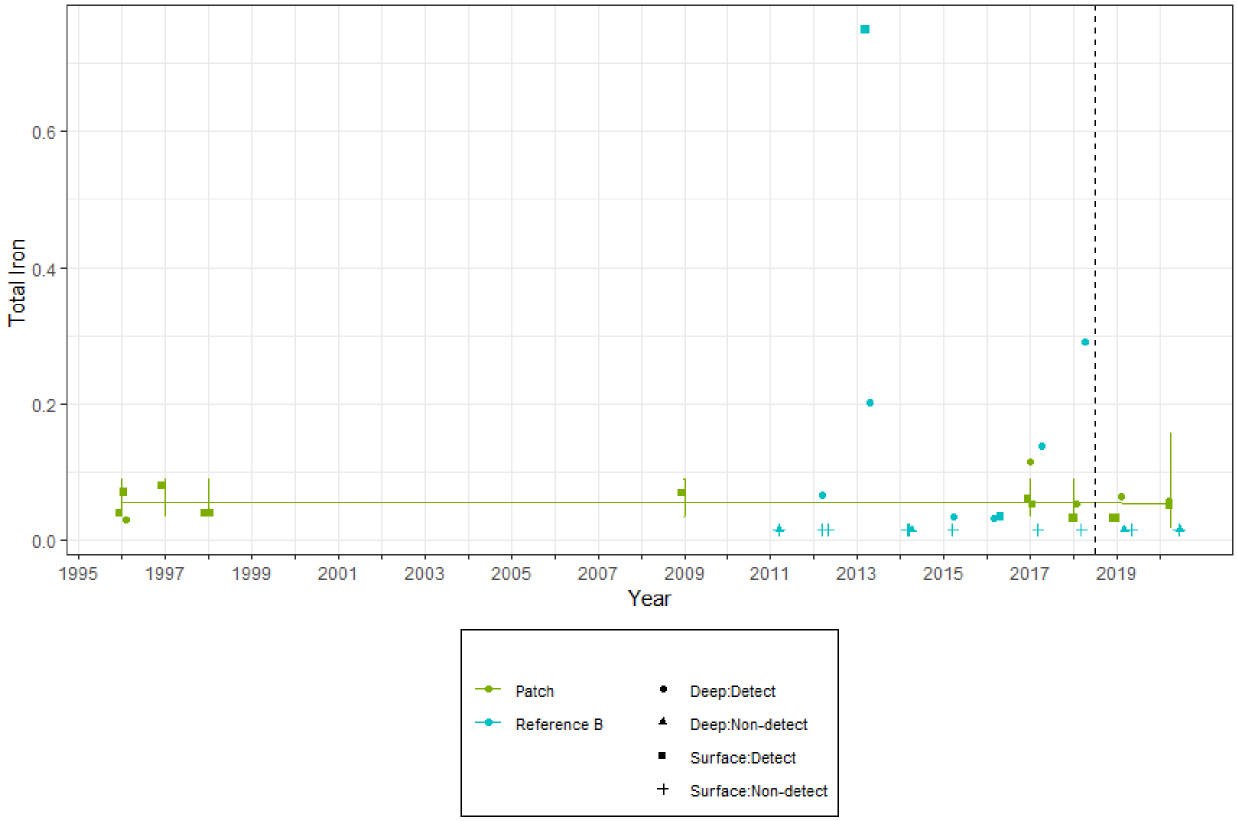
Conclusion:

The change in total iron concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.9191) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.3248	0.2243	4.885	1.448	0.2087	not sig.

Conclusion:

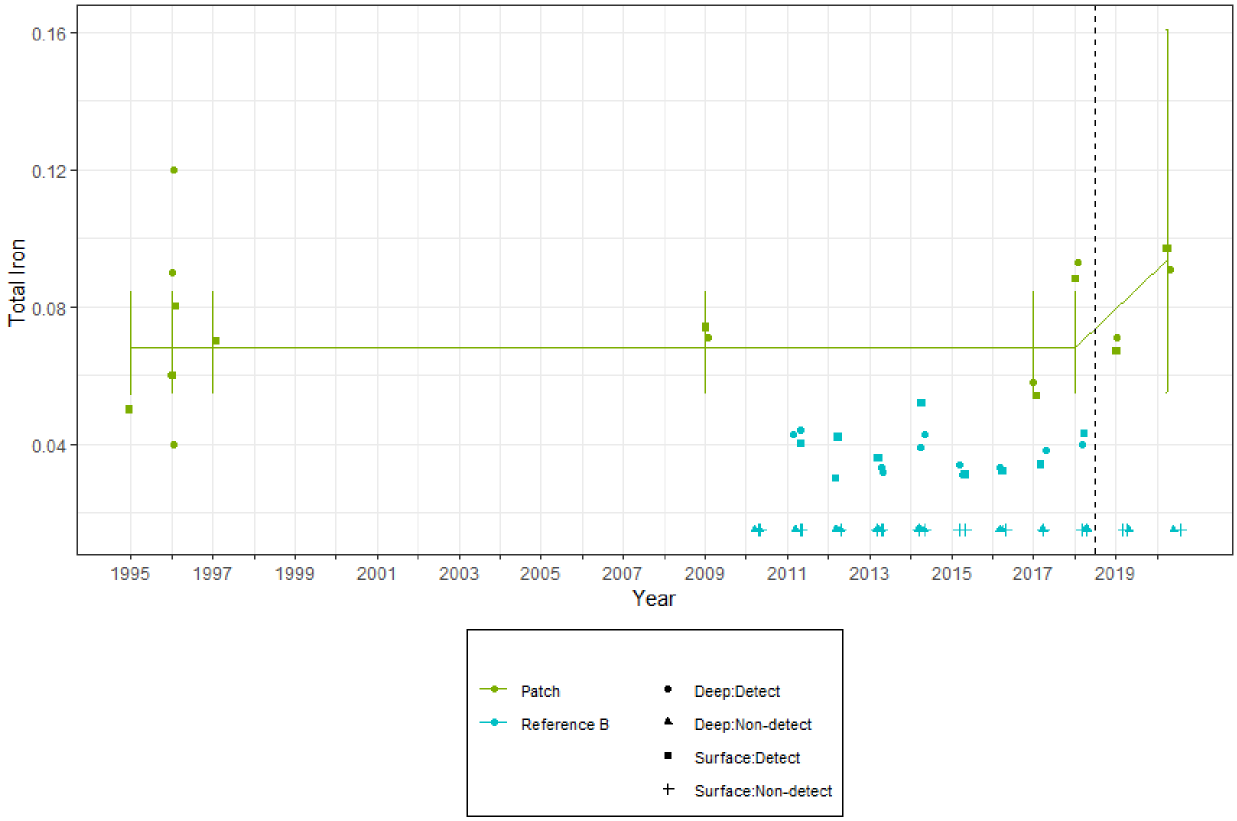
The change in total iron concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.2087) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.28	0.4591	8.347	-0.6099	0.5582	not sig.

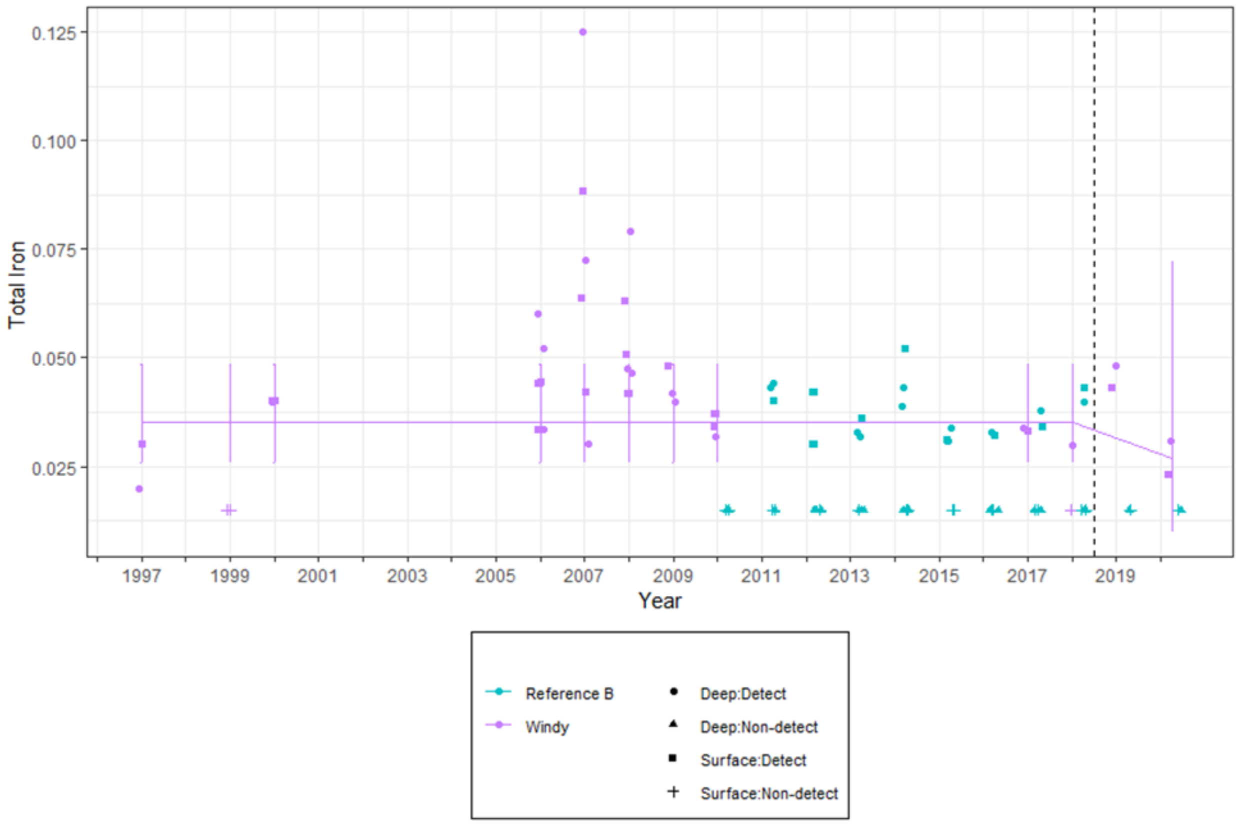
Conclusion:

The change in total iron concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.5582) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

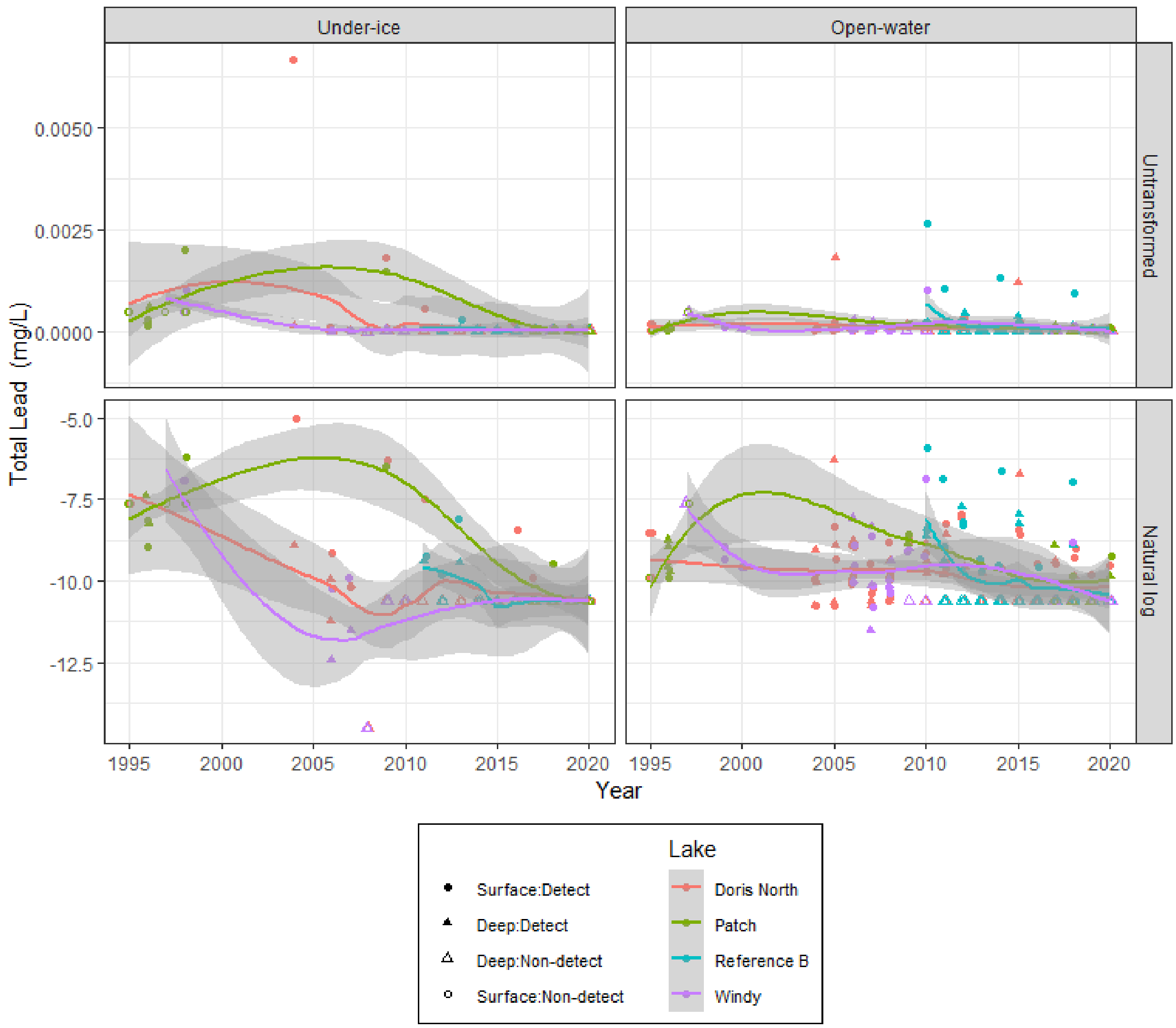
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.17 Total Lead

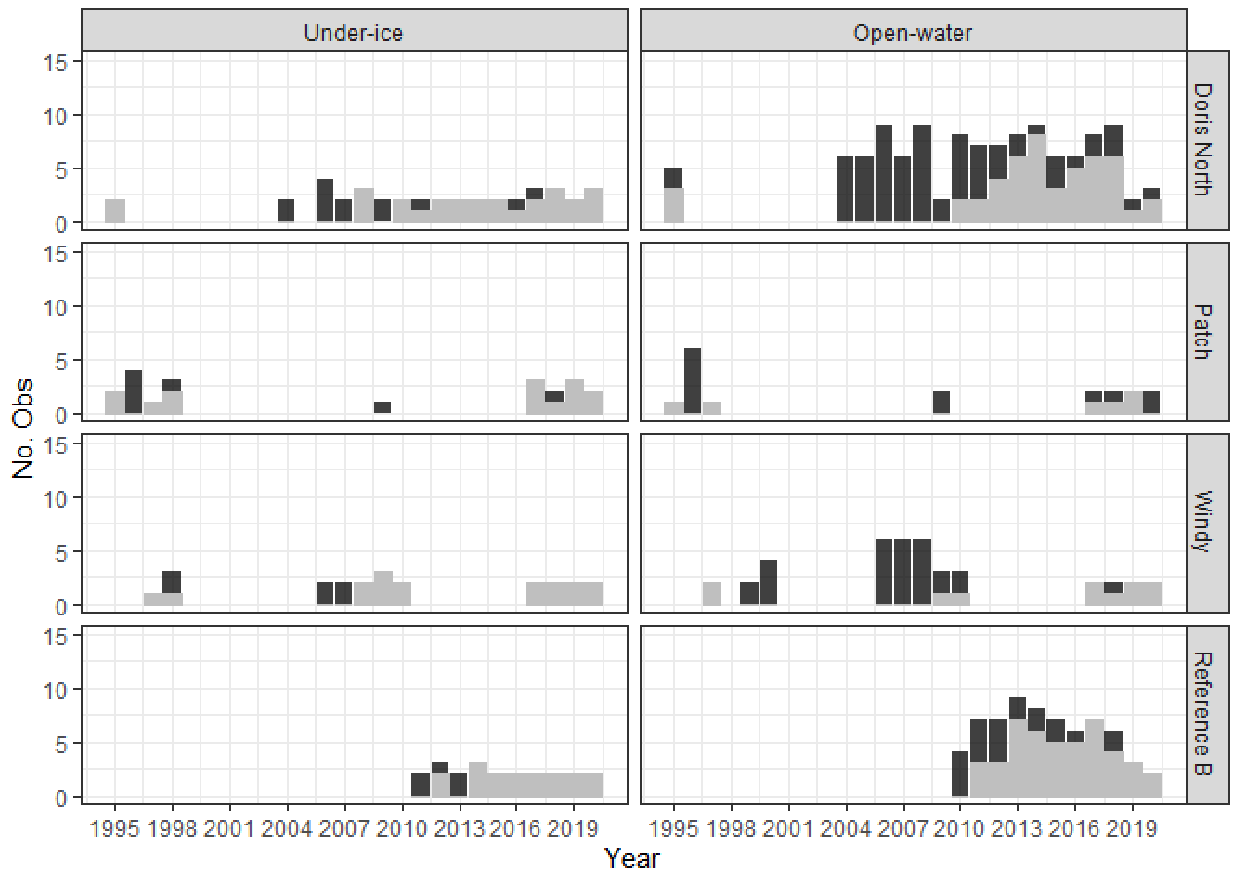
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

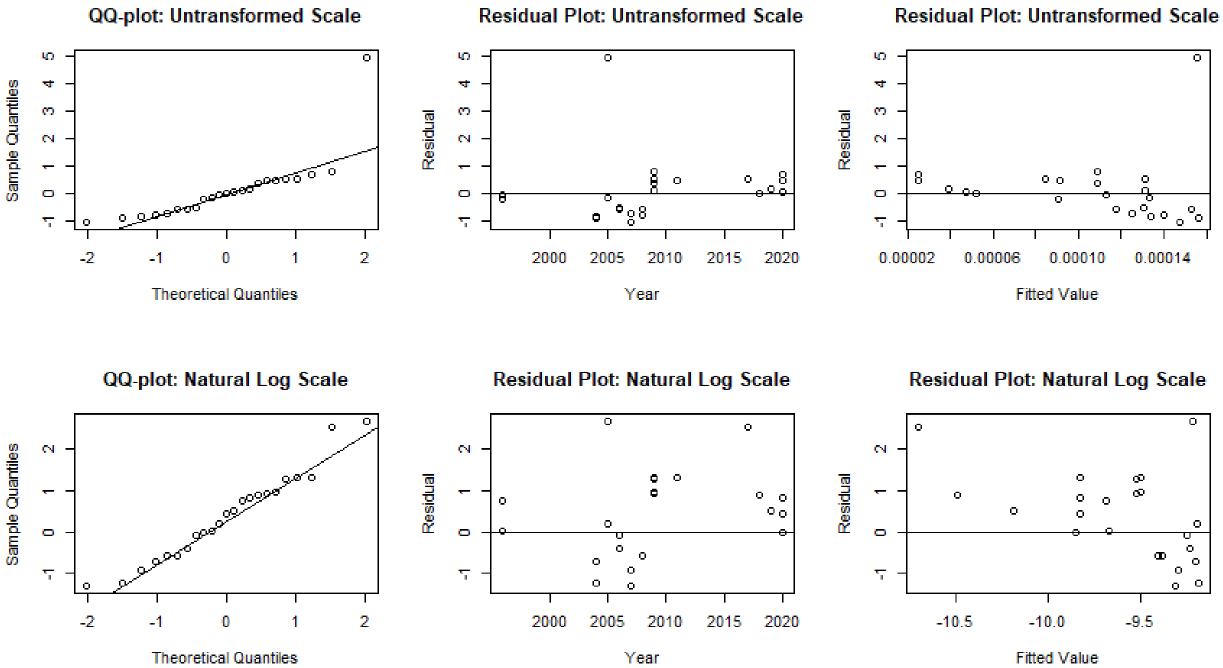
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	40	28	0.70	1.00	0.0000
Doris North	Open-water	116	48	0.41	0.67	0.0000
Patch	Under-ice	21	14	0.67	1.00	0.0001
Patch	Open-water	18	6	0.33	0.00	0.0001
Reference B	Under-ice	22	17	0.77	1.00	0.0000
Reference B	Open-water	66	45	0.68	1.00	0.0000
Windy	Under-ice	23	17	0.74	1.00	0.0000
Windy	Open-water	40	11	0.28	1.00	0.0001

More than 50% of data under detection limit in Doris under-ice, Patch under-ice, Reference B under-ice, Reference B open-water, and Windy under-ice. Data from those site-season groupings will be removed from the analysis. Doris open-water, Patch open-water, and Windy open-water exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris. The analysis proceeds with linear mixed effects regression for Patch and Windy.

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 fitted model 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
Doris	2005	Open-water	Deep	0.0007	0	4.931

Outliers on natural log scale: None

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

Doris Lake

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

Under-ice

All data from Doris under-ice removed from the analysis. No analysis performed.

Open-water

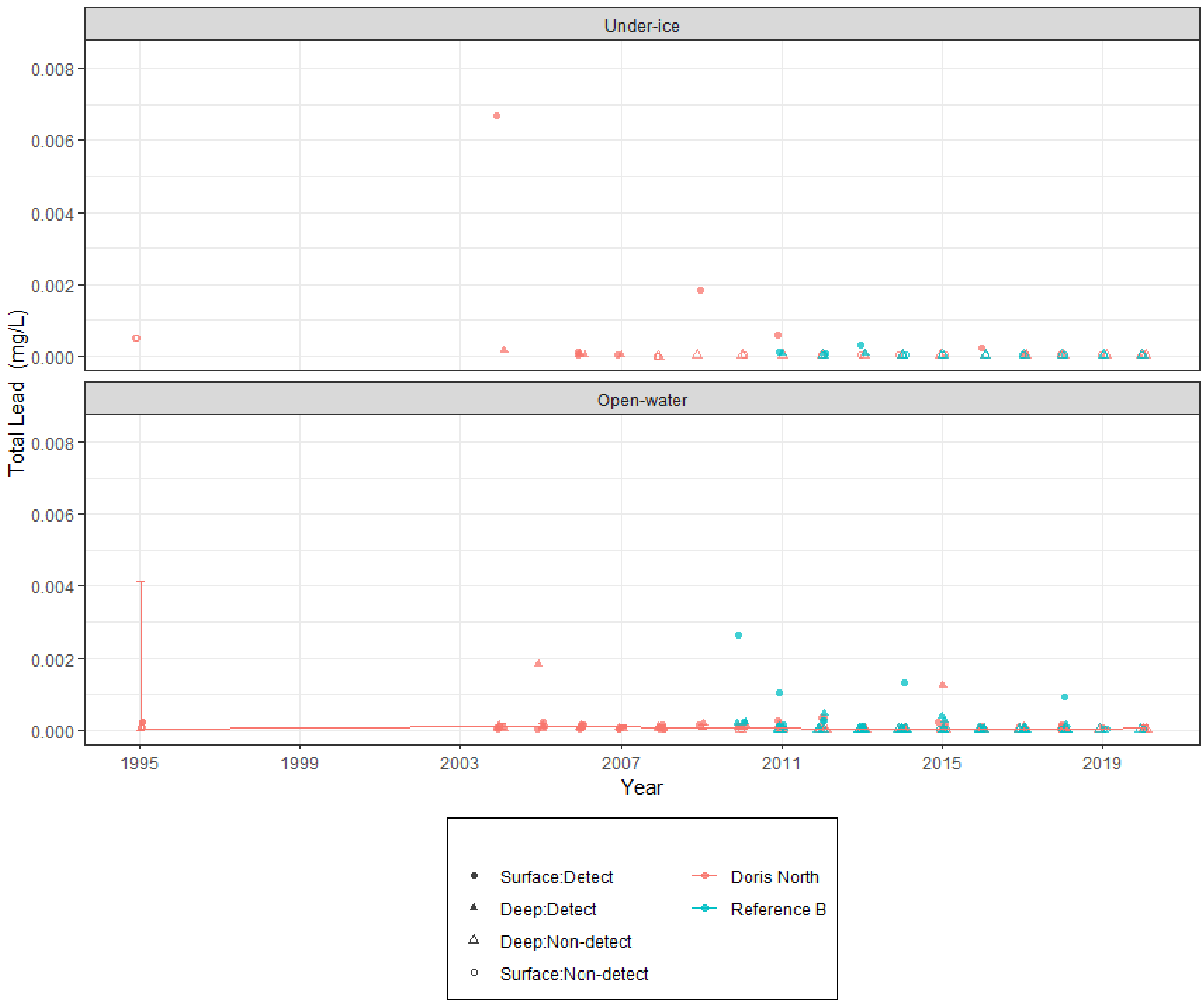
Analysis	Chi.sq	DF	P.value
Compare to slope 0	7.522	4	0.1107

Doris Lake does not exhibit significant deviation from no trend.

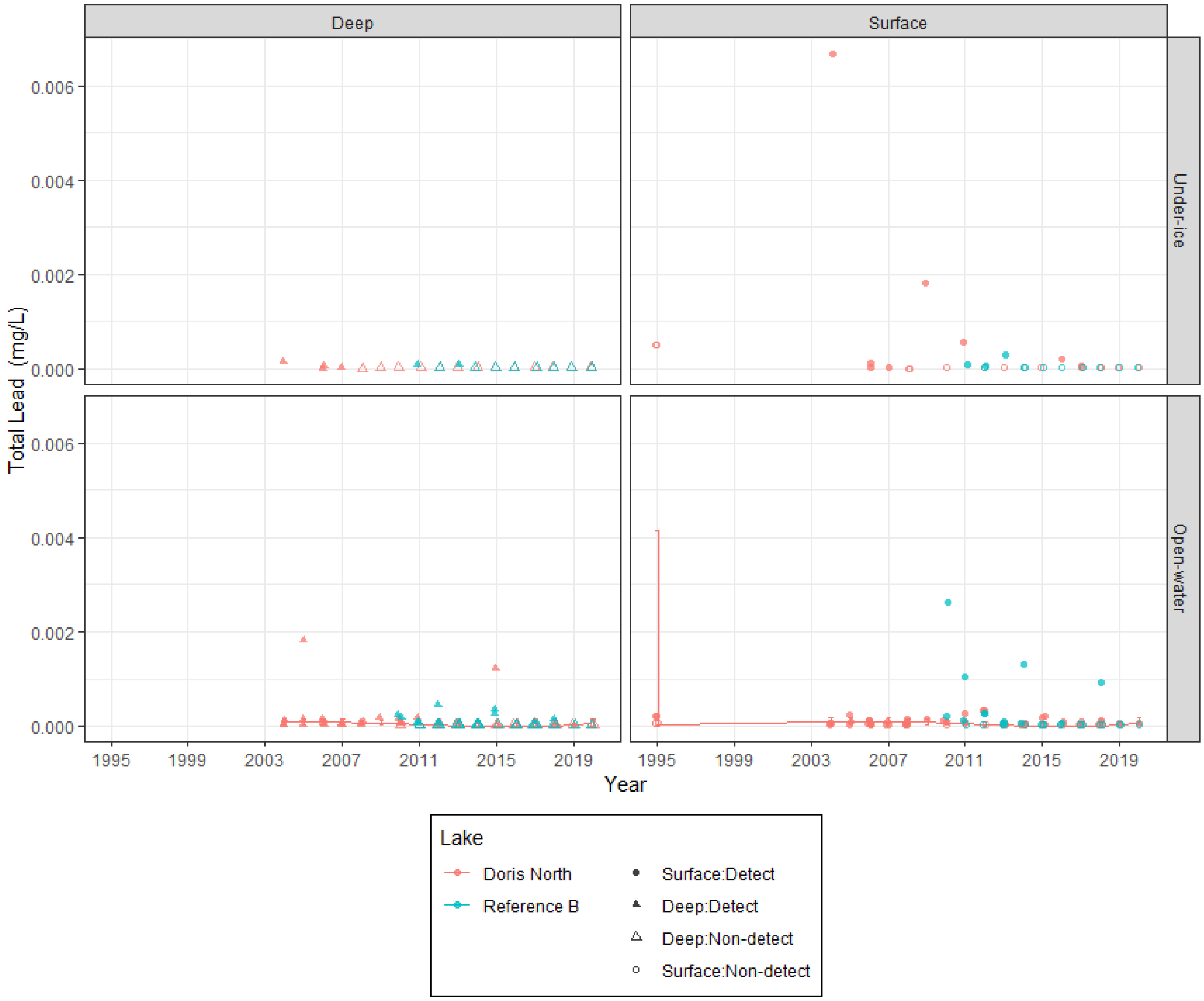
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.2295	0.8961	3.016	-0.2562	0.8143	not sig.

