# Appendix D-4

## Hope Bay Project: 2022 Aquatic Effects Monitoring Program Report

# Hope Bay Project

## 2022 Aquatic Effects Monitoring Program Report

March 2023

Project No. 0634519-0001

*The business of sustainability*

March 2023

# Hope Bay Project

## 2022 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 Mine (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 has been operated by Agnico Eagle Mines Ltd. (Agnico) since February 2021.

The Project area consists of three developments: Doris, Madrid (North and South), and Boston. Construction of the Doris development initially began in 2010, and commercial operations began in 2017. Initial construction of the Madrid North development began in April 2019, followed by operations (mining of the Naartok Pit) in August 2019 to March 2020 and in January and February 2021. In April 2022, the Project went into care and maintenance which suspended all mining and milling operations at Doris and Madrid North developments. As of December 2022, construction had not begun at the Madrid South or Boston developments.

This report presents the results of the 2022 Aquatic Effects Monitoring Program (AEMP), the fourth 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 2022 AEMP includes lakes that may potentially be influenced by current Project activities (exposure lakes), that is have the greatest potential to receive non-point-source inputs such as runoff or dust (i.e., Doris and Patch lakes) and/or 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 2022 included the following: fish habitat (water level, ice thickness, stream hydrology), under-ice dissolved oxygen concentration, water temperature, water quality, sediment quality, phytoplankton biomass, and benthic invertebrate community. Statistical and/or graphical analyses were undertaken to determine whether there were any apparent effects of Project activities on these aquatic components in the exposure lakes.

Table E-1 presents a summary of the overall findings of the evaluation of effects for the 2022 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, ice thickness, and stream hydrology), under-ice dissolved oxygen concentrations, water temperature, water quality, sediment quality, phytoplankton biomass, or lake benthos were detected for the exposure lakes evaluated (i.e., lakes with the potential to be influenced by the Project). Accordingly, no low action level responses were triggered for any assessed variable in the 2022 AEMP.

## Table E-1: Summary of Evaluation of Effects for 2022 AEMP

| Variable | Exposure Lakes Included in Evaluation of Effects | Conclusion of Effect | Low Action Level Triggered? | Report Section |
|---|---|---|---|---|
| Fish habitat (water level, ice thickness, and stream hydrology) | 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 (Under-ice dissolved oxygen and temperature) | Windy Lake, Patch Lake, Doris Lake | No Effect | No | 3.2 |
| Water quality | Windy Lake, Patch Lake, Doris Lake | No Effect | No | 3.3 |
| Sediment quality | Patch Lake, Doris Lake | No Effect | No | 3.4 |
| Phytoplankton biomass (chlorophyll *a*) | Patch Lake, Doris Lake | No Effect | No | 3.5 |
| Benthic invertebrates | Patch Lake, Doris Lake | No Effect | No | 3.6 |

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# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| Action level | The Response Framework includes three tiers of action levels: low, medium, and high. The low action level for each monitored component is based on baseline data, and/or water or sediment quality guidelines, and/or recommended critical effects sizes for that component. |
| 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 |
| Benthic | Pertaining to the bottom region of a water body, on or near bottom sediments or rocks. |
| Benthic invertebrates/ Benthos | Used interchangeably for this report. Benthos communities are a group of organisms that live associated with the bottom of lakes or streams. These communities contain a diverse assortment of organisms that have different mechanisms of feeding. Benthos are an important food source for fish. |
| Biomass | The amount of living matter as measured on a weight or concentration basis. Biomass is an indication of the amount of food available for higher trophic levels. In the AEMP, phytoplankton biomass is estimated as chlorophyll *a.* |
| Bray-Curtis index | A dissimilarity index. An estimate of the percentage of difference in the community composition between sites. The Bray-Curtis index compares the community composition at each exposure or reference lake to the median reference community composition. The Bray-Curtis index ranges from 0 to 1, with 0 representing identical communities and 1 representing completely dissimilar communities. Since the Bray-Curtis index measures the percent difference between sites, the greater the dissimilarity value between a site and the median reference community, the more dissimilar those benthos communities are. |
| 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. |
| Cont'd | Continued from previous page |

| | |
|---|---|
| DL | Detection limit |
| EEM | Environmental Effects Monitoring |
| ERM | ERM Consultants Canada Ltd. |
| Euphotic depth | The depth in the water column in which adequate light is present for photosynthesis to occur (i.e., which 1% of the surface irradiance reaches). |
| Evenness | A measure of how evenly distributed families are within the sampled benthos community. The index ranges from 0 to 1, with 1 representing complete evenness. |
| 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 |
| Invertebrates | Collective term for all animals without a backbone or spinal column. |
| ISQG | Interim sediment quality guideline |
| LME | Linear mixed effects |
| LOESS | Local regression |
| Low action level benchmark | One condition of a low action level exceedance: the value of a variable for water or sediment quality that is equivalent to 75% of the current benchmark value for that variable. |
| m | Metre |
| MDMER | Metal and Diamond Mining Effluent Regulations |
| mg/kg | Milligram per kilogram |
| mg/L | Milligram per litre |
| NIRB | Nunavut Impact Review Board |
| NTU | Nephelometric turbidity units |
| NWB | Nunavut Water Board |
| PEL | Probable effects level |
| Phytoplankton | Phytoplankton are microscopic primary producers that live free-floating in water. These organisms are single-celled algae that photosynthesize. |
| 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). |
| Richness | The number of distinct families within the sampled benthos community. |
| RPD | Relative percent difference |
| SD | Standard deviation |
| Secchi depth | Secchi depth is the depth at which a Secchi disk (standardized white and back disc) can no longer be seen when it is lowered into a lake. Secchi depth is be used to calculate the depth of the euphotic zone. |
| Stratification/stratified | Separation of the lake water column into distinct physical layers (temperature or dissolved oxygen). Stratification is interpreted from a thermocline (rapid change in water temperature over a relatively short depth) observed in the physical limnology profiles. The presence of a thermocline represents a density barrier to mixing and indicates that a lake is stratified. |
| TSS | Total suspended solids |
| µg/L | Microgram per litre |
| µm | Micrometre |

# 1. INTRODUCTION

## 1.1 Background

The Hope Bay Mine (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 (Figure 1.1-1). The Project has been operated by Agnico Eagle Mines Ltd. (Agnico Eagle) since February 2021.

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 development 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. The Madrid-Boston Final Environmental Impact Statement (FEIS; TMAC 2017b) was submitted 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 (the Project Certificate) 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; the Water Licence) 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. All mining and development activity was suspended at Madrid North in March 2020. Mining activity has remained suspended except for a brief period of activity at the Madrid North portal in January and February 2021. In February 2022 the Project went into care and maintenance. In April 2022, Doris-Madrid Care and Maintenance Plan (Agnico Eagle 2022) was submitted to the NWB and NIRB as per compliance with the Water Licence and the Project Certificate. As of December 2022, construction had not begun at the Madrid South or Boston developments.

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), when applicable, 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 2022 AEMP, implemented as per the approved Belt-wide Plan (TMAC 2018).

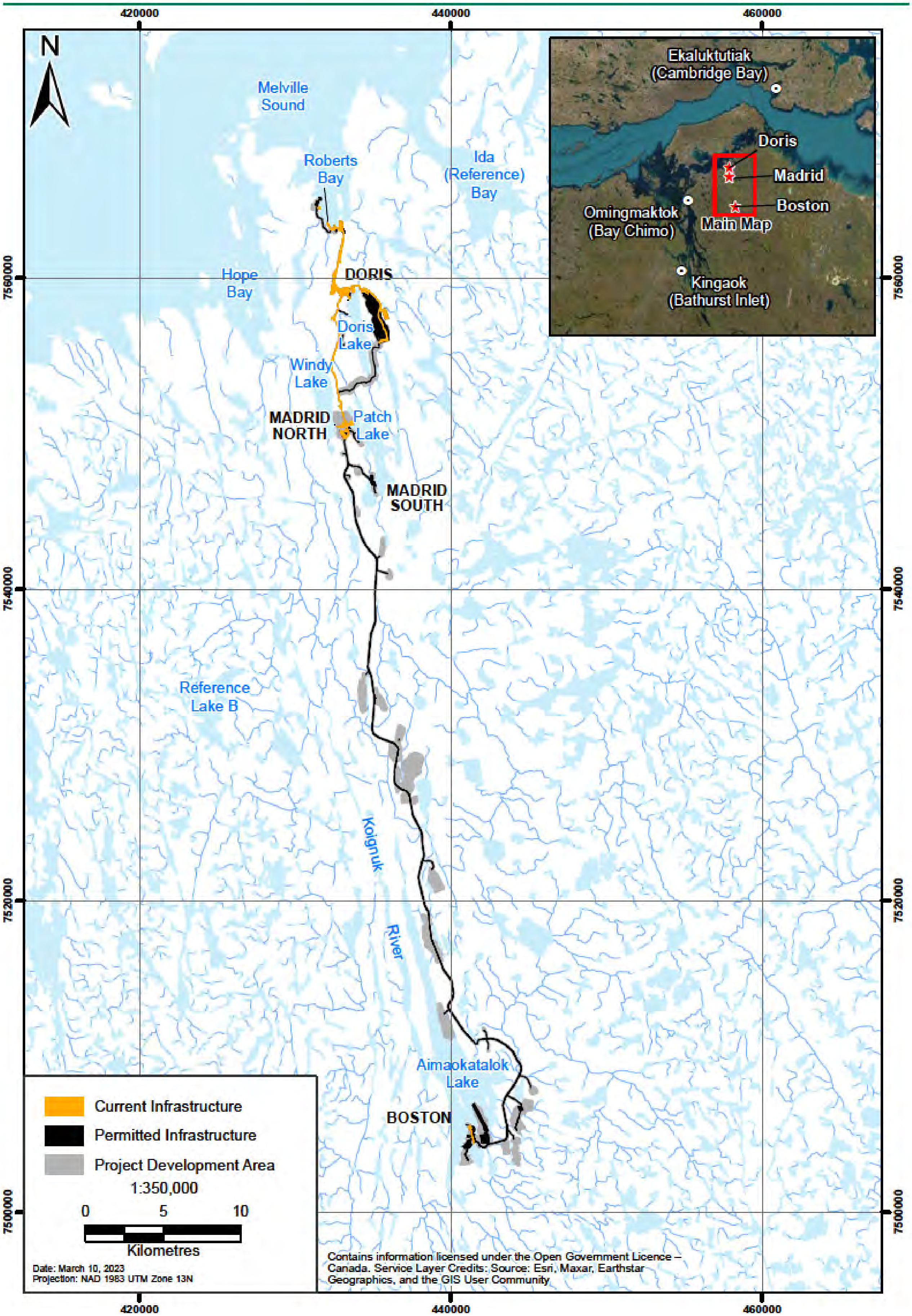



**Figure 1.1-1: The Hope Bay Project**

## 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 2022 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 2022 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;
- sediment quality;
- phytoplankton; and
- benthic invertebrates (benthos).

## 1.3 2022 Project Activities

Current, permitted, and future infrastructure associated with the Project is shown in Figure 1.1-1.

Agnico Eagle announced that the Doris Mill would be placed into care and maintenance and production on the Project would be temporarily suspended on February 18, 2022. Care and maintenance for Doris and Madrid includes the temporary suspension of ore extraction at the Doris and Madrid Developments and at milling operations. Agnico Eagle continued exploration activities as well as the management and modification of facilities to remain in regulatory compliance with various permits, licenses, and approvals for the Project. Ongoing Project activities occurring in and around infrastructure during all phases of the Project, that is construction, production, and/or care and maintenance, have the potential to affect the freshwater environment in the Project area through the dust deposition and/or runoff of site and mine contact water.

Project activities that occurred in 2022 are described below by development area.

### Doris

- Milling activities remained suspended (since October 2021).
- Underground ore extraction in Doris mine was suspended in February 2022.
- The Aquadam, a temporary structure, was installed to allow for segregation of underground water with high salinity and surface water with low salinity within the Tailings Impoundment Area (TIA).
- The construction of an interim dike design to replace the temporary Aquadam began in fall 2022.
- Work was initiated to build a new water treatment plan with commissioning planned before freshet 2023.
- MDMER compliant water from underground was discharged to Roberts Bay.

- MDMER compliant water within the TIA was discharged to Roberts Bay in October 2022. During TIA water discharge, underground water was reporting to the saline water storage, upstream of the Aquadam structure.
- Facilities to support mine-related activities (i.e., core storage areas, garages, waste management building) were completed within the Project footprint.
- Completed sealift operation with delivery of supplies, diesel fuel, explosives, and reagents to support site and exploration activities.
- The Roberts Lake Fish Enhancement Monitoring Program monitoring was completed during the open-water season.
- Doris Air Quality Station was operational.

#### Madrid

*Madrid North*

- Ore extraction and development at Madrid remained suspended (since October 2021).
- Structures from the old Windy Camp were dismantled.
- Freshwater intake from Windy was moved further offshore and the equipment was upgraded.
- Naartok Crown Pillar Recovery Trench was dewatered (to the TIA) in preparation for planned 2023 construction of an underground mine portal within the trench.

*Madrid South*

- As of December 2022, construction of the Madrid South development had not yet commenced.

#### Boston

- As of December 2021, construction of the Boston development had not yet commenced.
- The Hope Bay Project Boston Advanced Exploration site was occupied during summer months to conduct site maintenance, repairs, and enhancements (new Sewage Treatment Plant) to support future exploration.

## 1.4 Report Structure

This document presents the methods, results, and conclusions of the evaluation of effects of the 2022 Hope Bay AEMP. Appendix A details the sampling and data analysis methods, the quality assurance and quality control (QA/QC) program, and results for all AEMP components monitored in 2022, with the exception of stream hydrology. Water level and streamflow monitoring results and conclusions are provided in Appendix B. Supplemental information relevant to the 2022 analysis of effects (i.e., rationale for inclusion/exclusion of historical data, detailed statistical analysis methods and results) is provided in Appendix C.

# 2. METHODS

## 2.1 Study Design

The 2022 AEMP sampling program was conducted in accordance with the Plan (TMAC 2018). AEMP sampling sites were selected based on potential to be influenced by Project-related activities for current Project development and operational phases (TMAC 2018). Table 2.1-1 describes the Project phases that sequentially 'trigger' or mark the beginning of monitoring for an exposure lake (i.e., lakes potentially influenced by Project-related activities) identified as being potentially affected by those Project phases (TMAC 2018).

As of 2022, mine construction and operations have occurred at Doris and Madrid North developments Construction had not commenced at the Madrid South or Boston developments as of December 2022. Therefore, sampling locations for the 2022 AEMP were those sites triggered by Doris and Madrid North construction or operations activities (Table 2.1-1). Additional monitoring was completed at Wolverine Lake to augment the baseline data for this lake; ice thickness and under-ice water level data for Wolverine Lake is presented in Appendix A and B (respectively). Evaluation of Wolverine Lake will be initiated by construction of Madrid South.

The sampling site locations and relevant components sampled in 2022 are shown in Figure 2.1-1 and summarized in Table 2.1-2.

Full details of the 2022 AEMP sampling design, schedule, and methods are provided in Appendix A.

## 2.2 Evaluation of Effects Methodology

For each evaluated variable, historical data collected in the Project area were incorporated into the analysis to determine if there are any apparent changes over time that might be attributable to Project-related activities. Trends in Reference Lake B were also examined alongside the trends in the exposure lakes to determine if detected changes over time are likely naturally occurring or Project-related.

### *2.2.1 Evaluated Variables*

Table 2.2-1 presents the physical, chemical, and biological variables that were evaluated in 2022. 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.

Evaluated variables for water and sediment quality variables include those with the Canadian Council of Ministers of the Environment (CCME) established guidelines for the protection of aquatic life. Biological variables commonly used as indicators of nutrient loading or other changes to freshwater environments such as phytoplankton biomass and benthic invertebrate community metrics were also evaluated.

## Table 2.1-1: AEMP Sampling Sites, Monitoring Triggers, and Sampling Rationale, Hope Bay Project, 2022

| Watershed | Sampling Site | Sampling Rationale | Monitoring Trigger | 2022 Monitoring Rationale |
|---|---|---|---|---|
| Windy Watershed | Windy Lake | Water withdrawal for domestic use (potable water); drawdown from Madrid North mine groundwater inflow | Doris, Madrid North, and Madrid South construction and operations | Yes, Doris and Madrid North construction and operations |
| | Glenn Lake | 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, Madrid North, and Madrid South construction and operations | Yes, Doris and Madrid North construction and operations |
| Doris Watershed | Wolverine Lake | Drawdown from Madrid South mine groundwater inflow; inputs (e.g., dust deposition, runoff) due to proximity to infrastructure | Madrid South construction and operations | No |
| | Patch Lake | Drawdown from Madrid North and South mines groundwater inflow; inputs (e.g., dust deposition, runoff) due to proximity to infrastructure | Madrid North and South construction and operations | Yes, Madrid North construction and operations |
| | Imniagut Lake | Drawdown from Madrid North mine groundwater inflow | Madrid North and South operations | Yes, Madrid North construction and operations |
| | P.O. Lake | Drawdown from Madrid North mine groundwater inflow | Madrid North and South operations | Yes, Madrid North construction and operations |
| | Ogama Lake | Drawdown from Madrid North mine groundwater inflow | Madrid North and South operations | Yes, Madrid North construction and operations |
| | Doris Lake | 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 | Doris, Madrid North, and Madrid South construction and operations; Boston operations | Yes, Doris and Madrid North construction and operations |
| | Little Roberts Lake | 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 | Doris, Madrid North, and Madrid South construction and operations; Boston operations | Yes, Doris and Madrid North construction and operations |

| Watershed | Sampling Site | Sampling Rationale | Monitoring Trigger | 2022 Monitoring Rationale |
|---|---|---|---|---|
| Aimaokatalok Watershed | Stickleback Lake | Inputs (e.g., dust deposition, runoff) due to proximity to infrastructure | Boston construction and operations | No |
| | Aimaokatalok Lake | Inputs (e.g., dust deposition, runoff) due to proximity to infrastructure; permitted discharge | Boston construction and operations | No |
| Reference Watershed | Reference Lake B | Reference area for AEMP located outside of the zone of Project influence | Doris, Madrid, and Boston construction and operations | Yes, Doris and Madrid North construction and operations |

## Table 2.1-2: AEMP Sampling Locations and Monitoring Components, Hope Bay Project, 2022

| Site | Easting | Northing | Ice Thickness | Water Level | Discharge | Physical Limnology | Water Quality | Sediment Quality | Phytoplankton | Benthic Invertebrates |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | X | - | - | - | - | - | - |
| Patch Lake | 434660 | 7549739 | X | - | - | X | 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 | 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 | X | X |

*Notes:*
*Dash (-) indicates not applicable.*
*Coordinates are NAD83, UTM Zone 13N.*

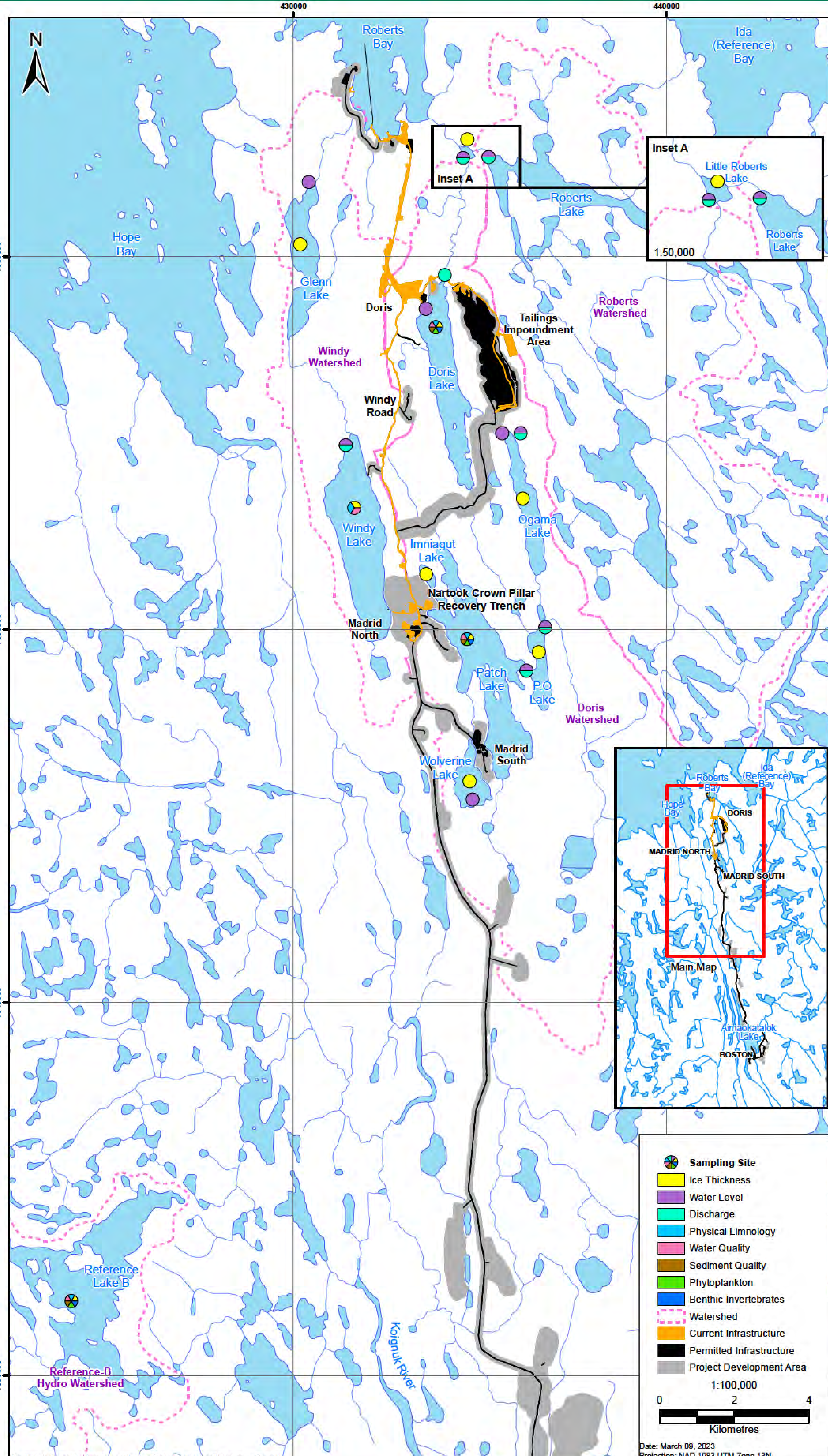



**Figure 2.1-1: Sampling Sites, Hope Bay AEMP, 2022**

### Table 2.2-1: Evaluated Variables, Hope Bay AEMP, 2022

| Category | Evaluated Variable | |
|---|---|---|
| Fish Habitat | Water Level<br>Ice Thickness<br>Stream Hydrology[a] | |
| Physical Limnology | Dissolved Oxygen<br>Temperature | |
| Water Quality | pH<br>Total Suspended Solids<br>Turbidity<br>Chloride<br>Fluoride<br>Total Ammonia<br>Nitrate<br>Nitrite<br>Total Phosphorus<br>Total Aluminum<br>Total Arsenic<br>Total Boron<br>Total Cadmium | Total Chromium<br>Total Copper<br>Total Iron<br>Total Lead<br>Total Mercury<br>Total Molybdenum<br>Total Nickel<br>Total Selenium<br>Total Silver<br>Total Thallium<br>Total Uranium<br>Dissolved Manganese<br>Dissolved Zinc |
| Sediment Quality | Arsenic<br>Cadmium<br>Chromium<br>Copper | Lead<br>Mercury<br>Zinc |
| Phytoplankton | Biomass (chlorophyll *a*) | |
| Benthic Invertebrates | Density<br>Family Richness<br>Simpson’s Evenness Index<br>Bray-Curtis Index | |

[a] *Stream hydrology evaluation is detailed in Appendix B but summarised in Section 3.1 and 4.*

### 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 and/or compared to the reference lake. 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 2022).

Doris Lake has a relatively large dataset (10+ years for most variables) and good temporal coverage which allows 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., total suspended solids, 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 (i.e., the trend was significantly different from zero), 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 modelling only the data for monitoring years in the exposure lake that align with monitoring in the reference lake. 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 not consistent through time. 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., 2019 to 2022) 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., 2022), 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., 2022) 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 and Sediment 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.

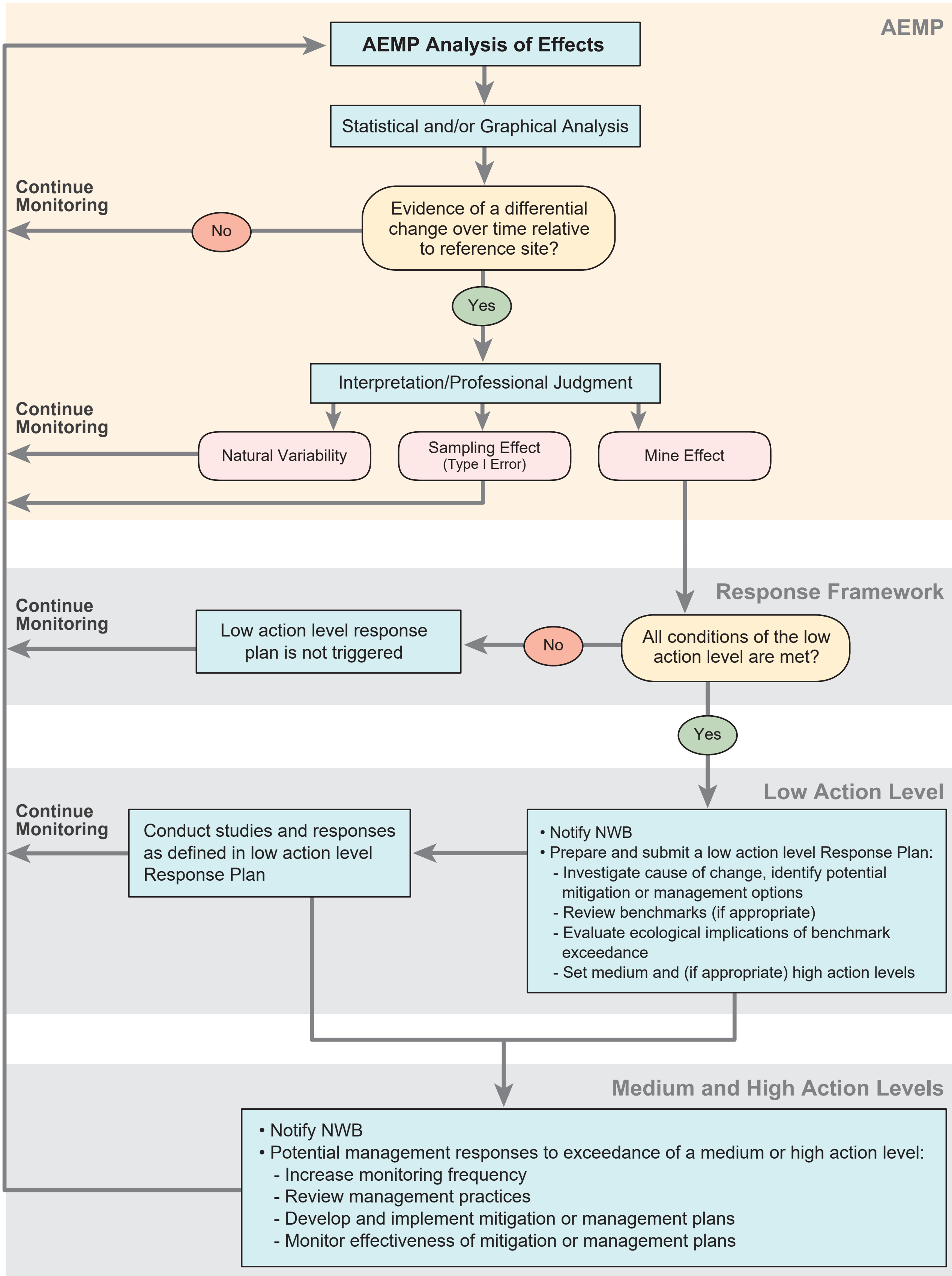



**Figure 2.2-1: AEMP Analysis of Effects and Response Framework**

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 and are summarized in Table 2.2-2 (CCME 2022a). The CCME guideline for Total Suspended Solids (TSS) is lake specific and presented in Table 2.2-3. The CCME guideline for total ammonia-N is pH and temperature dependent and presented in Table 2.2-4. The CCME sediment quality guidelines for the protection of aquatic life are summarised in Table 2.2-5 (CCME 2022b). 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, Hope Bay Project

| Water Quality Variable | Benchmark[a] |
|---|---|
| Dissolved Oxygen | 9.5 mg/L (cold-water biota: early life stages);<br>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 to 9.0 |
| Total Suspended Solids | Maximum average increase of 5 mg/L from background (for clear-flow waters; long-term exposure); see Table 2.2-3 |
| 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; see Table 2.2-4 |
| Nitrate-N | 3.0 mg/L (long term) |
| Nitrite-N | 0.06 mg/L |
| Total Aluminum | 0.005 mg/L (if pH < 6.5);<br>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; $10^{(0.83[\log(hardness)]-2.46)}$/1,000 mg/L for hardness of ≥ 17 to ≤ 280 mg/L; 0.00037 mg/L for hardness of > 280 mg/L (long term) |

| Water Quality Variable | Benchmark[a] |
|---|---|
| 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; $e^{(0.8545[\ln(hardness)]-1.465)}$/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 |
| Total Lead | 0.001 mg/L for hardness (as $CaCO_3$) of ≤ 60 mg/L; $e^{(1.273[\ln(hardness)]-4.705)}$/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; $e^{(0.76[\ln(hardness)]+1.06)}$/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 | $e^{(0.947[\ln(hardness)]-0.815[pH]+0.398[\ln(DOC)]+4.625)}$/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 |

Source: CCME Freshwater Water Quality Guidelines for the Protection of Aquatic Life, Summary Table (CCME 2022a).

*Note:*

*DOC = dissolved organic carbon*

## Table 2.2-3: Total Suspended Solids and Turbidity Benchmarks for Exposure Lakes, Hope Bay AEMP

| Lake | Season | Total Suspended Solids Benchmark (mg/L) | Turbidity Benchmark (NTU) |
|---|---|---|---|
| Windy | Under-ice | 6.21 | 2.46 |
| | Open-water | 6.10 | 3.04 |
| Patch | Under-ice | 7.06 | 4.77 |
| | Open-water | 6.11 | 3.10 |
| Doris | Under-ice | 7.18 | 4.91 |
| | Open-water | 9.85 | 5.69 |

## Table 2.2-4: Total Ammonia Benchmark as a Function of pH and Temperature

| Temperature (˚C) | pH | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 10.0 |
| 0 | 190 | 60 | 19 | 6.0 | 1.9 | 0.62 | 0.21 | 0.035 |
| 5 | 126 | 40 | 13 | 4.0 | 1.3 | 0.41 | 0.14 | 0.028 |
| 10 | 84 | 27 | 8.5 | 2.7 | 0.86 | 0.28 | 0.10 | 0.024 |
| 15 | 57 | 18 | 5.7 | 1.8 | 0.59 | 0.20 | 0.073 | 0.021 |
| 20 | 39 | 13 | 4.0 | 1.3 | 0.41 | 0.14 | 0.055 | 0.020 |
| 25 | 28 | 8.7 | 2.8 | 0.89 | 0.29 | 0.10 | 0.044 | 0.018 |
| 30 | 19 | 6.2 | 2.0 | 0.63 | 0.21 | 0.077 | 0.035 | 0.017 |

*Notes:*

*Total ammonia units are mg/L.*

*Values outside of the shaded area should be used with caution owing to a lack of toxicity data to accurately determine toxic effects at the extreme of these ranges (CCME 2010).*

## Table 2.2-5: Long-term Sediment Quality Benchmarks, Hope Bay AEMP

| Sediment Quality Variable | Benchmark[a] (mg/kg) | |
|---|---|---|
| | ISQG | PEL |
| Arsenic | 5.90 | 17.0 |
| Cadmium | 0.60 | 3.50 |
| Chromium | 37.3 | 90.0 |
| Copper | 35.7 | 197 |
| Lead | 35.0 | 91.3 |
| Mercury | 0.170 | 0.486 |
| Zinc | 123 | 315 |

[a] *Source: CCME Freshwater Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Table (CCME 2022b).*

*Note:*

*ISQG = Interim Sediment Quality Guideline; PEL = Probable Effects Level*

### 2.2.3.2 Phytoplankton

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.

#### *2.2.3.3 Benthic Invertebrates*

Potential effects to benthic invertebrate community indicators (i.e., total density, Simpson's evenness index, taxa richness, and Bray-Curtis similarity index) are evaluated against baseline and reference conditions, as well as a critical effects size as recommended by Environment Canada for Environmental Effects Monitoring (EEM) studies (Environment Canada 2012). The following conditions must be met to trigger a low action level response for benthic invertebrate community indicators (TMAC 2018):

1. the identification of a statistically significant decrease in density, evenness, richness, or similarity from baseline conditions;
2. the benthos indicator is less that the normal range based on baseline conditions;
3. if a decrease is detected at the exposure site, the absence of a similar decrease at the reference site; and
4. the magnitude of the decrease exceeds the critical effects size of ± 2 within-reference-area standard deviations (SD), as recommended by Environment Canada (2012).

### *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 2.2-6 show the specific locations in the 2022 AEMP study lakes where historical physical limnology (Figure 2.2-2), water quality (Figure 2.2-3), sediment quality (Figure 2.2-4), phytoplankton biomass (Figure 2.2-5) and benthic invertebrate (Figure 2.2-6) samples 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, 2017, 2018, 2019a, 2019b, 2020, 2021, 2022).

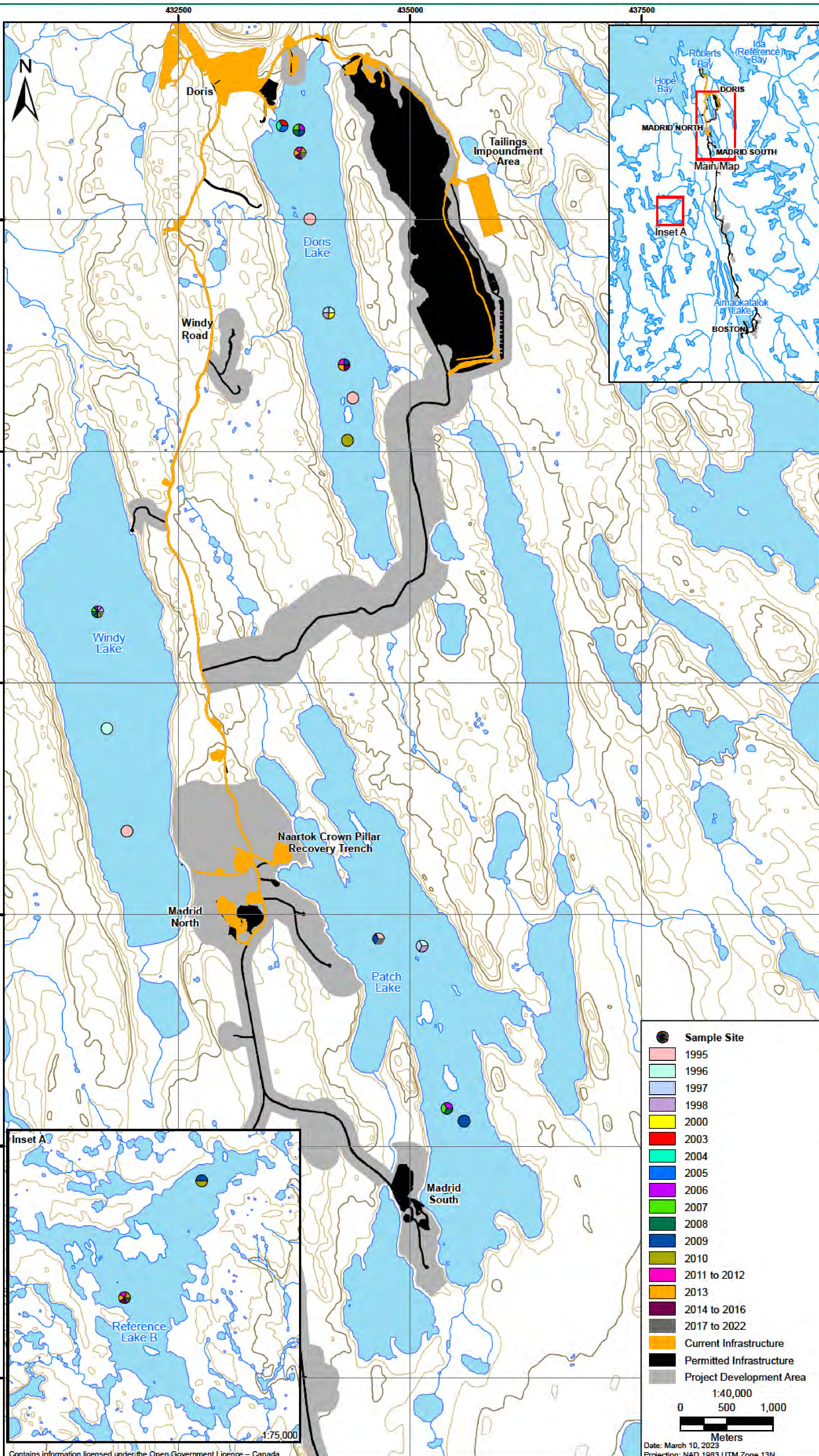



**Figure 2.2-2: Historical Physical Limnology Sampling Sites, Hope Bay AEMP, 1995 to 2022**

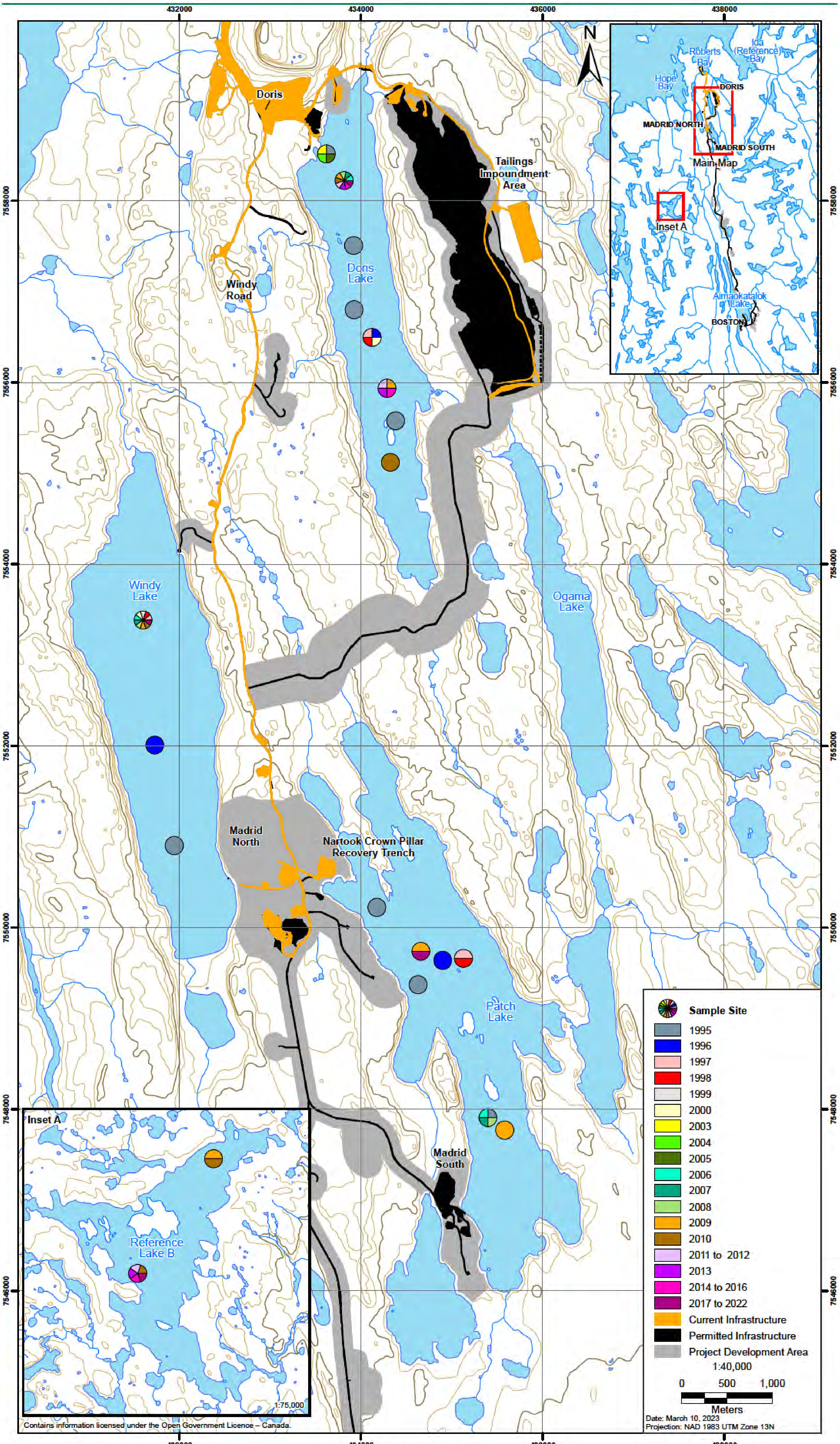



Figure 2.2-3: Historical Water Quality Sampling Sites, Hope Bay AEMP, 1995 to 2022

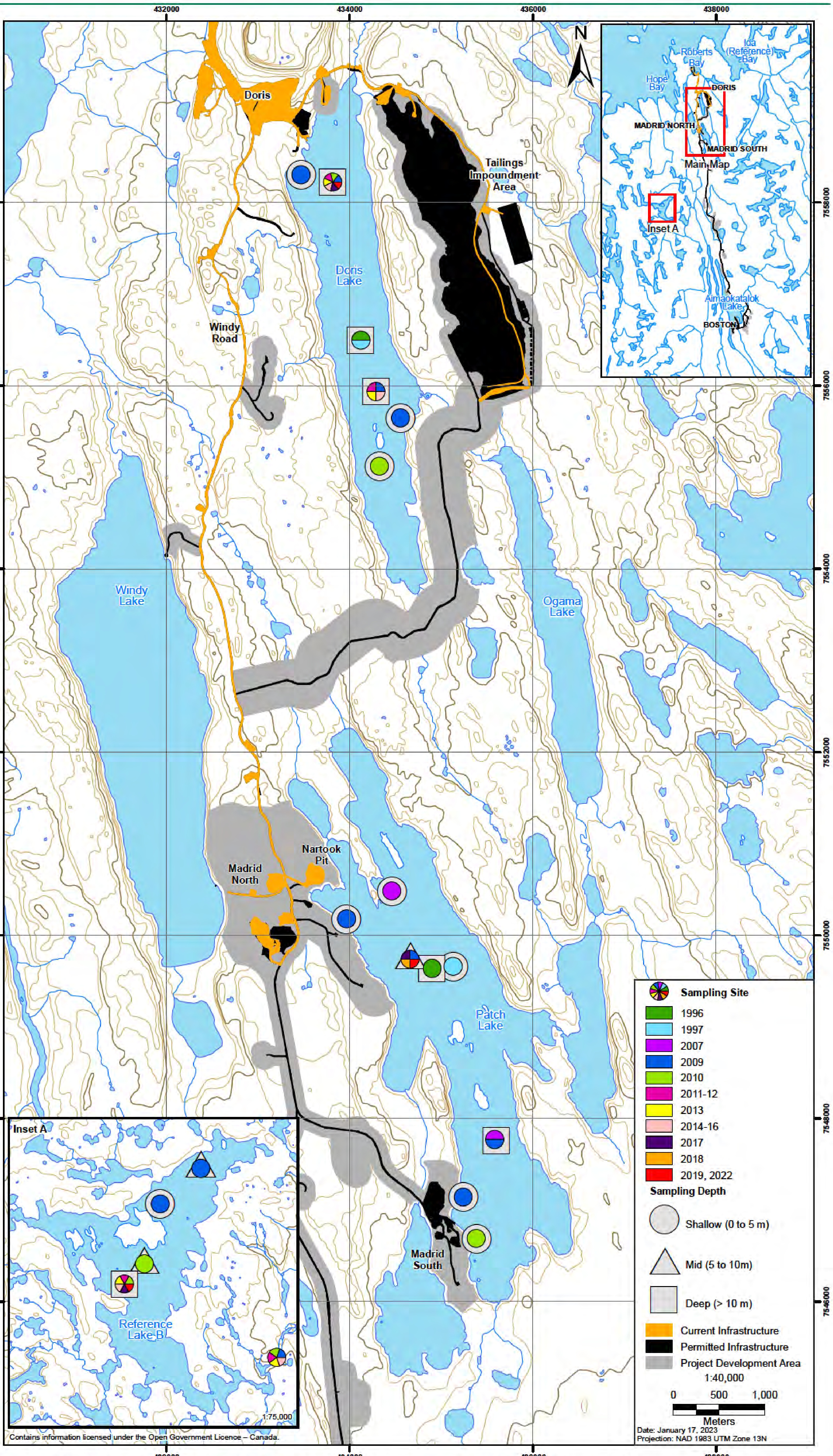



**Figure 2.2-4: Historical Sediment Quality Sampling Sites, Hope Bay AEMP, 1996 to 2022**

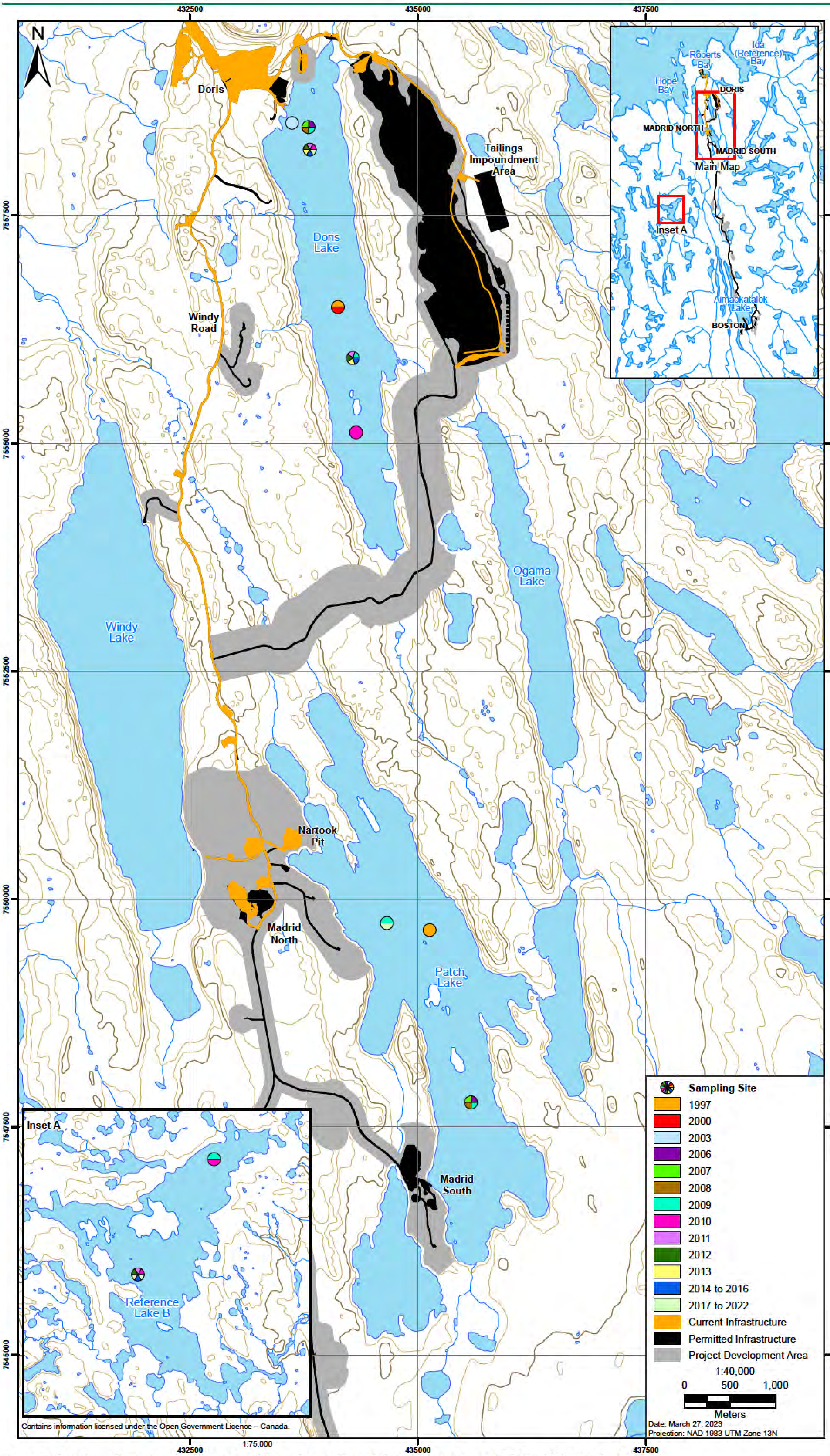



**Figure 2.2-5: Historical Phytoplankton Sampling Sites, Hope Bay AEMP, 1997 to 2022**

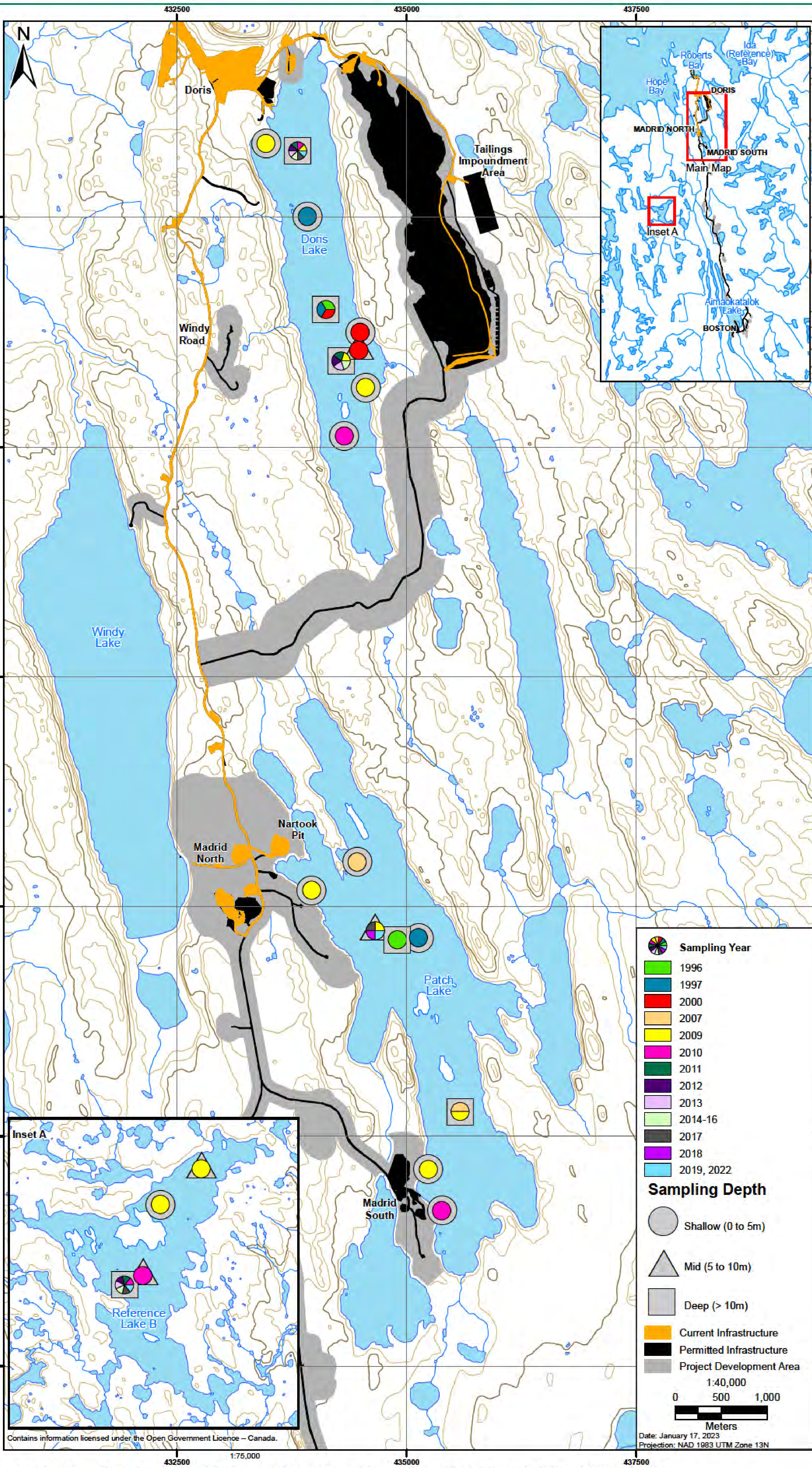



**Figure 2.2-6: Historical Benthic Invertebrate Sampling Sites, Hope Bay AEMP, 1996 to 2022**

# 3. EVALUATION OF EFFECTS

In 2022, data were collected from several exposure lakes that may be influenced 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;
- Sediment quality;
- Phytoplankton; and
- Benthic invertebrates.

Physical, chemical, and biological data from 2022 were evaluated against historical data. For the Doris development, baseline years are considered to be all years up to and including 2009 as Doris Mine construction began in 2010, and operations began in 2017 and continued into 2022, prior to entering care and maintenance phase in February 2022. For the Madrid North development, baseline years are considered to be all years up to and including 2018 as construction and operations began in 2019 and was active into 2020 and for a brief time in 2021 prior to being temporarily suspended.

The evaluation of effects was based on graphical and statistical analyses of trends over time within each exposure lake and between exposure lakes and the reference lake, 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 2022 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 Fish Habitat

Project-related water use, water withdrawal, and underground mining have the potential to reduce lake water level and stream hydrology, 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 streamflow at lake outflows 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-related activities, fisheries offsetting under applicable *Fisheries Act* Authorizations may be sought to compensate for the loss of fish habitat.

Fish habitat is evaluated through ice thickness, under-ice lake volumes, and open-water season streamflow. Ice-thickness and under-ice lake volumes are evaluated in Section 3.1.1 and 3.1.2 but stream hydrology evaluation is detailed in Appendix B but included in the summary due to its relevance to fish habitat in the Project area (Section 3.1.3).

### *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 water 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-related activities are predicted to potentially affect the lake water level and outflow 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.

Under-ice fish habitat considers the ice-covered season from approximately October 2021 (freeze-up) to June 2022 (freshet). In 2022, ice thickness and water level were measured in April in conjunction with water quality sampling. Figure 3.1-1 shows historical and 2022 ice thickness data for each lake. Ice thickness measurements collected in 2022 were within the range of historical measurements.

Table 3.1-1 presents maximum reduction in the baseline under-ice lake water surface elevation as reported in the FEIS, as well as 2021 to 2022 data for comparison. The water level fluctuations occurring during the open-water season of 2021 determine the water elevation at the start of freeze-up in 2021, so 2021 open-water season data are included in Table 3.1-1 for an assessment of the 2021 to 2022 under-ice fish habitat. In all lakes except for Glenn Lake, the reductions in under-ice lake surface elevation in the ice-covered season of 2021 to 2022 were within the range of maximum baseline reductions (Table 3.1-1). There was a greater reduction in lake surface elevation over the 2021 to 2022 season compared to the maximum naturally occurring reduction in both Glenn, Imniagut, and Little Roberts lakes (Table 3.1-1). However, this is not considered to be a Project effect for several reasons.

A reduction in under-ice water level in Glenn Lake would occur due to the upstream withdrawal of water from Windy Lake. Fluctuation of the Windy Lake water level was much lower than the fluctuations observed during the FEIS baseline period, indicating that the fluctuations in Glenn Lake are likely due to natural variation, and not an impact caused by water withdrawal from Windy Lake.

No baseline data was collected at Imniagut Lake prior to the FEIS, therefore modelled water level is used for comparison. While the modelled level is close, data collected in 2019 and 2020 varied by 15 to 20 cm, versus the 9 cm predicted by the model. To date, no Project-related activities have occurred that would cause drawdown of Imniagut Lake water levels, and this is concluded to be natural variation.

Similar to Glenn Lake, a reduction in under-ice water level at Little Roberts Lake would occur due to the upstream impacts to Doris Lake. Doris Lake water level variation was well below the fluctuations observed during the FEIS baseline period, indicating that the fluctuations in Little Roberts Lake are likely due to natural variation, and not an impact caused by water withdrawal from Doris Lake.

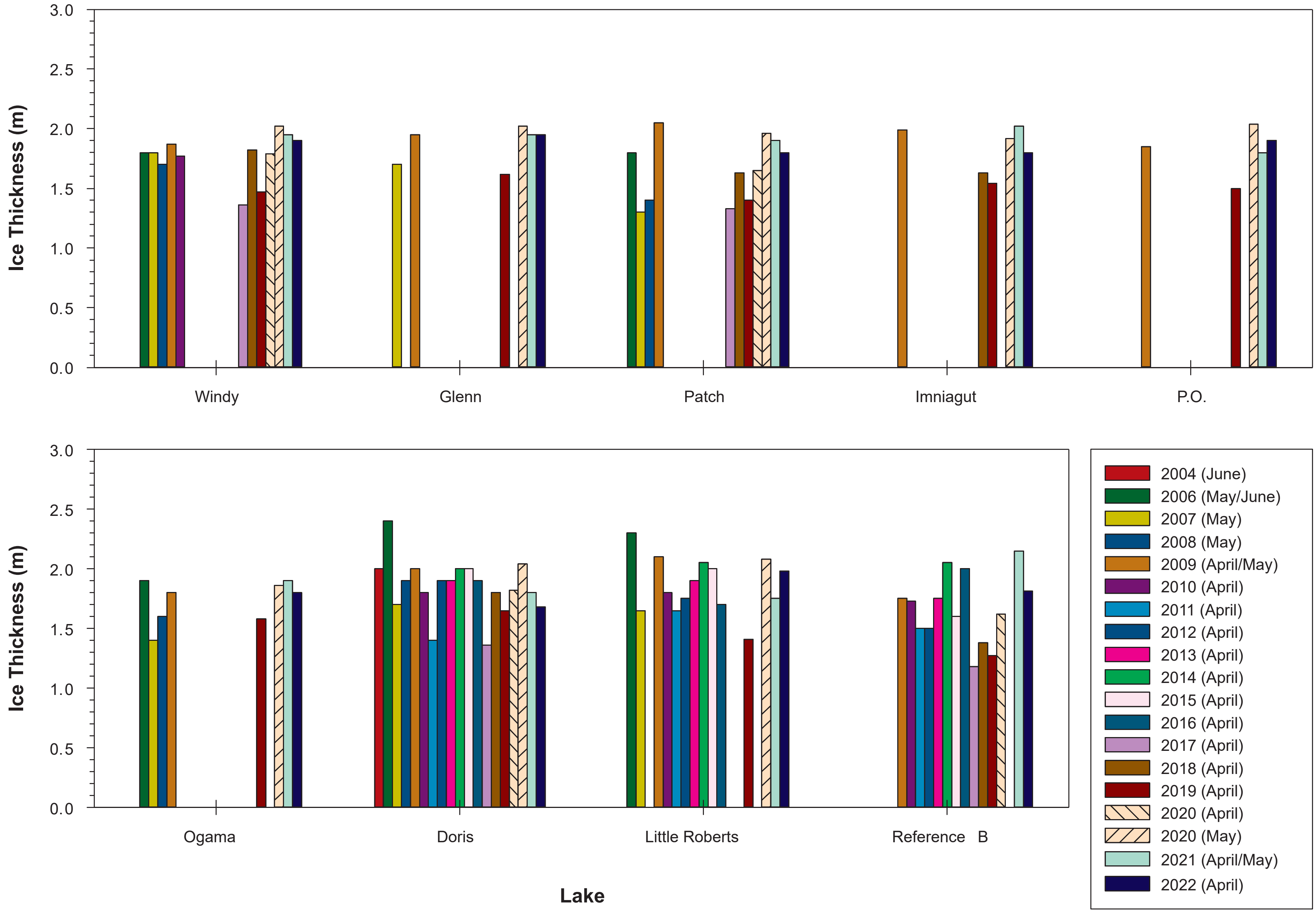



**Figure 3.1-1: Lake Ice Thickness, Hope Bay AEMP, 2004 to 2022**

### Table 3.1-1: Lake Water Level Fluctuation and Ice Thickness, Hope Bay AEMP, 2021 to 2022

| Lake | FEIS[a] | | | Ice-covered Season of 2021 to 2022 | | |
|---|---|---|---|---|---|---|
| | 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] | 2022 Ice Thickness (m) | Reduction in Under-ice Lake Surface Elevation (m) |
| Windy | 0.24 | 1.90 | 2.14 | 0.15 | 1.9 | 2.05 |
| Glenn | 0.26 | 1.95[b] | 2.21 | **0.34** | 1.95 | **2.29** |
| Patch | 0.44 | 2.05 | 2.49 | 0.37 | 1.8 | 2.17 |
| Imniagut | 0.09[c] | 1.91[c] (1.99[b]) | 2.00 (2.08) | **0.14** | 1.8 | 1.94 |
| P.O. | 0.64 | 1.85 | 2.49 | 0.30 | **1.9** | 2.2 |
| Ogama | 0.46 | 1.95 | 2.41 | **0.47** | 1.8 | 2.27 |
| Doris | 0.74 | 2.00 (2.4[d]) | 2.74 (3.89) | 0.61 | 1.68 | 2.29 |
| Little Roberts | 0.63 | 2.3[d] | 2.93 | **0.76** | 1.98 | 2.74 |

[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 (2022).*

*Notes:*

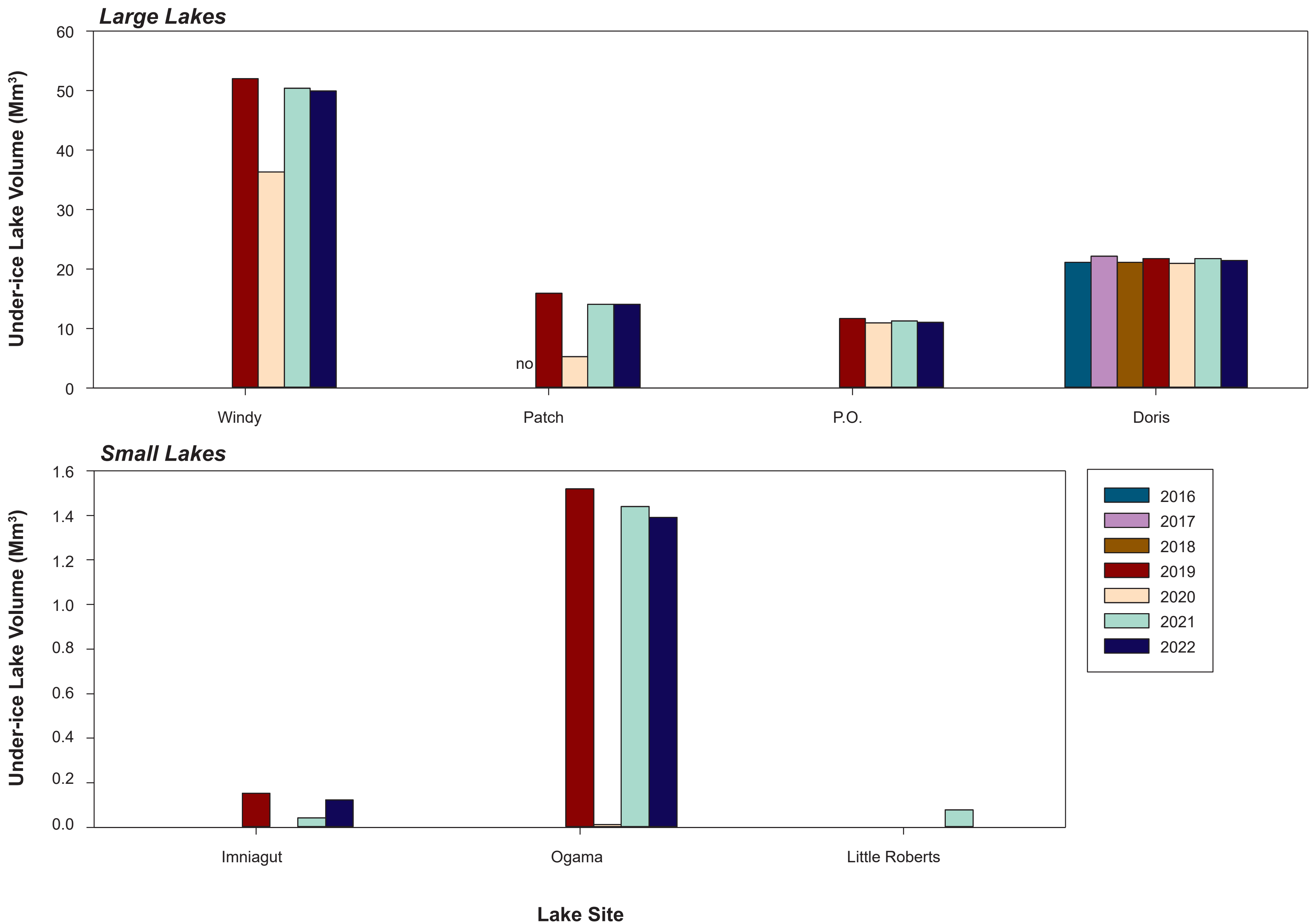
*Values in parentheses indicate updates of baseline predictions from the FEIS based on the more complete baseline dataset of ice thickness values included in Figure 3.1-1.*

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

### 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 2022 under-ice lake volumes are plotted in Figure 3.1-2. Data are limited to this 2016 to 2022 range as winter water levels were not collected prior to this. Glenn Lake was not included in the assessment of under-ice lake volume over time as there is no bathymetric data available for this lake.

The under-ice volume comparison was done using subsurface contours for the lakes created from bathymetric survey information collected in 2006 and 2008. The bathymetric survey elevations were not referenced to a geodetic elevation, so the lake surface of the bathymetric data for each lake was estimated from the average August water elevation for all years for which geodetic water levels were available. This provides a means to relate bathymetric data, with no elevation reference, with surveyed water levels tied to a geodetic datum. The value used remains constant and does not impact the comparison of water levels from year to year.




*Notes: 2020 survey results for winter water levels at Windy, Imniagut, Ogama and Little Roberts lakes were significantly higher or lower than what is plausible and were likely surveying errors.*
*2021 survey results at Little Roberts were erroneous and are not included.*

**Figure 3.1-2: Under-ice Lake Volumes, Hope Bay AEMP, 2016 to 2022**

As the hydrometric station benchmarks are buried in snow and not necessarily close to the under-ice water level survey location, surveys were performed using a Real Time Kenmatic (RTK) system. This 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. For some lakes, 2020 survey results of winter water levels were impossibly high or low, suggesting a survey error (Figure 3.1-2).

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 some lakes naturally, 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). Based on the Project-related activities at Madrid North, it is not anticipated that water levels would have been noticeably altered in any lakes upstream of Doris Lake. Winter water levels in Doris Lake have been relatively constant, and year to year variations in under-ice volume the result of natural variability in ice thickness and/or water level.

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; 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.

### *3.1.3 Fish Habitat Summary*

The hydrology compliance monitoring results show that there were no detectable Project-related effects to water levels or streamflows in 2022 (Appendix B). Observed water levels, runoff, and streamflow were within the expected range for a moderately wetter than average year.

Overall, data from 2022 show that there was no evidence for a Project-related reduction in under-ice lake volumes, lake water levels, or streamflow (see Appendix B; Table 3.1-2).

**Table 3.1-2: Summary of Evaluation of Effects to Fish Habitat, Hope Bay AEMP, 2021 to 2022**

| 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 during the under-ice season and open-water season in exposure lakes, Windy, Patch, and Doris lakes, and in Reference Lake B. Graphical analyses were used to determine if there were apparent changes in the limnological profiles for under-ice dissolved oxygen and temperature and open-water temperature in the exposure lakes over time.

For Patch and Windy lakes, 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, 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 compared to trends in Reference Lake B to establish whether any changes in the limnological profiles are likely naturally occurring or Project-related. Limnological profiles are plotted for all data measured throughout the monitoring period, as well as the 2022 observations relative to the lake-specific baseline years to assist interpretation.

Under-ice dissolved oxygen concentrations were compared to the benchmark in the Plan, which align with 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 2022a) to assess whether observed concentrations could adversely affect freshwater biota. Within the Response Framework, 2022 data were screened against the low action level benchmark (75% of the applicable 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.

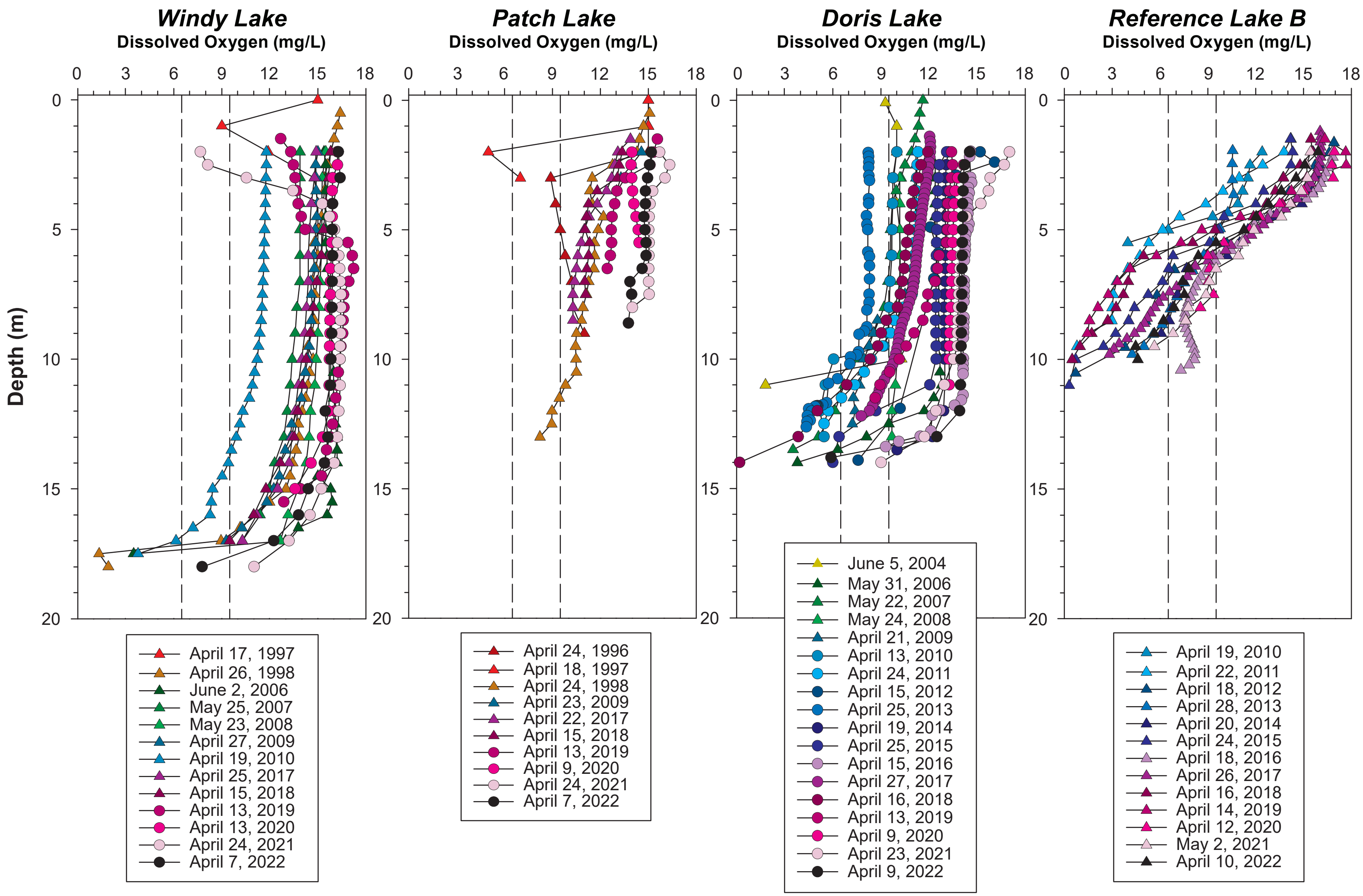
Water temperatures are evaluated to determine Project-related changes for water temperature, thermal stratification, or turnover dates in the exposure lakes, as the benchmark is aligned with the CCME guidance that thermal additions must not alter the thermal regime in an exposure lake.

The following sections present the evaluation of effects for physical limnology variables. Physical limnology data for 2022 are presented in Appendix A.

### *3.2.1 Under-ice Dissolved Oxygen*

Dissolved oxygen concentrations are typically lowest during the ice-covered period, and therefore represents the ‘worst case scenario’ for dissolved oxygen levels. Dissolved oxygen concentrations in ice-covered lakes typically decrease throughout the season because microbial decomposition and respiration continue to consume oxygen, but atmospheric sources of oxygen are excluded by ice cover. In addition, production of oxygen is reduced because ice and snow cover decrease light penetration, limiting the photosynthetic activity of phytoplankton. An adverse Project-related effect for under-ice dissolved oxygen concentrations would be manifested as a decrease in dissolved oxygen concentrations, since inputs of nutrients or organic carbon to a lake can increase productivity and therefore oxygen consumption through the microbial respiration of organic matter. If dissolved oxygen concentrations drop below the benchmarks (6.5 mg/L or 9.5 mg/L), this could negatively affect fish populations that live below the ice.

Dissolved oxygen concentrations in Reference Lake B decreased with depth and were less than the benchmarks (6.5 mg/L and/or 9.5 mg/L) near the bottom of the water column in all years (Figures 3.2-1a and 3.2-1b). The trend in dissolved oxygen throughout the water column observed in Reference Lake B in 2022 was typical of the trend for most monitoring years; with moderate concentrations, relative to the historical range, observed throughout the water column in 2022.




*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 Profiles, Hope Bay AEMP, 1996 to 2022**

For all the exposure lakes, under-ice dissolved oxygen concentrations in 2022 were relatively stable throughout the water column, with concentrations less than the 9.5 mg/L benchmark in Windy Lake and less than the 6.5 mg/L benchmark in Doris Lake only nearest the lakebed (Figure 3.2-1a). Under-ice dissolved oxygen concentrations in the exposure lakes were on the higher end of the range observed throughout the water column during baseline years and followed a similar trend throughout the water column as historically observed in Windy and Doris lakes (Figure 3.2-1b). In Patch Lake, concentrations were more stable throughout the water column than observed during the baseline years (Figure 3.2-1b), however, this is not considered to be an adverse effect as the waters remained well oxygenated and were the highest observed to date.

Overall, in 2022 under-ice dissolved oxygen concentrations in the exposure lakes were within the range or greater than baseline concentrations (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. Therefore, there is no evidence of a Project-related change in under-ice dissolved oxygen concentrations in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.2.2 Water Temperature

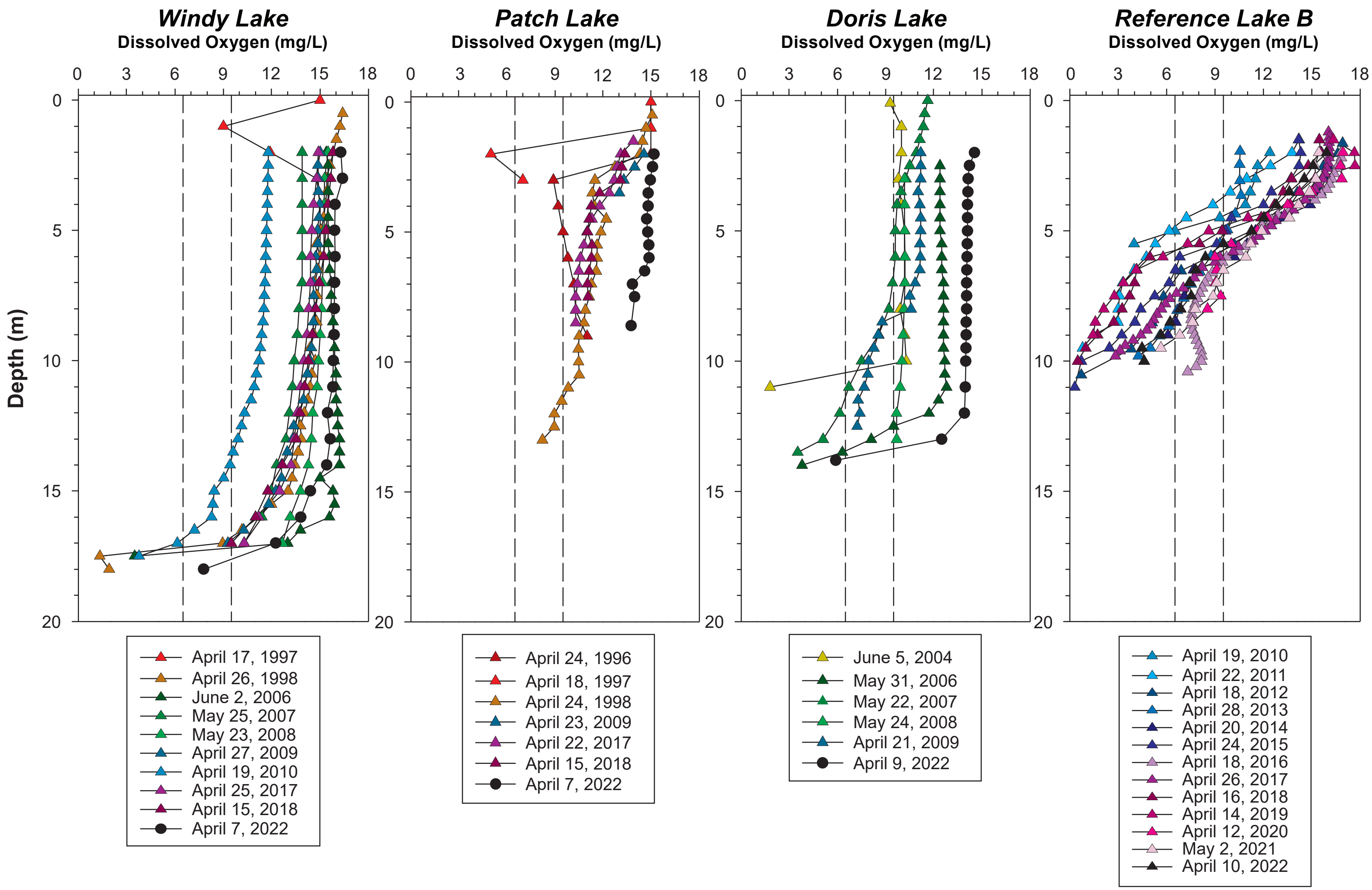
There are no current or planned Project-related activities that include thermally altered effluent to be released into the freshwater environment and therefore no expected changes in the temperature profiles for the exposure lakes.

Under-ice water temperatures in Reference Lake B were coolest just below the ice-water interface and gradually increased throughout the water column, with the warmest temperatures nearest the lakebed (Figures 3.2-2a and 3.2-2b). Under-ice temperatures observed in 2022 followed the same trend throughout the water column as historically observed in Reference Lake B. Absolute open-water temperatures have been more variable through time than the under-ice temperatures as during the open-water season water temperatures are influenced by the regional seasonal temperature regimes, whereas the under-ice temperatures are less likely to fluctuate as much inter-annually due to the ice-cover. Open-water temperatures in Reference Lake B in 2022 were within range and consistent throughout the water column, similar to the historically observed trends (Figures 3.2-3a and 3.2-3b).

For the exposure lakes, Windy, Patch, and Doris lakes, under-ice temperatures were similarly warmer at the ice-water interface and coolest near the lakebed (Figure 3.2-2a) and were similar to temperatures and trends throughout the water column as observed during baseline years (Figure 3.2-2b). During the open-water season for the exposure lakes, all temperatures profiles in 2022 were consistent throughout the water column (Figure 3.2-3a) and within the range of observed during baseline years (Figure 3.2-3b). Therefore, there is no evidence of a Project-related change in water temperatures in Windy, Patch, or Doris lakes, and no action level response was triggered.

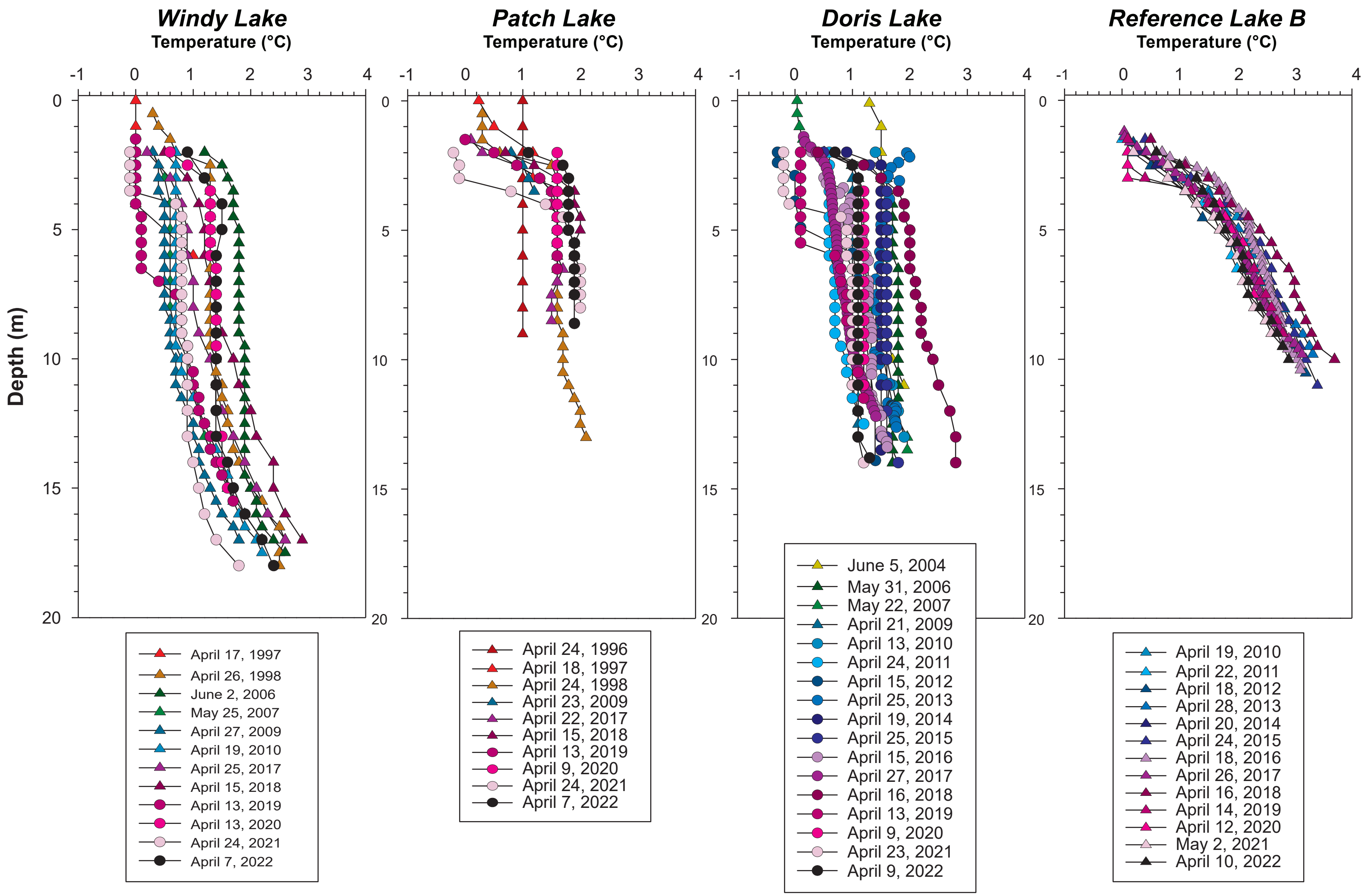
### 3.2.3 Physical Limnology Summary

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 2022 were similar to or greater than baseline concentrations, which is not considered an adverse change. Under-ice and open-water temperatures in both exposure and reference lakes were within the range and followed similar trends throughout the water column observed in the baseline years. There is no evidence of a Project-related change for the physical limnology variables evaluated (under-ice dissolved oxygen, and water temperature) and no low action level response was triggered. Table 3.2-1 presents a summary of the evaluation of effects for these physical components.