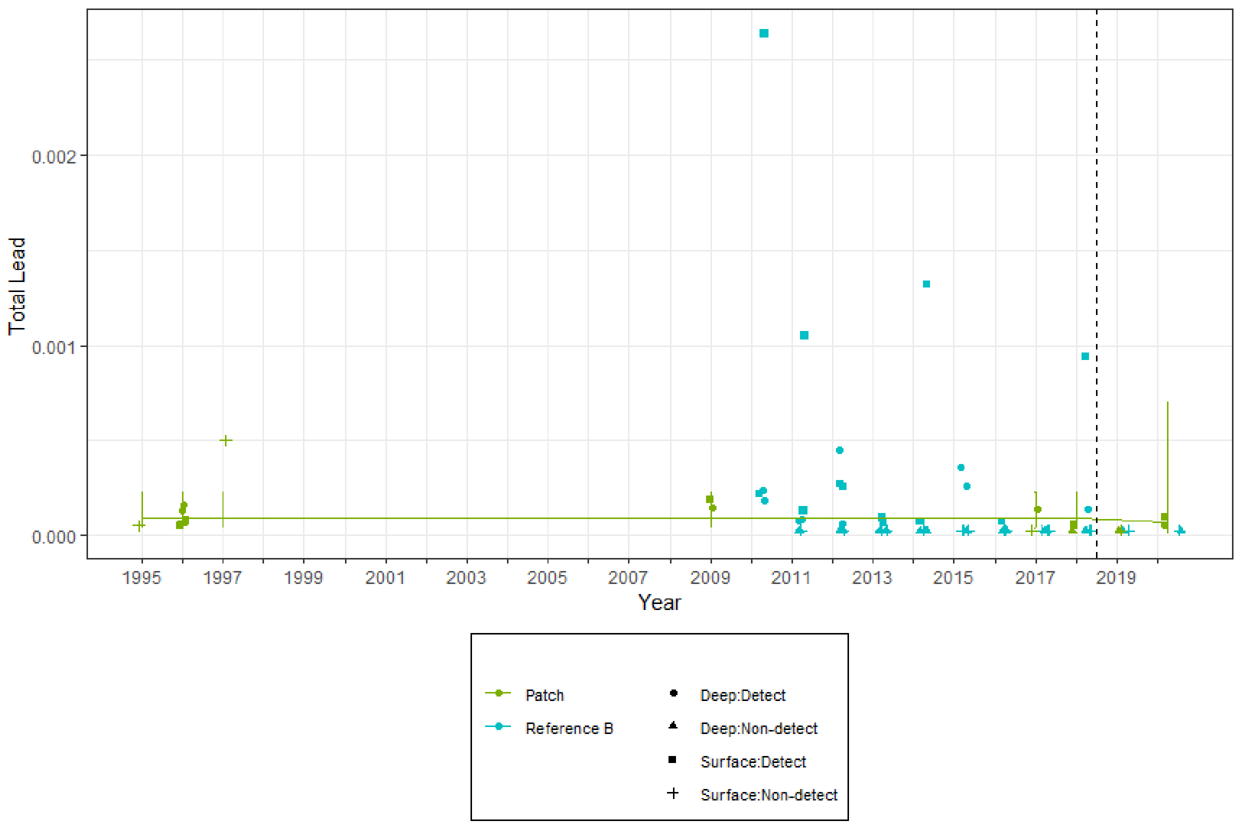
Conclusion:

The change in total lead concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.8143) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

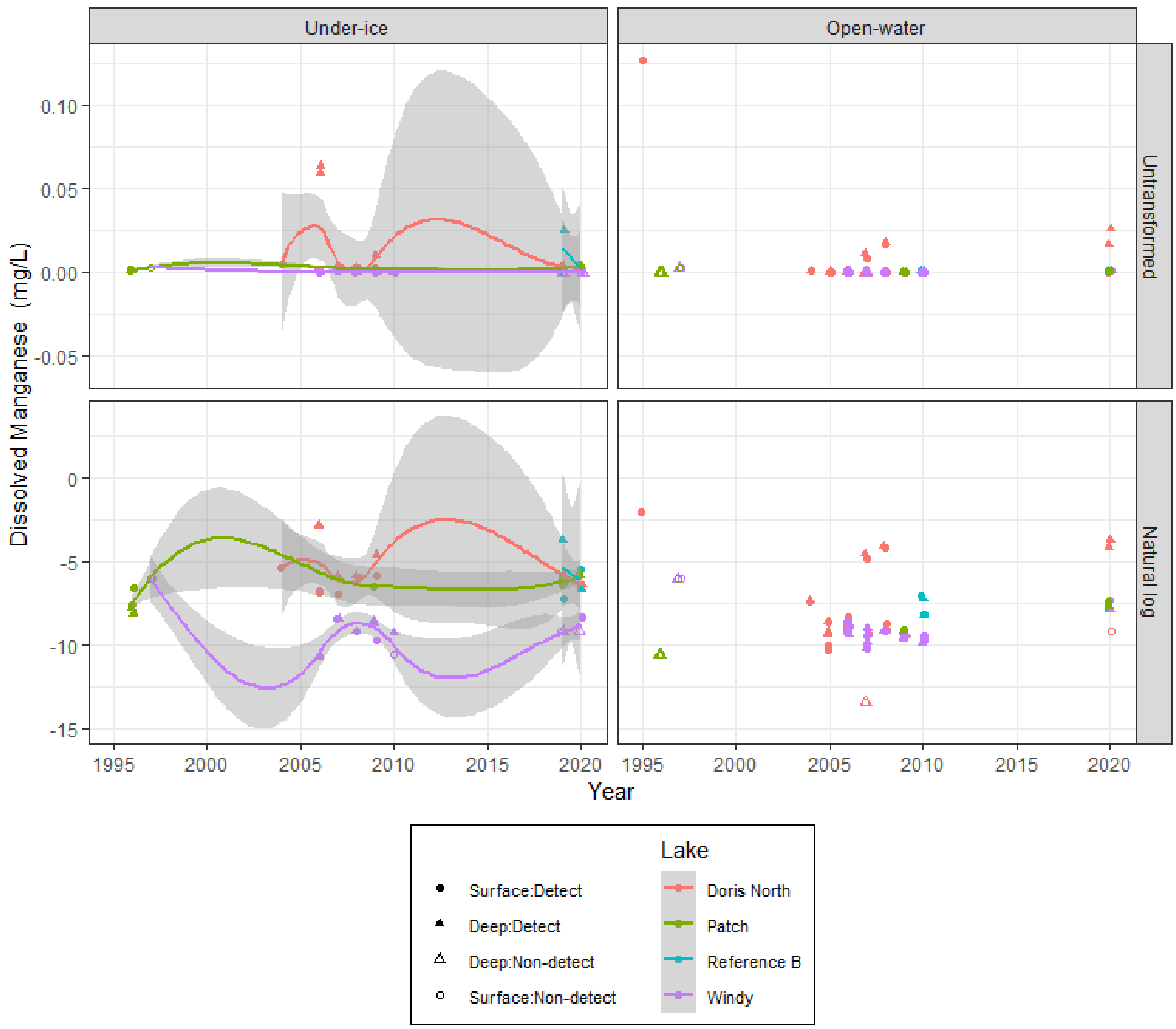
Open-water Before-vs-After Analysis

Analysis not performed.

C.3.1.18 Dissolved Manganese

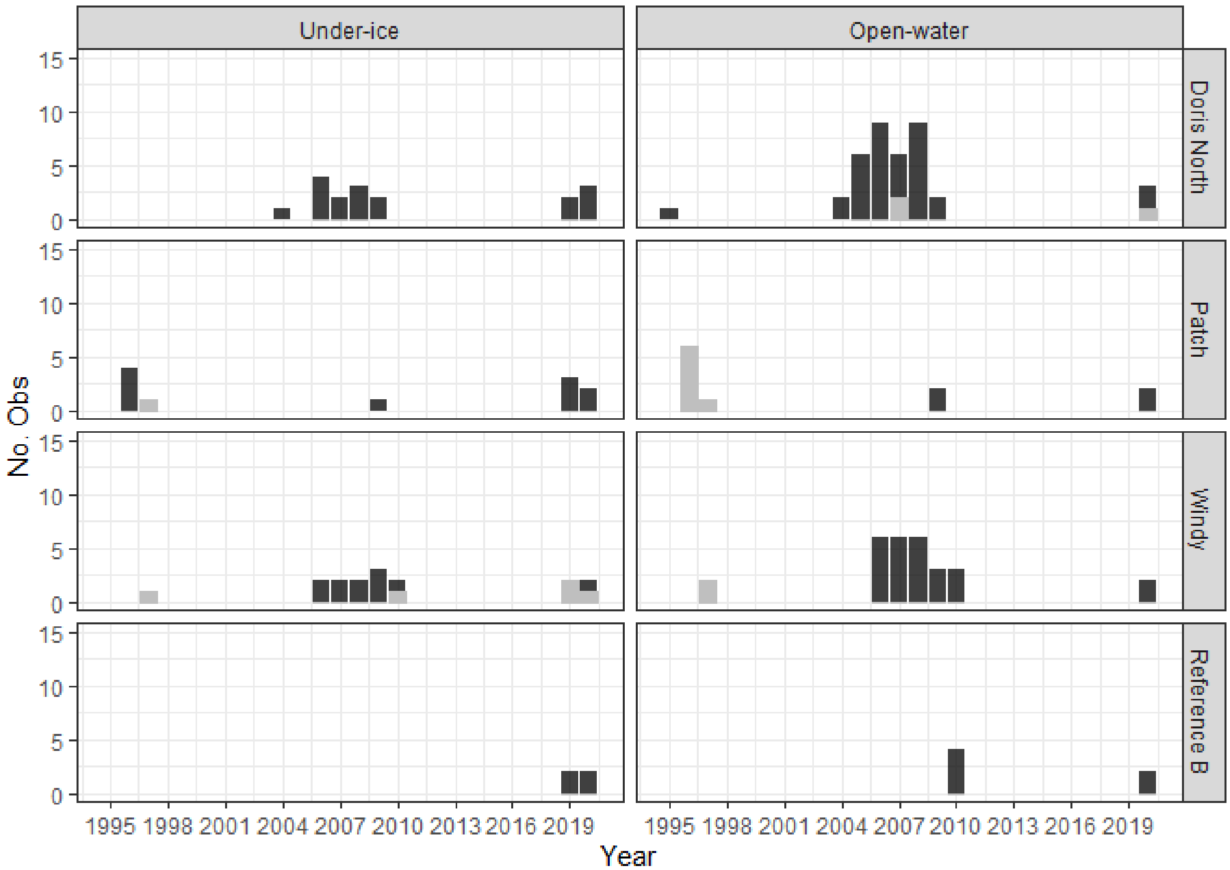
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

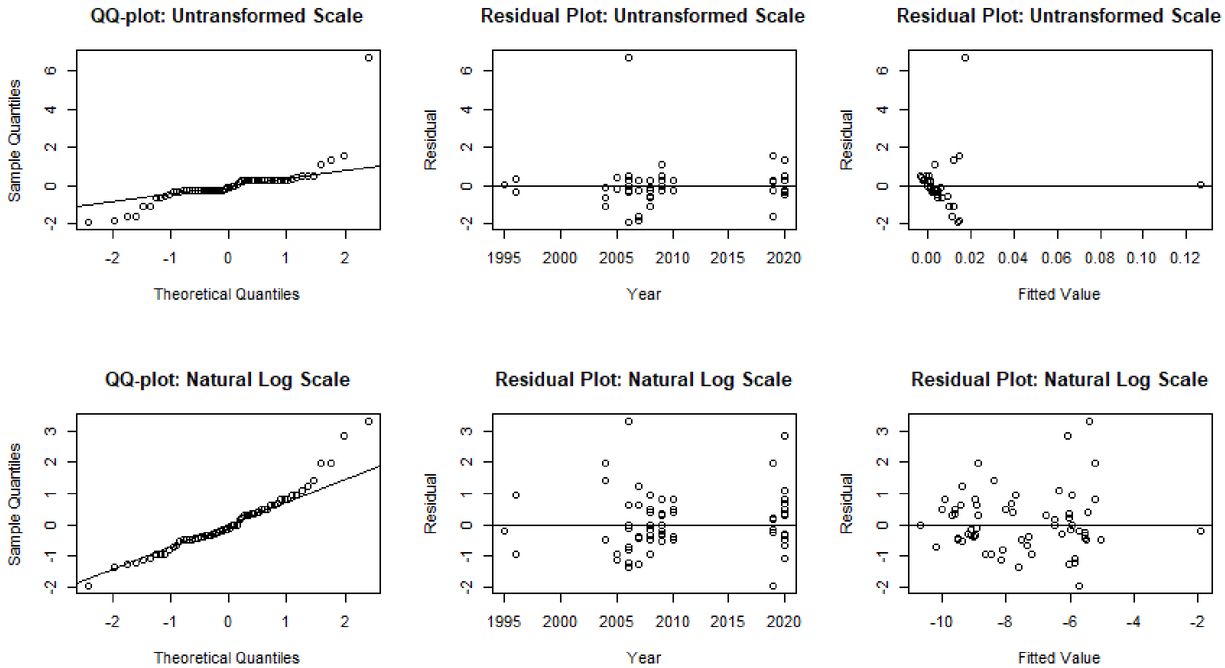
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	17	0	0.00	0.00	0.0028
Doris North	Open-water	38	3	0.08	0.33	0.0001
Patch	Under-ice	11	1	0.09	0.00	0.0017
Patch	Open-water	11	7	0.64	0.00	0.0000
Reference B	Under-ice	4	0	0.00	0.00	0.0027
Reference B	Open-water	6	0	0.00	0.00	0.0004
Windy	Under-ice	16	5	0.31	0.50	0.0002
Windy	Open-water	28	2	0.07	0.00	0.0001

More than 50% of data under detection limit in Patch open-water. Data from those site-season groupings will be removed from the analysis. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris North	2006	Under-ice	Deep	0.0611	0.017	6.699

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris North	2006	Under-ice	Deep	0.0611	-5.375	3.299

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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	2.22	4	0.6953

Doris Lake does not exhibit significant deviation from no trend.

Open-water

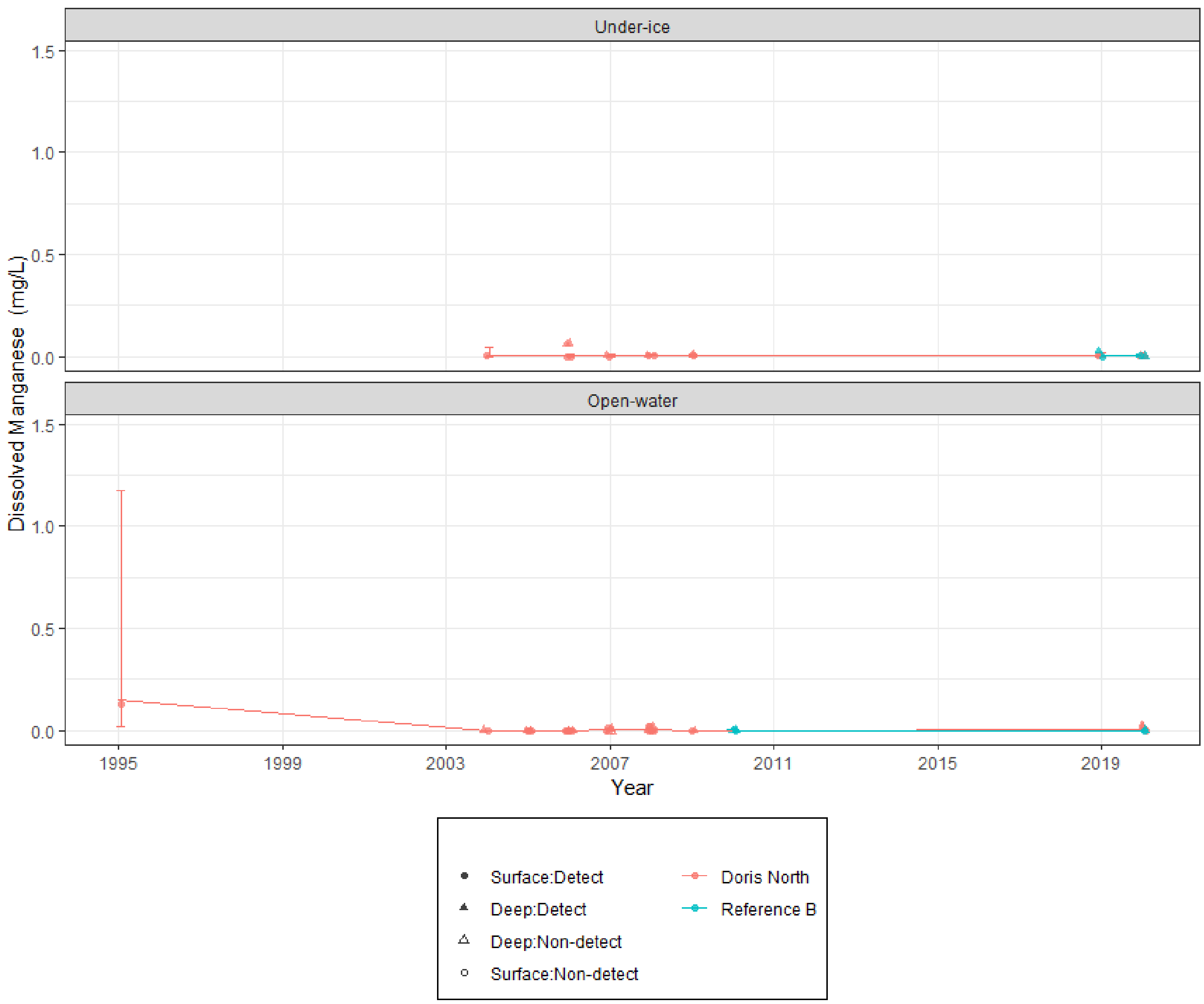
Analysis	Chi.sq	DF	P.value
Compare to slope 0	43.18	4	0.0000

Doris Lake appears to show significant deviation from no trend.

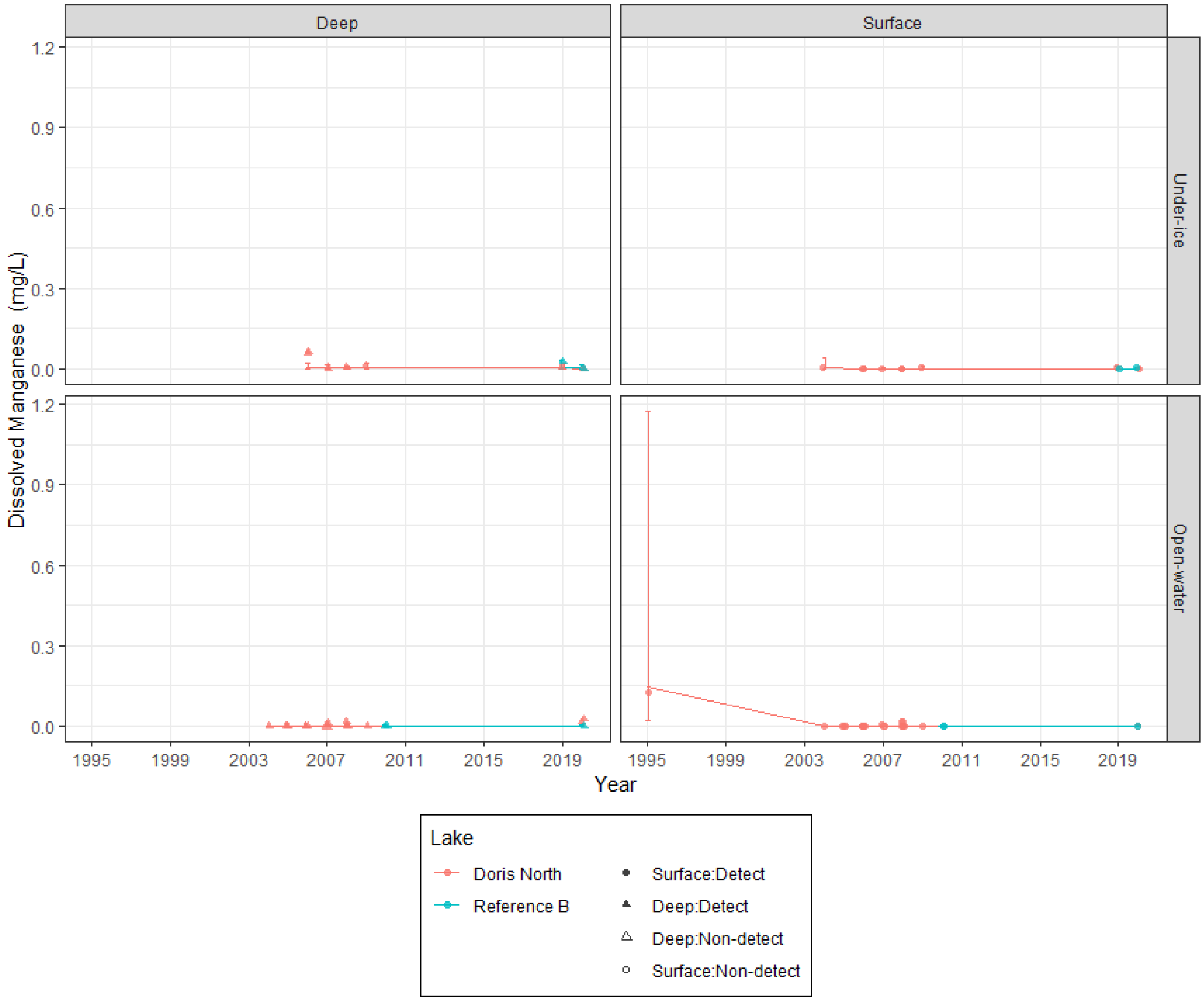
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	1.166	0.6619	1.44	1.762	0.2663	not sig.

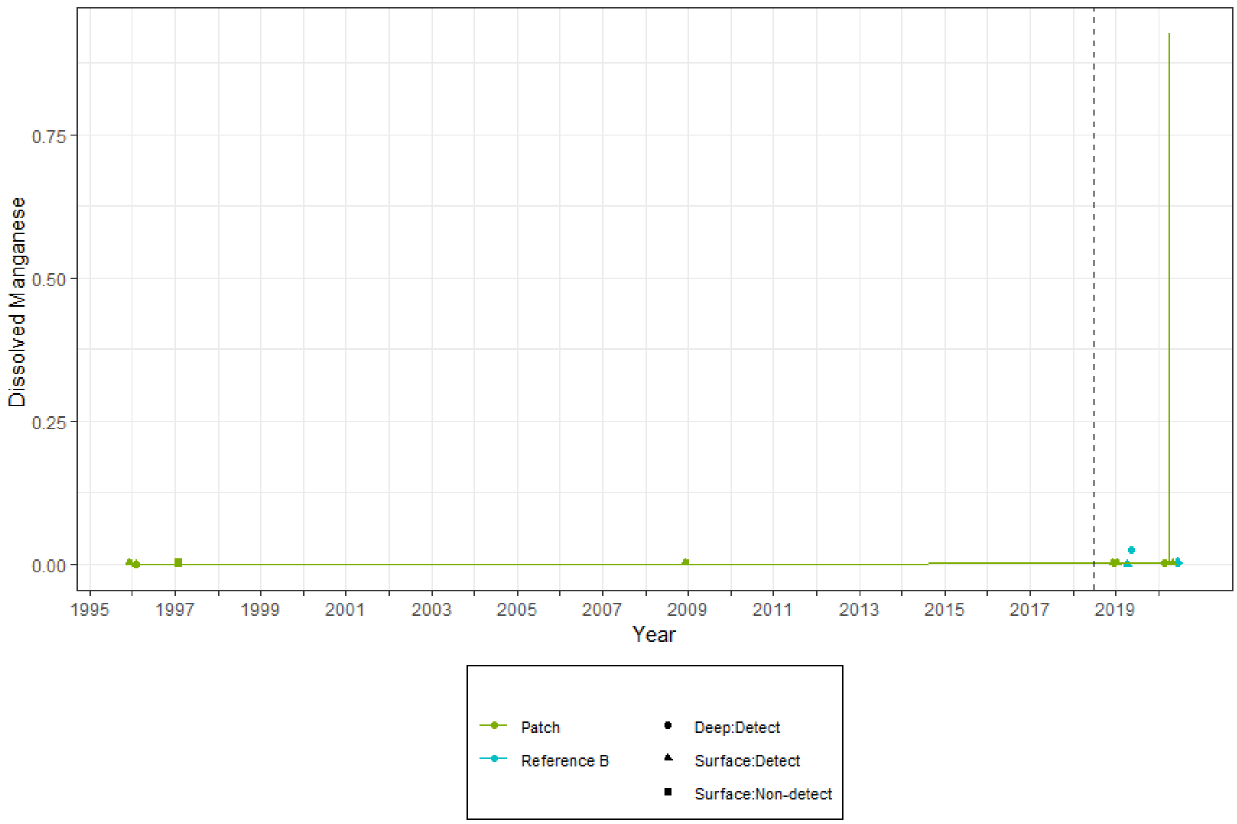
Conclusion:

The change in dissolved manganese concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.2663) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Analysis not performed.

Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.154	1.73	4.501	0.089	0.9329	not sig.

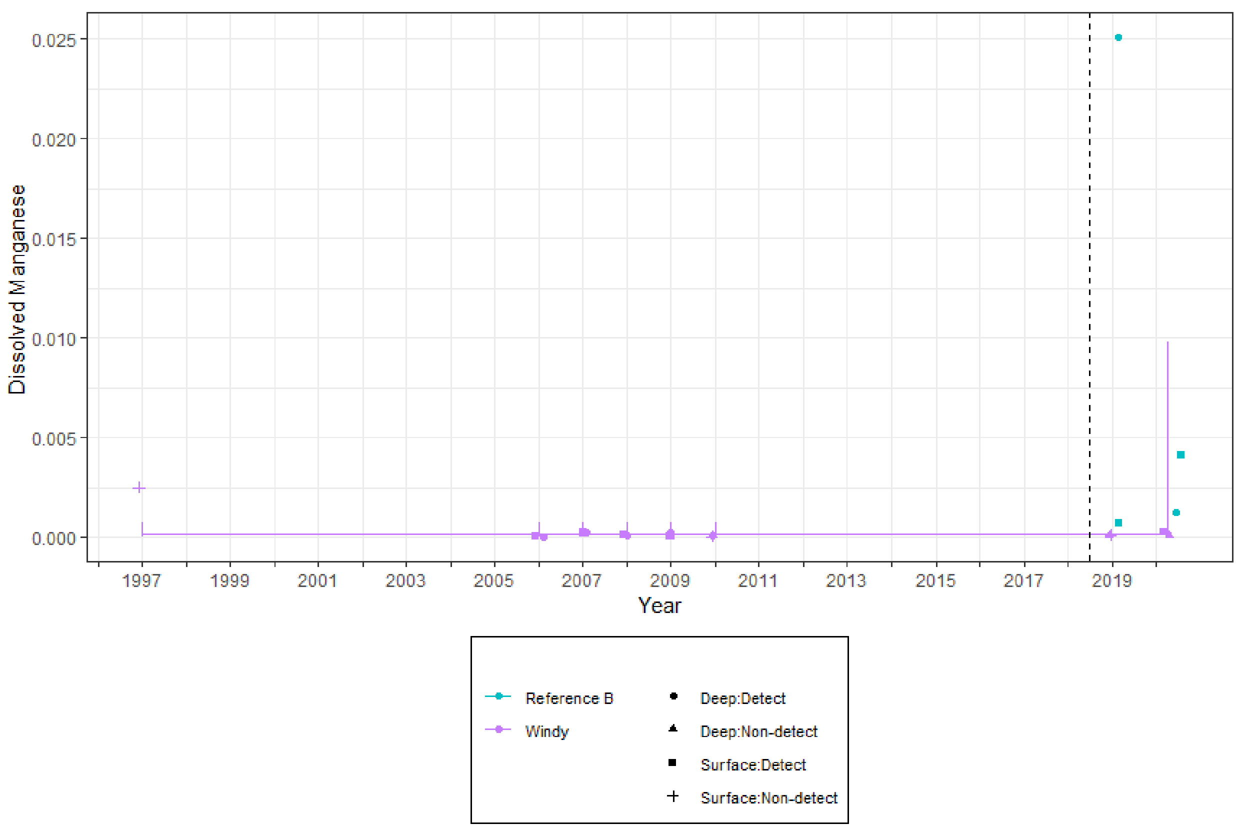
Conclusion:

The change in dissolved manganese concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.9329) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	1.243	1.527	5	0.8139	0.4527	not sig.

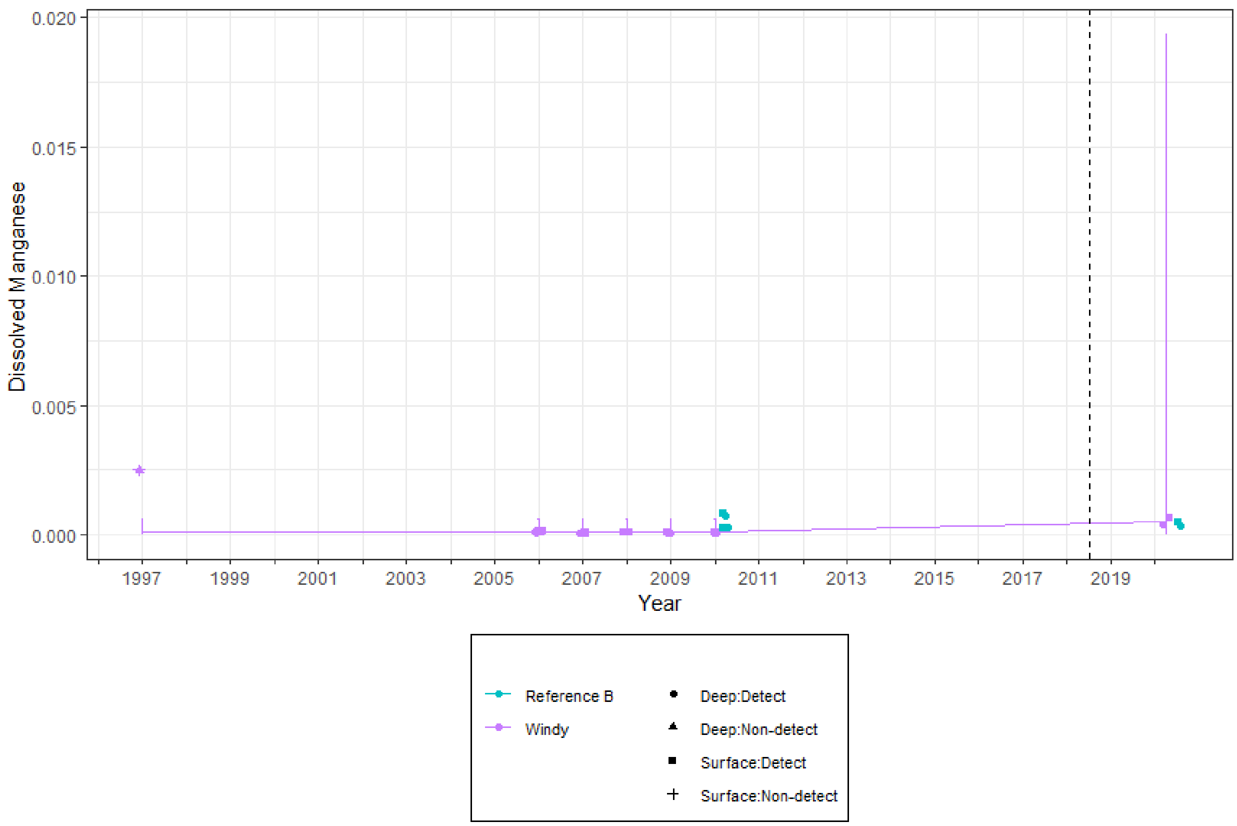
Conclusion:

The change in dissolved manganese concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.4527) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

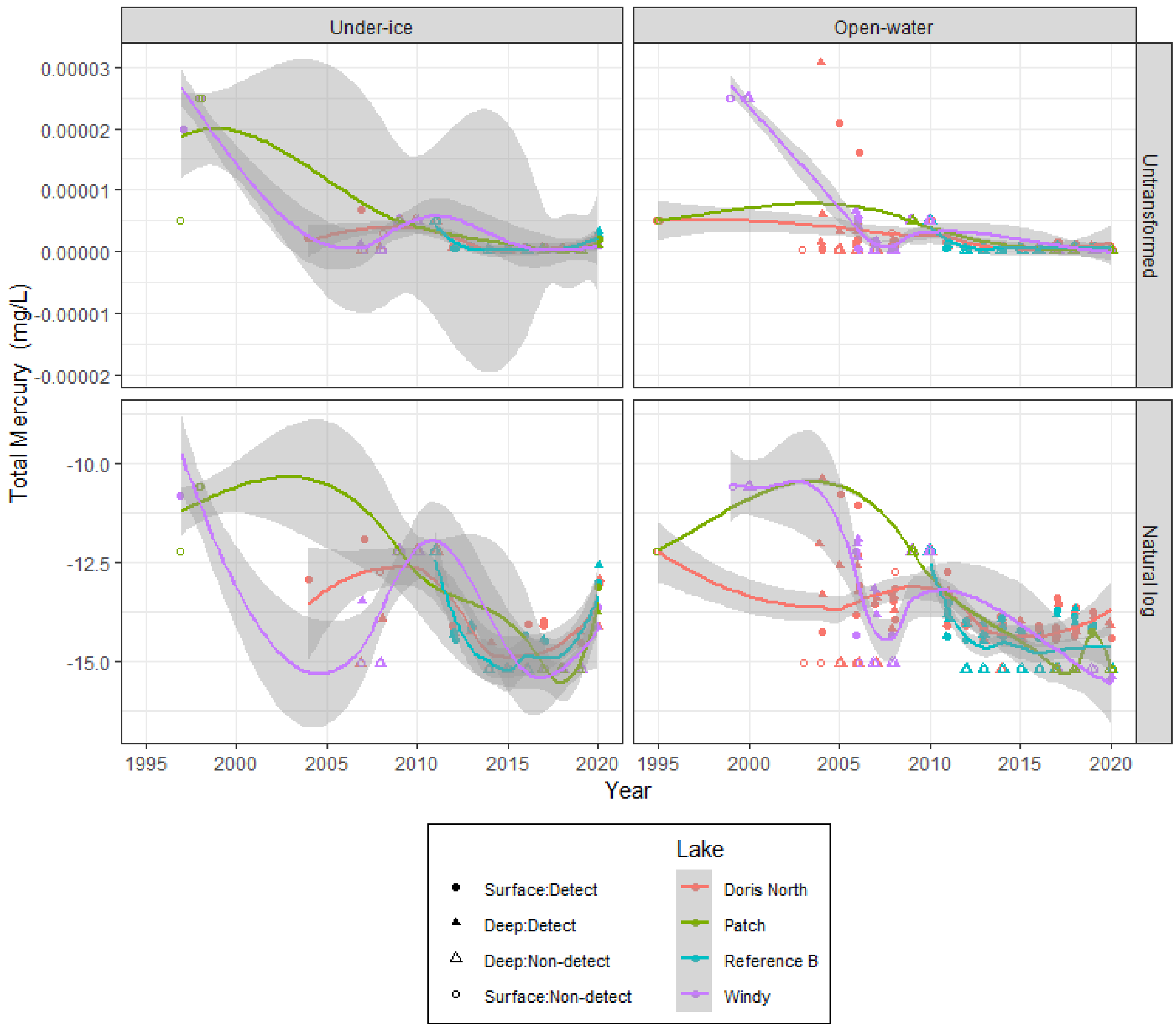
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.19 Total Mercury

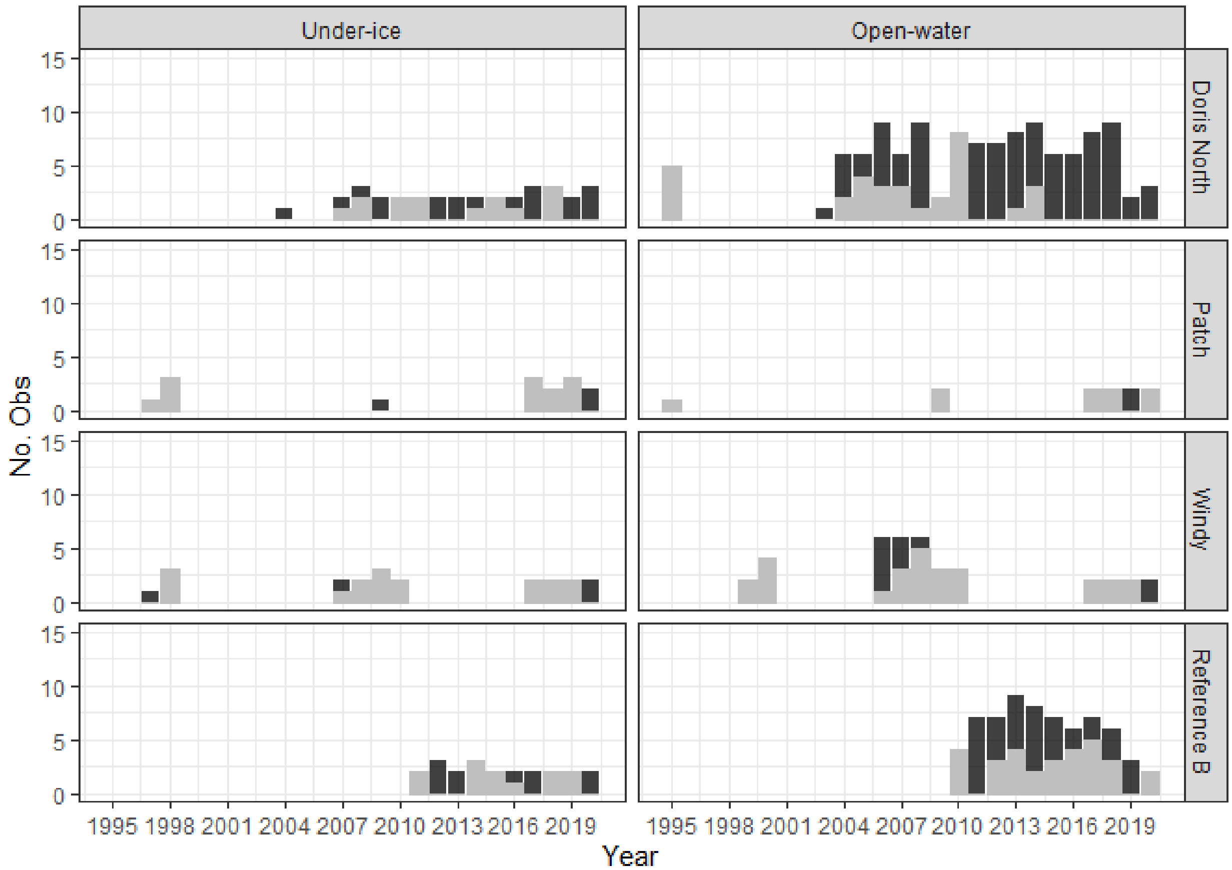
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

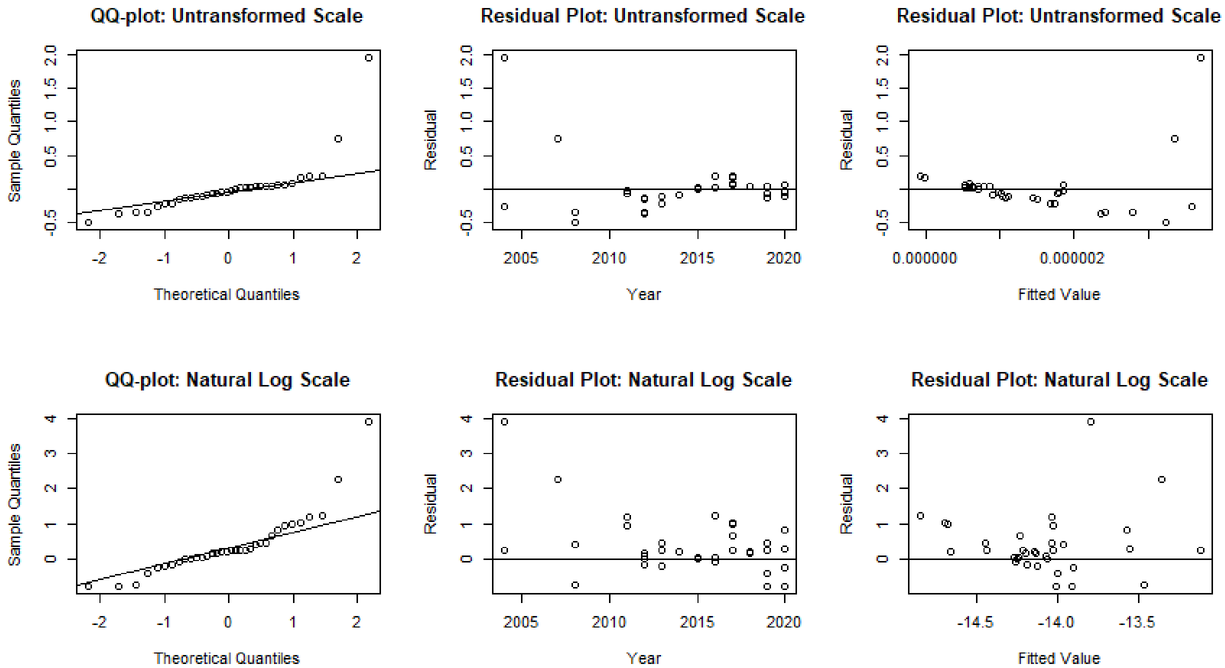
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	33	16	0.48	0	0
Doris North	Open-water	117	33	0.28	0	0
Patch	Under-ice	15	13	0.87	0	0
Patch	Open-water	11	9	0.82	1	0
Reference B	Under-ice	22	12	0.55	0	0
Reference B	Open-water	66	30	0.45	1	0
Windy	Under-ice	21	17	0.81	0	0
Windy	Open-water	38	27	0.71	0	0

More than 50% of data under detection limit Patch under-ice, Patch open-water, Reference B under-ice, Windy under-ice, and Windy open-water. Data from those site-season groupings will be removed from the analysis. Doris open-water and Reference B open-water exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris. Reference B exhibited close to 50% under detection limit in the open-water season. Inclusion of Reference B lead to unstable results, hence Reference B was 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 fitted model 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
Doris	2004	Open-water	Deep	0	-13.79	3.899

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

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	2.318	4	0.6776

Doris Lake does not exhibit significant deviation from no trend.

Open-water

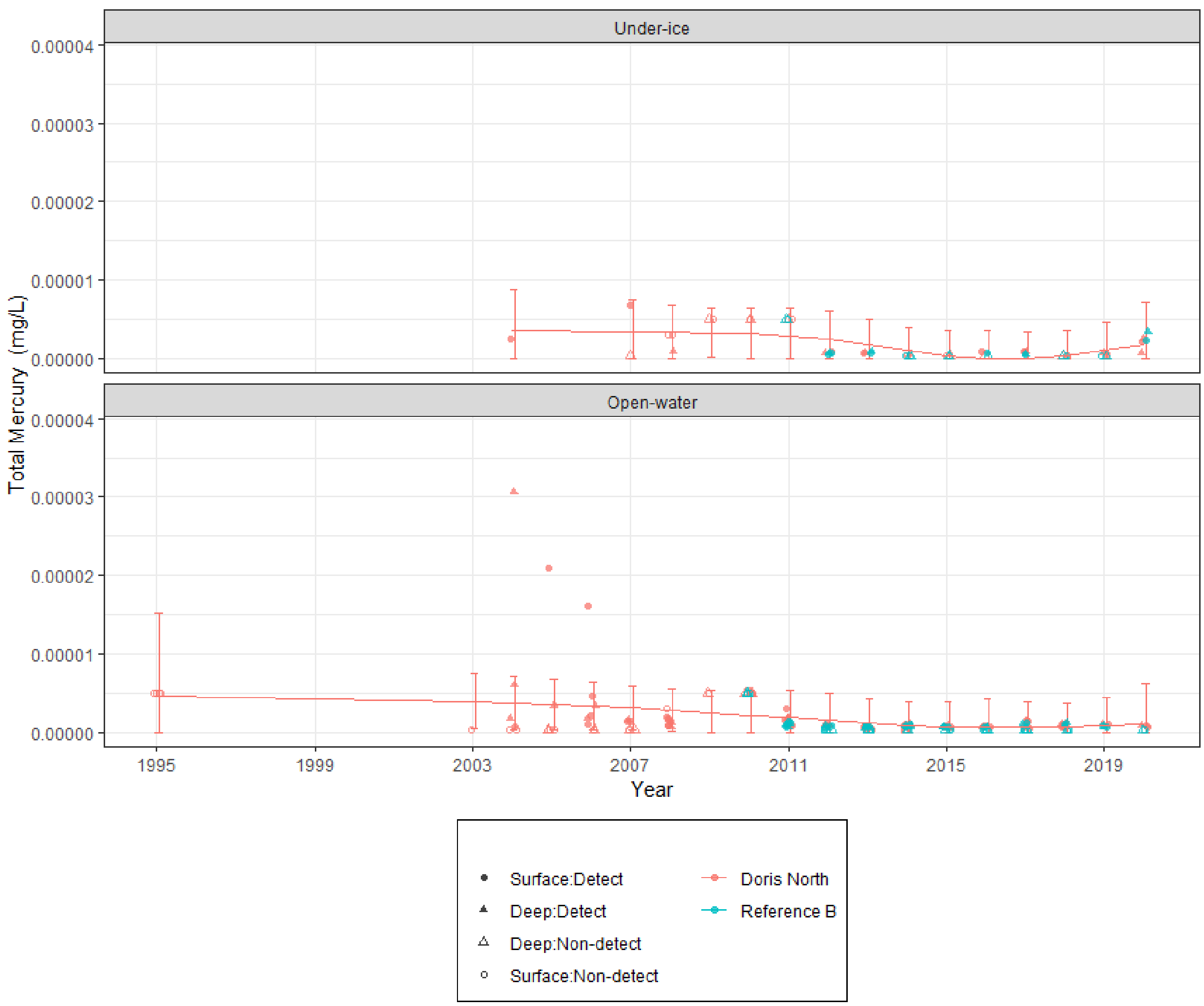
Analysis	Chi.sq	DF	P.value
Compare to slope 0	2.382	4	0.6659

Doris Lake does not exhibit significant deviation from no trend.

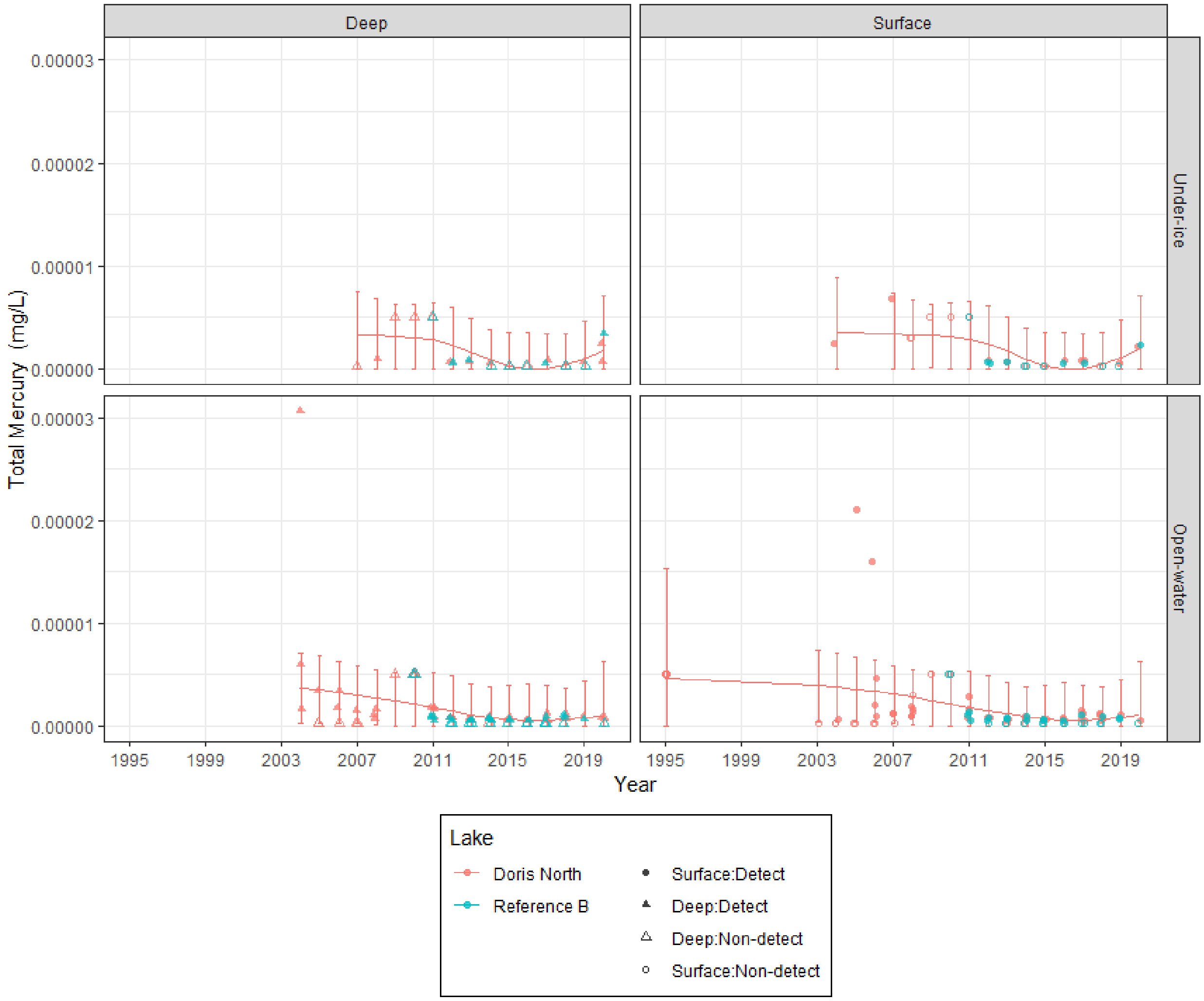
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

Open-water Before-vs-After Analysis

Analysis not performed.

Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

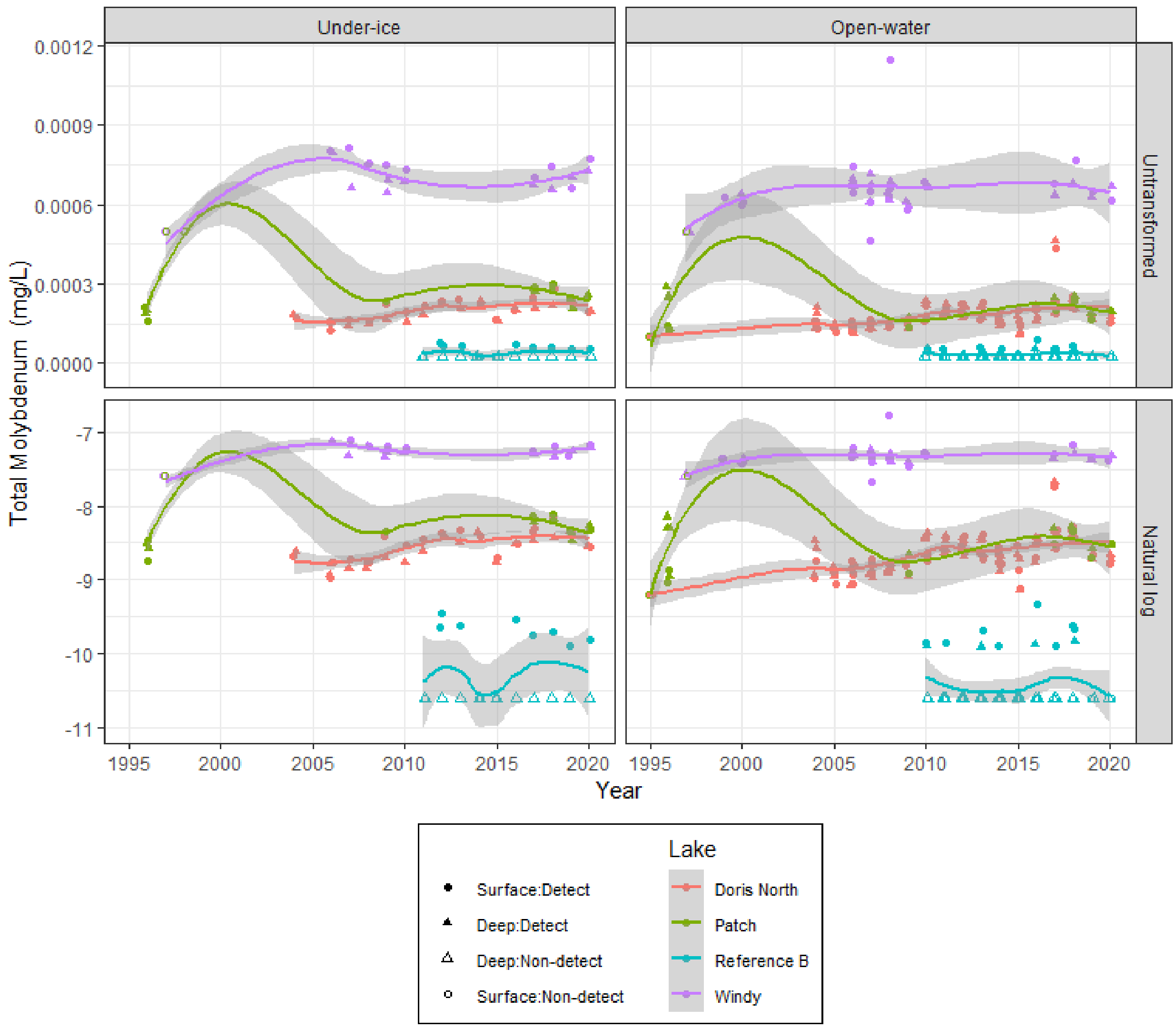
Open-water Before-vs-After Analysis

Analysis not performed.

C.3.1.20 Total Molybdenum

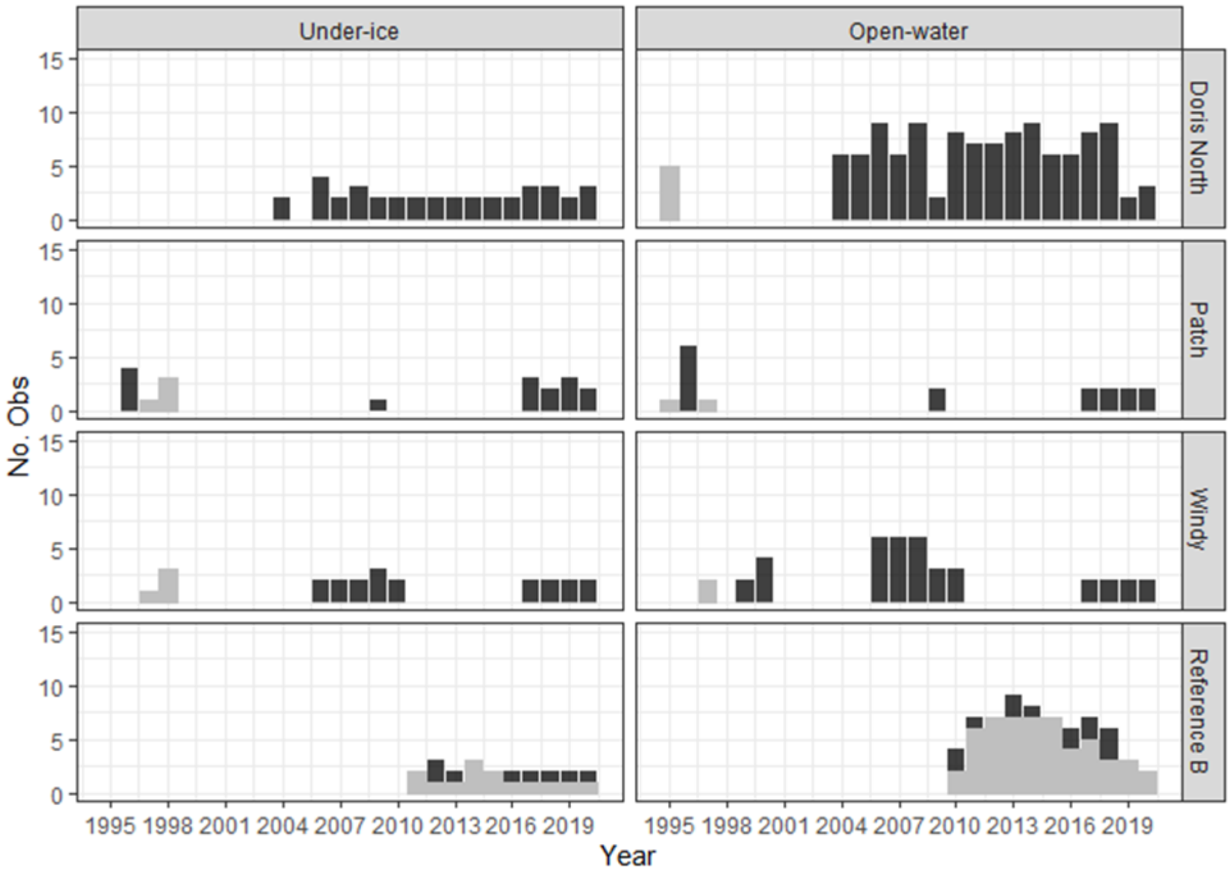
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

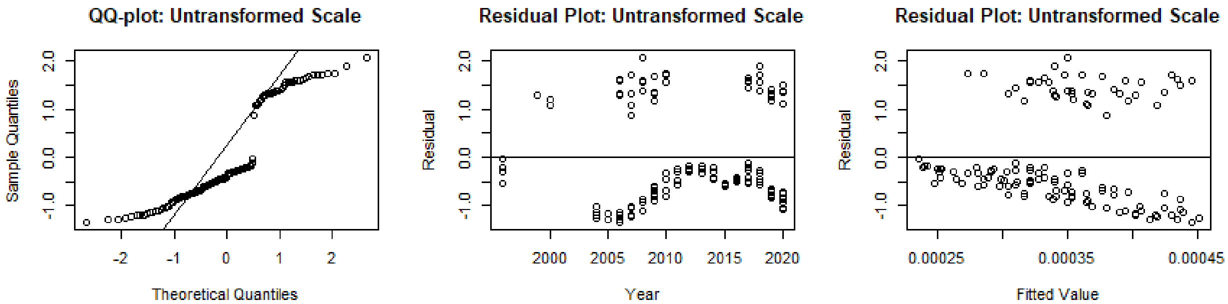
The sample sizes and median values per lake and season are summarized in the table below.

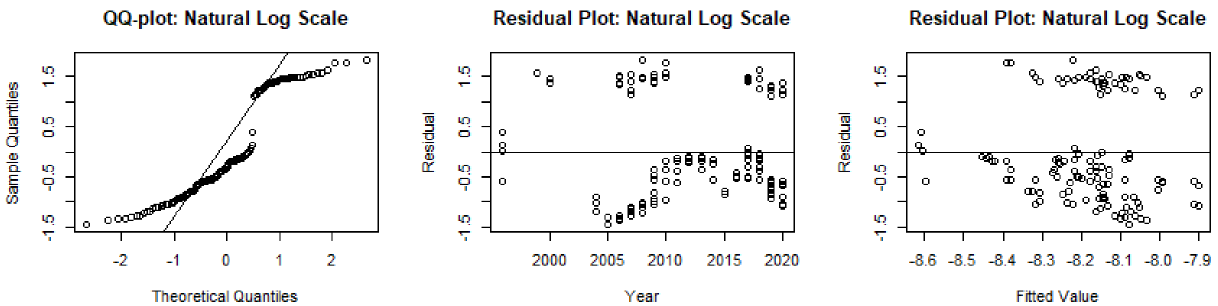
Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	0	0.00	0.0	0.0002
Doris North	Open-water	116	5	0.04	0.0	0.0002
Patch	Under-ice	19	4	0.21	0.0	0.0003
Patch	Open-water	18	2	0.11	0.0	0.0002
Reference B	Under-ice	22	14	0.64	0.5	0.0000
Reference B	Open-water	66	53	0.80	1.0	0.0000
Windy	Under-ice	23	4	0.17	0.0	0.0007
Windy	Open-water	40	2	0.05	0.0	0.0006

More than 50% of data under detection limit in Reference B under-ice and Reference B open-water. Data from those site-season groupings will be removed from the analysis. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	25.7	4	0.0000

Doris Lake appears to show significant deviation from no trend.