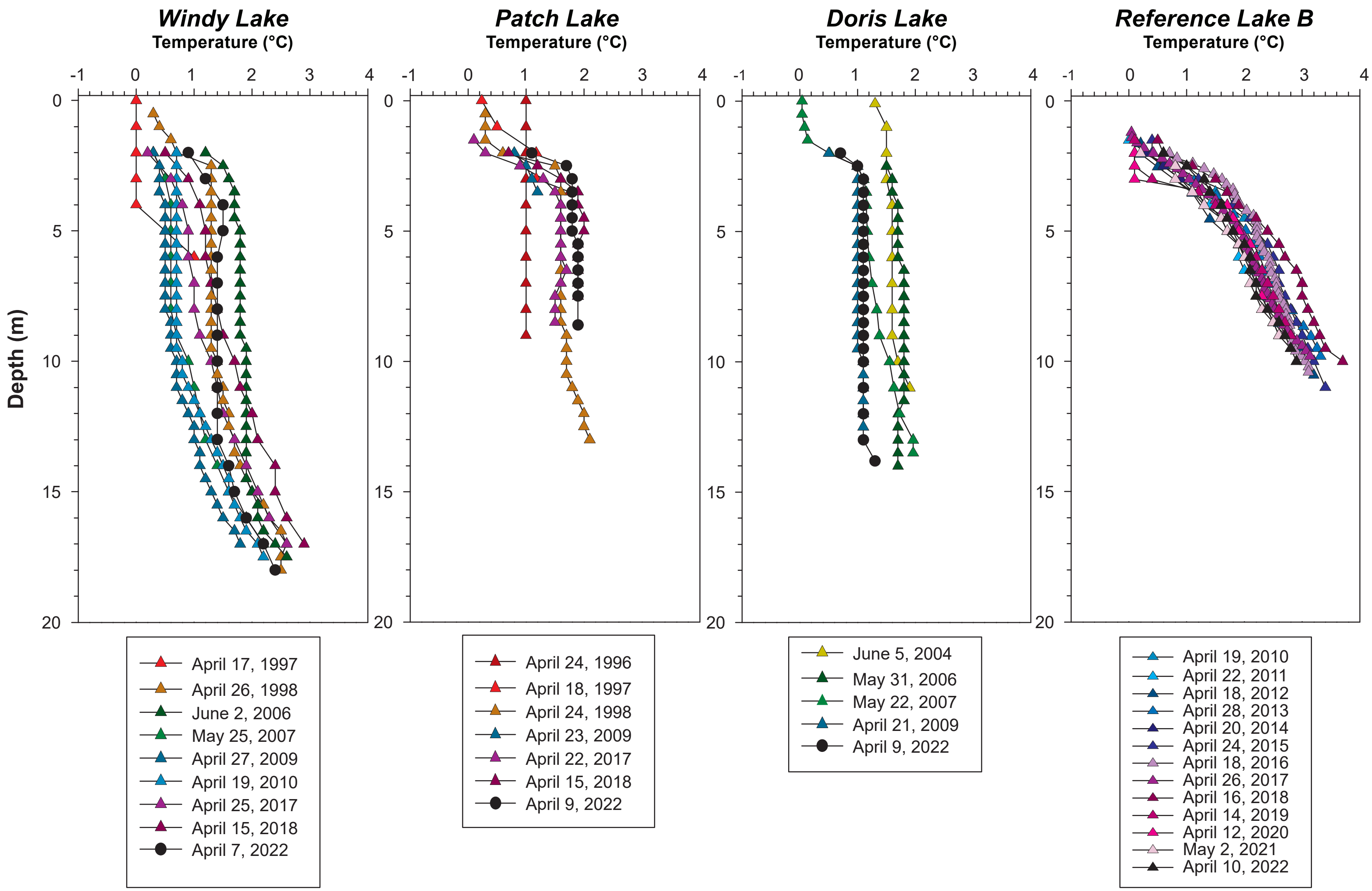

*Notes: Vertical dashed lines represent CCME freshwater dissolved oxygen guidelines for the protection of cold water aquatic life: 9.5 mg/L for early life stages; 6.5 mg/L for other life stages.*
*Triangle symbols represent baseline data (designated baseline years differ for each lake).*

**Figure 3.2-1b: Under-ice Dissolved Oxygen Profiles, Hope Bay AEMP, Baseline and 2022**



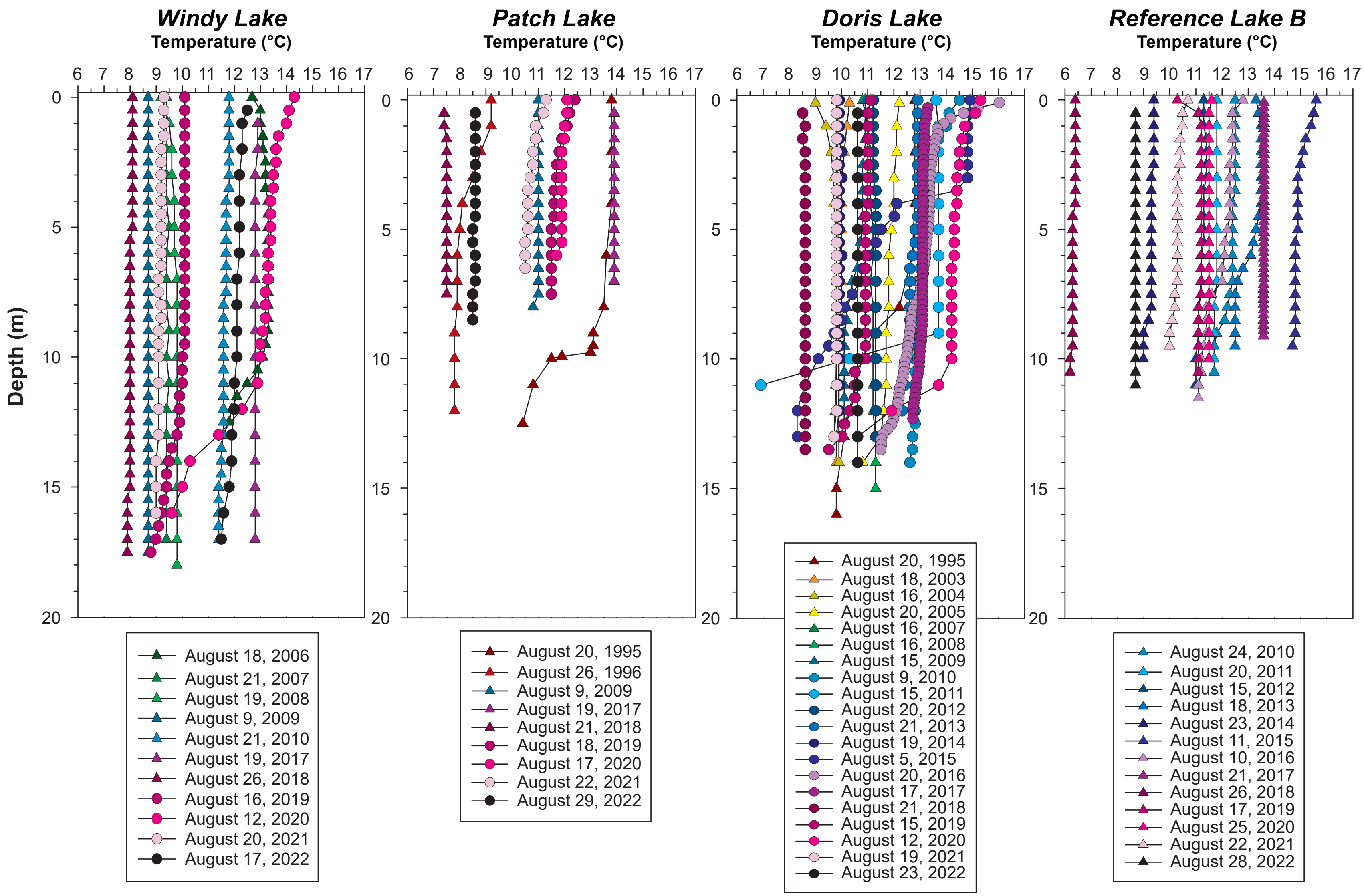

*Notes: Triangle symbols represent baseline years (designated baseline years differ for each lake).*

**Figure 3.2-2a: Under-ice Temperature Profiles, Hope Bay AEMP, 1996 to 2022**



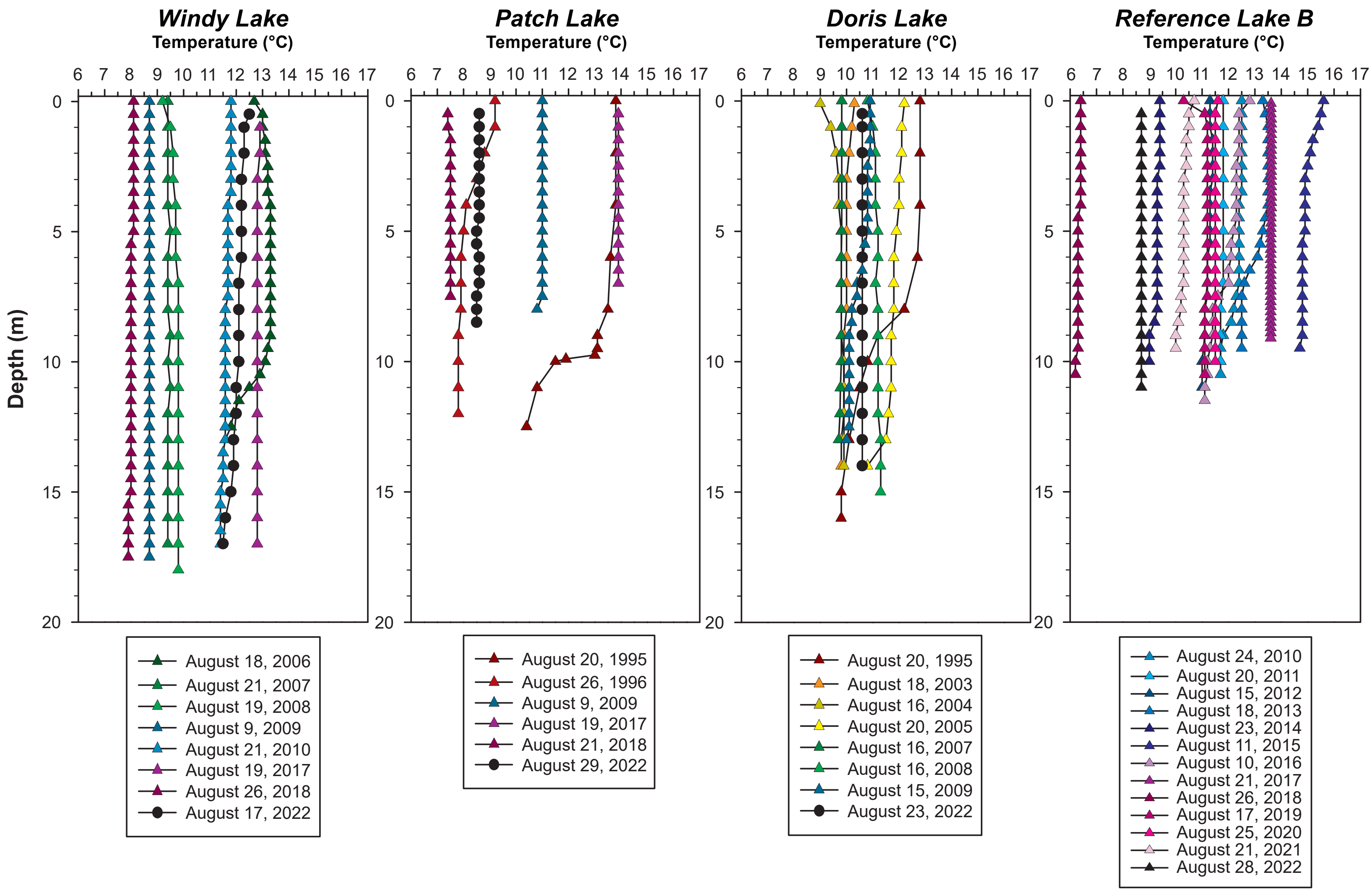

*Notes: Triangle symbols represent baseline years (designated baseline years differ for each lake).*

**Figure 3.2-2b: Under-ice Temperature Profiles, Hope Bay AEMP, Baseline and 2022**




*Notes: Triangle symbols represent baseline data (designated baseline years differ for each lake)*

**Figure 3.2-3a: Open-water Temperature Profiles, Hope Bay AEMP, 1995 to 2022**




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

**Figure 3.2-3b: Open-water Temperature Profiles, Hope Bay AEMP, Baseline and 2022**

**Table 3.2-1: Summary of Evaluation of Physical Limnology Effects, Hope Bay AEMP, 2022**

| 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 | NA | No effect | NA | No | NA |
| Temperature | No | No | No effect | No effect | No | No |

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

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

*Note:*

*NA indicates variable is not evaluated.*

## 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 2022. 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 lakes 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 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 the benchmarks in the Plan, which align with the CCME water quality guidelines for the protection of aquatic life (CCME 2022a), to assess whether observed concentrations could adversely affect freshwater biota. Within the Response Framework, 2022 data were screened against the low action level benchmark (75% of the applicable 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.

If any adverse changes to water quality variables are identified, they would be discussed in the context of the water and load balance model developed as part of the 2017 FEIS to verify the predictions of the freshwater quality assessment (TMAC 2017b). Doris Lake was not specifically included in the water and load balance model as an assessment node; results for Doris Creek are discussed instead for comparison with Doris Lake water quality. The Doris Creek node in the water balance model corresponds to the northern outflow from Doris Lake (TMAC 2017b). Water quality predictions were made for both Patch Lake and Windy Lake directly in the FEIS (TMAC 2017b).

The following sections present the evaluation of effects for water quality variables. Water quality data for 2022 are presented in Appendix A, and all statistical analysis results are presented in Appendix C.

### 3.3.1 pH

pH values in all three exposure lakes were variable in the early monitoring period (1995 to 2010) but have been relatively stable and followed a similar trend as observed in the reference lakes in recent years (Figure 3.3-1). For Windy and Patch lakes, the *before* period mean pH was not significantly different from the *after* period mean for both the under-ice ($p = 0.2632$ for Windy Lake; $p = 0.158$ for Patch Lake) and open-water seasons ($p = 0.1827$ for Windy Lake; $p = 0.3168$ for Patch Lake). pH values in 2022 were within the baseline ranges, benchmark range, and within the low action level benchmark (75% of the benchmark) for Windy and Patch lakes. For Doris Lake, the statistical analysis showed that the pH trend was significantly different from a slope of zero during both the under-ice ($p < 0.05$) and open-water seasons ($p < 0.05$), 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 2022 (Figure 3.3-1). However, there were no significant differences in under-ice or open-water season pH trends between Doris Lake and Reference Lake B ($p = 0.5542$ and $p = 0.0637$, respectively), pH values in 2022 were within the baseline range, benchmark range, and within the low action level condition (i.e., 75% of the benchmark) for Doris Lake.

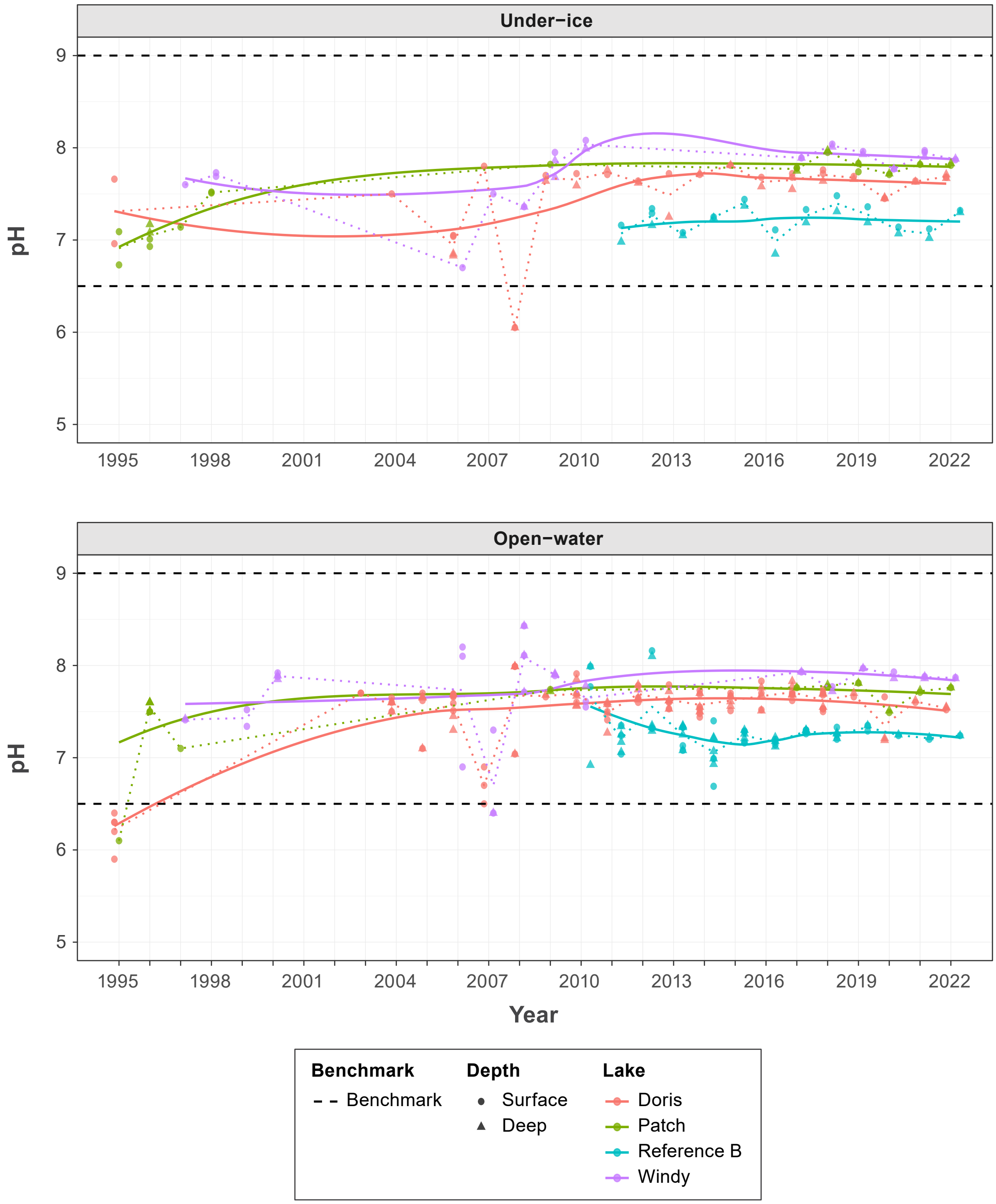
Overall, there is no evidence of a Project-related change in pH in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.2 Total Suspended Solids

Total suspended solids (TSS) concentrations have been generally low and stable throughout the monitoring period in Windy and Patch lakes (Figure 3.3-2). In Windy Lake during both under-ice and open-water seasons, and in Patch Lake during the under-ice season, TSS concentrations were below the analytical detection limit (< 1.0 mg/L) in 2022 and no statistical analyses were performed. During the open-water season in Patch Lake, the *before* period mean TSS was not significantly different from the *after* period mean ($p = 0.8966$). TSS concentrations in 2022 were within the baseline ranges for Windy and Patch lakes, less than the lake-specific benchmarks, and less than the low action level condition (i.e., 75% of the benchmark).

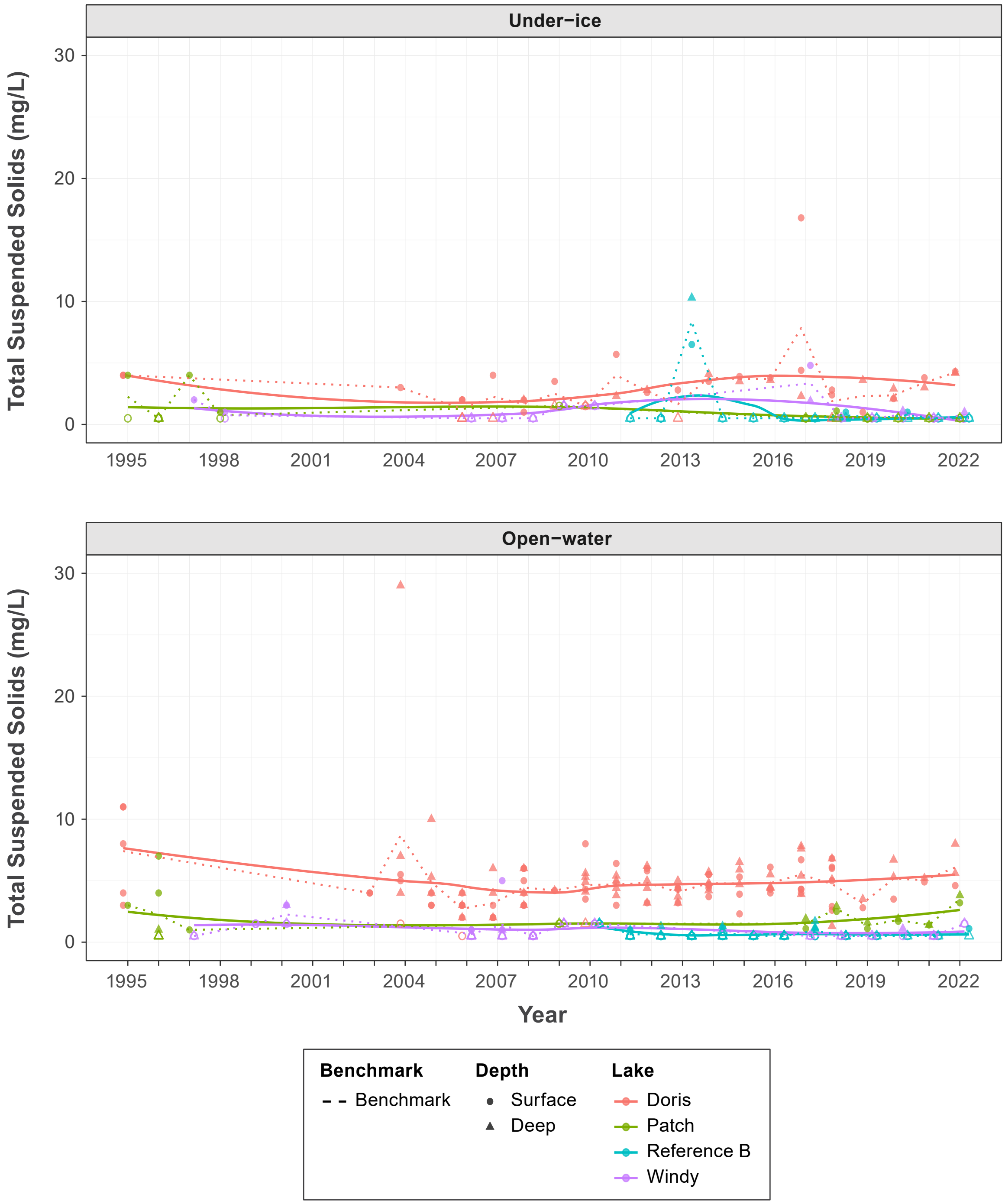
TSS concentrations have generally been higher in Doris Lake than in Windy and Patch lakes, or Reference Lake B since monitoring began (Figure 3.3-2). Statistical analyses for Doris Lake showed that the TSS trend was significantly different from a slope of zero during the under-ice season ($p < 0.05$), which was likely driven by the slightly greater concentrations observed in the early monitoring period (1995) compared to the relatively consistent concentrations observed since (Figure 3.3-2). The open-water TSS trend did not differ from a slope of zero ($p = 0.7749$). Statistical comparison to Reference Lake B trends were not possible because of the high proportion of censored concentrations. However, there was no evidence of an increasing trend in under-ice or open-water TSS concentrations in Doris Lake (Figure 3.3-2). TSS concentrations in 2022 were within the baseline range for Doris Lake, less than the lake-specific benchmark, and less than the low action level condition (i.e., 75% of the benchmark).

Overall, there is no evidence of a Project-related change in TSS in Windy, Patch, or Doris lakes, and no action level response was triggered for TSS.




*Notes: Symbols represent observed data values.*
*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 curve.*
*Black dashed lines represent the benchmark range (6.5 to 9.0).*

## Figure 3.3-1: pH Values in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*The benchmark is lake specific.*

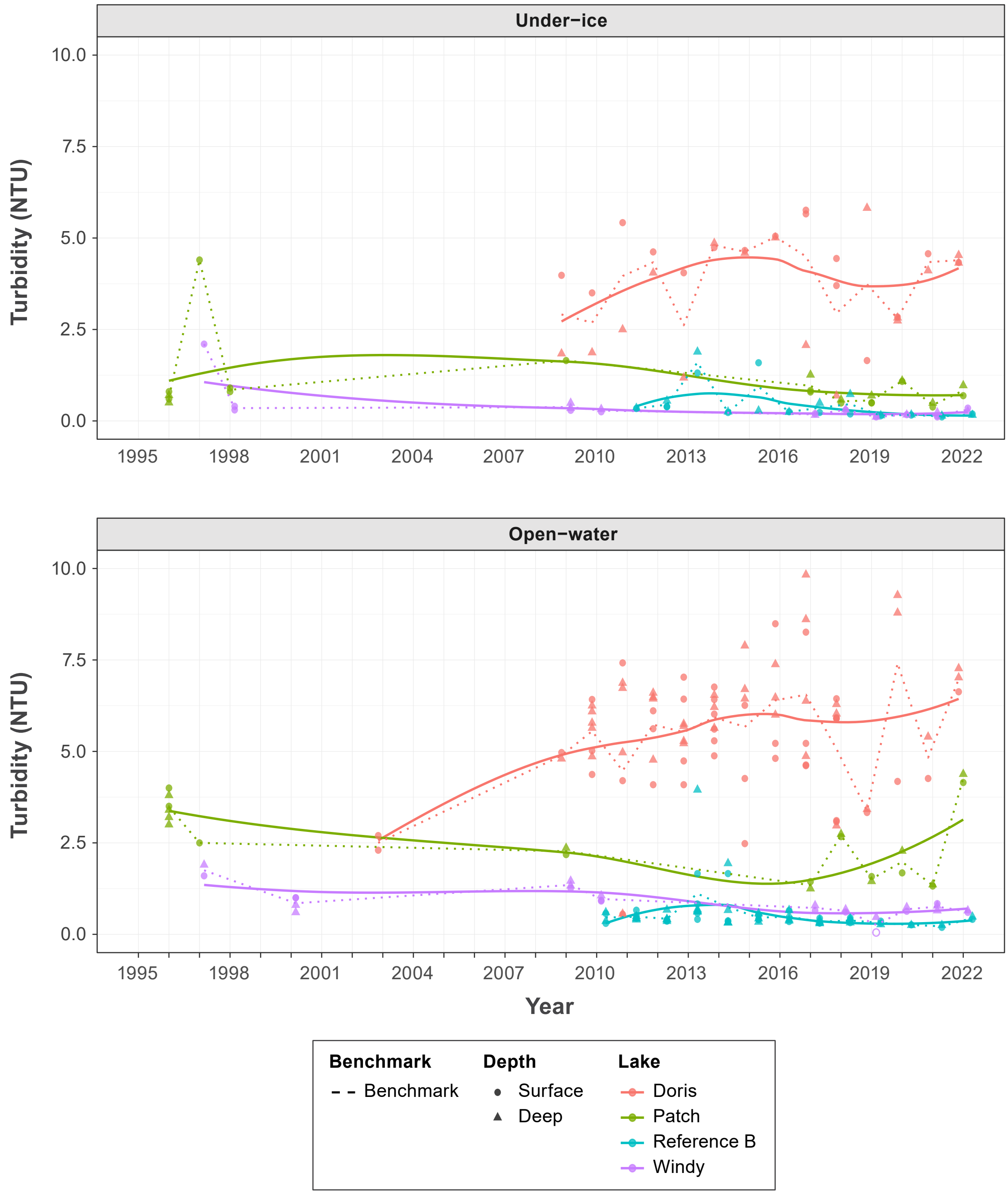
**Figure 3.3-2: Total Suspended Solids in Lakes, Hope Bay AEMP, 1995 to 2022**

### *3.3.3 Turbidity*

Turbidity in Windy Lake has been low and stable in both the under-ice and open-water seasons (Figure 3.3-3). In Patch Lake, under-ice turbidity been stable in recent years however values have been more variable in open-water season and turbidity observed during the open-water season in 2022 was slightly greater than the *before* period range (Figure 3.3-3). However, statistical analyses indicate that there were no significant differences in the *before* and *after* period means for turbidity in Windy and Patch lakes during both the under-ice and open-water seasons (Windy Lake: p = 0.1165 for under-ice, p = 0.0769 for open-water; Patch Lake: p = 0.2514 for under-ice, p = 0.6181 for open-water). Turbidity in Windy and Patch lakes was less than the lake-specific benchmarks for both seasons however, mean turbidity observed in Patch Lake during the open-water season exceeded the low action level condition (i.e., 75% of the benchmark) in 2022 (mean turbidity = 4.265 mg/L and low action level condition = 3.58 mg/L). Turbidity in Windy and Patch lakes were within or slightly less than the *before* period range in 2022, with the exception of open-water observations in Patch Lake (Figure 3.3-3). Open-water turbidity in Patch Lake was variable throughout the *before* period and although the observations in 2022 appear relatively elevated compared to recent years (e.g., 2019 to 2021), it was only slightly greater than the *before* values observed in 1996. The relatively elevated turbidity values in Patch Lake during the open-water season were likely influenced by the sustained high winds experienced at site prior to the August sampling event (see Nunami Stantec 2022) and the relatively shallow depth of Patch Lake resulting in wave disturbance of lake sediments. Similarly, slightly greater concentrations of total suspended solids, total phosphorus, and some metals (see Sections 3.3.2, 3.3.9, and 3.3.10 for example) were also observed in 2022 as well as in the baseline year 1997, suggesting this may attributed to natural phenomenon rather than a Project-related effect. In addition, the Project was in care and maintenance and development activities at Madrid North were suspended prior to sampling in 2022 and therefore there is no probable mechanism for a Project-related increase in turbidity in Patch Lake during the open-water season in 2022. Additional monitoring will confirm if the increased turbidity observed in Patch Lake persist.

Turbidity values have generally been higher in Doris Lake than in Windy and Patch lakes, or Reference Lake B since monitoring began (Figure 3.3-3). Under-ice and open-water turbidity within Doris Lake have been variable throughout the monitoring period (i.e., intra-annual variation) however, values have shown no clear directional trend since 2009. Statistical analyses showed that the slopes of the under-ice and open-water turbidity trends over time were not significantly different from zero (p = 0.0927 for under-ice; p = 0.2158 for open-water). Mean open-water turbidity levels in 2022 (6.97 NTU) were higher than baseline mean (3.69 NTU) and the lake specific benchmark (5.69 NTU). However, 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 statistical analysis for open-water turbidity in Doris Lake indicates no significant change through time, while the comparison to baseline levels indicates potentially increased mean turbidity and variability. Turbidity was not directly assessed in the 2017 FEIS predictions of Project effects to the freshwater environment, but total suspended solids 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).

Overall, there was no evidence of a Project-related increase in turbidity in Windy and Patch lakes. The evidence in Doris Lake is inconclusive however, in recent years there has been no consistent directional trend and therefore no Project-related effect was concluded. No action level response was triggered for turbidity in 2022.




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*The benchmark is lake specific.*

**Figure 3.3-3: Turbidity in Lakes, Hope Bay AEMP, 1995 to 2022**

### 3.3.4 Chloride

Chloride concentrations in all three exposure lakes have generally been stable through time but have been greater than concentrations observed in the Reference Lake B, including in baseline years (Figure 3.3-4). Concentrations in Windy and Patch lakes have been similar and slightly greater than Doris Lake through time. For Windy and Patch lakes, the *before* period mean chloride concentrations were not significantly different from the *after* period mean for both the under-ice and open-water seasons (Windy Lake: $p = 0.6536$ for under-ice, $p = 0.5354$ for open-water; Patch Lake: $p = 0.4622$ for under-ice, $p = 0.749$ for open-water). For Doris Lake, the statistical analyses showed that the under-ice and open-water chloride trends were significantly different from a slope of zero ($p < 0.05$ for both under-ice and open-water) and relative to the seasonal trends in Reference Lake B ($p < 0.05$ for both under-ice and open-water). Concentrations decreased slightly in Doris Lake between 2015 and 2019 but have remained stable in recent years.

Chloride concentrations were within the baseline range and less than the benchmark in all three exposure lakes. In Windy Lake during both seasons and Patch Lake during the under-ice season, concentrations were greater than the low action level condition (i.e., 75% of the benchmark). However, concentrations had exceeded this benchmark in baseline years and there was no evidence of an increasing trend in either Windy or Patch Lake. There is no evidence of a Project-related change in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.5 Fluoride

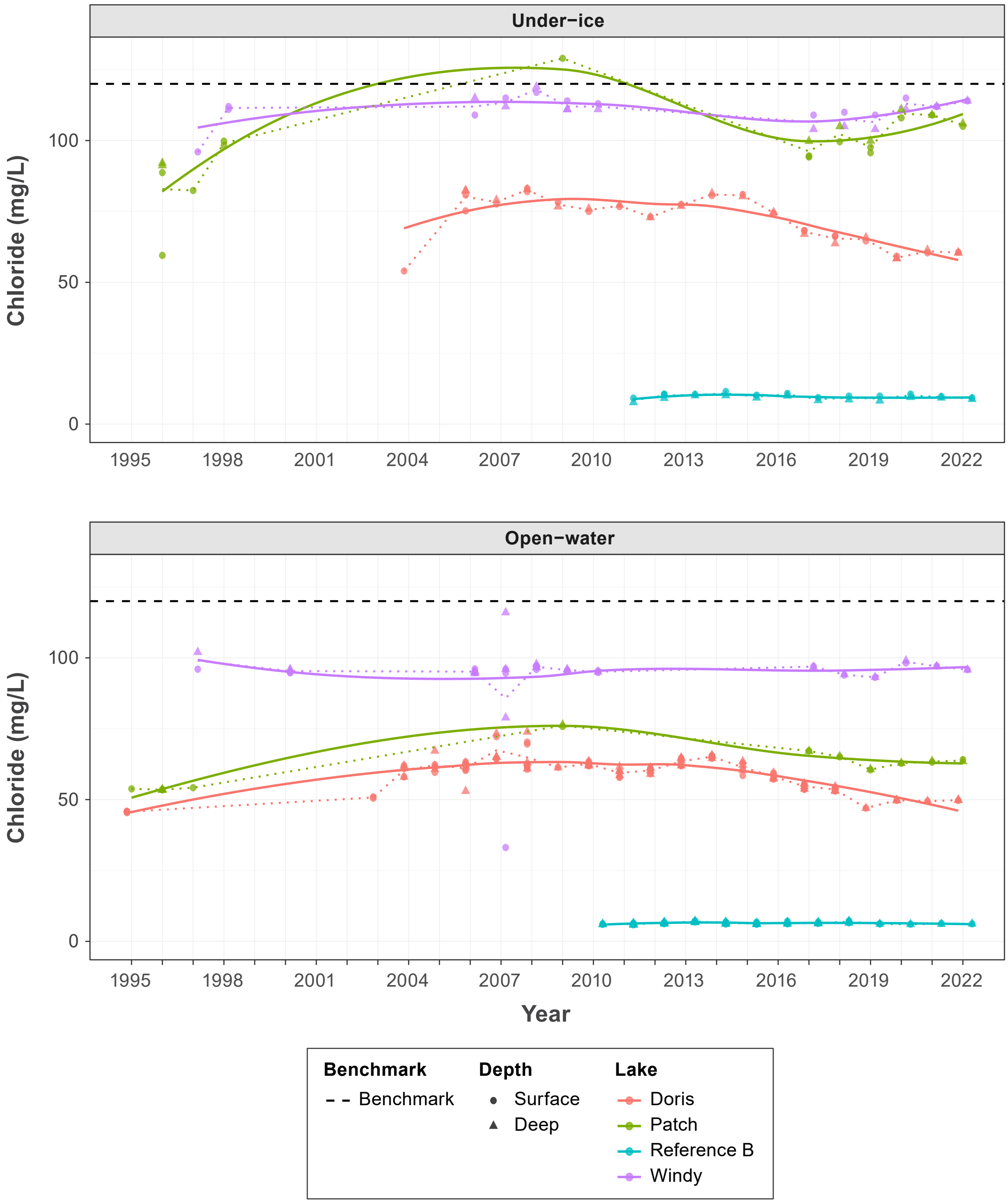
Fluoride concentrations were variable in the early monitoring period but have been relatively stable in recent years in all three exposure lakes (Figure 3.3-5). Statistical analyses indicate the mean *before* period fluoride concentrations in Windy and Patch Lake were not significantly different from the *after* period means (Windy Lake: $p = 0.9845$ for under-ice, $p = 0.5894$ for open-water; Patch Lake: $p = 0.7812$ for under-ice, $p = 0.7086$ for open-water), and the fluoride trends in Doris Lake were not significantly different from a slope of zero ($p = 0.2067$ for under-ice, $p = 0.8725$ for open-water).

Fluoride concentrations were within the baseline range and less than the benchmark in all three exposure lakes. In Windy and Patch lakes under-ice fluoride concentrations were greater than the low action level condition (i.e., 75% of the benchmark). However, concentrations had exceeded this benchmark in baseline years and there was no evidence of an increasing trend in either Windy or Patch Lake. There is no evidence of a Project-related change in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.6 Total Ammonia

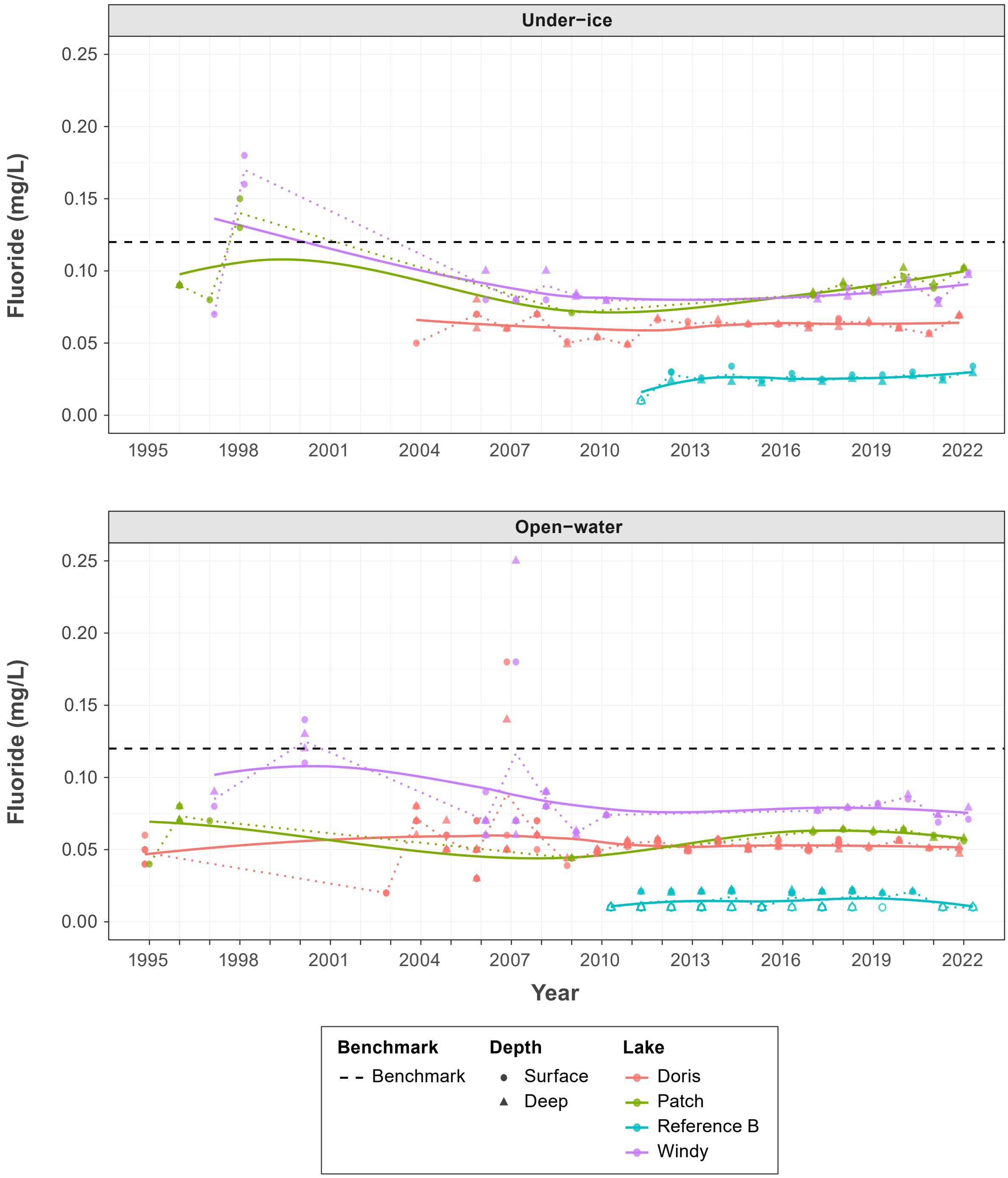
Total ammonia concentrations have been variable across depths within lakes in a given year and through time (Figure 3.3-6). In 2022, total ammonia was less than the detection limit in Doris and Windy lakes, and a high proportion (≥ 50%) were less than the detection limit in Patch Lake throughout the under-ice season and in Reference Lake B throughout the open-water season therefore, statistical analyses were only completed for Patch Lake during the under-ice season (see Appendix C.3.1.6). For Patch Lake under-ice total ammonia concentrations, the change from *before* to *after* was not significantly ($p = 0.0806$) different. Overall, concentrations in the exposure lakes have been similar to the concentrations observed in the reference lake (Figure 3.3-6).

Total ammonia concentrations in 2022 were within the baseline range, and less than the sample specific benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total ammonia in Windy, Patch, or Doris lakes, and no action level response was triggered.



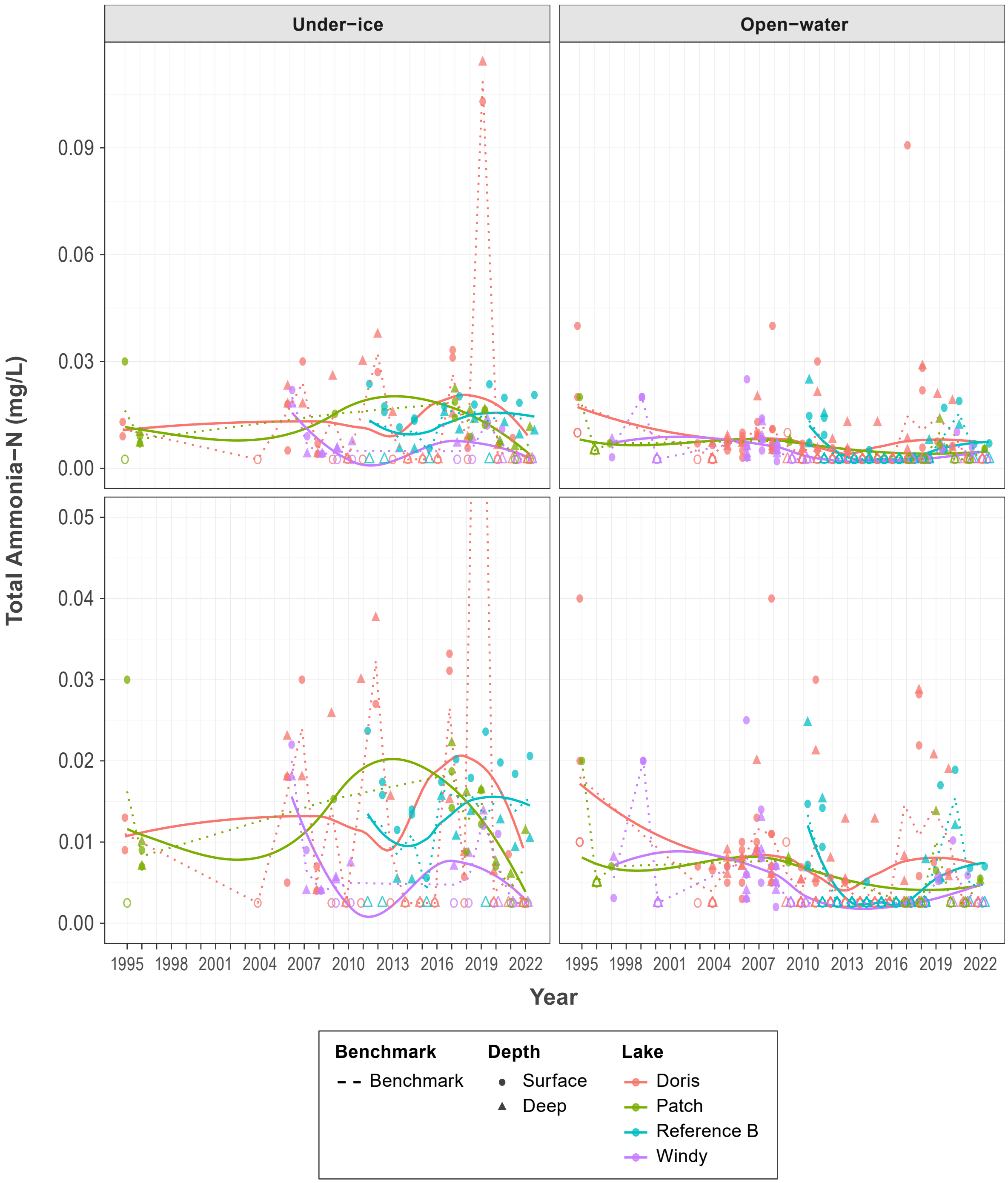

*Notes: Symbols represent observed data values.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines drawn through the scatter plots represent the annual means.*
*Solid lines drawn through the scatter plots represent LOESS smoothing curve.*
*Black dashed lines represent the benchmark (120 mg/L).*

## Figure 3.3-4: Chloride in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.12 mg/L).*

## Figure 3.3-5: Fluoride in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Benchmark is pH and temperature dependent (see Section 2.2.3).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

**Figure 3.3-6: Total Ammonia in Lakes, Hope Bay AEMP, 1995 to 2022**

### 3.3.7 Nitrate

Under-ice nitrate concentrations have been relatively variable in Doris and Patch lakes and Reference Lake B relative to the open-water season (Figure 3.3-7). Windy Lake nitrate concentrations have been relatively stable during both seasons. In 2022, statistical analyses were not completed due to the high proportion of concentrations less than the detection limit, with exception of Patch Lake during the under-ice season (see Appendix C.3.1.7). The change in concentrations from *before* to *after* was not significantly different ($p = 0.3304$) in Patch Lake. Nitrate concentrations in Doris Lake were slightly elevated in the deep depth samples between 2006 and 2018 but increased concentrations in the deeper depths of Reference Lake B have also been observed (Figure 3.3-7). Overall, concentrations have been low and stable in recent years or similar to concentrations observed in Reference Lake B.

Nitrate concentrations in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in nitrate in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.8 Nitrite

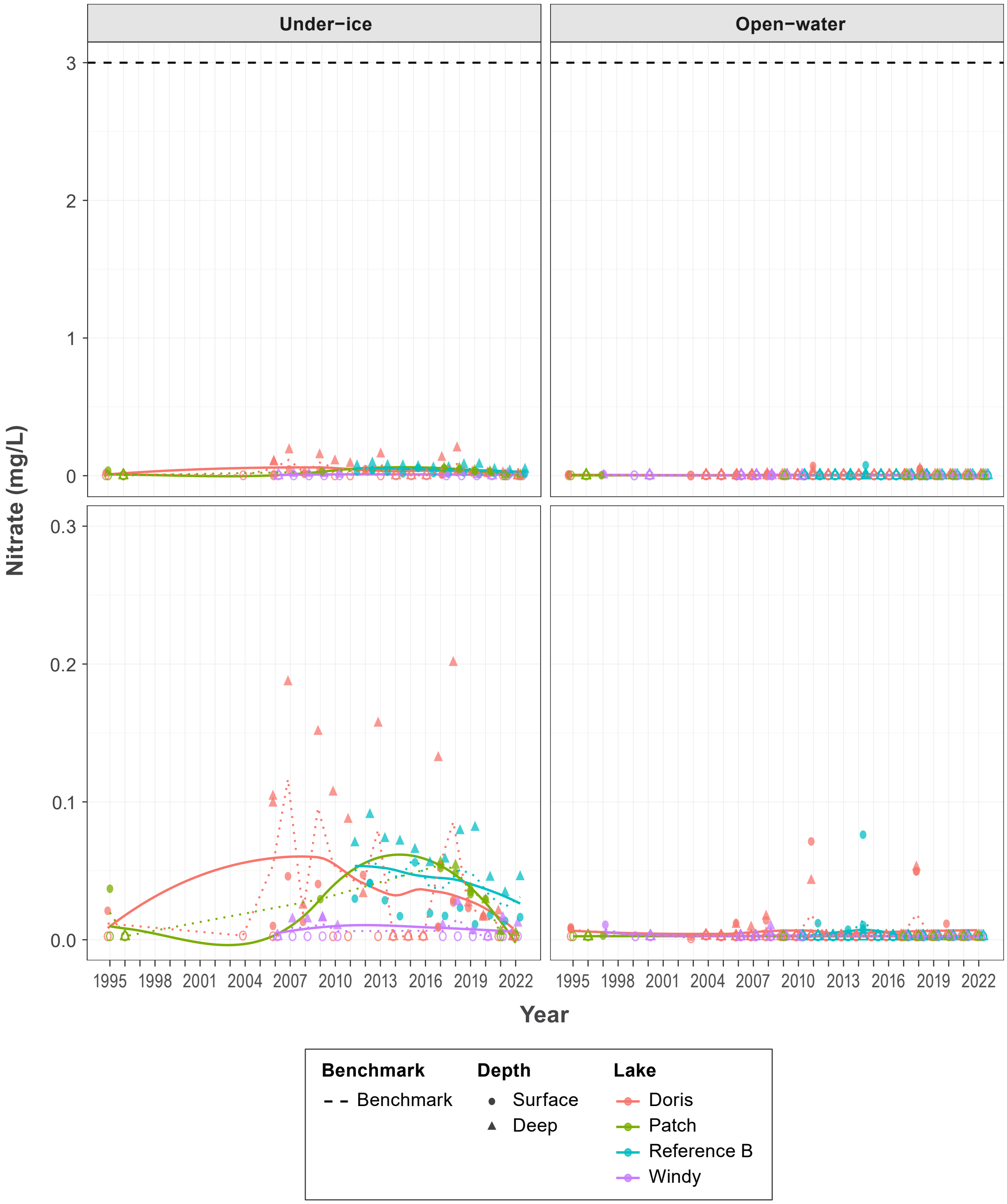
Overall, nitrite concentrations have been low through time in the exposure and reference lakes however, concentrations have occasionally been variable within lakes in a given year (Figure 3.3-8). In 2022, all nitrite concentrations were below the detection limit (< 0.0010 mg/L) and statistical analyses were not completed (see Appendix C.3.1.8). Nitrite concentrations were less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in nitrate in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.9 Total Phosphorus

Total phosphorus concentrations in the exposure lakes have generally been similar between the ice-covered and open-water seasons (Figure 3.3-9). Total phosphorus concentrations in Windy and Patch lakes have generally been low and characteristic of oligotrophic conditions through time (<0.01 mg/L; Wetzel 2001; CCME 2022a). Statistical analyses indicate no significant differences between *before* and *after* period means for Windy Lake during both seasons ($p = 0.1891$ and $p = 0.5854$, respectively) and Patch Lake during the under-ice season ($p = 0.6343$). During the open-water season, the difference in the *before* period mean and the *after* period mean was significantly different ($p < 0.05$) however, the change was not significant when compare to trends in Reference Lake B. Total phosphorus observations in Patch Lake during the open-water season in 2022 were slightly greater than the upper limit of the *before* period observations, particularly the deep sample was relatively elevated in 2022. The increased total phosphorus is likely associated with the slightly greater total suspended solids and turbidity that were attributed to natural phenomenon in Patch Lake (Section 3.3.3) and additional years of monitoring will indicate if the increase persists.

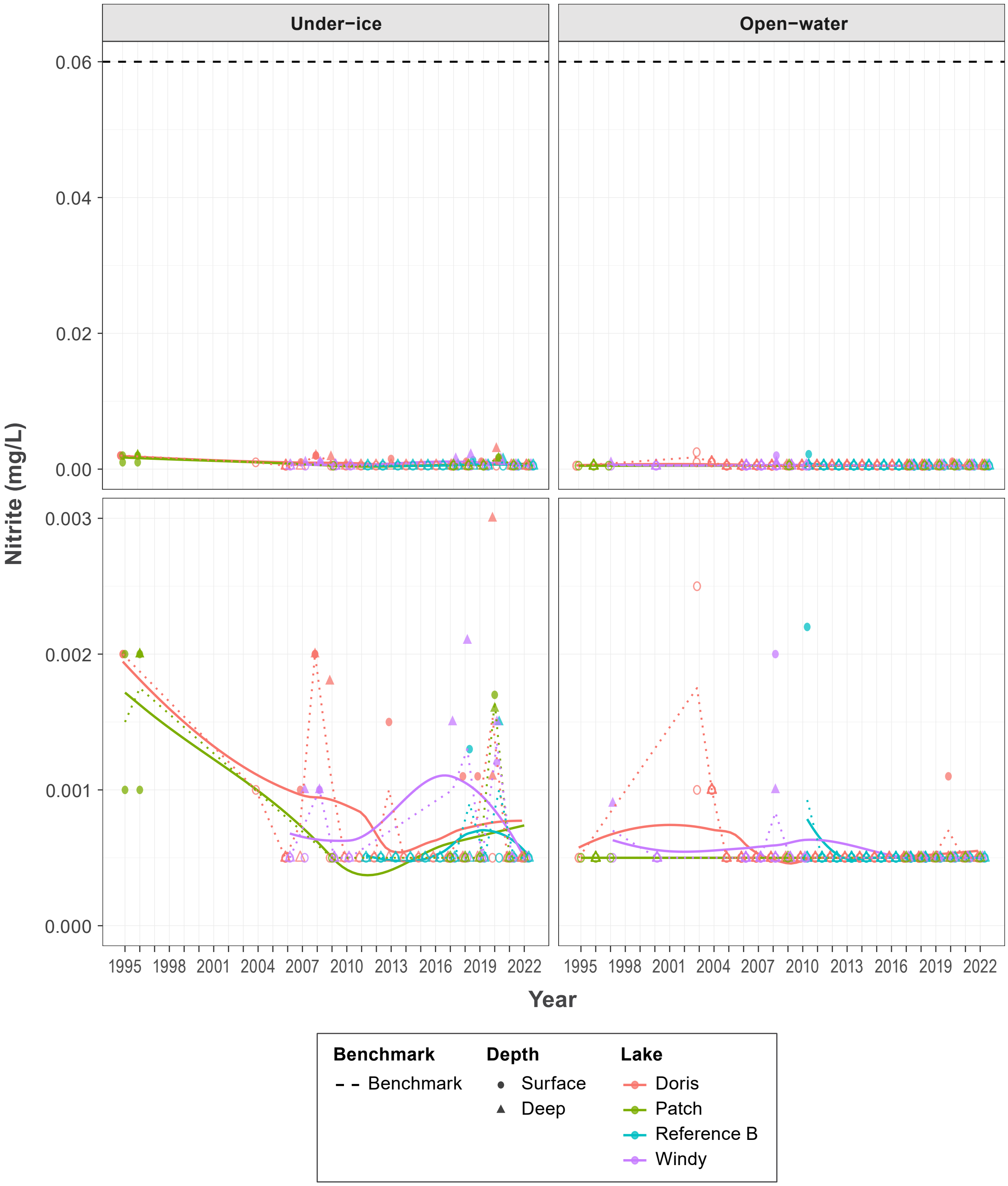
Total phosphorus concentrations in Doris Lake have been greater than the reference lake and other exposure lakes through time, including baseline years, suggesting that total phosphorus is naturally higher in Doris Lake (Figure 3.3-9). Doris Lake total phosphorus concentrations are characteristic of a meso-eutrophic lake (~0.035 mg/L; Wetzel 2001; CCME 2022a). Statistical analyses indicate that concentrations through time in Doris Lake did not differ significantly from a slope of zero during the under-ice and open-water seasons ($p = 0.4394$ and $p = 0.3743$, respectively). Total phosphorus concentrations have been variable within Doris Lake in a given year but show no clear directional trend through time (Figure 3.3-9).

Overall, total phosphorus concentrations were generally within the baseline range, and similar to the total phosphorus concentration range specific to each lakes trophic classification based on baseline observations (i.e., oligotrophic or meso-eutrophic). Therefore, there is no evidence of a Project-related change in total phosphorus in Windy, Patch, or Doris lakes, and no action level response was triggered.



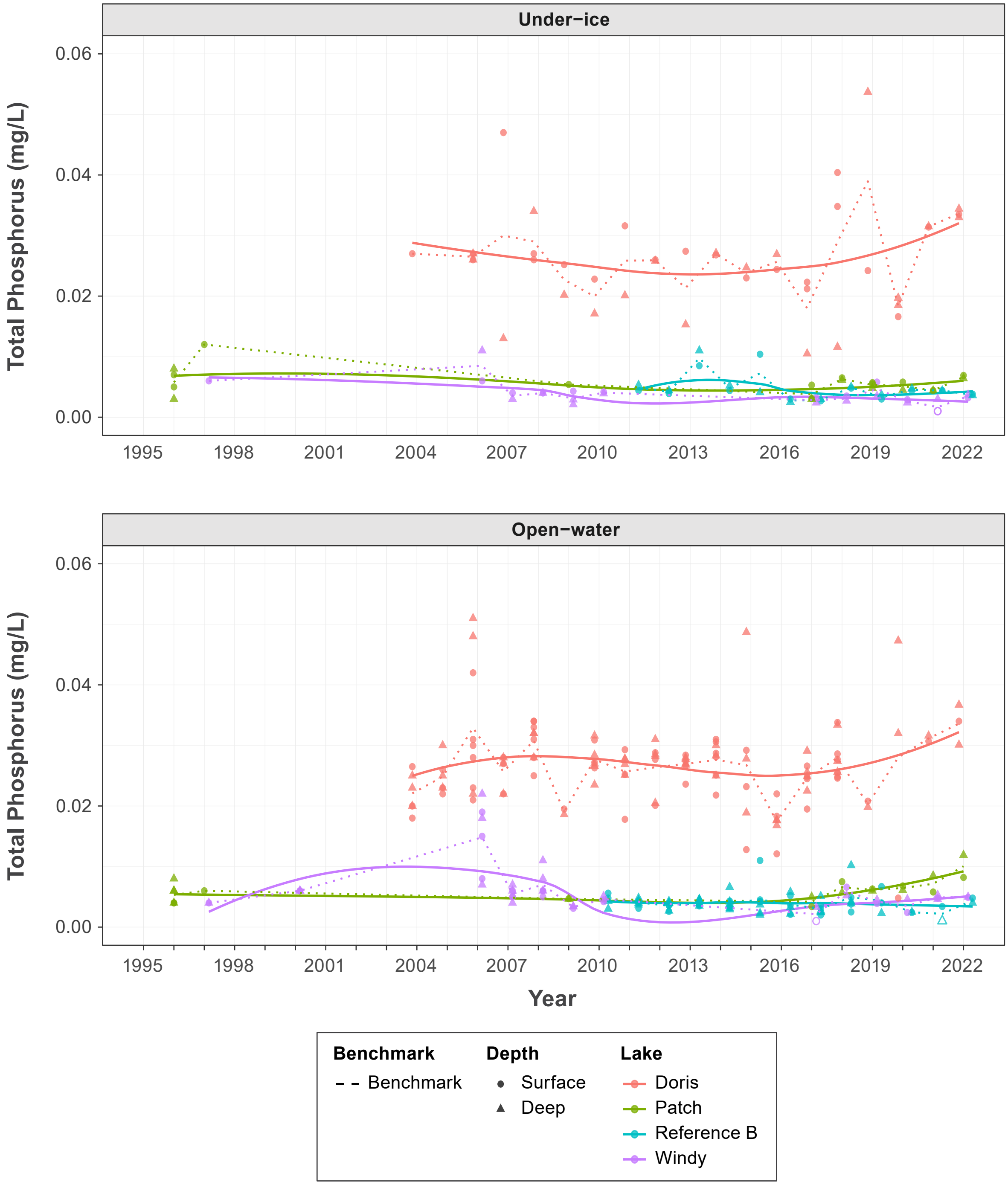

*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines drawn through the scatter plots represent the annual means.*
*Solid lines drawn through the scatter plots represent LOESS smoothing curve.*
*Black dashed lines represent the benchmark (3 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-7: Nitrate in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.06 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-8: Nitrite in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Benchmark is lake specific.*

## Figure 3.3-9: Total Phosphorus in Lakes, Hope Bay AEMP, 1995 to 2022

### 3.3.10 Total Aluminum

Under-ice total aluminum concentrations have been generally stable throughout the monitoring period, and slightly more variable during the open-water season in the three exposure lakes (Figure 3.3-10). For Windy and Patch lakes, the *before* period mean total aluminum concentrations were not significantly different from the *after* period mean for both the under-ice ($p = 0.0889$ for Windy Lake; $p = 0.9231$ for Patch Lake) and open-water seasons ($p = 0.9535$ for Windy Lake; $p = 0.2248$ for Patch Lake). Total aluminum concentrations in 2022 were within the baseline range, less than the benchmark, and less than the low action level condition (i.e., 75% of the benchmark) for both seasons in Windy Lake and during the under-ice season in Patch Lake. Open-water total aluminum concentration in Patch Lake in 2022 was slightly greater than the *before* period range and greater than the benchmark. There is no apparent Project-related mechanism that would result in increased total aluminum concentrations during the open-water season in 2022 and no change was observed during the under-ice season. The increased total aluminum may be associated with the slightly greater total suspended solids and turbidity that were attributed to natural phenomenon in Patch Lake (Section 3.3.3) and additional years of monitoring will indicate if the increase persists.

For Doris Lake, the statistical analysis showed that the total aluminium trend was not significantly different from a slope of zero during both the under-ice ($p = 0.3187$) and open-water seasons ($p = 0.9636$). Total aluminum concentrations in 2022 were within the baseline range and less than the benchmark in Doris Lake, but greater than the low action level condition (i.e., 75% of the benchmark) during the open-water season. However, similar concentrations have historically been observed in Doris Lake and thus concentrations in Doris Lake are naturally greater than the low action level condition.

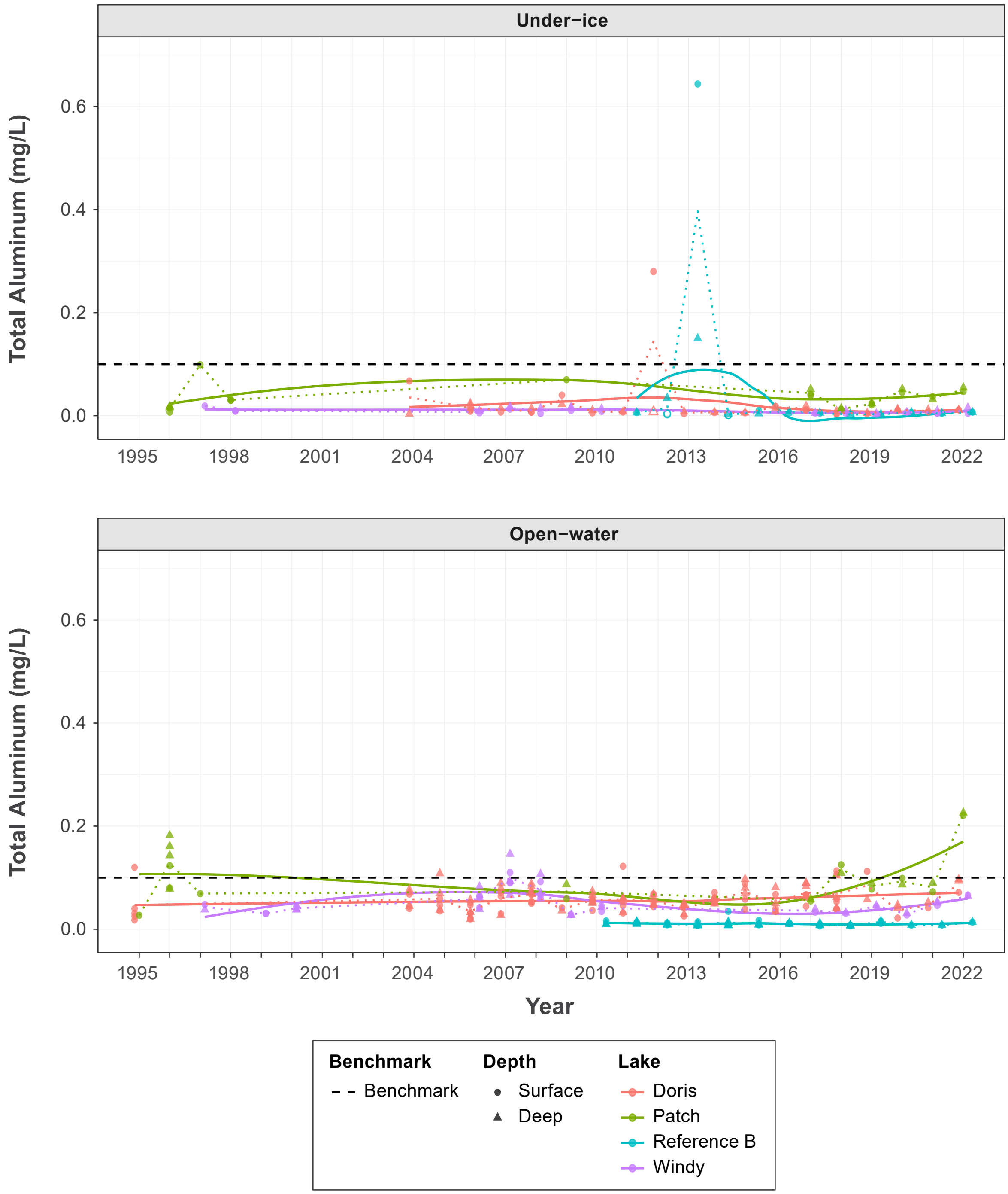
Overall, there is no evidence of a Project-related change in total aluminum in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.11 Total Arsenic

Total arsenic concentrations in all three exposure lakes were variable and/or slightly elevated in the early monitoring years but have been low and stable in recent years (Figure 3.3-11). For Windy and Patch lakes, the *before* period mean total arsenic concentrations were not significantly different from the *after* period mean for both the under-ice ($p = 0.0993$ for Windy Lake; $p = 0.1886$ for Patch Lake) and open-water seasons ($p = 0.2643$ for Windy Lake; $p = 0.6644$ for Patch Lake).

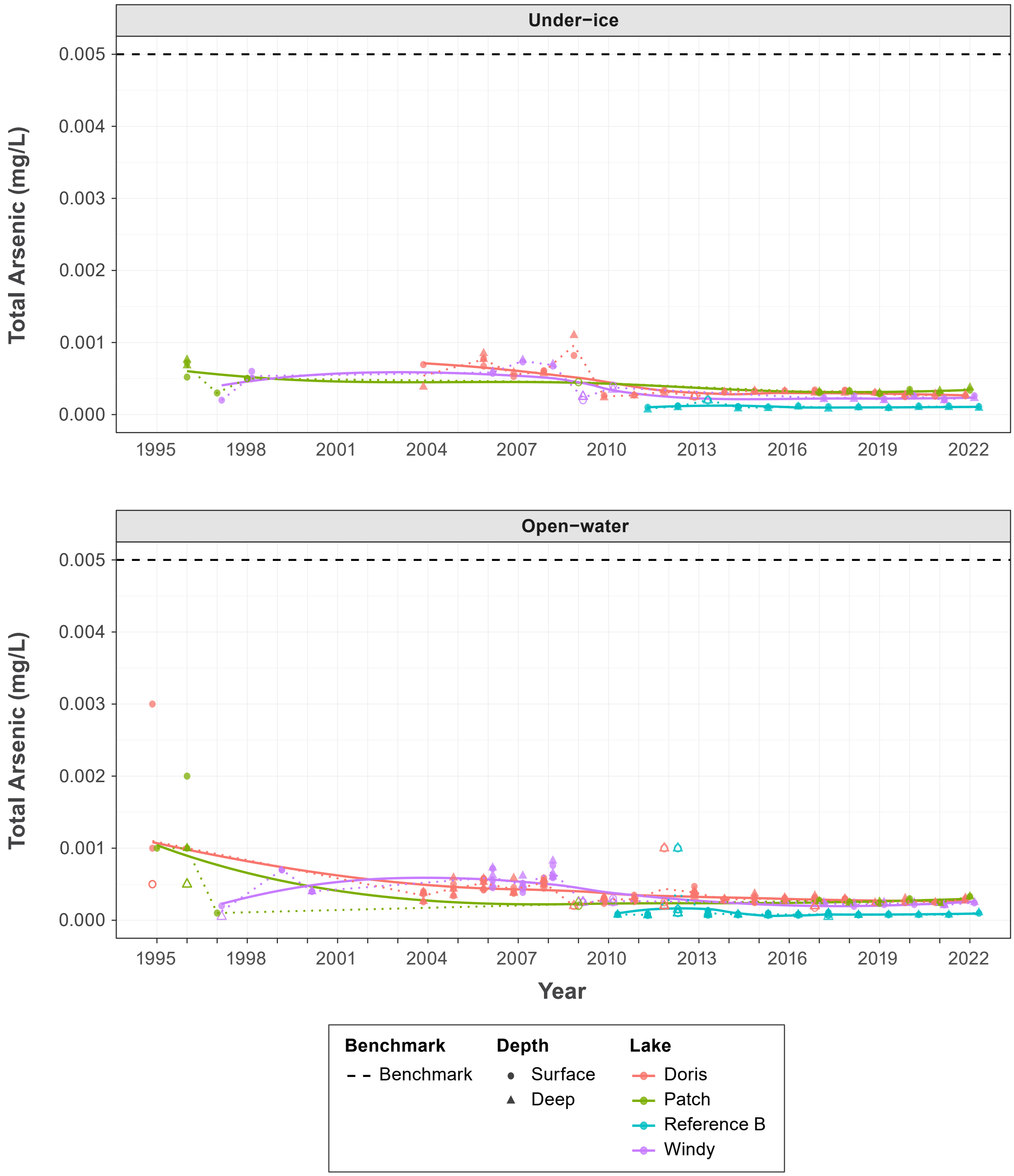
For Doris Lake, statistical analysis showed that the total arsenic trend was significantly different from a slope of zero during both the under-ice and open-water seasons ($p < 0.05$) and differed from the trend observed in Reference Lake B during both the under-ice and open water seasons ($p < 0.05$). Doris Lake concentrations have decreased slightly from earlier monitoring period observations (1995 to 2008) but have been relatively stable since 2010 (Figure 3.3-11). Monitoring at Reference Lake B was initiated in 2010 and total arsenic concentrations have been stable through time. The statistical difference in Doris Lake and Reference Lake B is likely influenced by the small variations in Doris Lake between 2010 and 2013 compared to the very low and stable concentrations observed in Reference Lake B. Overall, Doris Lake total arsenic concentrations have decreased from early monitoring observations and remained stable throughout the construction and operations of the Doris Development, therefore no adverse change was concluded for Doris Lake.

Total arsenic concentrations in 2022 were within, or less than, the baseline range and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total arsenic in Windy, Patch, or Doris lakes, and no action level response was triggered.




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.1 mg/L).*

**Figure 3.3-10: Total Aluminum in Lakes, Hope Bay AEMP, 1995 to 2022**




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.005 mg/L).*

## Figure 3.3-11: Total Arsenic in Lakes, Hope Bay AEMP, 1995 to 2022

### *3.3.12 Total Boron*

Total boron concentrations in all three exposure lakes have been slightly greater than concentrations observed in the Reference Lake B through time, including in baseline years (Figure 3.3-12). Total boron concentrations in Patch and Windy lakes have been low and stable throughout the monitoring period. Statistical analyses indicate, the *before* period mean total boron concentrations in Windy and Patch lakes were not significantly different from the *after* period mean for both the under-ice ($p = 0.3548$ for Windy Lake; $p = 0.4319$ for Patch Lake) and open-water seasons ($p = 0.2839$ for Windy Lake; $p = 0.4262$ for Patch Lake).

For Doris Lake, the statistical analysis showed that the total boron trend was significantly different from a slope of zero during both the under-ice and open-water seasons ($p < 0.05$). Graphical analysis indicates that both under-ice and open-water season total boron concentrations increased slightly from the earliest baseline years between 2010 to 2015, and then decreased back to baseline levels (Figure 3.312). Statistical comparison to trends in Reference Lake B were not completed due to the high proportion of concentrations below the detection limit through time (see Appendix C.3.1.12). However, graphical analyses indicated concentrations were marginally greater than the detection limit from 2010 to 2015 and have been low and stable since. Therefore, total boron concentrations in Doris Lake have followed a similar trend as observed in Reference Lake B and no adverse Project-related change was concluded.

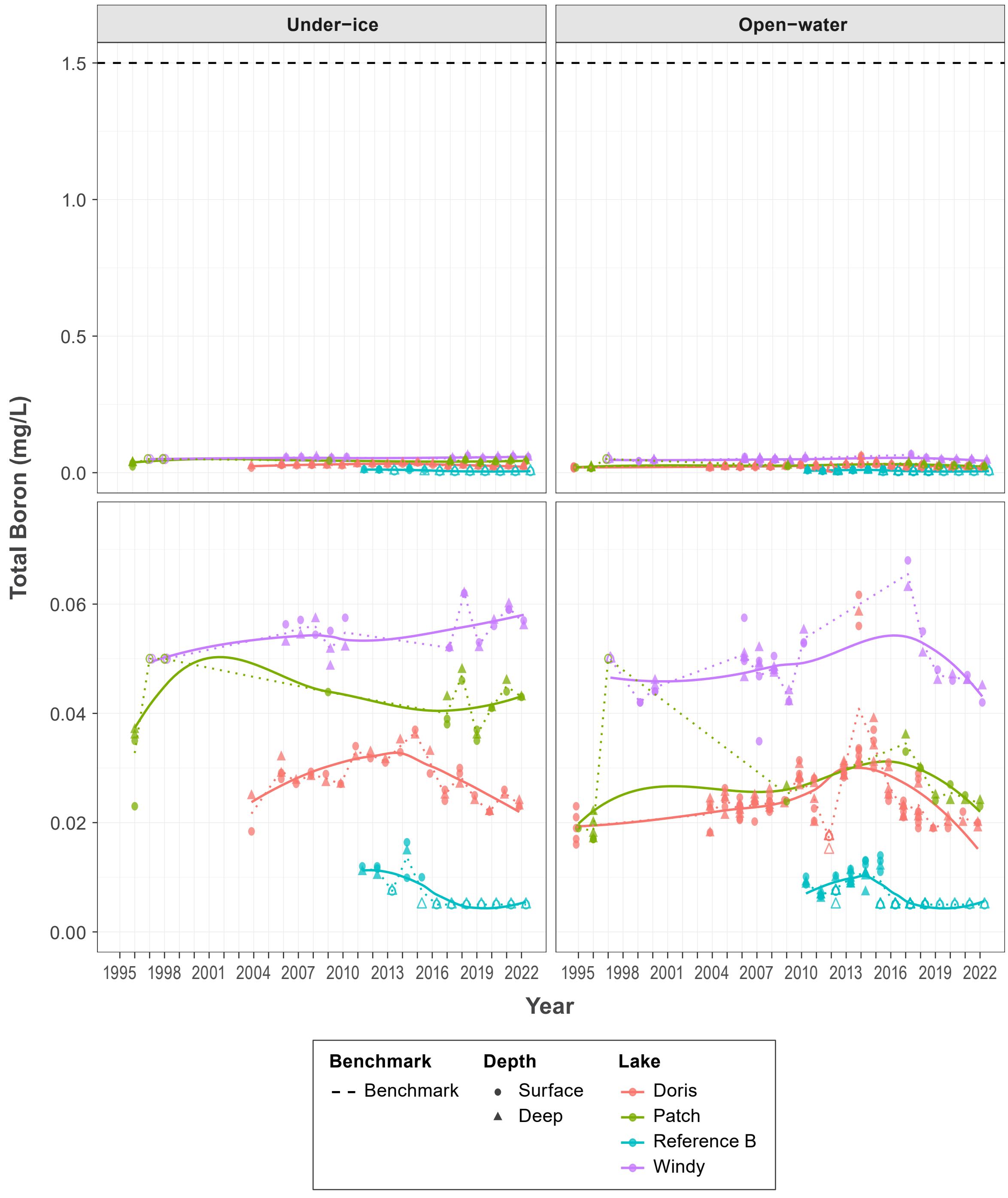
Total boron concentrations in 2022 were within the baseline range and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total boron in Windy, Patch, or Doris lakes, and no action level response was triggered

### *3.3.13 Total Cadmium*

A high proportion of total cadmium concentrations were less than the detection limit throughout the monitoring period, including all 2022 observations (Figure 3.3-13), and thus statistical analyses were not conducted (see Appendix C.3.1.13). Total cadmium concentrations were highly variable and elevated during the early monitoring period for all three exposure lakes, however concentrations have been low and stable in recent years. Total cadmium concentrations were less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes in 2022. There is no evidence of a Project-related change in total cadmium in Windy, Patch, or Doris lakes, and no action level response was triggered.

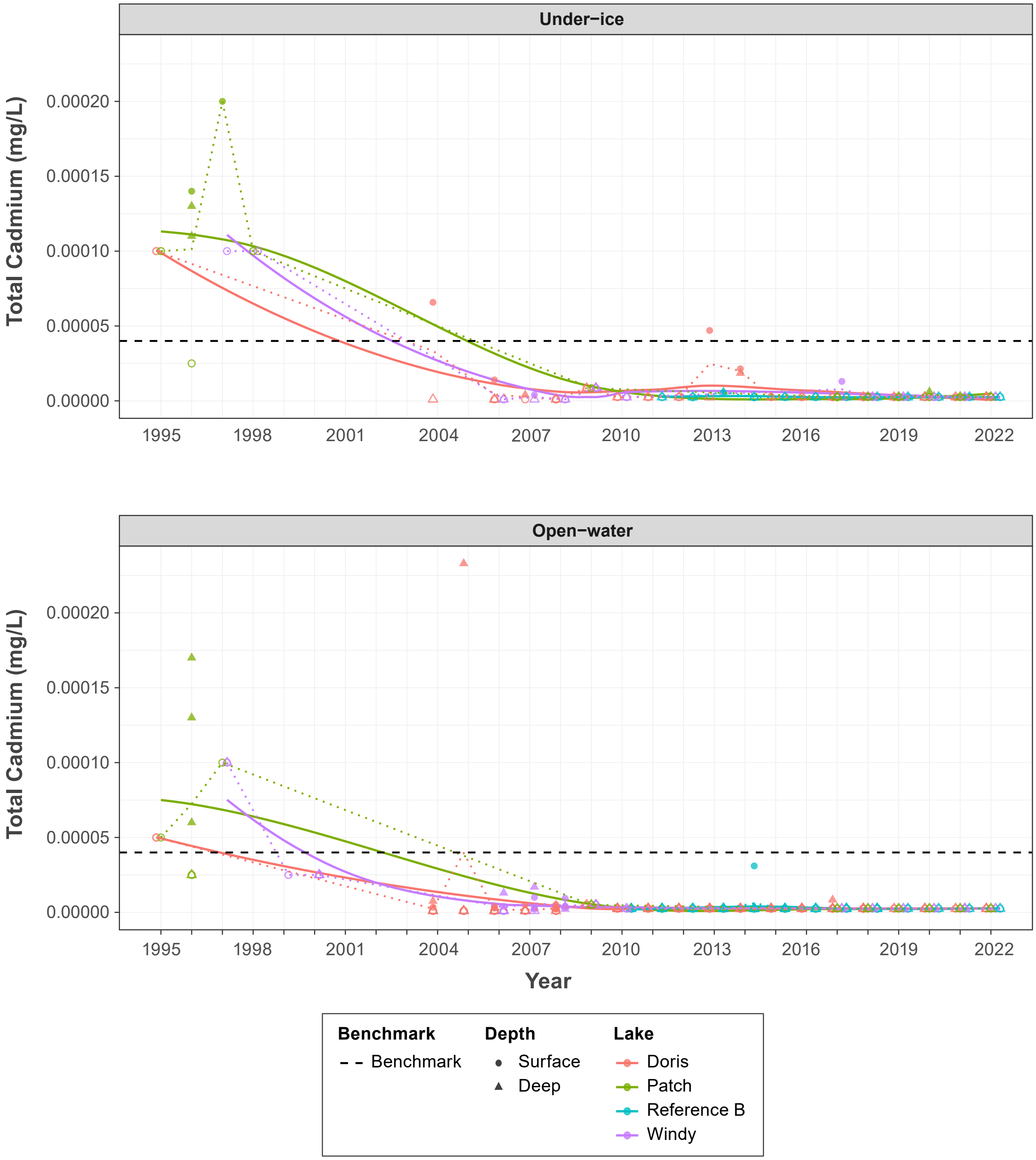
### *3.3.14 Total Chromium*

A high proportion of total chromium concentrations were less than the detection limit throughout the monitoring period, including all 2022 observations (Figure 3.3-14), and thus statistical analyses were not conducted (see Appendix C.3.1.14). Total chromium concentrations have occasionally been elevated relative to the long-term trend in all three exposure lakes and Reference Lake B throughout the monitoring period, however concentrations have been low and stable in recent years. Total chromium concentrations were less than the benchmark and the low action level condition (i.e., 75% of the benchmark) for both trivalent and hexavalent chromium in all exposure lakes in 2022. There is no evidence of a Project-related change in total chromium in Windy, Patch, or Doris lakes, and no action level response was triggered.



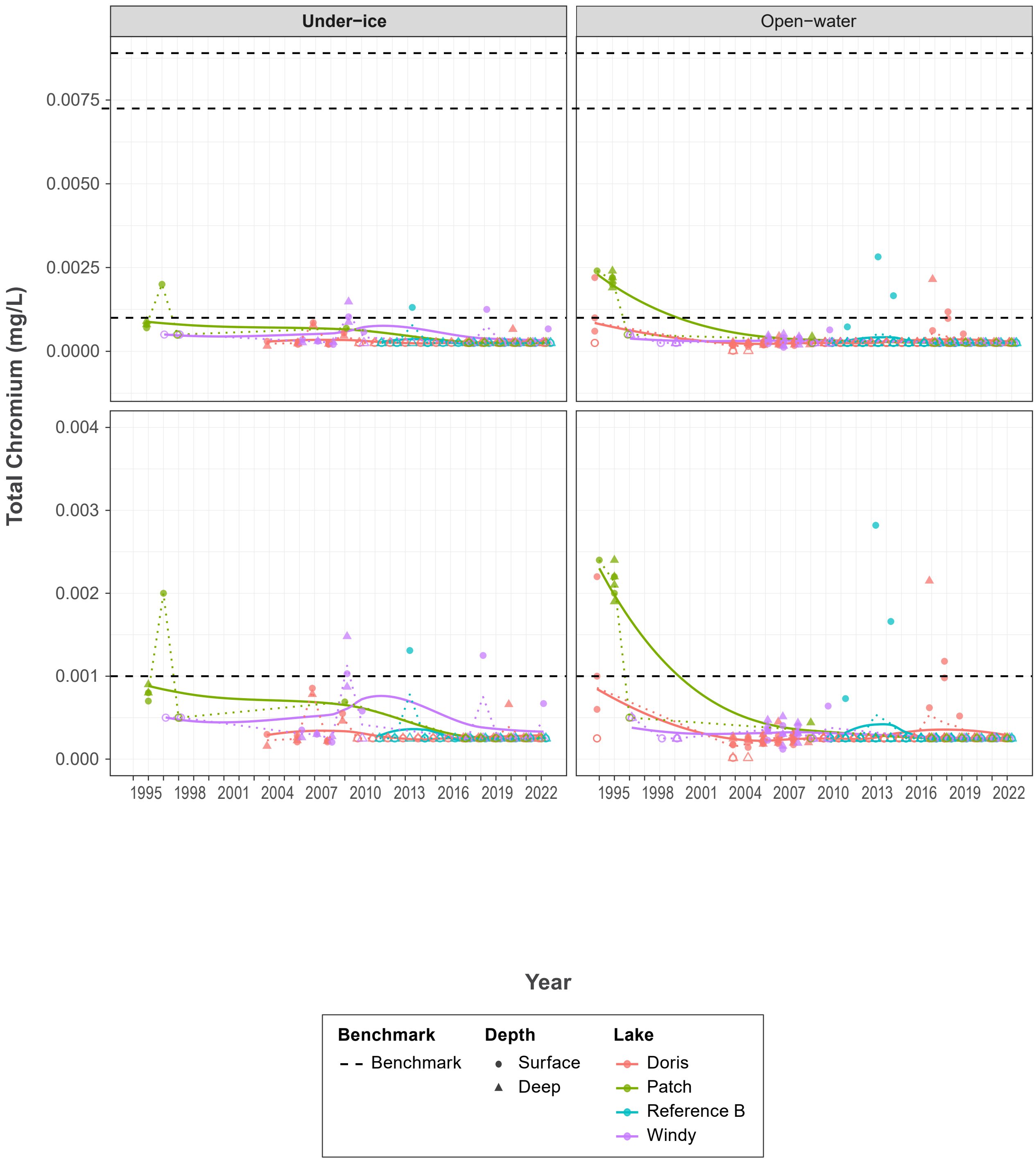

*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines drawn through the scatter plots represent the annual means.*
*Solid lines drawn through the scatter plots represent LOESS smoothing curve.*
*Black dashed lines represent the benchmark (1.5 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-12: Total Boron in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*The benchmark is hardness dependent, the black dashed lines represent the minimum benchmark for reference (0.00004 mg/L).*

**Figure 3.3-13: Total Cadmium in Lakes, Hope Bay AEMP, 1995 to 2022**




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.001 mg/L for hexavalent; 0.0089 mg/L for trivalent).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

**Figure 3.3-14: Total Chromium in Lakes, Hope Bay AEMP, 1995 to 2022**

### 3.3.15 Total Copper

Under-ice and open-water total copper concentrations in the exposure lakes have been variable but shown no directional trend in recent years (Figure 3.3-15). Concentrations were relatively elevated in the early monitoring years (1995 to 1998) but have been generally stable since 2004 for the under-ice season. Statistical analyses also indicate the *before* period mean total copper concentrations in Windy and Patch lakes were not significantly different from the *after* period mean for both the under-ice (p = 0. 9471 for Windy Lake; p = 0. 2875 for Patch Lake) and open-water seasons (p = 0.133 for Windy Lake; p = 0.4066 for Patch Lake). For Doris Lake, the statistical analysis showed that the total copper trend was not significantly different from a slope of zero during both the under-ice (p = 0.0573) and open-water seasons (p = 0.9707).

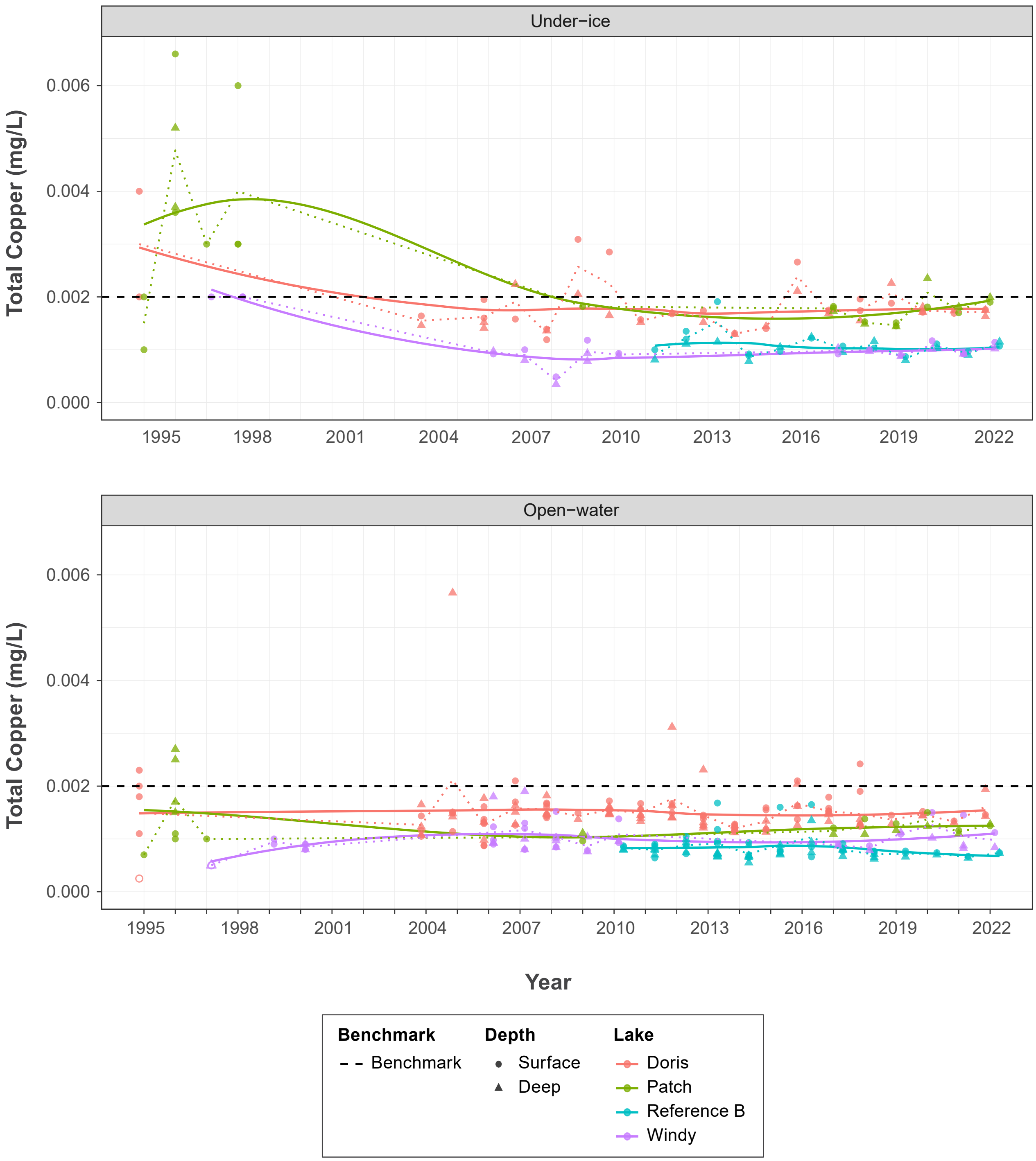
Total copper concentrations in 2022 were within the baseline range and less than the benchmark in all three exposure lakes. Patch Lake during the under-ice season and Doris Lake during both seasons exceeded the low action level condition (i.e., 75% of the benchmark) however, concentrations have not changed since baseline and naturally exceeded this concentration historically. Therefore, there is no evidence of a Project-related change in total copper in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.16 Total Iron

Total iron concentrations have generally been variable both through time and within each lake within a given year (Figure 3.3-16). However, under-ice total iron concentrations in Windy Lake have been low and stable throughout the monitoring period (Figure 3.3-16) and statistical analysis were not completed for the under-ice season due the high proportion of concentrations less than the detection limit (see Appendix C.3.1.16). During the open-water season in Windy Lake, concentration have been more variable with no clear directional trend through time, statistical analysis indicates the *before* period mean total iron concentration in Windy Lake was not significantly different from the *after* period mean (p = 0.5575). Statistical analyses for Patch Lake indicate the *before* period mean total iron concentrations were not significantly different from the *after* period mean during the under-ice (p= 0. 3575) or open-water season (p = 0.2096). Total iron concentrations in 2022 were within the baseline range, less than the benchmark, and less than the low action level condition (i.e., 75% of the benchmark) for both seasons in Windy Lake and during the under-ice season in Patch Lake. Open-water total iron concentration in Patch Lake in 2022 was slightly greater than the *before* period range. There is no apparent Project-related mechanism that would result in increased total iron concentrations during the open-water season in 2022 and no change was observed during the under-ice season. The increased total iron may be associated with the slightly greater total suspended solids and turbidity that were attributed to natural phenomenon in Patch Lake (Section 3.3.3) and additional years of monitoring will indicate if the increase persists.

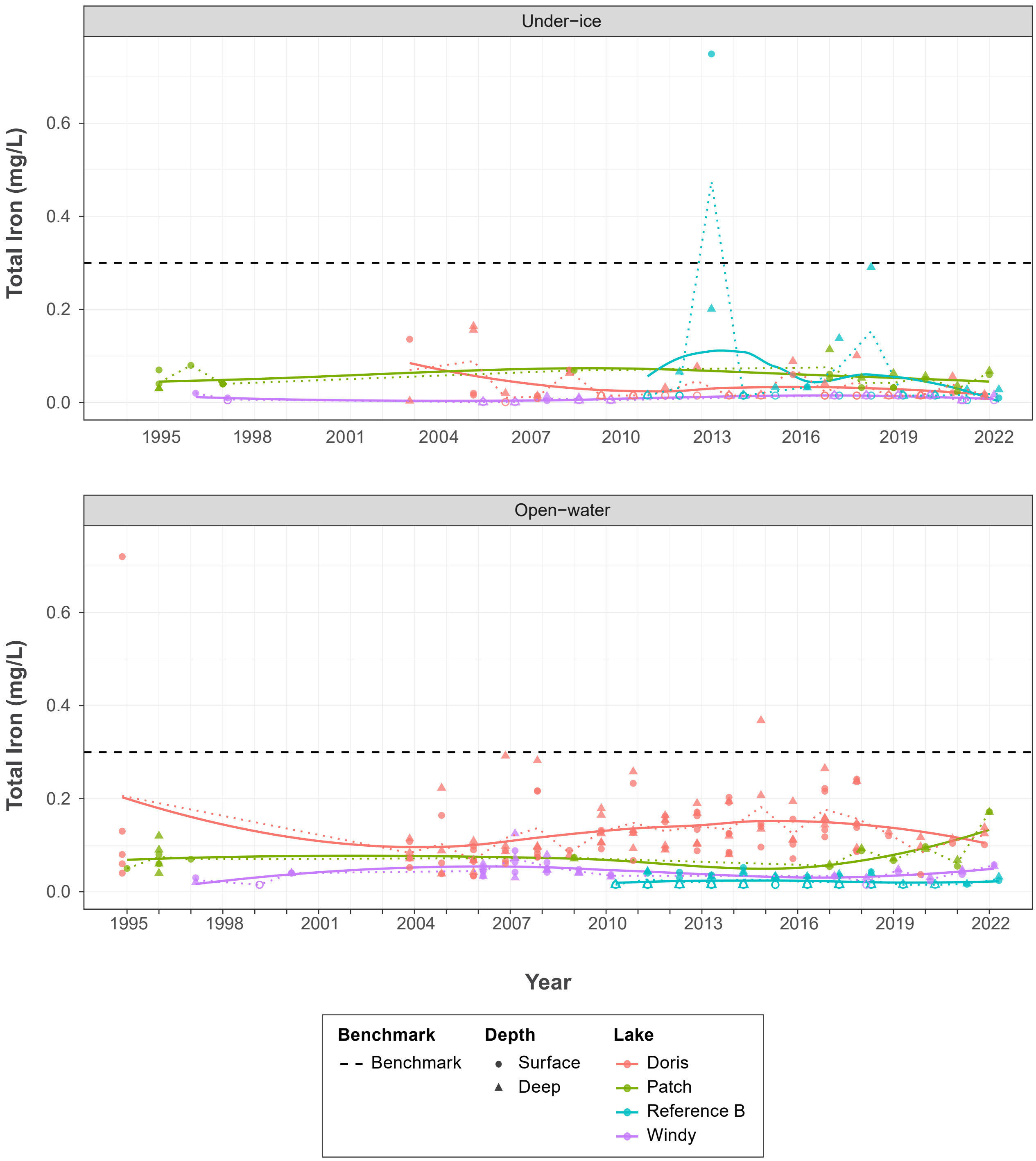
For Doris Lake, the statistical analysis showed that the total iron trend was significantly different from a slope of zero during the under-ice ($p < 0.05$) seasons but not during the open-water season (p = 0.3424). Statistical comparison to trends in Reference Lake B were not completed due to the high proportion of concentrations below the detection limit through time (see Appendix C.3.1.16). However, graphical analyses suggest that total iron concentrations in Doris Lake have been variable through time and were relatively low during the 2022 under-ice season (Figure 3.3-16). Total iron concentrations in Doris Lake in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark).

Therefore, there is no evidence of a Project-related change in total iron in Windy, Patch, or Doris lakes, and no action level response was triggered.




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*The benchmark is hardness dependent, the black dashed lines represent the minimum benchmark for reference (0.002 mg/L).*

## Figure 3.3-15: Total Copper in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.3 mg/L).*

**Figure 3.3-16: Total Iron in Lakes, Hope Bay AEMP, 1995 to 2022**

### 3.3.17 Total Lead

Total lead concentrations were highly variable and frequently elevated throughout much of the monitoring period in the exposure lakes and Reference Lake B but have been relatively low and stable in recent years for all lakes (Figure 3.3-17). A high proportion of total lead concentrations were less than the detection limit throughout the monitoring period and statistical analyses were only conducted for Windy and Patch lakes during the open-water season (see Appendix C.3.1.17). Statistical analyses indicate the *before* period mean was significantly different from the *after* period mean during the open-water season for Windy Lake ($p < 0.05$) but not for Patch ($p = 0.2185$). Total lead concentrations in recent years have been low and stable in Windy Lake, similar to observations in Reference Lake B. Total lead concentrations were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) for all exposure lakes in 2022. There is no evidence of a Project-related change in total lead in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.18 Total Mercury

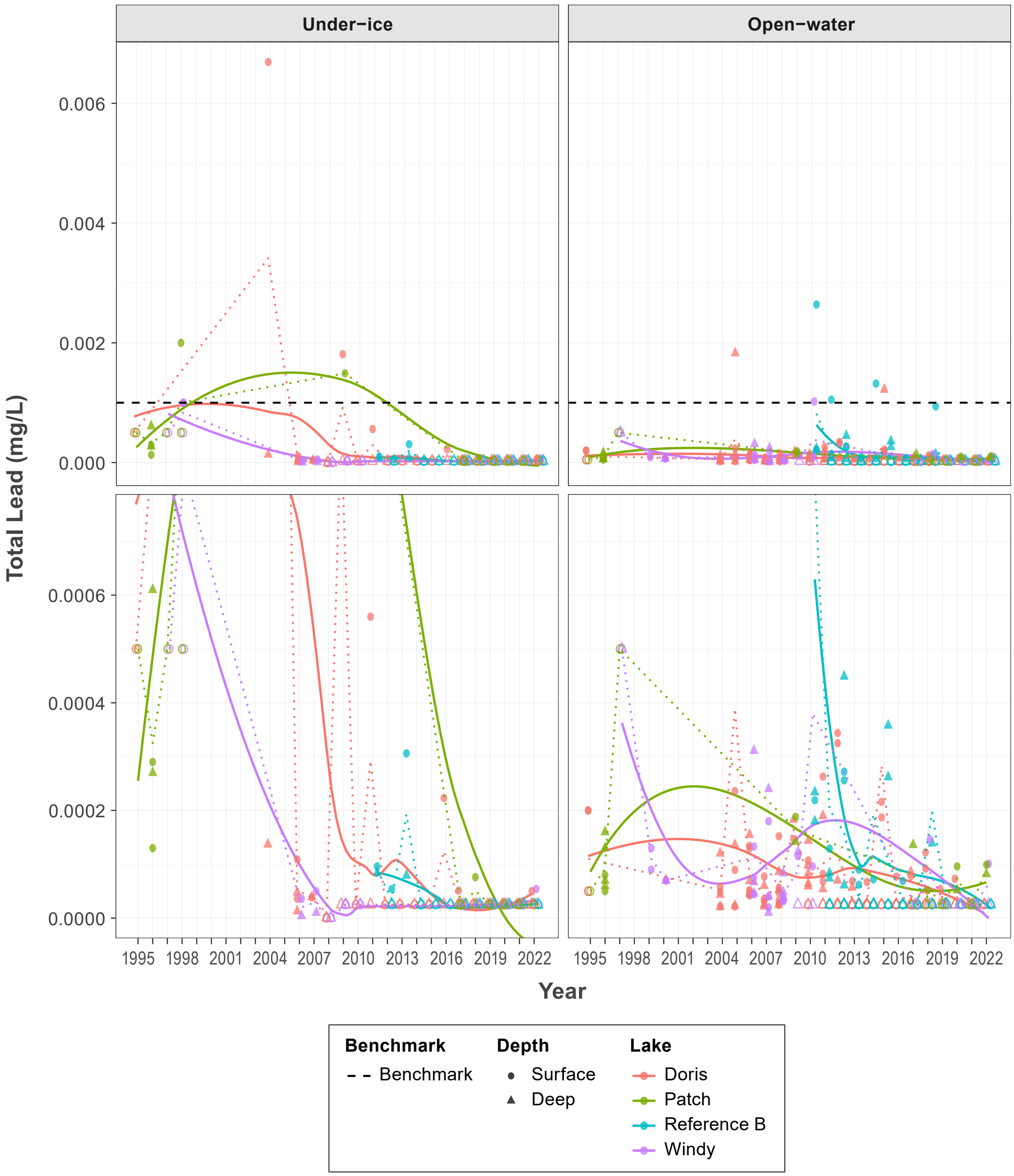
Total mercury detection limits have been variable through time however, total mercury concentrations in recent years have generally been stable and have been less, or marginally greater, than lowered detection limits achieved in recent years (Figure 3.3-18). Statistical analyses were only completed for Doris Lake during the under-ice season due the high proportion of concentrations less than the detection limit for Windy Lake, Patch Lake, Doris Lake during the open-water season, as well as Reference Lake B (Appendix C.3.1.18). During the under-ice season in Doris Lake, statistical analysis suggest that the total mercury trend was significantly different from a slope of zero ($p < 0.05$) but not statistically different from the trend in Reference Lake B ($p = 0.9905$).

Baseline total mercury concentrations are partially obscured by variable detection limits but the concentrations in 2022 were similar to the long-term trends observed (i.e., since 2011) in total mercury for each exposure lake and within the range observed in the reference lake. All total mercury concentrations in 2022 were less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total mercury in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.19 Total Molybdenum

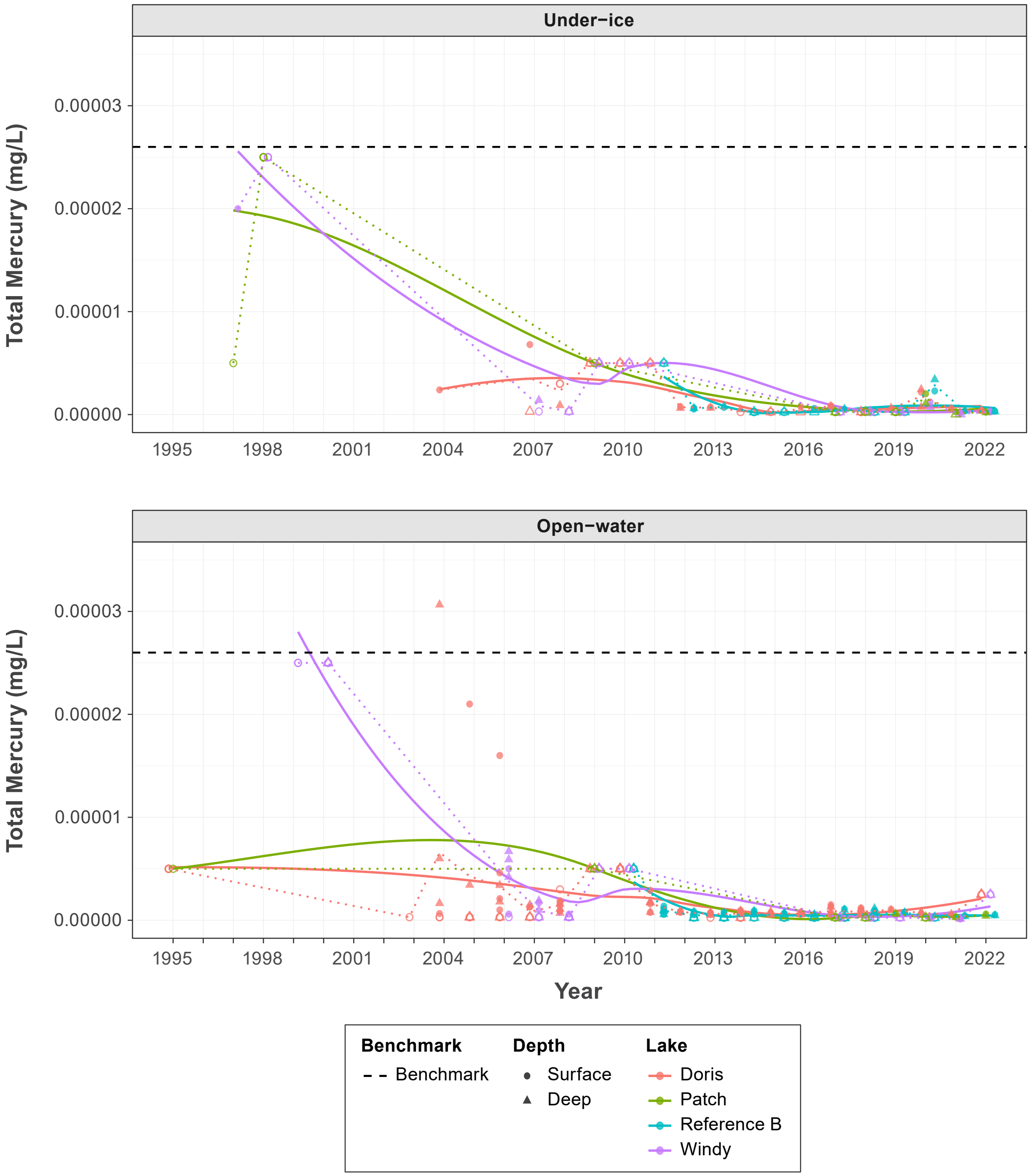
Total molybdenum concentrations in all three exposure lakes have generally been stable through time but have been greater than concentrations observed in the Reference Lake B, including in baseline years (Figure 3.3-19). Concentrations in Windy Lake have been the greatest through time and similar concentrations have been observed in Patch and Doris lakes. In Windy and Patch lakes, both under-ice and open-water total molybdenum concentrations were generally consistent through time (Figure 3.3-19) and there were no significant differences for the *after* period mean relative to the *before* period for both seasons (Windy Lake: $p = 0.4783$ for under-ice, $p = 0.9052$ for open-water; Patch Lake: $p = 0.2411$ for under-ice, $p = 0.6265$ for open-water). Trends in Windy and Patch lakes could not be compared to Reference Lake B due to the high proportion of concentrations that were below the detection limit through time (see Appendix C.3.1.19). Concentrations in the early monitoring period for Windy and Patch lakes were influenced by elevated detection limits but concentrations have been consistent since.

In Doris Lake, under-ice and open-water total molybdenum concentrations were statistically different from a slope of zero ($p < 0.05$ for both seasons) but have shown no clear directional trend through time and were within the range of baseline concentrations in 2022 (Figure 3.3-19). Total molybdenum concentrations in Reference Lake B have also been relatively low, and stable, however trends in Doris Lake could not be statistically compared to the Reference Lake B trends due to the high proportion of concentrations that were below the detection limit through time (see Appendix C.3.1.19).



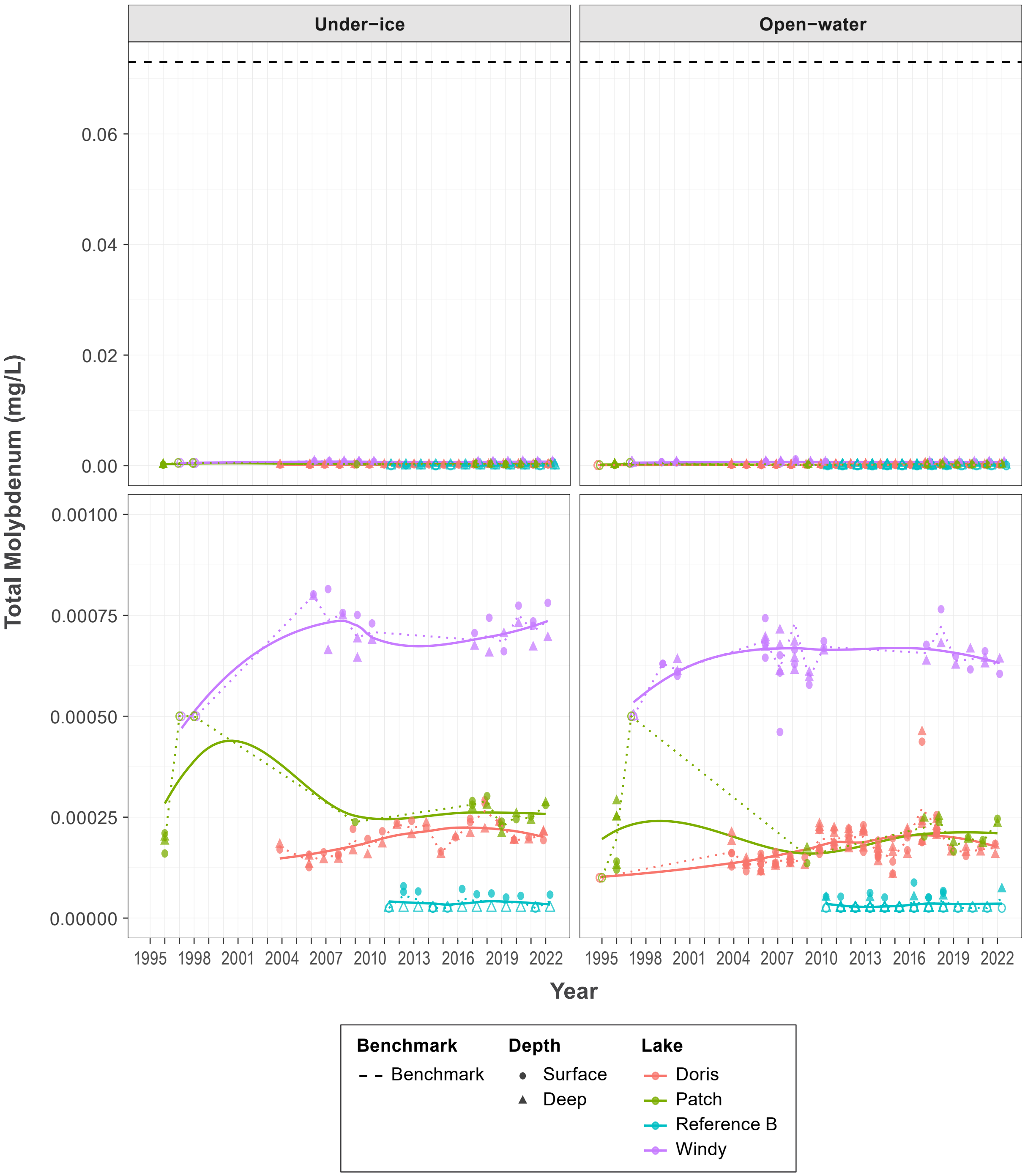

*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines drawn through the scatter plots represent the annual means.*
*Solid lines drawn through the scatter plots represent LOESS smoothing curve.*
*The benchmark is hardness dependent, the black dashed lines represent the minimum benchmark for reference (0.001 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-17: Total Lead in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.000026 mg/L).*

## Figure 3.3-18: Total Mercury in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.073 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

**Figure 3.3-19: Total Molybdenum in Lakes, Hope Bay AEMP, 1995 to 2022**

Total molybdenum concentrations in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total molybdenum in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.20 Total Nickel

Under-ice and open-water total nickel concentrations in Windy, Patch, and Doris lakes show no directional trend through time (Figure 3.3-20). Statistical analyses indicate no significant differences between *before* and *after* period means for total nickel concentrations in Windy Lake ($p = 0.4571$ for under-ice, $p = 0.2534$ for open-water) and Patch Lake ($p = 0.269$ for under-ice, $p = 0.351$ for open-water), and the temporal trends in total nickel concentrations in Doris Lake were not significantly different from a slope of zero ($p = 0.9803$ for under-ice, $p = 0.1634$ for open-water). Open-water concentrations have been variable within a lake in some years, particularly in Doris Lake, but there has been no consistent change observed for any lake or depth.

Total nickel concentrations in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total nickel in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.21 Total Selenium

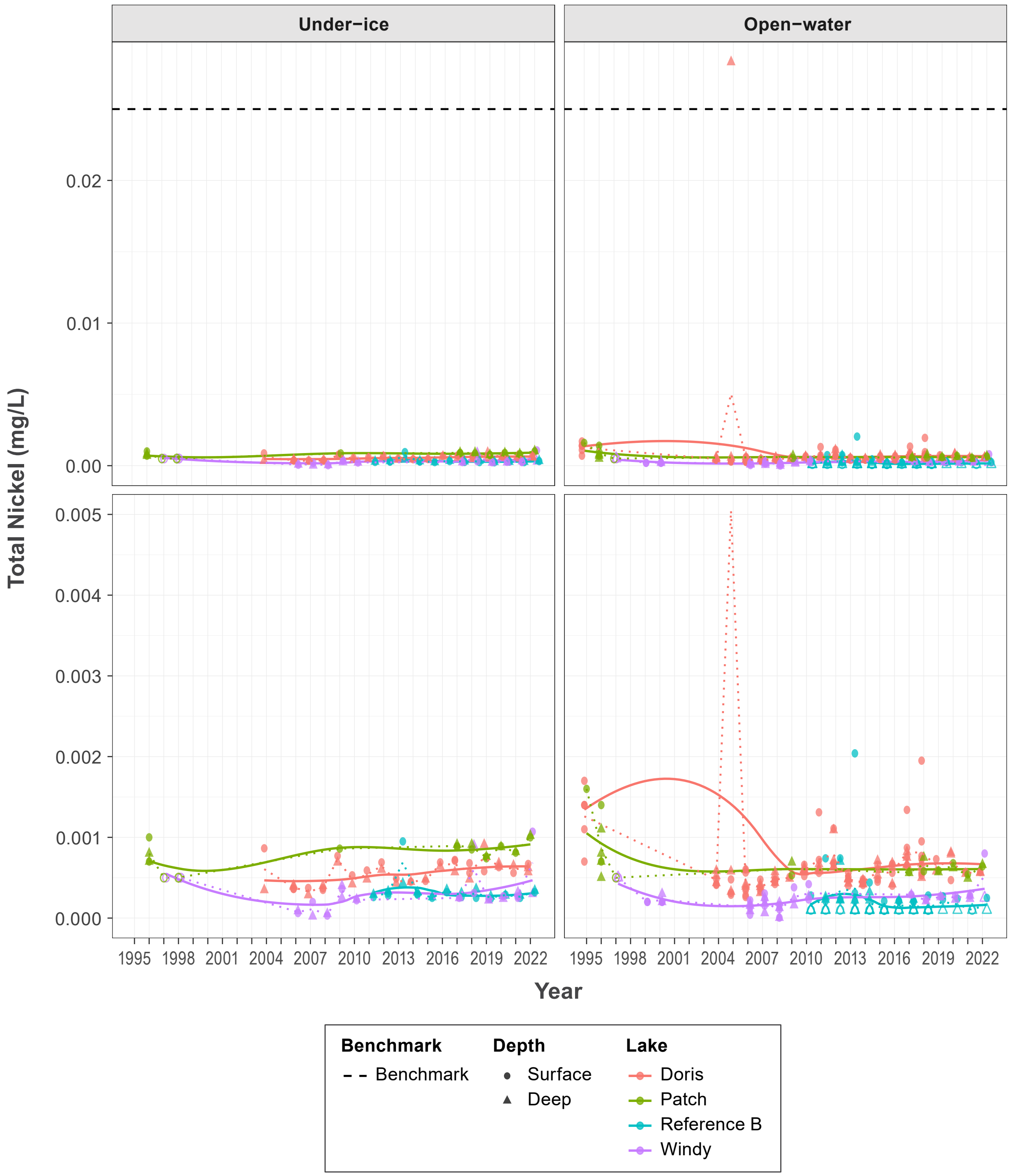
Total selenium concentrations and detection limits were variable in the early monitoring period but have been low and stable in recent years in the exposure and reference lakes and were below the analytical detection limit (< 0.00020 mg/L) in 2022 (Figure 3.3-21). Thus, statistical analyses were not completed (see Appendix C.3.1.21). Total selenium concentrations in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total selenium in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.22 Total Silver

Total silver concentrations and detection limits were variable in the early monitoring period but have generally been low and stable in recent years in the exposure and reference lakes and were below the analytical detection limit (< 0.000005 mg/L) in 2022 (Figure 3.3-22). Thus, statistical analyses were not completed (see Appendix C.3.1.22). Total silver concentrations in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total silver in Windy, Patch, or Doris lakes, and no action level response was triggered.

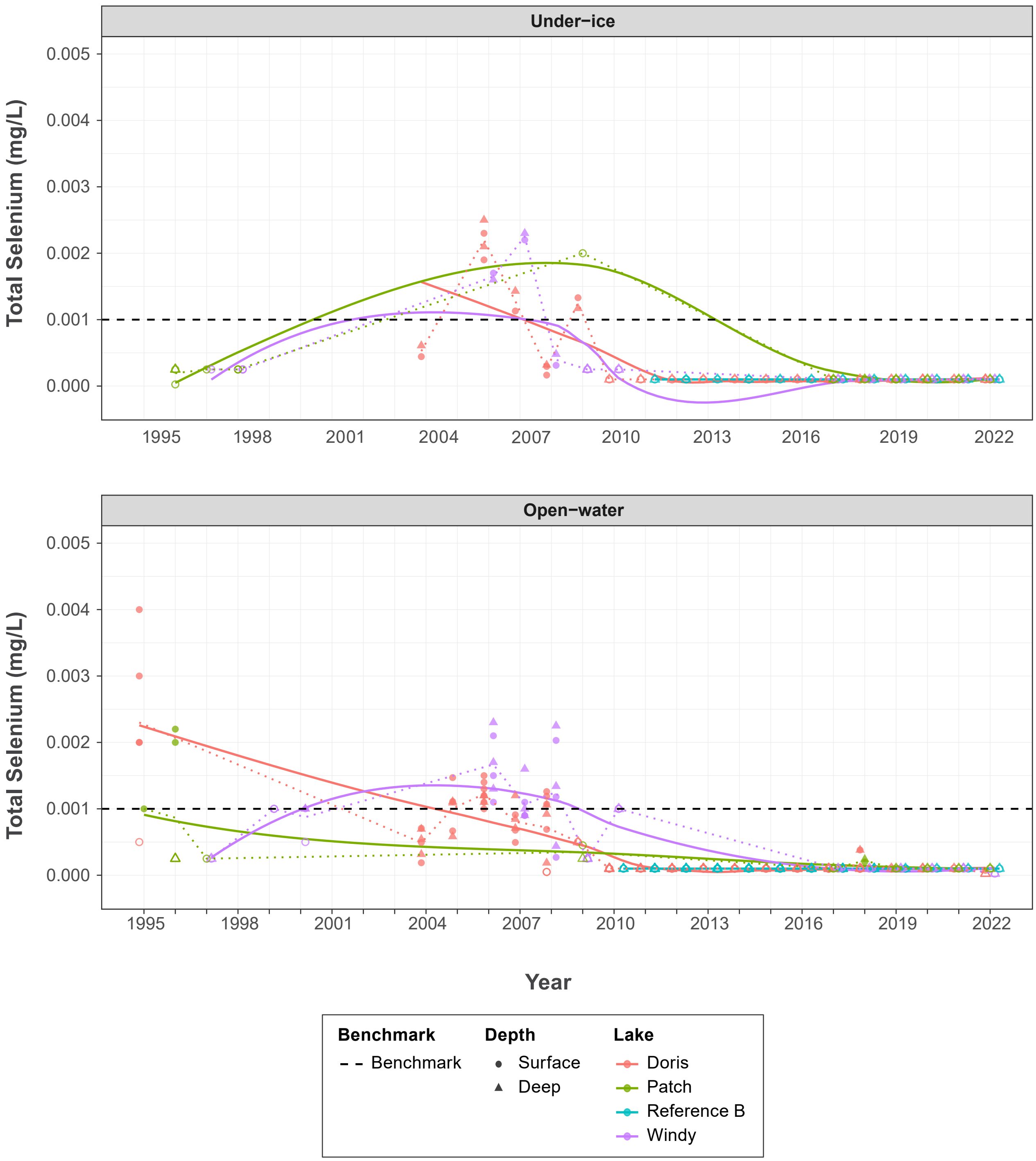
### 3.3.23 Total Thallium

Total thallium detection limits have been variable, but concentrations have been less than or marginally greater than detection limits in the exposure and reference lakes through time (Figure 3.3-23). Thus, statistical analyses were not completed (see Appendix C.3.1.23). Total thallium concentrations in 2022 were less than detection limit, benchmark, and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total thallium in Windy, Patch, or Doris lakes, and no action level response was triggered.



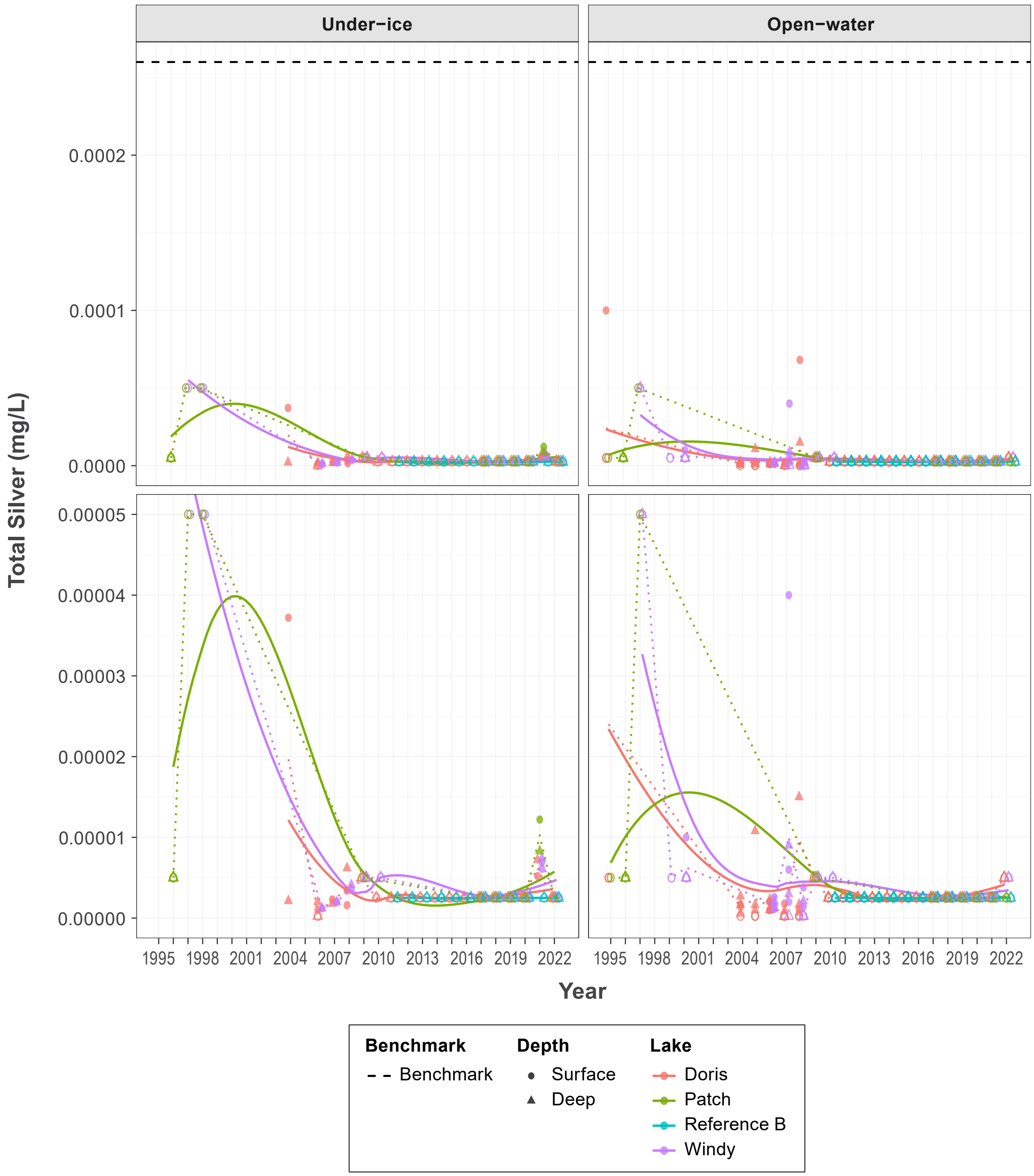

*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines drawn through the scatter plots represent the annual means.*
*Solid lines drawn through the scatter plots represent LOESS smoothing curve.*
*The benchmark is hardness dependent, the black dashed lines represent the minimum benchmark for reference (0.025 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-20: Total Nickel in Lakes, Hope Bay AEMP, 1995 to 2022



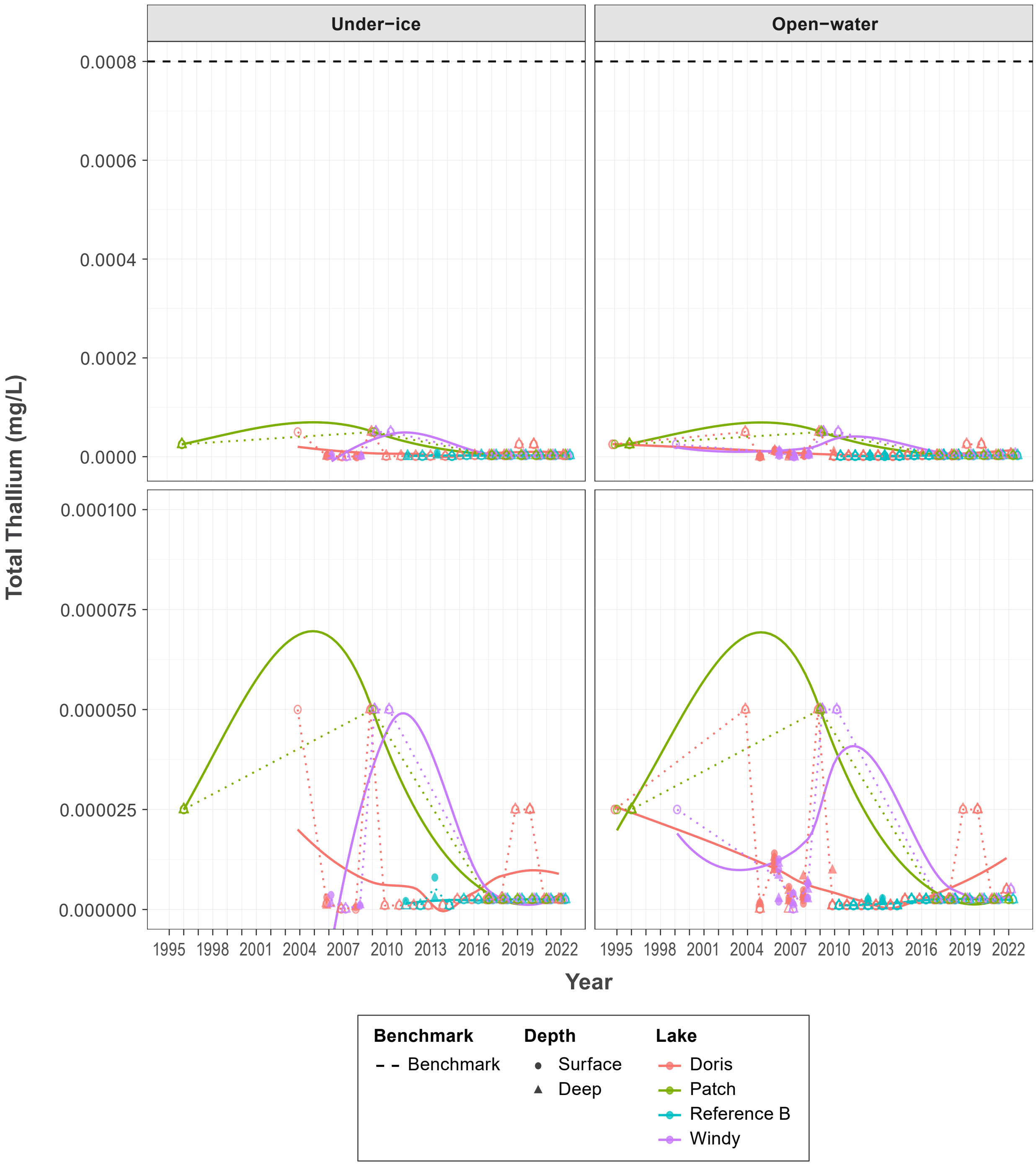

*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines drawn through the scatter plots represent the annual means.*
*Solid lines drawn through the scatter plots represent LOESS smoothing curve.*
*Black dashed lines represent the benchmark (0.001 mg/L).*

**Figure 3.3-21: Total Selenium in Lakes, Hope Bay AEMP, 1995 to 2022**




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.00026 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-22: Total Silver in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*Black dashed lines represent the benchmark (0.0008 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-23: Total Thallium in Lakes, Hope Bay AEMP, 1995 to 2022

### 3.3.24 Total Uranium

Overall, total uranium concentrations in exposure lakes and Reference Lake B have been low through time however, total uranium concentrations in Windy Lake have been slightly greater and more variable than concentrations observed in the Reference Lake B and in Patch and Doris lakes throughout the monitoring period, including in the baseline years (Figure 3.3-24). In Windy and Patch lakes, statistical results indicate no difference in the *before* and the *after period* mean (Windy Lake: $p = 0.2795$ for under-ice, $p = 0.0851$ for open-water; Patch Lake: $p = 0.6442$ for under-ice, $p = 0.496$ for open-water). In Doris Lake, under-ice total uranium concentrations were statistically different from a slope of zero ($p < 0.05$) but not different from the trend in Reference Lake B ($p = 0.5134$) and during the open-water season there was no difference from the slope of zero ($p = 0.0644$).

Total uranium concentrations in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in total uranium in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.25 Dissolved Manganese

Overall, dissolved manganese concentrations have been similar amongst the exposure lakes and Reference Lake B (Figure 3.3-25). In Windy and Patch lakes, statistical results indicate no difference in the *before* and the *after* period mean (Windy Lake: $p = 0.6173$ for under-ice, $p = 0.1799$ for open-water; Patch Lake: $p = 0.8631$ for under-ice, $p = 0.4266$ for open-water). In Doris Lake, under-ice dissolved manganese concentrations were not statistically different from a slope of zero ($p = 0.4399$), however the open-water trend was statistically different from a slope of zero ($p <0.05$). The statistically significant trend through time in Doris Lake is driven by occasionally, slightly elevated concentrations, though there is no clear directional change (Figure 3.3-25). Statistical comparison between Doris Lake and Reference Lake B was not completed due to only three years of continuous comparable sampling years between lakes (see Appendix C.3.1.25). Dissolved manganese concentrations in Doris Lake in 2022 were similar to Reference Lake B.

Dissolved manganese concentrations in 2022 were within the baseline range, and less than the benchmark and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in dissolved manganese in Windy, Patch, or Doris lakes, and no action level response was triggered.

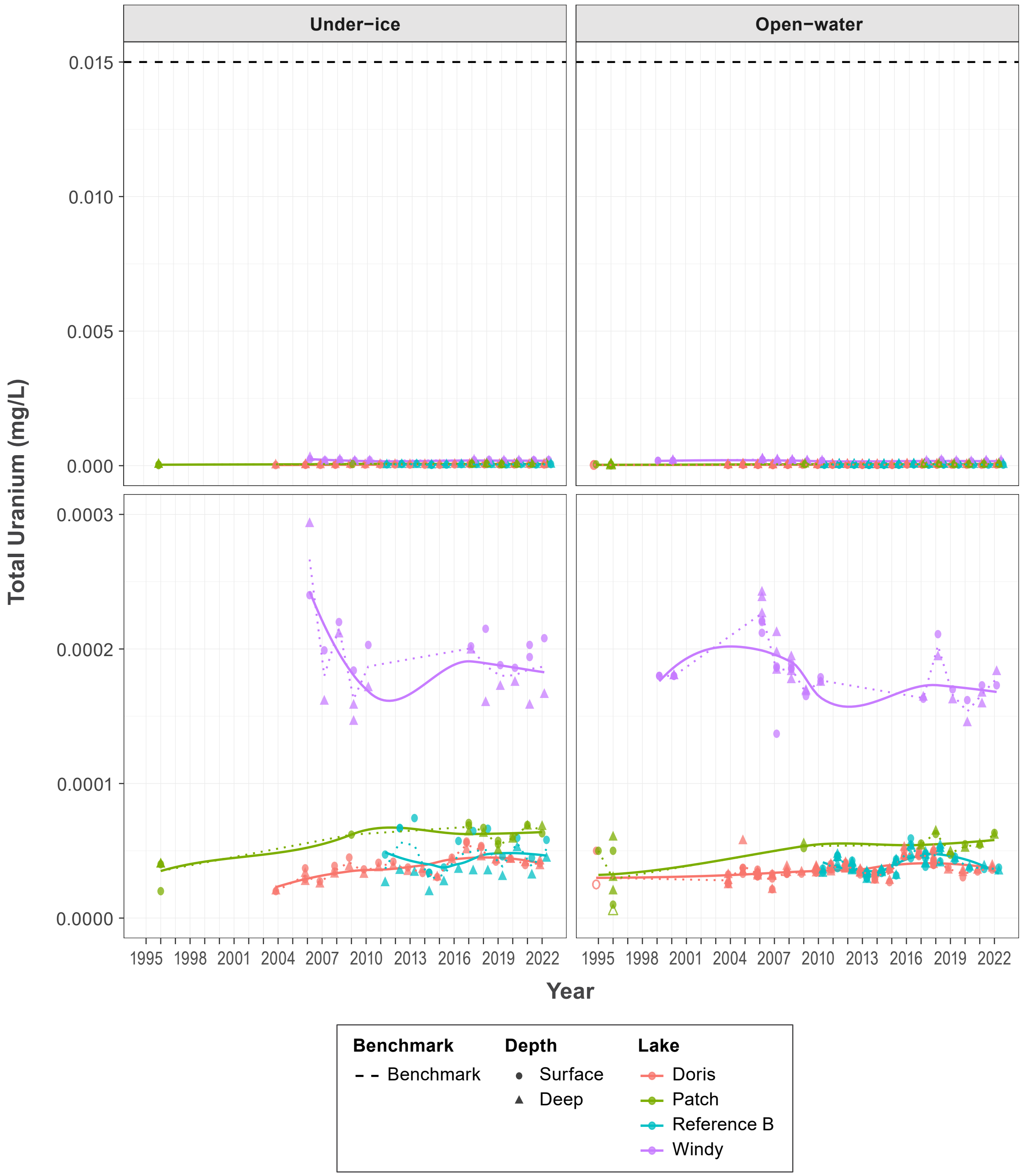
### 3.3.26 Dissolved Zinc

Dissolved zinc concentrations have been variable within lakes and through time for the exposure lakes and Reference Lake B (Figure 3.3-26). Statistical analyses were not completed in 2022 due to all or the majority of concentrations being less that the detection limit (< 0.0010 mg/L; see Appendix C.3.1.26). Dissolved zinc concentrations in 2022 were less than the detection limit, benchmark, and the low action level condition (i.e., 75% of the benchmark) in all exposure lakes. Therefore, there is no evidence of a Project-related change in dissolved zinc in Windy, Patch, or Doris lakes, and no action level response was triggered.

### 3.3.27 Water Quality Summary

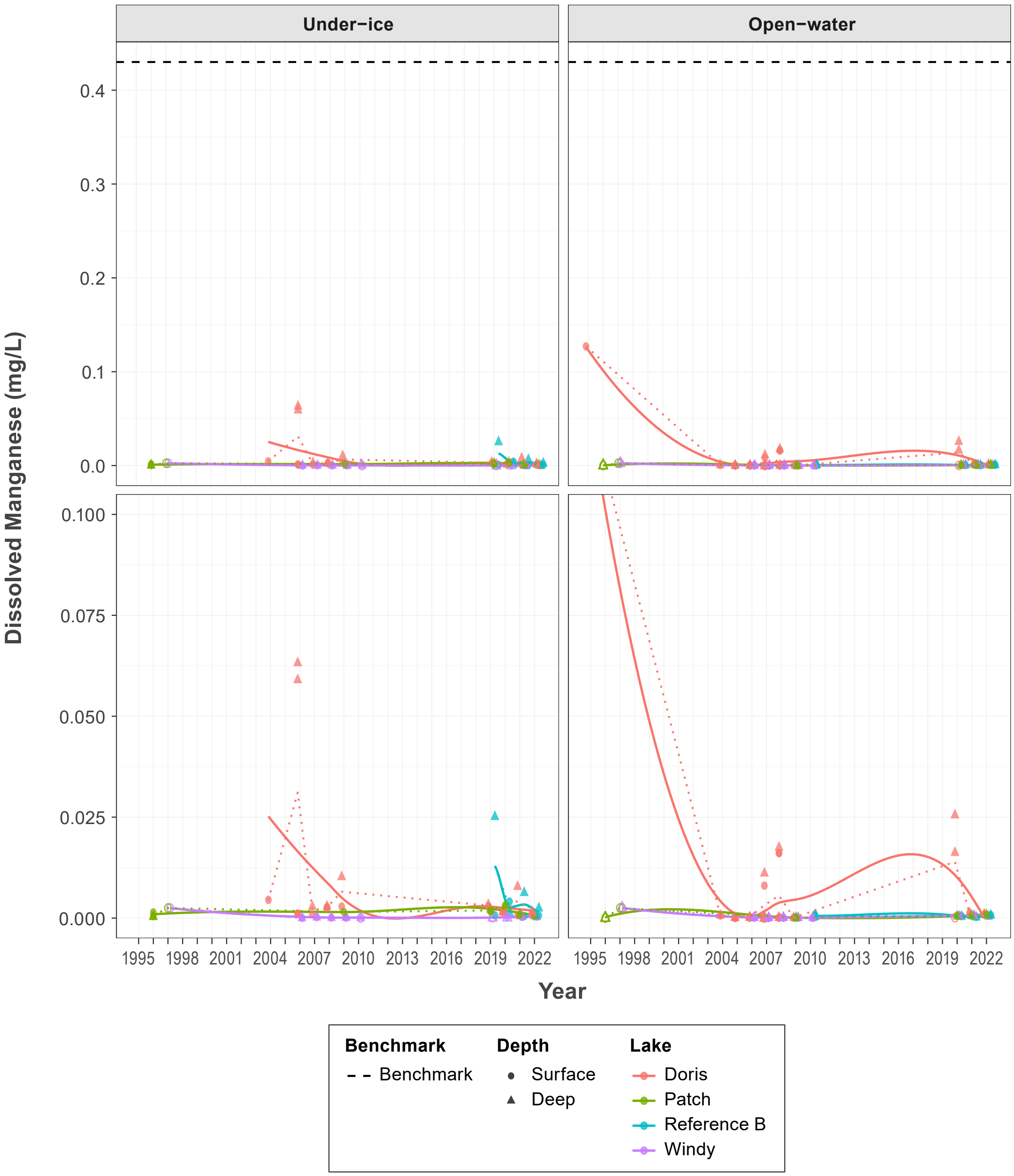
Tables 3.3-1 to 3.3-3 provide summaries of the evaluation of effects for water quality for each exposure lake (Windy, Patch, and Doris lakes, respectively). Table 3.3-4 presents a summary of the screening of the results of the evaluation of effects against the conditions that must be met to trigger a ‘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 2022 and no low action level responses were triggered. Comparisons to the FEIS water and load balance model were not completed as there were no adverse Project-related effects concluded in 2022 with the exception for turbidity in Doris Lake where the evidence of a change was concluded inconclusive (see Section 3.3.3).



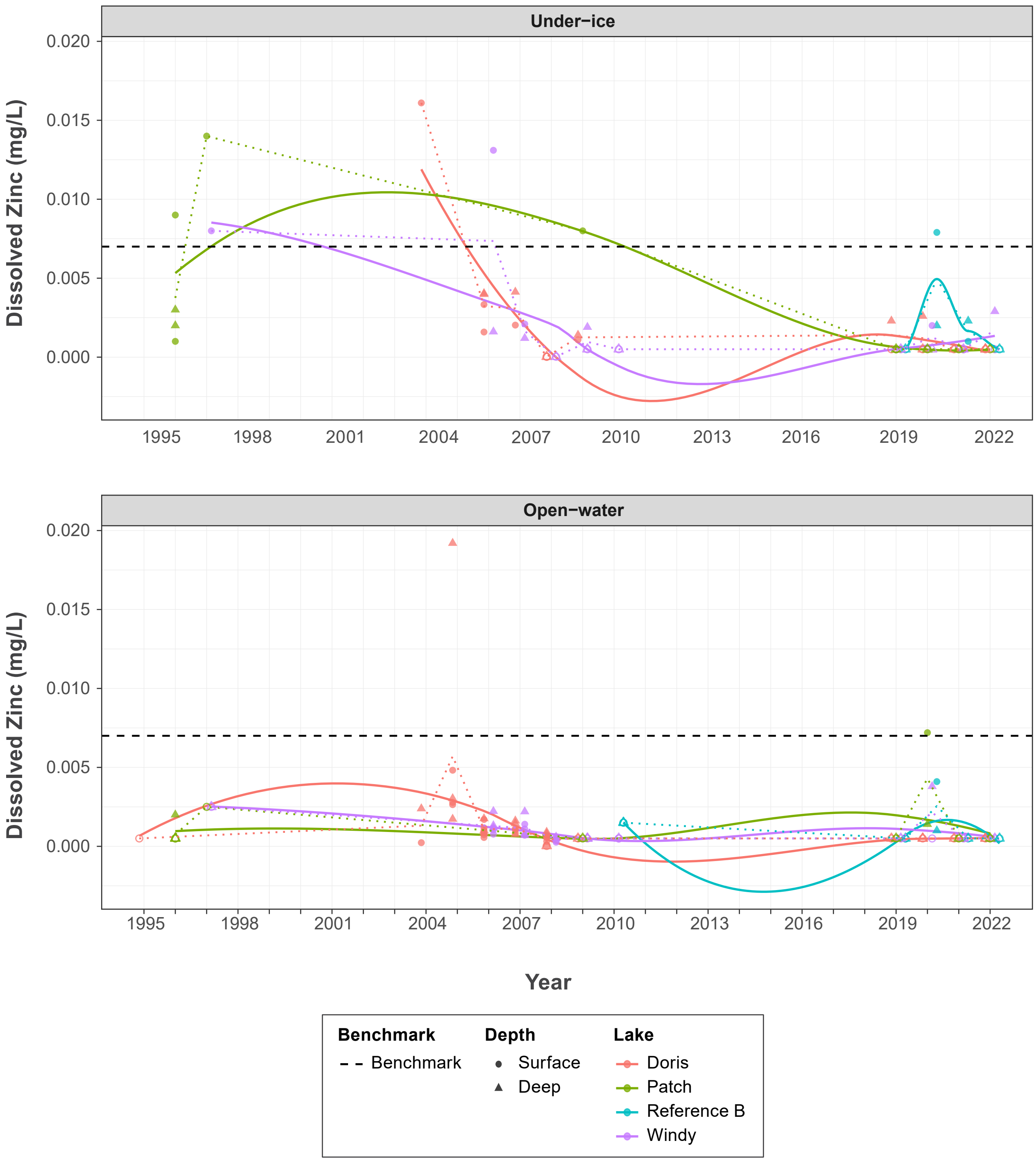

*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines drawn through the scatter plots represent the annual means.*
*Solid lines drawn through the scatter plots represent LOESS smoothing curve.*
*Black dashed lines represent the benchmark (0.015 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

**Figure 3.3-24: Total Uranium in Lakes, Hope Bay AEMP, 1995 to 2022**




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*The benchmark is dependent on hardness and pH, the black dashed lines represent the minimum benchmark for reference (0.43 mg/L).*
*The lower panel is an inset of the upper panel to magnify the low level trends.*

## Figure 3.3-25: Dissolved Manganese in Lakes, Hope Bay AEMP, 1995 to 2022




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*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 curve.*
*The benchmark is dependent on hardness, pH, and dissolved organic carbon; the black dashed lines represent the minimum benchmark for reference (0.007 mg/L).*

**Figure 3.3-26: Dissolved Zinc in Lakes, Hope Bay AEMP, 1995 to 2022**

**Table 3.3-1: Summary of Evaluation of Effects for Windy Lake Water Quality, Hope Bay AEMP, 2022**

| 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 | NA | NA | NA | NA | 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 | NA | NA | NA | NA | No | No | No effect | No effect |
| Nitrate | NA | NA | NA | NA | No | No | No effect | No effect |
| Nitrite | NA | NA | NA | NA | 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 | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Chromium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Copper | No | - | No | - | No | No | No effect | No effect |
| Total Iron | NA | NA | No | - | No | No | No effect | No effect |
| Total Lead | NA | NA | Yes | NA | No | No | No effect | No effect |
| Total Mercury | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Molybdenum | No | NA | No | NA | No | No | No effect | No effect |
| Total Nickel | No | - | No | - | No | No | No effect | No effect |
| Total Selenium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Silver | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Thallium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Uranium | No | - | No | - | No | No | No effect | No effect |
| Dissolved Manganese | No | - | No | - | No | No | No effect | No effect |
| Dissolved Zinc | NA | NA | NA | NA | No | No | No effect | No effect |

[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.*

*Notes:*

*BA = Before-After, BACI = Before-After/Control-Impact.*

*NA indicates that statistical analysis was not possible because of the high proportion of censored data.*

*Dash (-) 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 AEMP, 2022**

| 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 | NA | NA | 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 | NA | NA | No | - | No | No | No effect | No effect |
| Nitrate | No | - | NA | NA | No | No | No effect | No effect |
| Nitrite | NA | NA | NA | NA | 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 | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Chromium | NA | NA | NA | NA | 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 | NA | NA | No | - | No | No | No effect | No effect |
| Total Mercury | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Molybdenum | No | NA | No | NA | No | No | No effect | No effect |
| Total Nickel | No | - | No | - | No | No | No effect | No effect |
| Total Selenium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Silver | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Thallium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Uranium | No | - | No | - | No | No | No effect | No effect |
| Dissolved Manganese | No | - | No | - | No | No | No effect | No effect |
| Dissolved Zinc | NA | NA | NA | NA | No | No | No effect | No effect |

[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.*

*Notes:*

*BA = Before-After, BACI = Before-After/Control-Impact.*

*NA indicates that statistical analysis was not possible because of the high proportion of censored data.*

*Dash (-) 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 AEMP, 2022

| 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 | No | No | No | No effect | No effect |
| Total Suspended Solids | Yes | NA | No | NA | No | No | No effect | No effect |
| Turbidity | No | - | No | - | Inconclusive | Inconclusive | No effect | No effect |
| Chloride | Yes | Yes | Yes | Yes | No | No | No effect | No effect |
| Fluoride | No | - | No | - | No | No | No effect | No effect |
| Total Ammonia | NA | NA | NA | NA | No | No | No effect | No effect |
| Nitrate | NA | NA | NA | NA | No | No | No effect | No effect |
| Nitrite | NA | NA | NA | NA | 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 | Yes | Yes | No | No | No | No effect | No effect |
| Total Boron | Yes | NA | Yes | NA | No | No | No effect | No effect |
| Total Cadmium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Chromium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Copper | No | - | No | - | No | No | No effect | No effect |
| Total Iron | Yes | NA | No | - | No | No | No effect | No effect |
| Total Lead | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Mercury | Yes | No | NA | NA | No | No | No effect | No effect |
| Total Molybdenum | Yes | NA | Yes | NA | No | No | No effect | No effect |
| Total Nickel | No | - | No | - | No | No | No effect | No effect |
| Total Selenium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Silver | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Thallium | NA | NA | NA | NA | No | No | No effect | No effect |
| Total Uranium | Yes | No | No | - | No | No | No effect | No effect |
| Dissolved Manganese | No | - | Yes | NA | No | No | No effect | No effect |
| Dissolved Zinc | NA | NA | NA | NA | No | No | No effect | No effect |

*[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.*
*Notes:*
*NA indicates that statistical analysis was not possible because of the high proportion of censored data.*
*Dash (-) 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 AEMP, 2022

| Exposure Lake: | Windy Lake | | | | | | Patch 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] | |
| 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 | 2 (↓) | 1, 3 | 4 | | 1,2, 3 | 4 | 2 (↑) | 1, 3 | 4 | 2 (↑) | 1, 3 | 4 | 2 (↑) | 1, 3 | 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 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | | 1, 2, 3 | 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | No |
| Nitrate | | 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 |
| 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 | 2 (↑) | 1 | 3, 4 | | 1, 2 | 3, 4 | | 1, 2 | 3, 4 | No |
| Total Aluminum | | 1, 2, 3 | 4 | | 1, 2, 3 | 4 | | 1, 2, 3 | 4 | 2 (↑),3 | 1 | 4 | | 1, 2, 3 | 4 | 3 | 1, 2 | 4 | No |
| Total Arsenic | 2 (↓) | 1, 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 | 2 (↑) | 1, 3 | 4 | | 1, 2, 3 | 4 | | 1, 2, 3 | 4 | No |
| Total Lead | | 2, 3 | 1, 4 | | 1,2, 3 | 4 | | 2, 3 | 1, 4 | | 1,2, 3 | 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | No |
| Total Mercury | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | | 1, 2, 3 | 4 | | 2, 3 | 1, 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 Manganese | | 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, 3 | 1, 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | | 2, 3 | 1, 4 | No |

*[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).*

*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.*

## 3.4 Sediment Quality

Sediment quality samples were collected from two exposure lakes (Doris and Patch lakes) and one reference lake (Reference Lake B) in 2022. A subset of sediment quality variables (see Table 2.2-1) were evaluated to determine whether Project activities resulted in adverse changes to sediment quality.

Statistical and graphical analyses were used to determine if there are apparent changes in sediment quality in the exposure lakes over time. The statistical analyses consisted of a regression analysis for Doris Lake and a before-after or BACI analysis for Patch Lake (see Section 2.2.2 for an overview of the assessment methodology). For Patch Lake, sediment 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, sediment 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 compared to trends in Reference Lake B to establish whether any changes in sediment quality are likely naturally occurring or Project-related.

Sediment quality variable concentrations were compared to benchmarks outlined in the Plan, which align with the CCME sediment quality guidelines for the protection of aquatic life (CCME 2022b), to assess whether observed concentrations could adversely affect freshwater organisms. CCME guidelines for sediments include ISQGs and PELs. The more conservative ISQG, corresponds to the concentration which below, adverse biological effects are rarely observed. The higher PEL corresponds to the concentration which above, negative effects would be expected (CCME 2022b). Sediment quality data were also compared against the low action level condition (i.e., 75% of the benchmark for both the ISQG and PEL) as one of the conditions to determine whether a low action level threshold was exceeded (see Section 2.2.3).

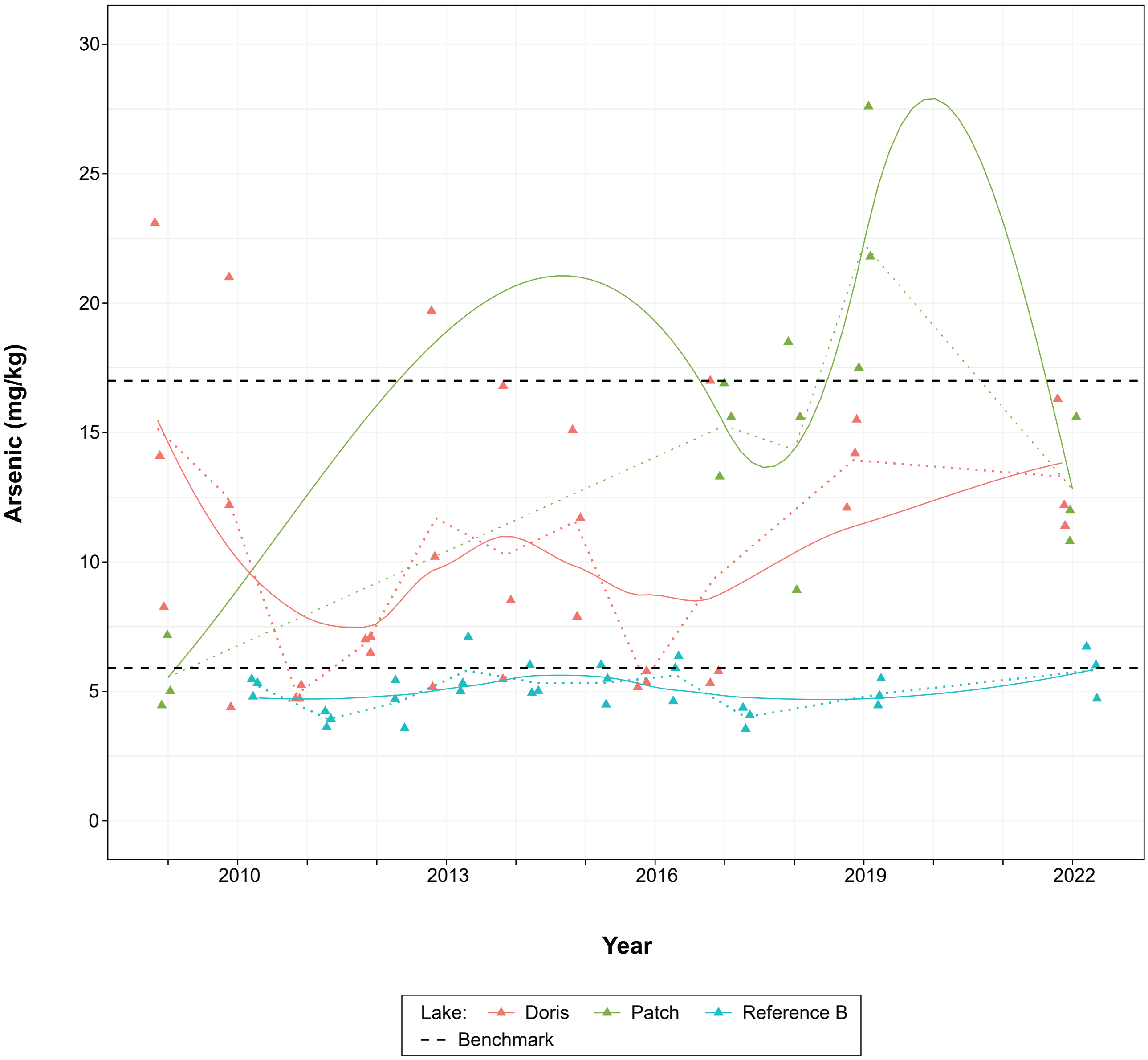
The following sections present the evaluation of effects for sediment quality variables. Sediment quality data for 2022 are presented in Appendix A, and all statistical analysis results are presented in Appendix C.

### *3.4.1 Arsenic*

Sediment arsenic concentrations in Patch and Doris lakes have been highly variable both inter-annually and among replicates within a given year, relative to the reference lake, throughout the monitoring period (Figure 3.4-1). In Patch Lake, the *before* period (i.e., all years up to and including 2018) mean sediment arsenic concentration was not significantly different from the *after* period (i.e., 2019 to 2022; $p = 0.3717$). Mean 2022 arsenic concentrations in Patch Lake sediments were greater than the ISQG benchmark and marginally greater than the PEL low action condition (75% PEL benchmark = 12.75 mg/kg: Figure 3.4-1). However, the mean 2022 concentration was similar to the 2017 and 2018 *before* period concentrations in Patch Lake (Figure 3.4-1).

In Doris Lake, statistical analyses indicate that arsenic sediment concentrations have changed through time, relative to a slope of zero ($p < 0.05$) but the trend was not significantly different from the trend in Reference Lake B ($p = 0.2093$). Similar to Patch Lake, mean 2022 concentrations in Doris Lake sediments were greater than the ISQG benchmark and greater than the low action condition (75% PEL benchmark = 12.75 mg/kg: Figure 3.4-1). However, the 2022 mean arsenic concentration in Doris Lake was also similar to the mean baseline concentration observed in 2009 (Figure 3.4-1). In addition to relatively elevated baseline concentrations, observations from Reference Lake B have exceeded the ISQG throughout the monitoring period suggesting that lake sediments may naturally exceed the ISQG benchmark in the Hope Bay AEMP Project lakes.

Therefore, no Project-related change for arsenic in the sediments of Patch or Doris lakes were concluded and no action level response was triggered.




*Notes: Symbols represent observed concentrations.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*
*Black dashed lines represent the benchmarks: ISQG = 5.9 mg/kg ; PEL = 17 mg/kg*

**Figure 3.4-1: Arsenic Concentrations in Lake Sediments, Hope Bay AEMP, 2009 to 2022**

### 3.4.2 Cadmium

Sediment cadmium concentrations have been lower than concentrations in Reference Lake B and stable throughout the monitoring period in both Patch and Doris lakes (Figure 3.4-2). Statistical analyses confirm that the before-after comparison of sediment cadmium concentrations in Patch Lake showed no significant difference ($p = 0.6536$) and that the trend for sediment cadmium concentrations over time in Doris Lake was not significantly different from a slope of zero ($p = 0.8941$). Mean cadmium sediment concentrations in 2022 were less than the low action level condition (i.e., 75% of the benchmarks) in all lakes. Therefore, no Project-related change for cadmium in the sediments of Patch or Doris lakes were concluded and no action level response was triggered.

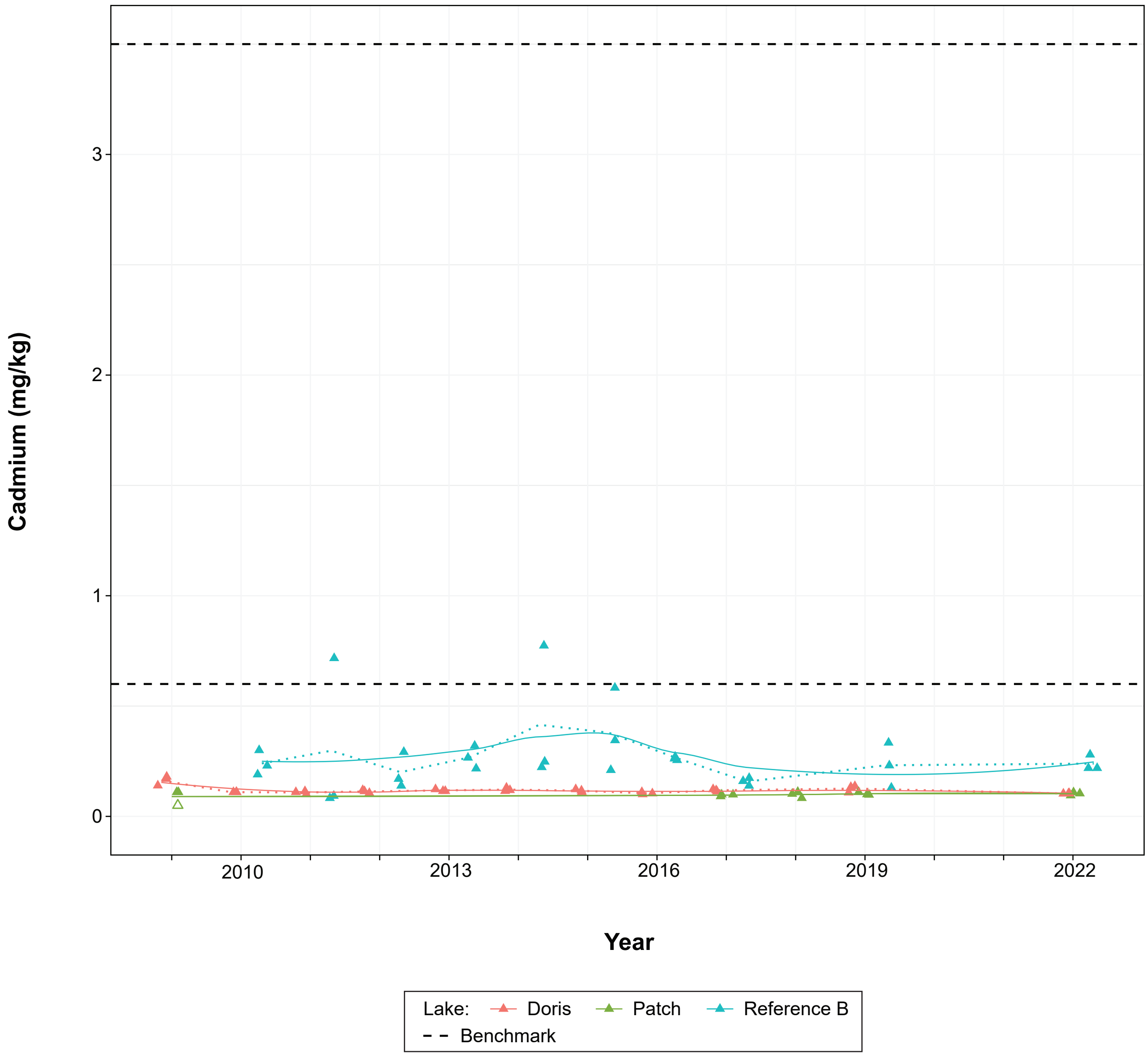
### 3.4.3 Chromium

Sediment chromium concentrations have generally been greater in exposure lakes, Patch and Doris lakes, compared to Reference Lake B since monitoring began but have generally been consistent amongst replicates and through time (Figure 3.4-3). The statistical analyses confirm that the before-after comparison of sediment chromium concentrations in Patch Lake showed no significant difference ($p = 0.9791$) and that the trend for sediment chromium concentrations over time in Doris Lake was not significantly different from a slope of zero ($p = 0.6082$). Mean 2022 sediment chromium concentrations in both Patch and Doris Lake sediments were greater than the ISQG benchmark and greater than the low action condition (75% PEL benchmark = 67.5 mg/kg: Figure 3.4-3). However, the statistical and graphical analysis indicate that has been no directional change in sediment chromium concentrations for these lakes. In addition, chromium concentrations in Reference Lake B sediments have exceeded the ISQG throughout the monitoring period suggesting that lake sediments are naturally elevated in the Hope Bay AEMP Project lakes.

Therefore, no Project-related change for chromium in the sediments of Patch or Doris lakes were concluded and no action level response was triggered.