Open-water

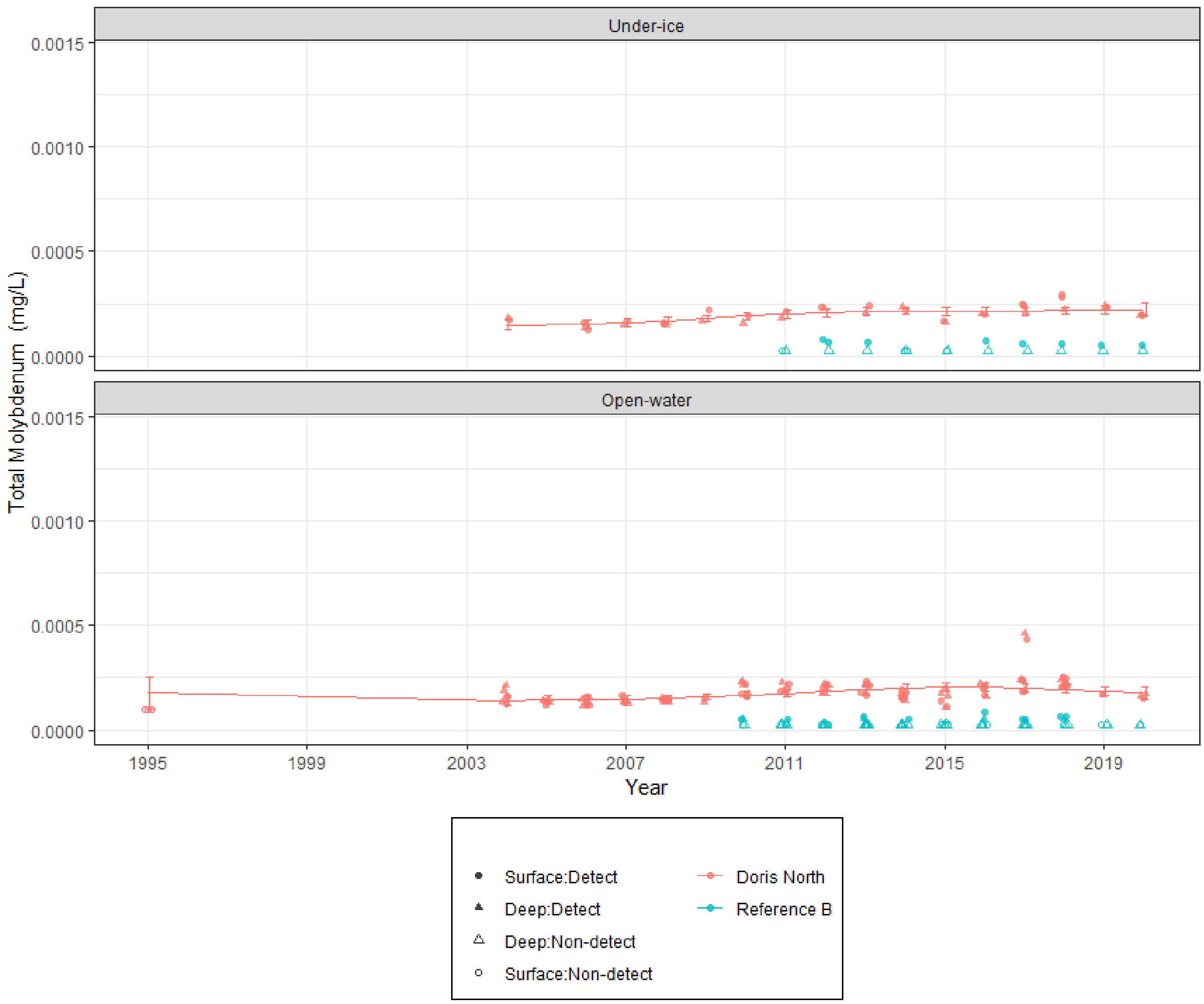
Analysis	Chi.sq	DF	P.value
Compare to slope 0	22.91	4	0.0001

Doris Lake appears to show significant deviation from no trend.

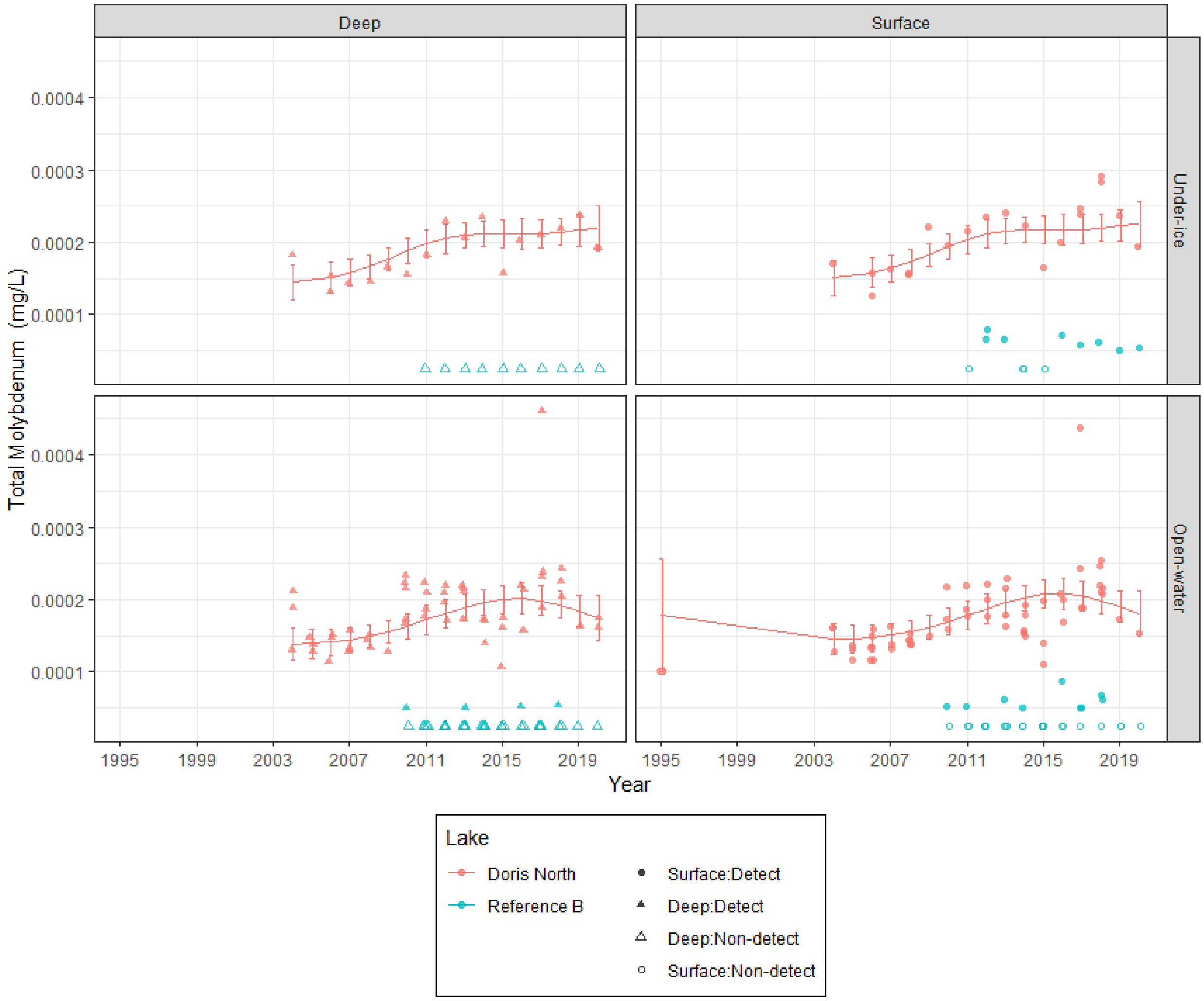
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-1e-04	1e-04	16940	-0.5574	0.5773	not sig.

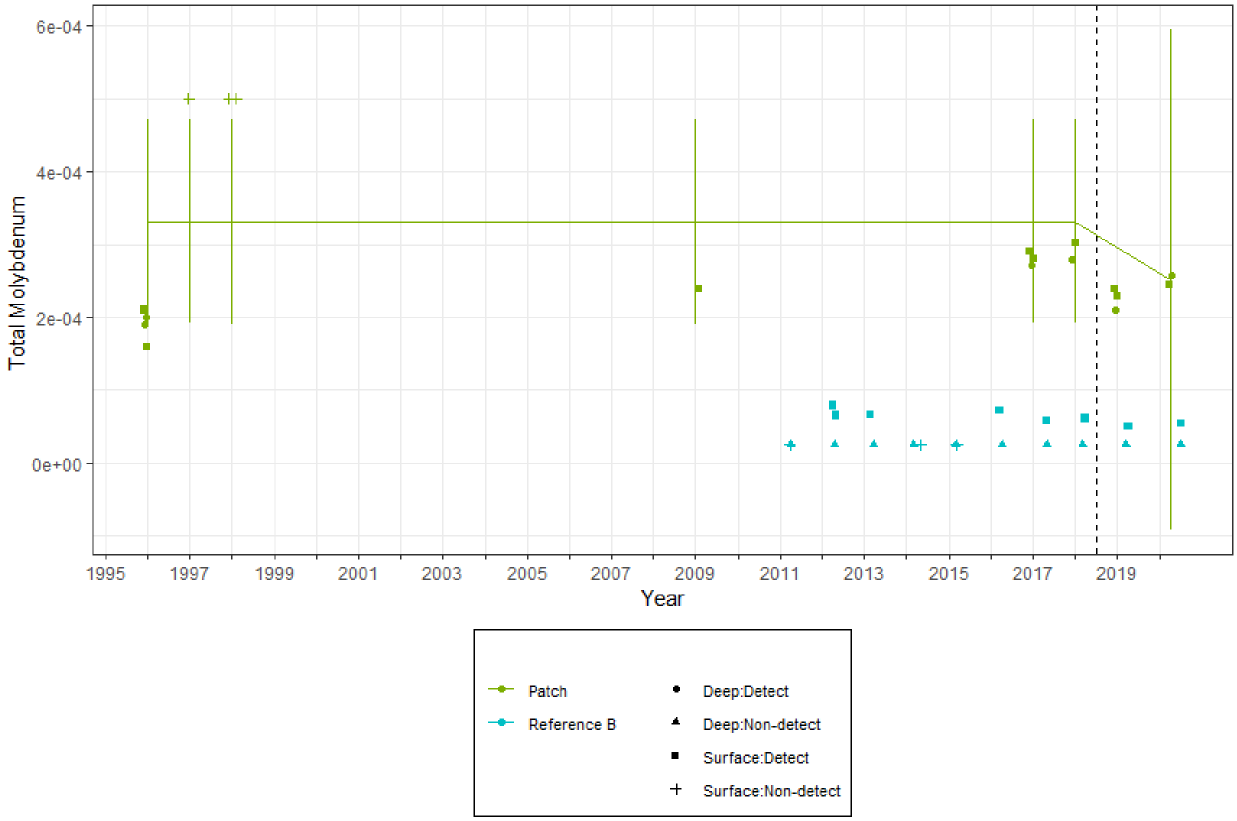
Conclusion:

The change in total molybdenum concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.5773) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-4e-05	2e-04	4.824	-0.2741	0.7954	not sig.

Conclusion:

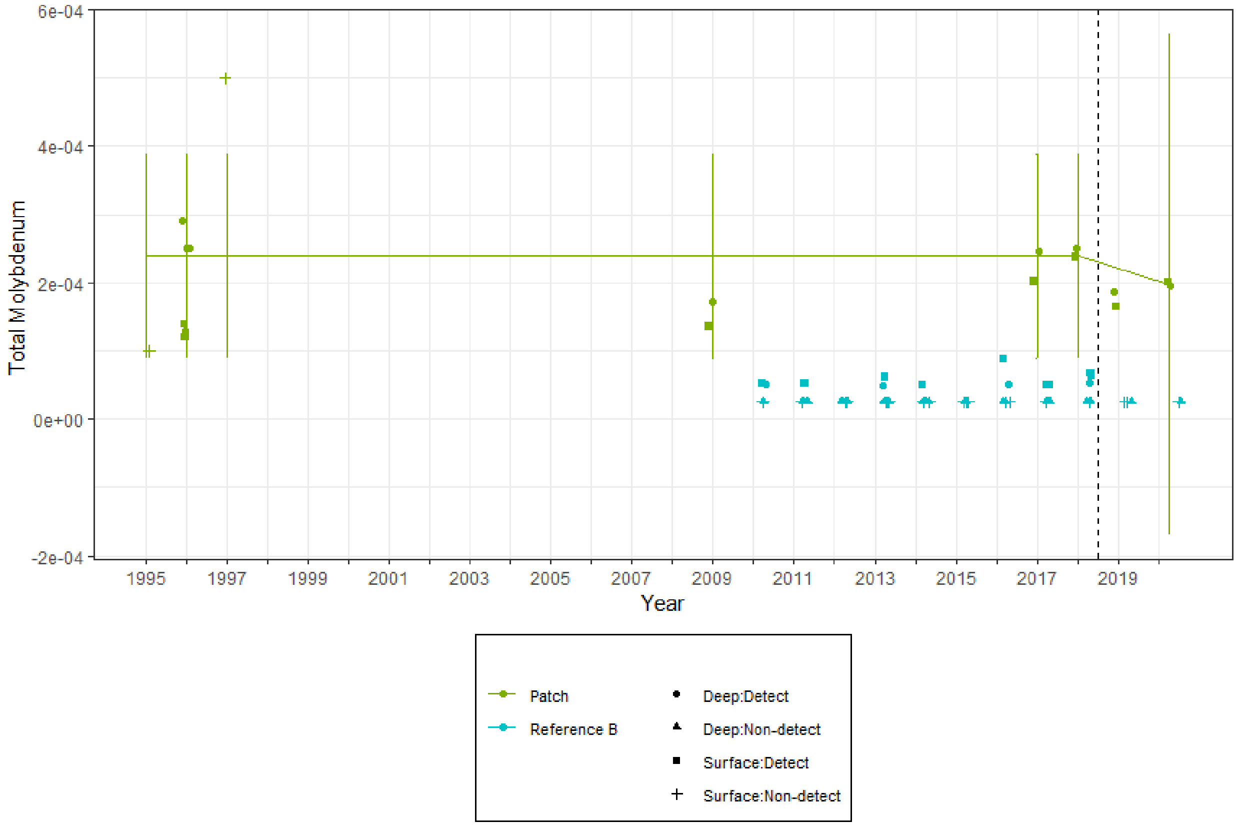
The change in total molybdenum concentrations in Patch Lake from *before* to *after* was not significantly ($p = 0.7954$) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	1e-04	1e-04	7.321	0.6496	0.5358	not sig.

Conclusion:

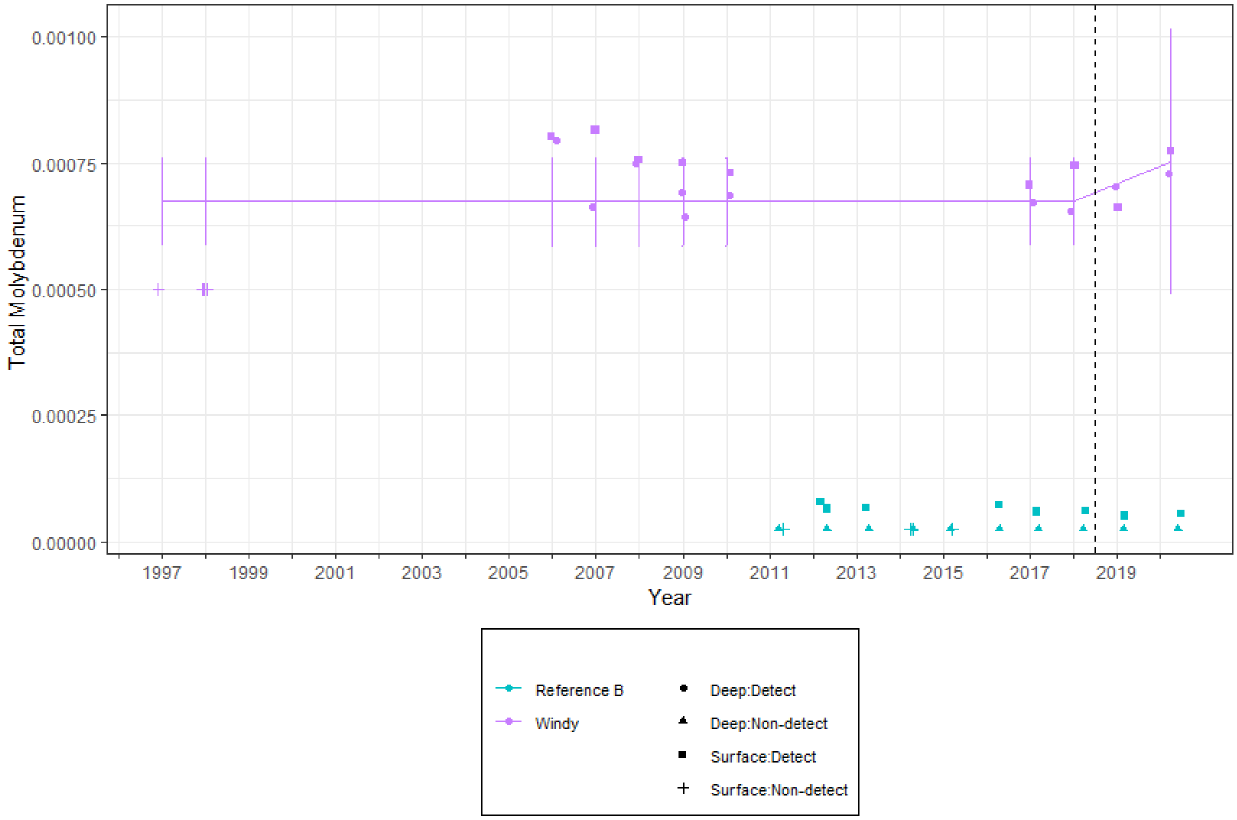
The change in total molybdenum concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.5358) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0	1e-04	8.962	-0.0098	0.9924	not sig.

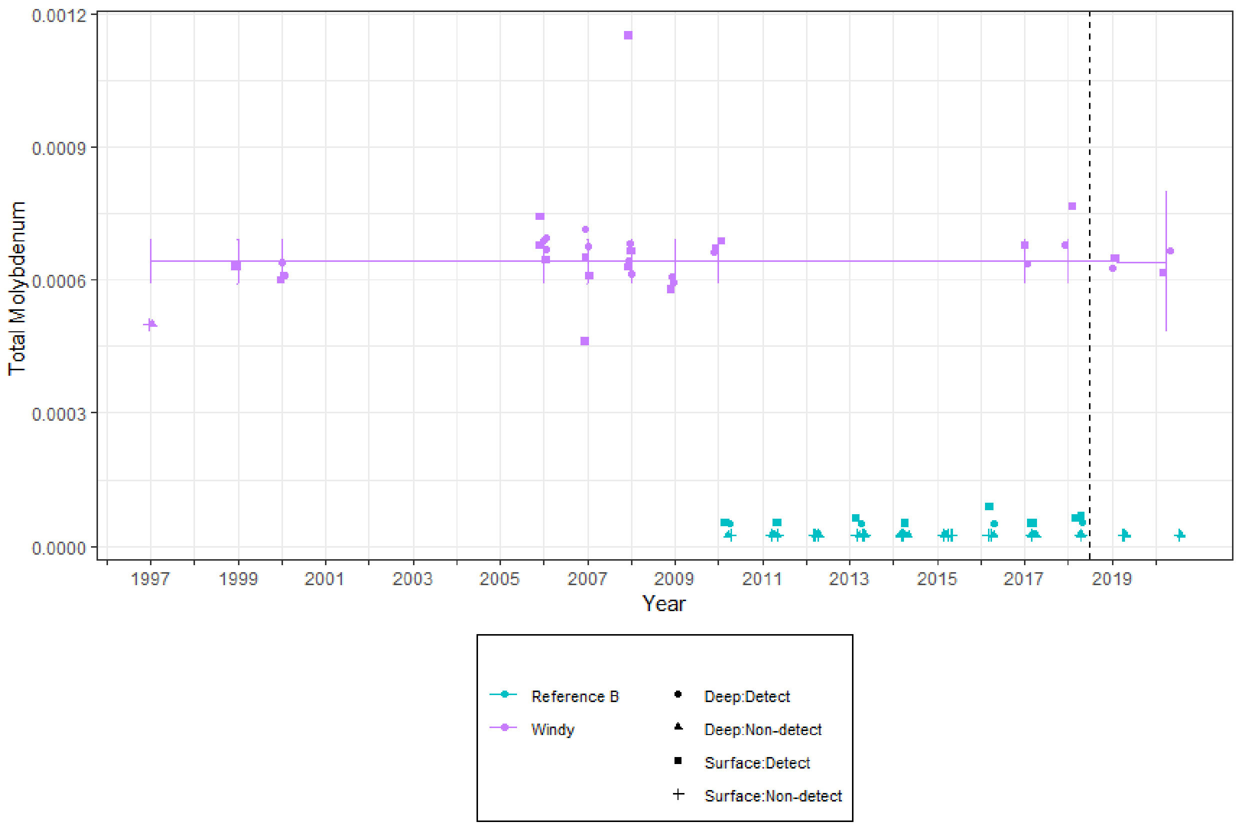
Conclusion:

The change in total molybdenum concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.9924) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

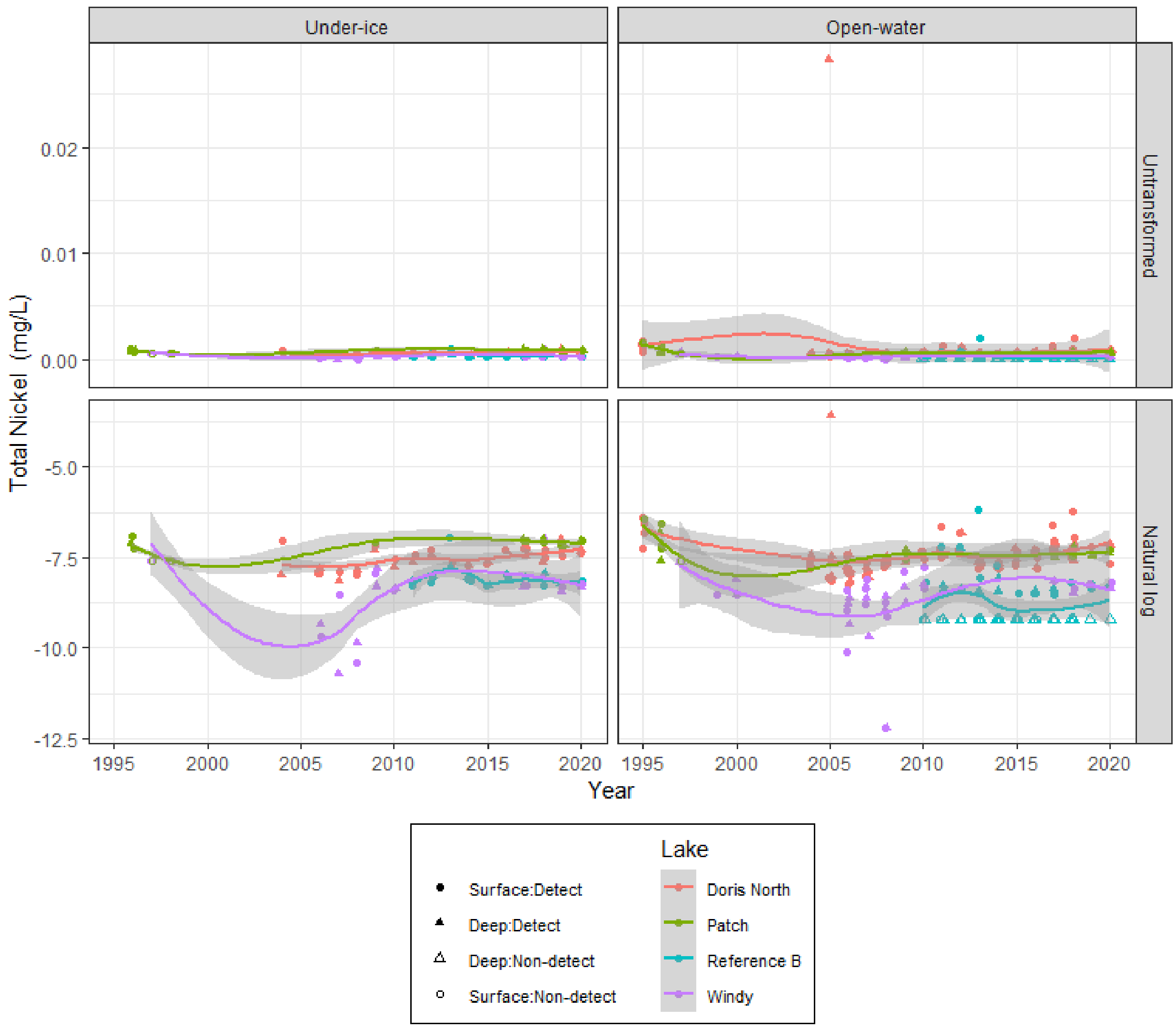
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.21 Total Nickel

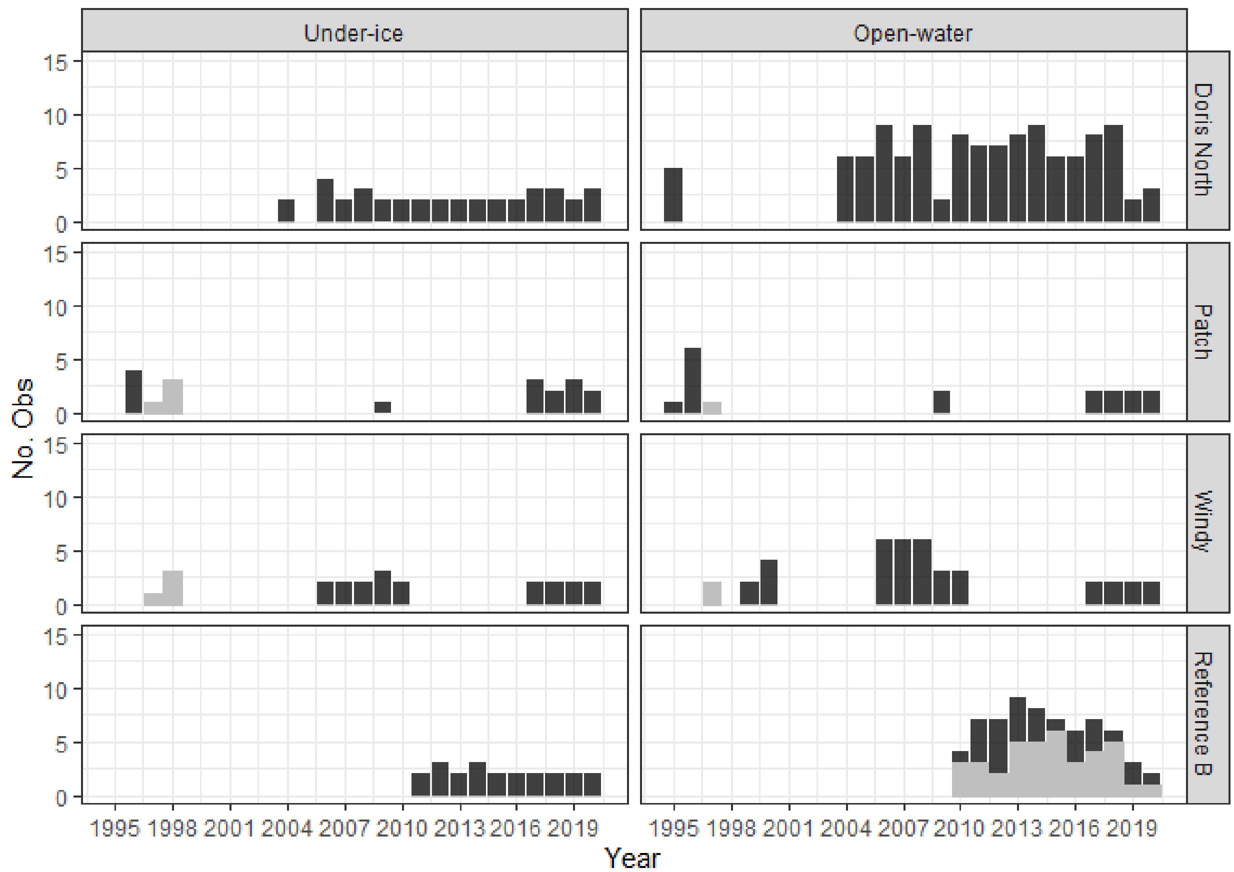
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

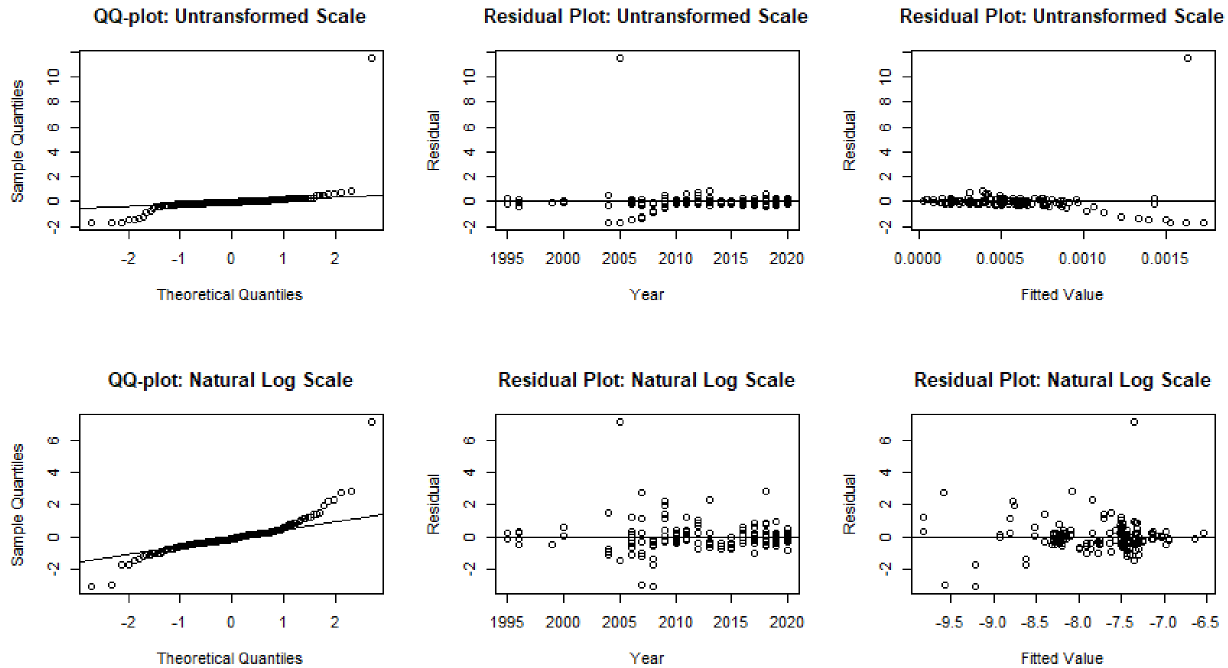
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	0	0.00	0.0	0.0005
Doris North	Open-water	116	0	0.00	0.0	0.0006
Patch	Under-ice	19	4	0.21	0.0	0.0009
Patch	Open-water	18	1	0.06	0.0	0.0007
Reference B	Under-ice	22	0	0.00	0.0	0.0003
Reference B	Open-water	66	38	0.58	0.5	0.0002
Windy	Under-ice	23	4	0.17	0.0	0.0003
Windy	Open-water	40	2	0.05	0.0	0.0002

More than 50% of data under detection limit in Reference B open-water. Data from those site-season groupings will be removed from the analysis. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Doris	2005	Open-water	Deep	0.0097	0.002	11.49

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Doris	2005	Open-water	Deep	0.0097	-7.353	7.134
Windy	2007	Under-ice	Deep	0.0000	-9.579	-3.004
Windy	2008	Under-ice	Surface	0.0000	-9.216	-3.098

There were outliers retained in the analysis. Results should be interpreted with caution and along with graphical results. The natural log data better meets the residual assumptions. Analysis proceeds with natural log data.