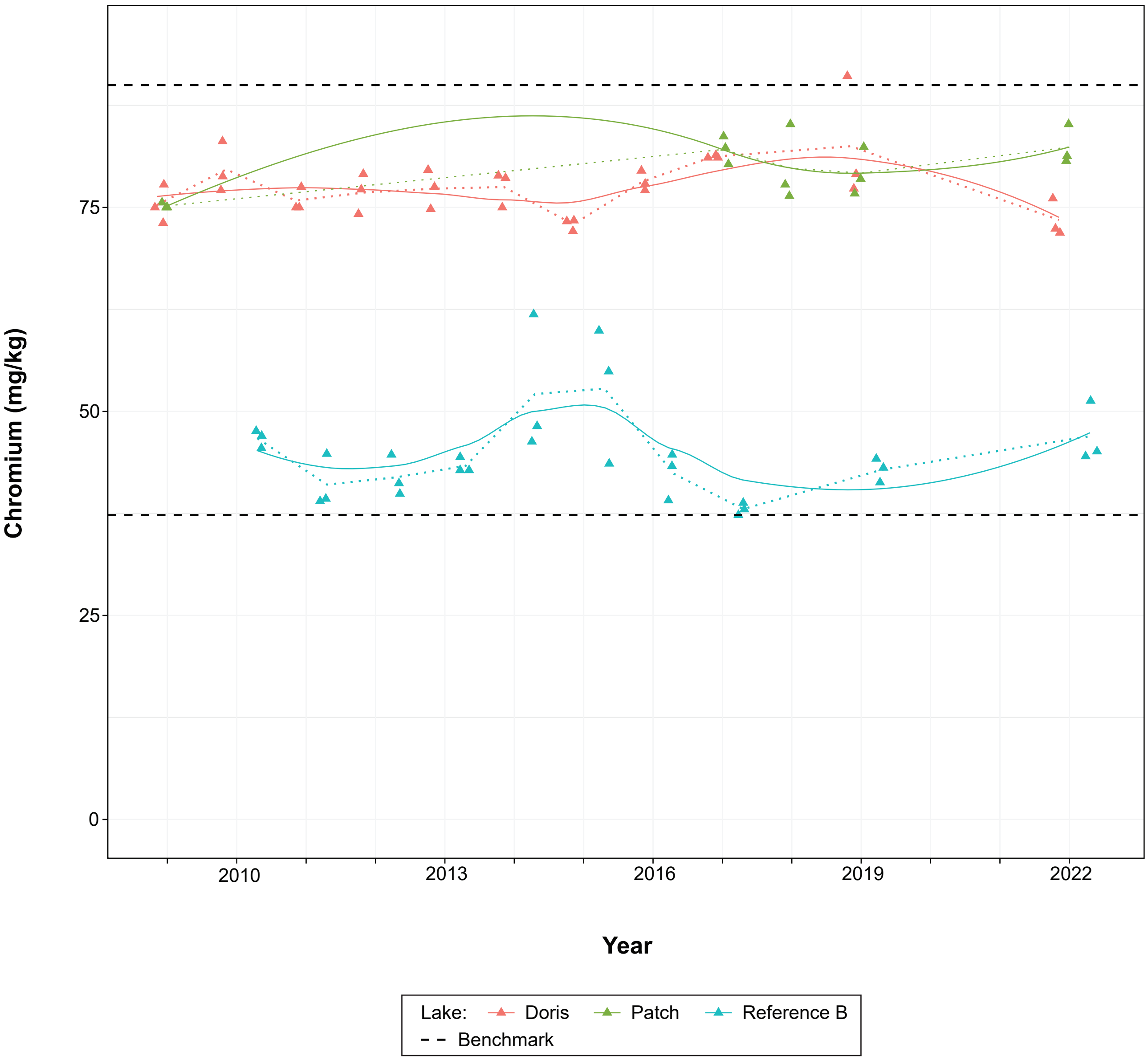
### 3.4.4 Copper

Sediment copper concentrations in exposure lakes, Patch and Doris lakes, have been slightly greater than concentrations observed in Reference Lake B throughout the monitoring period but concentrations in all lakes have been stable through time (Figure 3.4-4). The statistical analyses confirm that the before-after comparison of sediment copper concentrations in Patch Lake showed no significant difference ($p = 0.6399$) and that the trend for sediment copper concentrations over time in Doris Lake was not significantly different from a slope of zero ($p = 0.365$). Although, mean copper sediment concentrations in 2022 were greater than the ISQG benchmark in Doris Lake and greater than the low action level condition (75% ISQG benchmark = 26.76 mg/kg) in Patch Lake, long-term trends indicate these concentrations naturally occur and not related to Project activities. Therefore, no Project-related change for copper in the sediments of Patch or Doris lakes were concluded and no action level response was triggered.



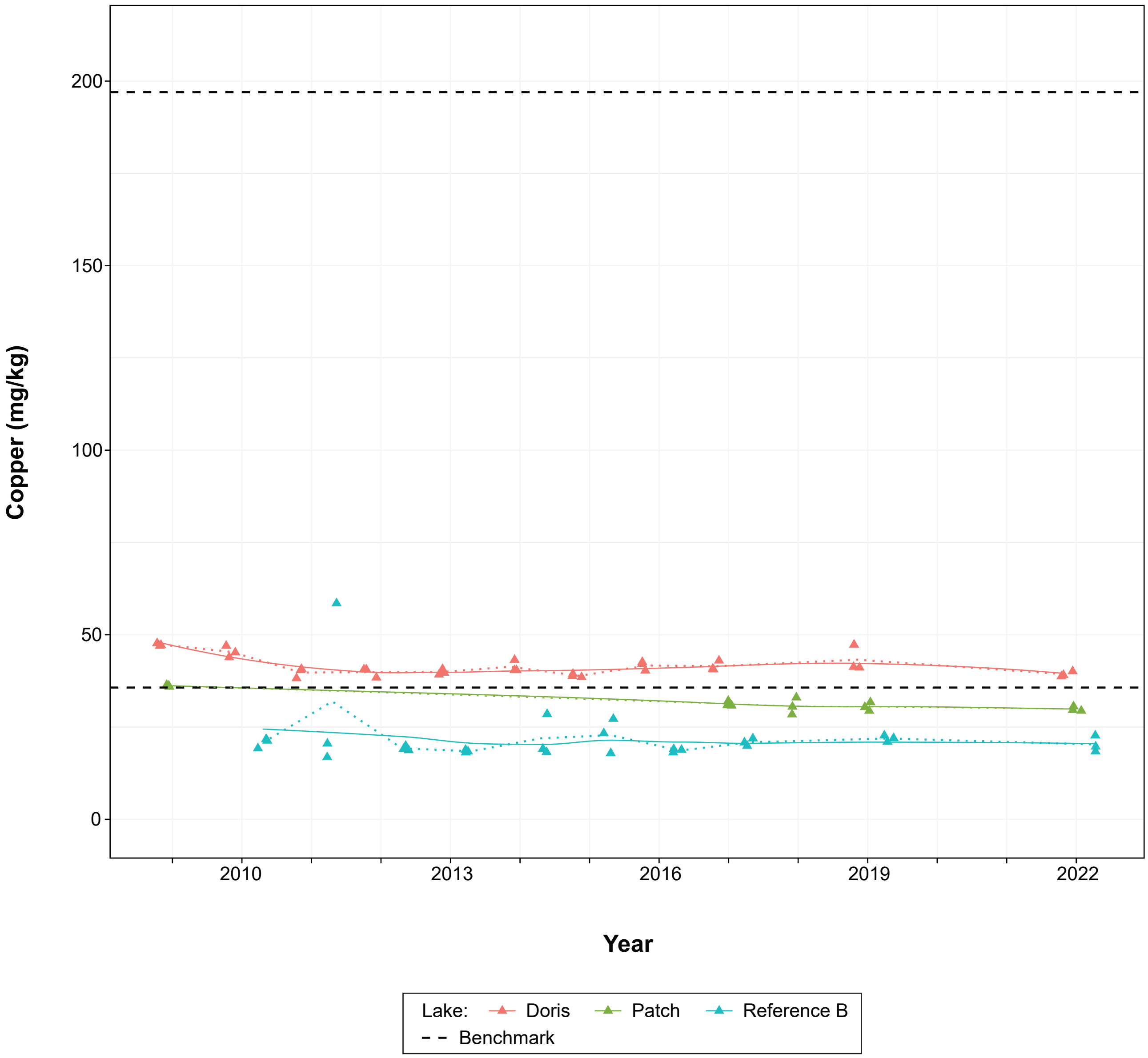

*Notes: Symbols represent observed concentrations.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*
*Black dashed lines represent the benchmarks: ISQG = 0.6 mg/kg ; PEL = 3.5 mg/kg*

**Figure 3.4-2: Cadmium Concentrations in Lake Sediments, Hope Bay AEMP, 2009 to 2022**




*Notes: Symbols represent observed concentrations.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*
*Black dashed lines represent the benchmarks: ISQG = 37.3 mg/kg ; PEL = 90 mg/kg*

**Figure 3.4-3: Chromium Concentrations in Lake Sediments, Hope Bay AEMP, 2009 to 2022**




*Notes: Symbols represent observed concentrations.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*
*Black dashed lines represent the benchmarks: ISQG = 35.7 mg/kg ; PEL = 197 mg/kg*

**Figure 3.4-4: Copper Concentrations in Lake Sediments, Hope Bay AEMP, 2009 to 2022**

### 3.4.5 Lead

Sediment lead concentrations in exposure lakes, Patch and Doris lakes, have been slightly greater than concentrations observed in Reference Lake B throughout the monitoring period but concentrations in all lakes have been low and stable through time (Figure 3.4-5). Statistical analyses indicated that the before-after comparison of sediment lead concentrations in Patch Lake showed no significant difference ($p = 0.4409$). Although the trend in sediment lead concentrations over time in Doris Lake sediments was significantly different from a slope of zero ($p < 0.05$), it was not significantly different from the trend in Reference Lake B ($p = 0.0902$). The statistical result for Doris Lake is likely attributed to the slightly greater concentrations initially observed in 2009, but concentrations have been stable since 2010. Mean sediment lead concentrations in 2022 were less than the lower benchmark (i.e., ISQG) and the low action level condition in all lakes. Therefore, no Project-related change for lead in the sediments of Patch or Doris lakes were concluded and no action level response was triggered.

### 3.4.6 Mercury

Sediment mercury concentrations in Patch Lake have been similar to concentrations observed in Reference Lake B and in Doris Lake concentrations have been slightly greater that observed in Reference Lake B throughout the monitoring period but concentrations in all lakes have been low and stable through time (Figure 3.4-6). Statistical analyses confirm that the before-after comparison of mercury concentrations in Patch Lake showed no significant difference ($p = 0.9957$) and that the trend for sediment mercury concentrations over time in Doris Lake was not significantly different from a slope of zero ($p = 0.0822$). Mean sediment mercury concentrations in 2022 were less than the lower benchmark (i.e., ISQG) and the low action level condition in all lakes. . Therefore, no Project-related change for mercury in the sediments of Patch or Doris lakes were concluded and no action level response was triggered.

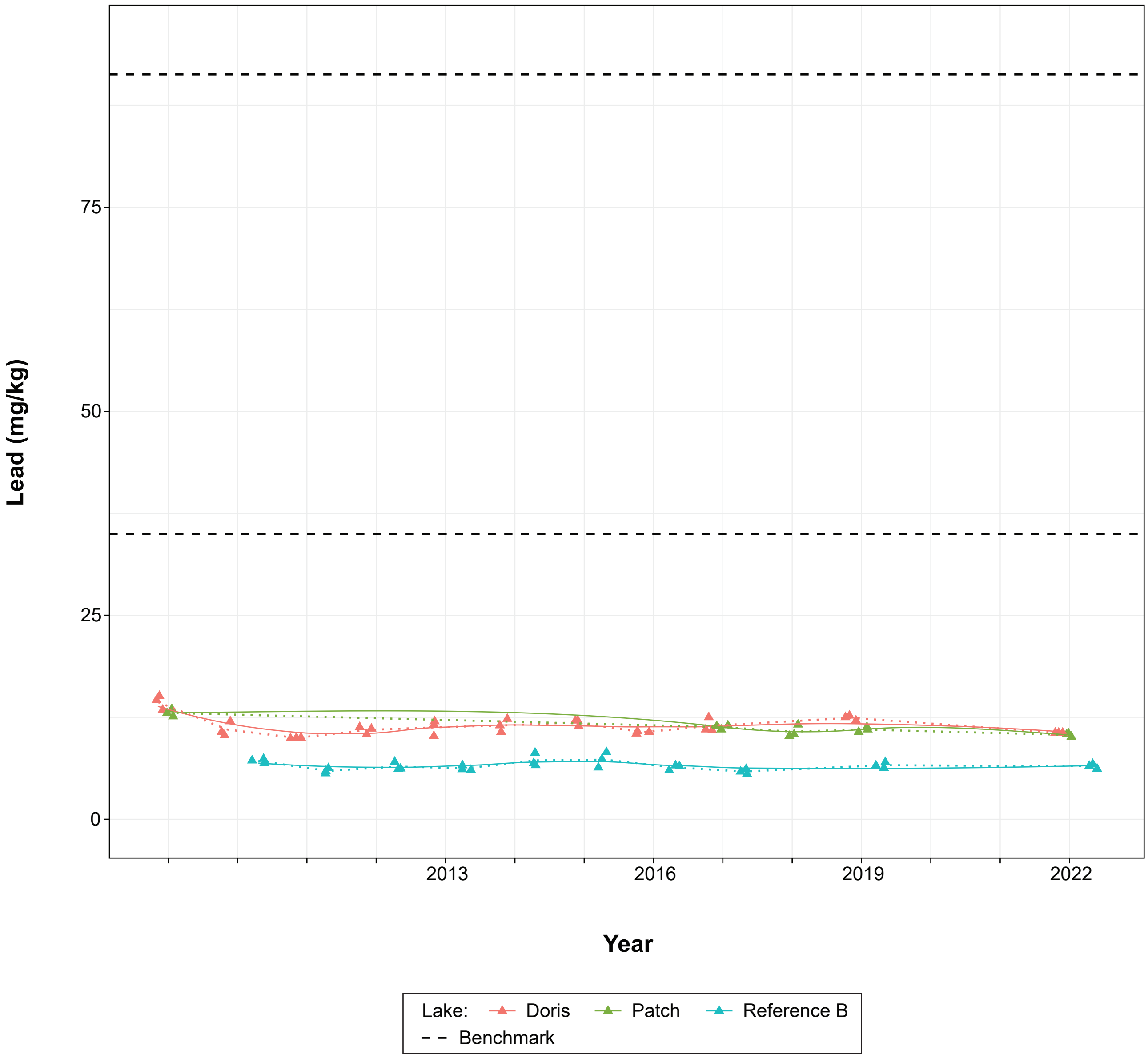
### 3.4.7 Zinc

Sediment zinc concentrations have generally been slightly greater in exposure lakes, Patch and Doris lakes, compared to Reference Lake B since monitoring began but have generally been consistent amongst replicates and through time (Figure 3.4-7). Statistical analyses confirm that the before-after comparison of sediment zinc concentrations in Patch Lake showed no significant difference ($p = 0.7209$) and that the trend for sediment chromium concentrations over time in Doris Lake was not significantly different from a slope of zero ($p = 0.9228$). Mean 2022 sediment zinc concentrations in Doris Lake were greater than the low action condition (75% PEL benchmark = 92.25 mg/kg). However, the 2022 mean concentrations were similar to the mean baseline concentration, and the stable long-term trend observed in Doris Lake.

Therefore, no Project-related change for zinc in the sediments of Patch or Doris lakes were concluded and no action level response was triggered.

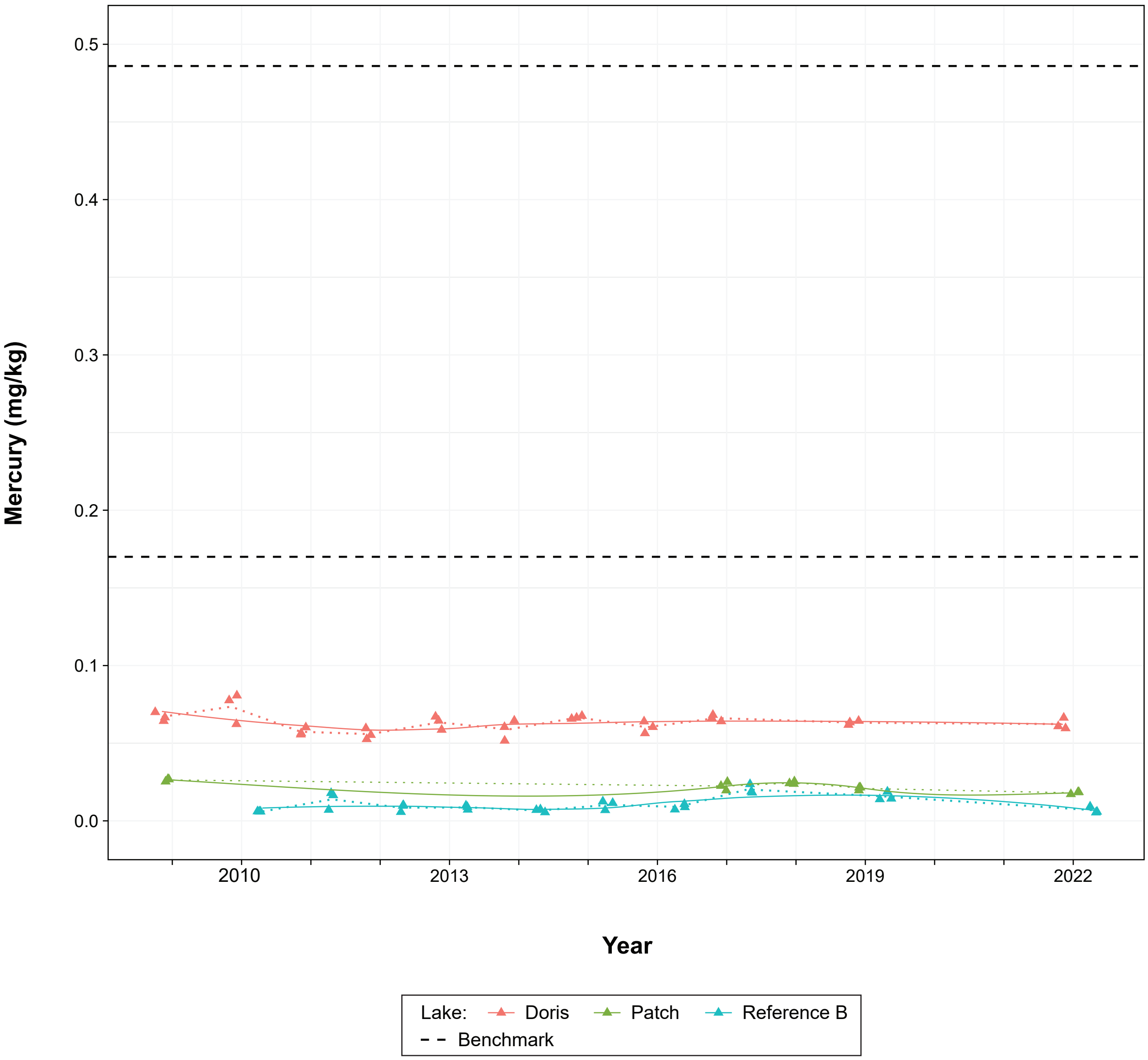
### 3.4.8 Sediment Quality Summary

Tables 3.4-1 and 3.4-2 provide summaries of the evaluation of effects for sediment quality in Patch and Doris lakes. Table 3.4-3 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).



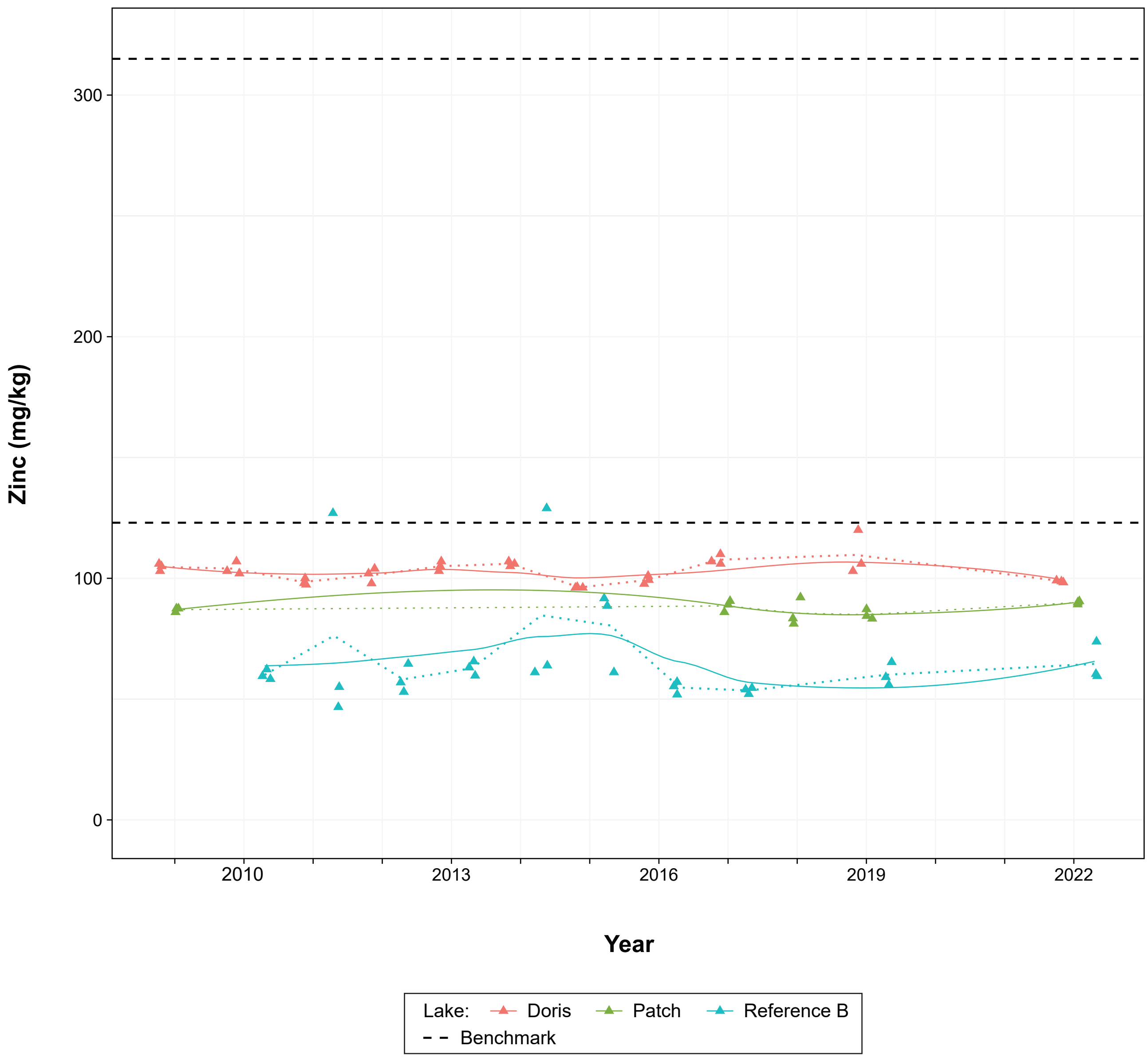

*Notes: Symbols represent observed concentrations.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*
*Black dashed lines represent the benchmarks: ISQG = 35 mg/kg ; PEL = 91.3 mg/kg*

## Figure 3.4-5: Lead Concentrations in Lake Sediments, Hope Bay AEMP, 2009 to 2022




*Notes: Symbols represent observed concentrations.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*
*Black dashed lines represent the benchmarks: ISQG = 0.17 mg/kg ; PEL = 0.486 mg/kg*

**Figure 3.4-6: Mercury Concentrations in Lake Sediments, Hope Bay AEMP, 2009 to 2022**




*Notes: Symbols represent observed concentrations.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*
*Black dashed lines represent the benchmarks: ISQG = 123 mg/kg ; PEL = 315 mg/kg*

**Figure 3.4-7: Zinc Concentrations in Lake Sediments, Hope Bay AEMP, 2009 to 2022**

### Table 3.4-1: Summary of Evaluation of Effects for Patch Lake Sediment Quality, Hope Bay AEMP, 2022

| Variable | Statistical Analysis: BA or BACI Analysis | | Graphical Analysis/ Interpretation | Conclusion of Effect [c] |
|---|---|---|---|---|
| | Before-After Change (BA Analysis)? [a] | Difference in Before-After Trend Relative to Reference Lake (BACI Analysis)? [a] | Evidence of an Adverse[b] Change? | |
| Arsenic | No | - | No | No effect |
| Cadmium | No | - | No | No effect |
| Chromium | No | - | No | No effect |
| Copper | No | - | No | No effect |
| Lead | No | - | No | No effect |
| Mercury | No | - | No | No effect |
| Zinc | No | - | No | No effect |

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

*[b] 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.*

*Notes:*

*BA = Before-After, BACI = Before-After/Control-Impact*

*Dash (-) 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 3.4-2: Summary of Evaluation of Effects for Doris Lake Sediment Quality, Hope Bay AEMP, 2022

| Variable | Statistical Analysis: Linear Mixed Model or Tobit Regression | | Graphical Analysis/Interpretation | Conclusion of Effect [c] |
|---|---|---|---|---|
| | Different from Slope 0? [a] | Different from Reference Lake B Slope? [a] | Evidence of an Adverse[b] Change? | |
| Arsenic | Yes | No | No | No effect |
| Cadmium | No | - | No | No effect |
| Chromium | No | - | No | No effect |
| Copper | No | - | No | No effect |
| Lead | Yes | No | No | No effect |
| Mercury | No | - | No | No effect |
| Zinc | No | - | No | No effect |

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

*[b] 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.*

*Note:*

*Dash (-) 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.*

The evaluation of effects concluded that there were no Project-related changes in sediment quality in 2022 for both Patch and Doris lakes. Concentrations of some sediment metals (i.e., arsenic and chromium in both lakes and copper in Doris Lake) exceeded the ISQG benchmark in 2022; however, these metals were naturally elevated as the benchmarks were exceeded during baseline years. As shown in Table 3.4-3, at least one condition was not met for each exposure lake/variable combination; therefore, no low action level responses were triggered for sediment quality in 2022.

**Table 3.4-3: Comparison of Sediment Quality to Response Framework Conditions for Triggering a Low Action Level Response, Hope Bay AEMP, 2022**

| Exposure Lake: | Patch Lake | | | Doris Lake | | | Low Action Level Response Triggered for Any Lake? |
|---|---|---|---|---|---|---|---|
| Conditions for Low Action Level Response: | Conditions Met | Conditions Not Met | Conditions Not Evaluated[a] | Conditions Met | Conditions Not Met | Conditions Not Evaluated[a] | |
| **Sediment Quality Variable** | | | | | | | |
| Arsenic | 3 | 1,2 | 4 | 3 | 1, 2 | 4 | No |
| Cadmium | | 1, 2, 3 | 4 | 2 (↓) | 1, 3 | 4 | No |
| Chromium | 3 | 1, 2 | 4 | 2 (↓), 3 | 1 | 4 | No |
| Copper | 3 | 1, 2 | 4 | 2 (↓), 3 | 1 | 4 | No |
| Lead | | 1, 2, 3 | 4 | 2 (↓) | 1, 3 | 4 | No |
| Mercury | | 1, 2, 3 | 4 | 2 (↓) | 1, 3 | 4 | No |
| Zinc | | 1, 2, 3 | 4 | 2 (↓), 3 | 1 | 4 | No |

*[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).*

*Notes:*

*Condition 1: identification of a statistically significant and potentially adverse change from baseline conditions.*

*Condition 2: the concentration of the sediment quality variable is outside of the normal range based on baseline concentration.*

*Condition 3: the concentration of the sediment 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 Patch Lake, baseline data were from 2009 to 2018; for Doris Lake, baseline data were from 2009.*

## 3.5 Phytoplankton

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-related 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.

Chlorophyll *a* samples were collected from the surface waters of two exposure lakes (Doris and Patch lakes) and one reference lake (Reference Lake B) during the open-water season to estimate phytoplankton biomass. For Patch Lake, phytoplankton biomass data collected between 2009 and 2018 are considered to represent baseline/*before* 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 was a change in phytoplankton biomass compared to baseline conditions. Biomass trends were also compared between the exposure and reference lake to determine whether a low action level was exceeded according to the Response Framework.

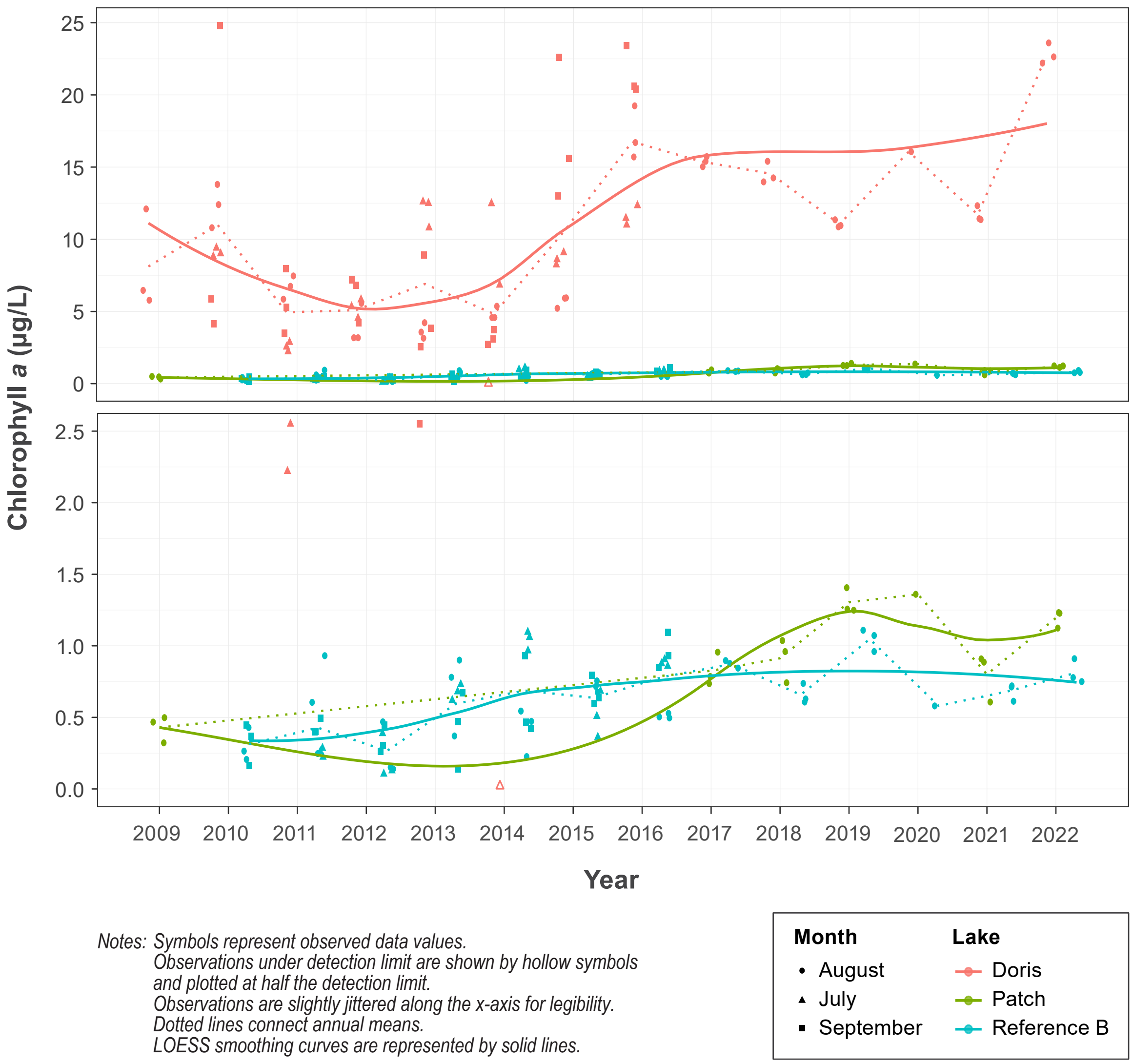
Phytoplankton biomass data collected in 2022 are presented in Appendix A, and all statistical analysis results are presented in Appendix C.

### 3.5.1 Biomass

Patch Lake chlorophyll *a* concentrations have followed a similar trend as observed in Reference Lake B in recent years when sampling has been completed in both lakes consistently (Figure 3.5-1). Chlorophyll *a* concentrations increased slightly in Patch Lake from initial baseline sampling in 2009 to 2017, however a similar magnitude of increase was observed in Reference Lake B across a similar timeframe. Statistical analysis indicate that mean chlorophyll *a* concentrations were not statistically different between the *before* period and *after* period in Patch Lake ($p = 0.8166$).

Chlorophyll *a* concentrations been greater and more variable within a given year in Doris Lake, relative to Patch Lake and Reference Lake B concentrations through time, including during the baseline year (2009; Figure 3.5-1). The Doris Lake chlorophyll *a* trend through time was significantly different from a slope of zero ($p < 0.05$) as well as the trend observed in Reference Lake B through time ($p < 0.05$). Mean chlorophyll *a* concentrations appear to have increased between 2014 and 2016 in Doris Lake, and concentrations since 2016 have shown no clear directional trend. Observed chlorophyll *a* concentrations in Doris Lake have periodically been elevated, similar to the concentrations observed in 2022, in 2010 and 2015/2016, which may be indicative of an oscillating or cyclical pattern over a decadal time scale rather than a consistent increase or decrease over time. Though the magnitude of the change is much smaller, there also appears to be a slight increase from the initial years of monitoring in Patch Lake and Reference Lake B chlorophyll *a* concentrations, which may be indicative of a larger regional effect on lakes in the Project area. In addition, there was no evidence of increased nutrient inputs to Doris Lake (Sections 3.3.6 to 3.3.9) that would provide a causal mechanism for any observed increase.

According to the widely used trophic classification system developed by Vollenweider and Kerekes (1982) and cited in Environment Canada's *Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems* (2004; Table 3.5-1), 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. Based on the mean open-water total phosphorus concentrations measured in Patch Lake during baseline years (0.005 mg/L; Section 3.3.9) and Reference Lake B from 2010 to 2022 (0.004 mg/L; Section 3.3.9), according to the Vollenweider and Kerekes classification system these lakes would both be classified as oligo-mesotrophic (Table 3.5-1)., According to the trophic categories proposed by Wetzel the Reference Lake B would be considered ultra-oligotrophic and Patch Lake was at the lower bound of Oligo-mesotrophic The 2022 mean chlorophyll *a* concentrations in these lakes (1.20 µg chl *a*/L in Patch Lake and 0.81 µg chl *a*/L in Reference Lake B) also correspond with the levels expected for these trophic categories. Doris Lake would be classified as meso-eutrophic based on the mean total phosphorus concentration measured in this lake during baseline years (0.027 mg/L; Section 3.3.9), and the 2022 mean chlorophyll *a* concentration in Doris Lake (22.81 µg chl *a*/L) is within the maximum range given in Table 3.5-1 for a meso-eutrophic lake.




*Notes: Symbols represent observed data values.*
*Observations under detection limit are shown by hollow symbols and plotted at half the detection limit.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dotted lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*

**Figure 3.5-1: Phytoplankton Biomass in Lakes, Hope Bay AEMP, 2009 to 2022**

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

| Variable: | 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) | |
| Trophic Level | | | | |
| 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).

Overall, there is no evidence of changing chlorophyll *a* concentrations for Patch Lake and concentrations were within the baseline range. For Doris Lake, although there was a statistically significant change in biomass over time and relative to the reference lake, there was no clear directional shift in chlorophyll *a* concentrations that corresponds with Project-related activities. Furthermore, while the mean 2022 phytoplankton biomass in Doris Lake was elevated compared to the single baseline year (2009), similar concentrations have been observed periodically throughout the monitoring period but did not persist; additional monitoring will confirm if the chlorophyll *a* concentration in Doris Lake continues to increase. Therefore, no Project-related change for phytoplankton biomass for Patch or Doris lakes were concluded and no action level response was triggered in 2022.

### *3.5.2 Phytoplankton Summary*

Tables 3.5-2 and 3.5-3 provide summaries of the evaluation of effects for phytoplankton indicators in Patch and Doris lakes respectively. Table 3.5-4 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 2.2.3.3).

### Table 3.5-2: Summary of Evaluation of Effects for Patch Lake Phytoplankton Biomass, Hope Bay AEMP, 2022

| Benthic Invertebrate Indicator | Statistical Analysis: BA or BACI Analysis | | Graphical Analysis/ Interpretation | Conclusion of Effect [b] |
|---|---|---|---|---|
| | Within Lake Before-After Change (BA Analysis)? [a] | Difference in Before-After Trend Relative to Reference Lake (BACI Analysis)? [a] | Evidence of an Adverse Project-related Effect? | |
| Biomass | No | - | No | No effect |

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

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

*Notes:*

*BA = Before-After, BACI = Before-After/Control-Impact.*

*Dash (-) 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 3.5-3: Summary of Evaluation of Effects for Doris Lake Phytoplankton Biomass, Hope Bay AEMP, 2022

| Benthic Invertebrate Indicator | Statistical Analysis: Linear Mixed Model or Tobit Regression | | Graphical Analysis/ Interpretation | Conclusion of Effect [b] |
|---|---|---|---|---|
| | Different from Slope 0? [a] | Different from Reference Lake B Slope? [a] | Evidence of an Adverse Effect? | |
| Biomass | Yes | Yes | No | No effect |

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

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

### Table 3.5-4: Comparison of Phytoplankton Biomass to Response Framework Conditions for Triggering a Low Action Level Response, Hope Bay AEMP, 2022

| Exposure Lake: | Patch Lake | | | Doris Lake | | | Low Action Level Response Triggered for Any Lake? |
|---|---|---|---|---|---|---|---|
| Conditions for Low Action Level Response: | Conditions Met | Conditions Not Met | Conditions Not Evaluated[a] | Conditions Met | Conditions Not Met | Conditions Not Evaluated[a] | |
| Biomass | 2[a] (↑) | 1, 3 | - | 1, 2[a] (↑), 3 | - | - | No[b] |

*[a] Condition 2 is met if at least one replicate is outside the baseline range.*

*[b] The observed change in Doris Lake is not concluded to be Project-related.*

*Notes:*

*Condition 1: the identification of a statistically significant change from baseline conditions.*

*Condition 2: the concentration is outside that the normal range based on baseline conditions.*

*Condition 3: if a change is detected, the absence of a similar change at the reference location.*

*Dash (-) indicates no conditions to report for that category.*

*↑ and ↓ indicate that at least one replicate concentration was higher or lower that the baseline range, respectively. For Patch Lake, baseline data were from 2009 to 2018; for Doris Lake, baseline data were from 2009.*

The evaluation of effects concluded that there were no Project-related changes for phytoplankton biomass in 2022 in either Patch or Doris lakes. As shown in Table 3.5-4, at least one condition was not met for Patch Lake and although the conditions were met in Doris Lake there was no plausible Project-related source for the observed changes; therefore, no low action level responses were triggered for phytoplankton in 2022.

## 3.6 Benthic Invertebrates

Benthos samples were collected from two exposure lakes (Doris and Patch lakes) and one reference lake (Reference Lake B) during the open-water season in 2022 and benthos density, taxa richness, Simpson's evenness index, and the Bray-Curtis index (a measure of similarity between sites) were calculated for each lake. For Patch Lake, benthos data collected between 2009 and 2018 are considered to represent baseline/*before* conditions prior to the start to Madrid North construction activities in 2019. For Doris Lake, benthos data collected in 2009 are considered to represent baseline conditions prior to the start of Doris construction activities in 2010. The data from 2009 are represented by a single data point as methods varied and the data was compiled to be more representative of current methods of sample collection.

Statistical and graphical analyses were used to determine if there were changes in benthos community descriptors over time from 2009 to 2022. Trends were also compared between the exposure and reference lakes to determine whether a low action level was triggered according to the Response Framework.

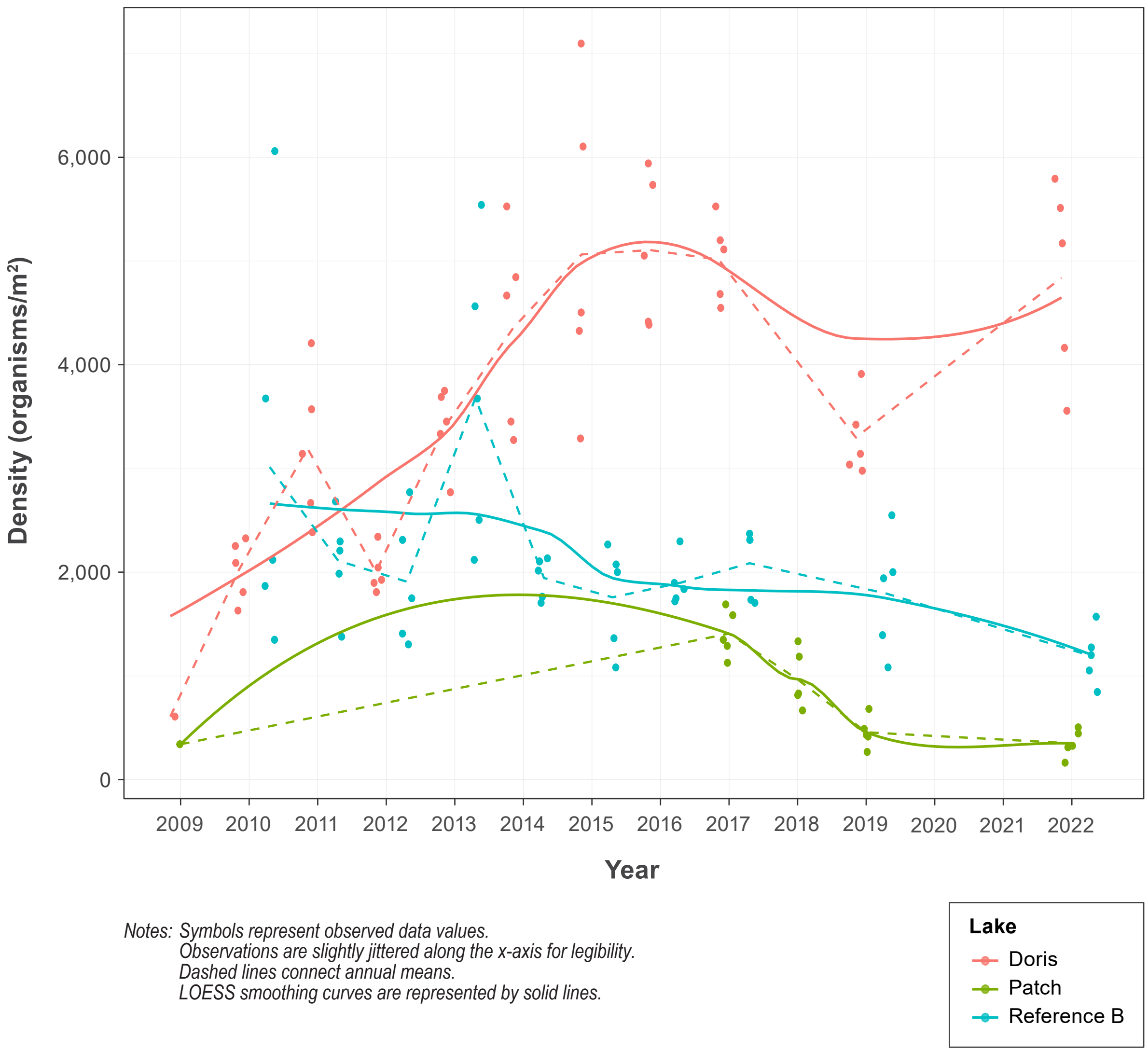
Benthos data collected in 2022 and calculated benthic community metrics are presented in Appendix A, and historical data inclusion and statistical analysis results are presented in Appendix C.

### 3.6.1 Density

For Patch Lake, benthos density in the *after* period (2019 and 2022) appear to be slightly less than densities observed in 2017 and 2018 but overall similar to densities observed in the early *before* period (2009; Figure 3.6-1). Some replicates of benthos density in 2022 were less than the *before* period range in Patch Lake though a similar observation was seen in Reference Lake B. Statistical analysis indicate there was no significant difference for the *after* period mean density relative to the *before* period ($p = 0.2622$).

Benthos density in recent years has been greater in Doris Lake than in Patch Lake and Reference Lake B (Figure 3.6-1). Lakes with greater productivity and nutrient concentrations are typically related to elevated abundance of benthic invertebrates (Nalepa et al. 2000). Given the indicators of greater productivity, greater nutrient concentrations (Section 3.3-7 to 3.3-9) and phytoplankton biomass (Section 3.5.1), naturally occurring in Doris Lake and its classification as meso-eutrophic compared to the oligotrophic/ oligo-mesotrophic Patch Lake and Reference Lake B (see Sections 3.3.9 and 3.5.1), it would be expected that benthos density would naturally be greater in Doris Lake. Temporal trends in benthos density in Doris Lake were significantly different from a slope of zero ($p < 0.05$) and compared to the trend in Reference Lake B ($p < 0.05$). Graphical analysis suggests benthos density increased between 2012 and 2015 relative to the baseline and early monitoring years in Doris Lake (Figure 3.6-1). However, there is only a single baseline observation for Doris Lake and therefore it is difficult to discern the range of natural variability for benthos density in Doris Lake. Total densities within Doris Lake have been variable in a given year but the mean density has shown no clear direction trend since 2015.

Increased densities in Doris Lake in 2014 to 2017 triggered a low action level response in the 2017 AEMP, and the *Aquatic Response Plan for Benthos Density* (ERM 2018) was written. A review of the monitoring data collected as part of the 2017 AEMP did not reveal an obvious Project-related cause for the observed increase in benthos density. There were no apparent Project-related increases in water column nutrient concentrations that might be indicative of eutrophication, nor to any indicators of enhanced productivity such as sediment total organic carbon content and chlorophyll *a* concentrations (ERM 2018). Several hypotheses were proposed in the Response Plan to explain the increase in density, including higher than usual under-ice dissolved oxygen concentrations that could have stimulated invertebrate density through increased reproduction, survival, growth, or emergence; a naturally occurring cyclical pattern of abundance; or natural variability (ERM 2018). The ecological implications of the observed increase in benthos density without a co-occurring change in an indicator of eutrophication (e.g., phytoplankton biomass, nutrient concentrations) and without any discernible change in benthos family composition, richness, or diversity was considered to be low (ERM 2018). An adverse change in benthos density is considered to be a decrease because benthic invertebrates serve as prey items for bottom-feeding fish. The Project does not have effluent discharge into the freshwater aquatic habitats, though monitoring programs that have studied the effects of mine effluent discharge on freshwater benthos communities have mostly reported declines in benthos density as a result of the toxic effects of metals in effluents (see AETE Program (1999) for a review). An increase in density is not considered to be adverse, unless it co-occurs with other changes in benthic community indicators (such as a decrease in richness, diversity, and evenness), changes in indicators of eutrophication, or other potentially adverse ecosystem changes. Therefore, since benthos densities in Doris Lake remain relatively stable since 2015 and greater than the 2009 baseline observation, no action level response was triggered in 2022.




*Notes: Symbols represent observed data values.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dashed lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*

**Figure 3.6-1: Benthic Invertebrate Density in Lakes, Hope Bay AEMP, 2009 to 2022**

### 3.6.2 Family Richness

Benthos family richness is the total number of benthos families (e.g., Chironomidae, Pisidiidae, Naididae, etc.) represented in each sample. Benthos family richness appears to have no directional trend through time in either of the exposure lakes, Patch and Doris lakes, or Reference Lake B (Figure 3.6-2). For Patch Lake, statistical analysis also indicates no significant difference between the *before* period and *after* period mean ($p = 0.6986$). The trend in family richness in Doris Lake was not significantly different from a slope of zero ($p = 0.7901$). Two replicates in Doris Lake were less than the baseline year observation in 2022, however there is only a single baseline observation to compare to and through time a similar range of variability has been consistently observed in Doris Lake, and Reference Lake B (Figure 3.6-2). Therefore, there was no evidence of a Project-related change in richness over time and no action level response was triggered in 2022.

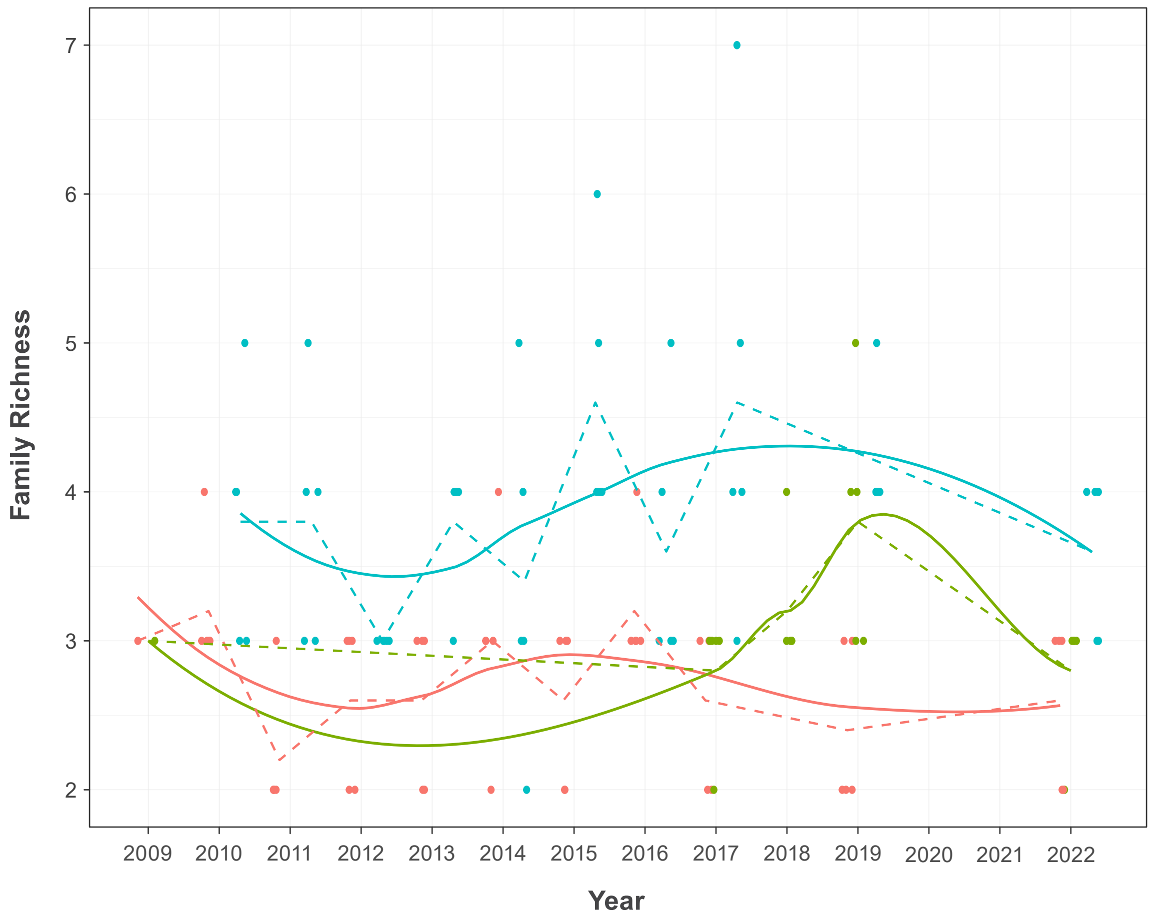
### 3.6.3 Family Evenness

Benthos family evenness is a measure of how evenly distributed families are within the benthos assemblage. The index ranges from 0 to 1, with 1 representing complete evenness. For example, given two hypothetical communities (A and B) each consisting of 100 individuals belonging to four benthos families but with differing family distributions of 25%, 25%, 25%, and 25% in Community A and 97%, 1%, 1%, and 1% in Community B, Community A would have an evenness index of 1, while Community B would have an evenness index of 0.27.

Family evenness has been variable both through time and among replicates within a given year for both exposure lakes, Patch and Doris lakes, and Reference Lake B (Figure 3.6-3). In Patch Lake, mean evenness appears to have been greater in 2019 and 2022 relative to the *before* period observations and statistical analyses indicated a significant difference between the *before* and *after* period means ($p < 0.05$). Although the statistical comparison of the *before* and *after* means in Patch Lake significantly differed from Reference Lake B ($p < 0.05$), graphical analysis suggest that years in both the *before* period (2017) and *after* period (2022) when Patch Lake and Reference Lake B were both monitored, similar evenness was observed. In addition, a slight increase in evenness over time with no corresponding change in other benthos community metrics is not of adverse concern for the aquatic ecosystem, periods of relatively high and relatively low evenness have been observed throughout time in Reference Lake B. The introduction of contaminants into aquatic systems typically results in a reduction in richness and evenness of benthic communities as sensitive species disappear and the community becomes dominated by relatively few opportunistic species capable of tolerating adverse environmental conditions (e.g., Rygg 1985; Johnston and Roberts 2009). For Doris Lake, the trend for benthos family evenness through time was not significantly different from a slope of zero ($p = 0.1762$). Some replicates in Doris Lake were less than the baseline year observation in 2022, however there is only a single baseline observation to compare to and through time a similar range of variability has been observed in Doris Lake, and Reference Lake B (Figure 3.6-3). Therefore, there was no evidence of an adverse Project-related change in family evenness and no action level response was triggered in 2022.

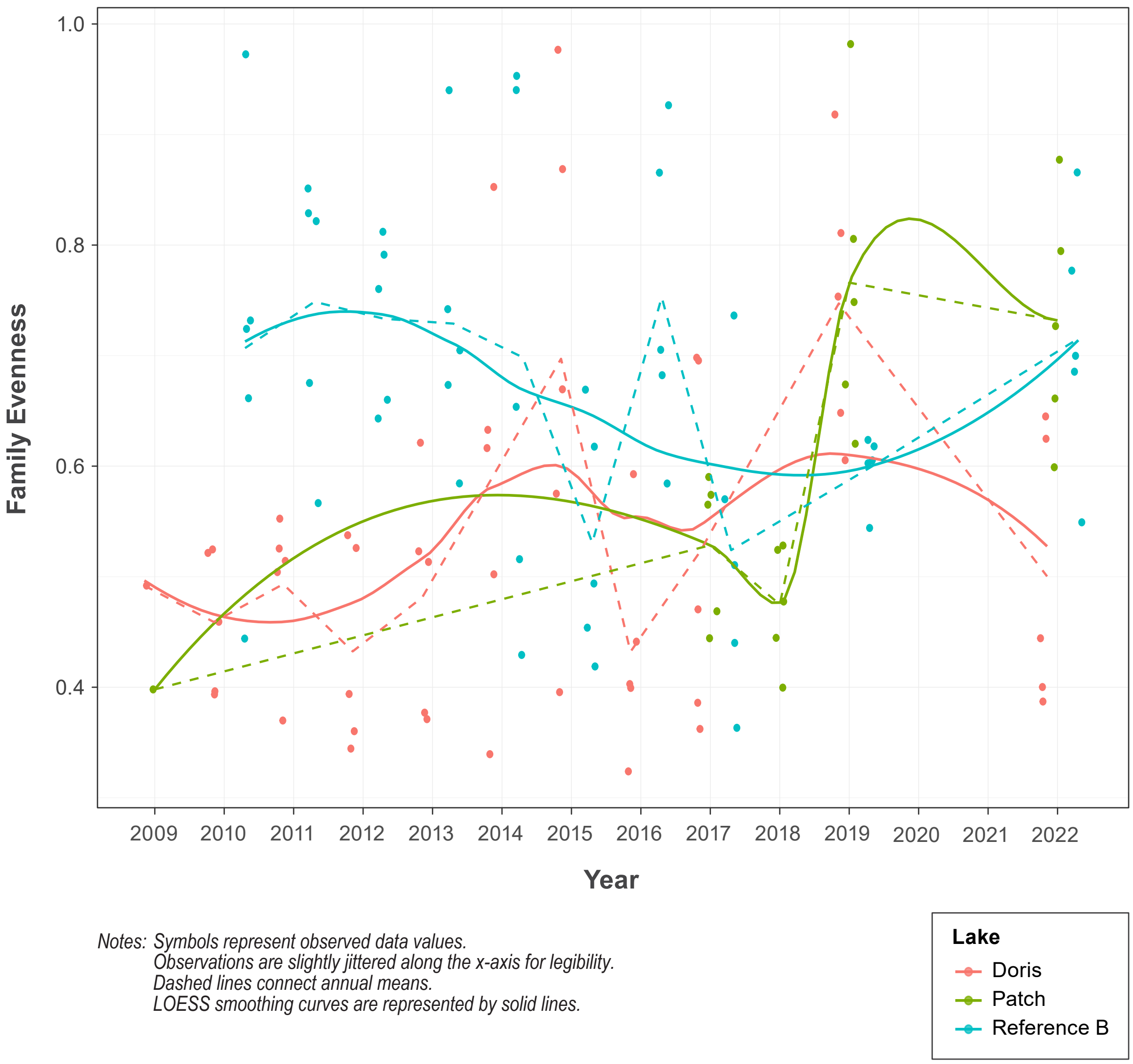
### 3.6.4 Bray-Curtis Index

The Bray-Curtis dissimilarity index is an estimate of the percentage of difference in the community composition between sites (Environment Canada 2012). The Bray-Curtis index compares the community composition at each exposure or reference lake to the median reference community composition. Since the Bray-Curtis index measures the percent difference between sites, the greater the dissimilarity value between a site and the median reference community, the more dissimilar those benthos communities are. The Bray-Curtis index ranges from 0 to 1, with 0 representing identical communities and 1 representing completely dissimilar communities.




*Notes: Symbols represent observed data values.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dashed lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*

**Figure 3.6-2: Benthic Invertebrate Family Richness in Lakes, Hope Bay AEMP, 2009 to 2022**




*Notes: Symbols represent observed data values.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dashed lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*

**Figure 3.6-3: Benthic Invertebrate Family Evenness in Lakes, Hope Bay AEMP, 2009 to 2022**

The Bray-Curtis dissimilarity index has been generally stable in both exposure lakes and Reference Lake B (Figure 3.6-4). The Bray-Curtis index has been greater in Patch and Doris lakes through time relative to Reference Lake B. The Bray-Curtis index calculated for the reference lake and the median reference community composition are auto-correlated (they are both calculated from the reference lake replicates and thus are not independent; Borcard and Legendre 2013); therefore, the Bray-Curtis index for the reference lake will generally be closer to zero (i.e., more similar to the median reference community composition) than the index calculated for each exposure site. The evaluation of effects is based on a determination of whether differences between exposure and reference lakes are increasing over time, which would suggest that communities are become increasingly divergent or less similar over time.
In Patch Lake observations in 2022 were variable with some replicates slightly lower than historically observed however, there is one year of baseline data (2017). Statistical analysis indicates no significant difference between the *before* and *after* period ($p = 0.6883$). For Doris Lake, there are no baseline data however statistical analysis indicate that the Bray-Curtis index was not significantly different from a slope of zero through time (p = 0. 0.0626). Therefore, there was no evidence of a Project-related change in Bray-Curtis dissimilarity index over time between either of the exposure lakes and the reference lake, and no action level response was triggered in 2022.

### 3.6.5 Benthic Invertebrate Summary

Tables 3.6-1 and 3.6-2 provide summaries of the evaluation of effects for benthos indicators in Patch and Doris lakes respectively. Table 3.6-3 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 2.2.3.3).

**Table 3.6-1: Summary of Evaluation of Effects for Patch Lake Benthic Invertebrate Indicators, Hope Bay AEMP, 2022**

| Benthic Invertebrate Indicator | Statistical Analysis: BA or BACI Analysis | | Graphical Analysis/ Interpretation | Conclusion of Effect [c] |
|---|---|---|---|---|
| | Within Lake Before-After Change (BA Analysis)? [a] | Difference in Before-After Trend Relative to Reference Lake (BACI Analysis)? [a] | Evidence of an Adverse[b] Project-related Change? | |
| Density | No | - | No | No effect |
| Richness | No | - | No | No effect |
| Evenness | Yes | Yes | No | No effect |
| Bray-Curtis Index | No | - | No | No effect |

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

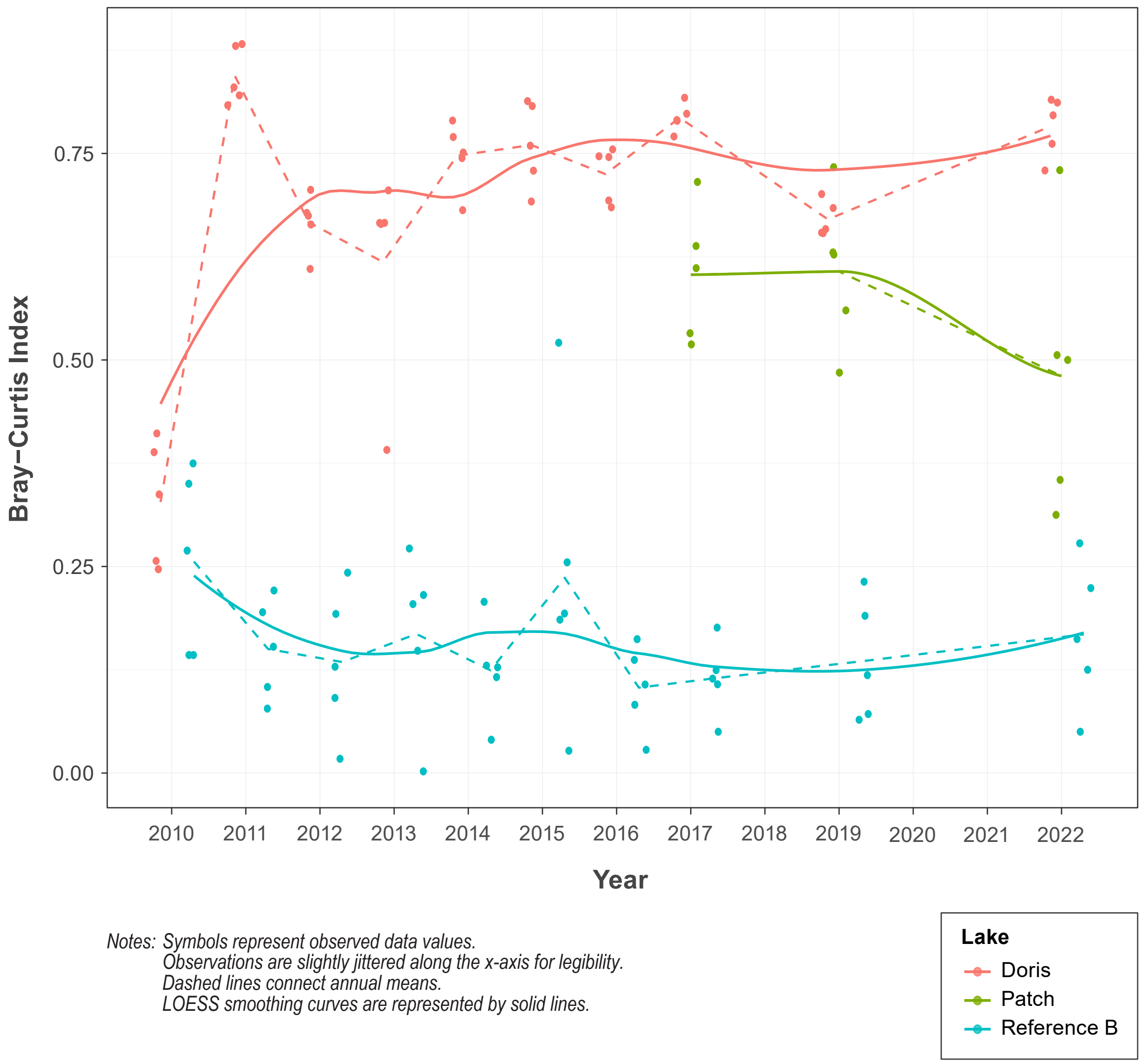
[b] *Only a decrease from baseline levels is considered to be an adverse effect.*

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

*Notes:*

*BA = Before-After, BACI = Before-After/Control-Impact.*

*Dash (-) 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.*




*Notes: Symbols represent observed data values.*
*Observations are slightly jittered along the x-axis for legibility.*
*Dashed lines connect annual means.*
*LOESS smoothing curves are represented by solid lines.*

**Figure 3.6-4: Benthic Invertebrate Bray-Curtis Index in Lakes, Hope Bay AEMP, 2009 to 2022**

### Table 3.6-2: Summary of Evaluation of Effects for Doris Lake Benthic Invertebrate Indicators, Hope Bay AEMP, 2022

| Benthic Invertebrate Indicator | Statistical Analysis: Linear Mixed Model or Tobit Regression | | Graphical Analysis/ Interpretation | Conclusion of Effect [b] |
|---|---|---|---|---|
| | Different from Slope 0? [a] | Different from Reference Lake B Slope? [a] | Evidence of an Adverse Project-related Change? | |
| Density | Yes | Yes | No | No effect |
| Richness | No | - | Yes | No effect |
| Evenness | No | - | No | No effect |
| Bray-Curtis Index | No | - | No baseline data available | No effect |

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

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

*Note:*

*Dash (-) 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.*

The evaluation of effects concluded that there were no Project-related changes in benthos indicators in 2022 in either Patch or Doris lakes. As shown in Table 3.6-3, at least one condition was not met for each exposure lake/indicator combination; therefore, no low action level responses were triggered for benthos in 2022.

### Table 3.6-3: Comparison of Benthic Invertebrate Indicators to Response Framework Conditions for Triggering a Low Action Level Response, Hope Bay AEMP, 2022

| Exposure Lake: | Patch Lake | | | Doris Lake | | | Low Action Level Response Triggered for Any Lake? |
|---|---|---|---|---|---|---|---|
| Conditions for Low Action Level Response: | Conditions Met | Conditions Not Met | Conditions Not Evaluated[a] | Conditions Met | Conditions Not Met | Conditions Not Evaluated[a] | |
| Density | 2[b] | 1 | 3, 4 | | 1, 2 | 3, 4 | No |
| Richness | | 1, 2 | 3, 4 | 2[b] | 1 | 3, 4 | No |
| Evenness | | 1, 2 | 3, 4 | 2[b] | 1, 2 | 3, 4 | No |
| Similarity | | 1, 2 | 3, 4 | | 1, 2 | 3, 4 | No |

*[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 baseline data).*

*[b] Condition 2 is met if at least one replicate is lower that the baseline range.*

*Notes:*

*Condition 1: the identification of a statistically significant decrease in density, evenness, richness, or similarity from baseline conditions.*

*Condition 2: the benthos indicator is less that the normal range based on baseline conditions.*

*Condition 3: if a decrease is detected at the exposure site, the absence of a similar decrease at the reference location.*

*Condition 4: the magnitude of the decrease exceeds the critical effects size of ± 2 within-reference-area standard deviations (SD), as recommended by Environment Canada (2012).*

# 4. SUMMARY OF EFFECTS ANALYSIS

Physical, chemical, and biological data from 2022 were evaluated against historical data and reference lake data to determine if there was any evidence of Project-related effects to the freshwater environment for the following components:

- Fish habitat (water level, ice thickness, and stream hydrology);
- Physical limnology (dissolved oxygen and water temperature);
- water quality;
- sediment quality;
- phytoplankton; and
- benthic invertebrates.

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. The conclusions of the AEMP evaluation of effects feed into the Response Framework. 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 (ice thickness, water level, and stream hydrology), under-ice dissolved oxygen concentrations, water temperature, water quality, or phytoplankton biomass were detected in the exposure lakes. Accordingly, no low action level responses were triggered for any assessed variable in the 2022 AEMP. Table 4-1 presents a summary of the conclusions of the 2022 evaluation of effects.

### Table 4-1: Summary of Evaluation of Effects, Hope Bay AEMP, 2022

| Variable | Exposure Lakes Included in Evaluation of Effects | Conclusion of Effect | Low Action Level Triggered? |
|---|---|---|---|
| **Fish Habitat** | | | |
| Water level, ice thickness, and stream hydrology | 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 | | No Effect | No |
| Chloride | | No Effect | No |
| Fluoride | | No Effect | No |
| Total Ammonia | | No Effect | No |
| Nitrate | | No Effect | No |

| Variable | Exposure Lakes Included in Evaluation of Effects | Conclusion of Effect | Low Action Level Triggered? |
|---|---|---|---|
| Nitrite | Windy Lake, Patch Lake, Doris Lake | 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 |
| Dissolved Manganese | | 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 |
| **Sediment Quality** | | | |
| Arsenic | Patch Lake, Doris Lake | No Effect | No |
| Cadmium | | No Effect | No |
| Chromium | | No Effect | No |
| Copper | | No Effect | No |
| Lead | | No Effect | No |
| Mercury | | No Effect | No |
| Zinc | | No Effect | No |
| **Phytoplankton** | | | |
| Biomass (chlorophyll *a*) | Patch Lake, Doris Lake | No Effect | No |
| **Benthic Invertebrates** | | | |
| Density | Patch Lake, Doris Lake | No Effect | No |
| Family Richness | | No Effect | No |
| Simpson’s Evenness Index | | No Effect | No |
| Bray-Curtis Index | | No Effect | No |

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# APPENDIX A 2022 DATA REPORT

March 2023

# HOPE BAY PROJECT

## 2022 Aquatic Effects Monitoring Program Report

# Appendix A: 2022 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

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# Appendix A: 2022 Data Report

This data report presents the sampling methods, the raw data, and summary figures and tables of the results of the 2022 Aquatic Effects Monitoring Program (AEMP) for the Hope Bay Project (the Project). Section A.1 presents the methods, and Sections A.2 to A.7 present the 2022 data and summary tables and figures.

The 2022 AEMP was conducted according to the *Hope Bay Project: Aquatic Effects Monitoring Plan* (the Plan; TMAC 2018). The 2022 AEMP included the collection of the following data in lakes with the potential to be affected by the current Project activities (i.e., exposure lakes): water level, ice thickness, Secchi depth, temperature and dissolved oxygen profiles, water quality, sediment quality, phytoplankton biomass, and the benthic invertebrate (benthos) community. All methods and data relating to water level and stream hydrological monitoring are presented in Appendix B and are not repeated here.

## A.1 Sampling Methods and Data Analysis

### *A.1.1 Sampling Sites*

Figure A.1-1 provides an overview of sampling sites included in the 2022 AEMP, and Figures A.1-2 to A.1-6 show detailed maps of the sampling components and bathymetric contours when available for each sampled lake.

### *A.1.2 Sampling Program Summary*

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

### *A.1.3 Ice Thickness*

Ice thickness was measured between April 7 and 10, 2022. Ice thickness data were collected at the ten lakes indicated in Figure A.1-1. Ice thickness measurements at Windy Lake, Patch Lake, Doris Lake, and Reference Lake B were collected concurrently with water quality sampling and water profiling. A 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.

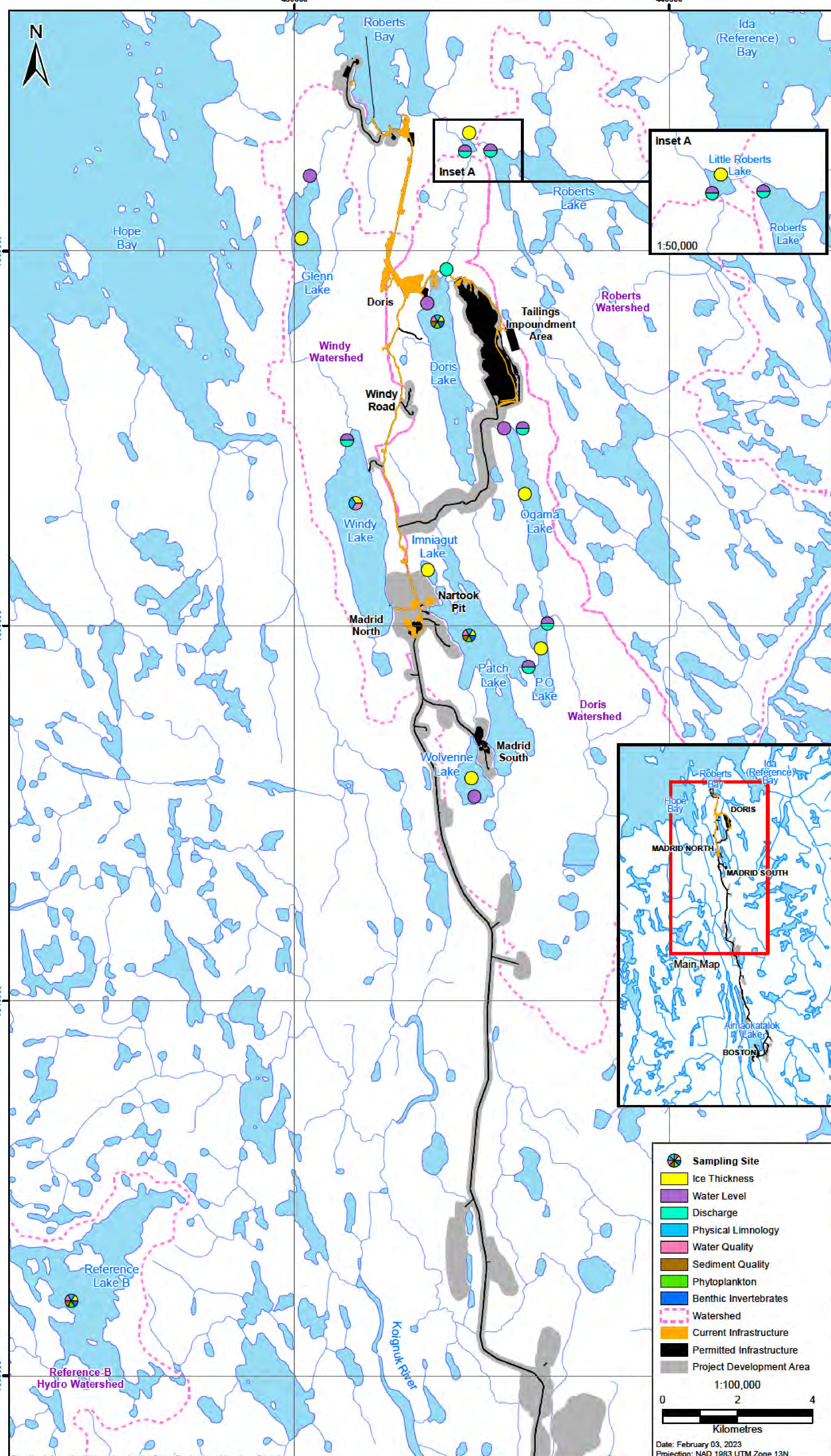



**Figure A.1-1: Sampling Sites, Hope Bay AEMP, 2022**

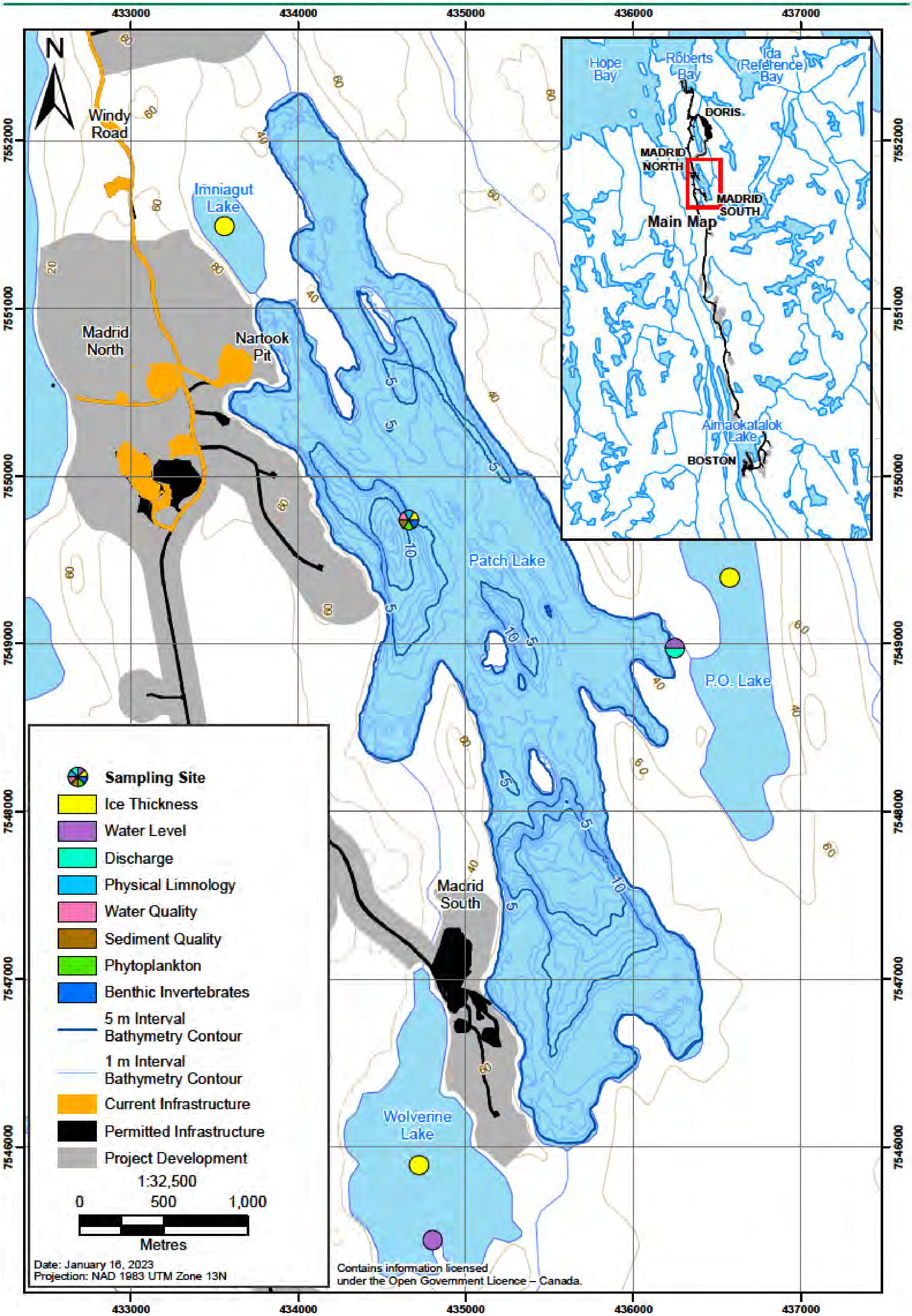



**Figure A.1-2: Patch Lake, Imniagut Lake, P.O. Lake, and Wolverine Lake Sampling Sites, Hope Bay AEMP, 2022**

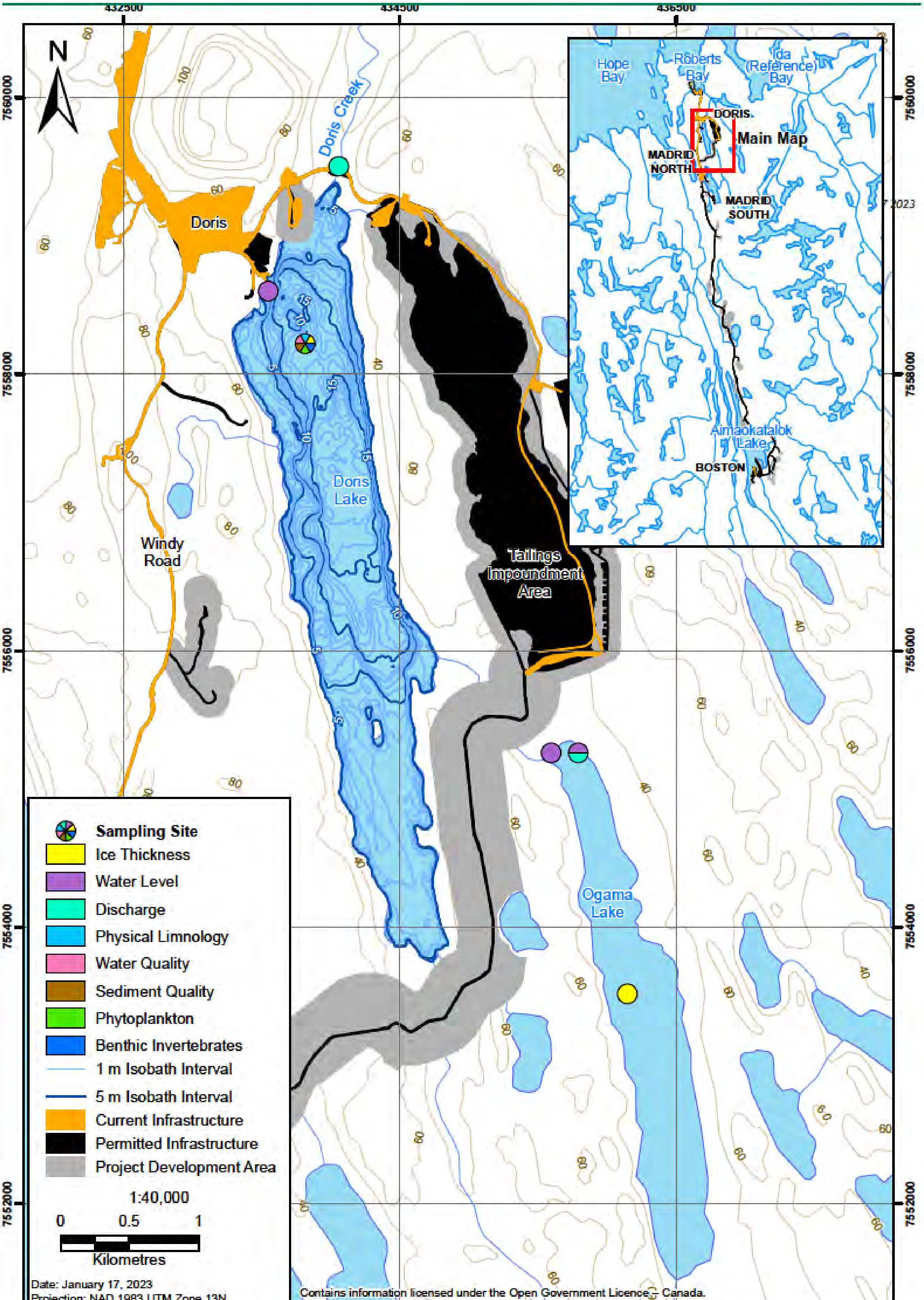



**Figure A.1-3: Doris Lake and Ogama Lake Sampling Sites, Hope Bay AEMP, 2022**

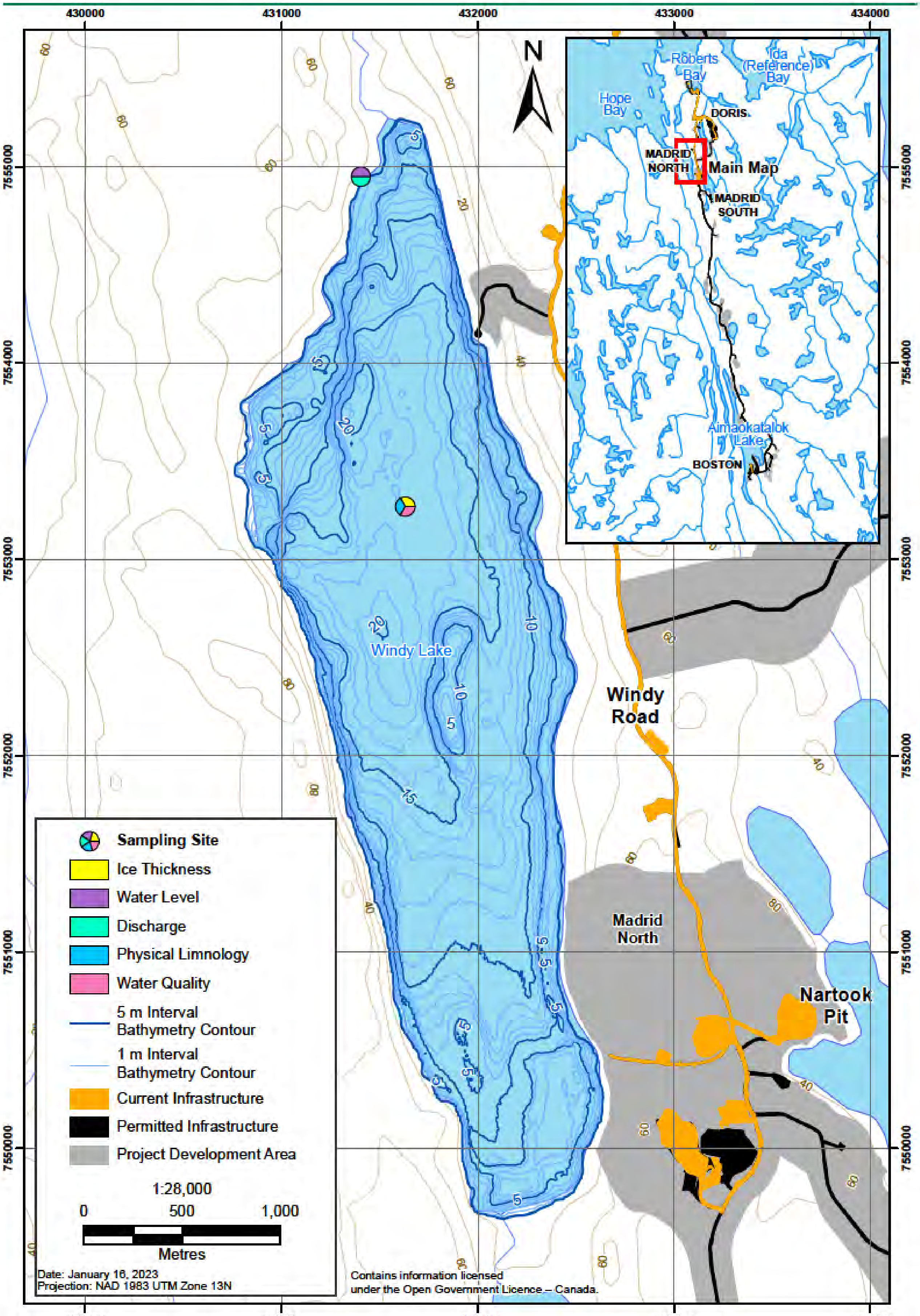



**Figure A.1-4: Windy Lake Sampling Sites, Hope Bay AEMP, 2022**

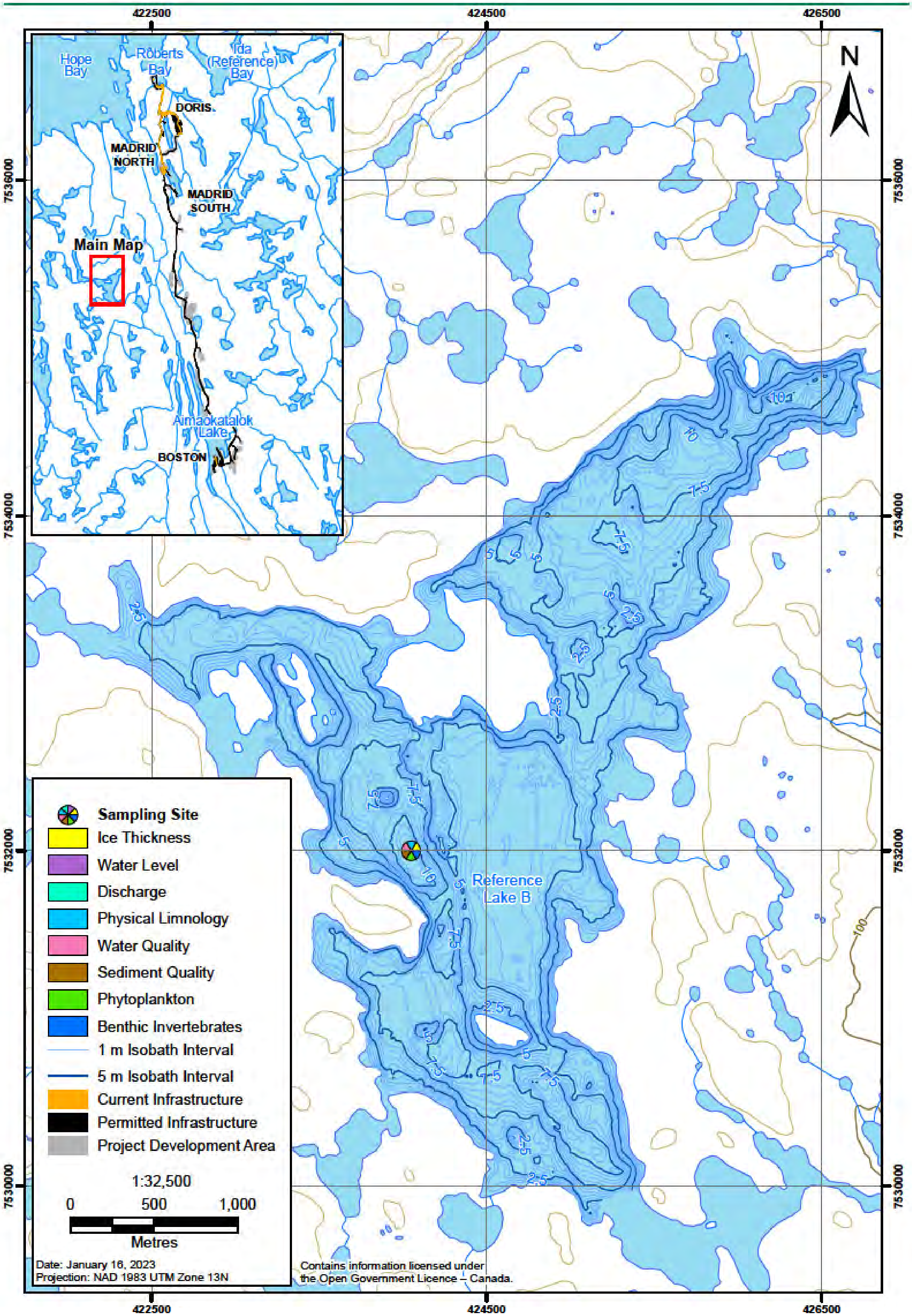



**Figure A.1-5: Reference Lake B Sampling Site, Hope Bay AEMP, 2022**

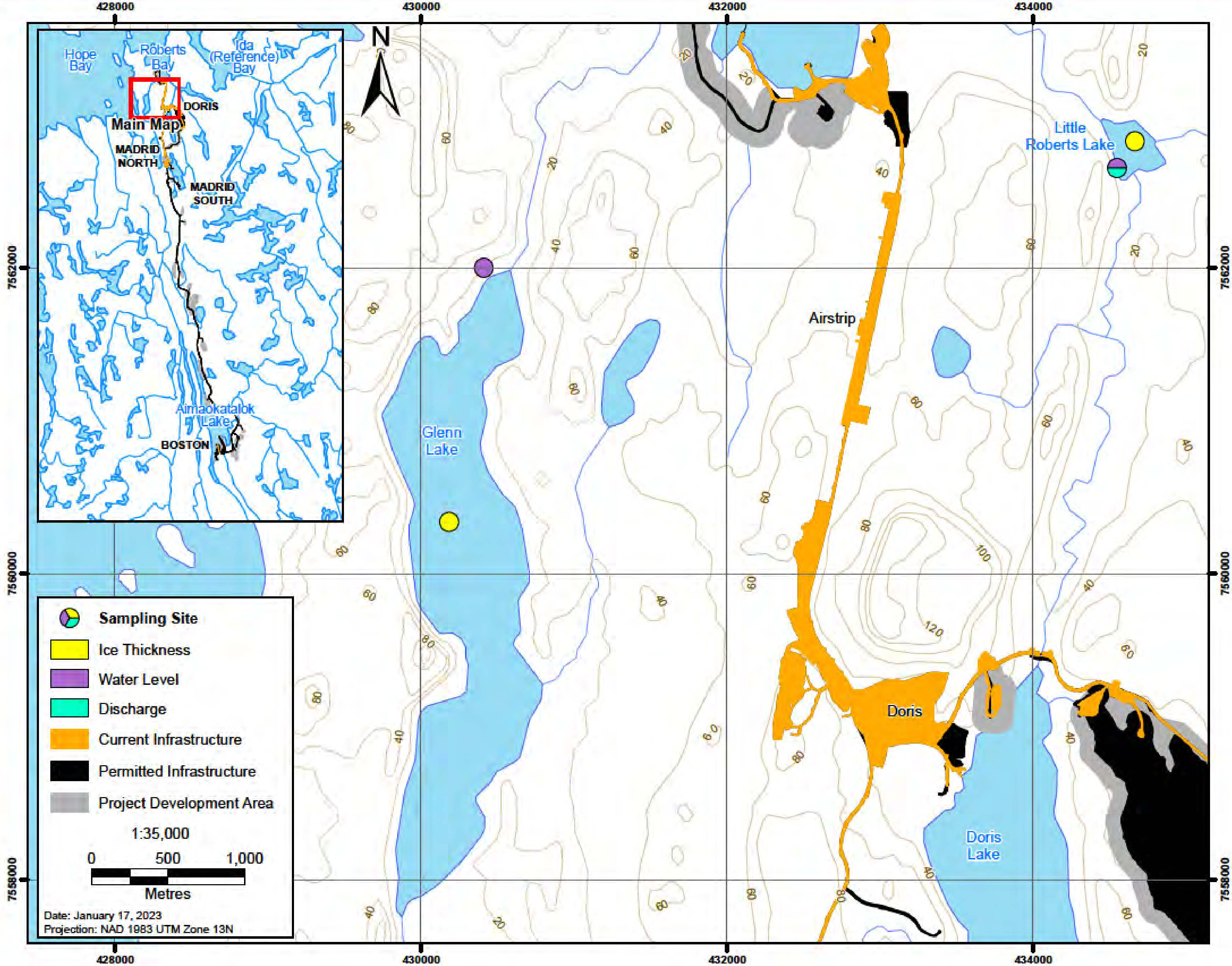



**Figure A.1-6: Glenn Lake and Little Roberts Lake Sampling Sites, Hope Bay AEMP, 2022**

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

| Monitoring Component | Sampling Frequency | Sample Replication and Depths | Sample Timing | Sampling Device |
|---|---|---|---|---|
| **Ice Thickness** | | | | |
| Ice thickness measurement | 1× per year | n = 1 measurement/site | April | 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 variable, nutrients, metals | 2× per year | n = 1 @ 1 m below the surface,<br>n = 1 @ 2 m above water-sediment interface,<br>+ 10% replication per sampling event | April, August | Niskin or GO-FLO water sampler |
| **Sediment Quality** | | | | |
| Particle size, metals | 1× every 3 years | n = 3/site | August | Ekman grab |
| **Phytoplankton** | | | | |
| Biomass (chlorophyll *a*) | 1× per year | n = 3/site @ 1 m below the surface | August | GO-FLO water sampler, filtration equipment |
| **Benthic Invertebrates** | | | | |
| Density and taxonomy | 1× every 3 years | n = 5/site (3 composite sub-samples per replicate) | August | Ekman grab, 500-µm sieve bag |

## *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 hole through the ice using a motorized auger. The water column depth under the ice was measured using a depth sounder.