Doris Lake

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

Under-ice

Analysis	Chi.sq	DF	P.value
Compare to slope 0	4.023	4	0.4028

Doris Lake does not exhibit significant deviation from no trend.

Open-water

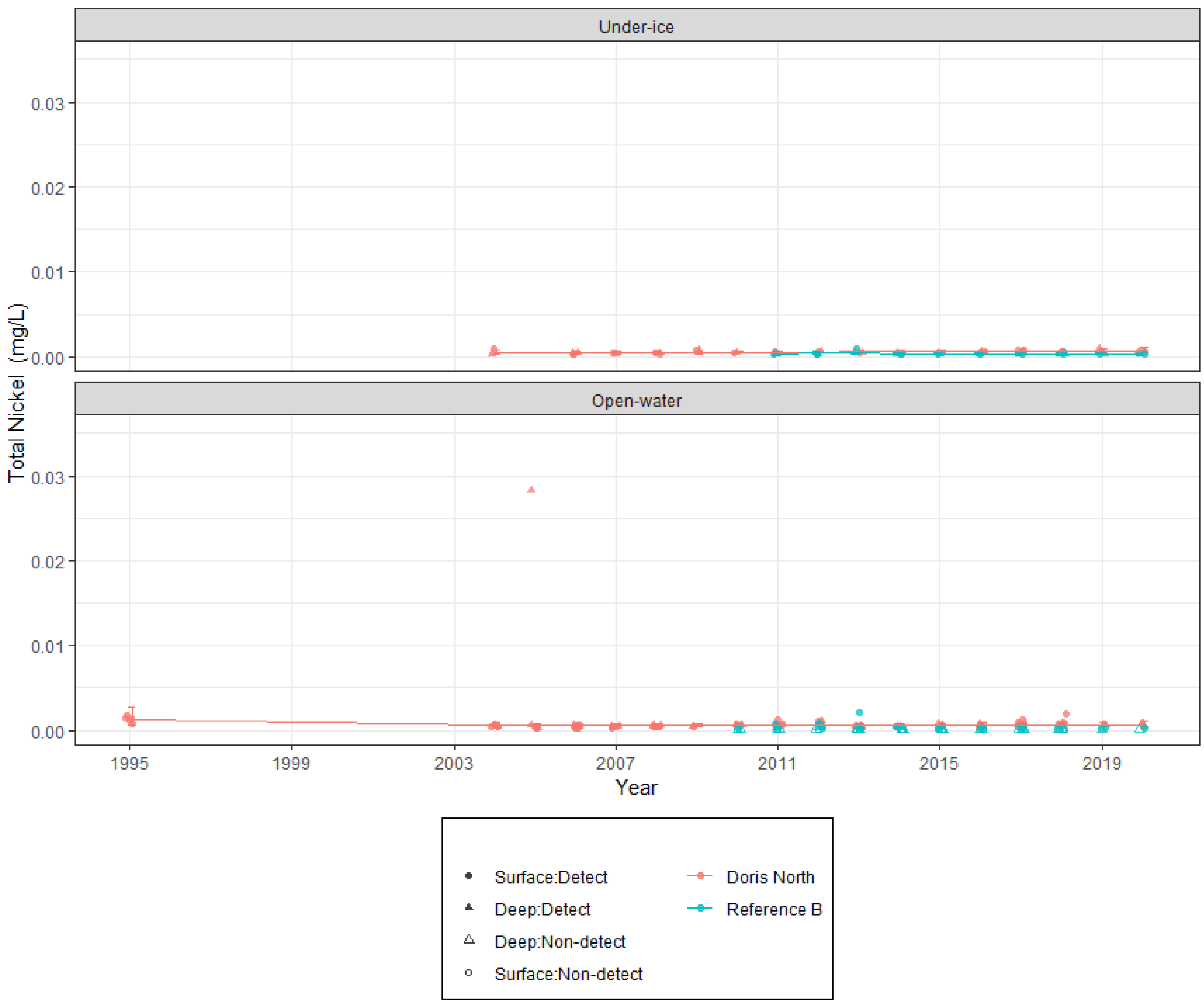
Analysis	Chi.sq	DF	P.value
Compare to slope 0	5.252	4	0.2624

Doris Lake does not exhibit significant deviation from no trend.

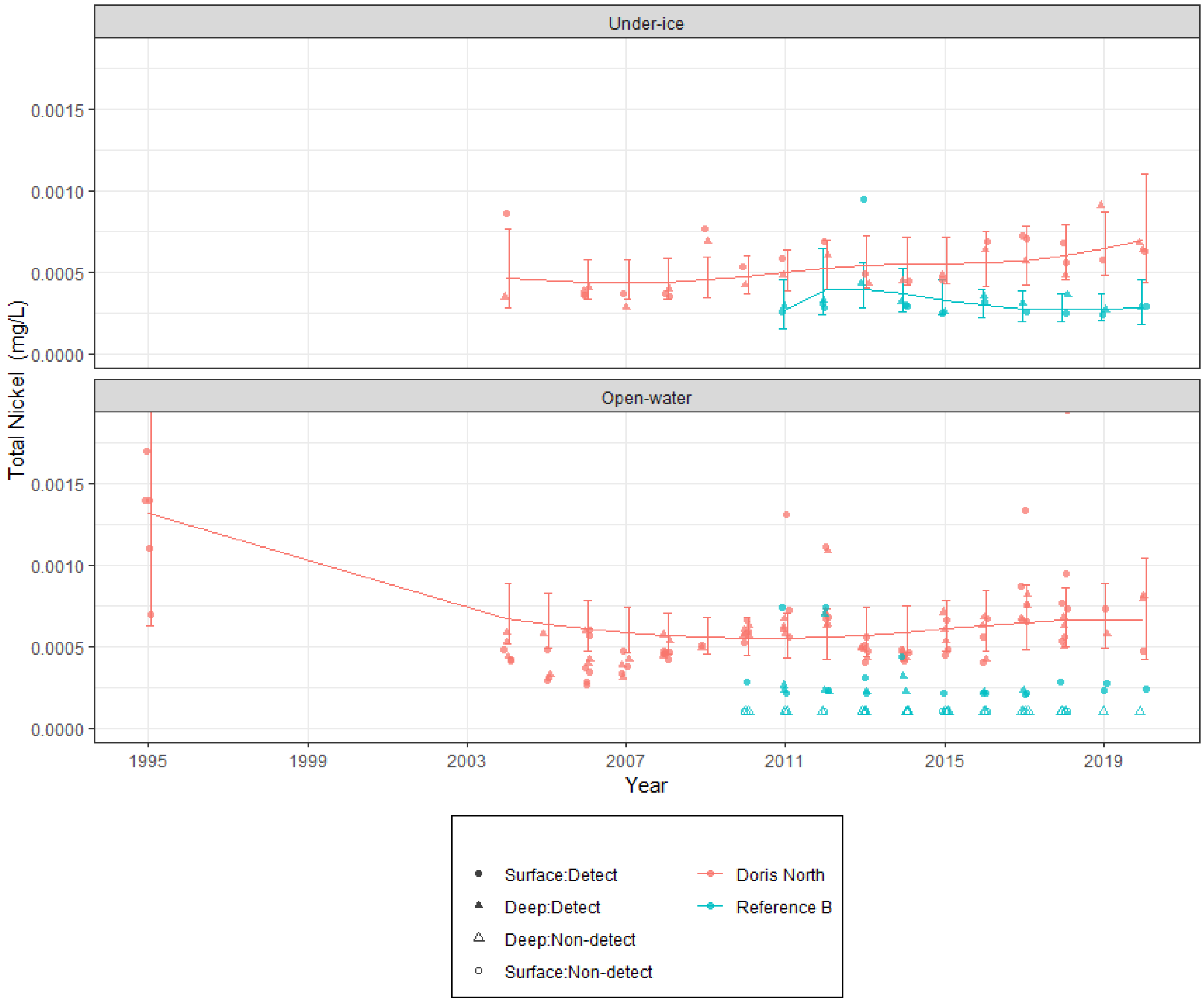
Observed data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

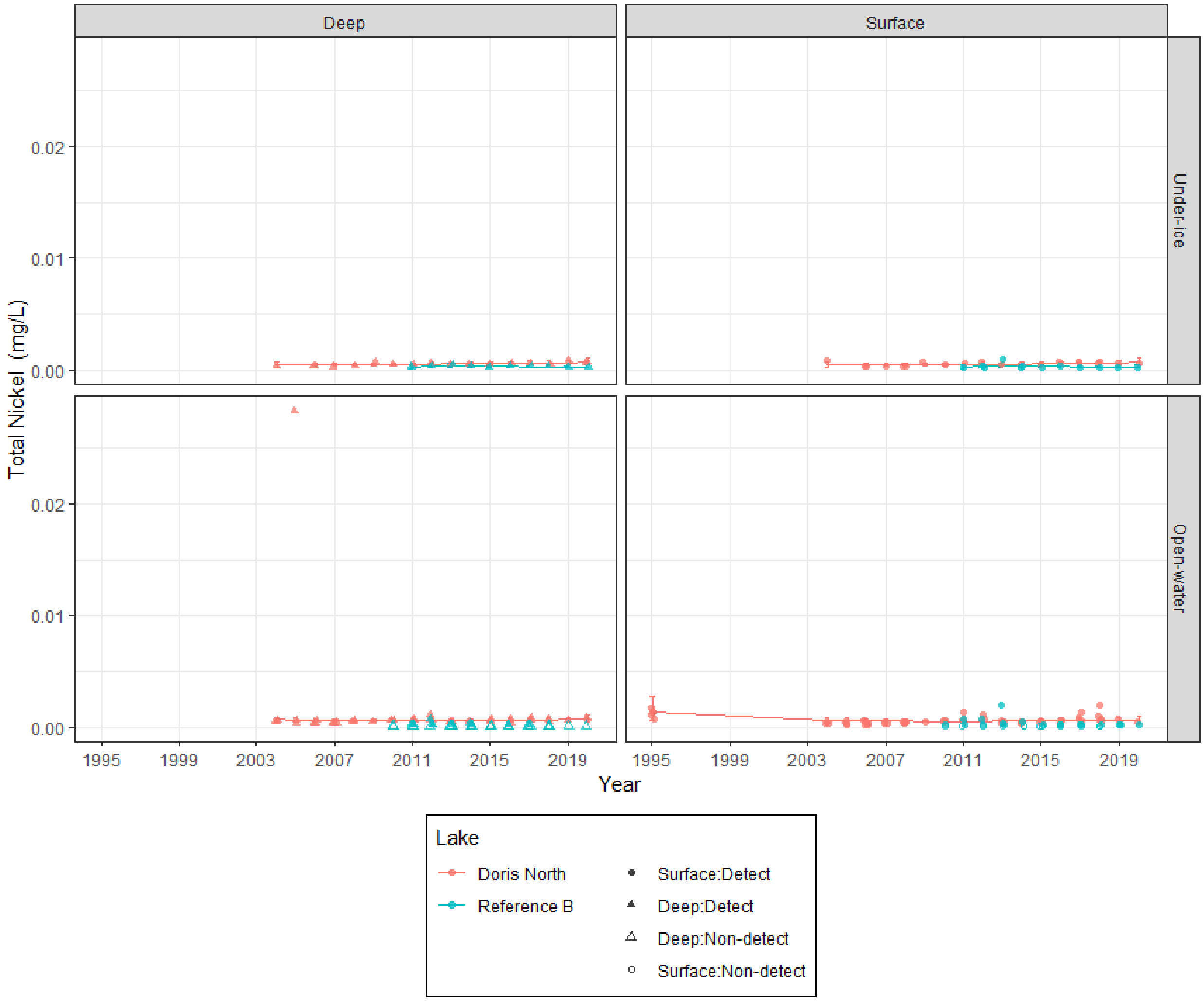
Plot of observed and fitted data averaged over depth.



Zoom-in:


Under-ice
Open-water
Total Nickel (mg/L)
0.0015
0.0010
0.0005
0.0000
1995
1999
2003
2007
2011
2015
2019
Year
Surface:Detect
Deep:Detect
Deep:Non-detect
Surface:Non-detect
Doris North
Reference B

Plot of observed and fitted data separated by depth.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.21	0.3024	4.82	0.6943	0.5195	not sig.

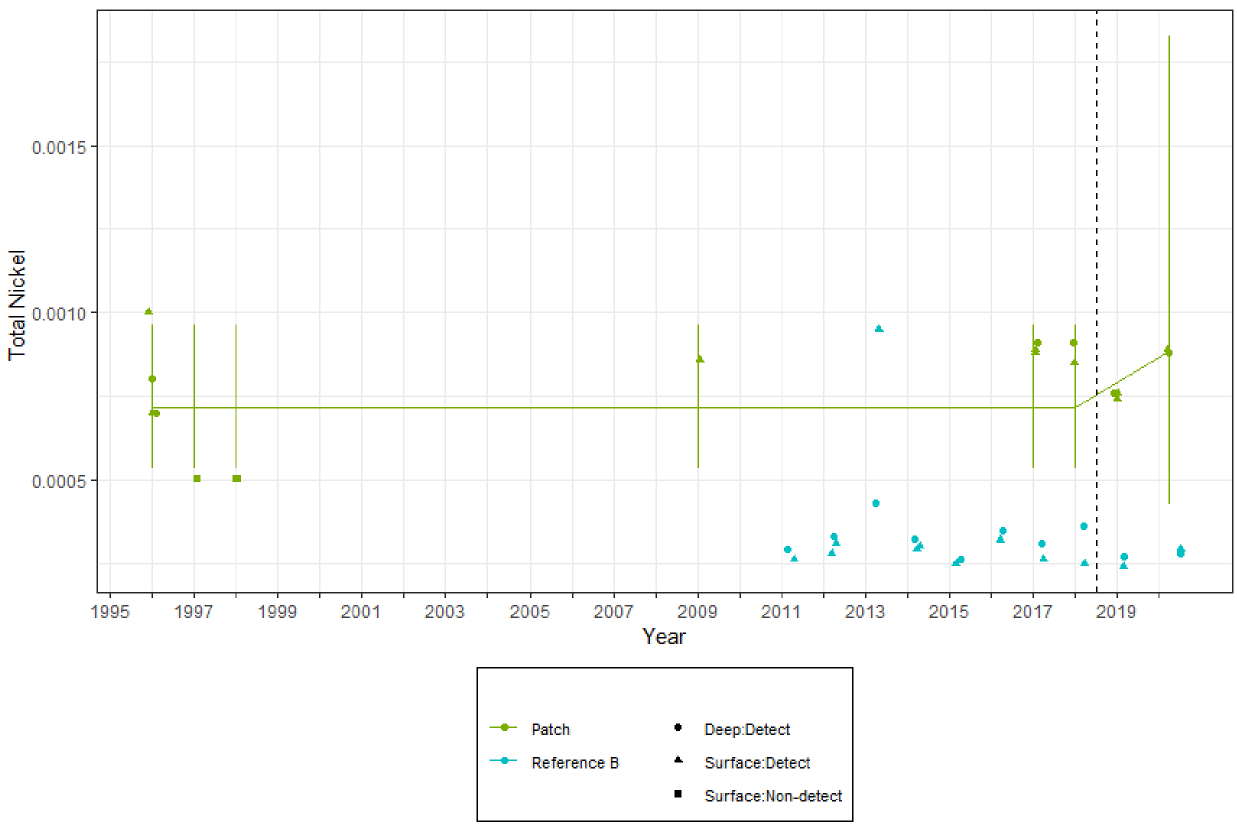
Conclusion:

The change in total nickel concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.5195) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.1247	0.4387	4.266	-0.2842	0.7895	not sig.

Conclusion:

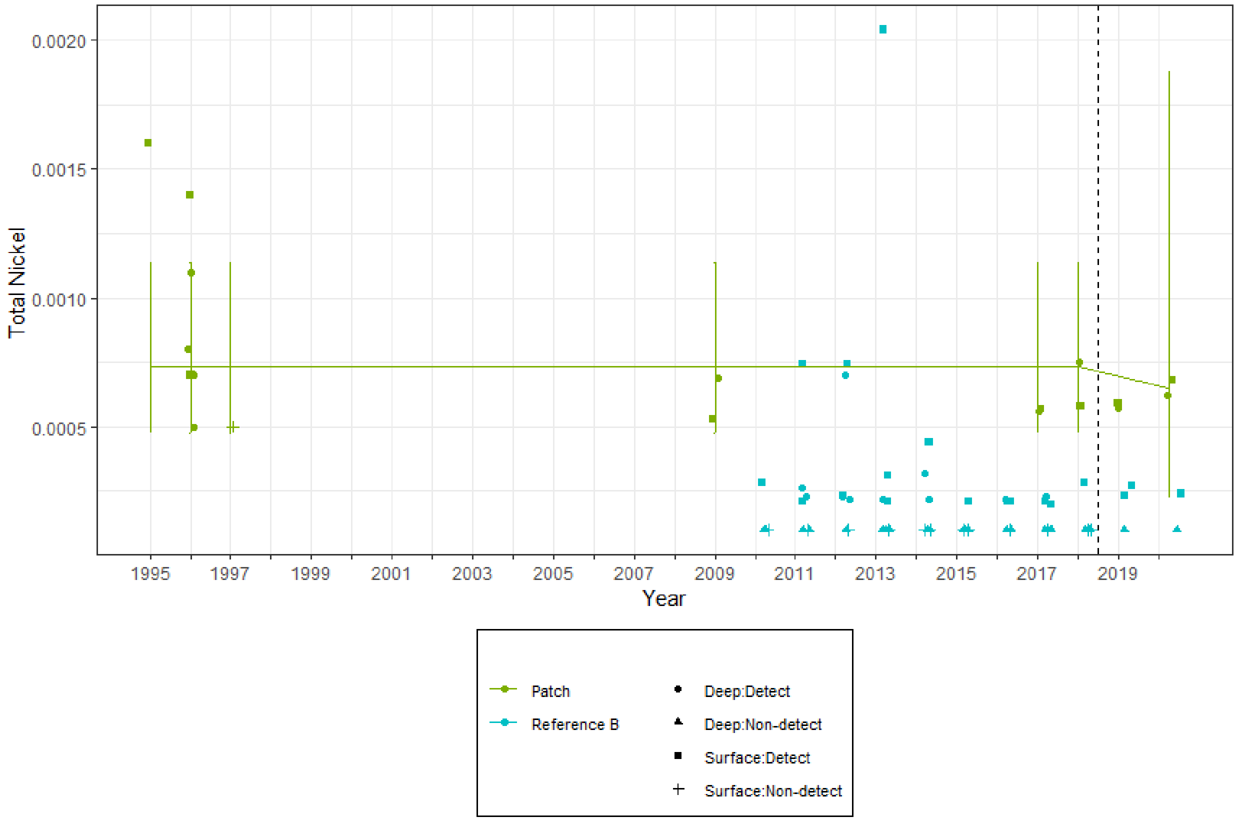
The change in total nickel concentrations at the Patch site from *before* to *after* was not significantly (p = 0.7895) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.301	1.012	7.409	0.2975	0.7742	not sig.

Conclusion:

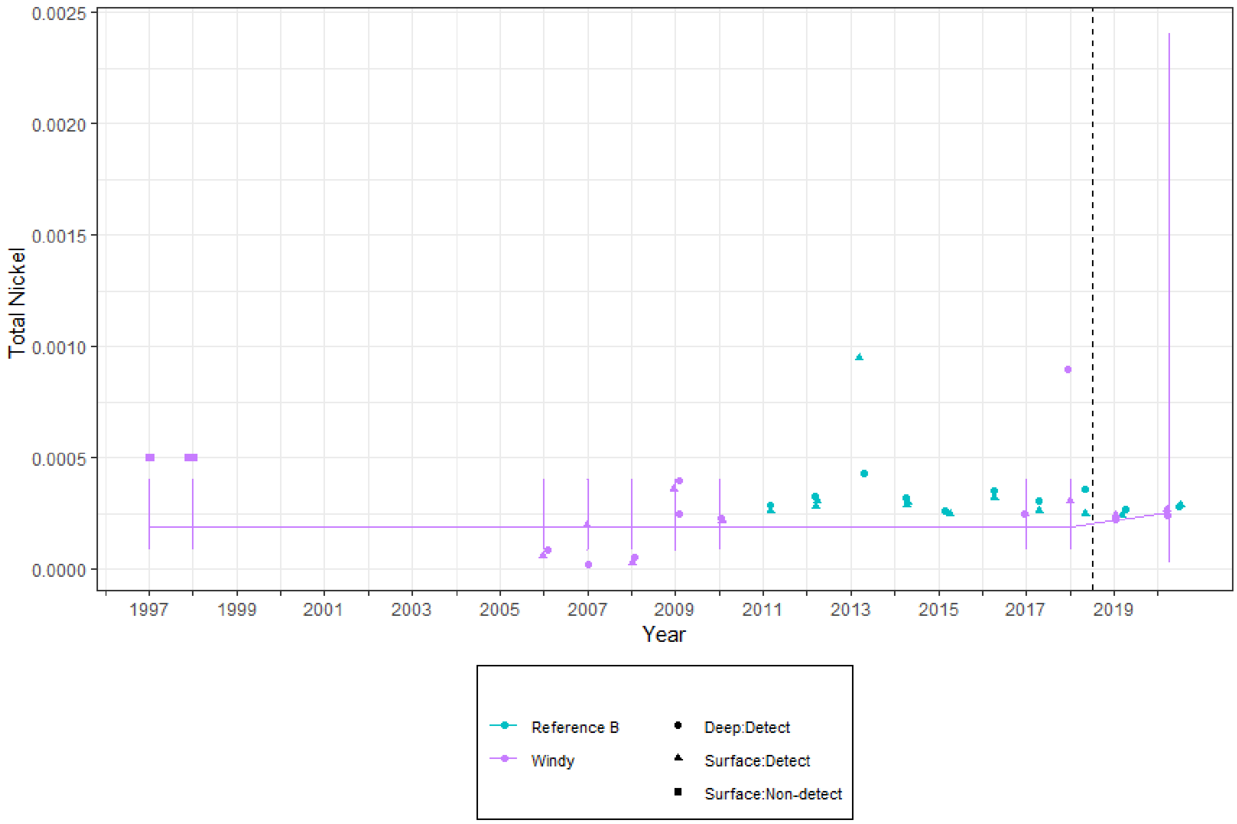
The change in total nickel concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.7742) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.132	0.4688	8.989	0.2816	0.7847	not sig.

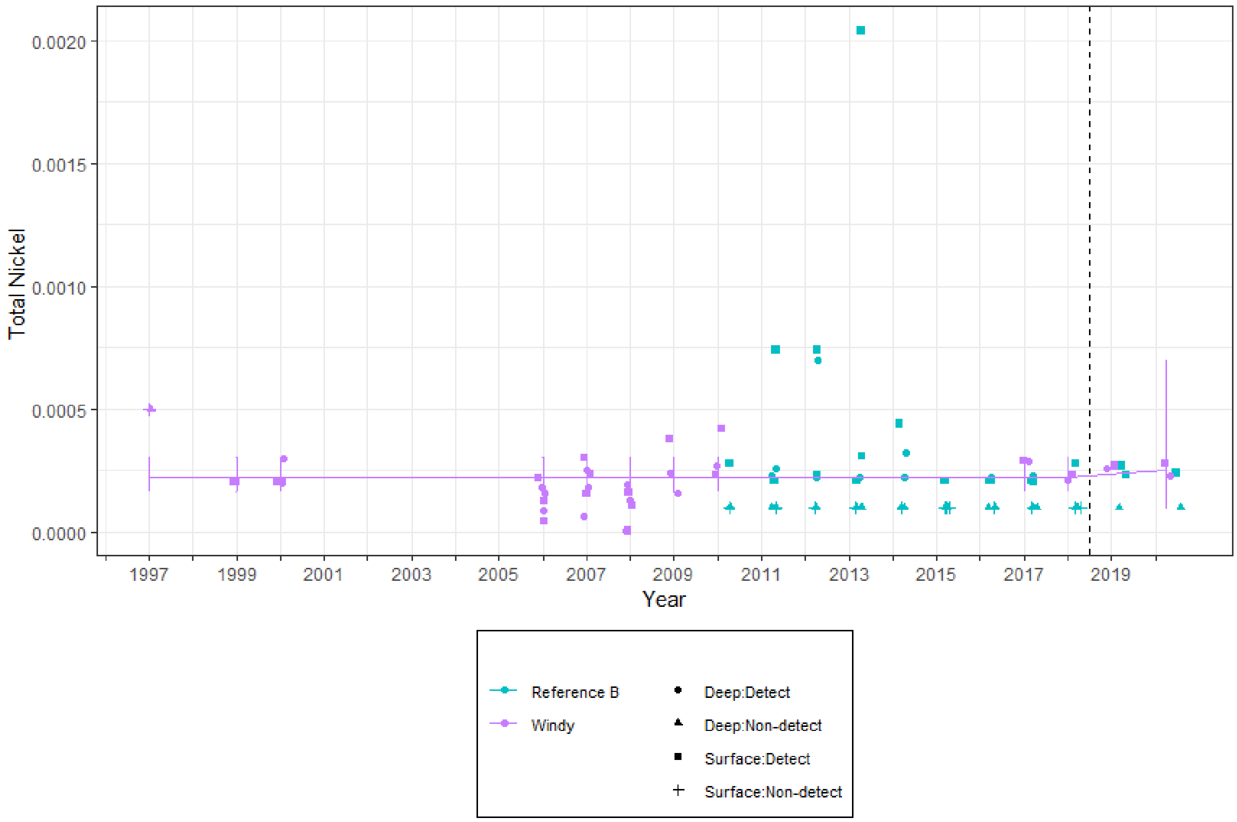
Conclusion:

The change in total nickel concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.7847) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

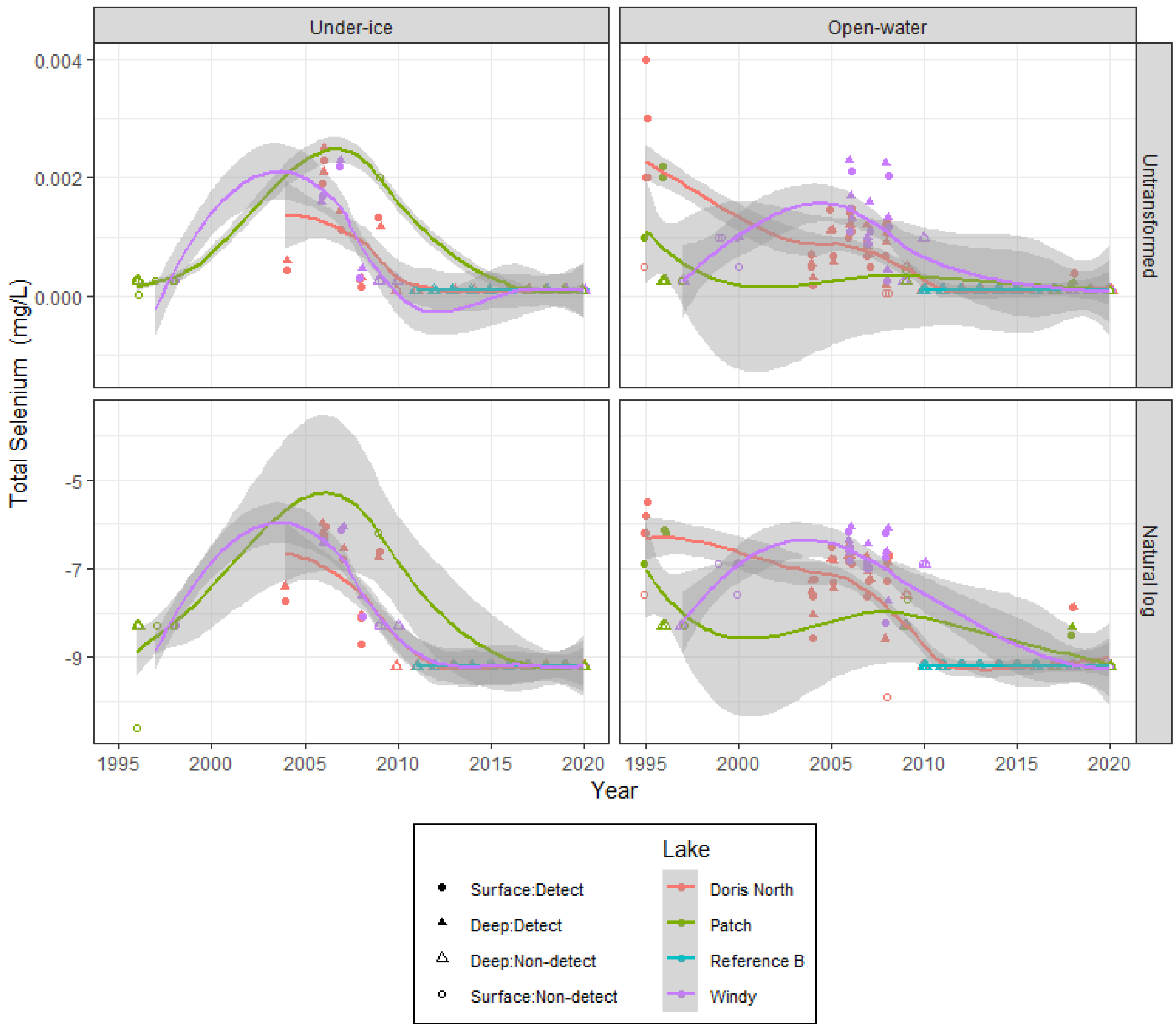
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.22 Total Selenium

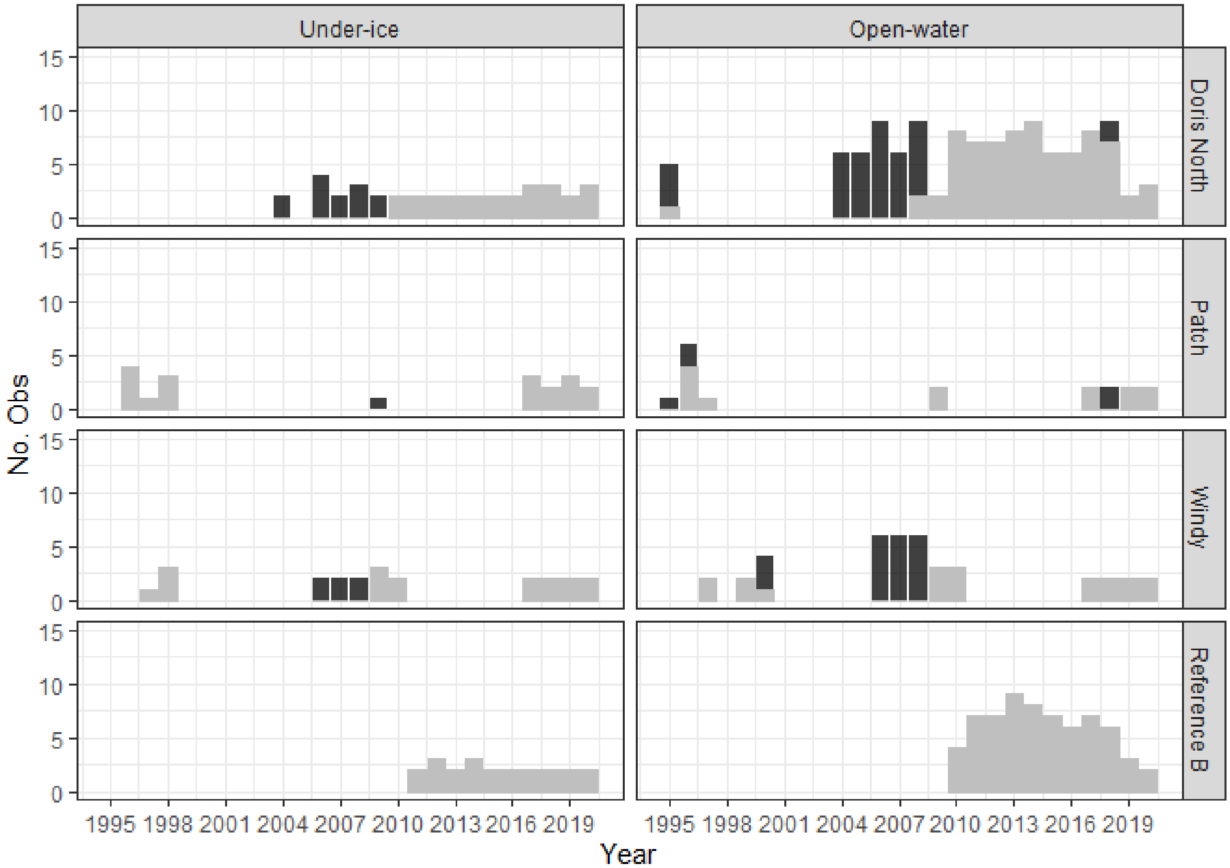
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

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

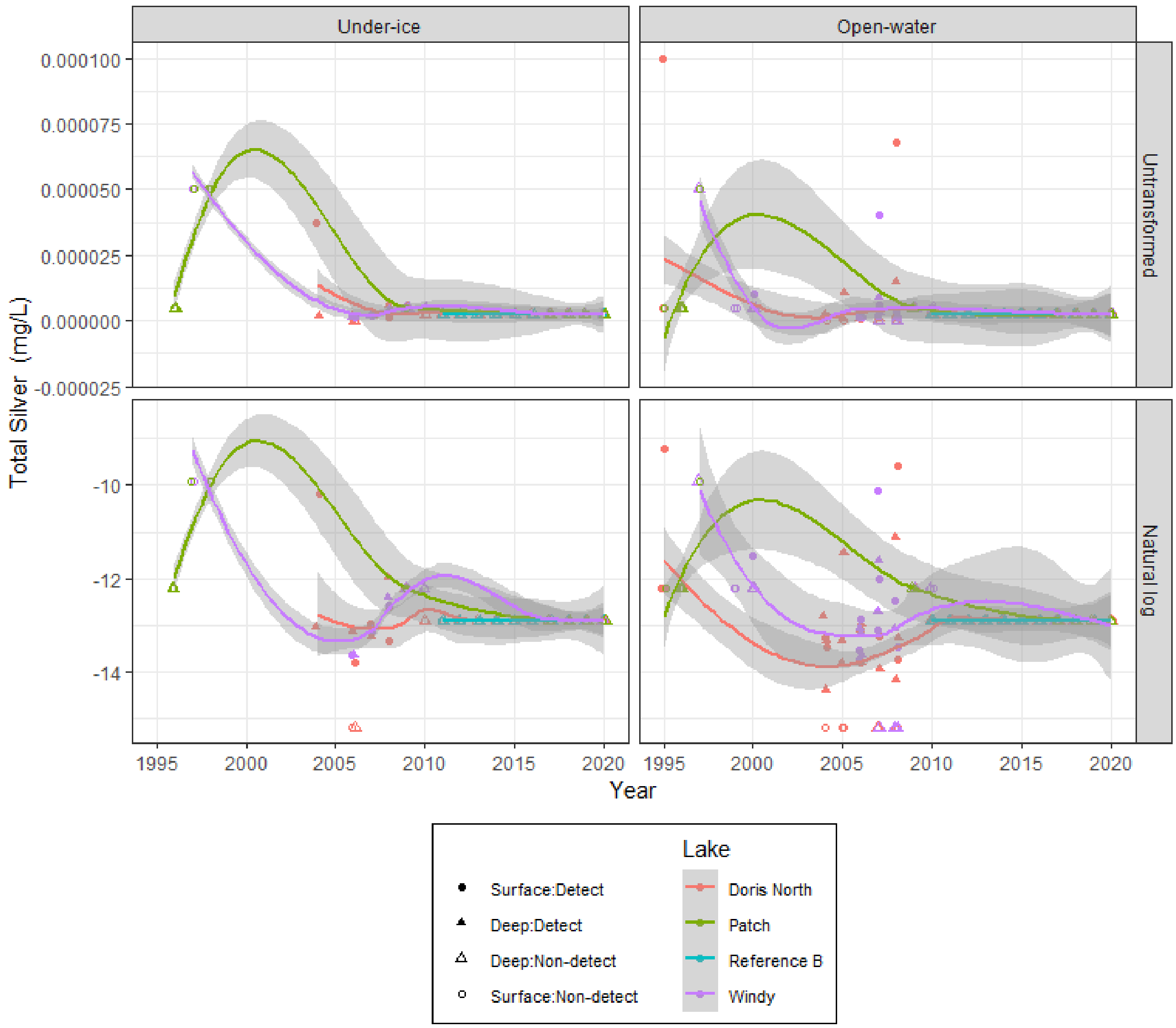
Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	25	0.66	1	0.0002
Doris North	Open-water	116	76	0.66	1	0.0002
Patch	Under-ice	19	19	1.00	1	0.0002
Patch	Open-water	18	13	0.72	1	0.0005
Reference B	Under-ice	22	22	1.00	1	0.0002
Reference B	Open-water	66	66	1.00	1	0.0002
Windy	Under-ice	23	17	0.74	1	0.0005
Windy	Open-water	40	19	0.48	1	0.0010

All data from 2020 were censored. All data removed from the analysis and no statistical analyses were performed.

C.3.1.23 Total Silver

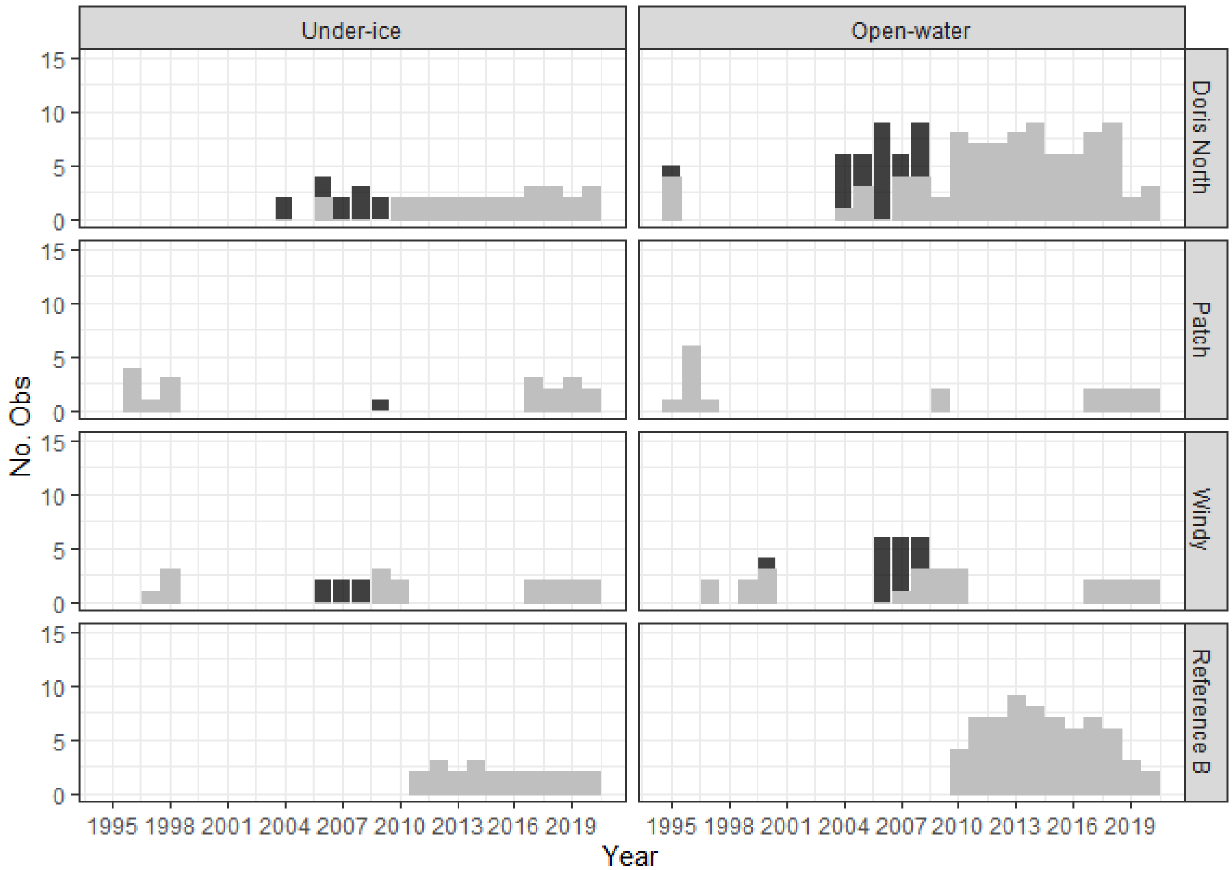
Observed Data

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. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

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

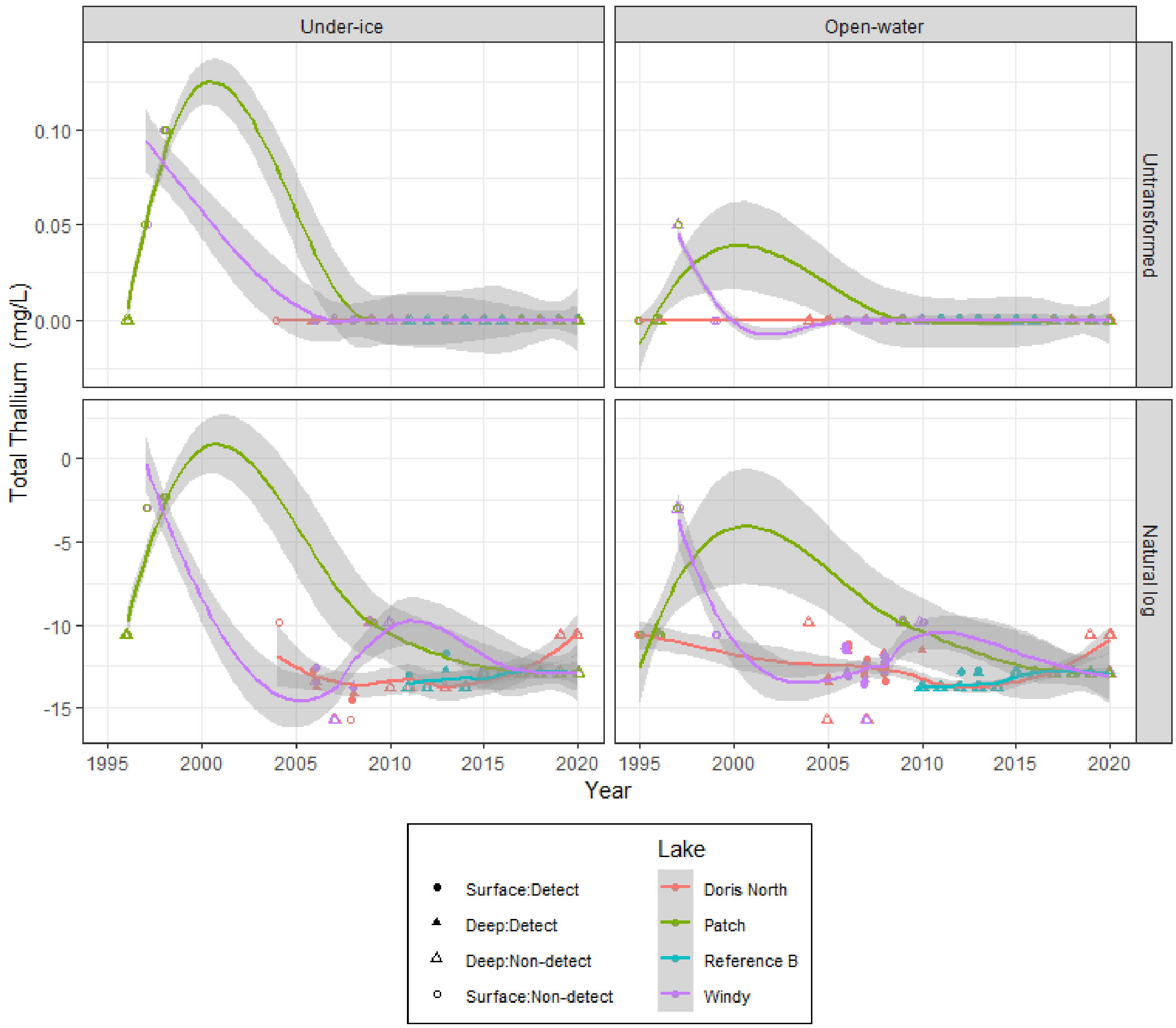
Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	29	0.76	1	0
Doris North	Open-water	116	91	0.78	1	0
Patch	Under-ice	19	19	1.00	1	0
Patch	Open-water	18	18	1.00	1	0
Reference B	Under-ice	22	22	1.00	1	0
Reference B	Open-water	66	66	1.00	1	0
Windy	Under-ice	23	17	0.74	1	0
Windy	Open-water	40	25	0.62	1	0

All data from 2020 were censored. All data removed from the analysis and no statistical analyses were performed.

C.3.1.24 Total Thallium

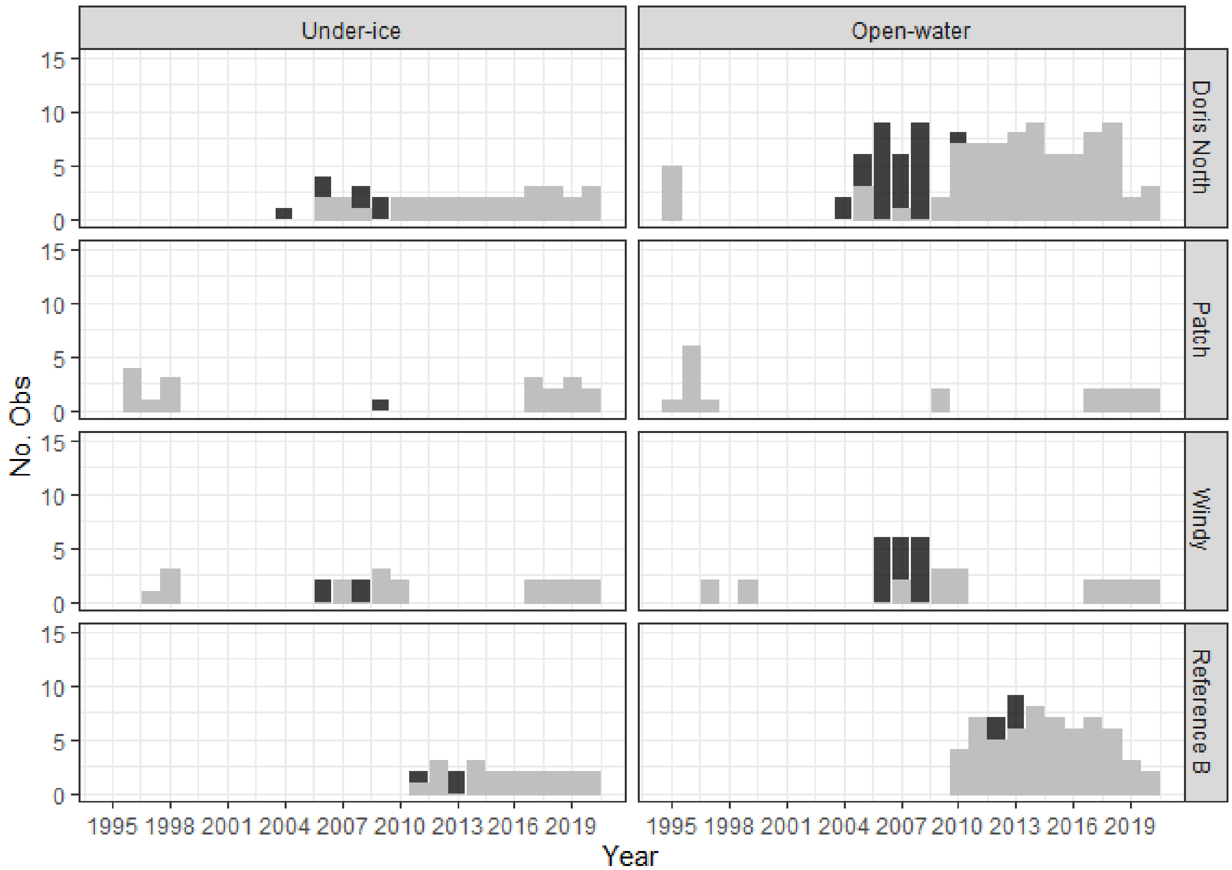
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

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

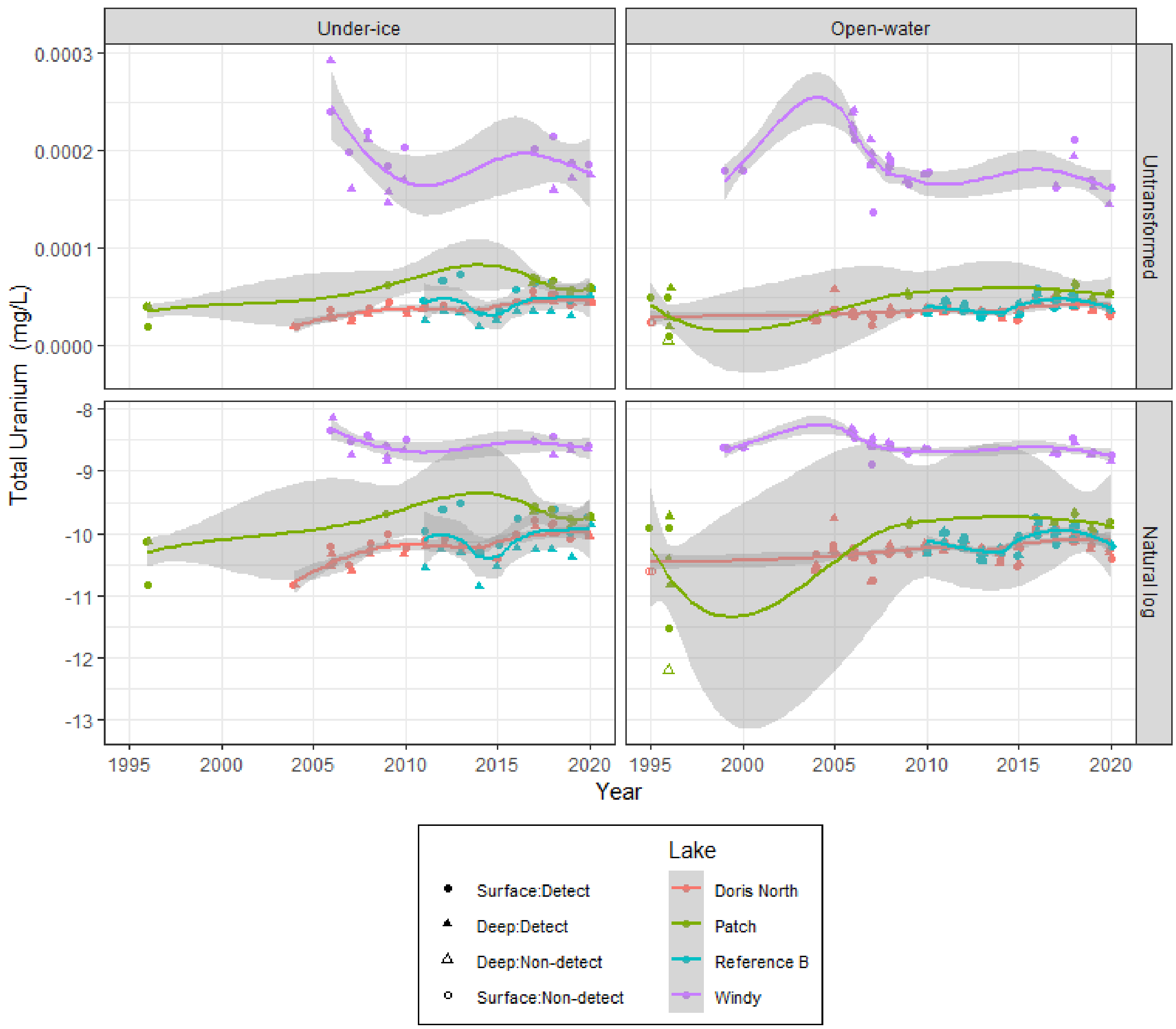
Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	37	33	0.89	1	0
Doris North	Open-water	112	85	0.76	1	0
Patch	Under-ice	19	19	1.00	1	0
Patch	Open-water	18	18	1.00	1	0
Reference B	Under-ice	22	19	0.86	1	0
Reference B	Open-water	66	61	0.92	1	0
Windy	Under-ice	23	19	0.83	1	0
Windy	Open-water	36	20	0.56	1	0

All data from 2020 were censored. All data removed from the analysis and no statistical analyses were performed.

C.3.1.25 Total Uranium

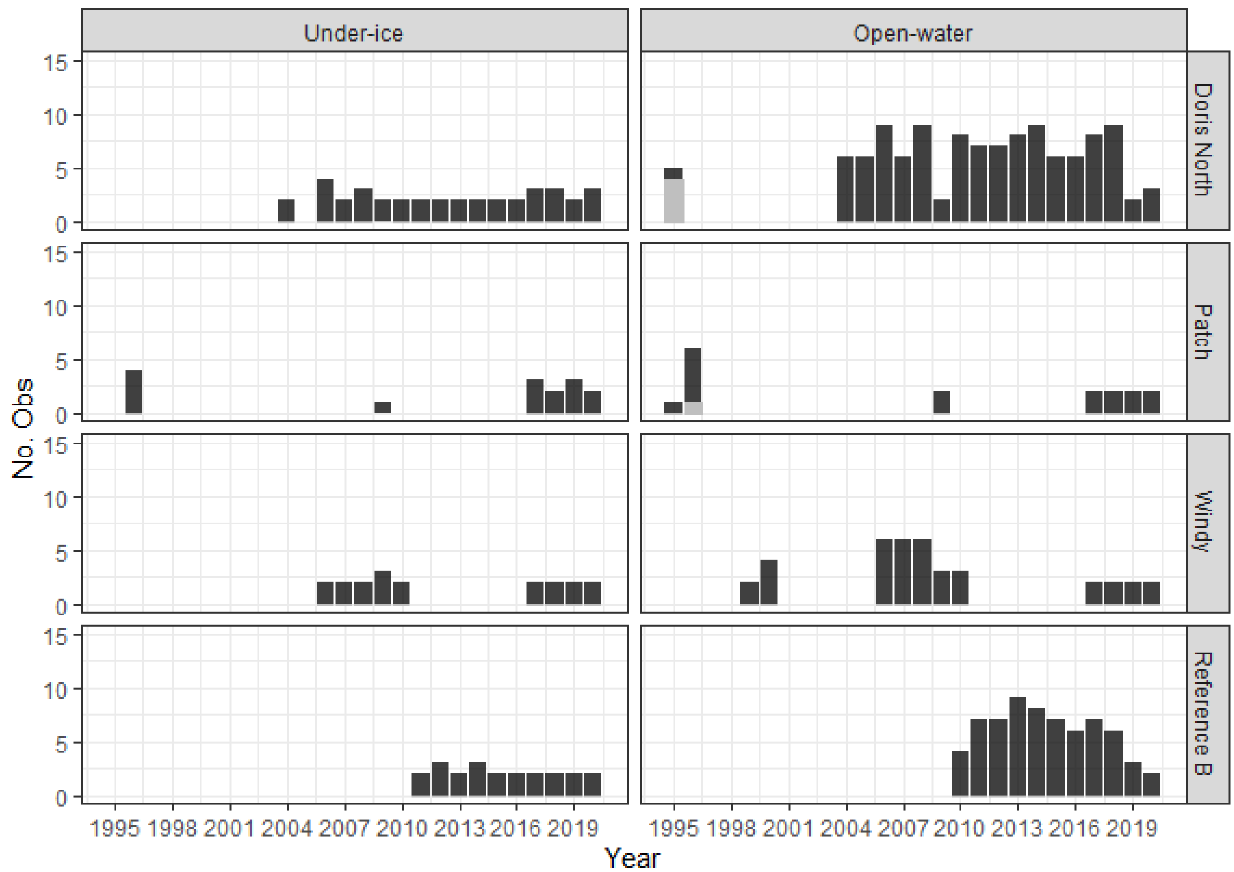
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

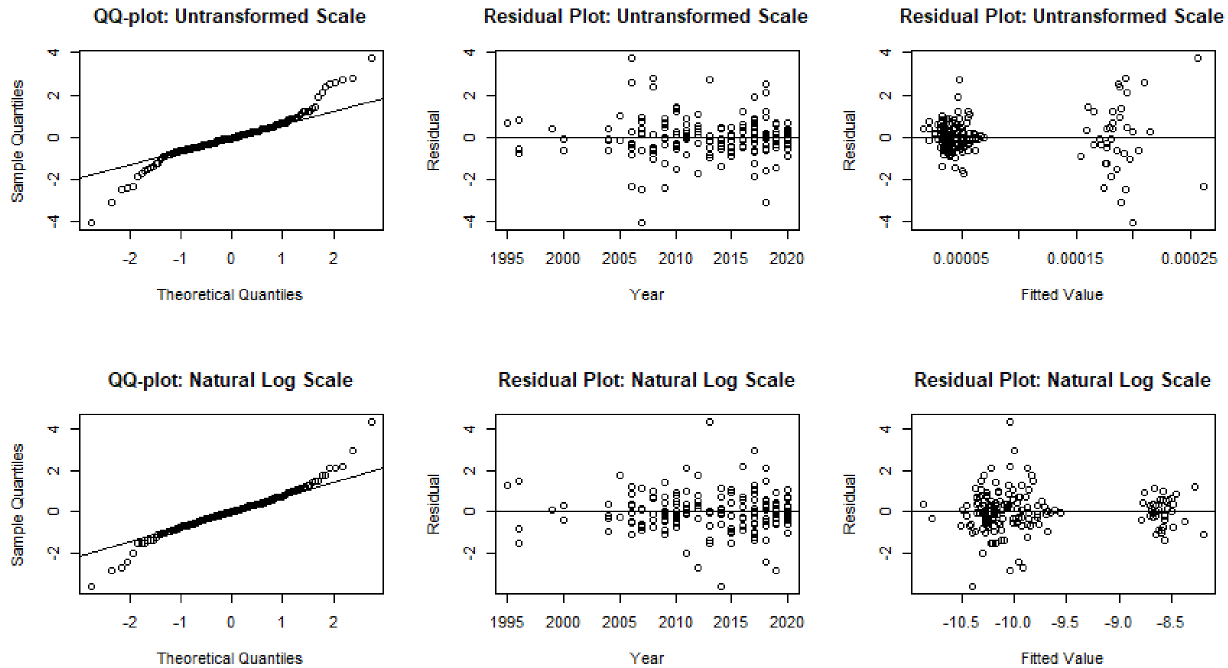
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	38	0	0.00	0	0.0000
Doris North	Open-water	116	4	0.03	0	0.0000
Patch	Under-ice	15	0	0.00	0	0.0001
Patch	Open-water	17	1	0.06	0	0.0001
Reference B	Under-ice	22	0	0.00	0	0.0000
Reference B	Open-water	66	0	0.00	0	0.0000
Windy	Under-ice	19	0	0.00	0	0.0002
Windy	Open-water	38	0	0.00	0	0.0002

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed effects regression for Doris, Patch, and Windy.

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 fitted model 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
Windy	2006	Under-ice	Deep	0.0003	0	3.749
Windy	2007	Under-ice	Deep	0.0002	0	-4.058
Windy	2018	Under-ice	Deep	0.0002	0	-3.112

Outliers on natural log scale:

Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
Reference B	2013	Under-ice	Surface	0.0001	-10.04	4.340
Reference B	2014	Under-ice	Deep	0.0000	-10.40	-3.643

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.