Temperature and dissolved oxygen measurements were collected using a calibrated YSI ProODO meter equipped with an optical dissolved oxygen 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 as the probe was lowered through the water.

### *A.1.4.2 Open-water Season*

Open-water season temperature and dissolved oxygen profiles were collected from a boat at the same sites as in the ice-covered season. Profiles were collected using a calibrated 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 through the water.

The euphotic zone depth was estimated from the light attenuation in each lake using a Secchi disk. Light attenuation measurements were collected at each site by lowering the 20-cm black and white Secchi disk on a metred line through the water column on the shaded side of the boat until it disappeared from sight. The depth of disappearance was recorded. 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 (Z1%) 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 et al. 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 dissolved oxygen concentrations.

## *A.1.5 Water Quality*

Water quality samples were collected at lake sites in April (under-ice) and in August (open-water) in 2022. For each lake, water quality samples were collected from 1 m below the ice-water interface (under-ice sampling) or water surface (open-water sampling) and approximately 2 m from the water-sediment interface (lake bottom).

Analysed variables are presented in Table A.1-2. Sampling sites are presented in Figures A.1-1 to A.1-6.

### *A.1.5.1 Under-ice Season*

During the under-ice season, the underlying water was accessed through an augured hole in the ice, following the collection of water column profiles. A 2.5-L Niskin water sampler was used to collect water from under the ice layer. This sampler was designed to “trip” and collect discrete samples during freezing temperatures. To minimize metal contamination, the tripping mechanism used acid-cleaned silicone tubing within the interior of the sampler. A dual rope system was used to trigger the sampler to close and to ensure the collection of discrete samples. Prior to the collection of water quality samples, the Niskin sampler 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.

## Table A.1-2: Analysed Water Quality Variables and Realized Detection Limits, Hope Bay AEMP, 2022

| Variable | Units | Realized Detection Limits | Variable | Units | Realized Detection Limits |
|---|---|---|---|---|---|
| **Physical Tests** | | | **Total Metals *(cont'd)*** | | |
| Conductivity | µS/cm | 2 | Lanthanum | mg/L | 0.00005 |
| Total Alkalinity (as $CaCO_3$) | mg/L | 1 | Lead | mg/L | 0.00005 |
| Total Hardness (as $CaCO_3$) | mg/L | 0.5 | Lithium | mg/L | 0.0005 to 0.001 |
| Dissolved Hardness (as $CaCO_3$) | mg/L | 0.5 | Magnesium | mg/L | 0.005 to 0.01 |
| pH | pH | 0.1 | Manganese | mg/L | 0.0001 to 0.0002 |
| Total Suspended Solids | mg/L | 1 to 3 | Mercury | mg/L | 0.000005 |
| Turbidity | NTU | 0.1 | Molybdenum | mg/L | 0.00005 |
| **Anions and Nutrients** | | | Nickel | mg/L | 0.0002 to 0.0005 |
| Total Ammonia (as N) | mg/L | 0.005 | Niobium | mg/L | 0.0001 |
| Bromide | mg/L | 0.05 | Phosphorus | mg/L | 0.05 |
| Chloride | mg/L | 0.5 | Potassium | mg/L | 0.03 to 0.05 |
| Fluoride | mg/L | 0.02 | Rhenium | mg/L | 0.000005 |
| Nitrate (as N) | mg/L | 0.005 | Rubidium | mg/L | 0.00002 to 0.0002 |
| Nitrite (as N) | mg/L | 0.001 | Selenium | mg/L | 0.00005 to 0.0002 |
| Total Phosphorus | mg/L | 0.002 | Silicon | mg/L | 0.1 |
| Sulphate ($SO_4$) | mg/L | 0.3 | Silver | mg/L | 0.000005 to 0.00001 |
| Organic Carbon | | | Sodium | mg/L | 0.02 to 0.05 |
| Dissolved Organic Carbon | mg/L | 0.5 | Strontium | mg/L | 0.0002 |
| Total Organic Carbon | mg/L | 0.5 | Sulphur | mg/L | 0.5 |
| **Total Metals** | | | Tantalum | mg/L | 0.0001 |
| Aluminum | mg/L | 0.003 | Tellurium | mg/L | 0.00005 to 0.0002 |
| Antimony | mg/L | 0.00003 to 0.0001 | Thallium | mg/L | 0.000005 to 0.00001 |
| Arsenic | mg/L | 0.00005 to 0.0001 | Thorium | mg/L | 0.000005 to 0.0001 |
| Barium | mg/L | 0.0001 | Tin | mg/L | 0.0001 to 0.0002 |
| Beryllium | mg/L | 0.000005 to 0.00002 | Titanium | mg/L | 0.0002 to 0.0003 |
| Bismuth | mg/L | 0.00005 | Tungsten | mg/L | 0.00001 to 0.0001 |
| Boron | mg/L | 0.01 | Uranium | mg/L | 0.000002 to 0.00001 |
| Cadmium | mg/L | 0.000005 | Vanadium | mg/L | 0.0002 to 0.0005 |
| Calcium | mg/L | 0.02 to 0.05 | Yttrium | mg/L | 0.000005 |
| Cesium | mg/L | 0.000005 to 0.00001 | Zinc | mg/L | 0.003 |
| Chromium | mg/L | 0.0005 | Zirconium | mg/L | 0.00005 to 0.0002 |
| Cobalt | mg/L | 0.00005 to 0.0001 | **Dissolved Metals** | | |
| Copper | mg/L | 0.0005 | Manganese | mg/L | 0.0001 to 0.0002 |
| Gallium | mg/L | 0.00005 | Zinc | mg/L | 0.001 |
| Iron | mg/L | 0.01 | | | |

Samples for the various water quality components (e.g., physical variables, 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 variables bottle and field filtered using clean syringe filters, the remaining water in the general variables sample bottle was then discarded and the bottle was refilled with sample water for general variables analysis.

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 variables analysed and realized detection limits are summarized in Table A.1-2.

#### *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 water sampler. 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 variable in each duplicate sample.

As recommended by Clark (2003), RPDs were calculated for specific water quality variables 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 for QA/QC samples with acceptable limits for sample recovery, precision, and accuracy. When data quality objectives are not met, ALS flags the sample for follow-up or adjusts the detection limit as required.

### *A.1.6 Sediment Quality*

Sediment quality samples were collected during the open-water season in August 2022. This sampling coincided with benthic invertebrate sampling. Sampling sites are indicated in Figures A.1-1 to A.1-6.

Lake sediments were collected using an Ekman grab sampler. For each lake, three replicates of sediment quality data were collected from the bottom approximately 20 metres apart to capture the heterogeneity of the lake sediments. The Ekman was opened and the trigger mechanism carefully set, the sampler was then lowered gradually onto the sediment surface using a metred line, and triggered to close with a messenger. The sampler was brought aboard the boat and inspected to ensure the collection of an intact, undisturbed sample. Water from the surface of the sediments was carefully decanted and the sample was transferred into a clean tray, where the top 2 to 3 cm of sediment was collected using a plastic spoon and transferred into a plastic bowl. The sample was homogenized in the plastic bowl and placed into two Whirl-Pak bags: one for particle size, and one for sediment chemistry. Samples were refrigerated (in darkness) until they were shipped to ALS Yellowknife and subsequently transferred to ALS Burnaby for analysis. The sediment quality variables that were analysed and their corresponding detection limits are presented in Table A.1-3.

### Table A.1-3: Analysed Sediment Quality Variables and Realized Detection Limits, Hope Bay AEMP, 2022

| Variable | Unit | Realized Detection Limit | Variable | Unit | Realized Detection Limit |
|---|---|---|---|---|---|
| **Physical Tests** | | | **Metals *(cont'd)*** | | |
| Moisture | % | 0.25 | Copper | mg/kg | 0.5 |
| pH (1:2 soil:water) | pH unit | 0.1 | Iron | mg/kg | 50 |
| **Particle Size** | | | Lead | mg/kg | 0.5 |
| Gravel (>2 mm) | % | 1 | Lithium | mg/kg | 2 |
| Sand (2.0 mm to 0.063 mm) | % | 1 | Magnesium | mg/kg | 20 |
| Silt (0.063 mm to 4 µm) | % | 1 | Manganese | mg/kg | 1 |
| Clay (<4 µm) | % | 1 | Mercury | mg/kg | 0.005 |
| **Anions and Nutrients** | | | Molybdenum | mg/kg | 0.1 |
| Total Nitrogen by LECO | % | 0.02 | Nickel | mg/kg | 0.5 |
| **Organic / Inorganic Carbon** | | | Phosphorus | mg/kg | 50 |
| Total Organic Carbon | % | 0.088 to 0.35 | Potassium | mg/kg | 100 |
| **Metals** | | | Selenium | mg/kg | 0.2 |
| Aluminum | mg/kg | 50 | Silver | mg/kg | 0.1 |
| Antimony | mg/kg | 0.1 | Sodium | mg/kg | 50 |
| Arsenic | mg/kg | 0.1 | Strontium | mg/kg | 0.5 |
| Barium | mg/kg | 0.5 | Sulfur | mg/kg | 500 |
| Beryllium | mg/kg | 0.1 | Thallium | mg/kg | 0.05 |
| Bismuth | mg/kg | 0.2 | Tin | mg/kg | 2 |
| Boron | mg/kg | 5 | Titanium | mg/kg | 1 |
| Cadmium | mg/kg | 0.02 | Uranium | mg/kg | 0.05 |
| Calcium | mg/kg | 50 | Vanadium | mg/kg | 0.2 |
| Chromium | mg/kg | 0.5 | Zinc | mg/kg | 2 |
| Cobalt | mg/kg | 0.1 | Zirconium | mg/kg | 1 |

#### A.1.6.1 Quality Assurance and Quality Control

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

The laboratory QA/QC program included 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 for QA/QC samples with acceptable limits for sample recovery, precision, and accuracy. When data quality objectives are not met, ALS flags the sample for follow-up or adjusts the detection limit as required.

### A.1.7 Phytoplankton Biomass

Chlorophyll *a* samples were collected during the open-water season in August 2022, coincident with the collection of water quality samples. Sampling sites are indicated in Figures A.1-1 to A.1-6.

Phytoplankton biomass samples were collected 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). 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 metre 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.1.7.1 Quality Assurance and Quality Control

The QA/QC program for chlorophyll a sampling included the collection of replicates and the use of chain of custody forms to track samples.

The laboratory QA/QC program included the use of method blanks and laboratory control samples. ALS has set data quality objectives for QA/QC samples with acceptable limits for sample recovery, precision, and accuracy. When data quality objectives are not met, ALS flags the sample for follow-up or adjusts the detection limit as required.

### A.1.8 Benthic Invertebrates

Benthos samples were collected during the open-water season in August 2022, coincident with the collection of sediment quality samples. Sampling sites are indicated in Figures A.1-1 to A.1-6.

For each lake, five replicate samples were collected from the bottom, approximately 20 metres apart to capture the heterogeneity of the benthic community within the lake sediments. Each replicate sample consisted of three separate subsamples that were collected and pooled. Samples were obtained using an Ekman grab sampler (surface sampling area of 0.0225 $m^2$), with subsamples collected from the same general area and replicates collected approximately 5 to 20 m apart. The Ekman was opened and the trigger mechanism carefully set, the sampler was then lowered slowly onto the sediment using a metred line, and triggered to close with a messenger. The sampler was brought aboard the boat and each grab was transferred into a 500 µm sieve bag and rinsed with site-specific lake water until free of sediments. The material retained within the sieve was then placed into a labelled plastic jar and preserved with buffered formalin to a final concentration of 10%. Benthos samples were sent to Dr. Jack Zloty (Summerland, BC) for enumeration and identification.

Raw benthic invertebrate counts were pre-processed to exclude a number of organisms: cladocerans and copepods were excluded as these groups are generally planktonic, and ostracods and nematodes were excluded as these groups belong to the meiofauna size class (invertebrates ranging in size between 63 µm and 500 µm) and are not sampled consistently with the AEMP methods (a 500-µm sieve). Community descriptors including total benthic invertebrate density, family richness, Simpson's evenness index, and the Bray-Curtis similarity index were calculated from the taxonomic data according to the methods described in Environment Canada (Environment Canada 2012).

Total benthos density in each replicate was calculated by taking the sum of all benthic organisms remaining after the pre-processing step that removed planktonic or meiobenthic invertebrates, and dividing this sum by three times the surface area of the Ekman sampler (i.e., 3 × 0.0225 $m^2$) to determine the benthos density in units of organisms/$m^2$ (because each replicate consisted of three pooled Ekman samples). Family richness was calculated as the total number of benthic invertebrate families present in each composite replicate sample.

The Simpson's Evenness Index (E) was calculated as:

$$E = 1 \ / \sum_{i=1}^{F} (p_i)^2 \ / \ F$$

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

The Bray-Curtis dissimilarity index is an estimate of the percentage of difference in the community composition between sites (Environment Canada 2012). The Bray-Curtis Index compares the community composition in a benthos replicate sample to the median reference community composition. This median reference composition is generated from the median density of each represented family from all of the reference site replicates (in this case, replicates collected at Reference Lake B). Since the median reference composition is generated from the median of five reference site replicates, the comparison of a single reference site replicate community composition to the median reference community composition will produce a dissimilarity value (although generally a much lower value than exposure site replicates). Because the Bray-Curtis Index measures the percent difference between sites, the greater the dissimilarity value between a site and the median reference community, the more dissimilar those benthos communities are. The Bray-Curtis Index ranges from zero to one, with zero representing identical communities and one representing completely dissimilar communities.

This index is calculated as:

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

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

### *A.1.8.1 Quality Assurance and Quality Control*

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

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

## A.2 Ice Thickness

Table A.2-1 presents the ice thickness measurements recorded from April 7 to 10, 2022.

### Table A.2-1: Ice Thickness Measurements, Hope Bay AEMP, 2022

| Lake | Sampling Date | Measured Ice Thickness (m) |
|---|---|---|
| Windy | 7-Apr-22 | 1.90 |
| Glenn | 8-Apr-22 | 1.95 |
| Wolverine | 8-Apr-22 | 1.60 |
| Patch | 9-Apr-22 | 1.80 |
| Imniagut | 7-Apr-22 | 1.80 |
| P.O. | 8-Apr-22 | 1.90 |
| Ogama | 8-Apr-22 | 1.80 |
| Doris | 9-Apr-22 | 1.68 |
| Little Roberts | 8-Apr-22 | 1.98 |
| Reference B | 10-Apr-22 | 1.81 |

## A.3 Physical Limnology

Under-ice physical limnology profiles were collected from April 7 to 10, 2022. Under-ice physical limnology data are presented in Figure A.3-1 and Table A.3-1.

Open-water physical limnology (profiles and Secchi depth) were collected from August 17 to 29, 2022. Open-water physical limnology profiles are presented in Figure A.3-2 and Table A.3-2; Secchi depths and calculated euphotic depths are presented in Figure A.3-3 and Table A.3-3.

### Table A.3-1: Under-ice Temperature and Dissolved Oxygen Profiles, Hope Bay AEMP, 2022

| Windy Lake – April 7, 2022 | | | |
|---|---|---|---|
| Ice Thickness = 1.9 m | | | |
| Maximum Depth = 18 m | | | |
| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
| 2 | 0.9 | 16.29 | 114.1 |
| 3 | 1.2 | 16.41 | 115.3 |
| 4 | 1.5 | 15.93 | 113.4 |
| 5 | 1.5 | 15.9 | 113.3 |
| 6 | 1.4 | 15.93 | 113.2 |
| 7 | 1.4 | 15.91 | 113.1 |
| 8 | 1.4 | 15.89 | 113 |
| 9 | 1.4 | 15.87 | 112 |
| 10 | 1.4 | 15.83 | 112.4 |

| Windy Lake – April 7, 2022 | | | |
|---|---|---|---|
| Ice Thickness = 1.9 m | | | |
| Maximum Depth = 18 m | | | |
| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
| 11 | 1.4 | 15.79 | 111.4 |
| 12 | 1.4 | 15.46 | 109.8 |
| 13 | 1.4 | 15.63 | 111.6 |
| 14 | 1.6 | 15.42 | 110.2 |
| 15 | 1.7 | 14.4 | 102.5 |
| 16 | 1.9 | 13.81 | 99.6 |
| 17 | 2.2 | 12.26 | 88.1 |
| 18 | 2.4 | 7.78 | 58.2 |

| Patch Lake – April 9, 2022 | | | |
|---|---|---|---|
| Ice Thickness = 1.8 m | | | |
| Maximum Depth = 8 m | | | |
| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
| 2 | 1.1 | 15.19 | 107.6 |
| 2.5 | 1.7 | 15.08 | 108.2 |
| 3 | 1.8 | 14.96 | 107.5 |
| 3.5 | 1.8 | 14.82 | 106.7 |
| 4 | 1.8 | 14.82 | 106.4 |
| 4.5 | 1.8 | 14.72 | 105.8 |
| 5 | 1.8 | 14.8 | 106.7 |
| 5.5 | 1.9 | 14.86 | 107.1 |
| 6 | 1.9 | 14.87 | 106.8 |
| 6.5 | 1.9 | 14.61 | 105.2 |
| 7 | 1.9 | 13.85 | 99.7 |
| 7.5 | 1.9 | 13.97 | 100.9 |
| 8 | 1.9 | 13.76 | 99.3 |

| Doris Lake – April 9, 2022 | | | |
|---|---|---|---|
| Ice Thickness = 1.68 m | | | |
| Maximum Depth = 14 m | | | |
| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
| 2 | 0.7 | 14.54 | 101.3 |
| 2.5 | 1 | 14.23 | 100.2 |
| 3 | 1.1 | 14.15 | 99.8 |
| 3.5 | 1.1 | 14.13 | 99.7 |
| 4 | 1.1 | 14.12 | 99.6 |
| 4.5 | 1.1 | 14.11 | 99.5 |
| 5 | 1.1 | 14.1 | 99.4 |
| 5.5 | 1.1 | 14.09 | 99.4 |
| 6 | 1.1 | 14.08 | 99.3 |
| 6.5 | 1.1 | 14.07 | 99.2 |
| 7 | 1.1 | 14.06 | 99.2 |
| 7.5 | 1.1 | 14.05 | 99.1 |

| Doris Lake – April 9, 2022 | | | |
|---|---|---|---|
| Ice Thickness = 1.68 m | | | |
| Maximum Depth = 14 m | | | |
| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
| 8 | 1.1 | 14.05 | 99.1 |
| 8.5 | 1.1 | 14.03 | 99 |
| 9 | 1.1 | 14.03 | 98.9 |
| 9.5 | 1.1 | 14.01 | 98.8 |
| 10 | 1.1 | 14 | 98.8 |
| 11 | 1.1 | 13.97 | 98.4 |
| 12 | 1.1 | 13.92 | 98.2 |
| 13 | 1.1 | 12.5 | 87.9 |
| 13.8 | 1.3 | 5.9 | 41.9 |

| Reference Lake B – April 10, 2022 | | | |
|---|---|---|---|
| Ice Thickness = 1.81 m | | | |
| Maximum Depth = 10 m | | | |
| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
| 2 | 0.6 | 15.91 | 110.8 |
| 2.5 | 1 | 15.07 | 106.2 |
| 3 | 1.3 | 14.52 | 103.1 |
| 3.5 | 1.4 | 13.59 | 95.5 |
| 4 | 1.6 | 12.79 | 90.8 |
| 4.5 | 1.7 | 12.02 | 85.2 |
| 5 | 1.8 | 11.25 | 78.9 |
| 5.5 | 2 | 9.52 | 67.9 |
| 6 | 2.1 | 8.41 | 60.1 |
| 6.5 | 2.1 | 7.79 | 55.6 |
| 7 | 2.2 | 7.41 | 56.2 |
| 7.5 | 2.2 | 7.52 | 54 |
| 8 | 2.4 | 6.88 | 49.8 |
| 8.5 | 2.6 | 6.21 | 44.8 |
| 9 | 2.7 | 5.65 | 41 |
| 9.5 | 2.8 | 4.46 | 32.8 |
| 10 | 2.9 | 4.61 | 34.1 |

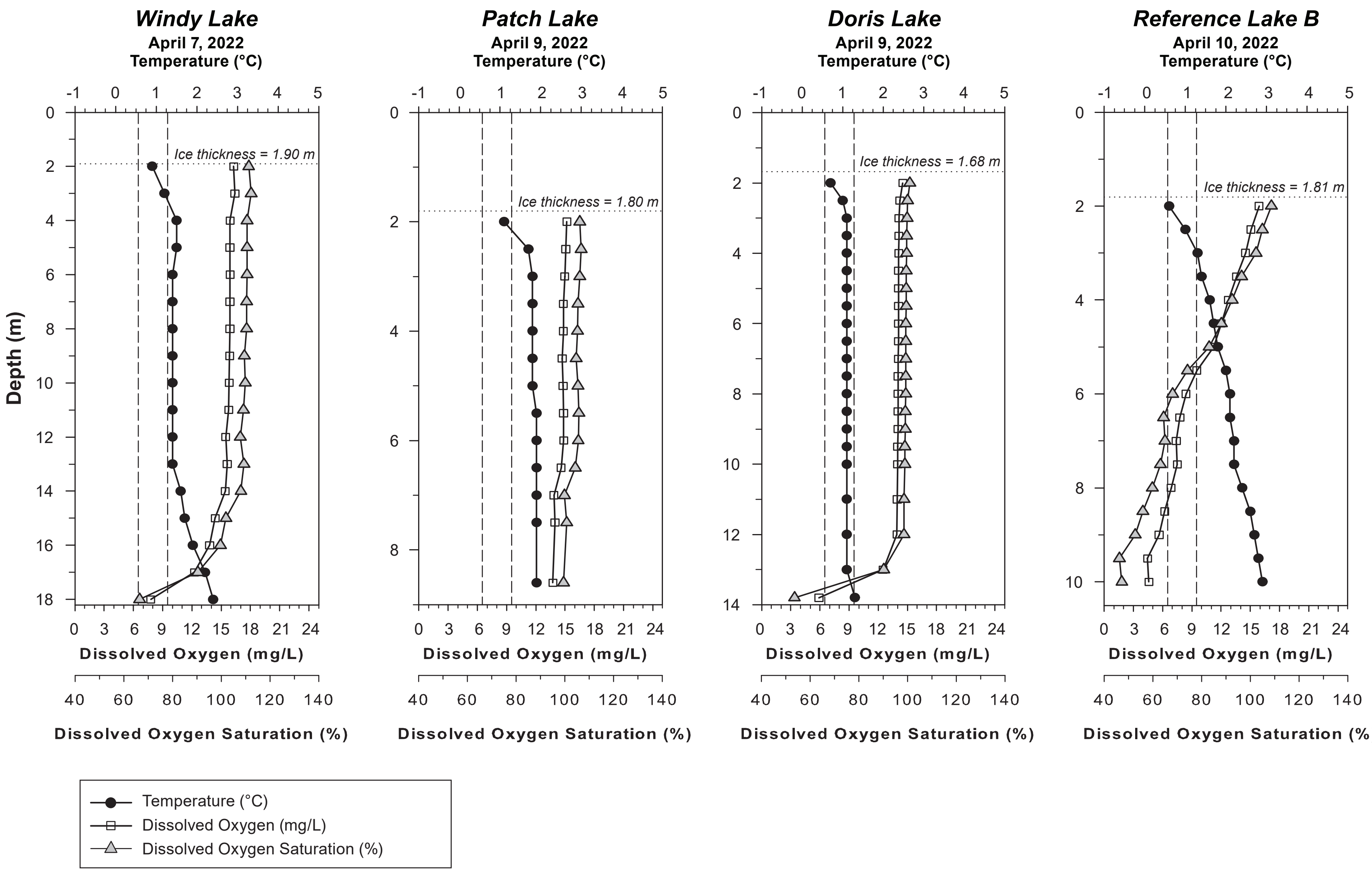
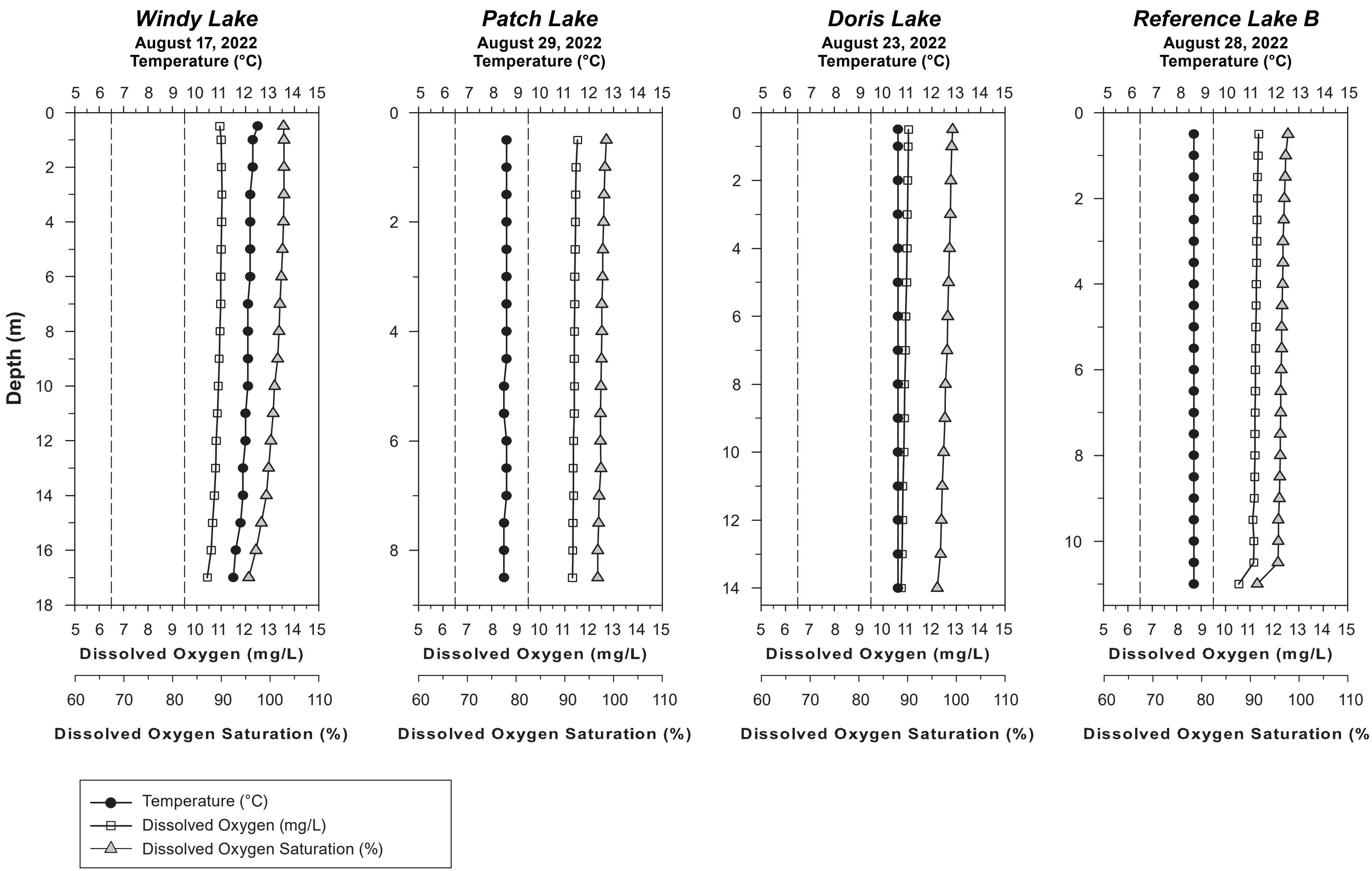



**Figure A.3-1: Under-ice Physical Limnology Profiles, Hope Bay AEMP, 2022**




*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.*

## Figure A.3-2: Open-water Physical Limnology Profiles, Hope Bay AEMP, 2022

## Table A.3-2: Open-water Temperature and Dissolved Oxygen Profiles, Hope Bay AEMP Lakes, 2022

**Windy Lake – August 17, 2022**

**Maximum Depth = 18 m**

| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
|---|---|---|---|
| 0.5 | 12.5 | 10.95 | 102.8 |
| 1 | 12.3 | 11.01 | 102.9 |
| 2 | 12.3 | 11.02 | 102.9 |
| 3 | 12.2 | 11.04 | 102.9 |
| 4 | 12.2 | 11.03 | 102.8 |
| 5 | 12.2 | 11.01 | 102.6 |
| 6 | 12.2 | 10.99 | 102.4 |
| 7 | 12.1 | 10.99 | 102.1 |
| 8 | 12.1 | 10.96 | 101.9 |
| 9 | 12.1 | 10.93 | 101.6 |
| 10 | 12.1 | 10.89 | 101 |
| 11 | 12 | 10.85 | 100.7 |
| 12 | 12 | 10.8 | 100.2 |
| 13 | 11.9 | 10.78 | 99.8 |
| 14 | 11.9 | 10.73 | 99.3 |
| 15 | 11.8 | 10.66 | 98.3 |
| 16 | 11.6 | 10.6 | 97.2 |
| 17 | 11.5 | 10.44 | 95.7 |

**Patch Lake – August 29, 2022**

**Maximum Depth = 8 m**

| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
|---|---|---|---|
| 0.5 | 8.6 | 11.52 | 98.5 |
| 1 | 8.6 | 11.46 | 98.2 |
| 1.5 | 8.6 | 11.44 | 98 |
| 2 | 8.6 | 11.43 | 97.9 |
| 2.5 | 8.6 | 11.42 | 97.8 |
| 3 | 8.6 | 11.4 | 97.7 |
| 3.5 | 8.6 | 11.4 | 97.6 |
| 4 | 8.6 | 11.39 | 97.6 |
| 4.5 | 8.6 | 11.38 | 97.5 |
| 5 | 8.5 | 11.39 | 97.4 |
| 5.5 | 8.5 | 11.38 | 97.3 |
| 6 | 8.6 | 11.35 | 97.3 |
| 6.5 | 8.6 | 11.34 | 97.4 |
| 7 | 8.6 | 11.35 | 97 |
| 7.5 | 8.5 | 11.33 | 96.9 |
| 8 | 8.5 | 11.32 | 96.7 |
| 8.5 | 8.5 | 11.31 | 96.7 |

**Doris Lake – August 23, 2022**

**Maximum Depth = 14.3 m**

| Depth (m) | Temperature (°C) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% Saturation) |
|---|---|---|---|
| 0.5 | 10.6 | 11.04 | 99.2 |
| 1 | 10.6 | 11.03 | 99.1 |
| 2 | 10.6 | 11.01 | 98.9 |
| 3 | 10.6 | 10.99 | 98.8 |
| 4 | 10.6 | 10.98 | 98.6 |
| 5 | 10.6 | 10.96 | 98.4 |
| 6 | 10.6 | 10.93 | 98.2 |
| 7 | 10.6 | 10.92 | 98.1 |
| 8 | 10.6 | 10.88 | 97.8 |
| 9 | 10.6 | 10.87 | 97.7 |
| 10 | 10.6 | 10.85 | 97.4 |
| 11 | 10.6 | 10.81 | 97.1 |
| 12 | 10.6 | 10.79 | 96.9 |
| 13 | 10.6 | 10.78 | 96.8 |
| 14 | 10.6 | 10.74 | 96.1 |

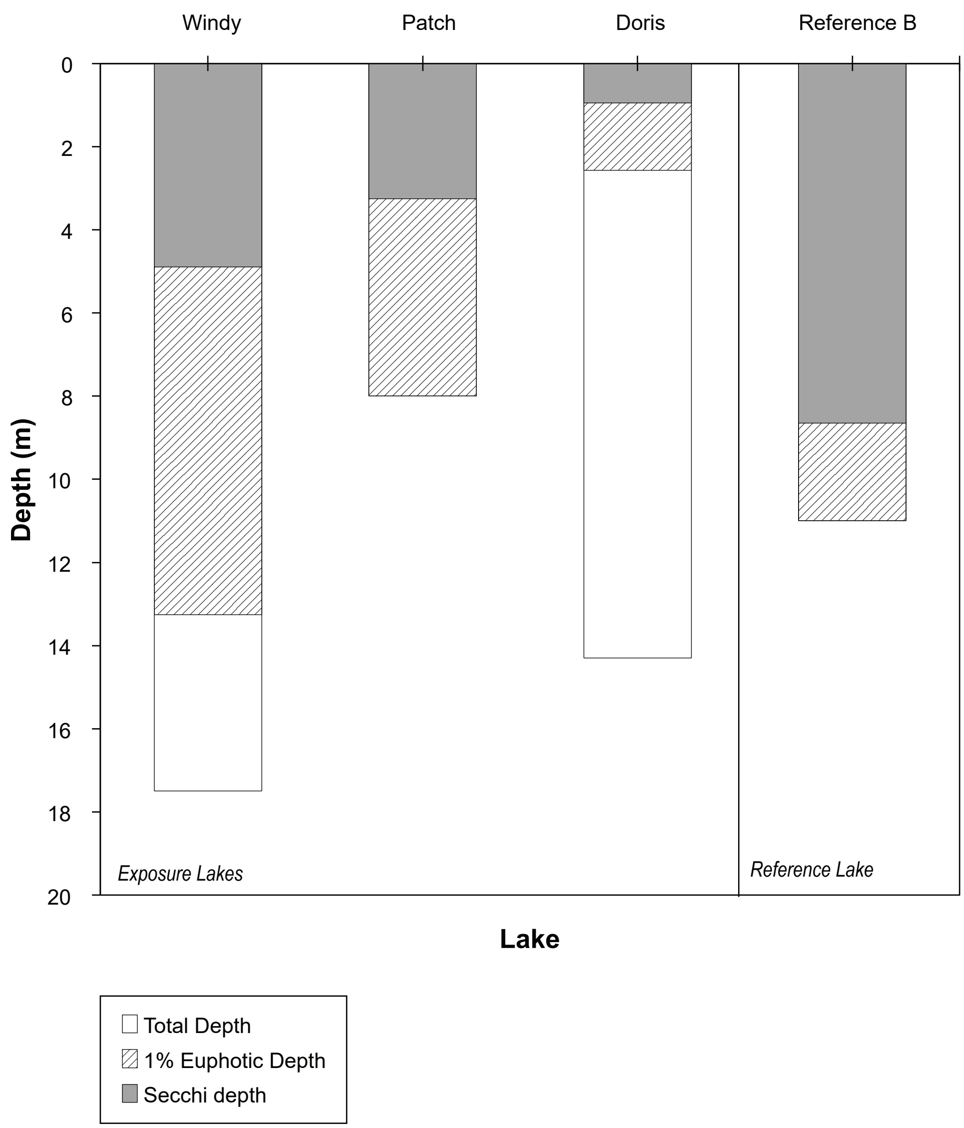
| Reference Lake B – August 28, 2022 | | | |
|---|---|---|---|
| **Maximum Depth = 11 m** | | | |
| **Depth (m)** | **Temperature (°C)** | **Dissolved Oxygen (mg/L)** | **Dissolved Oxygen (% Saturation)** |
| 0.5 | 8.7 | 11.36 | 97.8 |
| 1 | 8.7 | 11.33 | 97.3 |
| 1.5 | 8.7 | 11.31 | 97.2 |
| 2 | 8.7 | 11.3 | 97 |
| 2.5 | 8.7 | 11.29 | 96.9 |
| 3 | 8.7 | 11.28 | 96.8 |
| 3.5 | 8.7 | 11.27 | 96.8 |
| 4 | 8.7 | 11.26 | 96.7 |
| 4.5 | 8.7 | 11.25 | 96.6 |
| 5 | 8.7 | 11.24 | 96.5 |
| 5.5 | 8.7 | 11.23 | 96.5 |

| Reference Lake B – August 28, 2022 | | | |
|---|---|---|---|
| **Maximum Depth = 11 m** | | | |
| **Depth (m)** | **Temperature (°C)** | **Dissolved Oxygen (mg/L)** | **Dissolved Oxygen (% Saturation)** |
| 6 | 8.7 | 11.22 | 96.4 |
| 6.5 | 8.7 | 11.22 | 96.3 |
| 7 | 8.7 | 11.21 | 96.3 |
| 7.5 | 8.7 | 11.2 | 96.2 |
| 8 | 8.7 | 11.2 | 96.2 |
| 8.5 | 8.7 | 11.19 | 96.1 |
| 9 | 8.7 | 11.18 | 96 |
| 9.5 | 8.7 | 11.12 | 95.8 |
| 10 | 8.7 | 11.16 | 95.8 |
| 10.5 | 8.7 | 11.15 | 95.7 |
| 11 | 8.7 | 10.54 | 91.5 |

## Table A.3-3: Secchi Depths and Euphotic Zone Depths, Hope Bay AEMP, 2022

| Lake | Sampling Date | Secchi Depth (m) | Euphotic Zone Depth 1% Light Level (m) | Bottom Depth (m) |
|---|---|---|---|---|
| Windy | August 17, 2022 | 4.88 | 13.20 | 17.5 |
| Patch | August 29, 2022 | 3.25 | 8.79 | 8.0 |
| Doris | August 23, 2022 | 0.95 | 2.57 | 14.3 |
| Reference B | August 28, 2022 | 8.65 | 23.41* | 11 |

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




*Notes: Bars are stacked within the total depth for each lake.*

**Figure A.3-3: Open-water Secchi Depth and Calcualted Euphotic Depth, Hope Bay AEMP, 2022**

## A.4 Water Quality

Under-ice water quality samples were collected from April 7 to 10, 2022, and open-water water quality samples were collected from August 17 to 29, 2022.

Only the variables that were subjected to an evaluation of effects (Section 2.2.1 in main report) are presented graphically by season and depth in Figures A.4-1 to A.4-7. Water quality variables were screened against benchmarks (Tables 2.2-2 and 2.2-4 in main report) and benchmarks are presented on graphs where applicable.

Table A.4-1 presents all analysed variables for all water quality samples collected in 2022.

### *A.4.1 Quality Assurance/Quality Control Data*

#### *A.4.1.1 Field QA/QC*

##### Relative Percent Difference Calculations

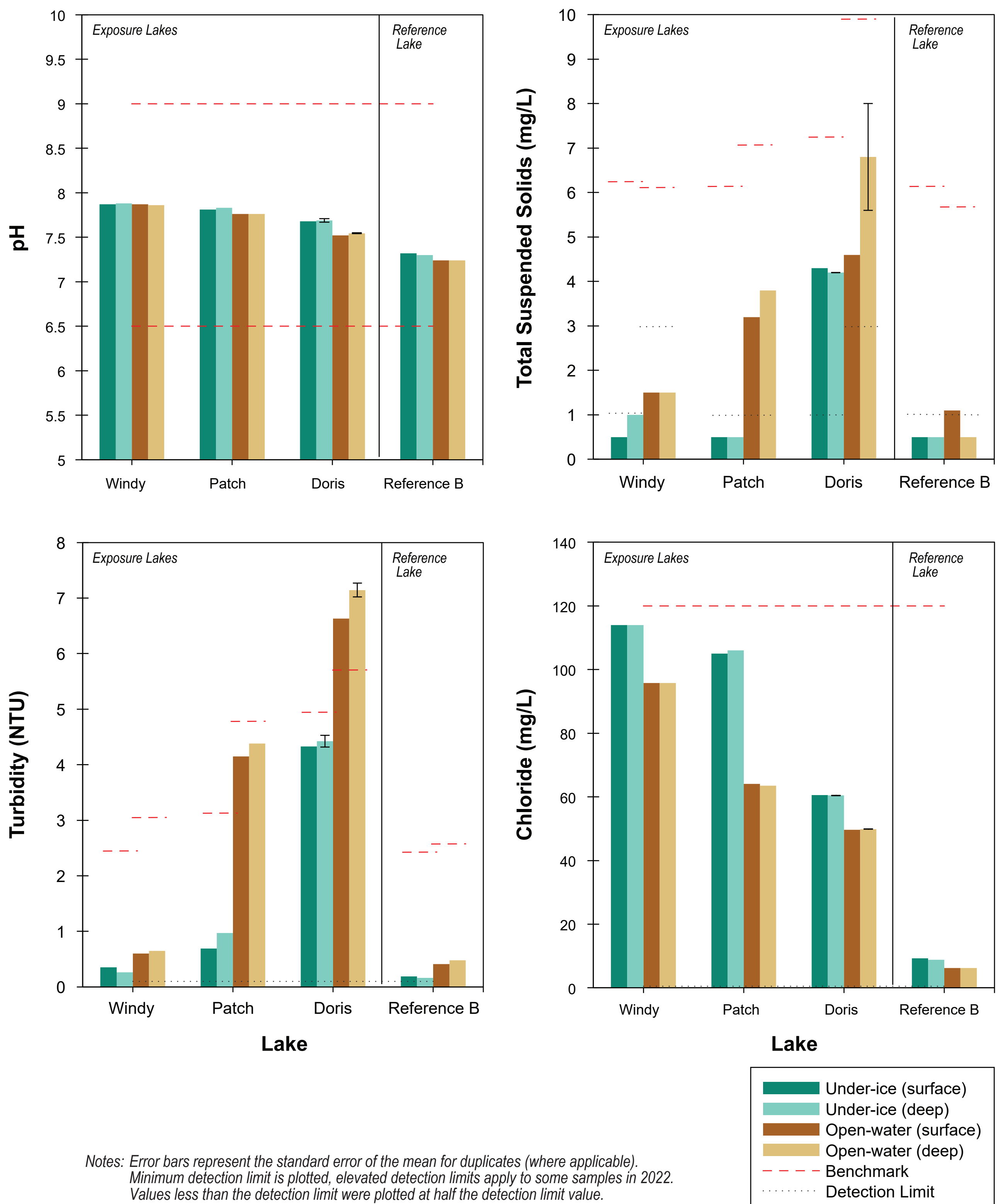
Field sample variability was accounted for by collecting duplicate samples to represent 10% of the samples collected, one duplicate was collected per sampling season. Both field duplicates were collected at Doris Lake in 2022. Relative percent difference (RPD) calculations for duplicate water quality samples are presented in Table A.4-2. For the 48 RPD calculations, one variable, total manganese had an RPD greater than 20%. Overall, this indicates that there was good agreement between variable concentrations in duplicate samples, and no evidence of contamination or lack of sample representativeness that would influence the evaluation of effects in 2022.

##### Blank QA/QC Data

Table 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 10% of the samples collected.

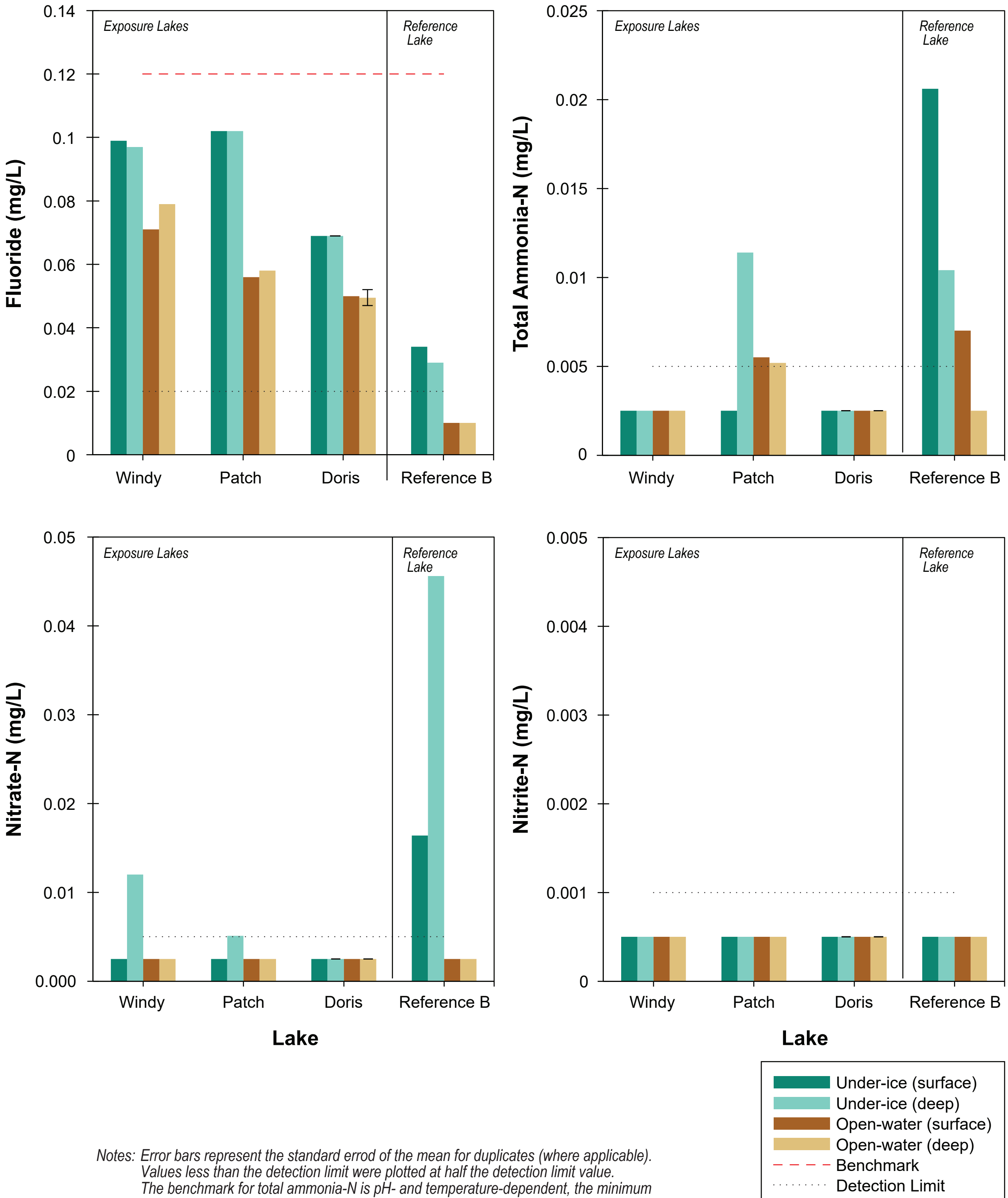
A subset of variables for blank samples were detectable above detection limits in at least one equipment, field, or travel blank: conductivity, total alkalinity, total ammonia, chloride, nitrate, total aluminum, total arsenic, total barium, total born, total calcium, total magnesium, total manganese, total sodium, dissolved manganese, and dissolved zinc. However, all these instances, with two exceptions, were less than five time the detection limit, which is the data quality objective for laboratory method blank analyses for reliable data and it is accepted that laboratory blanks would be more precise than field blanks. During the open-water season, total manganese in the equipment blank and total sodium in the field blank were greater than five time the detection limit (5.1 and 10.6 times, respectively) which indicate potential contamination during the field sampling process. However, these variables 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 results. There was no evidence of sample contamination for total manganese and total sodium during the open-water season as lake sample measured in the exposure and references lakes were similar to long-term historical trends.

Overall, the blank data indicate that potential for contamination from field handling, storage, transportation likely did not influence the water quality results for the sampled exposure and reference lakes and the results of the water quality samples collected in 2022 are of reliable quality.



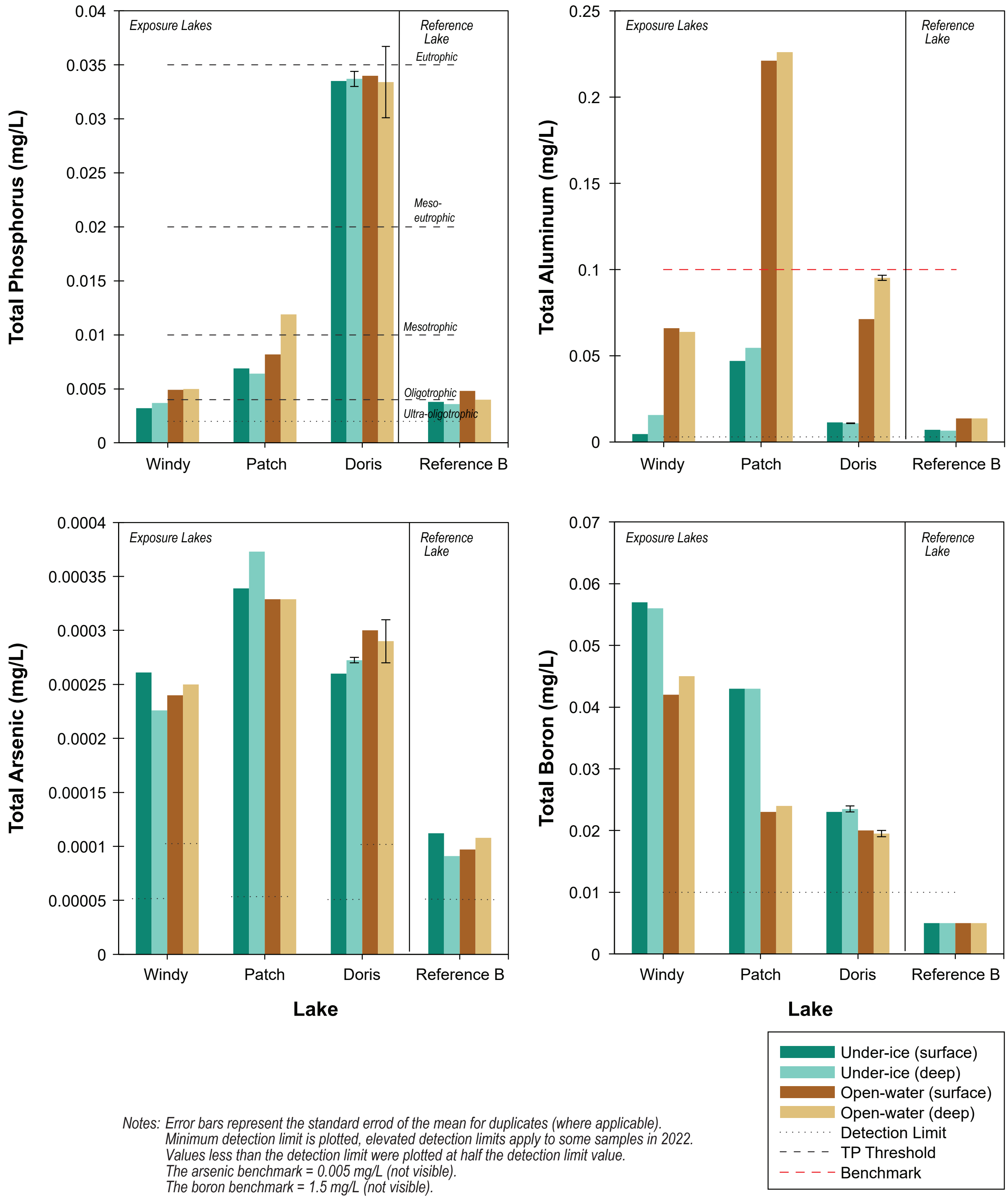

*Notes: Error bars represent the standard error of the mean for duplicates (where applicable).*
*Minimum detection limit is plotted, elevated detection limits apply to some samples in 2022.*
*Values less than the detection limit were plotted at half the detection limit value.*
*The pH benchmark is a range, the lower and upper benchmarks are plotted.*
*The total suspended solids and turbidity are lake and season specific, respective benchmarks plotted.*

**Figure A4-1: pH, Total Suspended Solids Concentrations, Turbidity, and Chloride Concentrations, Hope Bay AEMP, 2022**



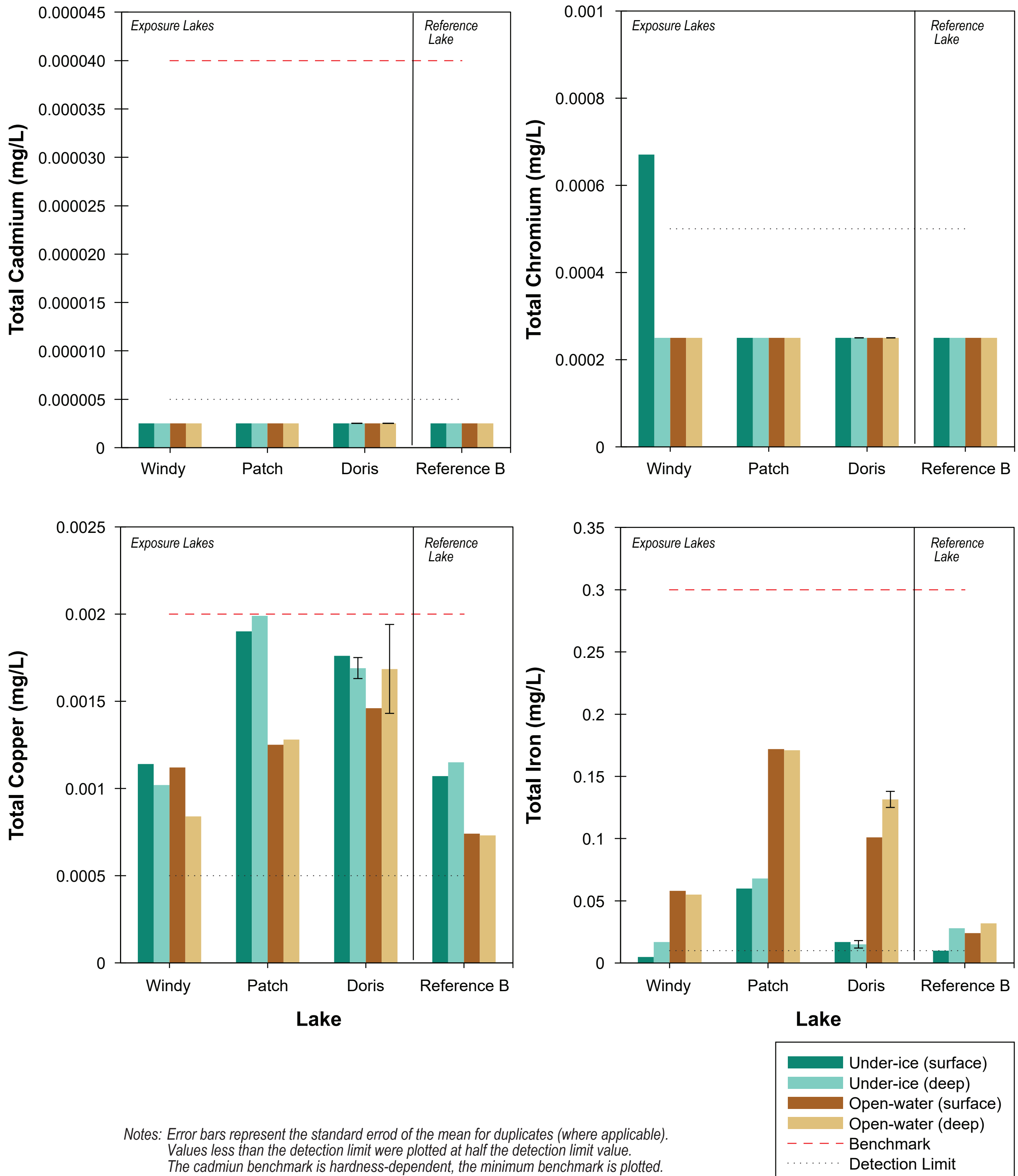

*Notes: Error bars represent the standard errod of the mean for duplicates (where applicable).*
*Values less than the detection limit were plotted at half the detection limit value.*
*The benchmark for total ammonia-N is pH- and temperature-dependent, the minimum benchmark calculated is 0.59 mg/L (not visible).*
*The nitrate-N benchmark = 3 mg/L (not visible).*
*The nitrite-N benchmark = 0.06 mg/L (not visible).*

**Figure A.4-2: Fluoride, Total Ammonia, Nitrate, and Nitrite Concentrations, Hope Bay AEMP, 2022**



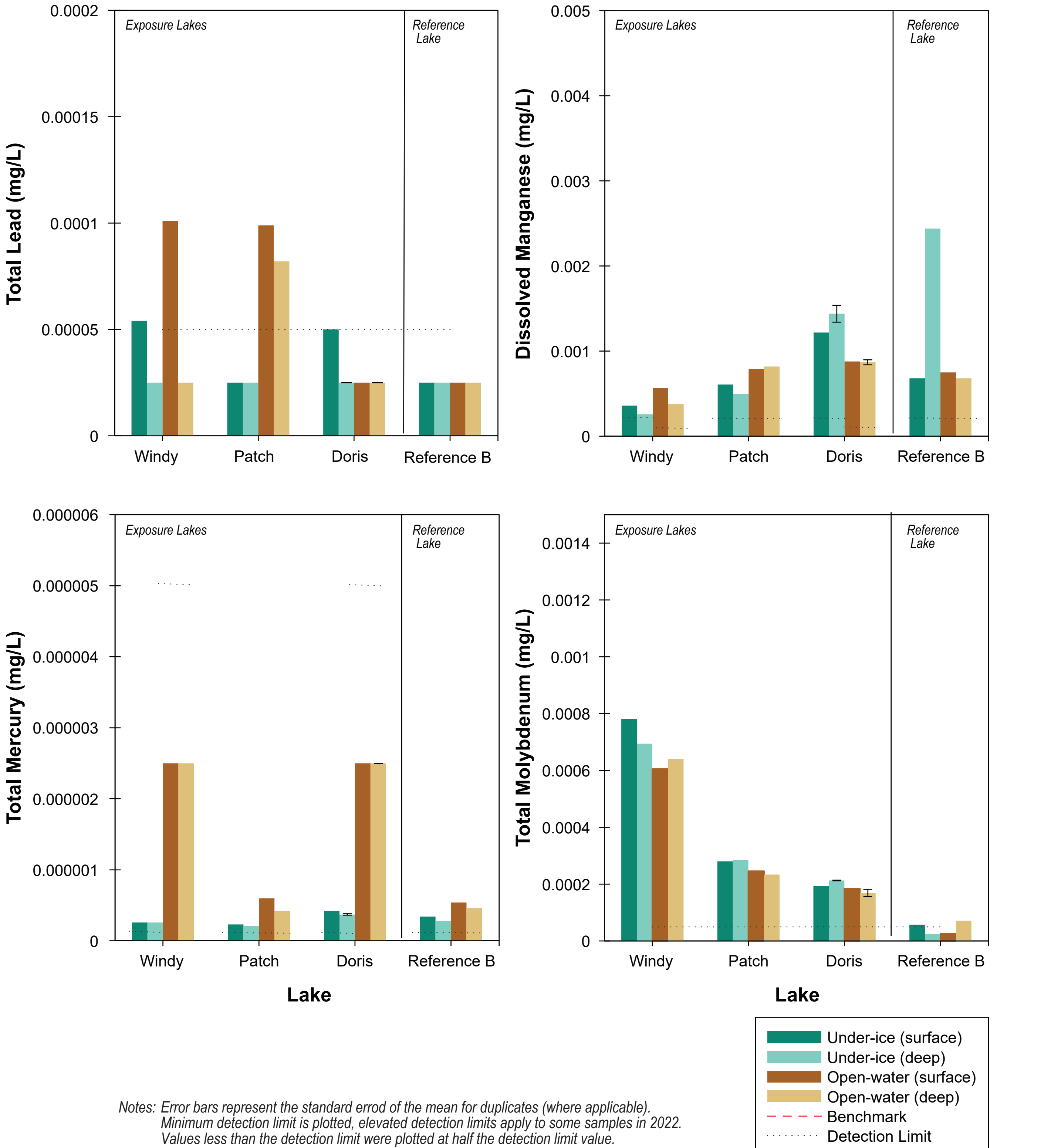

*Notes: Error bars represent the standard errod of the mean for duplicates (where applicable).*
*Minimum detection limit is plotted, elevated detection limits apply to some samples in 2022.*
*Values less than the detection limit were plotted at half the detection limit value.*
*The arsenic benchmark = 0.005 mg/L (not visible).*
*The boron benchmark = 1.5 mg/L (not visible).*

**Figure A.4-3: Total Phosphorus, Total Aluminum, Total Arsenic, and Total Boron Concentrations, Hope Bay AEMP, 2022**



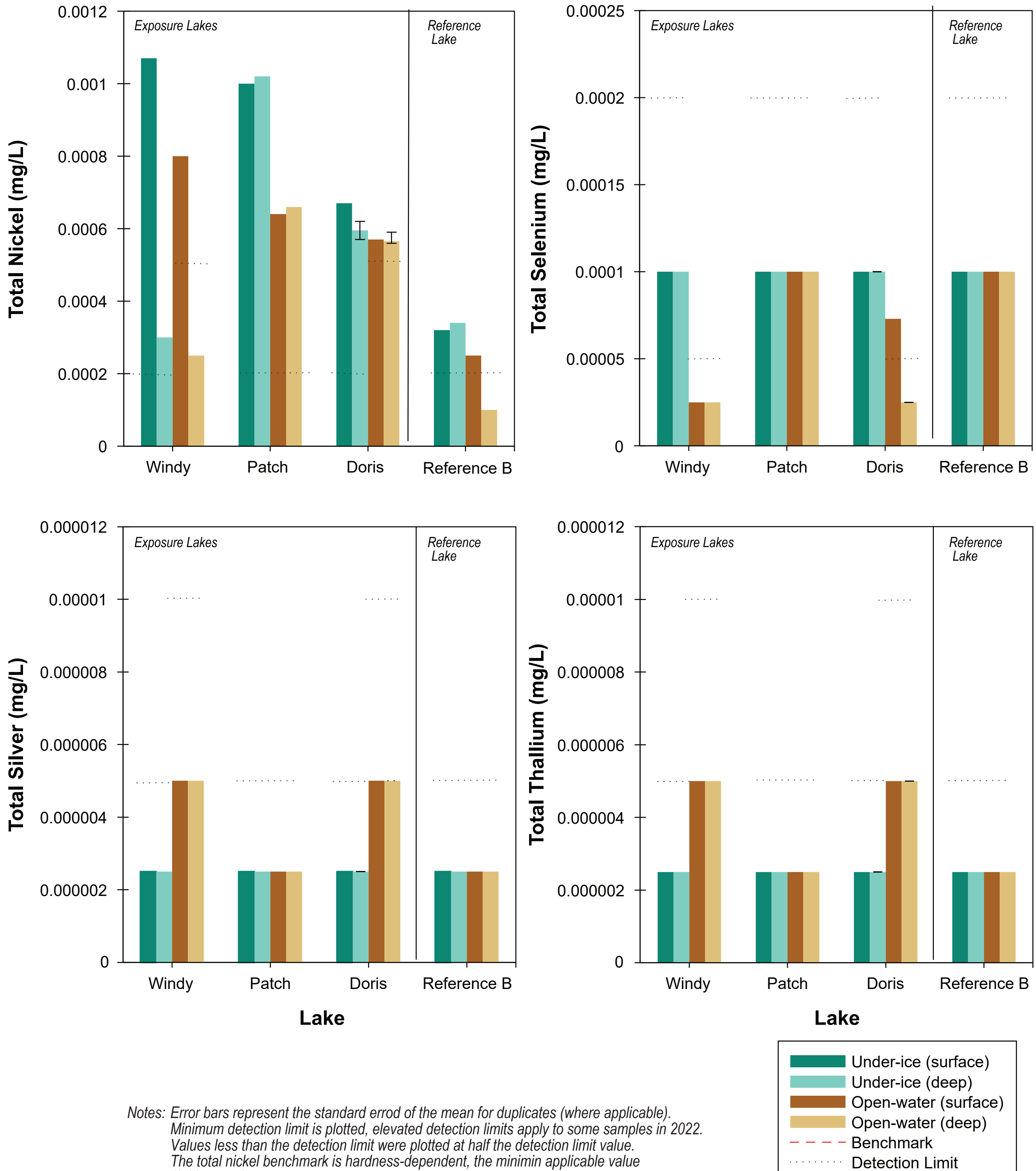

*Notes: Error bars represent the standard errod of the mean for duplicates (where applicable).*
*Values less than the detection limit were plotted at half the detection limit value.*
*The cadmiun benchmark is hardness-dependent, the minimum benchmark is plotted.*
*The chromium benchmark = 0.0089 mg/L (trivalent; not visible) and 0.001 mg/L (hexavalent; not visible).*
*The copper benchmark is hardness-dependent, the minimum benchmark is plotted.*

**Figure A.4-4: Total Cadmium, Total Chromium, Total Copper, and Total Iron Concentrations, Hope Bay AEMP, 2022**



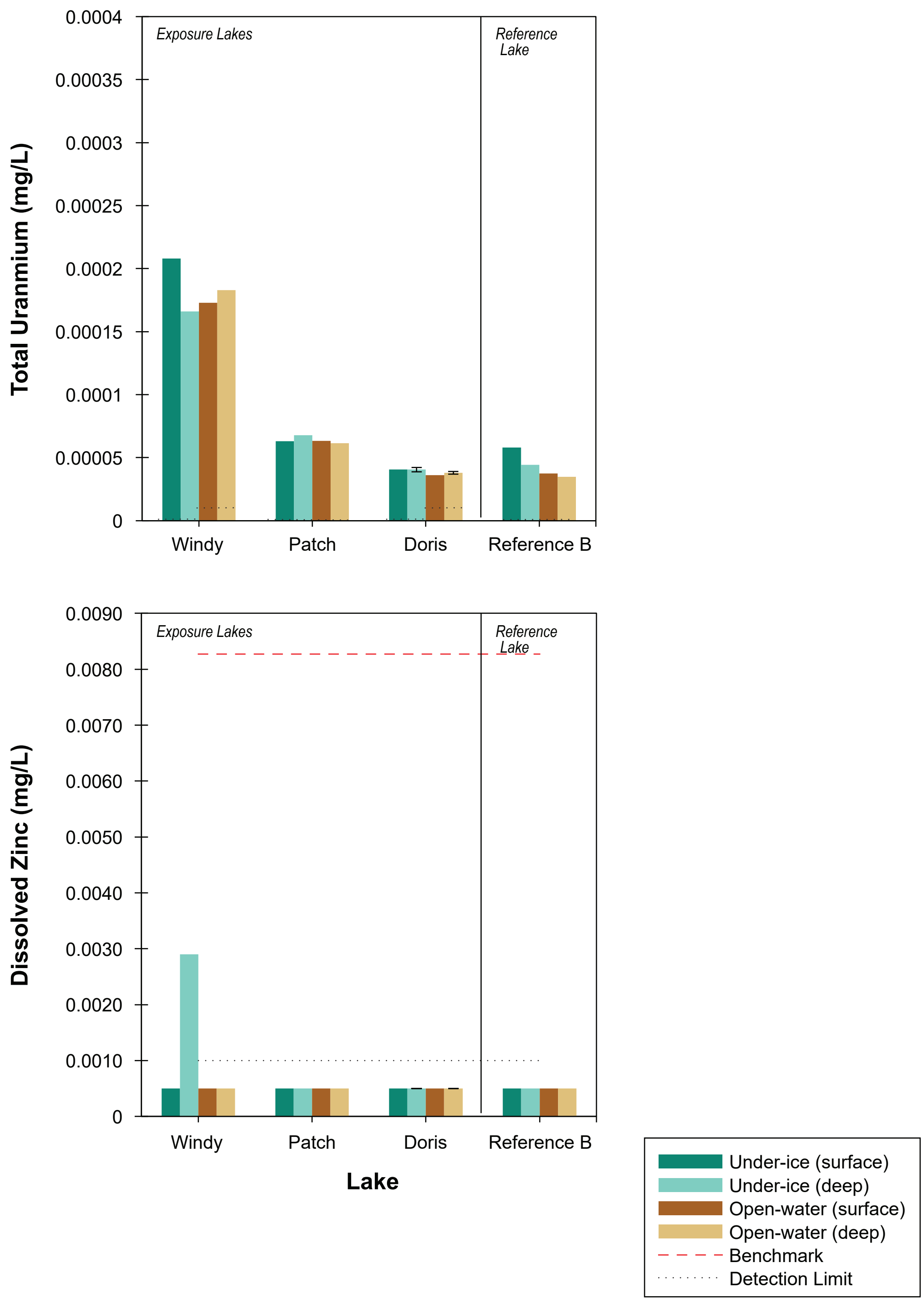

*Notes: Error bars represent the standard errod of the mean for duplicates (where applicable).*
*Minimum detection limit is plotted, elevated detection limits apply to some samples in 2022.*
*Values less than the detection limit were plotted at half the detection limit value.*
*The lead benchmark is hardness-dependent, the minimin (0.001 mg/L) is not visible on the plot.*
*Dissolved manganese benchmark is pH-, hardness-, and dissolved organic carbon-dependent, the minium applicable value (0.032 mg/L) is not visible on the plot.*
*The total mercury benchmark = 0.000026 mg/L (not visible).*
*The total molybdenum benchmark = 0.073 mg/L (not visible).*

**Figure A.4-5: Total Lead, Dissolved Manganese , Total Mercury, and Total Molybdenum Concentrations, Hope Bay AEMP, 2022**




Notes: *Error bars represent the standard errod of the mean for duplicates (where applicable).*
*Minimum detection limit is plotted, elevated detection limits apply to some samples in 2022.*
*Values less than the detection limit were plotted at half the detection limit value.*
*The total nickel benchmark is hardness-dependent, the minimin applicable value (0.025 mg/L) is not visible on the plot.*
*The total selenium benchmark is hardness-dependent, the minimin applicable value (0.001 mg/L) is not visible on the plot.*
*The total silver benchmark = 0.00025 mg/L (not visible).*
*The total thallium benchmark = 0.0008 mg/L (not visible).*

**Figure A.4-6: Total Nickel, Total Selenium, Total Silver and Total Thallium Concentrations, Hope Bay AEMP, 2022**




*Notes: Error bars represent the standard error of the mean for duplicates (where applicable).*
*Values less than the detection limit were plotted at half the detection limit value.*
*The total uranium benchmark = 0.015 mg/L (not visible).*
*The dissolved zinc benchmark is pH-, hardness-, and dissolved organic carbon-dependent, the minimum applicable value (0.0083 mg/L) is plotted for reference.*