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	45.912	4	0.0000
Compare to Reference B	5.198	4	0.2676

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

Open-water

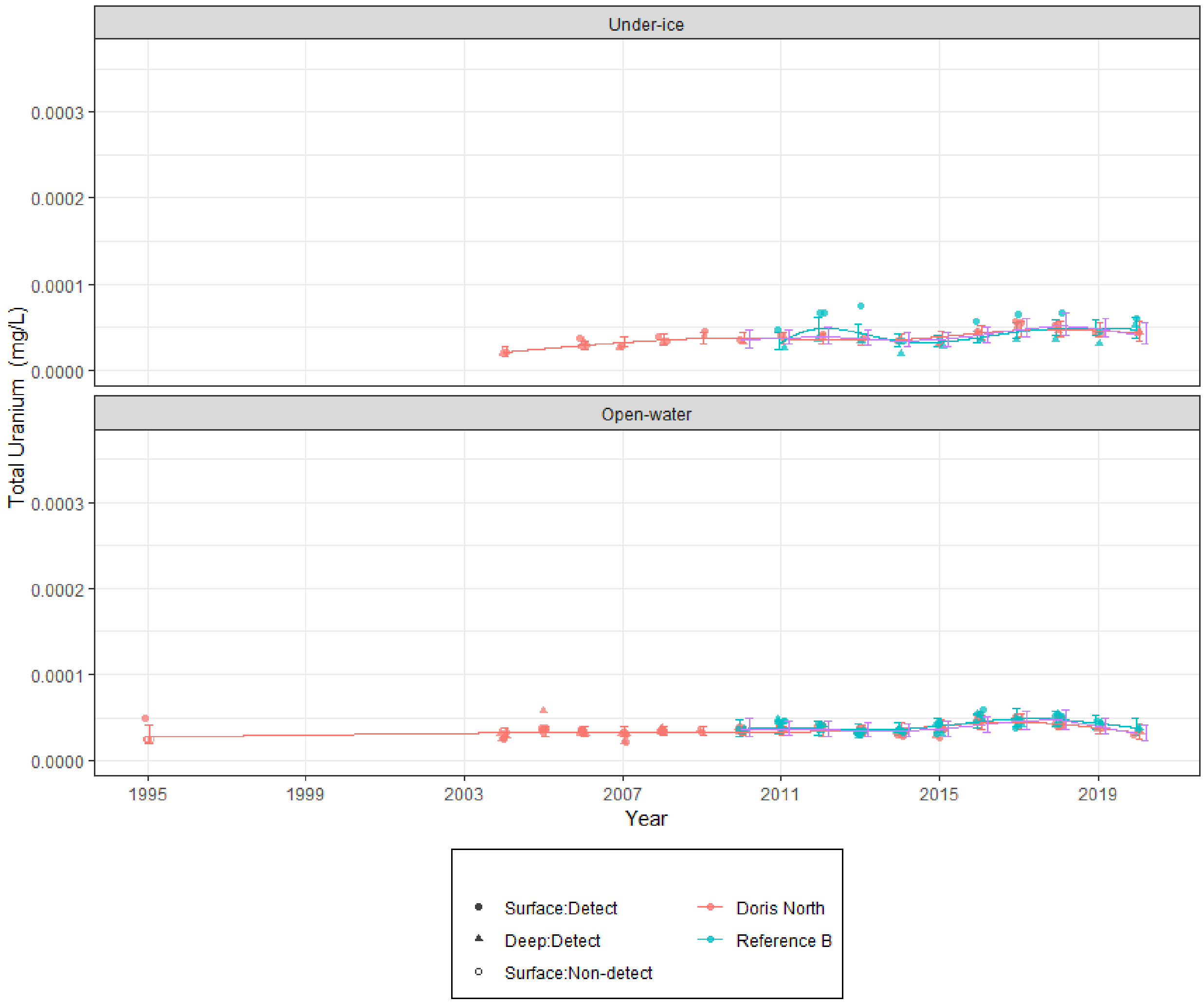
Analysis	Chi.sq	DF	P.value
Compare to slope 0	16.223	4	0.0027
Compare to Reference B	1.216	4	0.8755

Doris Lake appears to show significant deviation from no trend. Doris Lake 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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data; solid purple lines show fitted curves through comparable years of data for comparisons between Doris Lake and Reference B Lake data. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

Plot of observed and fitted data averaged over depth.


Under-ice
Open-water
Total Uranium (mg/L)
0.0003
0.0002
0.0001
0.0000
1995
1999
2003
2007
2011
2015
2019
Year
Surface:Detect
Deep:Detect
Surface:Non-detect
Doris North
Reference B

Plot of observed and fitted data separated by depth.

Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0743	0.354	2.995	0.2099	0.8472	not sig.

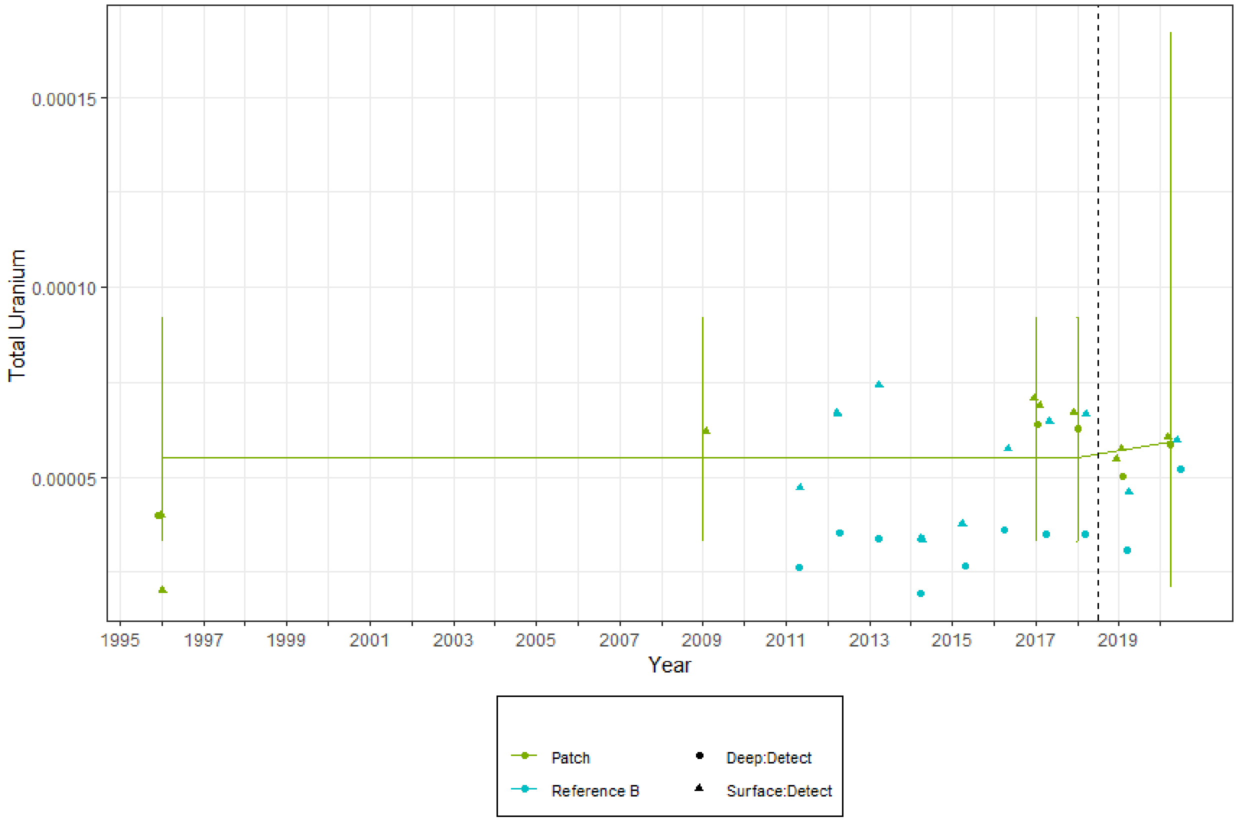
Conclusion:

The change in total uranium concentrations in Patch Lake from *before* to *after* was not significantly ($p = 0.8472$) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.0931	0.323	4.002	0.2882	0.7875	not sig.

Conclusion:

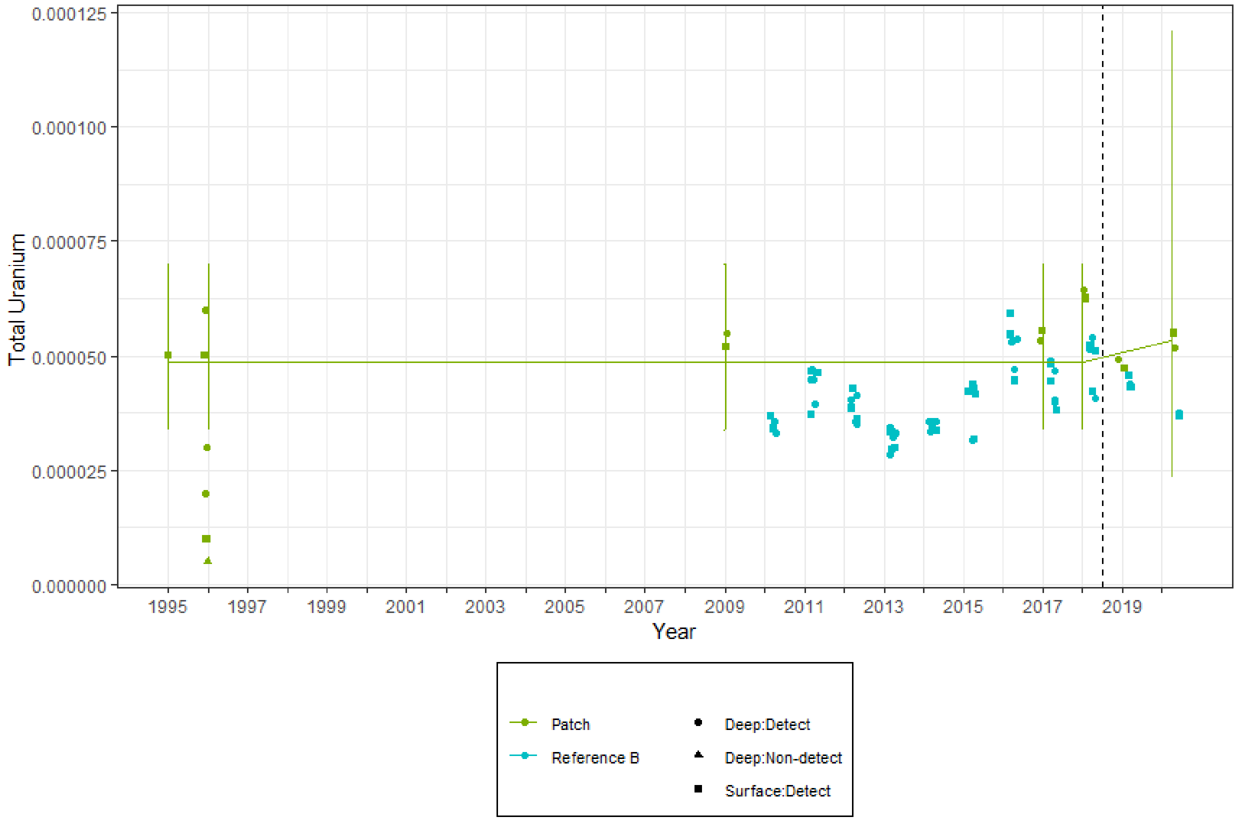
The change in total uranium concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.7875) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and

after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.092	0.1629	6	-0.5649	0.5926	not sig.

Conclusion:

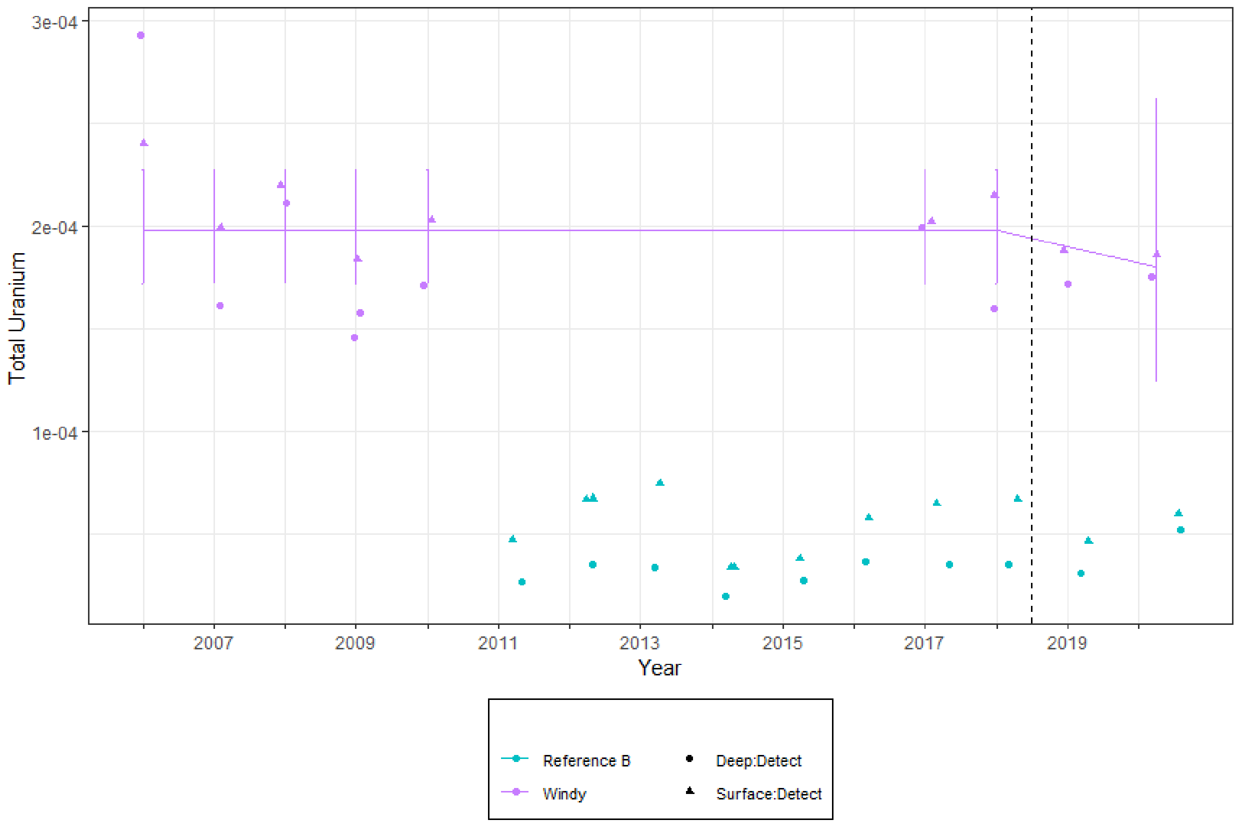
The change in total uranium concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.5926) different.

BACI analysis not performed.

Under-ice 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. The solid symbols represent the observed data values and hollow

symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	-0.1837	0.1052	7.995	-1.747	0.1189	not sig.

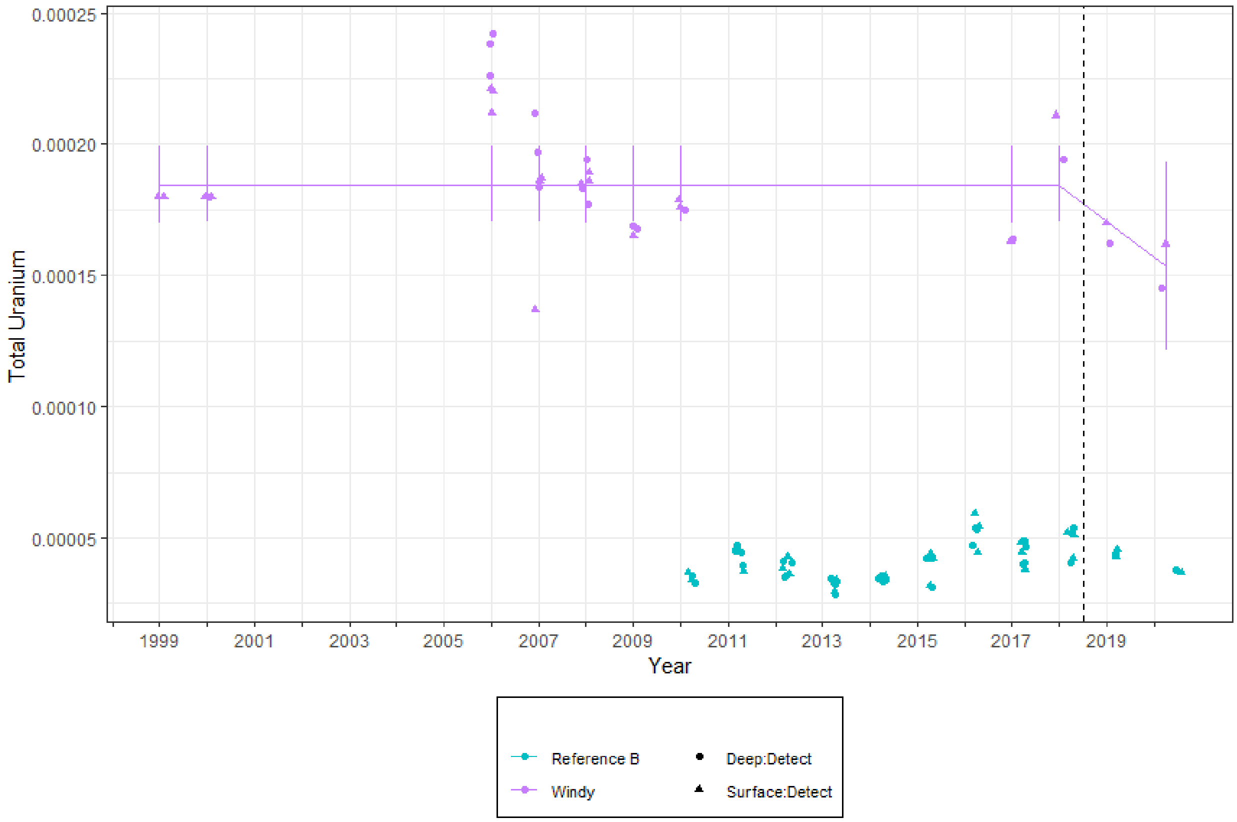
Conclusion:

The change in total uranium concentrations in Windy Lake from *before* to *after* was not significantly (p = 0.1189) different.

BACI analysis not performed.

Open-water Observed Data and Fitted Values

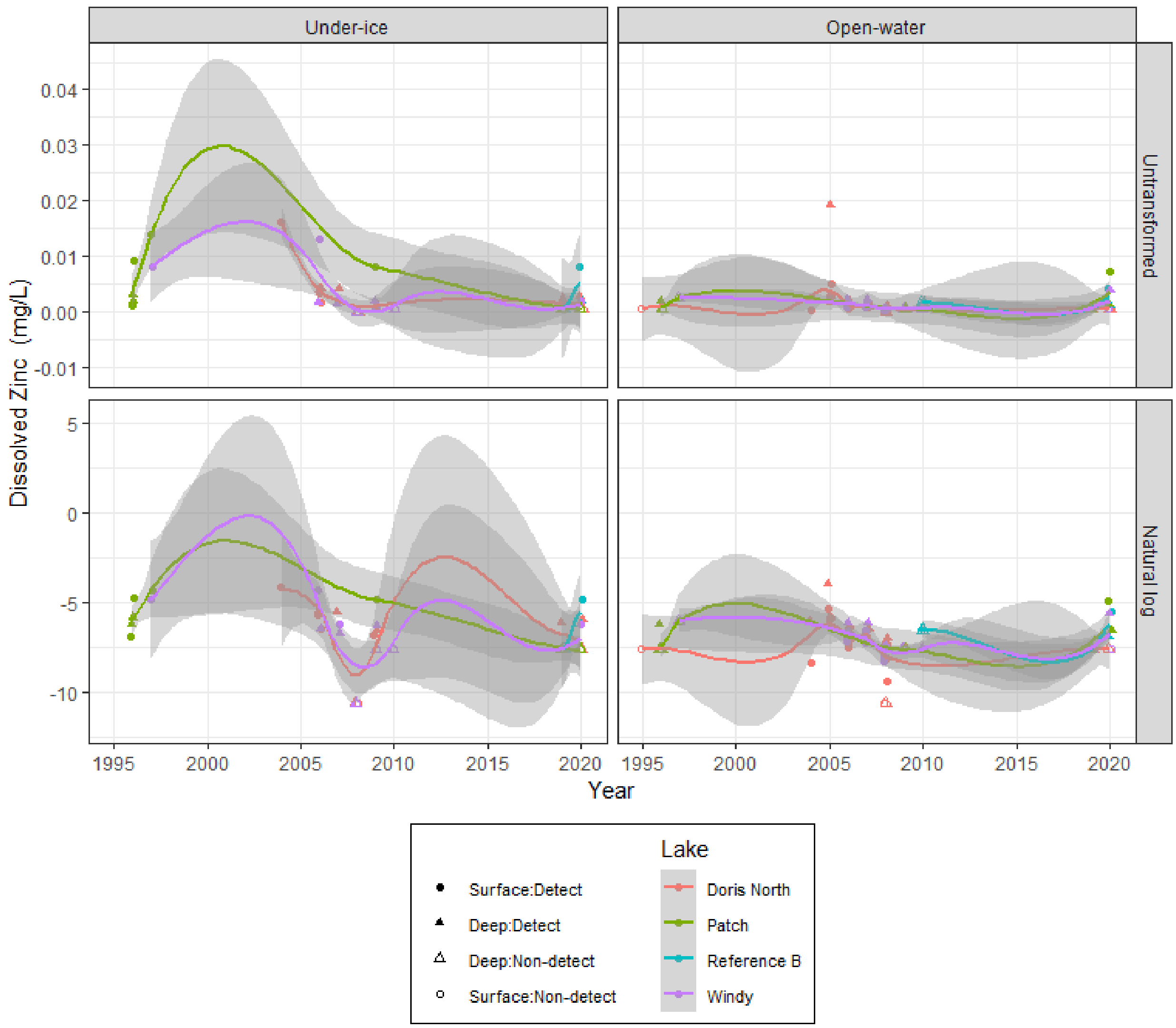
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.



C.3.1.26 Dissolved Zinc

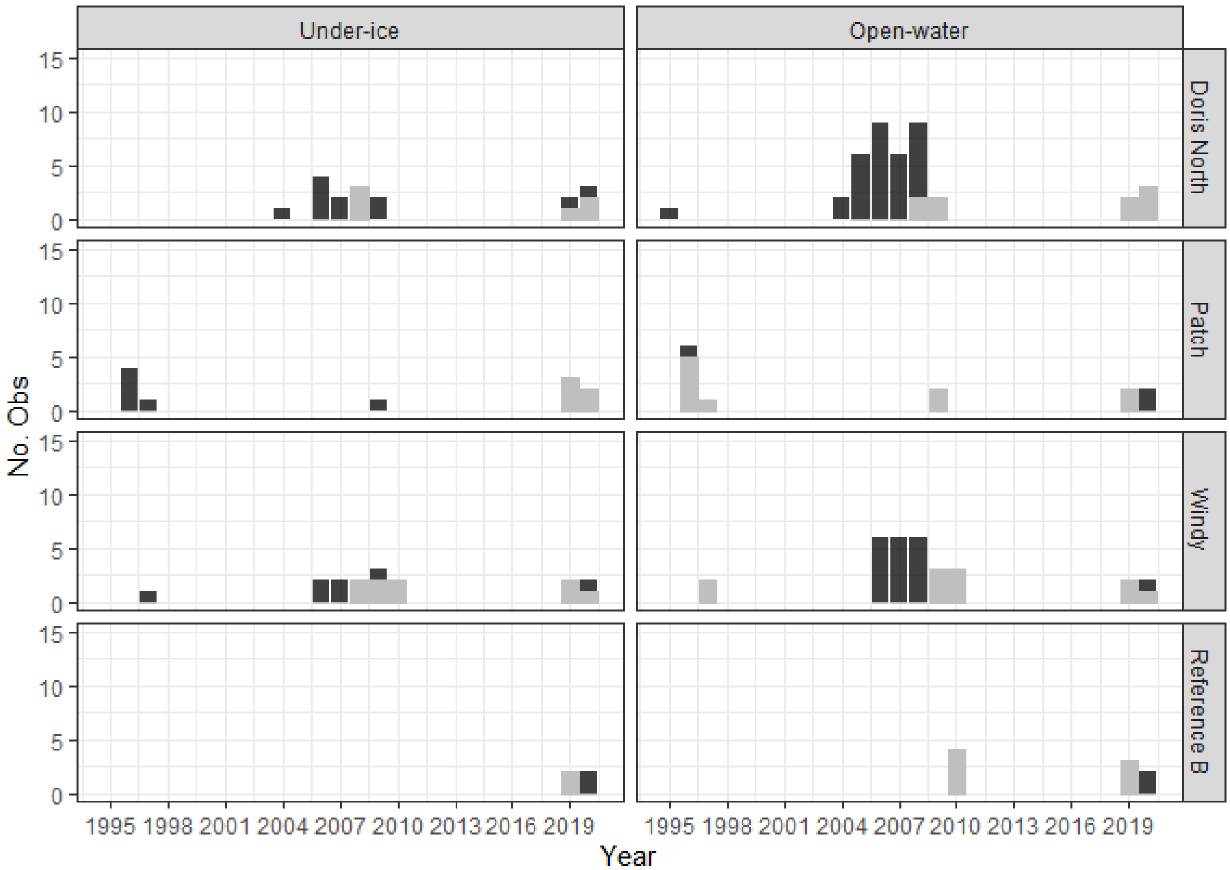
Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Under-ice samples were collected in April, May, or June, and open-water samples were collected in July, August, and/or September. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines drawn through the scatter plots represent the annual means. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. 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 below the analytical detection limit were considered censored.



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

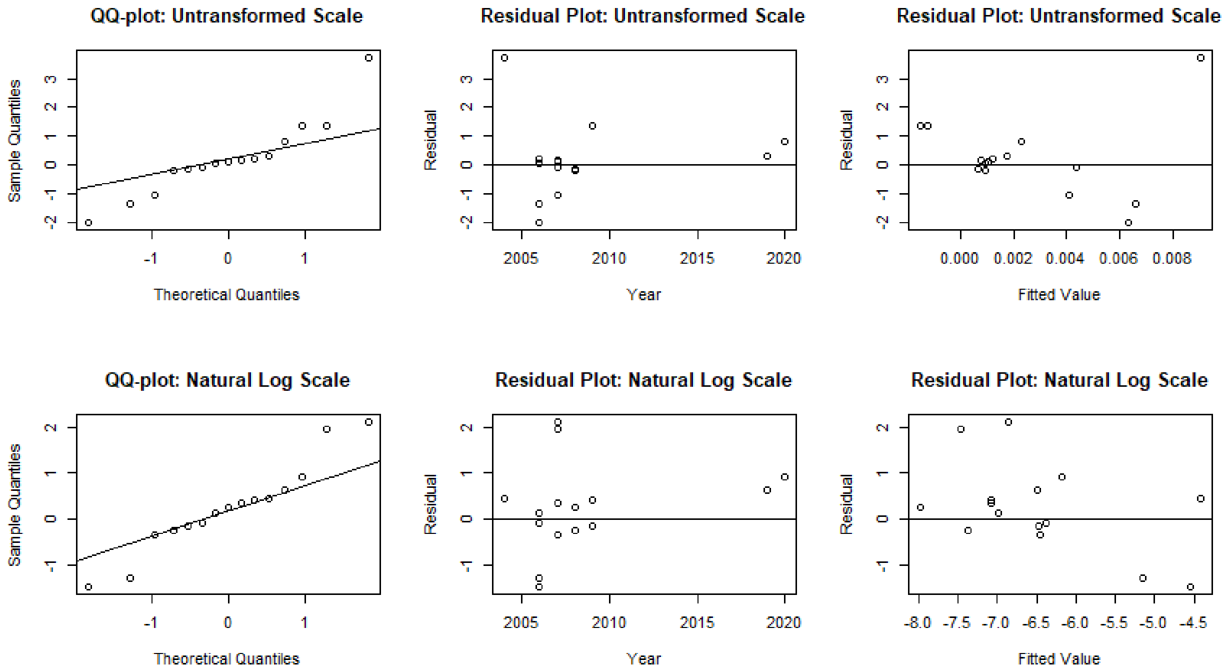
The sample sizes and median values per lake and season are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris North	Under-ice	17	6	0.35	0.67	0.0016
Doris North	Open-water	40	10	0.25	1.00	0.0010
Patch	Under-ice	11	5	0.45	1.00	0.0010
Patch	Open-water	13	10	0.77	0.00	0.0010
Reference B	Under-ice	4	2	0.50	0.00	0.0015
Reference B	Open-water	9	7	0.78	0.00	0.0030
Windy	Under-ice	16	9	0.56	0.50	0.0010
Windy	Open-water	30	11	0.37	0.50	0.0010

More than 50% of data under detection limit in Patch open-water, Reference B under-ice, Reference B open-water, and Windy under-ice. Data from those site-season groupings will be removed from the analysis. Doris under-ice, Doris open-water, Patch under-ice, and Windy open-water exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris. The analysis proceeds with linear mixed effects regression for Patch and Windy.

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 fitted model 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
Doris North	2004	Under-ice	Surface	0.0161	0.009	3.731

Outliers on natural log scale: None

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

Doris Lake

The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was 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	34.49	4	0.0000

Doris Lake appears to show significant deviation from no trend.

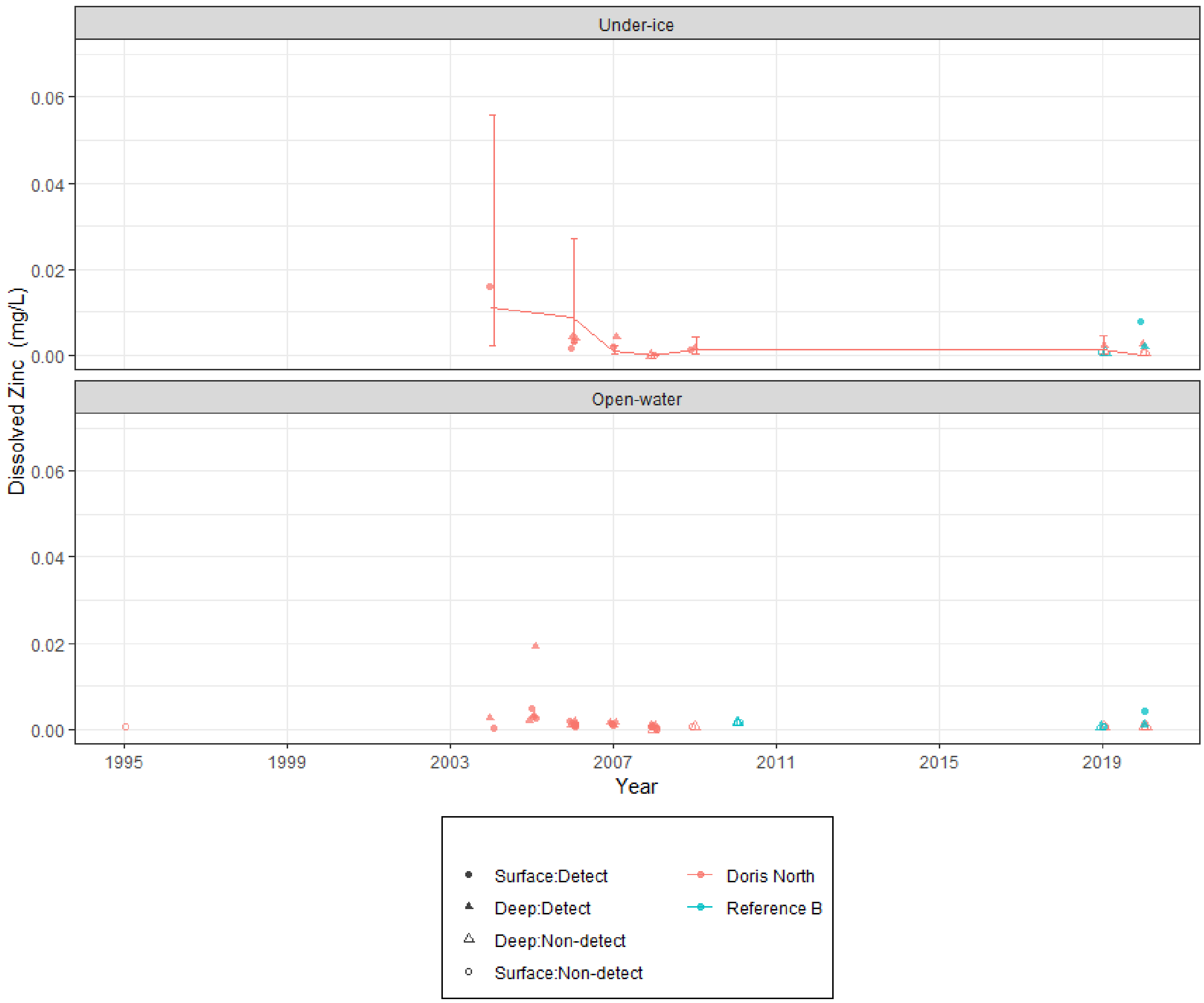
Open-water

All data from Doris open-water removed from the analysis. No analysis performed.

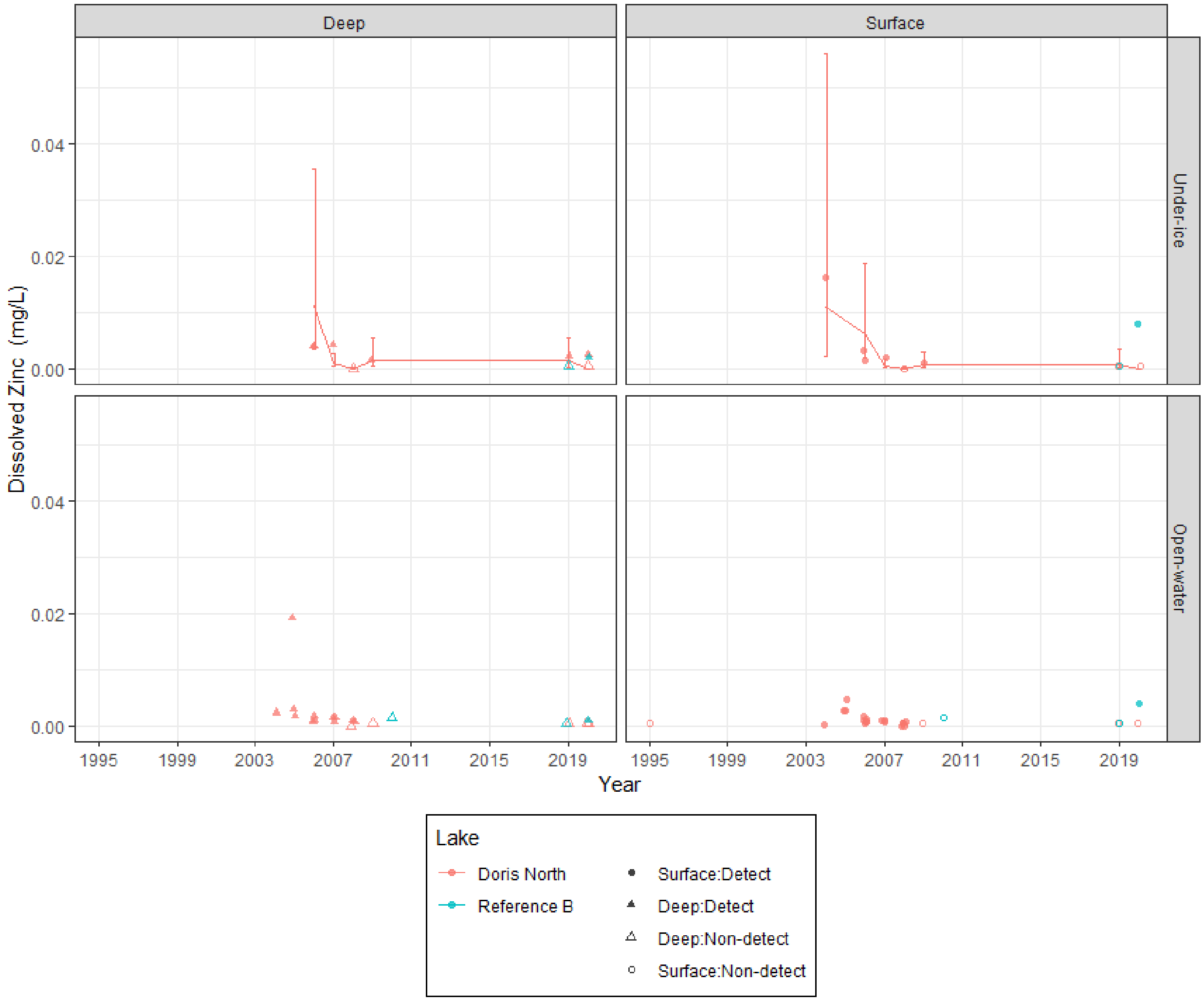
Observed Data and Fitted Values

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 solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. 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.



Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

Open-water Before-vs-After Analysis

Analysis not performed.

Windy Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Windy over comparable years of data. Models are fit separately for each season.

Under-ice Before-vs-After Analysis

Analysis not performed.

Open-water Before-vs-After Analysis

Coefficient	Estimate	Std. Error	df	t value	p	Significance
periodafter	0.4655	0.7349	5	0.6334	0.5543	not sig.

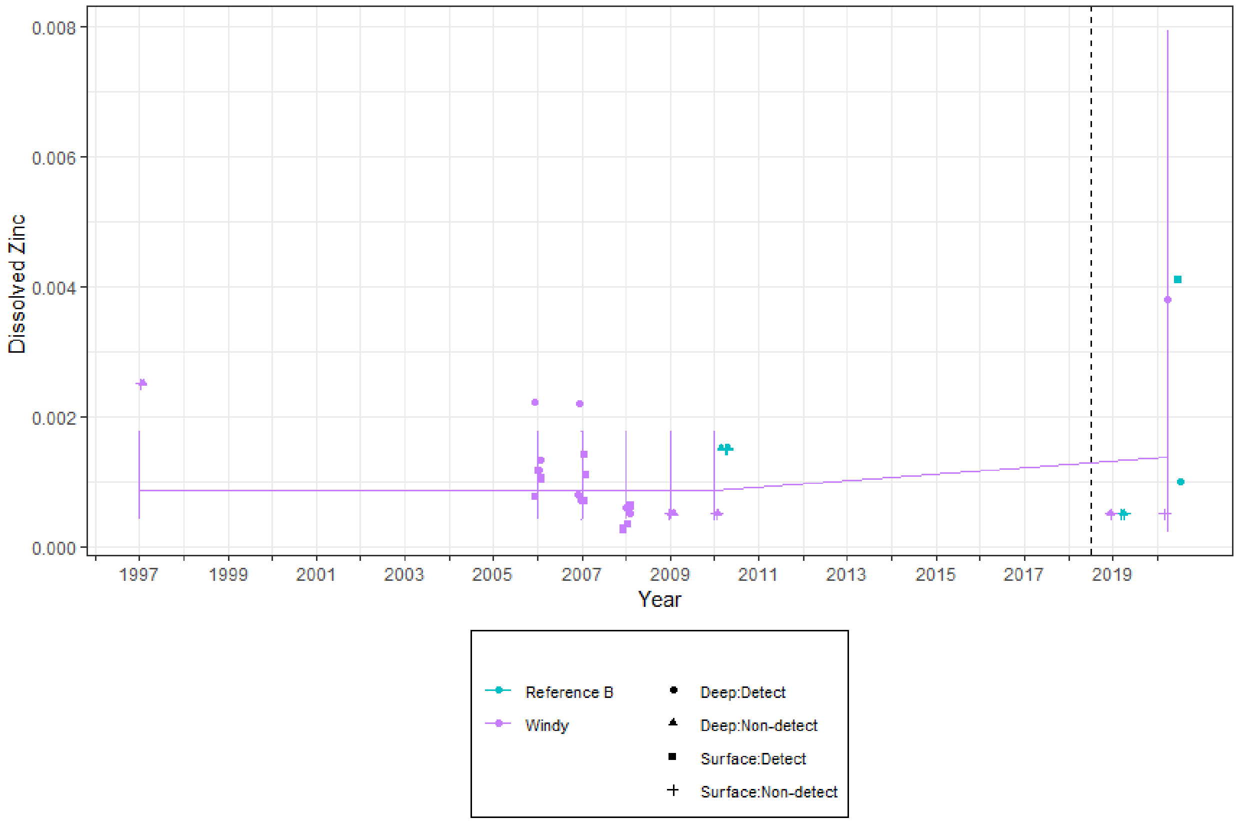
Conclusion:

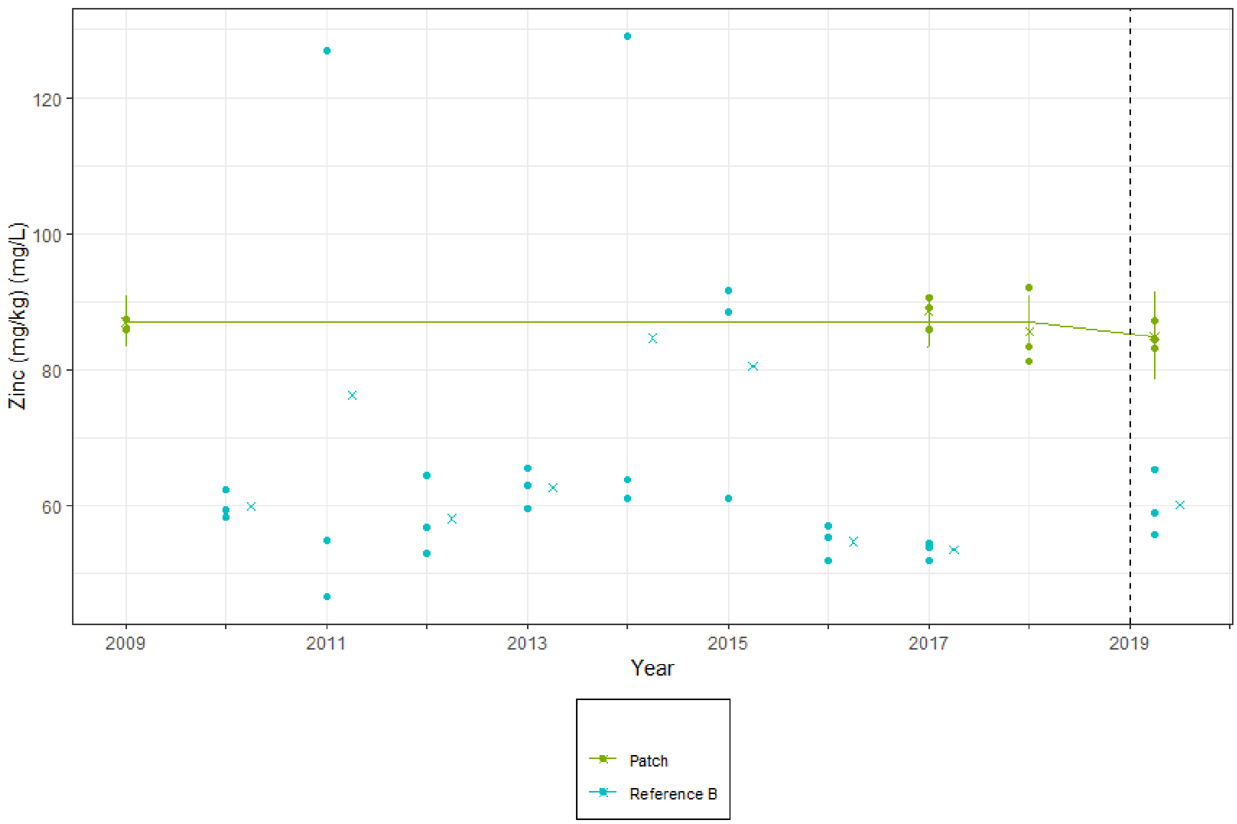
The change in dissolved zinc concentrations in Windy Lake from *before* to *after* was not significantly ($p = 0.5543$) different.

BACI analysis not performed.

Open-water 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. The solid symbols represent the observed data values and hollow symbols represent censored data at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.


Dissolved Zinc
0.008
0.006
0.004
0.002
0.000
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect


Zinc (mg/kg) (mg/L)
120
100
80
60
2009
2011
2013
2015
2017
2019
Year
Patch
Reference B

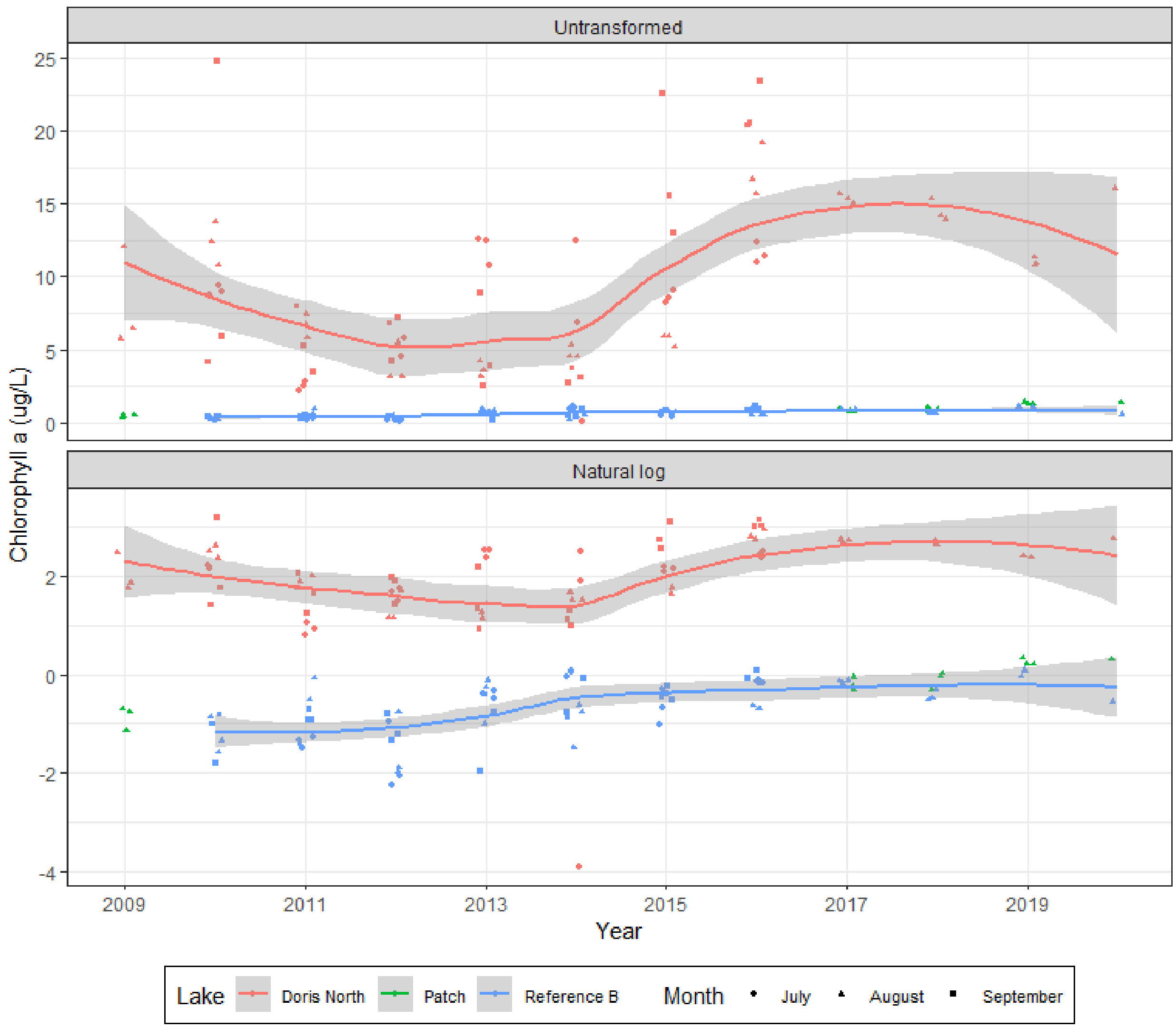
C.3.2 Phytoplankton Biomass (as Chlorophyll a)

Annual and monthly means

Lake	Year	Annual Mean	July	August	September
Doris	2009	8.1133		8.1133	
Doris	2010	11.0056	9.0700	12.3333	11.6133
Doris	2011	4.9400	2.5467	6.6833	5.5900
Doris	2012	5.0900	5.2333	3.9733	6.0633
Doris	2013	6.9067	11.9667	3.6467	5.1067
Doris	2014	4.8267	6.4467	4.8400	3.1933
Doris	2015	10.4667	8.6400	5.6933	17.0667
Doris	2016	16.7600	11.6000	17.2133	21.4667
Doris	2017	15.3845		15.3845	
Doris	2018	14.5417		14.5417	
Doris	2019	11.0524		11.0524	
Doris	2020	16.0667		16.0667	
Patch	2009	0.4290		0.4290	
Patch	2017	0.8257		0.8257	
Patch	2018	0.9129		0.9129	
Patch	2019	1.3038		1.3038	
Patch	2020	1.3600		1.3600	
Reference B	2010	0.3128		0.2997	0.3260
Reference B	2011	0.4274	0.2563	0.5943	0.4317
Reference B	2012	0.2658	0.2070	0.2530	0.3373
Reference B	2013	0.5956	0.6767	0.6833	0.4267
Reference B	2014	0.6873	1.0407	0.4140	0.6073
Reference B	2015	0.6365	0.5180	0.7153	0.6762
Reference B	2016	0.7821	0.8793	0.5090	0.9580
Reference B	2017	0.8727		0.8727	
Reference B	2018	0.6578		0.6578	
Reference B	2019	1.0469		1.0469	
Reference B	2020	0.5800		0.5800	

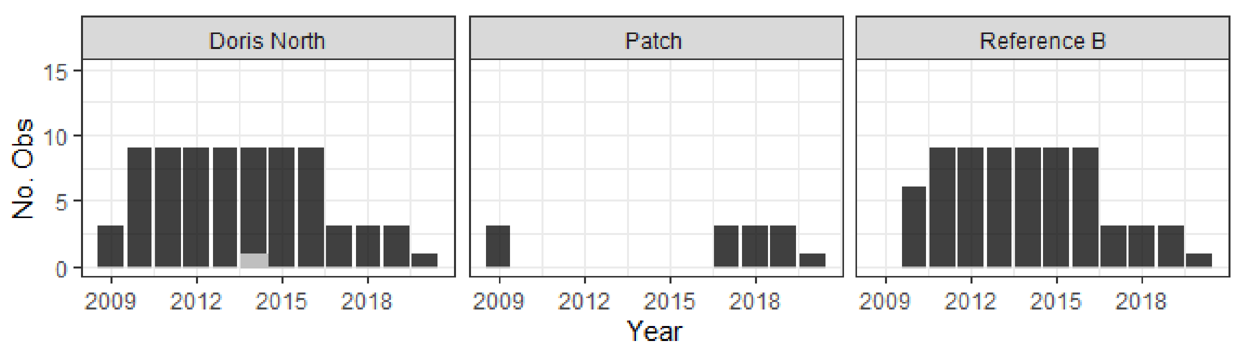
Observed Data

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



Censored Values and Sample Sizes

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



Analysis not performed if greater than 50% of observations from a site-season grouping were censored or if 100% of observations from the current assessment year (i.e., 2020) were censored.

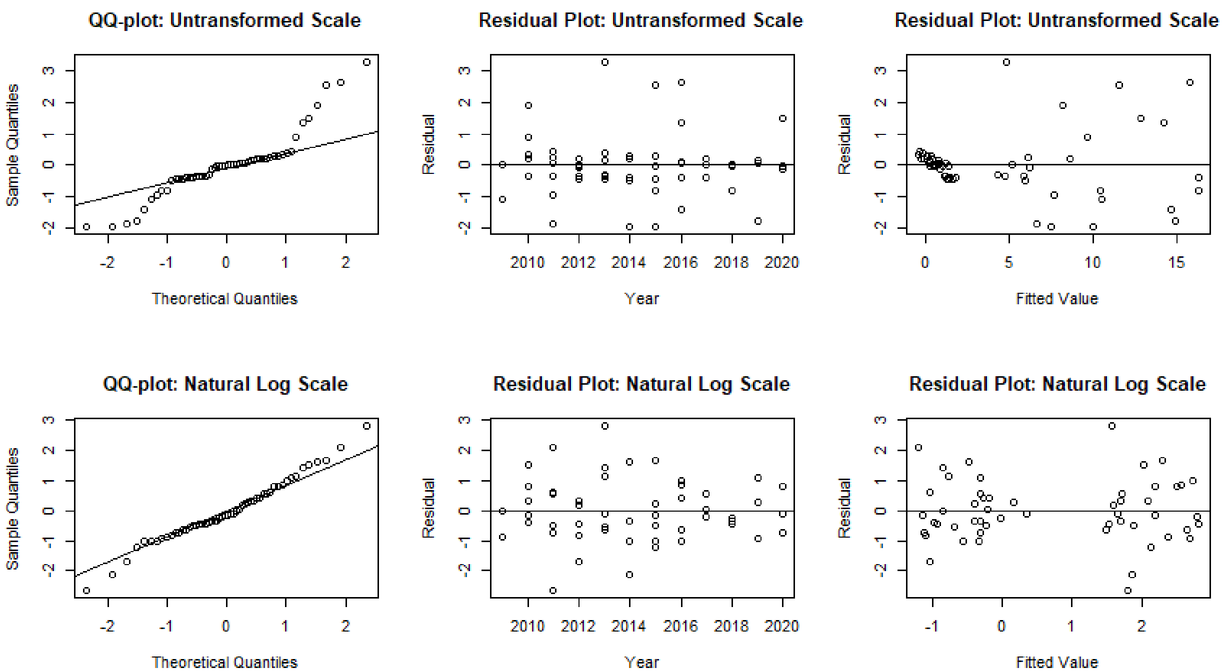
The sample sizes and median values per lake are summarized in the table below.

Lake	Season	# Obs	# Under DL	Prop. Under DL	Prop. Under DL (2020)	Median
Doris	Open-water	76	1	0.01	0	8.1050
Patch	Open-water	13	0	0.00	0	0.9557
Reference B	Open-water	70	0	0.00	0	0.5620

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

	Lake	Year	Season	Depth.Zone	Impute	Fitted	Std. Residual
11	Doris	2013	Open-water	Deep	11.97	4.795	3.281

Outliers on natural log scale: None

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

Doris Lake

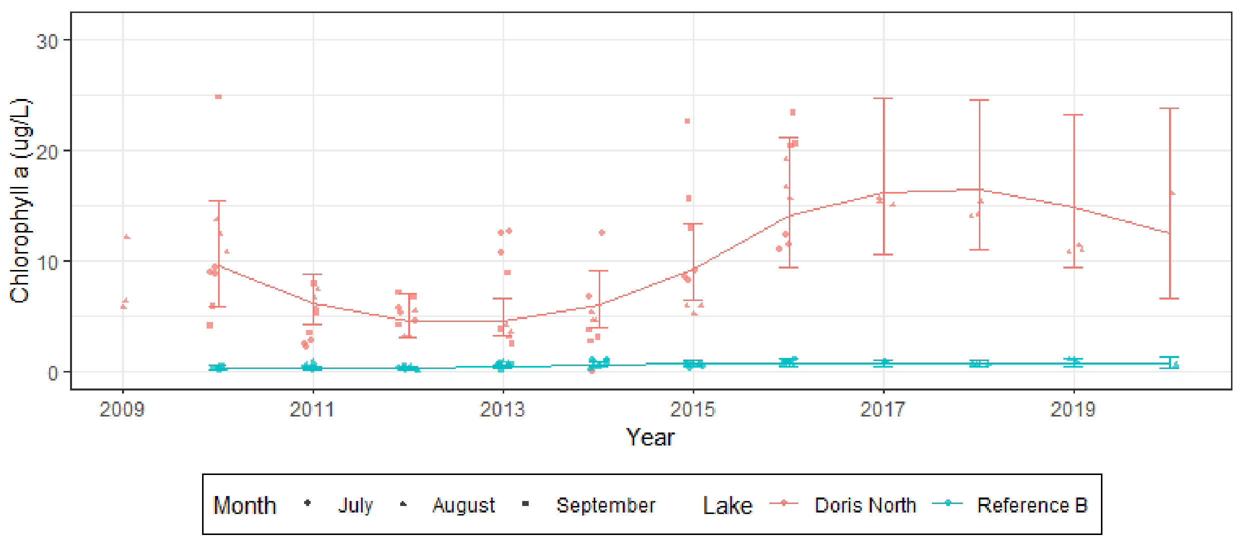
The trend of Doris Lake was compared to a slope of 0. If there was a significant trend, then the trend of Doris Lake was compared to the trend in Reference B. This contrast does not test for differences in intercepts between lakes.

Analysis	Chi.sq	DF	P.value
Compare to slope 0	42.29	4	0.0000
Compare to Reference B	12.35	4	0.0149

Conclusions:
Doris Lake appears to show significant deviation from no trend. Doris Lake appears to show 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. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Solid red and blue lines represent the fitted curves through all years of data. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



Plot of observed and fitted data separated by month.

Patch Lake

Before-after analyses were first performed to compare the change in concentrations from the before (i.e., all years up to and including 2018) to the after (i.e., 2020) period in the exposure site. If a change was detected, then before-after-control-impact linear modeling was applied to compare the change in concentrations from before to after periods between Reference B and Patch over comparable years of data.

Before-vs-After Analysis

Coefficient	Estimate	Std. Error	t value	p	Significance
Period after	0.6838	0.4736	1.444	0.2856	not sig.

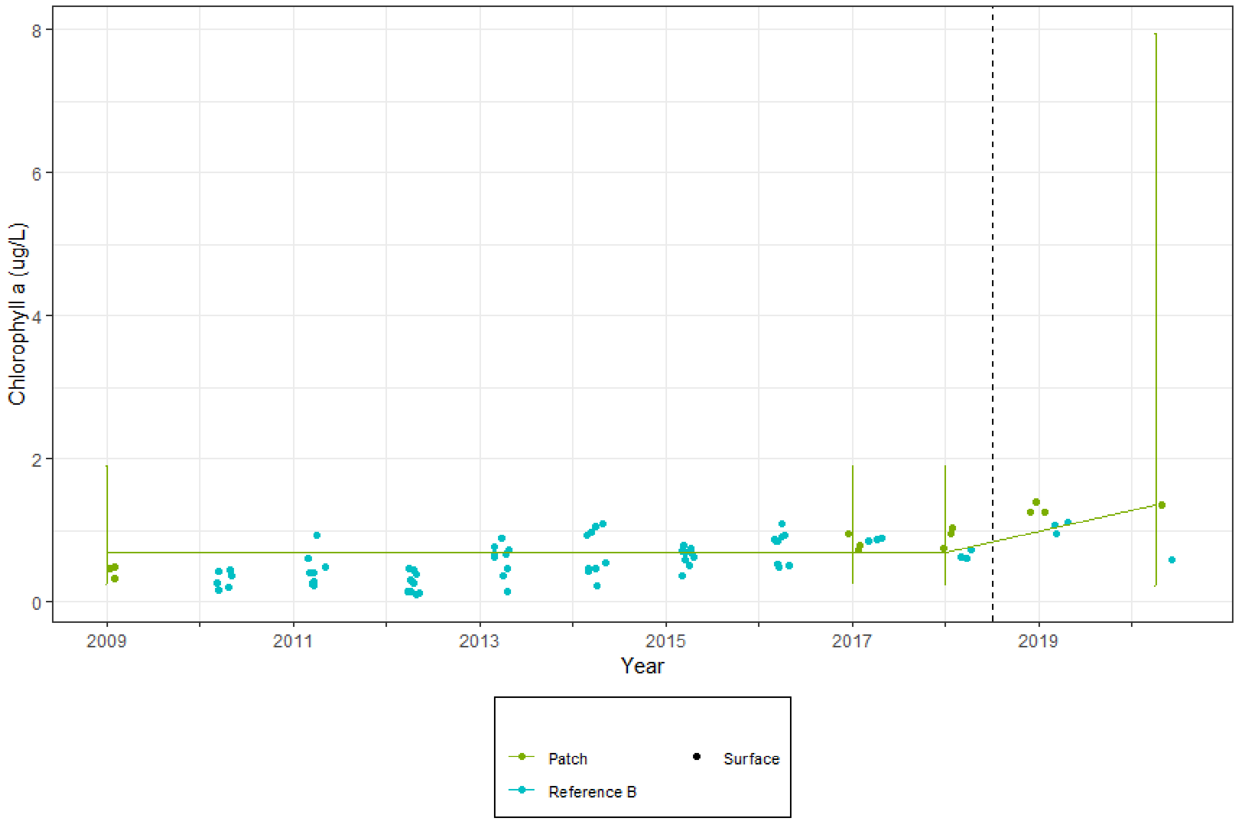
Conclusion:

The change in phytoplankton biomass (as chlorophyll *a*) concentrations in Patch Lake from *before* to *after* was not significantly (p = 0.2856) different.

BACI analysis not performed.

Observed Data and Fitted Values

Below are plots of the observed and fitted data. The symbols represent the observed data values. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the exposure site. Vertical dashed line represents the start of the after period. Only the assessment year (i.e., 2020) was included for the after period.


8
6
4
2
0
Chlorophyll a (ug/L)
2009
2011
2013
2015
2017
2019
Year
Patch
Surface
Reference B