**Figure A.4-7: Total Uranium and Dissolved Zinc Concentrations, Hope Bay AEMP, 2022**

## Table A.4-1: Water Quality Results, Hope Bay AEMP, 2022

| Lake: | Units | Windy Lake | | | | Patch Lake | | | | Doris Lake | | | | | | Reference Lake B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | 07-Apr-22 | | 17-Aug-22 | | 09-Apr-2022 | | 29-Aug-22 | | 09-Apr-22 | | | 23-Aug-22 | | | 10-Apr-22 | | 28-Aug-22 | |
| Sampling Depth (m): | | 3 | 16 | 1 | 15 | 3 | 6 | 1 | 6 | 3 | 12 | | 1 | 12 | | 3 | 8 | 1 | 8.5 |
| Replicate: | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| ALS Sample ID: | | YL2200326-001 | YL2200326-002 | YL2201313-003 | YL2201313-004 | YL2200326-003 | YL2200326-004 | YL2201398-001 | YL2201398-002 | YL2200326-005 | YL2200326-006 | YL2200326-009 | YL2201313-001 | YL2201313-002 | YL2201313-005 | YL2200326-007 | YL2200326-008 | YL2201399-001 | YL2201399-002 |
| **Physical Tests** | | | | | | | | | | | | | | | | | | | |
| Conductivity | µS/cm | 505 | 505 | 443 | 445 | 463 | 467 | 283 | 283 | 267 | 269 | 272 | 234 | 233 | 234 | 69.9 | 67.8 | 47.3 | 48 |
| Total Alkalinity (as $CaCO_3$) | mg/L | 55.7 | 55.1 | 49.8 | 49.4 | 55.3 | 56.7 | 33.5 | 33.1 | 34.5 | 34.1 | 39.6 | 28.4 | 28.4 | 28.6 | 22.7 | 20.6 | 11.3 | 10.6 |
| Dissolved Hardness (as $CaCO_3$) | mg/L | 80.4 | 78.3 | 73 | 72.7 | 80.6 | 81.6 | 51.4 | 50.8 | 46 | 46.8 | 46.6 | 43.2 | 42.3 | 42.7 | 19 | 18.2 | 12.5 | 12.6 |
| Total Hardness (as $CaCO_3$) | mg/L | 91.8 | 87.5 | 73.5 | 76.6 | 92.8 | 94.2 | 52.3 | 53 | 47.8 | 48.7 | 50.1 | 43.3 | 43 | 43.8 | 19.7 | 20 | 13.1 | 12.8 |
| pH | pH units | 7.87 | 7.88 | 7.87 | 7.86 | 7.81 | 7.83 | 7.76 | 7.76 | 7.68 | 7.67 | 7.71 | 7.52 | 7.55 | 7.54 | 7.32 | 7.3 | 7.24 | 7.24 |
| Total Suspended Solids | mg/L | <1.0 | 1 | <3.0 | <3.0 | <1.0 | <1.0 | 3.2 | 3.8 | 4.3 | 4.2 | 4.2 | 4.6 | 5.6 | 8 | <1.0 | <1.0 | 1.1 | <1.0 |
| Turbidity | NTU | 0.35 | 0.26 | 0.6 | 0.65 | 0.69 | 0.97 | 4.15 | 4.38 | 4.33 | 4.32 | 4.53 | 6.63 | 7.27 | 7.02 | 0.19 | 0.16 | 0.41 | 0.48 |
| **Anions and Nutrients** | | | | | | | | | | | | | | | | | | | |
| Total Ammonia (as N) | mg/L | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | 0.0114 | 0.0055 | 0.0052 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | 0.0206 | 0.0104 | 0.007 | <0.0050 |
| Bromide | mg/L | 0.429 | 0.428 | 0.354 | 0.361 | 0.322 | 0.326 | 0.192 | 0.192 | 0.2 | 0.204 | 0.202 | 0.168 | 0.17 | 0.164 | <0.050 | <0.050 | <0.050 | <0.050 |
| Chloride | mg/L | 114 | 114 | 95.8 | 95.8 | 105 | 106 | 64.1 | 63.5 | 60.6 | 60.5 | 60.4 | 49.7 | 49.8 | 49.9 | 9.29 | 8.8 | 6.18 | 6.19 |
| Fluoride | mg/L | 0.099 | 0.097 | 0.071 | 0.079 | 0.102 | 0.102 | 0.056 | 0.058 | 0.069 | 0.069 | 0.069 | 0.05 | 0.047 | 0.052 | 0.034 | 0.029 | <0.020 | <0.020 |
| Nitrate (as N) | mg/L | <0.0050 | 0.012 | <0.0050 | <0.0050 | <0.0050 | 0.0051 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | <0.0050 | 0.0164 | 0.0456 | <0.0050 | <0.0050 |
| Nitrite (as N) | mg/L | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| Total Phosphorus | mg/L | 0.0032 | 0.0037 | 0.0049 | 0.005 | 0.0069 | 0.0064 | 0.0082 | 0.0119 | 0.0335 | 0.0344 | 0.033 | 0.034 | 0.0301 | 0.0367 | 0.0038 | 0.0036 | 0.0048 | 0.004 |
| Sulphate | mg/L | 10.4 | 10.3 | 8.59 | 8.54 | 4.18 | 4.23 | 2.46 | 2.43 | 2.98 | 2.98 | 2.98 | 2.26 | 2.28 | 2.29 | 2.39 | 2.38 | 1.29 | 1.3 |
| **Organic/Inorganic Carbon** | | | | | | | | | | | | | | | | | | | |
| Dissolved Organic Carbon | mg/L | 2.24 | 2.1 | 1.97 | 2.24 | 7.27 | 7.62 | 4.9 | 4.71 | 6.6 | 6.76 | 6.67 | 5.99 | 5.84 | 5.62 | 4.28 | 3.52 | 2.77 | 2.75 |
| Total Organic Carbon | mg/L | 2.48 | 2.31 | 2.22 | 2.1 | 7.3 | 7.6 | 4.77 | 4.9 | 7.07 | 7.14 | 6.74 | 6.05 | 7.21 | 6.06 | 4.08 | 3.57 | 3.28 | 2.96 |
| **Total Metals** | | | | | | | | | | | | | | | | | | | |
| Aluminum | mg/L | 0.0046 | 0.0156 | 0.0659 | 0.0638 | 0.0469 | 0.0546 | 0.221 | 0.226 | 0.0113 | 0.0106 | 0.011 | 0.0713 | 0.0937 | 0.0966 | 0.007 | 0.0066 | 0.0136 | 0.0137 |
| Antimony | mg/L | 0.000084 | 0.000074 | <0.00010 | <0.00010 | 0.000037 | 0.000034 | 0.000034 | 0.000034 | <0.000030 | <0.000030 | <0.000030 | <0.00010 | <0.00010 | <0.00010 | <0.000030 | <0.000030 | <0.000030 | <0.000030 |
| Arsenic | mg/L | 0.000261 | 0.000226 | 0.00024 | 0.00025 | 0.000339 | 0.000373 | 0.000329 | 0.000329 | 0.00026 | 0.000275 | 0.00027 | 0.0003 | 0.00027 | 0.00031 | 0.000112 | 0.000091 | 0.000097 | 0.000108 |
| Barium | mg/L | 0.00281 | 0.00286 | 0.00282 | 0.0029 | 0.00406 | 0.00424 | 0.00423 | 0.00428 | 0.00227 | 0.00228 | 0.00238 | 0.003 | 0.00324 | 0.00334 | 0.00229 | 0.00257 | 0.00141 | 0.00139 |
| Beryllium | mg/L | <0.0000050 | <0.0000050 | <0.000020 | <0.000020 | <0.0000050 | <0.0000050 | 0.0000065 | 0.0000063 | <0.0000050 | <0.0000050 | <0.0000050 | <0.000020 | <0.000020 | <0.000020 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 |
| Bismuth | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Boron | mg/L | 0.057 | 0.056 | 0.042 | 0.045 | 0.043 | 0.043 | 0.023 | 0.024 | 0.023 | 0.023 | 0.024 | 0.02 | 0.019 | 0.02 | <0.010 | <0.010 | <0.010 | <0.010 |
| Cadmium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 |
| Calcium | mg/L | 16 | 15.6 | 12.3 | 13.2 | 16.4 | 16.3 | 8.93 | 8.94 | 8.55 | 8.5 | 8.84 | 7.57 | 7.49 | 7.67 | 4.84 | 4.96 | 3.17 | 3.11 |
| Cesium | mg/L | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.0000050 | <0.0000050 | 0.0000133 | 0.000014 | <0.0000050 | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.000010 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 |

| Lake: | Units | Windy Lake | | | | Patch Lake | | | | Doris Lake | | | | | | Reference Lake B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | 07-Apr-22 | | 17-Aug-22 | | 09-Apr-2022 | | 29-Aug-22 | | 09-Apr-22 | | | 23-Aug-22 | | | 10-Apr-22 | | 28-Aug-22 | |
| Sampling Depth (m): | | 3 | 16 | 1 | 15 | 3 | 6 | 1 | 6 | 3 | 12 | | 1 | 12 | | 3 | 8 | 1 | 8.5 |
| Replicate: | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| ALS Sample ID: | | YL2200326-001 | YL2200326-002 | YL2201313-003 | YL2201313-004 | YL2200326-003 | YL2200326-004 | YL2201398-001 | YL2201398-002 | YL2200326-005 | YL2200326-006 | YL2200326-009 | YL2201313-001 | YL2201313-002 | YL2201313-005 | YL2200326-007 | YL2200326-008 | YL2201399-001 | YL2201399-002 |
| **Total Metals** *(cont'd)* | | | | | | | | | | | | | | | | | | | |
| Chromium | mg/L | 0.00067 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| Cobalt | mg/L | <0.000050 | <0.000050 | <0.00010 | <0.00010 | <0.000050 | <0.000050 | 0.000084 | 0.00008 | <0.000050 | <0.000050 | <0.000050 | <0.00010 | <0.00010 | <0.00010 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Copper | mg/L | 0.00114 | 0.00102 | 0.00112 | 0.00084 | 0.0019 | 0.00199 | 0.00125 | 0.00128 | 0.00176 | 0.00163 | 0.00175 | 0.00146 | 0.00194 | 0.00143 | 0.00107 | 0.00115 | 0.00074 | 0.00073 |
| Gallium | mg/L | <0.000050 | <0.000050 | - | - | <0.000050 | <0.000050 | 0.000101 | 0.00011 | <0.000050 | <0.000050 | <0.000050 | - | - | - | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Iron | mg/L | <0.010 | 0.017 | 0.058 | 0.055 | 0.06 | 0.068 | 0.172 | 0.171 | 0.017 | 0.012 | 0.018 | 0.101 | 0.125 | 0.138 | 0.01 | 0.028 | 0.024 | 0.032 |
| Lanthanum | mg/L | <0.000050 | <0.000050 | - | - | 0.000079 | 0.000088 | 0.000243 | 0.000259 | <0.000050 | <0.000050 | <0.000050 | - | - | - | 0.000064 | 0.000084 | <0.000050 | <0.000050 |
| Lead | mg/L | 0.000054 | <0.000050 | 0.000101 | <0.000050 | <0.000050 | <0.000050 | 0.000099 | 0.000082 | 0.00005 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Lithium | mg/L | 0.0037 | 0.00354 | 0.003 | 0.0032 | 0.00701 | 0.00707 | 0.00401 | 0.00395 | 0.00355 | 0.00352 | 0.00364 | 0.0032 | 0.0032 | 0.0032 | 0.00063 | 0.00063 | <0.00050 | <0.00050 |
| Magnesium | mg/L | 12.6 | 11.8 | 10.4 | 10.6 | 12.6 | 13 | 7.29 | 7.45 | 6.42 | 6.68 | 6.81 | 5.93 | 5.9 | 5.99 | 1.86 | 1.84 | 1.25 | 1.22 |
| Manganese | mg/L | 0.00097 | 0.00147 | 0.00197 | 0.00188 | 0.00589 | 0.00624 | 0.00772 | 0.00792 | 0.0025 | 0.00201 | 0.00275 | 0.0179 | 0.02 | 0.0213 | 0.00117 | 0.00378 | 0.0019 | 0.00193 |
| Mercury | mg/L | 0.00000026 | 0.00000026 | <0.0000050 | <0.0000050 | 0.00000023 | 0.00000021 | 0.00000060 | 0.00000042 | 0.00000042 | 0.00000036 | 0.00000038 | <0.0000050 | <0.0000050 | <0.0000050 | 0.00000034 | 0.00000028 | 0.00000054 | 0.00000046 |
| Molybdenum | mg/L | 0.000781 | 0.000694 | 0.000605 | 0.000641 | 0.00028 | 0.000285 | 0.000246 | 0.000234 | 0.000193 | 0.000214 | 0.000212 | 0.000184 | 0.000157 | 0.00018 | 0.000058 | <0.000050 | <0.000050 | 0.000072 |
| Nickel | mg/L | 0.00107 | 0.0003 | 0.0008 | <0.00050 | 0.001 | 0.00102 | 0.00064 | 0.00066 | 0.00067 | 0.00057 | 0.00062 | 0.00057 | 0.00056 | 0.00057 | 0.00032 | 0.00034 | 0.00025 | <0.00020 |
| Niobium | mg/L | <0.00010 | <0.00010 | - | - | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | - | - | - | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Phosphorus | mg/L | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| Potassium | mg/L | 5.13 | 4.58 | 4.28 | 4.4 | 4.58 | 4.75 | 2.92 | 2.95 | 2.5 | 2.57 | 2.58 | 2.32 | 2.28 | 2.28 | 0.677 | 0.657 | 0.488 | 0.477 |
| Rhenium | mg/L | <0.0000050 | <0.0000050 | - | - | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | - | - | - | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 |
| Rubidium | mg/L | 0.00235 | 0.00217 | 0.0021 | 0.00211 | 0.00244 | 0.00254 | 0.00188 | 0.0019 | 0.00155 | 0.00158 | 0.00156 | 0.00149 | 0.00148 | 0.00155 | 0.00107 | 0.000992 | 0.000764 | 0.000743 |
| Selenium | mg/L | <0.00020 | <0.00020 | <0.000050 | <0.000050 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | 0.000073 | <0.000050 | <0.000050 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Silicon | mg/L | 0.46 | 0.57 | 0.44 | 0.44 | 0.65 | 0.66 | 0.62 | 0.62 | 1.46 | 1.47 | 1.51 | 1.38 | 1.39 | 1.38 | 0.2 | 0.48 | 0.13 | 0.14 |
| Silver | mg/L | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.000010 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 |
| Sodium | mg/L | 66.8 | 62.5 | 53.6 | 55 | 58 | 60.5 | 34.5 | 34.3 | 30.4 | 31.3 | 32 | 26.5 | 25.8 | 26 | 5.2 | 5.03 | 3.72 | 3.57 |
| Strontium | mg/L | 0.0744 | 0.0731 | 0.0584 | 0.0623 | 0.0854 | 0.0848 | 0.0454 | 0.0456 | 0.0399 | 0.0418 | 0.0424 | 0.0355 | 0.0355 | 0.0364 | 0.0248 | 0.0246 | 0.0155 | 0.0154 |
| Sulphur | mg/L | 4.18 | 3.86 | 3.21 | 3.17 | 1.68 | 1.63 | 0.85 | 1 | 0.94 | 0.92 | 0.94 | 0.94 | 0.87 | 0.86 | 0.67 | 0.74 | 0.6 | 0.55 |
| Tantalum | mg/L | <0.00010 | <0.00010 | - | - | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | - | - | - | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| Tellurium | mg/L | <0.000050 | <0.000050 | <0.00020 | <0.00020 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.00020 | <0.00020 | <0.00020 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Thallium | mg/L | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.000010 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 |
| Thorium | mg/L | <0.0000050 | 0.0000081 | <0.00010 | <0.00010 | 0.0000235 | 0.000023 | 0.0000573 | 0.000056 | 0.0000177 | 0.000012 | 0.0000167 | <0.00010 | <0.00010 | <0.00010 | 0.0000136 | 0.0000109 | 0.0000158 | 0.0000122 |
| Tin | mg/L | <0.00020 | <0.00020 | <0.00010 | <0.00010 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00010 | <0.00010 | <0.00010 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Titanium | mg/L | <0.00020 | 0.00073 | 0.0026 | 0.00274 | 0.00091 | 0.00118 | 0.00813 | 0.00822 | <0.00020 | <0.00020 | <0.00020 | 0.00222 | 0.00367 | 0.00343 | <0.00020 | <0.00020 | 0.00027 | 0.00028 |
| Tungsten | mg/L | <0.000010 | <0.000010 | <0.00010 | <0.00010 | 0.000012 | 0.000011 | 0.000017 | 0.000016 | <0.000010 | <0.000010 | <0.000010 | <0.00010 | <0.00010 | <0.00010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |

| Lake: | Units | Windy Lake | | | | Patch Lake | | | | Doris Lake | | | | | | Reference Lake B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | 07-Apr-22 | | 17-Aug-22 | | 09-Apr-2022 | | 29-Aug-22 | | 09-Apr-22 | | | 23-Aug-22 | | | 10-Apr-22 | | 28-Aug-22 | |
| Sampling Depth (m): | | 3 | 16 | 1 | 15 | 3 | 6 | 1 | 6 | 3 | 12 | | 1 | 12 | | 3 | 8 | 1 | 8.5 |
| Replicate: | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| ALS Sample ID: | | YL2200326-001 | YL2200326-002 | YL2201313-003 | YL2201313-004 | YL2200326-003 | YL2200326-004 | YL2201398-001 | YL2201398-002 | YL2200326-005 | YL2200326-006 | YL2200326-009 | YL2201313-001 | YL2201313-002 | YL2201313-005 | YL2200326-007 | YL2200326-008 | YL2201399-001 | YL2201399-002 |
| **Total Metals** *(cont'd)* | | | | | | | | | | | | | | | | | | | |
| Uranium | mg/L | 0.000208 | 0.000166 | 0.000173 | 0.000183 | 0.000063 | 0.0000679 | 0.0000633 | 0.0000614 | 0.0000406 | 0.0000387 | 0.0000423 | 0.000036 | 0.000037 | 0.000039 | 0.0000581 | 0.0000443 | 0.0000375 | 0.0000348 |
| Vanadium | mg/L | <0.00020 | <0.00020 | <0.00050 | <0.00050 | <0.00020 | 0.0002 | 0.00053 | 0.00054 | <0.00020 | <0.00020 | <0.00020 | <0.00050 | <0.00050 | 0.00055 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Yttrium | mg/L | <0.0000050 | 0.0000087 | - | - | 0.0000372 | 0.0000378 | 0.000053 | 0.0000517 | 0.0000225 | 0.0000241 | 0.0000266 | - | - | - | 0.0000209 | 0.0000247 | 0.0000115 | 0.0000134 |
| Zinc | mg/L | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | 0.003 | <0.0030 | <0.0030 |
| Zirconium | mg/L | <0.000050 | <0.000050 | <0.00020 | <0.00020 | 0.000065 | 0.000068 | 0.000076 | 0.00008 | 0.000052 | 0.000055 | 0.000061 | <0.00020 | <0.00020 | <0.00020 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| **Dissolved Metals (Field-filtered)** | | | | | | | | | | | | | | | | | | | |
| Manganese | mg/L | 0.00036 | 0.00026 | 0.00057 | 0.00038 | 0.00061 | 0.0005 | 0.00079 | 0.00082 | 0.00122 | 0.00154 | 0.00134 | 0.00088 | 0.0009 | 0.00084 | 0.00068 | 0.00244 | 0.00075 | 0.00068 |
| Zinc | mg/L | <0.0010 | 0.0029 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |

*Notes:*

*Dash (-) indicates that analysis was not completed.*

*Gray shading indicates value greater than respective benchmark (see Table 2.2-2 to 2.2-4 in main report).*

## Table A.4-2: Water Quality Duplicate Relative Percent Differences, Hope Bay AEMP, 2022

| Lake: | Units | Doris Lake | | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Date: | | 09-Apr-22 | | | 23-Aug-22 | | |
| Sampling Depth (m): | | 12 | | | 12 | | |
| Replicate: | | 1 | 2 | - | 1 | 2 | - |
| ALS Sample ID: | | YL2200326-006 | YL2200326-009 | RPD | YL2201313-002 | YL2201313-005 | RPD |
| **Physical Tests** | | | | | | | |
| Conductivity | µS/cm | 269 | 272 | 1.1 | 233 | 234 | 0.4 |
| Total Alkalinity (as $CaCO_3$) | mg/L | 34.1 | 39.6 | 14.9 | 28.4 | 28.6 | 0.7 |
| Dissolved Hardness (as $CaCO_3$) | mg/L | 46.8 | 46.6 | 0.4 | 42.3 | 42.7 | 0.9 |
| Total Hardness (as $CaCO_3$) | mg/L | 48.7 | 50.1 | 2.8 | 43 | 43.8 | 1.8 |
| pH | pH units | 7.67 | 7.71 | 0.5 | 7.55 | 7.54 | 0.1 |
| Total Suspended Solids | mg/L | 4.2 | 4.2 | - | 5.6 | 8 | - |
| Turbidity | NTU | 4.32 | 4.53 | 4.7 | 7.27 | 7.02 | 3.5 |
| **Anions and Nutrients** | | | | | | | |
| Total Ammonia (as N) | mg/L | <0.0050 | <0.0050 | - | <0.0050 | <0.0050 | - |
| Bromide | mg/L | 0.204 | 0.202 | - | 0.17 | 0.164 | - |
| Chloride | mg/L | 60.5 | 60.4 | 0.2 | 49.8 | 49.9 | 0.2 |
| Fluoride | mg/L | 0.069 | 0.069 | - | 0.047 | 0.052 | - |
| Nitrate (as N) | mg/L | <0.0050 | <0.0050 | - | <0.0050 | <0.0050 | - |
| Nitrite (as N) | mg/L | <0.0010 | <0.0010 | - | <0.0010 | <0.0010 | - |
| Total Phosphorus | mg/L | 0.0344 | 0.033 | 4.2 | 0.0301 | 0.0367 | 19.8 |
| Sulphate | mg/L | 2.98 | 2.98 | 0 | 2.28 | 2.29 | 0.4 |
| **Organic/Inorganic Carbon** | | | | | | | |
| Dissolved Organic Carbon | mg/L | 6.76 | 6.67 | 1.3 | 5.84 | 5.62 | 3.8 |
| Total Organic Carbon | mg/L | 7.14 | 6.74 | 5.8 | 7.21 | 6.06 | 17.3 |

| Lake: | Units | Doris Lake | | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Date: | | 09-Apr-22 | | | 23-Aug-22 | | |
| Sampling Depth (m): | | 12 | | | 12 | | |
| Replicate: | | 1 | 2 | - | 1 | 2 | - |
| ALS Sample ID: | | YL2200326-006 | YL2200326-009 | RPD | YL2201313-002 | YL2201313-005 | RPD |
| **Total Metals** | | | | | | | |
| Aluminum | mg/L | 0.0106 | 0.011 | - | 0.0937 | 0.0966 | 3.0 |
| Antimony | mg/L | <0.000030 | <0.000030 | - | <0.00010 | <0.00010 | - |
| Arsenic | mg/L | 0.000275 | 0.00027 | 1.8 | 0.00027 | 0.00031 | - |
| Barium | mg/L | 0.00228 | 0.00238 | 4.3 | 0.00324 | 0.00334 | 3.0 |
| Beryllium | mg/L | <0.0000050 | <0.0000050 | - | <0.000020 | <0.000020 | - |
| Bismuth | mg/L | <0.000050 | <0.000050 | - | <0.000050 | <0.000050 | - |
| Boron | mg/L | 0.023 | 0.024 | - | 0.019 | 0.02 | - |
| Cadmium | mg/L | <0.0000050 | <0.0000050 | - | <0.0000050 | <0.0000050 | - |
| Calcium | mg/L | 8.5 | 8.84 | 3.9 | 7.49 | 7.67 | 2.4 |
| Cesium | mg/L | <0.0000050 | <0.0000050 | - | <0.000010 | <0.000010 | - |
| Chromium | mg/L | <0.00050 | <0.00050 | - | <0.00050 | <0.00050 | - |
| Cobalt | mg/L | <0.000050 | <0.000050 | - | <0.00010 | <0.00010 | - |
| Copper | mg/L | 0.00163 | 0.00175 | - | 0.00194 | 0.00143 | - |
| Gallium | mg/L | <0.000050 | <0.000050 | - | - | - | - |
| Iron | mg/L | 0.012 | 0.018 | - | 0.125 | 0.138 | 9.9 |
| Lanthanum | mg/L | <0.000050 | <0.000050 | - | - | - | - |
| Lead | mg/L | <0.000050 | <0.000050 | - | <0.000050 | <0.000050 | - |
| Lithium | mg/L | 0.00352 | 0.00364 | 3.4 | 0.0032 | 0.0032 | - |
| Magnesium | mg/L | 6.68 | 6.81 | 1.9 | 5.9 | 5.99 | 1.5 |
| Manganese | mg/L | 0.00201 | 0.00275 | 31.1 | 0.02 | 0.0213 | 6.3 |
| Mercury | mg/L | 0.00000036 | 0.00000038 | - | <0.0000050 | <0.0000050 | - |

| Lake: | Units | Doris Lake | | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Date: | | 09-Apr-22 | | | 23-Aug-22 | | |
| Sampling Depth (m): | | 12 | | | 12 | | |
| Replicate: | | 1 | 2 | - | 1 | 2 | - |
| ALS Sample ID: | | YL2200326-006 | YL2200326-009 | RPD | YL2201313-002 | YL2201313-005 | RPD |
| **Total Metals** *(cont'd)* | | | | | | | |
| Molybdenum | mg/L | 0.000214 | 0.000212 | - | 0.000157 | 0.00018 | - |
| Nickel | mg/L | 0.00057 | 0.00062 | - | 0.00056 | 0.00057 | - |
| Niobium | mg/L | <0.00010 | <0.00010 | - | - | - | - |
| Phosphorus | mg/L | <0.050 | <0.050 | - | <0.050 | <0.050 | - |
| Potassium | mg/L | 2.57 | 2.58 | 0.4 | 2.28 | 2.28 | 0 |
| Rhenium | mg/L | <0.0000050 | <0.0000050 | - | - | - | - |
| Rubidium | mg/L | 0.00158 | 0.00156 | 1.3 | 0.00148 | 0.00155 | 4.6 |
| Selenium | mg/L | <0.00020 | <0.00020 | - | <0.000050 | <0.000050 | - |
| Silicon | mg/L | 1.47 | 1.51 | 2.7 | 1.39 | 1.38 | 0.7 |
| Silver | mg/L | <0.0000050 | <0.0000050 | - | <0.000010 | <0.000010 | - |
| Sodium | mg/L | 31.3 | 32 | 2.2 | 25.8 | 26 | 0.8 |
| Strontium | mg/L | 0.0418 | 0.0424 | 1.4 | 0.0355 | 0.0364 | 2.5 |
| Sulphur | mg/L | 0.92 | 0.94 | - | 0.87 | 0.86 | - |
| Tantalum | mg/L | <0.00010 | <0.00010 | - | - | - | - |
| Tellurium | mg/L | <0.000050 | <0.000050 | - | <0.00020 | <0.00020 | - |
| Thallium | mg/L | <0.0000050 | <0.0000050 | - | <0.000010 | <0.000010 | - |
| Thorium | mg/L | 0.000012 | 0.0000167 | - | <0.00010 | <0.00010 | - |
| Tin | mg/L | <0.00020 | <0.00020 | - | <0.00010 | <0.00010 | - |
| Titanium | mg/L | <0.00020 | <0.00020 | - | 0.00367 | 0.00343 | 6.8 |
| Tungsten | mg/L | <0.000010 | <0.000010 | - | <0.00010 | <0.00010 | - |
| Uranium | mg/L | 0.0000387 | 0.0000423 | 8.9 | 0.000037 | 0.000039 | - |

| Lake: | Units | Doris Lake | | | | | |
|---|---|---|---|---|---|---|---|
| Sampling Date: | | 09-Apr-22 | | | 23-Aug-22 | | |
| Sampling Depth (m): | | 12 | | | 12 | | |
| Replicate: | | 1 | 2 | - | 1 | 2 | - |
| ALS Sample ID: | | YL2200326-006 | YL2200326-009 | RPD | YL2201313-002 | YL2201313-005 | RPD |
| **Total Metals** *(cont'd)* | | | | | | | |
| Vanadium | mg/L | <0.00020 | <0.00020 | - | <0.00050 | 0.00055 | - |
| Yttrium | mg/L | 0.0000241 | 0.0000266 | - | - | - | - |
| Zinc | mg/L | <0.0030 | <0.0030 | - | <0.0030 | <0.0030 | - |
| Zirconium | mg/L | 0.000055 | 0.000061 | - | <0.00020 | <0.00020 | - |
| **Dissolved Metals (Field-filtered)** | | | | | | | |
| Manganese | mg/L | 0.00154 | 0.00134 | 13.9 | 0.0009 | 0.00084 | 6.9 |
| Zinc | mg/L | <0.0010 | <0.0010 | - | <0.0010 | <0.0010 | - |

*Notes:*
*RPD = Relative Percent Difference.*
*Dash (-) indicates that RPDs were not calculated (one or both replicates less than five times the detection limit).*
*Shaded cells indicate instances where the RPD was greater than 20%.*

## Table A.4-3: Water Quality QA/QC Results, Hope Bay AEMP, 2022

| Lake: | Units | Equipment Blank | Travel Blank | Field Blank | Equipment Blank | Travel Blank | Field Blank |
|---|---|---|---|---|---|---|---|
| Replicate: | | 07-Apr-22 | 10-Apr-22 | 09-Apr-22 | 17-Aug-22 | 23-Aug-22 | 28-Aug-22 |
| Sampling Depth (m): | | YL2200326-010 | YL2200326-011 | YL2200326-012 | YL2201313-007 | YL2201313-006 | YL2201399-003 |
| **Physical Tests** | | | | | | | |
| Conductivity | µS/cm | <2.0 | <2.0 | <2.0 | 5.6 | <2.0 | <2.0 |
| Total Alkalinity (as $CaCO_3$) | mg/L | <1.0 | 1.1 | 1.1 | <1.0 | <1.0 | 1.4 |
| Dissolved Hardness (as $CaCO_3$) | mg/L | <0.50 | - | <0.50 | <0.50 | - | <0.50 |
| Total Hardness (as $CaCO_3$) | mg/L | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |

| Lake: | Units | Equipment Blank | Travel Blank | Field Blank | Equipment Blank | Travel Blank | Field Blank |
|---|---|---|---|---|---|---|---|
| Replicate: | | 07-Apr-22 | 10-Apr-22 | 09-Apr-22 | 17-Aug-22 | 23-Aug-22 | 28-Aug-22 |
| Sampling Depth (m): | | YL2200326-010 | YL2200326-011 | YL2200326-012 | YL2201313-007 | YL2201313-006 | YL2201399-003 |
| **Physical Tests *(cont'd)*** | | | | | | | |
| pH | pH units | 5.72 | 5.69 | 5.66 | 5.03 | 5.23 | 6.31 |
| Total Suspended Solids | mg/L | <1.0 | <1.0 | <1.0 | <3.0 | <3.0 | <1.0 |
| Turbidity | NTU | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| **Anions and Nutrients** | | | | | | | |
| Total Ammonia (as N) | mg/L | <0.0050 | <0.0050 | <0.0050 | 0.0189 | <0.0050 | <0.0050 |
| Bromide | mg/L | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| Chloride | mg/L | <0.50 | <0.50 | <0.50 | 0.61 | <0.50 | <0.50 |
| Fluoride | mg/L | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| Nitrate (as N) | mg/L | <0.0050 | <0.0050 | <0.0050 | 0.0237 | <0.0050 | <0.0050 |
| Nitrite (as N) | mg/L | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| Total Phosphorus | mg/L | <0.0020 | <0.0020 | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Sulphate | mg/L | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 |
| **Organic/Inorganic Carbon** | | | | | | | |
| Dissolved Organic Carbon | mg/L | <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 | mg/L | <0.0030 | <0.0030 | <0.0030 | 0.01 | <0.0030 | <0.0030 |
| Antimony | mg/L | <0.000030 | <0.000030 | <0.000030 | <0.00010 | <0.00010 | <0.000030 |
| Arsenic | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.00010 | <0.00010 | 0.000051 |
| Barium | mg/L | <0.00010 | <0.00010 | 0.00021 | 0.00017 | <0.00010 | <0.00010 |
| Beryllium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | <0.000020 | <0.000020 | <0.0000050 |
| Bismuth | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Boron | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 0.041 |
| Cadmium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 | <0.0000050 |
| Calcium | mg/L | <0.020 | <0.020 | <0.020 | 0.057 | <0.050 | <0.020 |

| Lake: | Units | Equipment Blank | Travel Blank | Field Blank | Equipment Blank | Travel Blank | Field Blank |
|---|---|---|---|---|---|---|---|
| Replicate: | | 07-Apr-22 | 10-Apr-22 | 09-Apr-22 | 17-Aug-22 | 23-Aug-22 | 28-Aug-22 |
| Sampling Depth (m): | | YL2200326-010 | YL2200326-011 | YL2200326-012 | YL2201313-007 | YL2201313-006 | YL2201399-003 |
| **Total Metals** *(cont'd)* | | | | | | | |
| Cesium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.0000050 |
| Chromium | mg/L | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| Cobalt | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.00010 | <0.00010 | <0.000050 |
| Copper | mg/L | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| Gallium | mg/L | <0.000050 | <0.000050 | <0.000050 | - | - | <0.000050 |
| Iron | mg/L | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Lanthanum | mg/L | <0.000050 | <0.000050 | <0.000050 | - | - | <0.000050 |
| Lead | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Lithium | mg/L | <0.00050 | <0.00050 | <0.00050 | <0.0010 | <0.0010 | <0.00050 |
| Magnesium | mg/L | <0.010 | <0.010 | <0.010 | 0.006 | <0.0050 | <0.010 |
| Manganese | mg/L | <0.00020 | <0.00020 | <0.00020 | 0.00051 | <0.00010 | <0.00020 |
| Mercury | mg/L | <0.0000001 | <0.0000001 | <0.0000001 | <0.0000050 | <0.0000050 | <0.0000001 |
| Molybdenum | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| Nickel | mg/L | <0.00020 | <0.00020 | <0.00020 | <0.00050 | <0.00050 | <0.00020 |
| Niobium | mg/L | <0.00010 | <0.00010 | <0.00010 | - | - | <0.00010 |
| Phosphorus | mg/L | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| Potassium | mg/L | <0.030 | <0.030 | <0.030 | <0.050 | <0.050 | <0.030 |
| Rhenium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | - | - | <0.0000050 |
| Rubidium | mg/L | <0.000020 | <0.000020 | <0.000020 | <0.00020 | <0.00020 | <0.000020 |
| Selenium | mg/L | <0.00020 | <0.00020 | <0.00020 | <0.000050 | <0.000050 | <0.00020 |
| Silicon | mg/L | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Silver | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.0000050 |
| Sodium | mg/L | <0.020 | <0.020 | <0.020 | <0.050 | <0.050 | 0.528 |
| Strontium | mg/L | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| Sulphur | mg/L | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |

| Lake: | Units | Equipment Blank | Travel Blank | Field Blank | Equipment Blank | Travel Blank | Field Blank |
|---|---|---|---|---|---|---|---|
| Replicate: | | 07-Apr-22 | 10-Apr-22 | 09-Apr-22 | 17-Aug-22 | 23-Aug-22 | 28-Aug-22 |
| Sampling Depth (m): | | YL2200326-010 | YL2200326-011 | YL2200326-012 | YL2201313-007 | YL2201313-006 | YL2201399-003 |
| **Total Metals** *(cont'd)* | | | | | | | |
| Tantalum | mg/L | <0.00010 | <0.00010 | <0.00010 | - | - | <0.00010 |
| Tellurium | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.00020 | <0.00020 | <0.000050 |
| Thallium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | <0.000010 | <0.000010 | <0.0000050 |
| Thorium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | <0.00010 | <0.00010 | <0.0000100 |
| Tin | mg/L | <0.00020 | <0.00020 | <0.00020 | <0.00010 | <0.00010 | <0.00020 |
| Titanium | mg/L | <0.00020 | <0.00020 | <0.00020 | <0.00030 | <0.00030 | <0.00020 |
| Tungsten | mg/L | <0.000010 | <0.000010 | <0.000010 | <0.00010 | <0.00010 | <0.000010 |
| Uranium | mg/L | <0.0000020 | <0.0000020 | <0.0000020 | <0.000010 | <0.000010 | <0.0000020 |
| Vanadium | mg/L | <0.00020 | <0.00020 | <0.00020 | <0.00050 | <0.00050 | <0.00020 |
| Yttrium | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | - | - | <0.0000050 |
| Zinc | mg/L | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| Zirconium | mg/L | <0.000050 | <0.000050 | <0.000050 | <0.00020 | <0.00020 | <0.000050 |
| **Dissolved Metals (Field-filtered)** | | | | | | | |
| Manganese | mg/L | <0.00020 | - | <0.00020 | 0.00031 | - | <0.00020 |
| Zinc | mg/L | 0.0013 | - | <0.0010 | <0.0010 | - | <0.0010 |

*Notes:*

*Dash (-) indicates that analysis was not completed.*

*Light gray shading indicates values were greater than the detection limit; dark gray shading indicates that value was greater than five times the detection limit.*

### *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 data quality objectives is presented in Table A.4-4.

**Table A.4-4: Laboratory QA/QC Results, Hope Bay AEMP, 2022**

| Sampling Month | ALS Project | Hold Time Exceedance Details | ALS Data Quality Objective Exceedance Details | AEMP Data Quality Concern Details |
|---|---|---|---|---|
| April | YL2200326 | pH, turbidity, total suspended solids, alkalinity (Windy Lake and Equipment Blank), nitrate, and nitrite | Method blank for total alkalinity exceeded ALS Data Quality Objective | All associated sample results are greater than 5 times blank level and are considered reliable |
| August | YL2201313 | pH, turbidity, total suspended solids, nitrate, and nitrite | None | - |
| | YL2201398 | pH, turbidity, total suspended solids, nitrate, and nitrite | None | - |
| | YL2201399 | pH, turbidity, total suspended solids, nitrate, and nitrite | None | - |

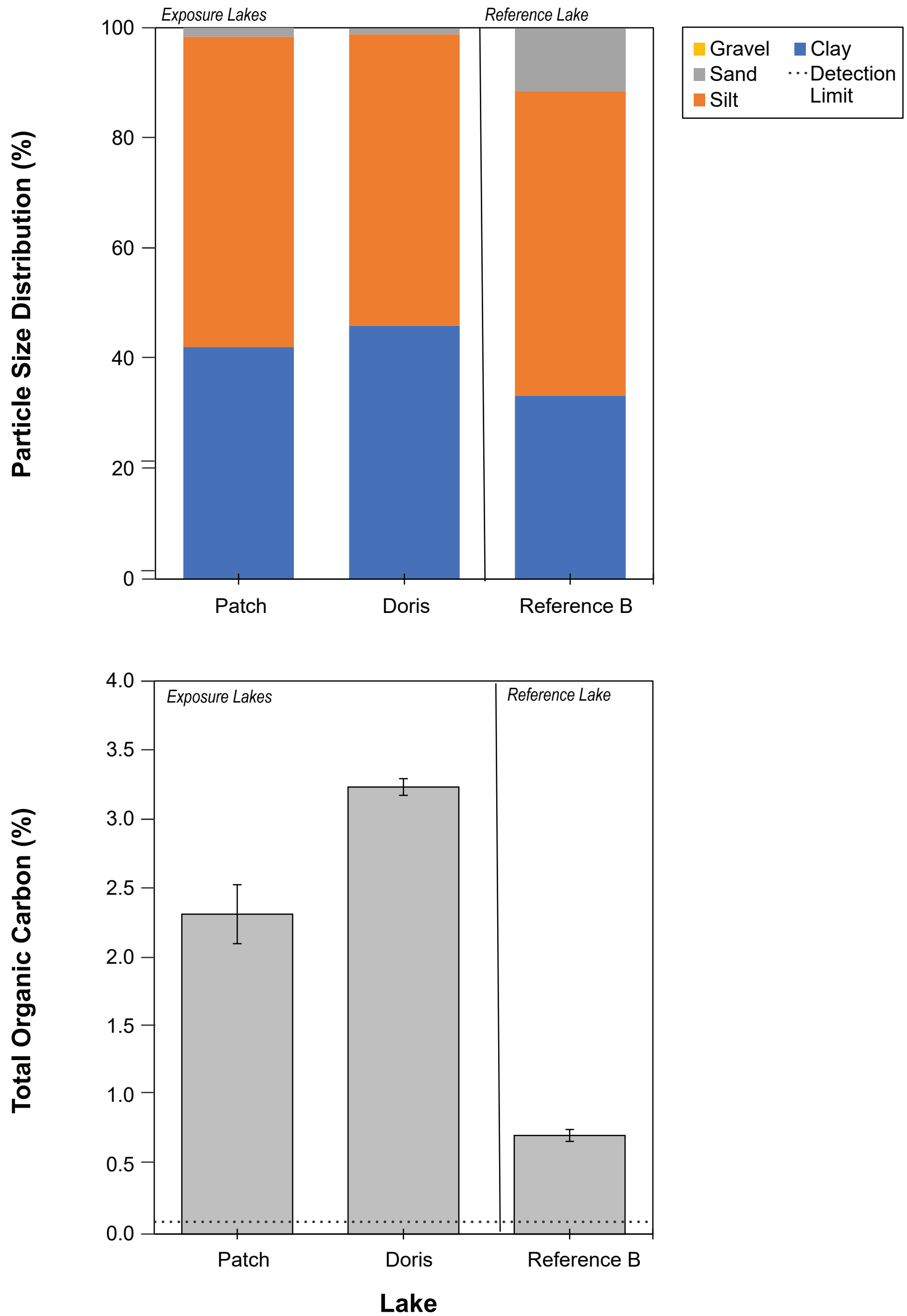
Holding time recommendations were not met for a subset of variables during both sampling seasons (pH, total alkalinity, total suspended solids, turbidity, nitrate, nitrite; Table A.4-4). Recommended hold times for these variables range from 15 minutes for pH to 7 days for total suspended solids, with the remaining variables 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 alkalinity in ALS work order YL2200326 exceeded ALS's data quality objective; therefore all sample results during the under-ice season that were within five times the method blank level of 1.7 mg/L (i.e., 8.5 mg/L) were not considered reliable. All total alkalinity concentrations were higher than this threshold and are considered reliable except for the total alkalinity concentrations in the open-water field and travel blank samples which were marginally greater than the detection limit (1.1 mg/L for both, Table A.4-3). Total alkalinity concentrations in the exposure and reference lakes is still considered reliable and total alkalinity is not an evaluated variable in the AEMP; therefore, this had no impact on the results of the AEMP evaluation of effects.

## A.5 Sediment Quality

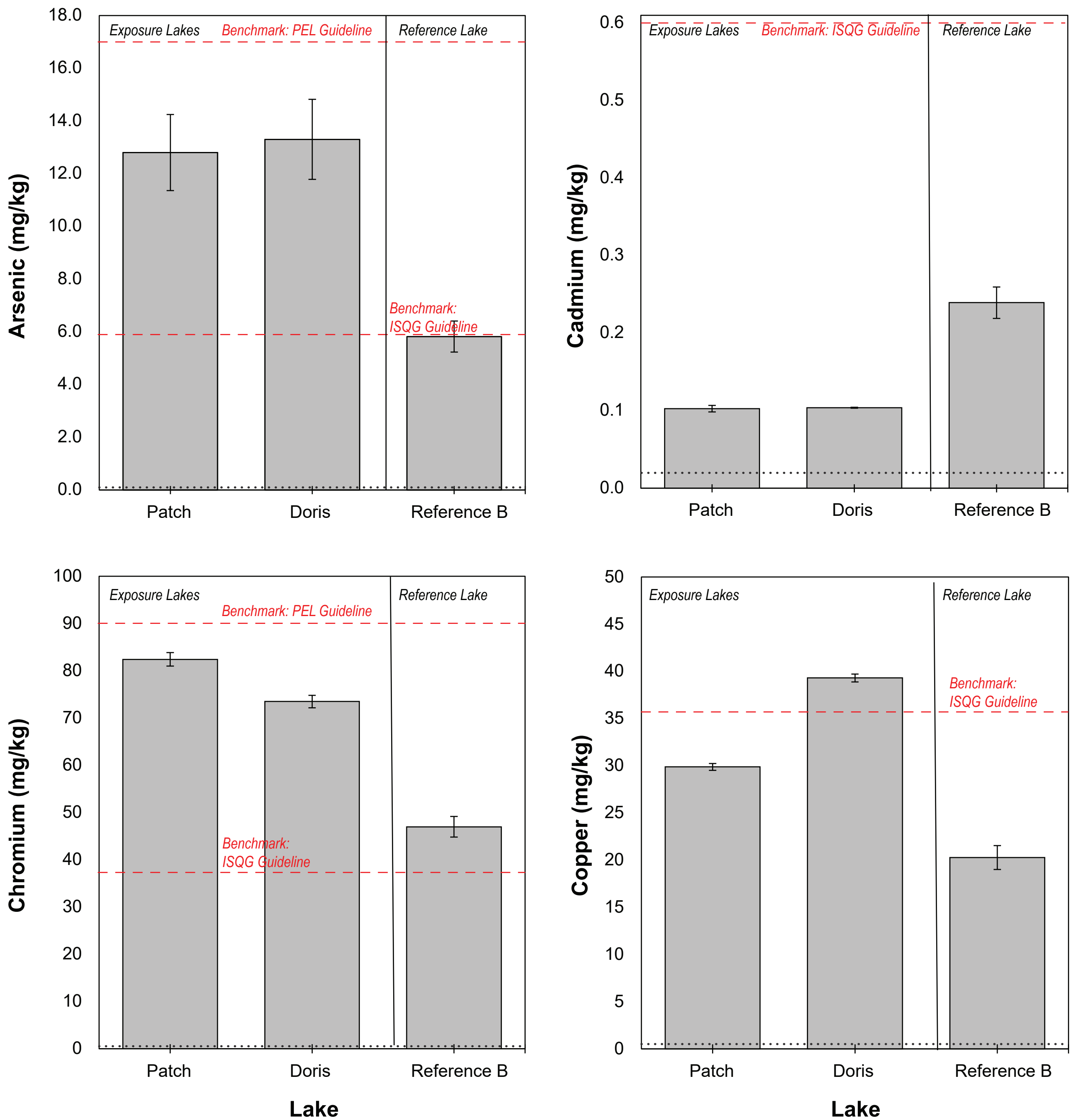
Sediment quality data were collected on August 22 and 24, 2022. Sediment quality variables that were subjected to an evaluation of effects (Section 2.2.1 in main report) as well as the particle size distribution are presented graphically in Figures A.5-1 to A.5-3. Sediment quality variables were screened against benchmarks (Table 2.2-5 in main report) and benchmarks are presented on graphs where applicable.

Table A.5-1 presents all analysed variables for all sediment quality samples collected in 2022.




*Notes: Stacked bars represent the mean composition per lake.*
*Error bars represent the standard error of the mean.*

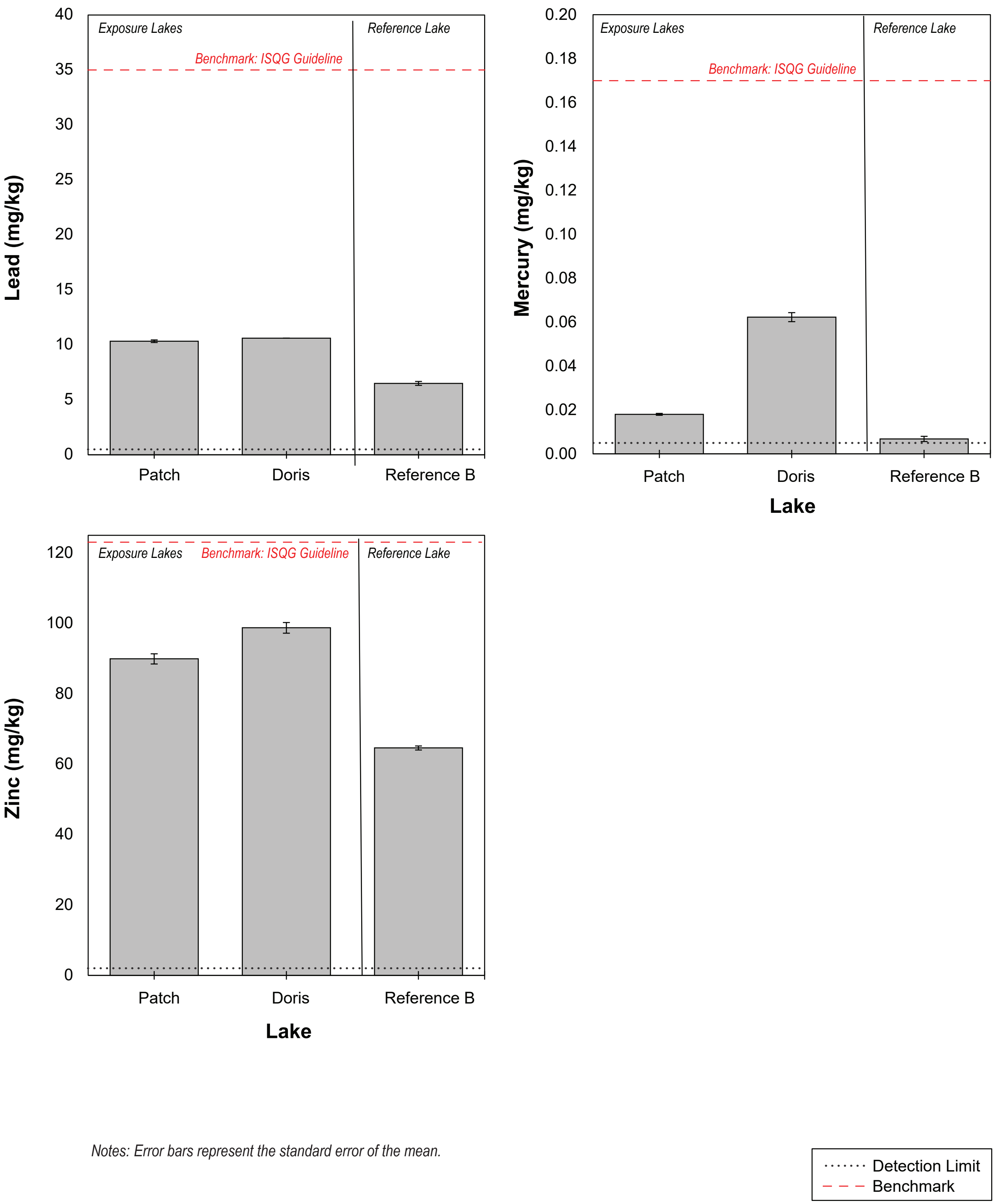
**Figure A.5-1: Particle Size Distribution and Total Organic Carbon Concentrations in Lake Sediments, Hope Bay AEMP, 2022**




*Notes: Error bars represent the standard error of the mean.*

| | |
|---|---|
| ······· | Detection Limit |
| – – – | Benchmark |

**Figure A.5-2: Arsenic, Cadmium, Chromium, and Copper Concentrations in Lake Sediments, Hope Bay AEMP, 2022**




*Notes: Error bars represent the standard error of the mean.*

**Figure A.5-3: Lead, Mercury, and Zinc Concentrations in Lake Sediments, Hope Bay AEMP, 2022**

## Table A.5-1: Sediment Quality Data Results, Hope Bay AEMP, 2022

| Lake: | Unit | Patch Lake | | | Doris Lake | | | Reference Lake B | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | 24-Aug-22 | | | 22-Aug-22 | | | 24-Aug-22 | | |
| Replicate: | | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Sampling Depth (m): | | 7.1 | 7.3 | 6.7 | 14.3 | 14.2 | 14.2 | 10.5 | 10.4 | 10.5 |
| ALS Sample ID: | | YL2201330-001 | YL2201330-002 | YL2201330-003 | YL2201312-001 | YL2201312-002 | YL2201312-003 | YL2201330-004 | YL2201330-005 | YL2201330-006 |
| **Physical Tests** | | | | | | | | | | |
| Moisture | % | 80 | 75.9 | 75 | 74.2 | 76 | 73.2 | 53 | 44.1 | 50.8 |
| pH (1:2 soil:water) | pH unit | 6.67 | 6.04 | 6.02 | 6.28 | 6 | 5.48 | 5.59 | 5.65 | 5.52 |
| **Particle Size** | | | | | | | | | | |
| Gravel (>2 mm) | % | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Sand (2.0 mm to 0.063 mm) | % | 1.5 | 1.6 | 1.8 | 1 | 1.1 | 1.1 | 11.3 | 12.8 | 10.3 |
| Silt (0.063 mm to 4 µm) | % | 56.3 | 56.8 | 55.8 | 50.1 | 53.4 | 55.1 | 54.9 | 56.8 | 53.8 |
| Clay (<4 µm) | % | 42.2 | 41.6 | 42.4 | 48.6 | 45.5 | 43.8 | 33.5 | 30.4 | 35.9 |
| **Anions and Nutrients** | | | | | | | | | | |
| Total Nitrogen by LECO | % | 0.415 | 0.293 | 0.286 | 0.367 | 0.373 | 0.355 | 0.095 | 0.1 | 0.13 |
| **Organic / Inorganic Carbon** | | | | | | | | | | |
| Total Organic Carbon | % | 2.74 | 2.08 | 2.12 | 3.2 | 3.35 | 3.15 | 0.662 | 0.675 | 0.799 |
| **Metals** | | | | | | | | | | |
| Aluminum | mg/kg | 25,000 | 25,800 | 25,700 | 26,600 | 26,200 | 27,400 | 15,000 | 15,700 | 17,500 |
| Antimony | mg/kg | 0.16 | 0.16 | 0.16 | 0.14 | 0.1 | <0.10 | 0.19 | 0.18 | 0.25 |
| Arsenic | mg/kg | 15.6 | 12 | 10.8 | 12.2 | 16.3 | 11.4 | 4.72 | 6.01 | 6.73 |
| Barium | mg/kg | 176 | 164 | 160 | 151 | 152 | 150 | 84.8 | 89.2 | 104 |
| Beryllium | mg/kg | 0.85 | 0.82 | 0.82 | 0.89 | 0.86 | 0.89 | 0.51 | 0.64 | 0.57 |
| Bismuth | mg/kg | 0.24 | 0.25 | 0.24 | 0.26 | 0.27 | 0.26 | <0.20 | <0.20 | <0.20 |
| Boron | mg/kg | 25.1 | 24.8 | 24.4 | 19.5 | 19.5 | 20.4 | 14.5 | 13.6 | 15.3 |

| Lake: | Unit | Patch Lake | | | Doris Lake | | | Reference Lake B | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | 24-Aug-22 | | | 22-Aug-22 | | | 24-Aug-22 | | |
| Replicate: | | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Sampling Depth (m): | | 7.1 | 7.3 | 6.7 | 14.3 | 14.2 | 14.2 | 10.5 | 10.4 | 10.5 |
| ALS Sample ID: | | YL2201330-001 | YL2201330-002 | YL2201330-003 | YL2201312-001 | YL2201312-002 | YL2201312-003 | YL2201330-004 | YL2201330-005 | YL2201330-006 |
| **Metals** *(cont'd)* | | | | | | | | | | |
| Cadmium | mg/kg | 0.109 | 0.095 | 0.104 | 0.105 | 0.104 | 0.103 | 0.219 | 0.219 | 0.28 |
| Calcium | mg/kg | 6,160 | 6,130 | 5,950 | 6,130 | 6,170 | 6,170 | 4,150 | 3,970 | 3,930 |
| Chromium | mg/kg | 85.2 | 80.7 | 81.3 | 71.9 | 72.4 | 76.1 | 44.5 | 45.1 | 51.3 |
| Cobalt | mg/kg | 16.5 | 16.6 | 16.7 | 15.4 | 15.6 | 15.4 | 14.1 | 15.2 | 18.9 |
| Copper | mg/kg | 30.6 | 29.6 | 29.4 | 39.1 | 38.7 | 40.1 | 19.7 | 18.4 | 22.7 |
| Iron | mg/kg | 47,300 | 43,700 | 44,000 | 51,200 | 55,600 | 49,800 | 29,600 | 29,500 | 29,000 |
| Lead | mg/kg | 10.1 | 10.4 | 10.5 | 10.6 | 10.6 | 10.6 | 6.54 | 6.19 | 6.77 |
| Lithium | mg/kg | 45.9 | 46 | 46.3 | 42.6 | 42.2 | 44.9 | 24.6 | 25 | 29.2 |
| Magnesium | mg/kg | 15,600 | 16,200 | 16,500 | 15,000 | 15,600 | 15,300 | 8,420 | 8,660 | 9,950 |
| Manganese | mg/kg | 2,420 | 1,090 | 1,130 | 896 | 1,100 | 879 | 245 | 238 | 271 |
| Mercury | mg/kg | 0.0184 | 0.0185 | 0.0172 | 0.0664 | 0.0596 | 0.0609 | 0.0092 | 0.0059 | 0.0054 |
| Molybdenum | mg/kg | 1.73 | 1.42 | 1.28 | 1.12 | 1.46 | 1.15 | 1.85 | 2.02 | 2.27 |
| Nickel | mg/kg | 50.6 | 47.4 | 47.1 | 45.8 | 45.1 | 47.1 | 24.8 | 25.8 | 32.2 |
| Phosphorus | mg/kg | 1,180 | 1,090 | 1,070 | 1,320 | 1,420 | 1,350 | 662 | 641 | 678 |
| Potassium | mg/kg | 7,150 | 7,110 | 6,990 | 5,890 | 5,920 | 6,200 | 3,690 | 3,960 | 4,310 |
| Selenium | mg/kg | 0.36 | 0.3 | 0.28 | 0.37 | 0.34 | 0.35 | 0.35 | 0.34 | 0.4 |
| Silver | mg/kg | 0.22 | 0.24 | 0.22 | 0.23 | 0.25 | 0.27 | <0.10 | <0.10 | <0.10 |
| Sodium | mg/kg | 1,330 | 1,370 | 1,320 | 1,380 | 1,420 | 1,440 | 502 | 542 | 547 |
| Strontium | mg/kg | 41.8 | 41.4 | 40.3 | 41 | 41 | 40.2 | 28.2 | 27.4 | 28.4 |
| Sulfur | mg/kg | 1,870 | 880 | 990 | 1,910 | 1,150 | 1,290 | 1,940 | 1,550 | 2,890 |

| Lake: | Unit | Patch Lake | | | Doris Lake | | | Reference Lake B | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | 24-Aug-22 | | | 22-Aug-22 | | | 24-Aug-22 | | |
| Replicate: | | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Sampling Depth (m): | | 7.1 | 7.3 | 6.7 | 14.3 | 14.2 | 14.2 | 10.5 | 10.4 | 10.5 |
| ALS Sample ID: | | YL2201330-001 | YL2201330-002 | YL2201330-003 | YL2201312-001 | YL2201312-002 | YL2201312-003 | YL2201330-004 | YL2201330-005 | YL2201330-006 |
| **Metals** *(cont'd)* | | | | | | | | | | |
| Thallium | mg/kg | 0.297 | 0.281 | 0.299 | 0.26 | 0.265 | 0.271 | 0.244 | 0.252 | 0.304 |
| Tin | mg/kg | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 |
| Titanium | mg/kg | 1,530 | 1,580 | 1,570 | 1,390 | 1,420 | 1,480 | 1,030 | 1,070 | 1,160 |
| Uranium | mg/kg | 2 | 2.01 | 2.04 | 2.2 | 2.2 | 2.23 | 2.05 | 1.65 | 1.77 |
| Vanadium | mg/kg | 83.6 | 85.4 | 84 | 81.7 | 83.3 | 83.4 | 49.6 | 48.4 | 55.5 |
| Zinc | mg/kg | 89.2 | 90.5 | 90 | 98.3 | 98.7 | 99.1 | 60.4 | 59.5 | 73.8 |
| Zirconium | mg/kg | 8.7 | 9.2 | 9.4 | 7.9 | 7.5 | 8.2 | 8 | 10.6 | 11.2 |

*Notes:*
*Shaded cells indicate values that exceed the benchmark (light grey = ISQG; dark grey = PEL; see Table 2.2-5 in main report).*

### *A.5.1 Quality Assurance/Quality Control Data*

The laboratory QA/QC program included method blanks, laboratory replicates, certified reference materials, internal reference materials, laboratory control samples, matrix spikes, and calibration verification standards. There were no occurrences of laboratory QA/QC samples not meeting data quality objectives in 2022.Therfore the sediment quality results are of good quality and reliable data.

## A.6 Phytoplankton Biomass

Phytoplankton biomass, as chlorophyll *a*, samples were collected from August 23 to 29, 2022. Table A.6-1 presents the measured chlorophyll *a* mass per sample and calculated concentrations. Figure A.6-1 presents the mean chlorophyll *a* for each lake.

**Table A.6-1: Phytoplankton Biomass Results, Hope Bay AEMP, 2022**

| Lake | Sampling Date | Sampling Depth (m) | Replicate | ALS Sample ID | Chlorophyll *a* (µg/sample) | Volume Filtered (L) | Phytoplankton Biomass (µg chl *a*/L) |
|---|---|---|---|---|---|---|---|
| Patch Lake | 29-Aug-22 | 1 | 1 | YL2201400-004 | 0.491 | 0.4 | 1.23 |
| | | | 2 | YL2201400-005 | 0.281 | 0.25 | 1.12 |
| | | | 3 | YL2201400-006 | 0.308 | 0.25 | 1.23 |
| Doris Lake | 23-Aug-22 | 1 | 1 | YL2201400-001 | 6.79 | 0.3 | 22.63 |
| | | | 2 | YL2201400-002 | 8.88 | 0.4 | 22.20 |
| | | | 3 | YL2201400-003 | 11.8 | 0.5 | 23.60 |
| Reference Lake B | 28-Aug-22 | 1 | 1 | YL2201400-007 | 0.375 | 0.5 | 0.75 |
| | | | 2 | YL2201400-008 | 0.389 | 0.5 | 0.78 |
| | | | 3 | YL2201400-009 | 0.455 | 0.5 | 0.91 |

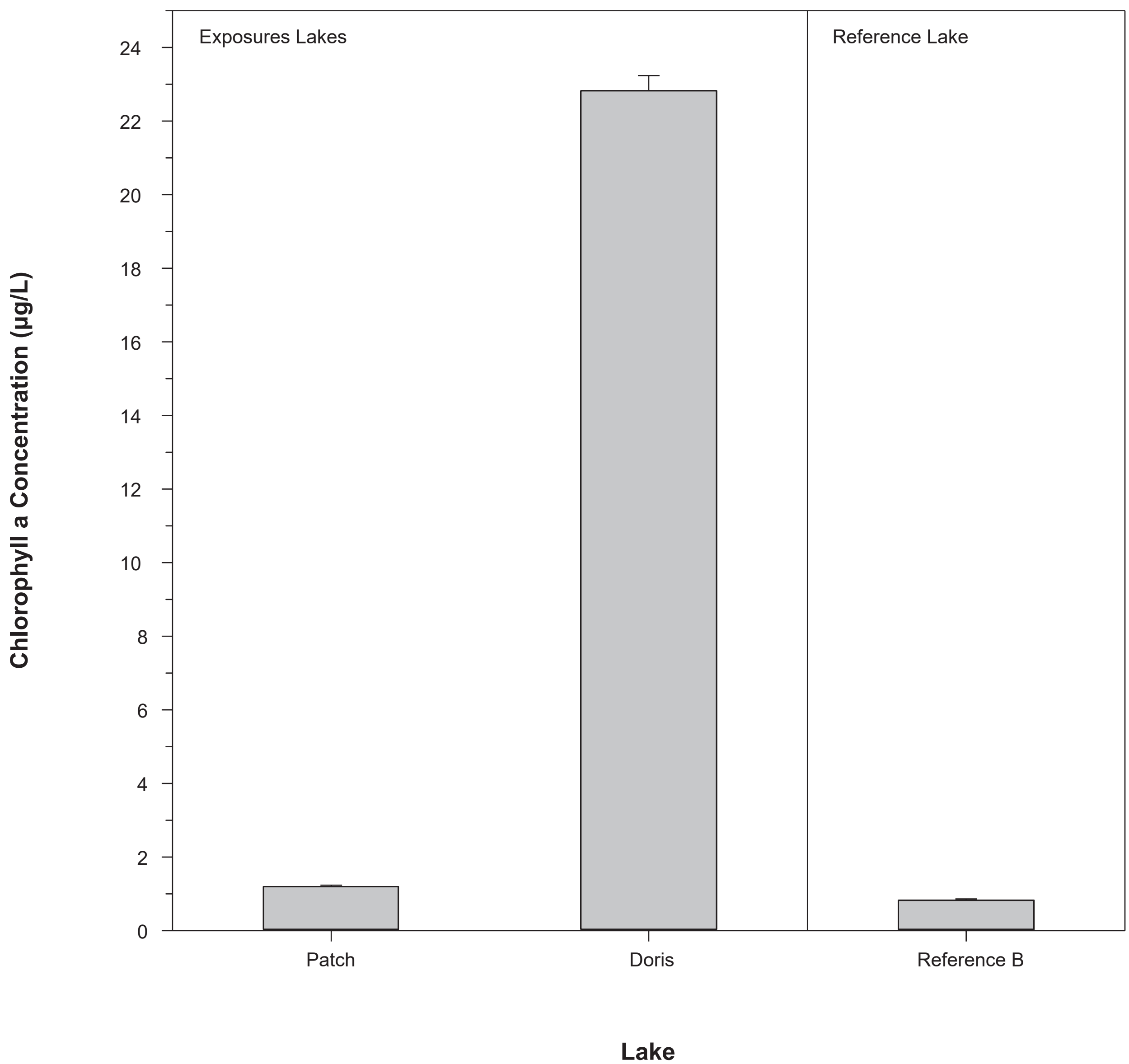
### *A.6.1 Quality Assurance/Quality Control Data*

The laboratory QA/QC program included method blanks and laboratory control samples. There were no occurrences of laboratory QA/QC samples not meeting data quality objectives in 2022. Therefore, the chlorophyll a results are of good quality and reliable data.

## A.7 Benthic Invertebrates

Benthos samples were collected on August 22 to 28, 2022. Table A.7-1 presents the benthic invertebrate taxonomy (enumeration) results for all samples; excluded taxa are those that were enumerated in the sample but not included in any analysis as they are not sampled in a standardized way with the AEMP methods.

Community descriptors including total benthos density, family richness, Simpson's evenness index, and the Bray-Curtis similarity index were calculated from the taxonomic data. Total density, family richness, Simpson's evenness index, and Bray-Curtis index are presented in Table A.7-2. Community descriptors as well as the community composition are presented in Figures A.7-1 and Figure A.7-2.




*Notes: Error bars represent the standard error of the mean.*

**Figure A.6-1: Phytoplankton Biomass in Lakes, Hope Bay AEMP, 2022**

## Table A.7-1: Benthic Invertebrate Taxonomy, Hope Bay AEMP, 2022

| Lake | | | | | Patch Lake | | | | | Doris Lake | | | | | Reference Lake B | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | | | | 24-Aug-22 | | | | | 22-Aug-22 | | | | | 24-Aug-22 | | | | 28-Aug-22 |
| Sampling Depth: | | | | | 7.1 | 7.3 | 6.1 | 6.8 | 7.3 | 14.1 | 14.2 | 14.1 | 14.3 | 14 | 10.5 | 10.9 | 10.4 | 10.5 | 10.8 |
| Replicate | | | | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Major Group | Family | Subfamily | Tribe | Genus | | | | | | | | | | | | | | | |
| Oligochaeta - cocoon | - | - | - | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Naididae | Naidinae | - | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Naididae | Tubificidae | - | - | 1 | 0 | 6 | 0 | 7 | 20 | 56 | 48 | 31 | 27 | 10 | 11 | 43 | 14 | 11 |
| Pelecypoda | Pisidiidae | - | - | (i/d) | 0 | 0 | 2 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 8 |
| | | - | - | *Sphaerium* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | | - | - | *Pisidium* | 10 | 0 | 7 | 9 | 2 | 0 | 0 | 0 | 1 | 0 | 20 | 16 | 20 | 34 | 33 |
| Hydracarina | - | - | - | (i/d) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | Lebertiidae | - | - | *Lebertia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Amphipoda | Epimeriidae | - | - | *Epimeria loricata* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Malacostraca | Mysidae | - | - | *Mysis relicta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Isopoda | Chaetiliidae | - | - | *Saduria entomon* | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trichoptera | Limnephilidae | - | - | *Grensia praeterita* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Diptera | Chironomidae | - | - | (pupa) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | | Tanypodinae | Pentaneurini | *Thienemannimyia* group | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | Procladiini | *Procladius* | 2 | 2 | 9 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 5 | 2 | 1 |
| | | Diamesinae | Protanypini | *Protanypus* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 2 | 2 | 2 | 3 |
| | | Prodiamesinae | | *Monodiamesa* | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| | | Orthocladiinae | Orthocladiini | *Heterotrissocladius* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | | | | *Psectrocladius* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 20 | 14 | 11 | 0 |
| | | | | *Zalutschia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 7 | 4 | 1 |
| | | Chironominae | Chironomini | *Chironomus* | 0 | 0 | 0 | 1 | 0 | 256 | 334 | 323 | 317 | 210 | 1 | 0 | 0 | 0 | 0 |
| | | | | *Sergenta* | 2 | 2 | 1 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | *Stictochironomus* | 0 | 1 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | Tanytarsini | *Corynocera* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 10 | 9 | 9 |
| | | | | *Micropsectra* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | *Paratanytarsus* | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 6 | 1 | 2 | 1 | 1 |
| | | | | *Tanytarsus* | 2 | 5 | 2 | 4 | 15 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 1 |
| **Total Abundance** | | | | | **21** | **11** | **30** | **22** | **34** | **281** | **391** | **372** | **349** | **240** | **86** | **57** | **106** | **81** | **71** |

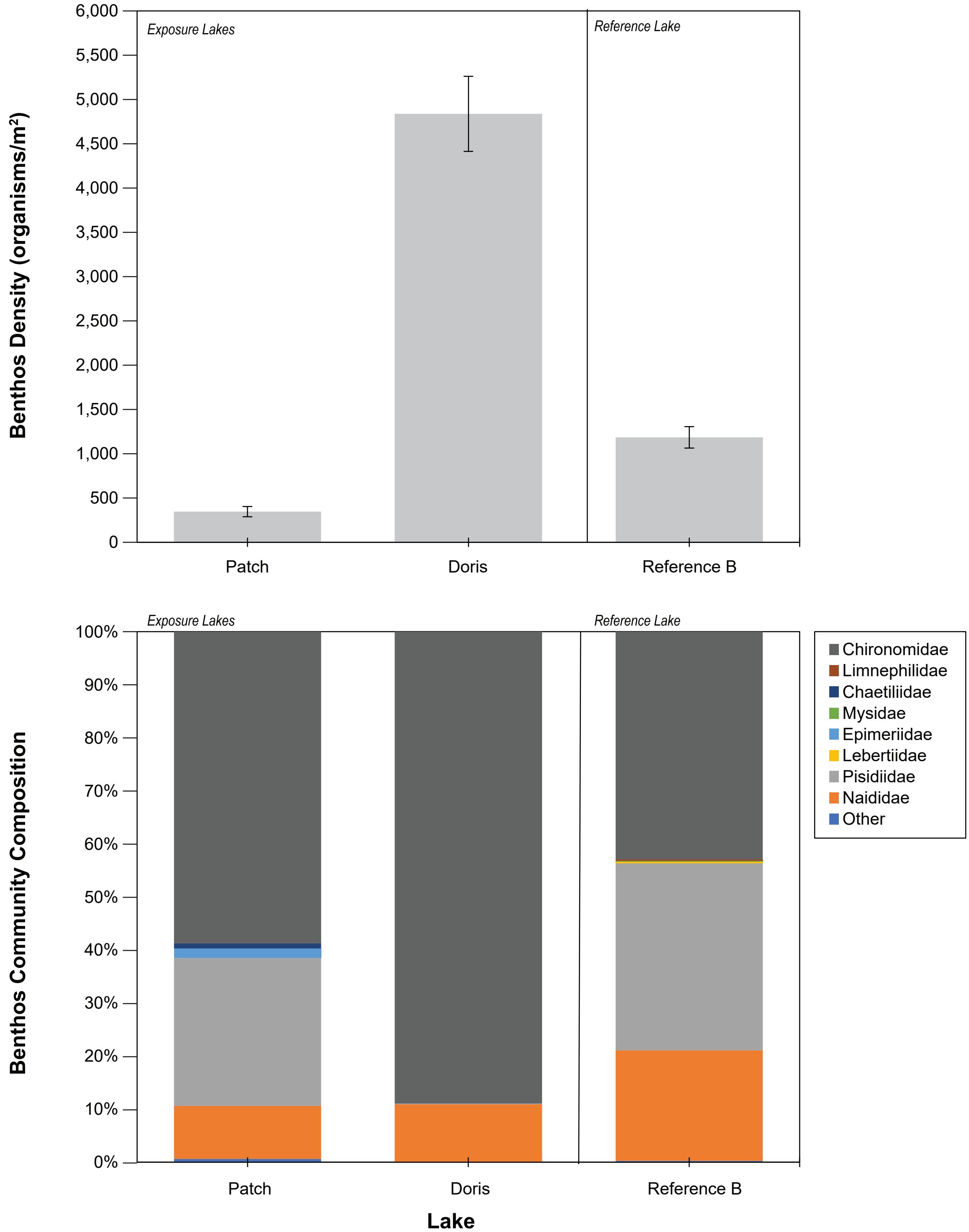
| Lake | | | | | Patch Lake | | | | | Doris Lake | | | | | Reference Lake B | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date: | | | | | 24-Aug-22 | | | | | 22-Aug-22 | | | | | 24-Aug-22 | | | | 28-Aug-22 |
| Sampling Depth: | | | | | 7.1 | 7.3 | 6.1 | 6.8 | 7.3 | 14.1 | 14.2 | 14.1 | 14.3 | 14 | 10.5 | 10.9 | 10.4 | 10.5 | 10.8 |
| Replicate | | | | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Major Group | Family | Subfamily | Tribe | Genus | | | | | | | | | | | | | | | |
| **Excluded Taxa** | | | | | | | | | | | | | | | | | | | |
| Nematoda | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 11 | 35 | 19 | 3 |
| Copepoda - Calanoida | - | - | - | - | 1 | 0 | 2 | 2 | 0 | 3 | 21 | 28 | 23 | 15 | 0 | 0 | 0 | 0 | 0 |
| Copepoda – Cyclopoida | - | - | - | - | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 |
| Ostracoda | - | - | - | - | 6 | 6 | 0 | 2 | 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 4 | 0 | 0 |
| Cladocera | Daphnidae | - | - | *Daphnia* | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| | Holopedidae | - | - | *Holopedium gibberum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

*Notes:*
*Data represent raw counts of the number of organisms in each sample.*
*Sampling area = 0.0675 $m^2$.*
*i/d = immature or damaged.*

## Table A.7-2: Summary of Calculated Benthic Invertebrate Community Descriptors, Hope Bay AEMP Lakes, 2022

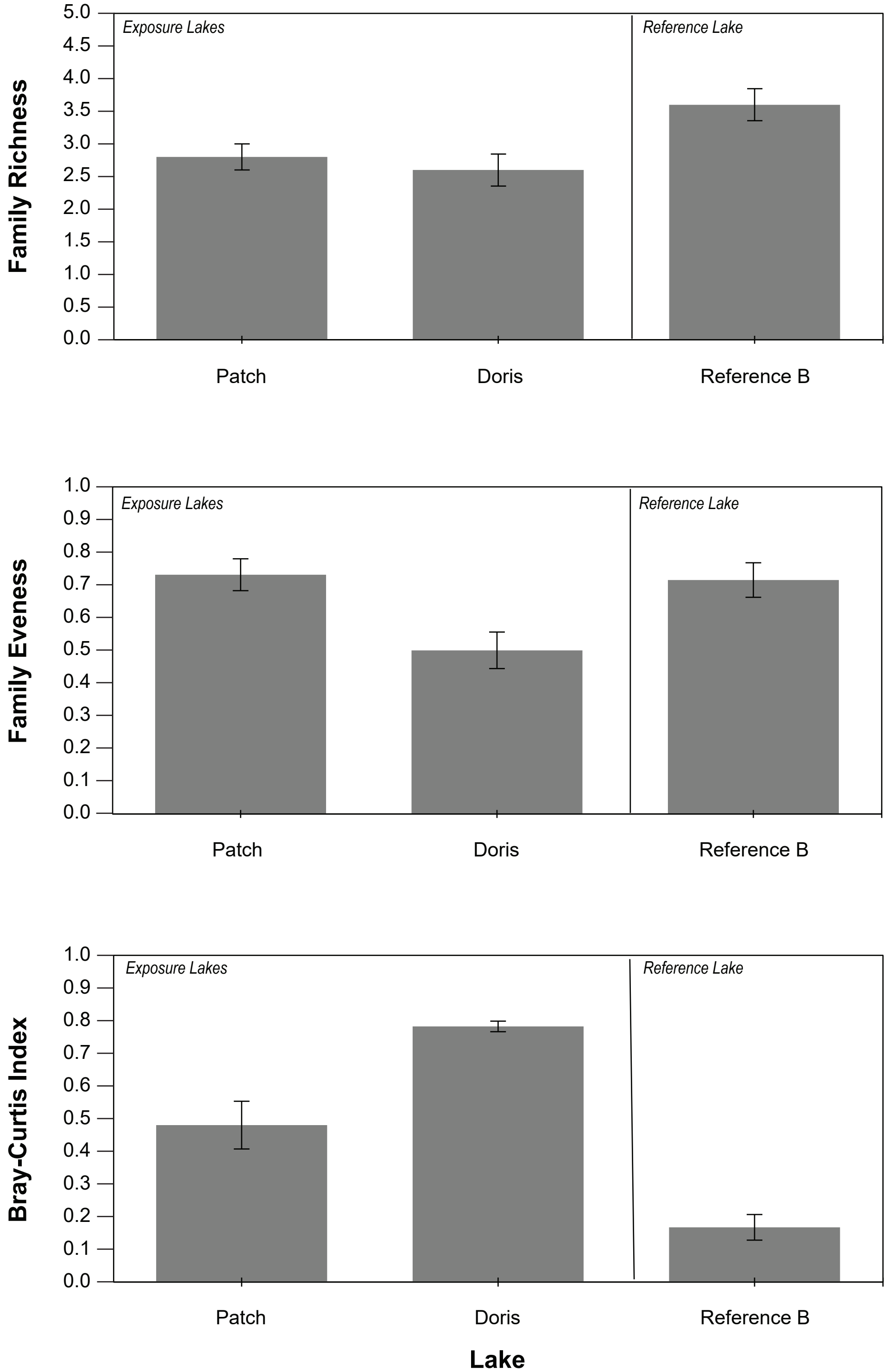
| Lake | Replicate | Total Density (#/m$^2$) | Family Richness | Simpson's Evenness Index | Bray-Curtis Index |
|---|---|---|---|---|---|
| Patch Lake | 1 | 311 | 3 | 0.79 | 0.58 |
| | 2 | 163 | 2 | 0.60 | 0.17 |
| | 3 | 444 | 3 | 0.88 | 0.62 |
| | 4 | 326 | 3 | 0.73 | 0.54 |
| | 5 | 504 | 3 | 0.66 | 0.50 |
| | **Mean** | **350** | **2.8** | **0.73** | **0.48** |
| | **SE** | **59** | **0.2** | **0.05** | **0.08** |
| Doris Lake | 1 | 4,163 | 3 | 0.39 | 0.14 |
| | 2 | 5,793 | 3 | 0.44 | 0.25 |
| | 3 | 5,511 | 2 | 0.64 | 0.22 |
| | 4 | 5,170 | 3 | 0.40 | 0.17 |
| | 5 | 3,556 | 2 | 0.62 | 0.20 |
| | **Mean** | **4,839** | **2.6** | **0.50** | **0.20** |
| | **SE** | **423** | **0.2** | **0.06** | **0.02** |
| Reference Lake B | 1 | 1,274 | 4 | 0.55 | 0.54 |
| | 2 | 844 | 3 | 0.87 | 0.61 |
| | 3 | 1,570 | 4 | 0.70 | 0.64 |
| | 4 | 1,200 | 4 | 0.69 | 0.64 |
| | 5 | 1,052 | 3 | 0.78 | 0.57 |
| | **Mean** | **1,188** | **3.6** | **0.72** | **0.60** |
| | **SE** | **120** | **0.2** | **0.05** | **0.02** |

*Note:*
*SE = Standard error of the mean.*




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

**Figure A.7-1: Benthic Invertebrate Density and Taxonomic Composition, Hope Bay AEMP, 2022**




*Notes: Error bars represent the standard error of the mean of replicates.*

## Figure A.7-2: Lake Benthos Richness, Evenness, and Bray-Curtis Index, Hope Bay AEMP, 2022

### A.7.1 Quality Assurance/Quality Control Data

The laboratory QA/QC program included assessing sorting efficiency. A re-sorting of randomly selected sample residues was conducted by the taxonomist on a minimum of 10% of the benthos samples to determine the level of sorting efficiency. Sorting efficiency was 100% as detailed in Table A.7-3. Therefore, the benthos samples enumerated were reliable representations of the sample collected.

**Table A.7-3: Benthic Invertebrate QA/QC Sorting Efficiencies, Hope Bay AEMP, 2022**

| Sample ID | Abundance from Initial Sort | Abundance from Re-sort | Initial Sort Efficiency (%) | Re-sort Required? |
|---|---|---|---|---|
| Patch Lake, Replicate 1 | 34 | 0 | 100 | No |
| Reference Lake B, Replicate 2 | 69 | 0 | 100 | No |

*Notes:*

*If the efficiency is 95% or better nothing further is done and the QA/QC invertebrates are not added to the data.*

*If the efficiency is less than 95%, the QA/QC invertebrates are added to the sample, it is re-sorted, and a second 20% QA/QC is performed.*

*% Sorting Efficiency = [1- {# in QA/QC re-sort/(# sorted originally + # in QA/QC re-sort)}]*100*

## A.8 References

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 2022 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** | Drew Copeland (ERM), Cameron Evans (ERM) |
| **Cc** | Danielle Willmon (ERM) |
| **Date** | 29 March 2023 |
| **Reference** | 06354519-0002 |
| **Subject** | Hope Bay Project 2022 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 is operated by Agnico Eagle Mines Ltd. (Agnico) who acquired it through the purchase of TMAC Resources Inc. (TMAC) on February 2, 2021.

This memorandum provides a summary of the hydrology compliance monitoring program performed for the Project in 2022. 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-HOP2232 Type B, renewed 2022), 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-HOP2232) 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 February 2022 the Project went into care and maintenance. In April 2022 the Doris-Madrid Care and Maintenance Plan was subm itted to the Nunavut Water Board (NWB) and Nunavut Impact Review Board (NIRB) as per compliance with the Type A Water Licence 2AM-DOH1335 and the Project Certificate No. 009, in April 2022. Prior to entering care and maintenance, the Doris development was in the operations phase and Madrid North was in the construction and operations phase, though operations at Madrid North were suspended in February 2021 to allow for a thorough review of the proposed work plan.

These works 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.

The following section consists of 2022 monitoring data and results. These results are based on the comparison of 2022 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 2022 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, after the installation of the pressure transducers in June. Pressure transducers were pulled from stations in late September.

### 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 | Seasonal[1] |
| Little Roberts Outflow | Discharge and Water Level | Seasonal |

*[1] Roberts Hydro-2 was previously operated as a year-round station but was destroyed by ice and was operated as a seasonal station in 2021 and 2022.*

### Table 2-2: 2022 Station Locations

| Station | UTM Zone 13W | | Watershed Area ($km^2$) | Lake Coverage (%) |
|---|---|---|---|---|
| | Easting | Northing | | |
| 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 |

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 is operated year-round. Roberts Hydro-2 had previously been operated year-round; however, the station was destroyed by ice and was operated seasonally in 2021 and 2022.

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 m to monitor lake level year-round. 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. 2022 ANALYSIS AND RESULTS

Tables 3-1 to 3-8 present the 2022 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.

## 3.1 Stage Discharge Measurements

ERM, assisted by Agnico personnel, performed water level and discharge measurements during station remobilization in June. Agnico personnel conducted open-water season water level and discharge measurements in July and August. Seasonal stations were 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. Manual measurements are presented in Table 3-1.

**Table 3-1: Summary of 2022 Stage and Discharge Measurements**

| Station | Date | Stage (m) | Discharge ($m^3/s$) | Measurement Made by |
|---|---|---|---|---|
| Windy Outflow | 6/11/2022 | 18.349 | 0.200 | ERM |
| | 6/15/2022 | 18.366 | 0.216 | ERM |
| | 7/29/2022 | 18.288 | 0.023 | Agnico |
| | 8/23/2022 | 18.213 | 0.045 | Agnico |
| | 9/29/2022 | 18.277 | n/a[1] | ERM |
| Glenn Lake | 6/12/2022 | 9.885 | n/a[2] | ERM |
| | 6/15/2022 | 9.970 | n/a[2] | ERM |
| | 6/20/2022 | 9.971 | n/a[2] | ERM |
| | 7/29/2022 | 9.577 | n/a[2] | Agnico |
| | 8/25/2022 | 9.500 | n/a[2] | Agnico |
| | 9/29/2022 | 9.701 | n/a[2] | ERM |
| Imniagut Lake | 6/11/2022 | 27.412 | n/a[2] | ERM |
| | 6/15/2022 | 27.413 | n/a[2] | ERM |
| | 8/23/2022 | 27.295 | n/a[2] | Agnico |
| | 9/29/2022 | 27.328 | n/a[2] | ERM |

| Station | Date | Stage (m) | Discharge ($m^3/s$) | Measurement Made by |
|---|---|---|---|---|
| Patch Outflow | 6/10/2022 | 26.396 | No Flow | ERM |
| | 6/14/2022 | 26.393 | 0.222 | ERM |
| | 6/16/2022 | 26.398 | 0.267 | ERM |
| | 7/30/2022 | 26.235 | 0.127 | Agnico |
| | 8/23/2022 | 26.154 | 0.136 | Agnico |
| | 9/30/2022 | 26.329 | n/a[1] | ERM |
| PO Outflow | 6/10/2022 | 26.335 | 0.044 | ERM |
| | 6/16/2022 | 26.376 | 0.392 | ERM |
| | 7/29/2022 | 26.142 | 0.165 | Agnico |
| | 8/23/2022 | 26.014 | 0.096 | Agnico |
| | 9/30/2022 | 26.315 | n/a[2] | ERM |
| Ogama Outflow | 6/11/2022 | 24.345 | 1.072 | ERM |
| | 6/16/2022 | 24.360 | 1.125 | ERM |
| | 7/30/2022 | 24.100 | 0.130 | Agnico |
| | 8/25/2022 | 24.064 | 0.105 | Agnico |
| | 9/30/2022 | 24.324 | n/a[2] | ERM |
| Doris Lake-2 | 6/13/2022 | 22.058 | n/a[2] | ERM |
| | 6/15/2022 | 22.069 | n/a[2] | ERM |
| | 7/31/2022 | 21.775 | n/a[2] | Agnico |
| | 8/29/2022 | 21.781 | n/a[2] | Agnico |
| | 10/1/2022 | 21.959 | n/a[2] | ERM |
| | 6/13/2022 | 21.975 | 1.359 | ERM |
| | 6/19/2022 | 21.984 | 1.419 | ERM |
| Doris Creek (TL-2) | 7/30/2022 | 21.679 | 0.255 | Agnico |
| | 8/29/2022 | 21.659 | 0.260 | Agnico |
| | 10/1/2022 | 21.864 | 1.221 | ERM |
| Roberts Hydro-2 | 6/12/2022 | 6.577 | 1.143 | ERM |
| | 6/18/2022 | 6.640 | 1.815 | ERM |
| | 7/28/2022 | 6.432 | 0.434 | Agnico |
| | 8/25/2022 | 6.324 | 0.175 | Agnico |
| | 10/3/2022 | 6.603 | 2.211 | ERM |

| Station | Date | Stage (m) | Discharge ($m^3/s$) | Measurement Made by |
|---|---|---|---|---|
| Little Roberts Outflow | 6/14/2022 | 5.023 | 3.098 | ERM |
| | 6/18/2022 | 5.026 | 3.311 | ERM |
| | 7/27/2022 | 4.964 | n/a[1] | Agnico |
| | 8/26/2022 | 4.486 | n/a[1] | Agnico |
| | 9/29/2022 | 4.911 | n/a[1] | ERM |

*[1] Not measured due to time constraints, access limitations, or staffing limitations due to the COVID-19 pandemic.*

*[2] Lake Level measured only.*

## 3.2 Hydrographs

Seasonal stations were re-installed in June and were demobilized in late September, early October. 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 modelled. For stations with no discharge monitoring, lake level was modelled 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 modelled data.

Tables 3-2 and 3-3 present the estimated discharge and the lake level, respectively. 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. Appendix A and B provide the Lake Level Graphs and Hydrographs for each monitored station in 2022. 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 2022 with previous years.

### Table 3-2: 2022 Observed, Modelled and Estimated Discharge

| Station | Observed | Modelled | Estimated |
|---|---|---|---|
| Windy Outflow | Jun 14 – Sep 29 | Jun 7 – Jun 13<br>Sep 30 – Nov 1 | May 28 – Jun 6<br>Nov 2 – Nov 18 |
| Patch Outflow | Jun 23 – Sep 30 | Jun 14 – Jun 22<br>Oct 1 – Nov 1 | May 28 – Jun13<br>Jun 7 – Jun 16<br>Nov 1 – Nov 18 |
| PO Outflow | Jun 23 – Sep 30 | Jun 10 – Jun 23<br>Sep 30 – Nov 1 | May 28 – Jun 9<br>Nov 1 – Nov 18 |

| Station | Observed | Modelled | Estimated |
|---|---|---|---|
| Ogama Outflow | Jun 11 – Sep 30 | Oct 10 – Nov 1 | May 28 – Jun 10<br>Oct 1 – Oct 9<br>Nov 2 – Nov 18 |
| Doris Creek TL-2 | Jun 14 – Sep 28 | May 31 – Jun 6<br>Oct 3 – Nov 1 | May 28 – May 30<br>Jun 7 – Jun 13<br>Sep 28 – Oct 3<br>Nov 1 – Nov 18 |
| Roberts Hydro-2 | Jun 13 – Oct 4 | Jun 8 – Jun 12<br>Oct 9 – Nov 1 | May 28 – Jun 7<br>Oct 5 – Oct 8<br>Nov 1 – Nov 18 |
| Little Roberts Outflow | Jun 12 – Sep 29 | Sep 30 – Nov 2 | May 28 – Jun 11<br>Nov 3 – Nov 18 |

**Table 3-3: 2022 Observed, Modelled and Estimated Lake Levels**

| Station | Observed | Modelled | Estimated |
|---|---|---|---|
| Windy Outflow | Jun 13 – Sep 29 | Jun 6 – Jun 12<br>Sep 30 – Nov 1 | Jan 1 – Jun 7<br>Nov 1 – Dec 31 |
| Glenn Lake | Jun 15 – Sep 29 | May 31 – Jun 9<br>Oct 2 – Nov 1 | Jan 1 – May 30<br>Jun 10 – Jun 14<br>Sep 29 – Oct 1<br>Nov 2 – Dec 31 |
| Imniagut Lake | Jun 11 – Sep 29 | Jan 1 – Jun 10<br>Oct 1 – Dec 31 | Jan 1 – Jun 3<br>30-Sep<br>Nov 1 – Dec 31 |
| Patch Outflow | Jun 15 – Sep 30 | Jun 1 – Jun 10<br>Sep 29 – Nov 1 | Jan 1 – May 30<br>Jun 11 – Jun 14<br>Nov 1 – Dec 31 |
| PO Outflow | Jun10 – Sep 30 | May 31 – Jun 9<br>Oct 4 – Nov 1 | Jan 1 –.May 30<br>Oct 1 – Oct 3 |
| Ogama Outflow | Jun 11 – Sep 30 | Oct 1 – Nov 4 | Jan 1 – Jun 10<br>Oct 2 – Oct 9<br>Nov 5 – Dec 31 |
| Doris Lake-2 | Jan 1 – Dec 31 | n/a | n/a |
| Roberts Hydro-2 | Jun 13 – Oct 4 | Jun 8 – Jun 12<br>Oct 9 – Nov 1 | Jan 1 – Jun 7<br>Oct 5 – Oct 8<br>Nov 1 – Dec 31 |
| Little Roberts Outflow | Jun 12 - Sep 29 | Sep 30 - Nov 2 | Nov 3 – Nov 18<br>May 28 – Jun 11 |

Flow was predicted to have started on May 28, based on site photos taken at Doris Creek every 3 to 5 days, and ended on November 18, based on the Doris Lake water level no longer dropping and a significant cold snap.

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.

## 3.3 Rating Curves

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 from previous years are used in the development of rating curves. Older measurements are excluded from the rating curves when they no longer align with recent measurements. This adjustment is common as erosion and aggradation of the channel changes the stage-discharge relationship over time.

Minor updates to rating curves were made where appropriate based on the data collected in 2022. Stage data collected in 2022 was converted to discharge using the equations listed in Table 3-5.

## 3.4 Hydrologic Indices

Table 3-6 presents the 2022 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 = $km^2$).

Peak daily flows are the highest mean daily flow during the year and typically occur during freshet. The lowest 7-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 that 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 3-4: Summary of 2022 Lake Levels

| Station | Parameter | 2022 Monthly Lake Level1 (m) | | | | | | | | | | | | Lake Level Fluctuation[2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jun-Sep | Annual |
| Windy Outflow | Mean | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.334 | 18.337 | 18.260 | 18.270 | 18.279 | 18.257 | 18.251 | 0.146 | 0.146 |
| | Max | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.373 | 18.367 | 18.287 | 18.280 | 18.286 | 18.270 | 18.251 | | |
| | Min | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.293 | 18.228 | 18.254 | 18.271 | 18.251 | 18.251 | | |
| Glenn Lake | Mean | 9.490 | 9.490 | 9.490 | 9.490 | 9.495 | 9.841 | 9.652 | 9.542 | 9.660 | 9.782 | 9.545 | 9.490 | 0.451 | 0.479 |
| | Max | 9.490 | 9.490 | 9.490 | 9.490 | 9.566 | 9.969 | 9.765 | 9.607 | 9.725 | 9.863 | 9.675 | 9.490 | | |
| | Min | 9.490 | 9.490 | 9.490 | 9.490 | 9.490 | 9.596 | 9.562 | 9.518 | 9.602 | 9.686 | 9.490 | 9.490 | | |
| Imniagut Lake | Mean | 27.268 | 27.261 | 27.251 | 27.242 | 27.241 | 27.381 | 27.316 | 27.291 | 27.340 | 27.371 | 27.335 | 27.377 | 0.163 | 0.193 |
| | Max | 27.274 | 27.269 | 27.256 | 27.251 | 27.267 | 27.421 | 27.367 | 27.389 | 27.377 | 27.409 | 27.371 | 27.392 | | |
| | Min | 27.261 | 27.251 | 27.245 | 27.233 | 27.228 | 27.282 | 27.259 | 27.258 | 27.297 | 27.325 | 27.313 | 27.361 | | |
| Patch Outflow | Mean | 26.210 | 26.210 | 26.210 | 26.210 | 26.211 | 26.369 | 26.292 | 26.177 | 26.270 | 26.355 | 26.231 | 26.210 | 0.265 | 0.277 |
| | Max | 26.210 | 26.210 | 26.210 | 26.210 | 26.224 | 26.399 | 26.363 | 26.211 | 26.333 | 26.412 | 26.280 | 26.210 | | |
| | Min | 26.210 | 26.210 | 26.210 | 26.210 | 26.210 | 26.225 | 26.218 | 26.134 | 26.204 | 26.288 | 26.210 | 26.210 | | |
| PO Outflow | Mean | 25.949 | 25.949 | 25.949 | 25.949 | 25.963 | 26.313 | 26.215 | 26.072 | 26.226 | 26.299 | 26.027 | 25.949 | 0.375 | 0.436 |
| | Max | 25.949 | 25.949 | 25.949 | 25.949 | 26.122 | 26.385 | 26.290 | 26.175 | 26.308 | 26.362 | 26.210 | 25.949 | | |
| | Min | 25.949 | 25.949 | 25.949 | 25.949 | 25.949 | 26.147 | 26.126 | 26.010 | 26.145 | 26.219 | 25.949 | 25.949 | | |
| Ogama Outflow | Mean | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.259 | 24.188 | 24.092 | 24.253 | 24.312 | 24.105 | 24.092 | 0.303 | 0.303 |
| | Max | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.363 | 24.260 | 24.177 | 24.327 | 24.346 | 24.250 | 24.092 | | |
| | Min | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.112 | 24.060 | 24.181 | 24.257 | 24.092 | 24.092 | | |
| Doris Lake-2 | Mean | 21.788 | 21.774 | 21.753 | 21.735 | 21.733 | 22.021 | 21.888 | 21.757 | 21.889 | 22.000 | 21.925 | 22.013 | 0.354 | 0.373 |
| | Max | 21.802 | 21.790 | 21.764 | 21.753 | 21.787 | 22.079 | 21.998 | 21.796 | 21.993 | 22.078 | 21.999 | 22.043 | | |
| | Min | 21.774 | 21.755 | 21.742 | 21.718 | 21.706 | 21.817 | 21.787 | 21.725 | 21.799 | 21.905 | 21.880 | 21.979 | | |

| Station | Parameter | 2022 Monthly Lake Level1 (m) | | | | | | | | | | | | Lake Level Fluctuation[2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jun-Sep | Annual |
| Roberts Hydro-2 | Mean | 6.153 | 6.153 | 6.153 | 6.153 | 6.156 | 6.488 | 6.488 | 6.358 | 6.496 | 6.566 | 6.213 | 6.153 | 0.447 | 0.500 |
| | Max | 6.153 | 6.153 | 6.153 | 6.153 | 6.186 | 6.641 | 6.542 | 6.407 | 6.597 | 6.653 | 6.450 | 6.153 | | |
| | Min | 6.153 | 6.153 | 6.153 | 6.153 | 6.153 | 6.194 | 6.411 | 6.322 | 6.409 | 6.459 | 6.153 | 6.153 | | |
| Little Roberts Outflow | Mean | 4.430 | 4.430 | 4.430 | 4.430 | 4.437 | 4.894 | 4.683 | 4.551 | 4.784 | 4.894 | 4.526 | 4.430 | 0.527 | 0.593 |
| | Max | 4.430 | 4.430 | 4.430 | 4.430 | 4.540 | 5.023 | 4.843 | 4.642 | 4.905 | 4.975 | 4.774 | 4.430 | | |
| | Min | 4.430 | 4.430 | 4.430 | 4.430 | 4.430 | 4.577 | 4.589 | 4.496 | 4.645 | 4.787 | 4.430 | 4.430 | | |

[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.*

## Table 3-5: Stage-Discharge Rating Equations for Madrid Hydrometric Stations in 2022

| Station | Rating Equation[1] $Q = C\,(h-a)^b$ | Number of Measurements Used[2] | Root Mean Square – Error ($m^3/s$) |
|---|---|---|---|
| Windy Outflow | $Q = 7.419\,(h - 18.160)^{2.289}$ | 13 | 15.3 |
| Patch Outflow | $Q = 6.283\,(h - 26.095)^{2.235}$ ; $h < 26.510$<br>$Q = 4.910\,(h - 26.140)^{1.729}$ ; $h > 26.510$ | 21 | 9.5 (5.2) |
| PO Outflow | $Q = 7.145\,(h - 25.9)^{3.060}$ ; $h < 26.33$<br>$Q = 6.332\,(h - 26.1)^{1.675}$ ; $h > 26.33$ | 11 | 2.8 (1.4) |
| Ogama Outflow | $Q = 7.058\,(h - 23.855)^{2.703}$ ; $h < 24.31$<br>$Q = 8.145\,(h - 23.95)^{2.296}$ ; $h > 24.31$ | 21 | 7.4 |
| Doris Creek TL-2 | $Q = 5.071\,(h - 21.511)^{1.666}$ ; $h < 22.00$<br>$Q = 8.545\,(h - 21.611)^{1.815}$ ; $h > 22.00$ | 36 | 12.2 (1) |
| Roberts Outflow-2 | $Q = 6.311\,(h - 6.104)^{1.978}$ ; $h < 6.50$<br>$Q = 11.137\,(h - 6.153)^{2.268}$ ; $h > 6.50$ | 25 | 10.5 (17.8) |
| Little Roberts Outflow | $Q = 4.491\,(h - 4.24)^{1.423}$ ; $h < 4.95$<br>$Q = 17.202\,(h - 4.41)^{3.061}$ ; $h > 4.95$ | 9 | 4.8 |

*[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 2022 stage-discharge rating equations were developed using measurements from 2017 to 2022, where available.*

## Table 3-6: Summary of 2022 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 | 86 | 0.22 | 23-Jun | 0.02 | 26-Aug |
| Patch Outflow | 118 | 0.57 | 17-Oct | 0.08 | 10-Aug |
| PO Outflow | 115 | 0.77 | 14-Jun | 0.08 | 18-Aug |
| Ogama Outflow | 95 | 1.12 | 15-Jun | 0.10 | 26-Aug |

| 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 |
| Doris Creek TL-2 | 121 | 1.48 | 17-Oct | 0.09 | 27-Aug |
| Roberts Outflow-2 | 127 | 2.31 | 17-Oct | 0.26 | 15-Aug |
| Little Roberts Outflow | 100 | 3.30 | 17-Jun | 0.55 | 26-Aug |

*[1] Peak flows refer to peak daily discharges in 2022 and are based on estimated and observed data.*
*[2] 7-day low flows are June peak to September 31 data only.*

**Table 3-7: Summary of 2022 Monthly Runoff Distributions**

| Station | 2022 Monthly Runoff (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Windy Outflow | 0 | 28 | 28 | 8 | 9 | 11 | 2 | 0 |
| Patch Outflow | 0 | 20 | 20 | 11 | 26 | 38 | 3 | 0 |
| PO Outflow | 0 | 24 | 14 | 6 | 22 | 32 | 2 | 0 |
| Ogama Outflow | 0 | 23 | 13 | 5 | 21 | 31 | 2 | 0 |
| Doris Creek TL-2 | 0 | 35 | 21 | 5 | 22 | 35 | 3 | 0 |
| Roberts Outflow-2 | 0 | 33 | 20 | 7 | 22 | 42 | 4 | 0 |
| Little Roberts Outflow | 0 | 26 | 16 | 9 | 20 | 27 | 2 | 0 |

## 3.5 Ice Measurements

Agnico conducted ice thickness measurements in April at the same time as the under-ice aquatic sampling. Under-ice water level surveying occurred from April 7 to April 10, 2022. Table 3-8 presents surveyed water level, ice thickness, and water gap for each monitored lake. As the hydrometric station benchmarks are buried in snow and not necessarily close to the under-ice water level survey location, surveys were performed using a Real Time Kenmatic (RTK) system. 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 water levels higher than open-water season water levels.

The under-ice volume determined using subsurface contours for the lakes created from bathymetric survey information collected in 2006 and 2008. The bathymetric survey elevations were not referenced to a geodetic elevation, so the lake surface of the bathymetric data for each lake was estimated from the average August water elevation for all years for which geodetic water levels were available from 2016-2020. This provides a means to relate bathymetric data, with no elevation reference, with surveyed water levels tied to a geodetic datum. The value used remains constant and does not impact the comparison of water levels from year to year.

**Table 3-8: Summary of 2022 Under-Ice Lake Level Surveys with Under-Ice Volumes of Monitored Lakes with Bathymetry Information**

| Station | 2022 | | | | |
|---|---|---|---|---|---|
| | Water Surface Elevation[1] (masl) | Ice Thickness (m) | Water Gap (m) | Ice Bottom Elevation (masl) | Under-Ice Volume ($mm^3$) |
| Windy Outflow | 18.25 | 1.90 | 0.16 | 16.51 | 49.91 |
| Glenn Lake | 9.49 | 1.95 | 0.18 | 7.72 | N/A[2] |
| Wolverine Lake | 32.21 | 1.60 | 0.04 | 30.64 | N/A[2] |
| Imniagut Lake | 27.16 | 1.80 | 0.15 | 25.51 | 0.12 |
| Patch Outflow | 26.21 | 1.80 | 0.14 | 24.55 | 14.03 |
| PO Outflow | 25.95 | 1.90 | 0.19 | 24.24 | 10.99 |
| Ogama Outflow | 24.09 | 1.80 | 0.11 | 22.40 | 1.39 |
| Doris Lake-2 | 21.75 | 1.68 | 0.02 | 20.09 | 21.41 |
| Little Roberts Outflow | 6.18[3] | 1.98 | 0.14 | 4.34 | N/A[3] |

*[1] UTM Zone 13W.*

*[2] No bathymetric data available.*

*[3] The winter waterlevel surveyed at Little Roberts Outflow is significantly higher than any waterlevel recorded during the open water season and does not provide an accurate measurement of under-ice volume.*

The surveyed water level at Little Roberts Outflow was considerably higher than the values observed during the open water season 6.18 m compared to 5.02 m in June. This is potentially due to an erroneous survey, or could be due to ice conditions on the lake. It was observed that a pressure ridge had formed near the outlet, which could have resulted in a pocket of water forming in the middle of the lake as the outlet and sides froze, allowing the water in the middle of the lake to rise to a level that would otherwise not be possible. Either option results in an inaccurate calculation of under-ice volume, so no value was calculated.

# 4. DISCUSSION AND COMPARISON WITH FEIS PREDICTIONS

## 4.1 Precipitation Influence

Table 4.1-1 presents the precipitation at the Hope Bay meteorological station for the 2022 hydrologic year (typically October to September). Unfortunately, the precipitation gauge at the meteorology station was not functioning properly for a portion of the year, so the total observed precipitation of 189 mm during the 2022 hydrologic year does not account for precipitation in May, June and July.

The hydrologic year is the period where precipitation will contribute to the runoff of that year. It generally spans October to September, starting at the beginning of freezup when precipitation that falls will be stored until the spring, and ends at the start of freeze up the following year. As every year is variable as to when freeze up occurs, comparing precipitation to runoff in a specific year can require some adjustment to the dates of that specific hydrologic year.

**Table 4.1-1: Doris Hydrometric Station Precipitation October 2021 – September 2022**

| Month | Total Rainfall (mm) | Total Snowfall (SWE; mm) | Total Precipitation (mm) | Expected Mean Monthly Precipitation[1] (mm) |
|---|---|---|---|---|
| Oct-21 | 7.5 | 28.8 | 36.2 | 24 |
| Nov-21 | 0.0 | 12.6 | 12.6 | 16 |
| Dec-21 | 0.0 | 4.9 | 4.9 | 11 |
| Jan-22 | 0.0 | 6.4 | 6.4 | 10 |
| Feb-22 | 0.0 | 12.3 | 12.3 | 9 |
| Mar-22 | 0.0 | 9.0 | 9.0 | 11 |
| Apr-22 | 0.0 | 5.2 | 5.2 | 11 |
| May-22 | M | M | M | 14 |
| Jun-22 | M | M | M | 18 |
| Jul-22 | INV [2] | INV [2] | INV [2] | 29 |
| Aug-22 | 38.7 | 0.0 | 38.7 | 31 |
| Sep-22 | 37.9 | 26.1 | 64.0 | 26 |
| **Total** | **84.1** | **105.3** | **189.3** | **210** |
| Oct-22 | 21.1[3] | 10.3[3] | 31.4[3] | - |
| **Total Nov-21 to Oct-22** | **97.7** | **86.8** | **184.5**[4] | - |

*[1] Package P5-2 (Table 5) of the Hope Bay FEIS (SRK 2017).*

*[2] Incomplete data*

*[3] Incomplete data, includes only October 1-8*

*[4] Total measured precipitation only*

In the 2022 hydrologic year, warm Octobers in both 2021 and 2022 resulted in a 2022 hydrologic year that is more likely measured from November 2021 to October 2022. October 2021 was relatively warm and much of the precipitation likely runoff during the 2021 hydrologic year, instead of remaining as snow to melt in spring 2022. Likewise, a portion of October 2022 was also relatively warm and likely contributed to 2022 runoff, instead of remaining as snow to melt in spring 2023. While the ongoing issues with the precipitation gauge prevented data from being collected, there were 31.8 mm of precipitation in the first 8 days of October 2022. If the 2022 hydrologic year is adjusted to be November 2021 to October 2022 the measured total is 184 mm. If the expected mean monthly precipitation is used for the missing data from May to July, the total estimated precipitation for the 2022 hydrologic year is 246 mm.

Table 4.1-2 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 246 mm of precipitation corresponds to a wet year with a return period close to 5 years.

**Table 4.1-2: 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 |

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

*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.*

It is also worth noting that a considerable amount of precipitation fell during the fall, with more than twice the expected rainfall in September. Winter precipitation was also lower than average. This resulted in a relatively abnormal hydrograph, with a much lower than normal freshet peak and a much higher than normal fall peak. Across the monitoring stations freshet and fall peaks were similar in magnitude, which is not typical of the conditions seen on the site.

## 4.2 Runoff

A portion of the precipitation is converted to runoff, which enters the lakes and streams, resulting in streamflow. Table 4.2-1 presents the comparison of the 2022 runoff with historical baseline data collected between 2004 and 2015, as well as the 2019, 2020 and 2021 monitoring data. Runoff in 2022 was similar to the 2004-2015 average, with the exception of Windy and PO. Uncertainty in the fall end of flow period likely had a larger effect than during a typical year, as the fall flows were higher than usual while the spring flows were lower than usual, thus having a greater impact on overall flow calculations for the year.

### Table 4.2-1: Comparison of 2022 Runoff with Historical Averages and Predicted Values

| Station | Monitored Runoff (mm) | | | | | FEIS Predicted Runoff[1] | | |
|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2022 | 2004-2015 Average[1] | Predicted Average Runoff | Predicted 20-y Dry Runoff | Predicted 20-y Wet Runoff |
| Windy Outflow | 174 | 107 | 166 | 86 | 130 | 58 | 21 | 119 |
| Patch Outflow | 189 | 82 | 105 | 118 | 112 | 77 | 40 | 137 |
| PO Outflow | 222 | 102 | 157 | 117 | 153 | 80 | 41 | 143 |
| Ogama Outflow | 167 | 58 | 128 | 95 | 117 | 100 | 46 | 199 |
| Doris Creek TL-2 | 191 | 75 | 153 | 121 | 110 | 101 | 48 | 213 |
| Roberts Outflow-2 | 156 | N/A | 141 | 127 | 112 | n/a | n/a | n/a |
| Little Roberts Outflow | 175 | 83 | 144 | 100 | 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 4.2-2 presents model results from the FEIS Hope Bay Project Water and Load Balance Report (SRK 2017). Effects to Doris Lake were predicted due to water withdrawal and mine dewatering activities. A Doris Lake water level drawdown could result in downstream effects to Little Roberts Outflow. Effects to Windy Lake were predicted due to the withdrawal of water from Windy Lake.

### Table 4.2-2: Predicted Impact due to Annual Outflow from Monitored Lakes

| Station | FEIS Predicted Impact[1] to Annual Flow in 2022 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 |

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

[1] *Project Phase "Existing and Permitted Projects".*

Drawdown to the Doris Lake water level was not detected in 2022 (Table 3-4 and Figure A8). The 2022 hydrologic year experienced a slightly wetter than normal year, as shown in Table 4.1-1 and Table 4.1-2, with corresponding higher than average runoff values, as shown in Table 4.2-1. 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 consistent with those from past years, as shown in Figure E8. Given that no effect was measured in Doris Lake, there is consequently no downstream effect to Little Roberts Lake.

Water withdrawal from Windy Lake did not cause a detectable impact in 2022. Total withdrawal for the year was 14,018 $m^3$, which represents 1.2% of the total volumetric discharge for the year.

In 2022, 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:

Drew Copeland
Consultant, ERM

Cameron Evans, B.A.Sc.
Senior Consultant, ERM

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## APPENDIX A LAKE LEVELS GRAPHS

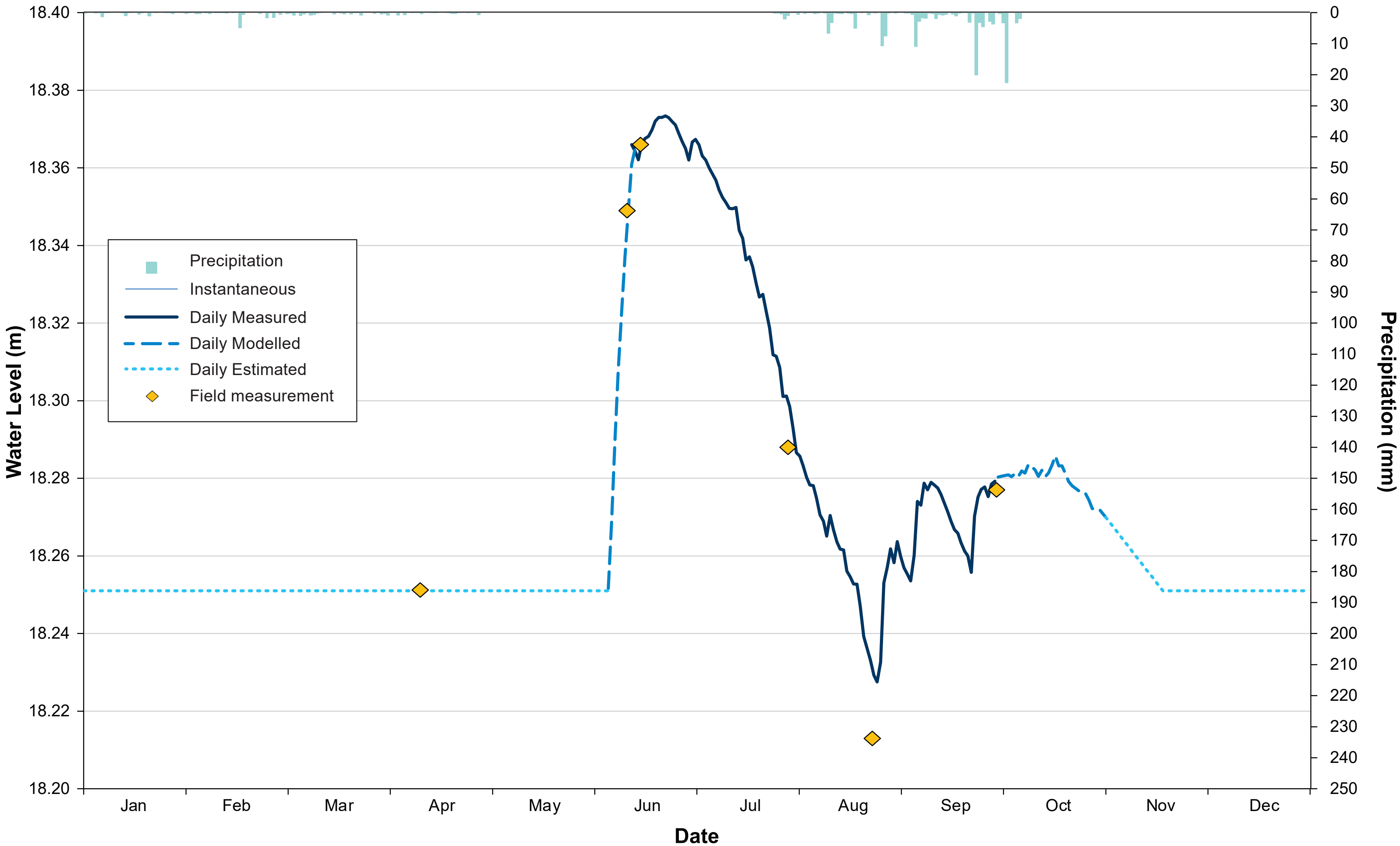



**Figure A1: 2022 Mean Daily Lake Level for Monitoring Station Windy Outflow**

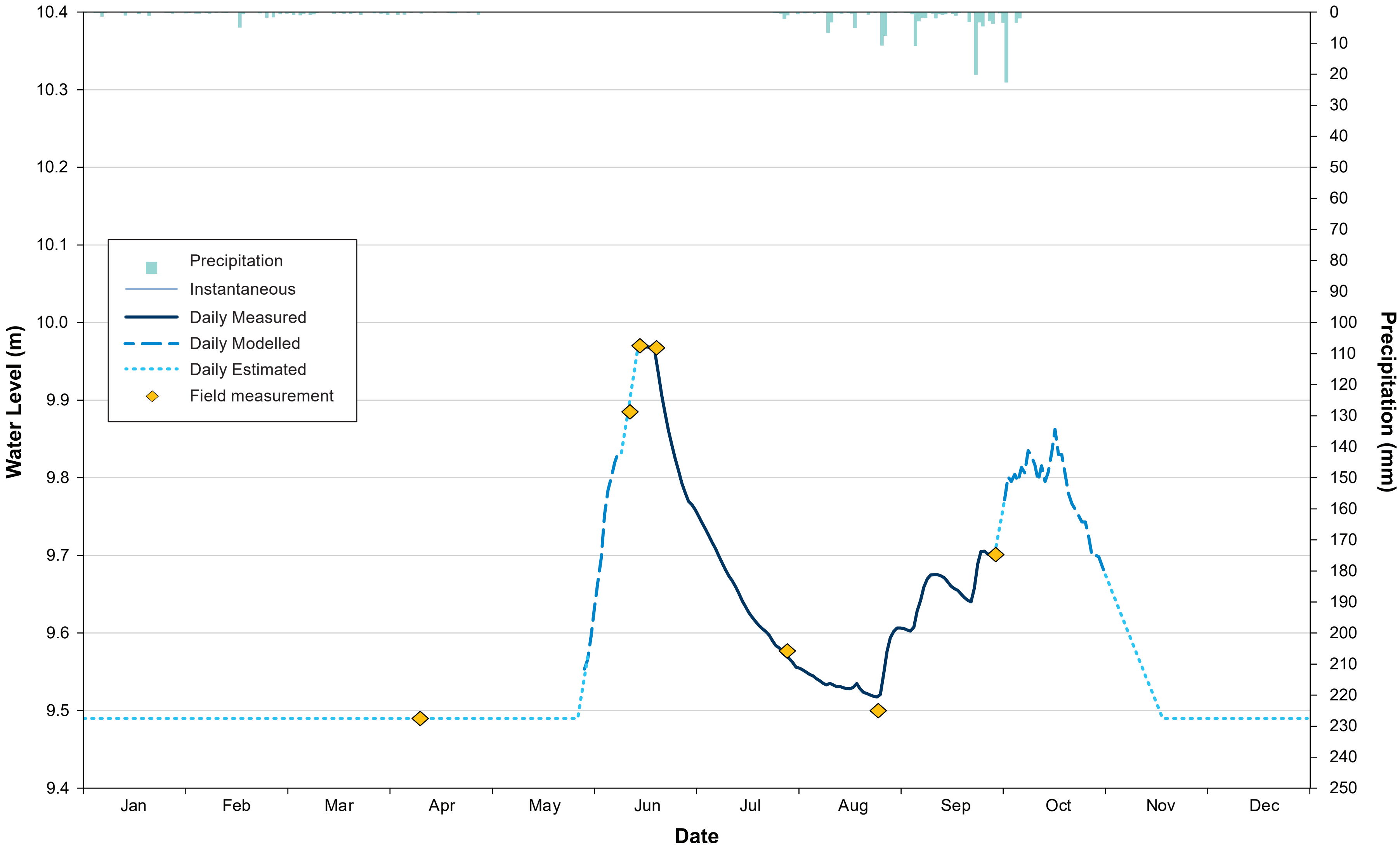



**Figure A2: 2022 Mean Daily Lake Level for Monitoring Station Glenn Lake**

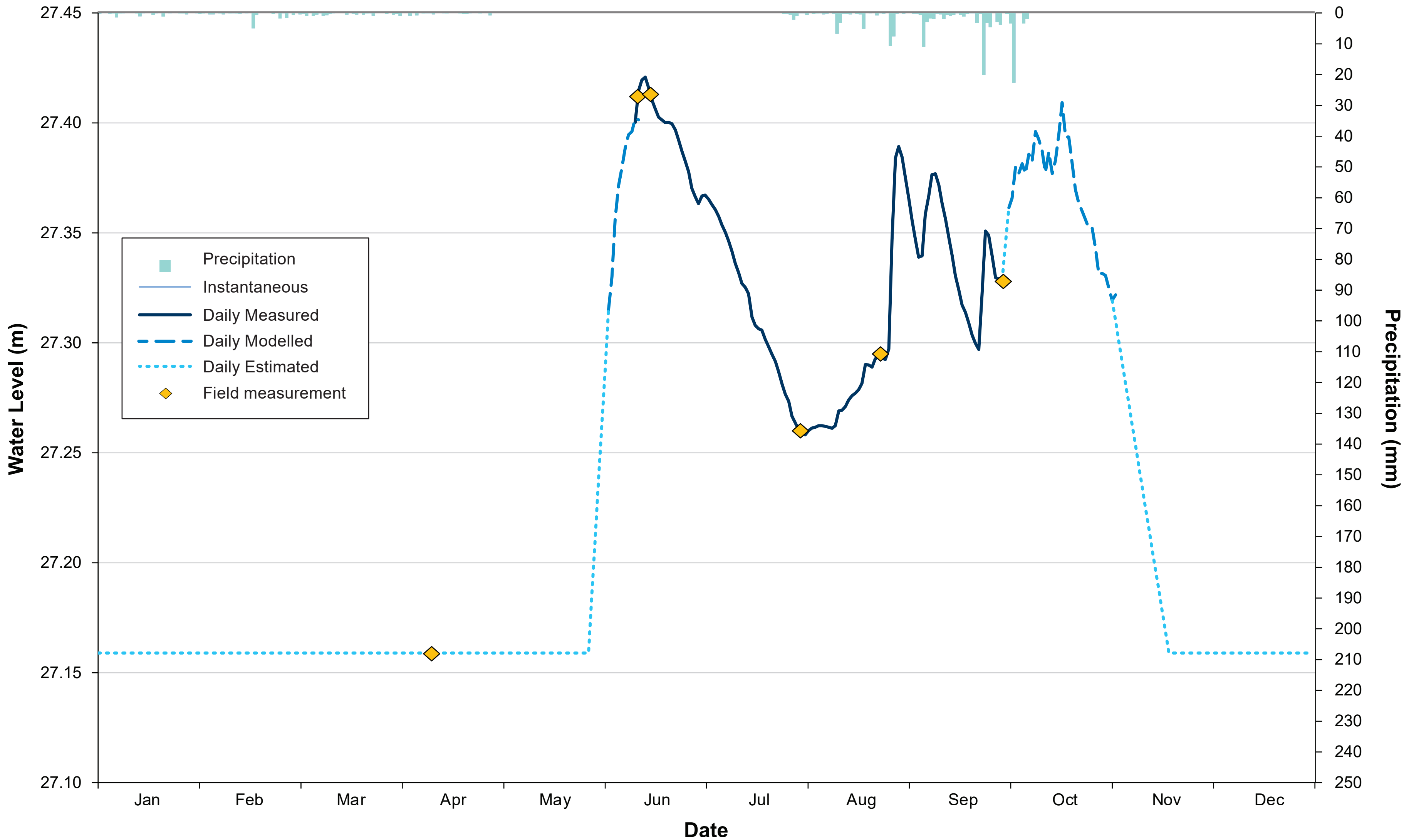



**Figure A3: 2022 Mean Daily Lake Level for Monitoring Station Imniagut Lake**

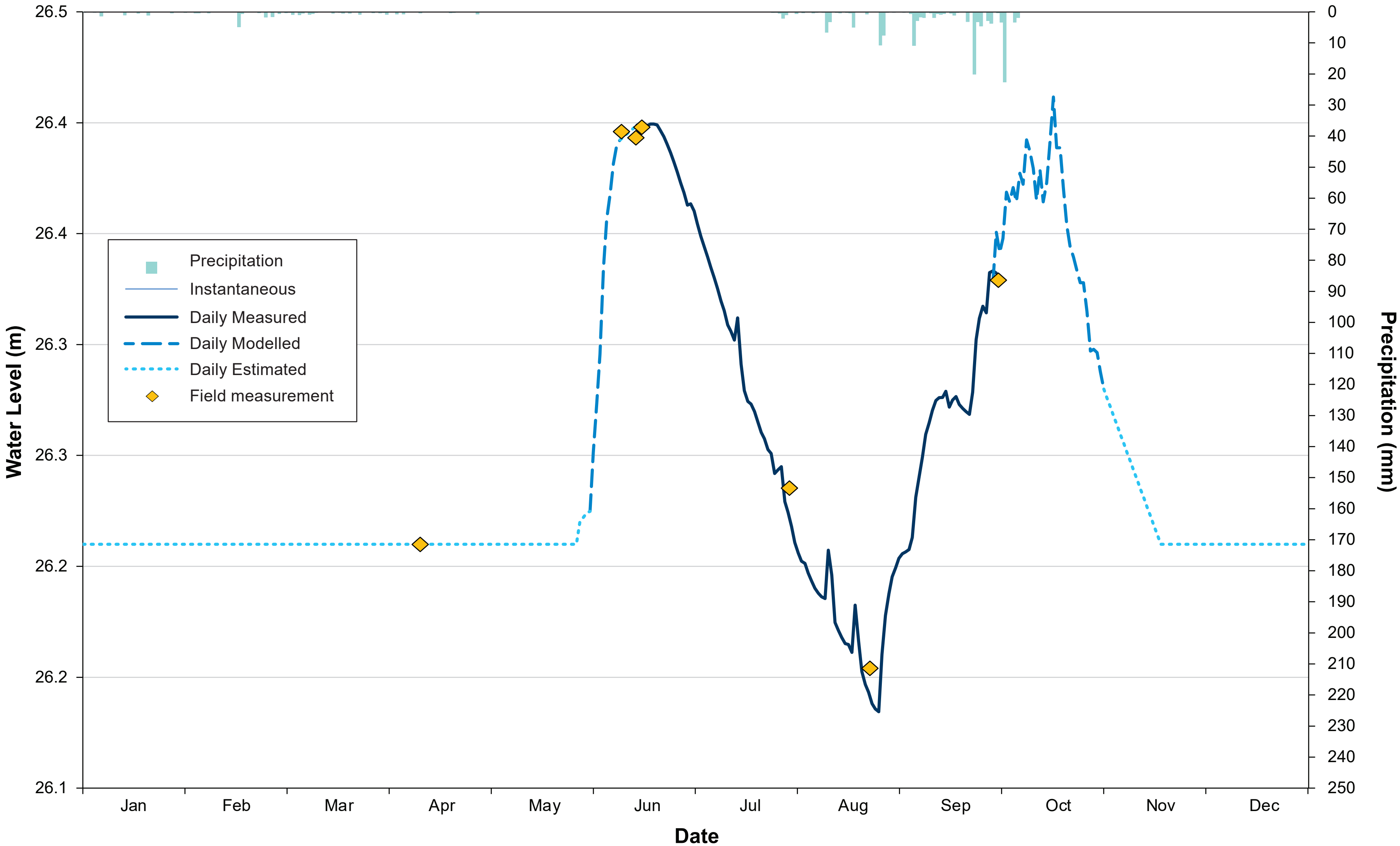



**Figure A4: 2022 Mean Daily Lake Level for Monitoring Station Patch Outflow**

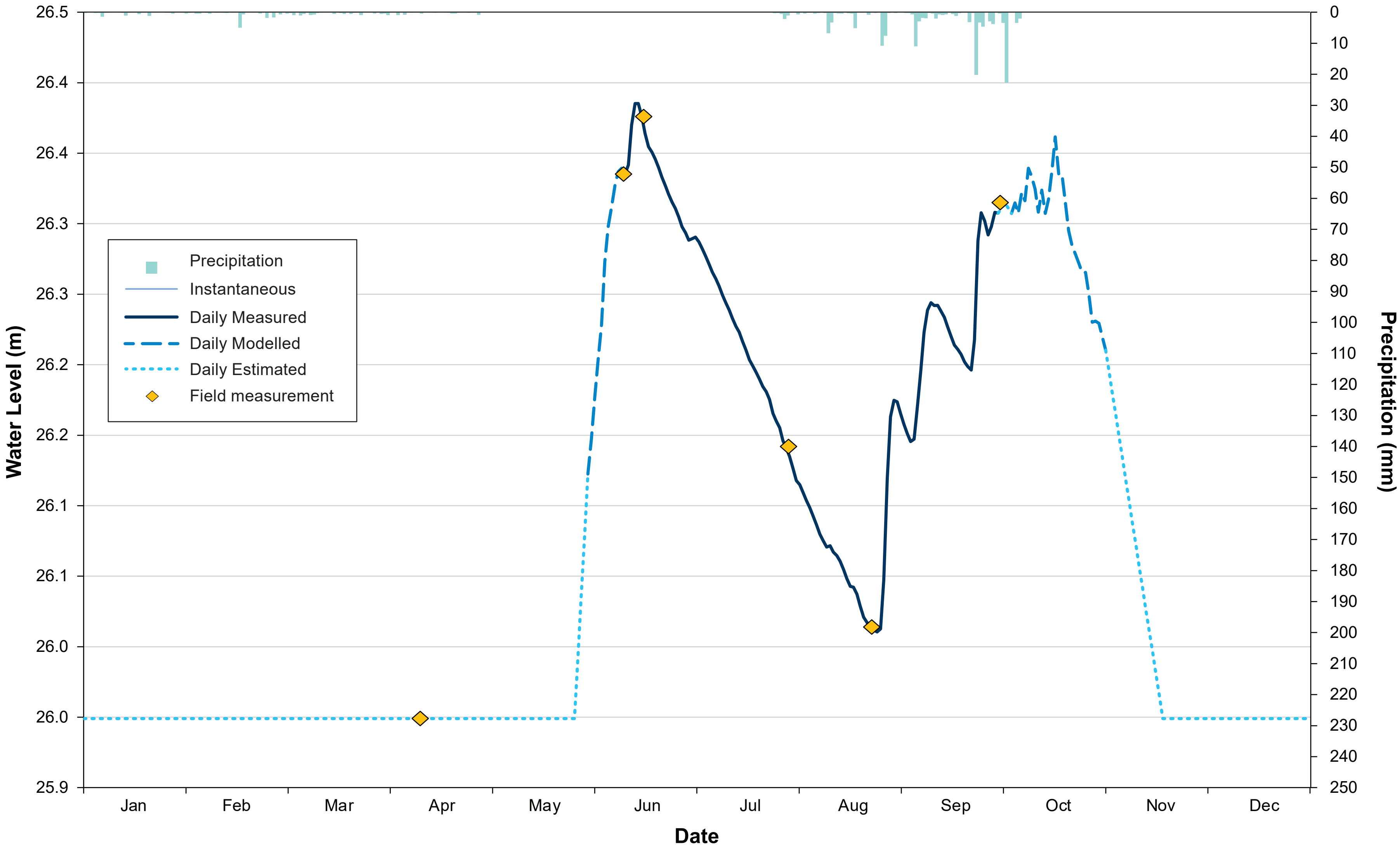



**Figure A5: 2022 Mean Daily Lake Level for Monitoring Station PO Outflow**

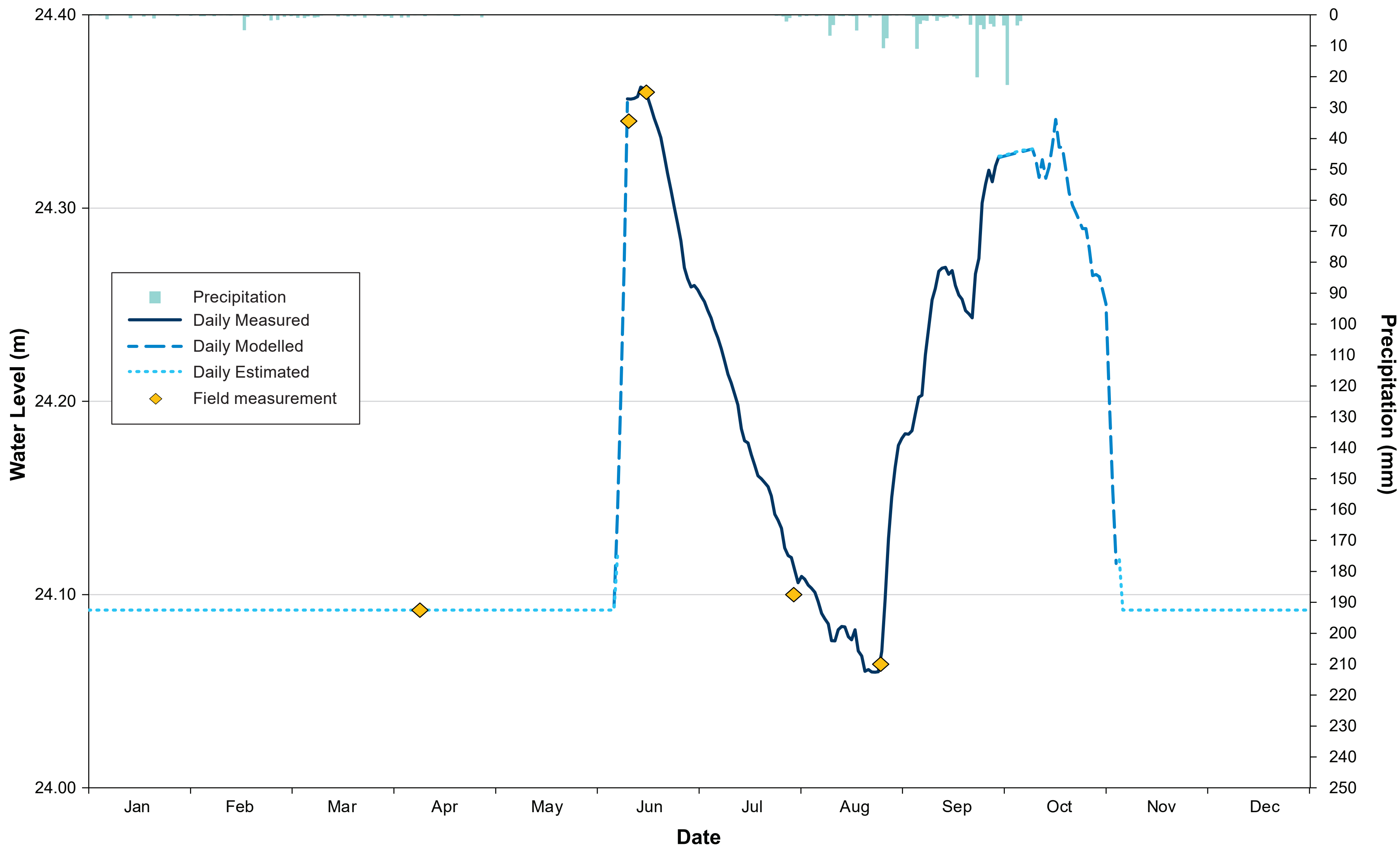



**Figure A6: 2022 Mean Daily Lake Level for Monitoring Station Ogama Outflow**

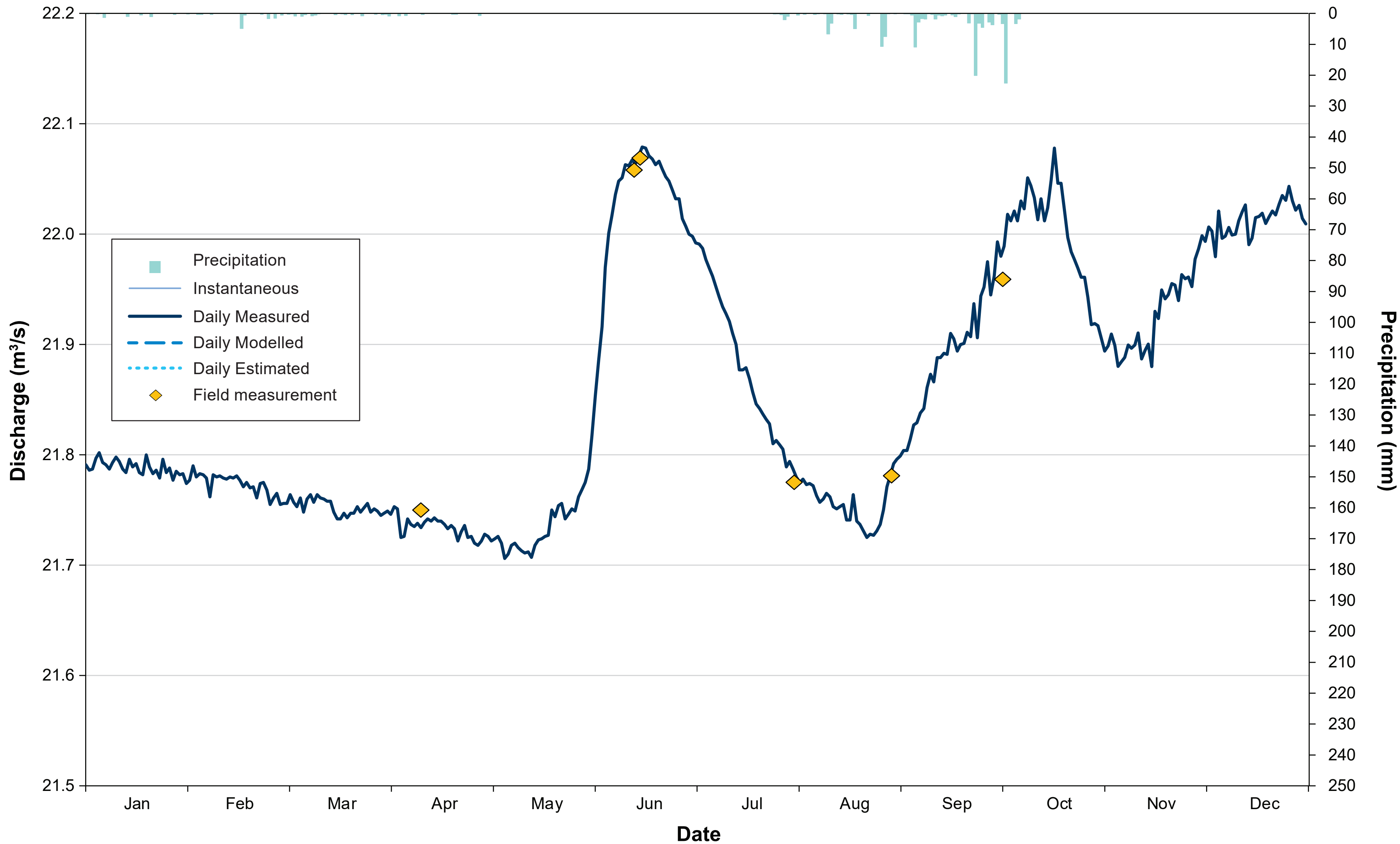



**Figure A7: 2022 Mean Daily Lake Level for Monitoring Station Doris Lake-2**

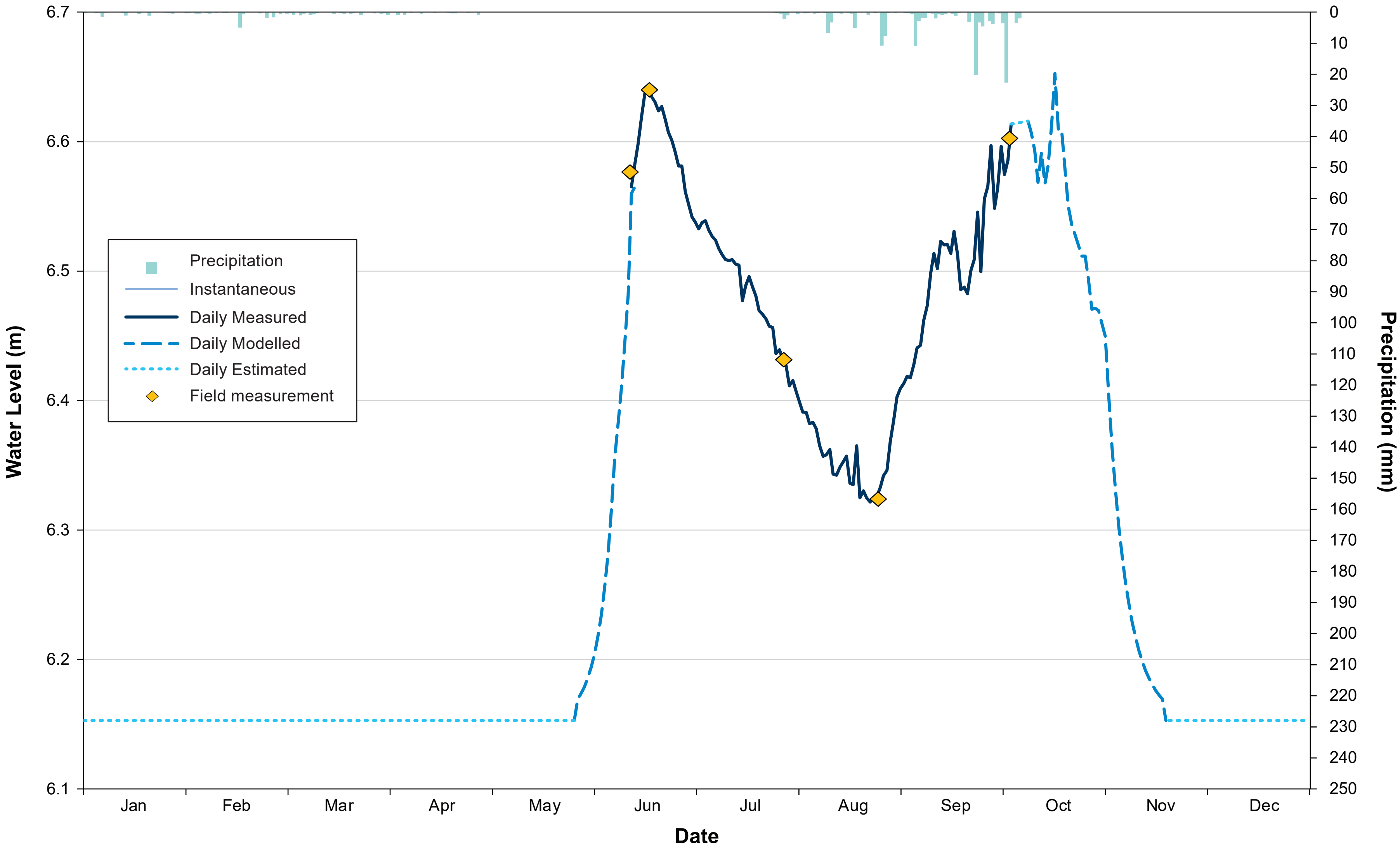



**Figure A8: 2022 Mean Daily Lake Level for Monitoring Station Roberts Hydro-2**

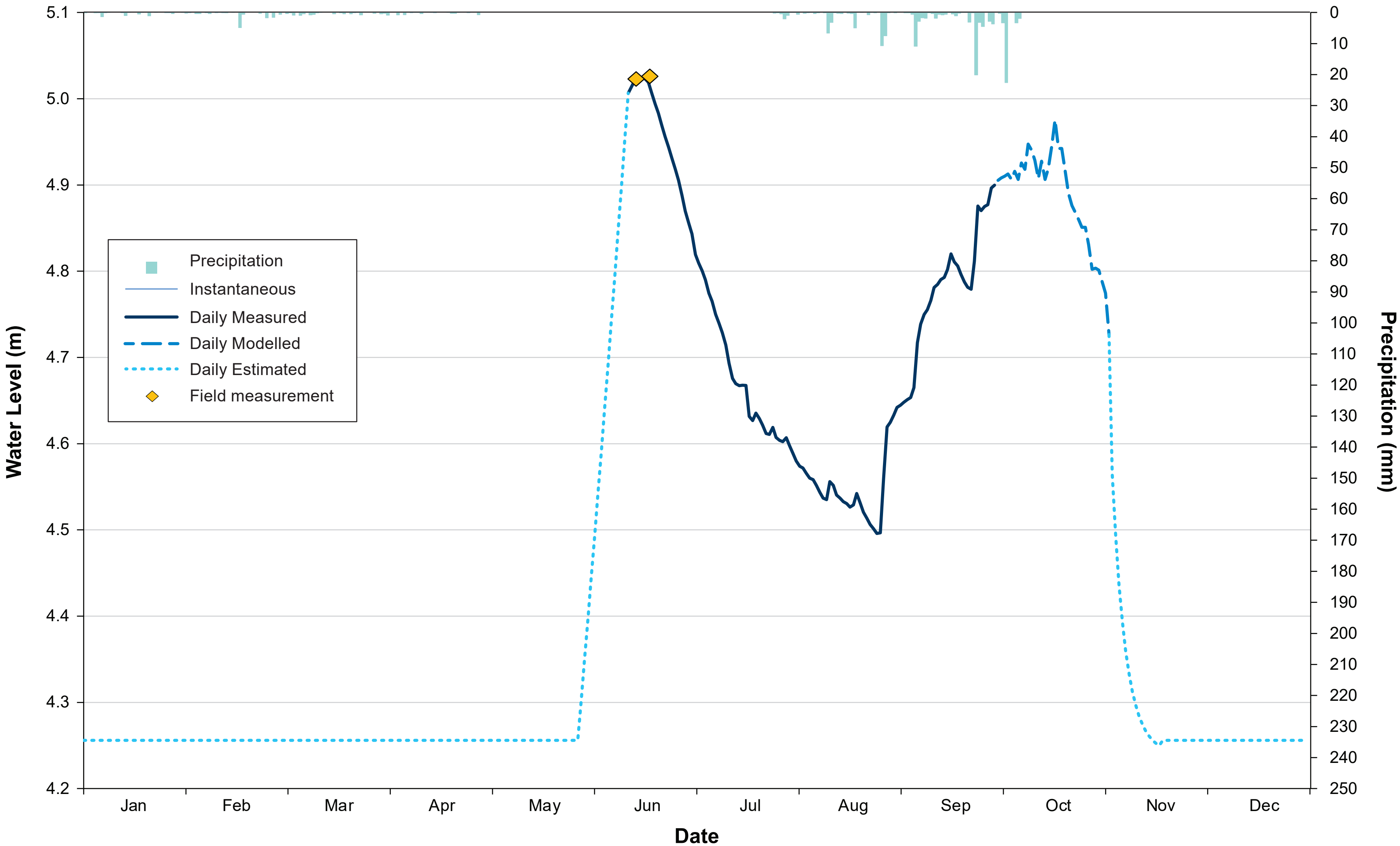



**Figure A9: 2022 Mean Daily Lake Level for Monitoring Station Little Roberts Outflow**

# APPENDIX B HYDROGRAPHS

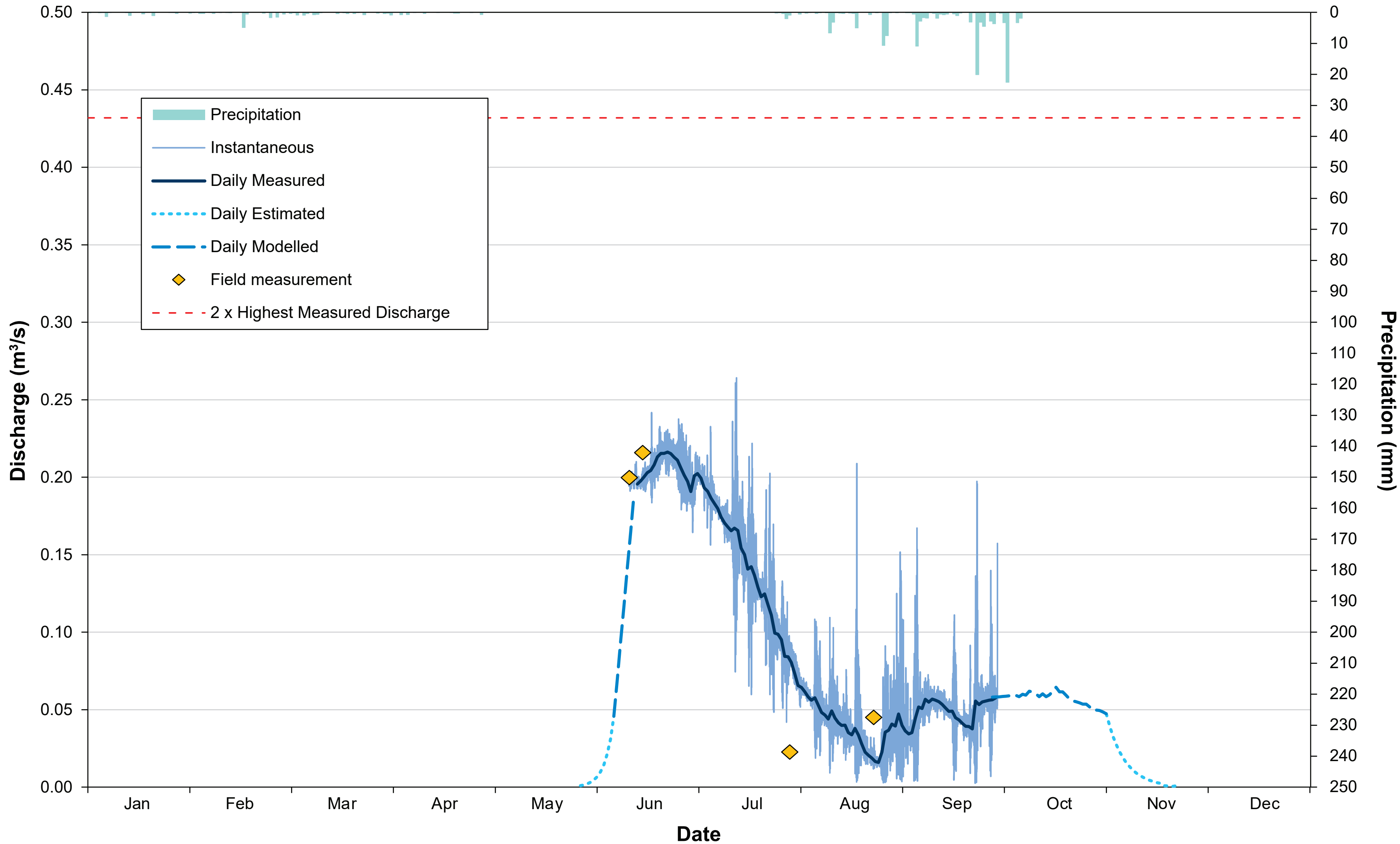



**Figure B1: 2022 Mean Daily Hydrograph at Monitoring Station Windy Lake Outflow**

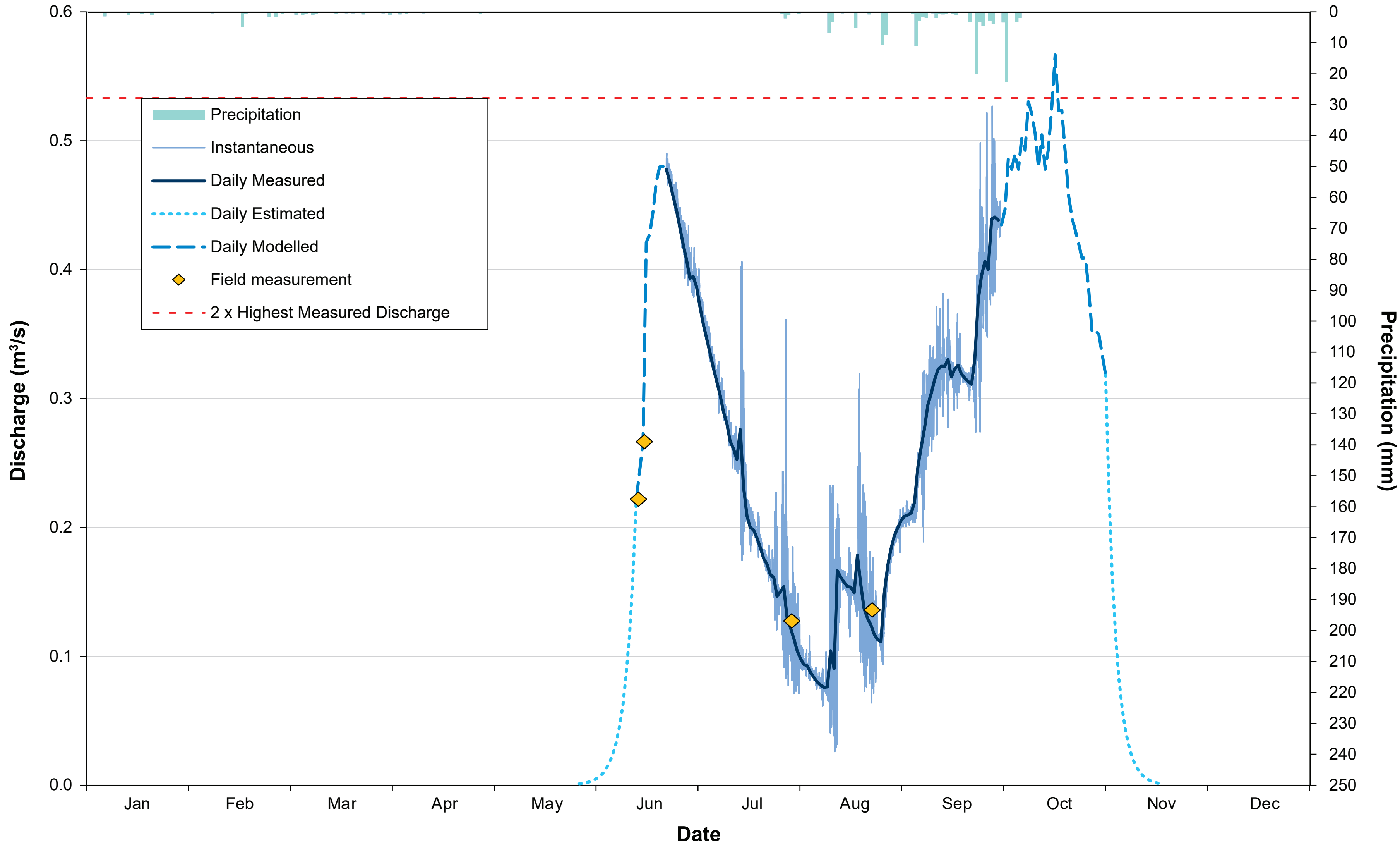



**Figure B2: 2022 Mean Daily Hydrograph at Monitoring Station Patch Outflow**

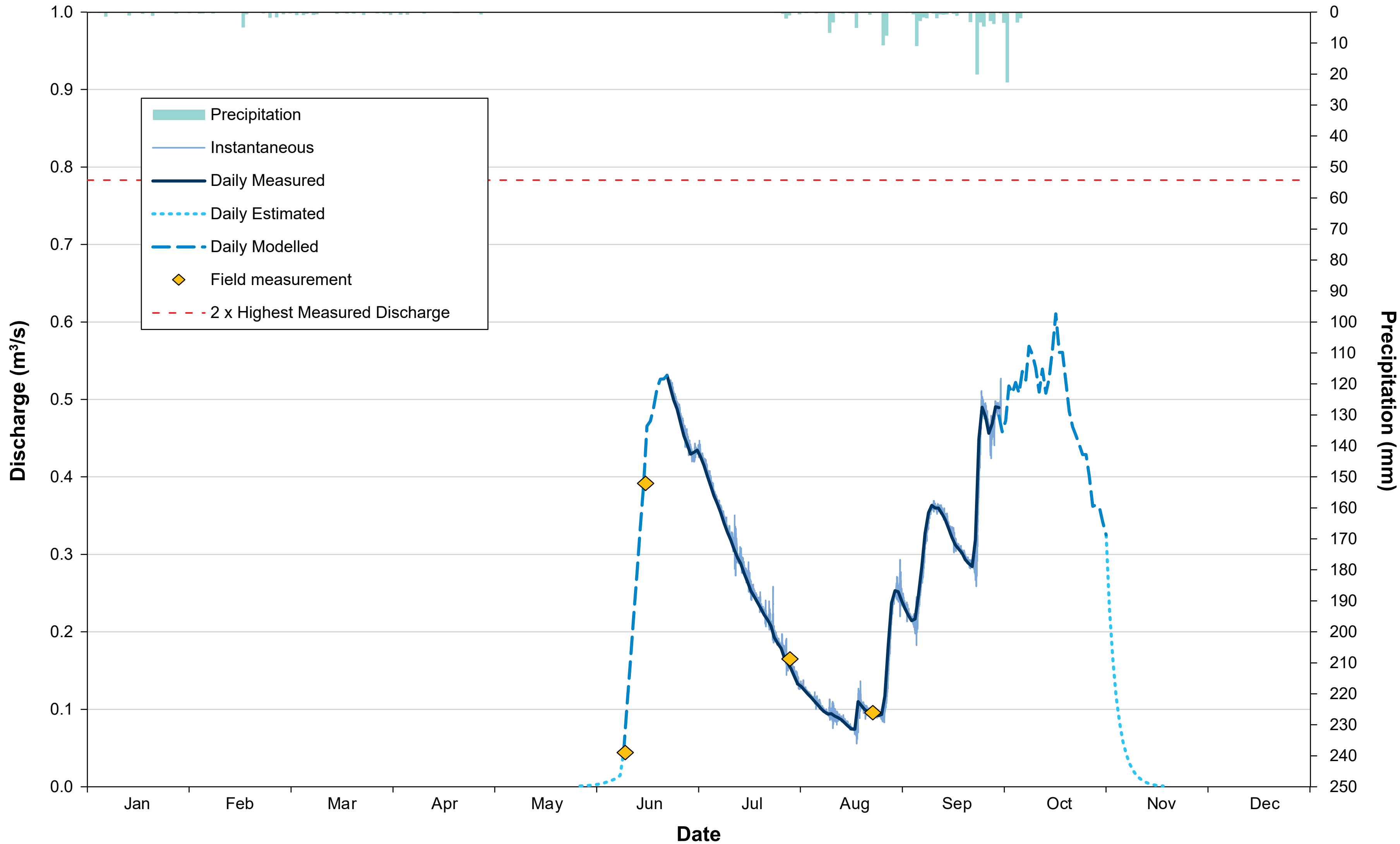



**Figure B3: 2022 Mean Daily Hydrograph at Monitoring Station PO Outflow**

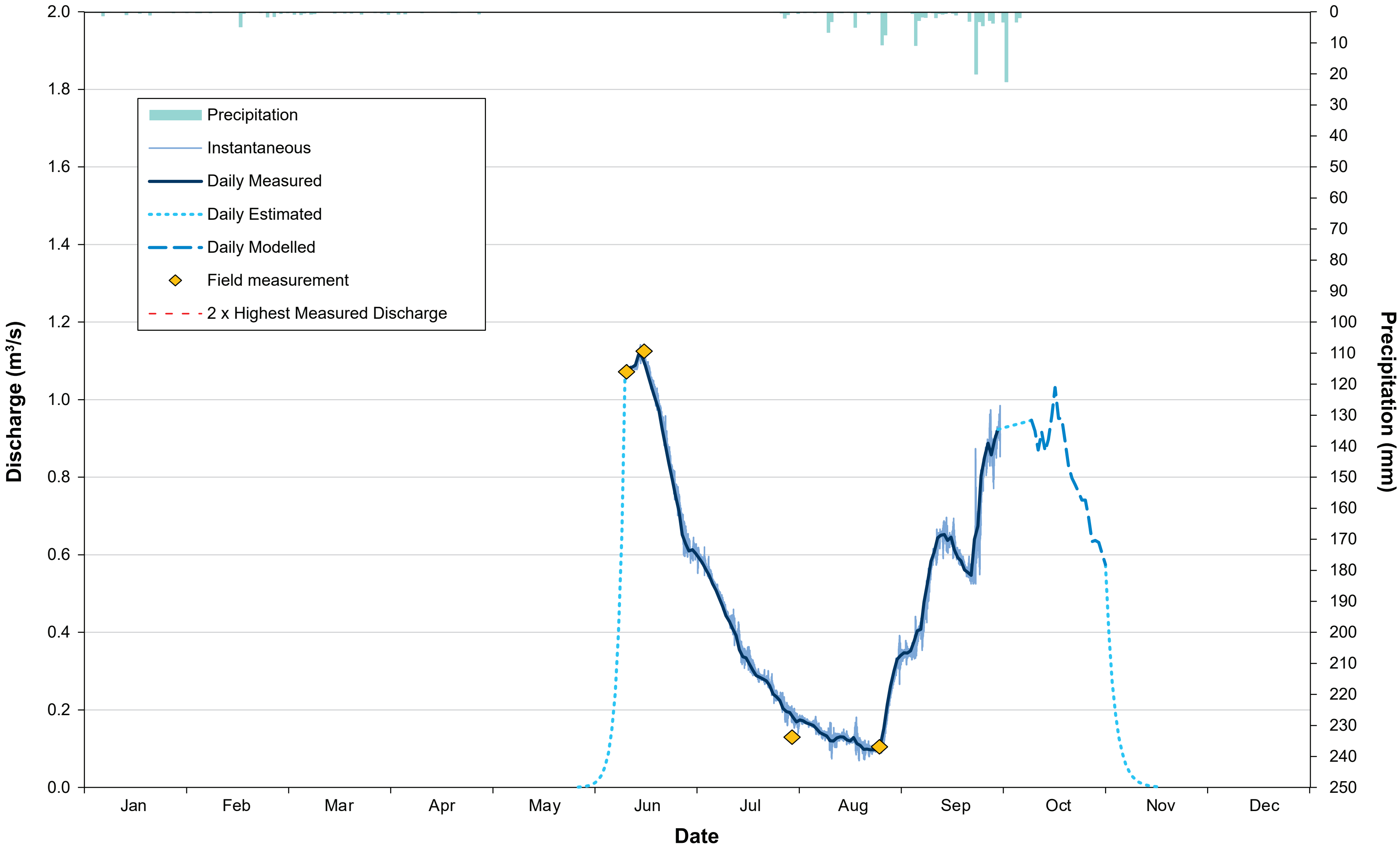



**Figure B4: 2022 Mean Daily Hydrograph at Monitoring Station Ogama Outflow**

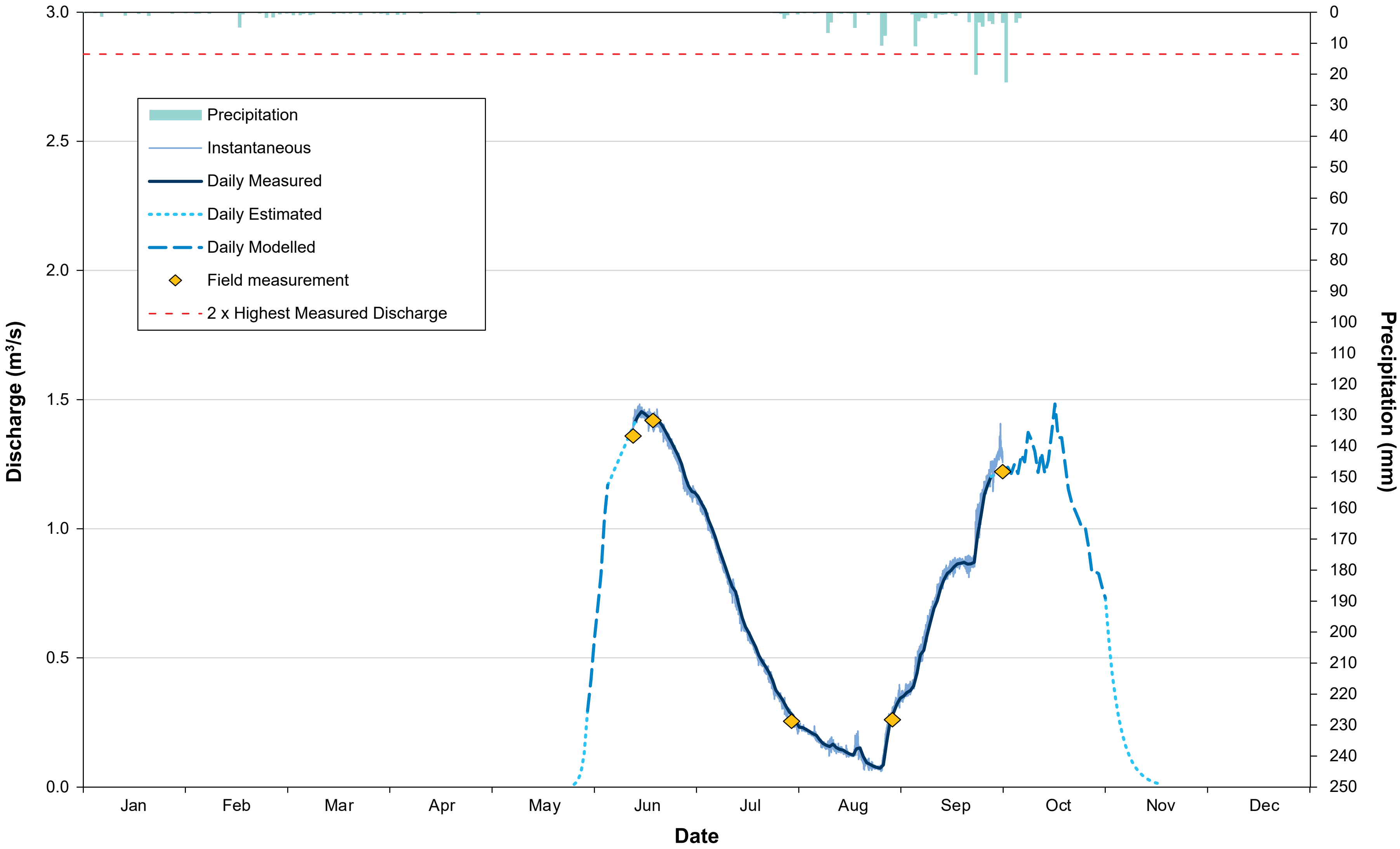



**Figure B5: 2022 Mean Daily Hydrograph at Monitoring Station Dorris Creek**

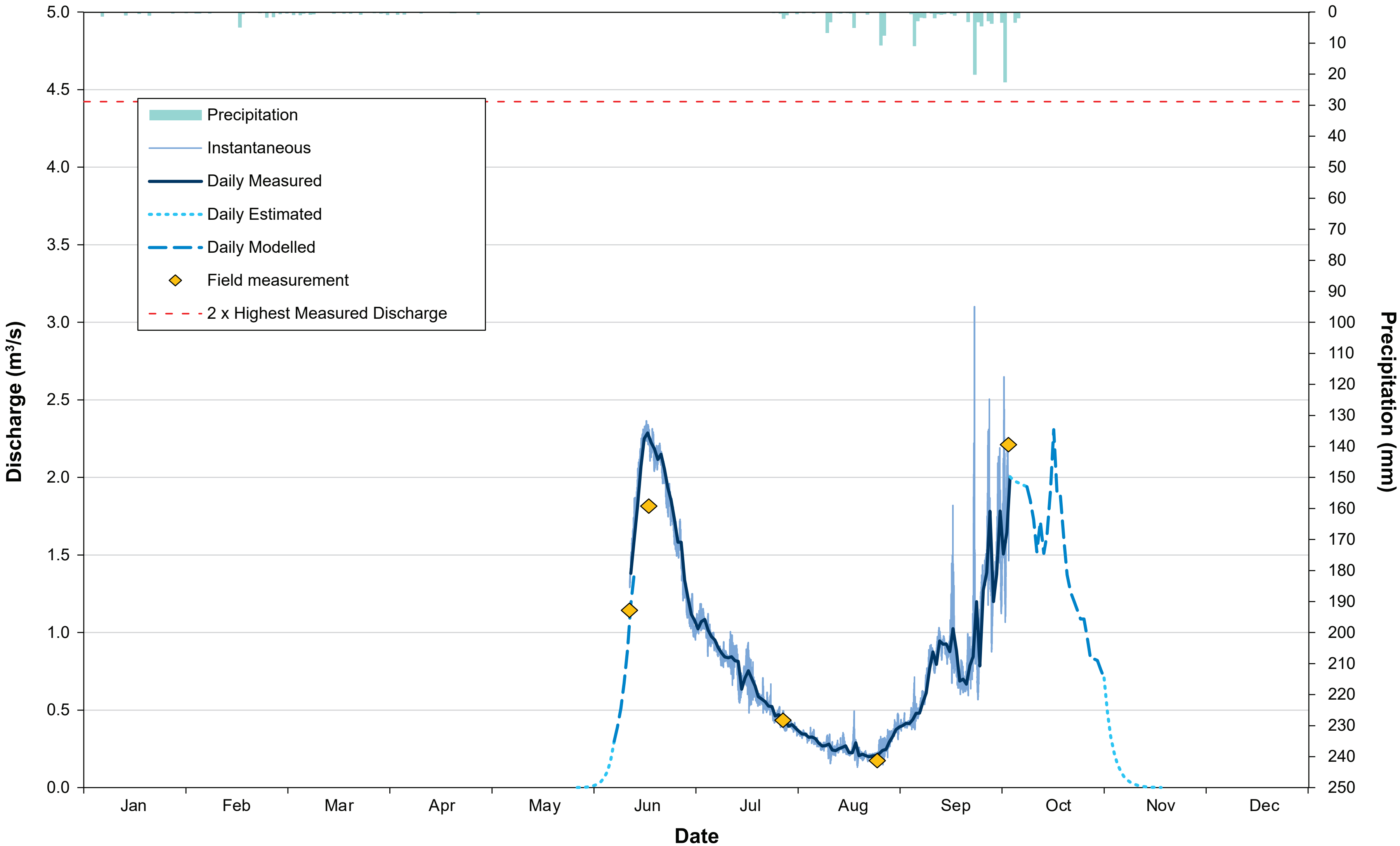



**Figure B6: 2022 Mean Daily Hydrograph at Monitoring Station Roberts Hydro-2**

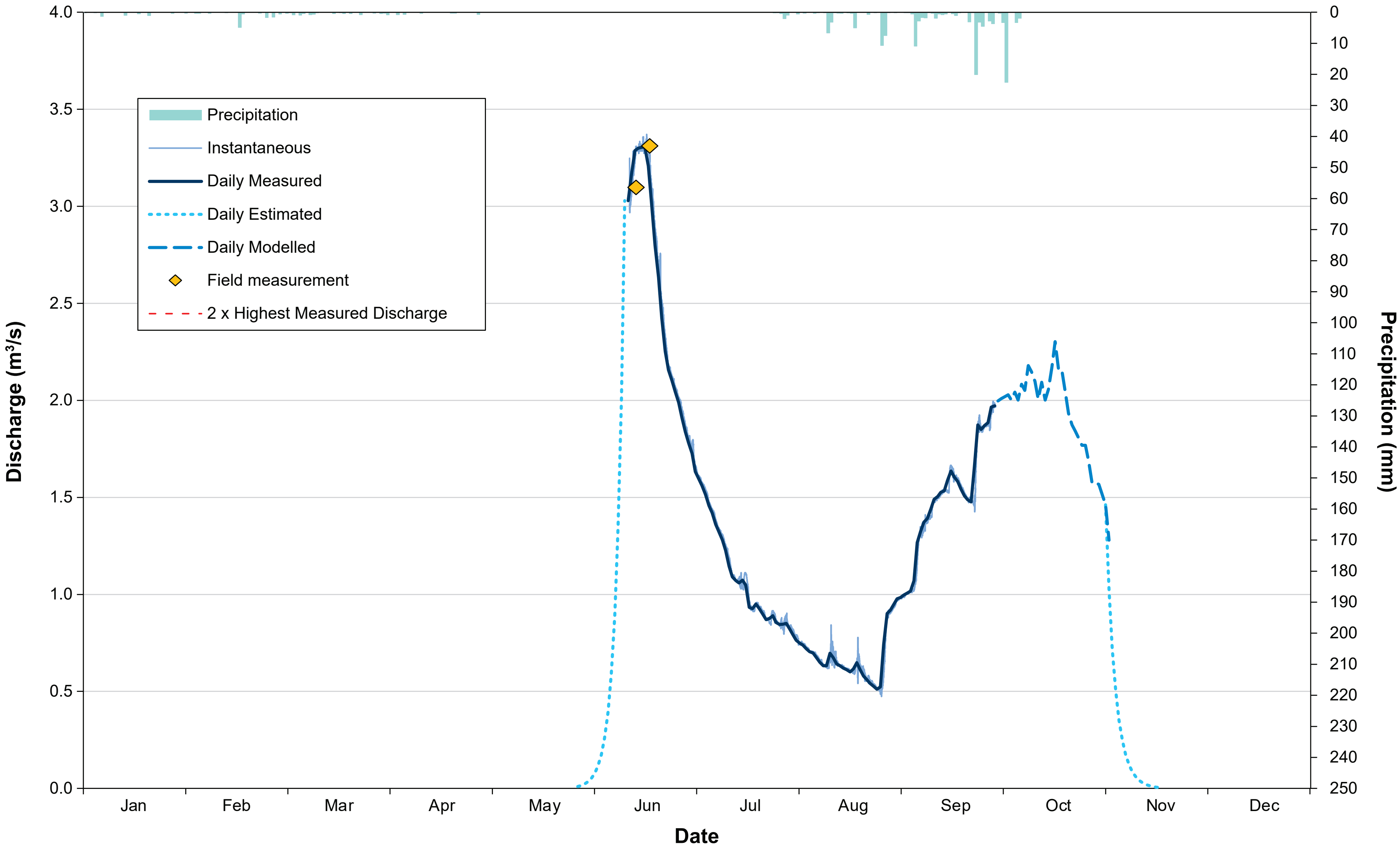



**Figure B7: 2022 Mean Daily Hydrograph at Monitoring Station Little Roberts Outflow**

# APPENDIX C MEAN DAILY LAKE LEVEL TABLES

# Appendix C1: Summary of Mean Daily Water Level (m) at Hydrometric Station Windy Outflow, 2022

**Drainage Area = 13.73 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.367 | 18.287 | 18.260 | *18.281* | *18.270* | *18.251* |
| 2 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.367 | 18.286 | 18.257 | *18.281* | *18.269* | *18.251* |
| 3 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.366 | 18.283 | 18.255 | *18.281* | *18.268* | *18.251* |
| 4 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.363 | 18.280 | 18.254 | *18.280* | *18.267* | *18.251* |
| 5 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.362 | 18.278 | 18.260 | *18.281* | *18.266* | *18.251* |
| 6 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.252* | 18.360 | 18.278 | 18.274 | *18.280* | *18.264* | *18.251* |
| 7 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.268* | 18.358 | 18.275 | 18.273 | *18.282* | *18.263* | *18.251* |
| 8 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.290* | 18.357 | 18.271 | 18.279 | *18.281* | *18.262* | *18.251* |
| 9 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.308* | 18.354 | 18.269 | 18.277 | *18.284* | *18.261* | *18.251* |
| 10 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.323* | 18.352 | 18.265 | 18.279 | *18.283* | *18.260* | *18.251* |
| 11 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.337* | 18.351 | 18.270 | 18.278 | *18.282* | *18.259* | *18.251* |
| 12 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | *18.349* | 18.350 | 18.267 | 18.277 | *18.281* | *18.258* | *18.251* |
| 13 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.366 | 18.349 | 18.264 | 18.276 | *18.282* | *18.257* | *18.251* |
| 14 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.364 | 18.350 | 18.262 | 18.274 | *18.280* | *18.255* | *18.251* |
| 15 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.362 | 18.344 | 18.262 | 18.271 | *18.281* | *18.254* | *18.251* |
| 16 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.366 | 18.342 | 18.256 | 18.269 | *18.283* | *18.253* | *18.251* |
| 17 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.368 | 18.336 | 18.255 | 18.267 | *18.286* | *18.252* | *18.251* |
| 18 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.368 | 18.337 | 18.253 | 18.266 | *18.283* | *18.251* | *18.251* |
| 19 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.370 | 18.335 | 18.253 | 18.263 | *18.283* | *18.251* | *18.251* |
| 20 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.372 | 18.330 | 18.247 | 18.261 | *18.281* | *18.251* | *18.251* |
| 21 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.373 | 18.327 | 18.239 | 18.260 | *18.279* | *18.251* | *18.251* |
| 22 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.373 | 18.327 | 18.236 | 18.256 | *18.278* | *18.251* | *18.251* |
| 23 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.373 | 18.323 | 18.233 | 18.270 | *18.277* | *18.251* | *18.251* |
| 24 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.373 | 18.319 | 18.229 | 18.275 | *18.277* | *18.251* | *18.251* |
| 25 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.372 | 18.312 | 18.228 | 18.277 | *18.276* | *18.251* | *18.251* |
| 26 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.371 | 18.311 | 18.233 | 18.278 | *18.276* | *18.251* | *18.251* |
| 27 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.369 | 18.309 | 18.253 | 18.275 | *18.274* | *18.251* | *18.251* |
| 28 | *18.251* | *18.251* | *18.251* | *18.251* | *18.251* | 18.367 | 18.301 | 18.257 | 18.279 | *18.272* | *18.251* | *18.251* |
| 29 | *18.251* | | *18.251* | *18.251* | *18.251* | 18.365 | 18.301 | 18.262 | 18.279 | *18.272* | *18.251* | *18.251* |
| 30 | *18.251* | | *18.251* | *18.251* | *18.251* | 18.362 | 18.298 | 18.258 | *18.280* | *18.272* | *18.251* | *18.251* |
| 31 | *18.251* | | *18.251* | | *18.251* | | 18.293 | 18.264 | | *18.271* | | *18.251* |
| **Mean** | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.334 | 18.337 | 18.260 | 18.270 | 18.279 | 18.257 | 18.251 |
| **Max** | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.373 | 18.367 | 18.287 | 18.280 | 18.286 | 18.270 | 18.251 |
| **Min** | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.251 | 18.293 | 18.228 | 18.254 | 18.271 | 18.251 | 18.251 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C2: Summary of Mean Daily Water Level (m) at Hydrometric Station Glenn Lake, 2022

**Drainage Area = 20.59 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *9.490* | 9.490 | 9.490 | 9.490 | 9.490 | *9.596* | 9.765 | 9.556 | 9.606 | *9.748* | *9.675* | *9.490* |
| 2 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.634* | 9.759 | 9.555 | 9.606 | *9.772* | *9.664* | *9.490* |
| 3 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.666* | 9.750 | 9.552 | 9.604 | *9.801* | *9.653* | *9.490* |
| 4 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.697* | 9.742 | 9.550 | 9.602 | *9.795* | *9.642* | *9.490* |
| 5 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.752* | 9.734 | 9.547 | 9.608 | *9.804* | *9.631* | *9.490* |
| 6 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.784* | 9.725 | 9.545 | 9.628 | *9.795* | *9.620* | *9.490* |
| 7 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.800* | 9.717 | 9.541 | 9.642 | *9.814* | *9.609* | *9.490* |
| 8 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.820* | 9.709 | 9.538 | 9.659 | *9.806* | *9.598* | *9.490* |
| 9 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.832* | 9.699 | 9.535 | 9.670 | *9.835* | *9.587* | *9.490* |
| 10 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.832* | 9.690 | 9.533 | 9.675 | *9.828* | *9.577* | *9.490* |
| 11 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | *9.859* | 9.682 | 9.535 | 9.675 | *9.817* | *9.566* | *9.490* |
| 12 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | 9.885 | 9.673 | 9.533 | 9.675 | *9.796* | *9.555* | *9.490* |
| 13 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | 9.913 | 9.667 | 9.531 | 9.674 | *9.816* | *9.544* | *9.490* |
| 14 | *9.490* | 9.490 | 9.490 | 9.490 | *9.490* | 9.942 | 9.659 | 9.531 | 9.671 | *9.795* | *9.533* | *9.490* |
| 15 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.968 | 9.651 | 9.530 | 9.667 | *9.807* | *9.522* | *9.490* |
| 16 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.968 | 9.641 | 9.528 | 9.661 | *9.833* | *9.512* | *9.490* |
| 17 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.969 | 9.634 | 9.528 | 9.657 | *9.863* | *9.501* | *9.490* |
| 18 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.968 | 9.626 | 9.530 | 9.655 | *9.830* | *9.490* | *9.490* |
| 19 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.969 | 9.620 | 9.535 | 9.651 | *9.830* | *9.490* | *9.490* |
| 20 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.961 | 9.615 | 9.528 | 9.646 | *9.804* | *9.490* | *9.490* |
| 21 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.934 | 9.610 | 9.524 | 9.642 | *9.780* | *9.490* | *9.490* |
| 22 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.907 | 9.605 | 9.522 | 9.640 | *9.767* | *9.490* | *9.490* |
| 23 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.883 | 9.602 | 9.520 | 9.657 | *9.760* | *9.490* | *9.490* |
| 24 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.861 | 9.597 | 9.519 | 9.689 | *9.751* | *9.490* | *9.490* |
| 25 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.842 | 9.589 | 9.518 | 9.705 | *9.743* | *9.490* | *9.490* |
| 26 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.825 | 9.584 | 9.521 | 9.705 | *9.743* | *9.490* | *9.490* |
| 27 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.809 | 9.581 | 9.547 | 9.701 | *9.725* | *9.490* | *9.490* |
| 28 | 9.490 | 9.490 | 9.490 | 9.490 | *9.490* | 9.793 | 9.574 | 9.576 | 9.702 | *9.699* | *9.490* | *9.490* |
| 29 | 9.490 | | 9.490 | 9.490 | *9.516* | 9.780 | 9.570 | 9.594 | 9.701 | *9.700* | *9.490* | *9.490* |
| 30 | 9.490 | | 9.490 | 9.490 | *9.554* | 9.770 | 9.567 | 9.602 | *9.725* | *9.698* | *9.490* | *9.490* |
| 31 | 9.490 | | 9.490 | | *9.566* | | 9.562 | 9.607 | | *9.686* | | *9.490* |
| **Mean** | 9.490 | 9.490 | 9.490 | 9.490 | 9.495 | 9.841 | 9.652 | 9.542 | 9.660 | 9.782 | 9.545 | 9.490 |
| **Max** | 9.490 | 9.490 | 9.490 | 9.490 | 9.566 | 9.969 | 9.765 | 9.607 | 9.725 | 9.863 | 9.675 | 9.490 |
| **Min** | 9.490 | 9.490 | 9.490 | 9.490 | 9.490 | 9.596 | 9.562 | 9.518 | 9.602 | 9.686 | 9.490 | 9.490 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C3: Summary of Mean Daily Water Level (m) at Hydrometric Station Imniagut Lake, 2022

**Drainage Area = 1.31 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.263* | 27.367 | 27.258 | 27.366 | *27.361* | *27.319* | *27.159* |
| 2 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.289* | 27.367 | 27.260 | 27.356 | *27.366* | *27.322* | *27.159* |
| 3 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.315* | 27.365 | 27.261 | 27.347 | *27.380* | *27.301* | *27.159* |
| 4 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.330* | 27.363 | 27.262 | 27.339 | *27.377* | *27.291* | *27.159* |
| 5 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.357* | 27.361 | 27.262 | 27.340 | *27.381* | *27.282* | *27.159* |
| 6 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.372* | 27.358 | 27.262 | 27.358 | *27.377* | *27.272* | *27.159* |
| 7 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.380* | 27.354 | 27.262 | 27.367 | *27.386* | *27.263* | *27.159* |
| 8 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.389* | 27.350 | 27.262 | 27.377 | *27.382* | *27.253* | *27.159* |
| 9 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.395* | 27.346 | 27.261 | 27.377 | *27.396* | *27.244* | *27.159* |
| 10 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | *27.396* | 27.342 | 27.262 | 27.372 | *27.393* | *27.234* | *27.159* |
| 11 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.400 | 27.336 | 27.269 | 27.364 | *27.387* | *27.225* | *27.159* |
| 12 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.415 | 27.332 | 27.269 | 27.356 | *27.378* | *27.216* | *27.159* |
| 13 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.419 | 27.327 | 27.271 | 27.348 | *27.387* | *27.206* | *27.159* |
| 14 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.421 | 27.325 | 27.274 | 27.340 | *27.377* | *27.197* | *27.159* |
| 15 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.416 | 27.322 | 27.276 | 27.331 | *27.383* | *27.187* | *27.159* |
| 16 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.411 | 27.312 | 27.277 | 27.324 | *27.395* | *27.178* | *27.159* |
| 17 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.407 | 27.308 | 27.279 | 27.317 | *27.409* | *27.168* | *27.159* |
| 18 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.403 | 27.306 | 27.282 | 27.314 | *27.394* | *27.159* | *27.159* |
| 19 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.401 | 27.306 | 27.290 | 27.309 | *27.394* | *27.159* | *27.159* |
| 20 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.400 | 27.302 | 27.290 | 27.304 | *27.381* | *27.159* | *27.159* |
| 21 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.400 | 27.298 | 27.289 | 27.300 | *27.370* | *27.159* | *27.159* |
| 22 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.400 | 27.295 | 27.293 | 27.297 | *27.363* | *27.159* | *27.159* |
| 23 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.397 | 27.292 | 27.294 | 27.322 | *27.360* | *27.159* | *27.159* |
| 24 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.392 | 27.287 | 27.293 | 27.351 | *27.356* | *27.159* | *27.159* |
| 25 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.387 | 27.281 | 27.292 | 27.349 | *27.352* | *27.159* | *27.159* |
| 26 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.383 | 27.277 | 27.297 | 27.340 | *27.352* | *27.159* | *27.159* |
| 27 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.378 | 27.273 | 27.347 | 27.330 | *27.343* | *27.159* | *27.159* |
| 28 | *27.159* | *27.159* | *27.159* | *27.159* | *27.159* | 27.370 | 27.267 | 27.384 | 27.329 | *27.331* | *27.159* | *27.159* |
| 29 | *27.159* | | *27.159* | *27.159* | *27.185* | 27.366 | 27.264 | 27.389 | 27.329 | *27.332* | *27.159* | *27.159* |
| 30 | *27.159* | | *27.159* | *27.159* | *27.211* | 27.363 | 27.261 | 27.384 | *27.345* | *27.331* | *27.159* | *27.159* |
| 31 | *27.159* | | *27.159* | | *27.237* | | 27.259 | 27.375 | | *27.325* | | *27.159* |
| **Mean** | 27.159 | 27.159 | 27.159 | 27.159 | 27.164 | 27.380 | 27.316 | 27.291 | 27.340 | 27.371 | 27.208 | 27.159 |
| **Max** | 27.159 | 27.159 | 27.159 | 27.159 | 27.237 | 27.421 | 27.367 | 27.389 | 27.377 | 27.409 | 27.322 | 27.159 |
| **Min** | 27.159 | 27.159 | 27.159 | 27.159 | 27.159 | 27.263 | 27.259 | 27.258 | 27.297 | 27.325 | 27.159 | 27.159 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C4: Summary of Mean Daily Water Level (m) at Hydrometric Station Patch Outflow, 2022

**Drainage Area = 32.16 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.225* | 26.363 | 26.211 | 26.204 | *26.341* | *26.280* | *26.210* |
| 2 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.251* | 26.360 | 26.206 | 26.206 | *26.348* | *26.276* | *26.210* |
| 3 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.273* | 26.354 | 26.202 | 26.207 | *26.369* | *26.272* | *26.210* |
| 4 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.296* | 26.349 | 26.201 | 26.208 | *26.364* | *26.268* | *26.210* |
| 5 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.334* | 26.344 | 26.197 | 26.213 | *26.371* | *26.263* | *26.210* |
| 6 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.357* | 26.340 | 26.193 | 26.231 | *26.364* | *26.259* | *26.210* |
| 7 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.368* | 26.335 | 26.190 | 26.240 | *26.377* | *26.255* | *26.210* |
| 8 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.382* | 26.330 | 26.188 | 26.249 | *26.372* | *26.251* | *26.210* |
| 9 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.390* | 26.325 | 26.186 | 26.260 | *26.392* | *26.247* | *26.210* |
| 10 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.392* | 26.320 | 26.186 | 26.265 | *26.387* | *26.243* | *26.210* |
| 11 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.394* | 26.315 | 26.207 | 26.270 | *26.379* | *26.239* | *26.210* |
| 12 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.395* | 26.309 | 26.196 | 26.275 | *26.365* | *26.235* | *26.210* |
| 13 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.396* | 26.306 | 26.175 | 26.276 | *26.379* | *26.231* | *26.210* |
| 14 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | *26.398* | 26.302 | 26.171 | 26.276 | *26.364* | *26.226* | *26.210* |
| 15 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.399 | 26.312 | 26.168 | 26.279 | *26.373* | *26.222* | *26.210* |
| 16 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.398 | 26.291 | 26.165 | 26.272 | *26.391* | *26.218* | *26.210* |
| 17 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.398 | 26.279 | 26.165 | 26.275 | *26.412* | *26.214* | *26.210* |
| 18 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.399 | 26.274 | 26.161 | 26.277 | *26.389* | *26.210* | *26.210* |
| 19 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.399 | 26.273 | 26.183 | 26.273 | *26.389* | *26.210* | *26.210* |
| 20 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.399 | 26.270 | 26.166 | 26.271 | *26.371* | *26.210* | *26.210* |
| 21 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.399 | 26.265 | 26.153 | 26.270 | *26.354* | *26.210* | *26.210* |
| 22 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.397 | 26.260 | 26.147 | 26.269 | *26.344* | *26.210* | *26.210* |
| 23 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.394 | 26.258 | 26.143 | 26.279 | *26.339* | *26.210* | *26.210* |
| 24 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.390 | 26.253 | 26.138 | 26.302 | *26.334* | *26.210* | *26.210* |
| 25 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.386 | 26.251 | 26.136 | 26.312 | *26.328* | *26.210* | *26.210* |
| 26 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.382 | 26.242 | 26.134 | 26.317 | *26.328* | *26.210* | *26.210* |
| 27 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.378 | 26.243 | 26.160 | 26.314 | *26.315* | *26.210* | *26.210* |
| 28 | *26.210* | *26.210* | *26.210* | *26.210* | *26.210* | 26.373 | 26.245 | 26.178 | 26.332 | *26.297* | *26.210* | *26.210* |
| 29 | *26.210* | | *26.210* | *26.210* | *26.220* | 26.369 | 26.229 | 26.188 | 26.333 | *26.298* | *26.210* | *26.210* |
| 30 | *26.210* | | *26.210* | *26.210* | *26.222* | 26.363 | 26.224 | 26.195 | 26.332 | *26.296* | *26.210* | *26.210* |
| 31 | *26.210* | | *26.210* | | *26.224* | | 26.218 | 26.199 | | *26.288* | | *26.210* |
| **Mean** | 26.210 | 26.210 | 26.210 | 26.210 | 26.211 | 26.369 | 26.292 | 26.177 | 26.270 | 26.355 | 26.231 | 26.210 |
| **Max** | 26.210 | 26.210 | 26.210 | 26.210 | 26.224 | 26.399 | 26.363 | 26.211 | 26.333 | 26.412 | 26.280 | 26.210 |
| **Min** | 26.210 | 26.210 | 26.210 | 26.210 | 26.210 | 26.225 | 26.218 | 26.134 | 26.204 | 26.288 | 26.210 | 26.210 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C5: Summary of Mean Daily Water Level (m) at Hydrometric Station PO Outflow, 2022

**Drainage Area = 35.3 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.147* | 26.289 | 26.118 | 26.165 | *26.311* | *26.210* | *25.949* |
| 2 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.178* | 26.290 | 26.115 | 26.158 | *26.315* | *26.195* | *25.949* |
| 3 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.203* | 26.287 | 26.109 | 26.151 | *26.311* | *26.180* | *25.949* |
| 4 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.228* | 26.282 | 26.104 | 26.145 | *26.307* | *26.164* | *25.949* |
| 5 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.273* | 26.277 | 26.099 | 26.147 | *26.315* | *26.149* | *25.949* |
| 6 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.298* | 26.271 | 26.092 | 26.170 | *26.307* | *26.134* | *25.949* |
| 7 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.311* | 26.266 | 26.086 | 26.196 | *26.322* | *26.118* | *25.949* |
| 8 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.327* | 26.261 | 26.080 | 26.223 | *26.316* | *26.103* | *25.949* |
| 9 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | *26.337* | 26.256 | 26.075 | 26.239 | *26.339* | *26.087* | *25.949* |
| 10 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.337 | 26.249 | 26.071 | 26.244 | *26.334* | *26.072* | *25.949* |
| 11 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.335 | 26.244 | 26.072 | 26.242 | *26.325* | *26.057* | *25.949* |
| 12 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.342 | 26.239 | 26.067 | 26.242 | *26.308* | *26.041* | *25.949* |
| 13 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.370 | 26.233 | 26.065 | 26.238 | *26.324* | *26.026* | *25.949* |
| 14 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.385 | 26.227 | 26.061 | 26.234 | *26.307* | *26.011* | *25.949* |
| 15 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.385 | 26.223 | 26.055 | 26.227 | *26.317* | *25.995* | *25.949* |
| 16 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.376 | 26.216 | 26.048 | 26.220 | *26.338* | *25.980* | *25.949* |
| 17 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.364 | 26.211 | 26.043 | 26.214 | *26.362* | *25.964* | *25.949* |
| 18 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.355 | 26.203 | 26.042 | 26.211 | *26.335* | *25.949* | *25.949* |
| 19 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.351 | 26.199 | 26.037 | 26.207 | *26.335* | *25.949* | *25.949* |
| 20 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.346 | 26.195 | 26.029 | 26.202 | *26.315* | *25.949* | *25.949* |
| 21 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.340 | 26.190 | 26.021 | 26.199 | *26.295* | *25.949* | *25.949* |
| 22 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.333 | 26.185 | 26.017 | 26.196 | *26.284* | *25.949* | *25.949* |
| 23 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.327 | 26.181 | 26.013 | 26.218 | *26.279* | *25.949* | *25.949* |
| 24 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.321 | 26.175 | 26.012 | 26.288 | *26.272* | *25.949* | *25.949* |
| 25 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.315 | 26.165 | 26.010 | 26.308 | *26.265* | *25.949* | *25.949* |
| 26 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.311 | 26.160 | 26.013 | 26.302 | *26.265* | *25.949* | *25.949* |
| 27 | *25.949* | *25.949* | *25.949* | *25.949* | *25.949* | 26.305 | 26.155 | 26.048 | 26.292 | *26.251* | *25.949* | *25.949* |
| 28 | *25.949* | *25.949* | *25.949* | *25.949* | *25.992* | 26.298 | 26.146 | 26.119 | 26.298 | *26.230* | *25.949* | *25.949* |
| 29 | *25.949* | | *25.949* | *25.949* | *26.036* | 26.294 | 26.141 | 26.163 | 26.308 | *26.231* | *25.949* | *25.949* |
| 30 | *25.949* | | *25.949* | *25.949* | *26.079* | 26.288 | 26.135 | 26.175 | 26.307 | *26.229* | *25.949* | *25.949* |
| 31 | *25.949* | | *25.949* | | *26.122* | | 26.126 | 26.174 | | *26.219* | | *25.949* |
| **Mean** | 25.949 | 25.949 | 25.949 | 25.949 | 25.963 | 26.313 | 26.215 | 26.072 | 26.226 | 26.299 | 26.027 | 25.949 |
| **Max** | 25.949 | 25.949 | 25.949 | 25.949 | 26.122 | 26.385 | 26.290 | 26.175 | 26.308 | 26.362 | 26.210 | 25.949 |
| **Min** | 25.949 | 25.949 | 25.949 | 25.949 | 25.949 | 26.147 | 26.126 | 26.010 | 26.145 | 26.219 | 25.949 | 25.949 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C6: Summary of Mean Daily Water Level (m) at Hydrometric Station Ogama Outflow, 2022

**Drainage Area = 74.93 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.260 | 24.106 | 24.181 | *24.327* | *24.250* | *24.092* |
| 2 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.258 | 24.109 | 24.183 | *24.327* | *24.199* | *24.092* |
| 3 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.254 | 24.108 | 24.183 | *24.328* | *24.155* | *24.092* |
| 4 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.252 | 24.105 | 24.185 | *24.328* | *24.116* | *24.092* |
| 5 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.247 | 24.103 | 24.193 | *24.328* | *24.118* | *24.092* |
| 6 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.243 | 24.101 | 24.202 | *24.329* | *24.092* | *24.092* |
| 7 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.094* | 24.238 | 24.096 | 24.203 | *24.329* | *24.092* | *24.092* |
| 8 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.142* | 24.233 | 24.090 | 24.224 | *24.330* | *24.092* | *24.092* |
| 9 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.200* | 24.227 | 24.087 | 24.238 | *24.330* | *24.092* | *24.092* |
| 10 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | *24.270* | 24.221 | 24.085 | 24.252 | *24.331* | *24.092* | *24.092* |
| 11 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.357 | 24.214 | 24.076 | 24.258 | *24.325* | *24.092* | *24.092* |
| 12 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.356 | 24.210 | 24.076 | 24.267 | *24.316* | *24.092* | *24.092* |
| 13 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.357 | 24.204 | 24.082 | 24.269 | *24.325* | *24.092* | *24.092* |
| 14 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.358 | 24.198 | 24.083 | 24.269 | *24.315* | *24.092* | *24.092* |
| 15 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.363 | 24.186 | 24.083 | 24.266 | *24.321* | *24.092* | *24.092* |
| 16 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.362 | 24.180 | 24.078 | 24.268 | *24.333* | *24.092* | *24.092* |
| 17 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.358 | 24.178 | 24.077 | 24.260 | *24.346* | *24.092* | *24.092* |
| 18 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.352 | 24.173 | 24.082 | 24.255 | *24.332* | *24.092* | *24.092* |
| 19 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.347 | 24.167 | 24.071 | 24.253 | *24.332* | *24.092* | *24.092* |
| 20 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.342 | 24.161 | 24.068 | 24.247 | *24.320* | *24.092* | *24.092* |
| 21 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.336 | 24.160 | 24.060 | 24.245 | *24.308* | *24.092* | *24.092* |
| 22 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.327 | 24.158 | 24.061 | 24.243 | *24.301* | *24.092* | *24.092* |
| 23 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.318 | 24.156 | 24.060 | 24.266 | *24.298* | *24.092* | *24.092* |
| 24 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.309 | 24.151 | 24.060 | 24.274 | *24.294* | *24.092* | *24.092* |
| 25 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.301 | 24.142 | 24.060 | 24.303 | *24.289* | *24.092* | *24.092* |
| 26 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.292 | 24.139 | 24.071 | 24.313 | *24.289* | *24.092* | *24.092* |
| 27 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.283 | 24.134 | 24.097 | 24.320 | *24.279* | *24.092* | *24.092* |
| 28 | *24.092* | *24.092* | *24.092* | *24.092* | *24.092* | 24.269 | 24.124 | 24.129 | 24.314 | *24.265* | *24.092* | *24.092* |
| 29 | *24.092* | | *24.092* | *24.092* | *24.092* | 24.263 | 24.120 | 24.150 | 24.322 | *24.266* | *24.092* | *24.092* |
| 30 | *24.092* | | *24.092* | *24.092* | *24.092* | 24.259 | 24.119 | 24.166 | 24.327 | *24.264* | *24.092* | *24.092* |
| 31 | *24.092* | | *24.092* | | *24.092* | | 24.112 | 24.177 | | *24.257* | | *24.092* |
| **Mean** | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.259 | 24.188 | 24.092 | 24.253 | 24.312 | 24.105 | 24.092 |
| **Max** | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.363 | 24.260 | 24.177 | 24.327 | 24.346 | 24.250 | 24.092 |
| **Min** | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.092 | 24.112 | 24.060 | 24.181 | 24.257 | 24.092 | 24.092 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C7: Summary of Mean Daily Water Level (m) at Hydrometric Station Doris Lake-2, 2022

**Drainage Area = 90.29 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 21.791 | 21.777 | 21.756 | 21.749 | 21.726 | 21.817 | 21.998 | 21.780 | 21.799 | 21.980 | 21.894 | 21.993 |
| 2 | 21.786 | 21.790 | 21.756 | 21.746 | 21.722 | 21.854 | 21.992 | 21.775 | 21.804 | 21.989 | 21.899 | 22.006 |
| 3 | 21.787 | 21.780 | 21.764 | 21.753 | 21.724 | 21.885 | 21.991 | 21.778 | 21.804 | 22.018 | 21.909 | 22.003 |
| 4 | 21.797 | 21.783 | 21.757 | 21.751 | 21.726 | 21.916 | 21.987 | 21.773 | 21.814 | 22.012 | 21.899 | 21.979 |
| 5 | 21.802 | 21.782 | 21.753 | 21.725 | 21.720 | 21.970 | 21.977 | 21.774 | 21.827 | 22.021 | 21.880 | 22.021 |
| 6 | 21.793 | 21.779 | 21.761 | 21.726 | 21.706 | 22.001 | 21.969 | 21.772 | 21.829 | 22.012 | 21.885 | 21.996 |
| 7 | 21.791 | 21.762 | 21.748 | 21.742 | 21.710 | 22.017 | 21.962 | 21.763 | 21.838 | 22.030 | 21.888 | 21.998 |
| 8 | 21.787 | 21.782 | 21.760 | 21.737 | 21.718 | 22.036 | 21.952 | 21.757 | 21.842 | 22.023 | 21.900 | 22.006 |
| 9 | 21.793 | 21.780 | 21.764 | 21.735 | 21.720 | 22.048 | 21.943 | 21.760 | 21.861 | 22.051 | 21.896 | 21.999 |
| 10 | 21.798 | 21.781 | 21.757 | 21.738 | 21.716 | 22.051 | 21.934 | 21.765 | 21.873 | 22.044 | 21.899 | 22.000 |
| 11 | 21.794 | 21.779 | 21.764 | 21.734 | 21.713 | 22.063 | 21.928 | 21.762 | 21.866 | 22.033 | 21.910 | 22.012 |
| 12 | 21.787 | 21.778 | 21.761 | 21.739 | 21.711 | 22.062 | 21.921 | 21.753 | 21.888 | 22.013 | 21.887 | 22.020 |
| 13 | 21.784 | 21.780 | 21.760 | 21.742 | 21.712 | 22.067 | 21.910 | 21.751 | 21.888 | 22.032 | 21.895 | 22.026 |
| 14 | 21.796 | 21.779 | 21.758 | 21.740 | 21.707 | 22.064 | 21.900 | 21.753 | 21.892 | 22.012 | 21.900 | 21.990 |
| 15 | 21.789 | 21.781 | 21.758 | 21.743 | 21.718 | 22.071 | 21.877 | 21.755 | 21.891 | 22.024 | 21.880 | 21.996 |
| 16 | 21.792 | 21.777 | 21.748 | 21.740 | 21.723 | 22.079 | 21.877 | 21.741 | 21.910 | 22.049 | 21.930 | 22.015 |
| 17 | 21.784 | 21.771 | 21.742 | 21.740 | 21.724 | 22.078 | 21.879 | 21.741 | 21.905 | 22.078 | 21.924 | 22.016 |
| 18 | 21.782 | 21.775 | 21.742 | 21.737 | 21.726 | 22.071 | 21.869 | 21.764 | 21.894 | 22.046 | 21.949 | 22.019 |
| 19 | 21.800 | 21.770 | 21.747 | 21.733 | 21.727 | 22.068 | 21.857 | 21.740 | 21.900 | 22.046 | 21.941 | 22.010 |
| 20 | 21.789 | 21.771 | 21.743 | 21.736 | 21.750 | 22.063 | 21.846 | 21.737 | 21.901 | 22.021 | 21.945 | 22.015 |
| 21 | 21.783 | 21.761 | 21.747 | 21.733 | 21.744 | 22.066 | 21.842 | 21.731 | 21.911 | 21.997 | 21.955 | 22.021 |
| 22 | 21.786 | 21.774 | 21.747 | 21.722 | 21.754 | 22.059 | 21.837 | 21.725 | 21.907 | 21.984 | 21.954 | 22.017 |
| 23 | 21.779 | 21.775 | 21.753 | 21.730 | 21.756 | 22.052 | 21.832 | 21.728 | 21.937 | 21.977 | 21.940 | 22.027 |
| 24 | 21.796 | 21.768 | 21.748 | 21.736 | 21.742 | 22.048 | 21.828 | 21.727 | 21.906 | 21.969 | 21.963 | 22.035 |
| 25 | 21.784 | 21.755 | 21.752 | 21.725 | 21.746 | 22.040 | 21.810 | 21.731 | 21.944 | 21.961 | 21.960 | 22.031 |
| 26 | 21.788 | 21.761 | 21.756 | 21.726 | 21.751 | 22.032 | 21.813 | 21.737 | 21.952 | 21.961 | 21.961 | 22.043 |
| 27 | 21.777 | 21.765 | 21.748 | 21.720 | 21.749 | 22.032 | 21.809 | 21.750 | 21.975 | 21.943 | 21.952 | 22.030 |
| 28 | 21.785 | 21.755 | 21.751 | 21.718 | 21.762 | 22.014 | 21.805 | 21.771 | 21.945 | 21.918 | 21.977 | 22.022 |
| 29 | 21.782 | | 21.749 | 21.722 | 21.768 | 22.007 | 21.789 | 21.781 | 21.962 | 21.919 | 21.987 | 22.026 |
| 30 | 21.783 | | 21.745 | 21.728 | 21.775 | 22.000 | 21.794 | 21.792 | 21.993 | 21.917 | 21.999 | 22.014 |
| 31 | 21.774 | | 21.747 | | 21.787 | | 21.787 | 21.796 | | 21.905 | | 22.009 |
| **Mean** | 21.788 | 21.774 | 21.753 | 21.735 | 21.733 | 22.021 | 21.888 | 21.757 | 21.889 | 22.000 | 21.925 | 22.013 |
| **Max** | 21.802 | 21.790 | 21.764 | 21.753 | 21.787 | 22.079 | 21.998 | 21.796 | 21.993 | 22.078 | 21.999 | 22.043 |
| **Min** | 21.774 | 21.755 | 21.742 | 21.718 | 21.706 | 21.817 | 21.787 | 21.725 | 21.799 | 21.905 | 21.880 | 21.979 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C8: Summary of Mean Daily Water Level (m) at Hydrometric Station Doris Creek TL-2, 2022

**Drainage Area = 90.29 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *21.680* | *21.664* | *21.640* | *21.633* | *21.607* | *21.709* | 21.920 | 21.676 | 21.684 | 21.881 | *21.795* | *21.906* |
| 2 | *21.674* | *21.678* | *21.640* | *21.629* | *21.602* | *21.750* | 21.919 | 21.668 | 21.686 | 21.877 | *21.800* | *21.920* |
| 3 | *21.675* | *21.667* | *21.649* | *21.637* | *21.605* | *21.785* | 21.915 | 21.667 | 21.690 | *21.934* | *21.812* | *21.917* |
| 4 | *21.686* | *21.671* | *21.641* | *21.635* | *21.607* | *21.820* | 21.910 | 21.664 | 21.692 | *21.927* | *21.800* | *21.890* |
| 5 | *21.692* | *21.669* | *21.637* | *21.606* | *21.600* | *21.880* | 21.905 | 21.661 | 21.697 | *21.937* | *21.779* | *21.937* |
| 6 | *21.682* | *21.666* | *21.646* | *21.607* | *21.584* | *21.915* | 21.896 | 21.657 | 21.709 | *21.927* | *21.785* | *21.909* |
| 7 | *21.680* | *21.647* | *21.631* | *21.625* | *21.589* | *21.933* | 21.889 | 21.655 | 21.726 | *21.947* | *21.788* | *21.911* |
| 8 | *21.675* | *21.669* | *21.645* | *21.619* | *21.598* | *21.954* | 21.881 | 21.648 | 21.730 | *21.939* | *21.802* | *21.920* |
| 9 | *21.682* | *21.667* | *21.649* | *21.617* | *21.600* | *21.967* | 21.871 | 21.641 | 21.743 | *21.971* | *21.797* | *21.912* |
| 10 | *21.687* | *21.668* | *21.641* | *21.620* | *21.596* | *21.971* | 21.862 | 21.638 | 21.755 | *21.963* | *21.800* | *21.914* |
| 11 | *21.683* | *21.666* | *21.649* | *21.616* | *21.592* | *21.984* | 21.854 | 21.635 | 21.765 | *21.951* | *21.813* | *21.927* |
| 12 | *21.675* | *21.665* | *21.646* | *21.621* | *21.590* | *21.983* | 21.844 | 21.639 | 21.771 | *21.928* | *21.787* | *21.936* |
| 13 | *21.672* | *21.667* | *21.645* | *21.625* | *21.591* | *21.989* | 21.835 | 21.633 | 21.781 | *21.949* | *21.796* | *21.943* |
| 14 | *21.685* | *21.666* | *21.643* | *21.622* | *21.585* | 21.975 | 21.830 | 21.630 | 21.787 | *21.927* | *21.802* | *21.902* |
| 15 | *21.677* | *21.668* | *21.643* | *21.626* | *21.598* | 21.980 | 21.817 | 21.628 | 21.792 | *21.940* | *21.779* | *21.909* |
| 16 | *21.681* | *21.664* | *21.631* | *21.622* | *21.603* | 21.983 | 21.804 | 21.624 | 21.794 | *21.968* | *21.835* | *21.930* |
| 17 | *21.672* | *21.657* | *21.625* | *21.622* | *21.605* | 21.982 | 21.794 | 21.621 | 21.797 | *22.001* | *21.828* | *21.932* |
| 18 | *21.669* | *21.662* | *21.625* | *21.619* | *21.607* | 21.979 | 21.788 | 21.619 | 21.799 | *21.965* | *21.856* | *21.935* |
| 19 | *21.690* | *21.656* | *21.630* | *21.615* | *21.608* | 21.978 | 21.780 | 21.628 | 21.800 | *21.965* | *21.848* | *21.925* |
| 20 | *21.677* | *21.657* | *21.626* | *21.618* | *21.634* | 21.975 | 21.772 | 21.623 | 21.800 | *21.937* | *21.852* | *21.930* |
| 21 | *21.671* | *21.646* | *21.630* | *21.615* | *21.627* | 21.977 | 21.763 | 21.610 | 21.799 | *21.910* | *21.863* | *21.937* |
| 22 | *21.674* | *21.661* | *21.630* | *21.602* | *21.638* | 21.973 | 21.756 | 21.600 | 21.799 | *21.896* | *21.862* | *21.933* |
| 23 | *21.666* | *21.662* | *21.637* | *21.611* | *21.640* | 21.969 | 21.749 | 21.597 | 21.800 | *21.888* | *21.846* | *21.944* |
| 24 | *21.685* | *21.654* | *21.631* | *21.618* | *21.625* | 21.964 | 21.742 | 21.593 | 21.820 | *21.879* | *21.872* | *21.953* |
| 25 | *21.672* | *21.639* | *21.636* | *21.606* | *21.629* | 21.960 | 21.733 | 21.591 | 21.833 | *21.870* | *21.869* | *21.948* |
| 26 | *21.676* | *21.646* | *21.640* | *21.607* | *21.635* | 21.954 | 21.721 | 21.589 | 21.847 | *21.870* | *21.870* | *21.962* |
| 27 | *21.664* | *21.650* | *21.631* | *21.600* | *21.633* | 21.949 | 21.714 | 21.595 | 21.853 | *21.850* | *21.860* | *21.947* |
| 28 | *21.673* | *21.639* | *21.635* | *21.598* | *21.647* | 21.942 | 21.708 | 21.632 | 21.859 | *21.822* | *21.888* | *21.938* |
| 29 | *21.669* | | *21.633* | *21.602* | *21.654* | 21.932 | 21.699 | 21.657 | 21.864 | *21.823* | *21.899* | *21.943* |
| 30 | *21.671* | | *21.628* | *21.609* | *21.662* | 21.925 | 21.691 | 21.668 | 21.871 | *21.821* | *21.912* | *21.929* |
| 31 | *21.661* | | *21.630* | | *21.675* | | 21.686 | 21.678 | | *21.807* | | *21.924* |
| **Mean** | 21.677 | 21.660 | 21.637 | 21.617 | 21.615 | 21.935 | 21.808 | 21.634 | 21.778 | 21.912 | 21.830 | 21.928 |
| **Max** | 21.692 | 21.678 | 21.649 | 21.637 | 21.675 | 21.989 | 21.920 | 21.678 | 21.871 | 22.001 | 21.912 | 21.962 |
| **Min** | 21.661 | 21.639 | 21.625 | 21.598 | 21.584 | 21.709 | 21.686 | 21.589 | 21.684 | 21.807 | 21.779 | 21.890 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C9: Summary of Mean Daily Water Level (m) at Hydrometric Station Roberts Hydro-2, 2022

**Drainage Area = 97.83 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.194* | 6.542 | 6.407 | 6.409 | 6.596 | *6.450* | *6.153* |
| 2 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.205* | 6.538 | 6.399 | 6.413 | 6.574 | *6.403* | *6.153* |
| 3 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.218* | 6.533 | 6.391 | 6.419 | 6.586 | *6.364* | *6.153* |
| 4 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.234* | 6.537 | 6.391 | 6.418 | 6.614 | *6.331* | *6.153* |
| 5 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.255* | 6.539 | 6.382 | 6.428 | *6.614* | *6.303* | *6.153* |
| 6 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.282* | 6.531 | 6.383 | 6.441 | *6.614* | *6.280* | *6.153* |
| 7 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.315* | 6.527 | 6.378 | 6.443 | *6.615* | *6.260* | *6.153* |
| 8 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.356* | 6.524 | 6.365 | 6.462 | *6.615* | *6.243* | *6.153* |
| 9 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.381* | 6.517 | 6.357 | 6.473 | *6.616* | *6.229* | *6.153* |
| 10 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.410* | 6.512 | 6.358 | 6.498 | *6.607* | *6.217* | *6.153* |
| 11 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.443* | 6.509 | 6.362 | 6.514 | *6.593* | *6.207* | *6.153* |
| 12 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | *6.482* | 6.508 | 6.343 | 6.502 | *6.569* | *6.199* | *6.153* |
| 13 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.565 | 6.509 | 6.342 | 6.523 | *6.592* | *6.191* | *6.153* |
| 14 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.583 | 6.505 | 6.348 | 6.520 | *6.567* | *6.185* | *6.153* |
| 15 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.598 | 6.505 | 6.353 | 6.521 | *6.582* | *6.180* | *6.153* |
| 16 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.619 | 6.477 | 6.357 | 6.514 | *6.613* | *6.176* | *6.153* |
| 17 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.637 | 6.489 | 6.336 | 6.531 | *6.653* | *6.172* | *6.153* |
| 18 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.641 | 6.496 | 6.335 | 6.513 | *6.609* | *6.169* | *6.153* |
| 19 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.635 | 6.488 | 6.365 | 6.486 | *6.609* | *6.153* | *6.153* |
| 20 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.631 | 6.481 | 6.325 | 6.488 | *6.578* | *6.153* | *6.153* |
| 21 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.624 | 6.469 | 6.330 | 6.483 | *6.550* | *6.153* | *6.153* |
| 22 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.627 | 6.467 | 6.325 | 6.501 | *6.536* | *6.153* | *6.153* |
| 23 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.617 | 6.463 | 6.322 | 6.509 | *6.528* | *6.153* | *6.153* |
| 24 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.607 | 6.457 | 6.325 | 6.546 | *6.520* | *6.153* | *6.153* |
| 25 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.601 | 6.456 | 6.326 | 6.500 | *6.512* | *6.153* | *6.153* |
| 26 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.592 | 6.436 | 6.333 | 6.556 | *6.512* | *6.153* | *6.153* |
| 27 | *6.153* | *6.153* | *6.153* | *6.153* | *6.153* | 6.581 | 6.439 | 6.342 | 6.565 | *6.494* | *6.153* | *6.153* |
| 28 | *6.153* | *6.153* | *6.153* | *6.153* | *6.169* | 6.581 | 6.432 | 6.346 | 6.597 | *6.470* | *6.153* | *6.153* |
| 29 | *6.153* | | *6.153* | *6.153* | *6.174* | 6.561 | 6.427 | 6.368 | 6.548 | *6.471* | *6.153* | *6.153* |
| 30 | *6.153* | | *6.153* | *6.153* | *6.179* | 6.552 | 6.411 | 6.385 | 6.565 | *6.470* | *6.153* | *6.153* |
| 31 | *6.153* | | *6.153* | | *6.186* | | 6.416 | 6.403 | | *6.459* | | *6.153* |
| **Mean** | 6.153 | 6.153 | 6.153 | 6.153 | 6.156 | 6.488 | 6.488 | 6.358 | 6.496 | 6.566 | 6.213 | 6.153 |
| **Max** | 6.153 | 6.153 | 6.153 | 6.153 | 6.186 | 6.641 | 6.542 | 6.407 | 6.597 | 6.653 | 6.450 | 6.153 |
| **Min** | 6.153 | 6.153 | 6.153 | 6.153 | 6.153 | 6.194 | 6.411 | 6.322 | 6.409 | 6.459 | 6.153 | 6.153 |

*Note:*

*Estimated and modelled values are italicized.*

## Appendix C10: Summary of Mean Daily Water Level (m) at Hydrometric Station Little Roberts, 2022

**Drainage Area = 194.15 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.444* | 4.843 | 4.580 | 4.645 | *4.908* | *4.774* | *4.256* |
| 2 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.493* | 4.819 | 4.574 | 4.648 | *4.910* | *4.727* | *4.256* |
| 3 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.542* | 4.809 | 4.572 | 4.651 | *4.913* | *4.564* | *4.256* |
| 4 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.591* | 4.800 | 4.565 | 4.654 | *4.906* | *4.492* | *4.256* |
| 5 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.641* | 4.790 | 4.560 | 4.665 | *4.916* | *4.436* | *4.256* |
| 6 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.692* | 4.775 | 4.558 | 4.717 | *4.906* | *4.393* | *4.256* |
| 7 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.743* | 4.765 | 4.552 | 4.739 | *4.925* | *4.359* | *4.256* |
| 8 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.794* | 4.750 | 4.543 | 4.750 | *4.918* | *4.333* | *4.256* |
| 9 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.847* | 4.739 | 4.537 | 4.755 | *4.948* | *4.312* | *4.256* |
| 10 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.899* | 4.729 | 4.535 | 4.766 | *4.940* | *4.296* | *4.256* |
| 11 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | *4.953* | 4.715 | 4.556 | 4.781 | *4.929* | *4.284* | *4.256* |
| 12 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.007 | 4.693 | 4.552 | 4.785 | *4.907* | *4.274* | *4.256* |
| 13 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.014 | 4.676 | 4.540 | 4.790 | *4.928* | *4.267* | *4.256* |
| 14 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.022 | 4.670 | 4.537 | 4.793 | *4.906* | *4.261* | *4.256* |
| 15 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.023 | 4.667 | 4.533 | 4.802 | *4.919* | *4.256* | *4.256* |
| 16 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.023 | 4.668 | 4.530 | 4.820 | *4.945* | *4.253* | *4.256* |
| 17 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.023 | 4.668 | 4.526 | 4.811 | *4.975* | *4.250* | *4.256* |
| 18 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.019 | 4.632 | 4.529 | 4.806 | *4.942* | *4.256* | *4.256* |
| 19 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 5.007 | 4.627 | 4.542 | 4.796 | *4.942* | *4.256* | *4.256* |
| 20 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.994 | 4.635 | 4.531 | 4.787 | *4.916* | *4.256* | *4.256* |
| 21 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.983 | 4.629 | 4.521 | 4.781 | *4.890* | *4.256* | *4.256* |
| 22 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.969 | 4.621 | 4.514 | 4.779 | *4.876* | *4.256* | *4.256* |
| 23 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.956 | 4.612 | 4.506 | 4.812 | *4.868* | *4.256* | *4.256* |
| 24 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.944 | 4.611 | 4.501 | 4.876 | *4.860* | *4.256* | *4.256* |
| 25 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.931 | 4.619 | 4.496 | 4.870 | *4.851* | *4.256* | *4.256* |
| 26 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.918 | 4.607 | 4.497 | 4.875 | *4.851* | *4.256* | *4.256* |
| 27 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.905 | 4.604 | 4.559 | 4.877 | *4.831* | *4.256* | *4.256* |
| 28 | *4.256* | *4.256* | *4.256* | *4.256* | *4.256* | 4.888 | 4.602 | 4.619 | 4.897 | *4.802* | *4.256* | *4.256* |
| 29 | *4.256* | | *4.256* | *4.256* | *4.302* | 4.870 | 4.607 | 4.625 | 4.900 | *4.803* | *4.256* | *4.256* |
| 30 | *4.256* | | *4.256* | *4.256* | *4.349* | 4.856 | 4.598 | 4.633 | *4.905* | *4.801* | *4.256* | *4.256* |
| 31 | *4.256* | | *4.256* | | *4.397* | | 4.589 | 4.642 | | *4.787* | | *4.256* |
| **Mean** | 4.256 | 4.256 | 4.256 | 4.256 | 4.265 | 4.866 | 4.683 | 4.551 | 4.784 | 4.894 | 4.329 | 4.256 |
| **Max** | 4.256 | 4.256 | 4.256 | 4.256 | 4.397 | 5.023 | 4.843 | 4.642 | 4.905 | 4.975 | 4.774 | 4.256 |
| **Min** | 4.256 | 4.256 | 4.256 | 4.256 | 4.256 | 4.444 | 4.589 | 4.496 | 4.645 | 4.787 | 4.250 | 4.256 |

*Note:*

*Estimated and modelled values are italicized.*

# APPENDIX D MEAN DAILY DISCHARGE TABLES

## Appendix D1: Summary of Daily Discharge [Q, $m^3/s$] at Hydrometric Station Windy Outflow, 2022

**Drainage Area = 13.73 $km^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | *0.005* | 0.201 | 0.066 | 0.040 | *0.059* | *0.047* | - |
| 2 | - | - | - | - | - | *0.007* | 0.202 | 0.064 | 0.036 | *0.059* | *0.039* | - |
| 3 | - | - | - | - | - | *0.010* | 0.199 | 0.062 | 0.034 | *0.059* | *0.033* | - |
| 4 | - | - | - | - | - | *0.015* | 0.193 | 0.058 | 0.035 | *0.058* | *0.027* | - |
| 5 | - | - | - | - | - | *0.021* | 0.191 | 0.056 | 0.045 | *0.059* | *0.023* | - |
| 6 | - | - | - | - | - | *0.031* | 0.186 | 0.058 | 0.052 | *0.058* | *0.019* | - |
| 7 | - | - | - | - | - | *0.046* | 0.183 | 0.053 | 0.051 | *0.060* | *0.016* | - |
| 8 | - | - | - | - | - | *0.070* | 0.180 | 0.048 | 0.057 | *0.059* | *0.013* | - |
| 9 | - | - | - | - | - | *0.093* | 0.174 | 0.046 | 0.055 | *0.062* | *0.011* | - |
| 10 | - | - | - | - | - | *0.117* | 0.171 | 0.044 | 0.057 | *0.061* | *0.009* | - |
| 11 | - | - | - | - | - | *0.141* | 0.168 | 0.049 | 0.056 | *0.060* | *0.008* | - |
| 12 | - | - | - | - | - | *0.165* | 0.165 | 0.045 | 0.055 | *0.058* | *0.006* | - |
| 13 | - | - | - | - | - | *0.188* | 0.167 | 0.042 | 0.054 | *0.060* | *0.005* | - |
| 14 | - | - | - | - | - | 0.196 | 0.166 | 0.040 | 0.051 | *0.058* | *0.004* | - |
| 15 | - | - | - | - | - | 0.198 | 0.154 | 0.040 | 0.049 | *0.059* | *0.004* | - |
| 16 | - | - | - | - | - | 0.200 | 0.150 | 0.035 | 0.049 | *0.062* | *0.003* | - |
| 17 | - | - | - | - | - | 0.203 | 0.141 | 0.034 | 0.045 | *0.064* | *0.003* | - |
| 18 | - | - | - | - | - | 0.204 | 0.142 | 0.038 | 0.043 | *0.062* | *0.001* | - |
| 19 | - | - | - | - | - | 0.208 | 0.137 | 0.034 | 0.041 | *0.062* | *0.001* | - |
| 20 | - | - | - | - | - | 0.213 | 0.129 | 0.028 | 0.039 | *0.059* | *0.001* | - |
| 21 | - | - | - | - | - | 0.215 | 0.123 | 0.023 | 0.039 | *0.057* | *0.001* | - |
| 22 | - | - | - | - | - | 0.215 | 0.125 | 0.021 | 0.038 | *0.056* | *0.001* | - |
| 23 | - | - | - | - | - | 0.216 | 0.118 | 0.019 | 0.056 | *0.055* | - | - |
| 24 | - | - | - | - | - | 0.215 | 0.111 | 0.016 | 0.053 | *0.054* | - | - |
| 25 | - | - | - | - | - | 0.213 | 0.099 | 0.016 | 0.055 | *0.054* | - | - |
| 26 | - | - | - | - | - | 0.211 | 0.099 | 0.023 | 0.056 | *0.054* | - | - |
| 27 | - | - | - | - | - | 0.206 | 0.095 | 0.035 | 0.056 | *0.052* | - | - |
| 28 | - | - | - | - | *0.001* | 0.201 | 0.084 | 0.037 | 0.056 | *0.050* | - | - |
| 29 | - | | - | - | *0.001* | 0.197 | 0.084 | 0.041 | 0.058 | *0.050* | - | - |
| 30 | - | | - | - | *0.002* | 0.191 | 0.080 | 0.039 | *0.058* | *0.050* | - | - |
| 31 | - | | - | | *0.003* | | 0.073 | 0.047 | | *0.048* | | - |
| **Mean** | - | - | - | - | 0.002 | 0.147 | 0.145 | 0.041 | 0.049 | 0.057 | 0.012 | - |
| **Max** | 0.000 | 0.000 | 0.000 | 0.000 | 0.003 | 0.216 | 0.202 | 0.066 | 0.058 | 0.064 | 0.047 | 0.000 |
| **Min** | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.005 | 0.073 | 0.016 | 0.034 | 0.048 | 0.001 | 0.000 |

*Notes:*

*Estimated and modelled values are italicized.*

*Values in red denote high uncertainty based on extrapolation of the rating curve beyond 2 times the greatest measured discharge.*

## Appendix D2: Summary of Daily Discharge [Q, $m^3/s$] at Hydrometric Station Patch Outflow, 2022

**Drainage Area = 32.16 $km^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | *0.004* | 0.395 | 0.105 | 0.205 | *0.435* | *0.319* | - |
| 2 | - | - | - | - | - | *0.005* | 0.386 | 0.098 | 0.209 | *0.447* | *0.227* | - |
| 3 | - | - | - | - | - | *0.007* | 0.372 | 0.094 | 0.210 | *0.486* | *0.162* | - |
| 4 | - | - | - | - | - | *0.009* | 0.358 | 0.093 | 0.211 | *0.478* | *0.115* | - |
| 5 | - | - | - | - | - | *0.013* | 0.347 | 0.088 | 0.219 | *0.490* | *0.082* | - |
| 6 | - | - | - | - | - | *0.017* | 0.335 | 0.084 | 0.247 | *0.478* | *0.059* | - |
| 7 | - | - | - | - | - | *0.024* | 0.324 | 0.080 | 0.262 | *0.502* | *0.042* | - |
| 8 | - | - | - | - | - | *0.033* | 0.313 | 0.078 | 0.278 | *0.493* | *0.030* | - |
| 9 | - | - | - | - | - | *0.045* | 0.302 | 0.076 | 0.295 | *0.530* | *0.021* | - |
| 10 | - | - | - | - | - | *0.062* | 0.290 | 0.076 | 0.304 | *0.521* | *0.015* | - |
| 11 | - | - | - | - | - | *0.086* | 0.280 | 0.104 | 0.314 | *0.506* | *0.011* | - |
| 12 | - | - | - | - | - | *0.118* | 0.267 | 0.090 | 0.323 | *0.479* | *0.008* | - |
| 13 | - | - | - | - | - | *0.162* | 0.261 | 0.166 | 0.325 | *0.505* | *0.005* | - |
| 14 | - | - | - | - | - | *0.222* | 0.253 | 0.161 | 0.325 | *0.478* | *0.004* | - |
| 15 | - | - | - | - | - | *0.243* | 0.276 | 0.158 | 0.330 | *0.494* | *0.003* | - |
| 16 | - | - | - | - | - | *0.267* | 0.232 | 0.154 | 0.317 | *0.528* | *0.002* | - |
| 17 | - | - | - | - | - | *0.421* | 0.209 | 0.154 | 0.323 | *0.567* | *0.001* | - |
| 18 | - | - | - | - | - | *0.427* | 0.200 | 0.149 | 0.326 | *0.524* | *0.001* | - |
| 19 | - | - | - | - | - | *0.444* | 0.198 | 0.178 | 0.319 | *0.524* | - | - |
| 20 | - | - | - | - | - | *0.469* | 0.192 | 0.155 | 0.316 | *0.490* | - | - |
| 21 | - | - | - | - | - | *0.480* | 0.184 | 0.137 | 0.313 | *0.458* | - | - |
| 22 | - | - | - | - | - | *0.480* | 0.176 | 0.129 | 0.311 | *0.440* | - | - |
| 23 | - | - | - | - | - | 0.478 | 0.171 | 0.124 | 0.330 | *0.431* | - | - |
| 24 | - | - | - | - | - | 0.468 | 0.163 | 0.117 | 0.376 | *0.420* | - | - |
| 25 | - | - | - | - | - | 0.457 | 0.161 | 0.113 | 0.395 | *0.409* | - | - |
| 26 | - | - | - | - | - | 0.446 | 0.147 | 0.111 | 0.407 | *0.409* | - | - |
| 27 | - | - | - | - | - | 0.433 | 0.150 | 0.148 | 0.400 | *0.385* | - | - |
| 28 | - | - | - | - | *0.001* | 0.419 | 0.154 | 0.170 | 0.439 | *0.351* | - | - |
| 29 | - | | - | - | *0.001* | 0.408 | 0.129 | 0.183 | 0.441 | *0.353* | - | - |
| 30 | - | | - | - | *0.002* | 0.393 | 0.122 | 0.194 | 0.438 | *0.350* | - | - |
| 31 | - | | - | | *0.003* | | 0.114 | 0.199 | | *0.334* | | - |
| **Mean** | - | - | - | - | 0.002 | 0.251 | 0.241 | 0.128 | 0.317 | 0.461 | 0.061 | - |
| **Max** | 0.000 | 0.000 | 0.000 | 0.000 | 0.003 | 0.480 | 0.395 | 0.199 | 0.441 | 0.567 | 0.319 | 0.000 |
| **Min** | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.004 | 0.114 | 0.076 | 0.205 | 0.334 | 0.001 | 0.000 |

*Notes:*

*Estimated and modelled values are italicized.*

*Values in red denote high uncertainty based on extrapolation of the rating curve beyond 2 times the greatest measured discharge.*

## Appendix D3: Summary of Daily Discharge [Q, m$^3$/s] at Hydrometric Station PO Outflow, 2022

**Drainage Area = 35.3 km$^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | *0.002* | 0.432 | 0.132 | 0.240 | *0.458* | *0.325* | - |
| 2 | - | - | - | - | - | *0.003* | 0.434 | 0.129 | 0.230 | *0.472* | *0.231* | - |
| 3 | - | - | - | - | - | *0.004* | 0.426 | 0.125 | 0.221 | *0.517* | *0.165* | - |
| 4 | - | - | - | - | - | *0.005* | 0.415 | 0.119 | 0.214 | *0.508* | *0.117* | - |
| 5 | - | - | - | - | - | *0.006* | 0.402 | 0.115 | 0.217 | *0.522* | *0.083* | - |
| 6 | - | - | - | - | - | *0.007* | 0.388 | 0.110 | 0.246 | *0.508* | *0.059* | - |
| 7 | - | - | - | - | - | *0.009* | 0.376 | 0.106 | 0.284 | *0.536* | *0.042* | - |
| 8 | - | - | - | - | - | *0.012* | 0.365 | 0.100 | 0.327 | *0.525* | *0.030* | - |
| 9 | - | - | - | - | - | *0.014* | 0.354 | 0.097 | 0.354 | *0.569* | *0.021* | - |
| 10 | - | - | - | - | - | *0.044* | 0.340 | 0.094 | 0.363 | *0.558* | *0.015* | - |
| 11 | - | - | - | - | - | *0.102* | 0.329 | 0.095 | 0.360 | *0.541* | *0.011* | - |
| 12 | - | - | - | - | - | *0.160* | 0.318 | 0.091 | 0.360 | *0.510* | *0.008* | - |
| 13 | - | - | - | - | - | *0.218* | 0.307 | 0.089 | 0.353 | *0.539* | *0.005* | - |
| 14 | - | - | - | - | - | *0.276* | 0.296 | 0.087 | 0.345 | *0.508* | *0.004* | - |
| 15 | - | - | - | - | - | *0.334* | 0.288 | 0.083 | 0.333 | *0.527* | *0.003* | - |
| 16 | - | - | - | - | - | *0.392* | 0.275 | 0.078 | 0.322 | *0.565* | *0.002* | - |
| 17 | - | - | - | - | - | *0.466* | 0.265 | 0.075 | 0.312 | *0.610* | *0.001* | - |
| 18 | - | - | - | - | - | *0.472* | 0.253 | 0.074 | 0.307 | *0.561* | *0.001* | - |
| 19 | - | - | - | - | - | *0.490* | 0.246 | 0.110 | 0.302 | *0.561* | - | - |
| 20 | - | - | - | - | - | *0.515* | 0.238 | 0.104 | 0.293 | *0.522* | - | - |
| 21 | - | - | - | - | - | *0.526* | 0.230 | 0.099 | 0.288 | *0.485* | - | - |
| 22 | - | - | - | - | - | *0.526* | 0.222 | 0.097 | 0.284 | *0.465* | - | - |
| 23 | - | - | - | - | - | 0.531 | 0.216 | 0.094 | 0.319 | *0.454* | - | - |
| 24 | - | - | - | - | - | 0.514 | 0.208 | 0.093 | 0.449 | *0.441* | - | - |
| 25 | - | - | - | - | - | 0.499 | 0.193 | 0.092 | 0.490 | *0.429* | - | - |
| 26 | - | - | - | - | - | 0.487 | 0.185 | 0.093 | 0.477 | *0.429* | - | - |
| 27 | - | - | - | - | - | 0.470 | 0.179 | 0.117 | 0.456 | *0.401* | - | - |
| 28 | - | - | - | - | *0.001* | 0.453 | 0.166 | 0.184 | 0.469 | *0.362* | - | - |
| 29 | - | | - | - | *0.001* | 0.442 | 0.159 | 0.237 | 0.491 | *0.364* | - | - |
| 30 | - | | - | - | *0.002* | 0.429 | 0.152 | 0.253 | 0.489 | *0.361* | - | - |
| 31 | - | | - | | *0.002* | | 0.142 | 0.252 | | *0.342* | | - |
| **Mean** | - | - | - | - | 0.001 | 0.280 | 0.284 | 0.117 | 0.340 | 0.489 | 0.062 | - |
| **Max** | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.531 | 0.434 | 0.253 | 0.491 | 0.610 | 0.325 | 0.000 |
| **Min** | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.142 | 0.074 | 0.214 | 0.342 | 0.001 | 0.000 |

*Notes:*

*Estimated and modelled values are italicized.*

*Values in red denote high uncertainty based on extrapolation of the rating curve beyond 2 times the greatest measured discharge.*

## Appendix D4: Summary of Daily Discharge [Q, $m^3/s$] at Hydrometric Station Ogama Outflow, 2022

**Drainage Area = 74.93 $km^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | *0.007* | 0.613 | 0.169 | 0.341 | *0.926* | *0.575* | - |
| 2 | - | - | - | - | - | *0.012* | 0.604 | 0.174 | 0.347 | *0.928* | *0.395* | - |
| 3 | - | - | - | - | - | *0.020* | 0.591 | 0.172 | 0.347 | *0.930* | *0.272* | - |
| 4 | - | - | - | - | - | *0.033* | 0.579 | 0.166 | 0.352 | *0.933* | *0.187* | - |
| 5 | - | - | - | - | - | *0.054* | 0.562 | 0.163 | 0.377 | *0.935* | *0.129* | - |
| 6 | - | - | - | - | - | *0.089* | 0.547 | 0.160 | 0.404 | *0.937* | *0.089* | - |
| 7 | - | - | - | - | - | *0.147* | 0.526 | 0.152 | 0.408 | *0.940* | *0.061* | - |
| 8 | - | - | - | - | - | *0.242* | 0.509 | 0.141 | 0.478 | *0.942* | *0.042* | - |
| 9 | - | - | - | - | - | *0.399* | 0.488 | 0.137 | 0.527 | *0.944* | *0.029* | - |
| 10 | - | - | - | - | - | *0.657* | 0.467 | 0.133 | 0.583 | *0.947* | *0.020* | - |
| 11 | - | - | - | - | - | 1.082 | 0.443 | 0.120 | 0.607 | *0.919* | *0.014* | - |
| 12 | - | - | - | - | - | 1.082 | 0.428 | 0.120 | 0.644 | *0.870* | *0.009* | - |
| 13 | - | - | - | - | - | 1.083 | 0.409 | 0.128 | 0.650 | *0.917* | *0.006* | - |
| 14 | - | - | - | - | - | 1.088 | 0.392 | 0.130 | 0.652 | *0.867* | *0.004* | - |
| 15 | - | - | - | - | - | 1.116 | 0.355 | 0.130 | 0.637 | *0.897* | *0.003* | - |
| 16 | - | - | - | - | - | 1.111 | 0.337 | 0.123 | 0.645 | *0.959* | *0.002* | - |
| 17 | - | - | - | - | - | 1.089 | 0.334 | 0.120 | 0.613 | *1.031* | *0.001* | - |
| 18 | - | - | - | - | - | 1.058 | 0.318 | 0.129 | 0.593 | *0.952* | *0.001* | - |
| 19 | - | - | - | - | - | 1.027 | 0.303 | 0.113 | 0.584 | *0.952* | - | - |
| 20 | - | - | - | - | - | 1.000 | 0.289 | 0.108 | 0.561 | *0.890* | - | - |
| 21 | - | - | - | - | - | 0.973 | 0.285 | 0.098 | 0.555 | *0.830* | - | - |
| 22 | - | - | - | - | - | 0.925 | 0.280 | 0.099 | 0.547 | *0.798* | - | - |
| 23 | - | - | - | - | - | 0.879 | 0.275 | 0.097 | 0.640 | *0.781* | - | - |
| 24 | - | - | - | - | - | 0.836 | 0.263 | 0.097 | 0.674 | *0.761* | - | - |
| 25 | - | - | - | - | - | 0.794 | 0.241 | 0.099 | 0.804 | *0.741* | - | - |
| 26 | - | - | - | - | - | 0.752 | 0.234 | 0.112 | 0.852 | *0.741* | - | - |
| 27 | - | - | - | - | - | 0.712 | 0.225 | 0.152 | 0.887 | *0.696* | - | - |
| 28 | - | - | - | - | *0.001* | 0.652 | 0.204 | 0.214 | 0.858 | *0.634* | - | - |
| 29 | - | | - | - | *0.002* | 0.628 | 0.195 | 0.261 | 0.898 | *0.637* | - | - |
| 30 | - | | - | - | *0.003* | 0.610 | 0.193 | 0.300 | 0.923 | *0.632* | - | - |
| 31 | - | | - | | *0.004* | | 0.180 | 0.331 | | *0.602* | | - |
| **Mean** | - | - | - | - | 0.002 | 0.672 | 0.376 | 0.150 | 0.600 | 0.854 | 0.102 | - |
| **Max** | 0.000 | 0.000 | 0.000 | 0.000 | 0.004 | 1.116 | 0.613 | 0.331 | 0.923 | 1.031 | 0.575 | 0.000 |
| **Min** | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.007 | 0.180 | 0.097 | 0.341 | 0.602 | 0.001 | 0.000 |

*Notes:*

*Estimated and modelled values are italicized.*

*Values in red denote high uncertainty based on extrapolation of the rating curve beyond 2 times the greatest measured discharge.*

## Appendix D5: Summary of Daily Discharge [Q, $m^3/s$] at Hydrometric Station Doris Creek TL-2, 2022

**Drainage Area = 90.29 $km^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | *0.418* | 1.145 | 0.253 | 0.344 | *1.221* | *0.732* | - |
| 2 | - | - | - | - | - | *0.569* | 1.139 | 0.231 | 0.352 | *1.229* | *0.569* | - |
| 3 | - | - | - | - | - | *0.695* | 1.122 | 0.231 | 0.366 | *1.238* | *0.442* | - |
| 4 | - | - | - | - | - | *0.822* | 1.097 | 0.223 | 0.374 | *1.214* | *0.343* | - |
| 5 | - | - | - | - | - | *1.042* | 1.073 | 0.215 | 0.391 | *1.251* | *0.267* | - |
| 6 | - | - | - | - | - | *1.169* | 1.034 | 0.206 | 0.442 | *1.214* | *0.207* | - |
| 7 | - | - | - | - | - | *1.199* | 1.002 | 0.201 | 0.512 | *1.287* | *0.161* | - |
| 8 | - | - | - | - | - | *1.229* | 0.968 | 0.184 | 0.529 | *1.259* | *0.125* | - |
| 9 | - | - | - | - | - | *1.259* | 0.926 | 0.168 | 0.588 | *1.373* | *0.097* | - |
| 10 | - | - | - | - | - | *1.289* | 0.888 | 0.162 | 0.641 | *1.344* | *0.075* | - |
| 11 | - | - | - | - | - | *1.319* | 0.852 | 0.156 | 0.692 | *1.300* | *0.059* | - |
| 12 | - | - | - | - | - | *1.349* | 0.811 | 0.166 | 0.721 | *1.218* | *0.046* | - |
| 13 | - | - | - | - | - | *1.379* | 0.776 | 0.152 | 0.770 | *1.295* | *0.035* | - |
| 14 | - | - | - | - | - | 1.411 | 0.757 | 0.146 | 0.803 | *1.214* | *0.027* | - |
| 15 | - | - | - | - | - | 1.436 | 0.707 | 0.143 | 0.827 | *1.263* | *0.021* | - |
| 16 | - | - | - | - | - | 1.454 | 0.655 | 0.135 | 0.837 | *1.365* | *0.017* | - |
| 17 | - | - | - | - | - | 1.445 | 0.620 | 0.128 | 0.853 | *1.483* | *0.013* | - |
| 18 | - | - | - | - | - | 1.434 | 0.596 | 0.124 | 0.864 | *1.353* | *0.010* | - |
| 19 | - | - | - | - | - | 1.427 | 0.569 | 0.149 | 0.867 | *1.353* | - | - |
| 20 | - | - | - | - | - | 1.410 | 0.542 | 0.152 | 0.870 | *1.251* | - | - |
| 21 | - | - | - | - | - | 1.420 | 0.509 | 0.118 | 0.863 | *1.153* | - | - |
| 22 | - | - | - | - | - | 1.403 | 0.486 | 0.094 | 0.864 | *1.099* | - | - |
| 23 | - | - | - | - | - | 1.383 | 0.465 | 0.088 | 0.870 | *1.071* | - | - |
| 24 | - | - | - | - | - | 1.357 | 0.443 | 0.081 | 0.979 | *1.038* | - | - |
| 25 | - | - | - | - | - | 1.335 | 0.414 | 0.076 | 1.049 | *1.006* | - | - |
| 26 | - | - | - | - | - | 1.308 | 0.375 | 0.073 | 1.133 | *1.006* | - | - |
| 27 | - | - | - | - | *0.010* | 1.281 | 0.356 | 0.085 | 1.169 | *0.932* | - | - |
| 28 | - | - | - | - | *0.023* | 1.250 | 0.338 | 0.177 | 1.202 | *0.830* | - | - |
| 29 | - | | - | - | *0.054* | 1.201 | 0.313 | 0.252 | *1.210* | *0.834* | - | - |
| 30 | - | | - | - | *0.127* | 1.167 | 0.291 | 0.287 | *1.210* | *0.826* | - | - |
| 31 | - | | - | | *0.295* | | 0.278 | 0.321 | | *0.777* | | - |
| **Mean** | - | - | - | - | 0.102 | 1.229 | 0.695 | 0.167 | 0.773 | 1.171 | 0.180 | - |
| **Max** | 0.000 | 0.000 | 0.000 | 0.000 | 0.295 | 1.454 | 1.145 | 0.321 | 1.210 | 1.483 | 0.732 | 0.000 |
| **Min** | 0.000 | 0.000 | 0.000 | 0.000 | 0.010 | 0.418 | 0.278 | 0.073 | 0.344 | 0.777 | 0.010 | 0.000 |

*Notes:*

*Estimated and modelled values are italicized.*

*Values in red denote high uncertainty based on extrapolation of the rating curve beyond 2 times the greatest measured discharge.*

## Appendix D6: Summary of Daily Discharge [Q, $m^3/s$] at Hydrometric Station Roberts Hydro-2, 2022

**Drainage Area = 97.83 $km^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | *0.008* | 1.118 | 0.385 | 0.391 | 1.784 | *0.707* | - |
| 2 | - | - | - | - | - | *0.013* | 1.078 | 0.364 | 0.400 | 1.506 | *0.481* | - |
| 3 | - | - | - | - | - | *0.022* | 1.024 | 0.346 | 0.415 | 1.645 | *0.327* | - |
| 4 | - | - | - | - | - | *0.038* | 1.071 | 0.345 | 0.412 | 2.004 | *0.222* | - |
| 5 | - | - | - | - | - | *0.063* | 1.085 | 0.325 | 0.439 | *1.980* | *0.151* | - |
| 6 | - | - | - | - | - | *0.106* | 1.015 | 0.327 | 0.479 | *1.970* | *0.481* | - |
| 7 | - | - | - | - | - | *0.179* | 0.975 | 0.316 | 0.480 | *1.960* | *0.327* | - |
| 8 | - | - | - | - | - | *0.300* | 0.951 | 0.287 | 0.549 | *1.950* | *0.222* | - |
| 9 | - | - | - | - | - | *0.391* | 0.903 | 0.269 | 0.610 | *1.941* | *0.151* | - |
| 10 | - | - | - | - | - | *0.512* | 0.868 | 0.272 | 0.771 | *1.855* | *0.103* | - |
| 11 | - | - | - | - | - | *0.675* | 0.843 | 0.281 | 0.876 | *1.729* | *0.070* | - |
| 12 | - | - | - | - | - | *0.892* | 0.838 | 0.243 | 0.795 | *1.520* | *0.047* | - |
| 13 | - | - | - | - | - | 1.381 | 0.844 | 0.239 | 0.946 | *1.717* | *0.032* | - |
| 14 | - | - | - | - | - | 1.606 | 0.818 | 0.251 | 0.925 | *1.510* | *0.022* | - |
| 15 | - | - | - | - | - | 1.813 | 0.814 | 0.260 | 0.927 | *1.631* | *0.015* | - |
| 16 | - | - | - | - | - | 2.072 | 0.634 | 0.270 | 0.876 | *1.916* | *0.010* | - |
| 17 | - | - | - | - | - | 2.250 | 0.706 | 0.227 | 1.026 | *2.309* | *0.007* | - |
| 18 | - | - | - | - | - | 2.287 | 0.754 | 0.225 | 0.883 | *1.879* | *0.005* | - |
| 19 | - | - | - | - | - | 2.225 | 0.706 | 0.289 | 0.687 | *1.879* | - | - |
| 20 | - | - | - | - | - | 2.185 | 0.657 | 0.207 | 0.700 | *1.600* | - | - |
| 21 | - | - | - | - | - | 2.116 | 0.587 | 0.216 | 0.667 | *1.371* | - | - |
| 22 | - | - | - | - | - | 2.150 | 0.571 | 0.206 | 0.787 | *1.261* | - | - |
| 23 | - | - | - | - | - | 2.051 | 0.554 | 0.200 | 0.844 | *1.206* | - | - |
| 24 | - | - | - | - | - | 1.935 | 0.526 | 0.205 | 1.199 | *1.145* | - | - |
| 25 | - | - | - | - | - | 1.849 | 0.523 | 0.207 | 0.785 | *1.088* | - | - |
| 26 | - | - | - | - | - | 1.729 | 0.462 | 0.221 | 1.274 | *1.088* | - | - |
| 27 | - | - | - | - | - | 1.582 | 0.470 | 0.240 | 1.386 | *0.969* | - | - |
| 28 | - | - | - | - | *0.001* | 1.583 | 0.452 | 0.248 | 1.782 | *0.825* | - | - |
| 29 | - | | - | - | *0.002* | 1.338 | 0.437 | 0.294 | 1.199 | *0.831* | - | - |
| 30 | - | | - | - | *0.003* | 1.228 | 0.396 | 0.331 | 1.378 | *0.820* | - | - |
| 31 | - | | - | | *0.005* | | 0.407 | 0.374 | | *0.759* | | - |
| **Mean** | - | - | - | - | 0.003 | 1.219 | 0.745 | 0.273 | 0.830 | 1.537 | 0.188 | - |
| **Max** | 0.000 | 0.000 | 0.000 | 0.000 | 0.005 | 2.287 | 1.118 | 0.385 | 1.782 | 2.309 | 0.707 | 0.000 |
| **Min** | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.008 | 0.396 | 0.200 | 0.391 | 0.759 | 0.005 | 0.000 |

*Notes:*

*Estimated and modelled values are italicized.*

*Values in red denote high uncertainty based on extrapolation of the rating curve beyond 2 times the greatest measured discharge.*

## Appendix D7: Summary of Daily Discharge [Q, $m^3/s$] at Hydrometric Station Little Roberts Outflow, 2022

**Drainage Area = 194.15 $km^2$**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | *0.051* | 1.726 | 0.764 | 0.985 | *2.009* | *1.462* | - |
| 2 | - | - | - | - | - | *0.077* | 1.633 | 0.749 | 0.997 | *2.018* | *1.279* | - |
| 3 | - | - | - | - | - | *0.116* | 1.596 | 0.739 | 1.007 | *2.029* | *0.717* | - |
| 4 | - | - | - | - | - | *0.174* | 1.560 | 0.719 | 1.017 | *2.001* | *0.502* | - |
| 5 | - | - | - | - | - | *0.262* | 1.515 | 0.704 | 1.070 | *2.042* | *0.352* | - |
| 6 | - | - | - | - | - | *0.394* | 1.457 | 0.698 | 1.267 | *2.001* | *0.246* | - |
| 7 | - | - | - | - | - | *0.592* | 1.420 | 0.675 | 1.327 | *2.084* | *0.173* | - |
| 8 | - | - | - | - | - | *0.890* | 1.361 | 0.650 | 1.373 | *2.052* | *0.121* | - |
| 9 | - | - | - | - | - | *1.339* | 1.323 | 0.632 | 1.391 | *2.179* | *0.085* | - |
| 10 | - | - | - | - | - | *2.014* | 1.281 | 0.633 | 1.440 | *2.148* | *0.059* | - |
| 11 | - | - | - | - | - | *3.029* | 1.227 | 0.697 | 1.490 | *2.097* | *0.042* | - |
| 12 | - | - | - | - | - | 3.029 | 1.145 | 0.674 | 1.503 | *2.006* | *0.029* | - |
| 13 | - | - | - | - | - | 3.163 | 1.091 | 0.641 | 1.526 | *2.093* | *0.020* | - |
| 14 | - | - | - | - | - | 3.287 | 1.072 | 0.632 | 1.534 | *2.001* | *0.014* | - |
| 15 | - | - | - | - | - | 3.300 | 1.059 | 0.620 | 1.587 | *2.056* | *0.010* | - |
| 16 | - | - | - | - | - | 3.304 | 1.073 | 0.612 | 1.636 | *2.170* | *0.007* | - |
| 17 | - | - | - | - | - | 3.305 | 1.048 | 0.601 | 1.605 | *2.303* | *0.005* | - |
| 18 | - | - | - | - | - | 3.208 | 0.933 | 0.616 | 1.582 | *2.157* | *0.010* | - |
| 19 | - | - | - | - | - | 3.000 | 0.927 | 0.649 | 1.544 | *2.157* | - | - |
| 20 | - | - | - | - | - | 2.798 | 0.950 | 0.613 | 1.509 | *2.042* | - | - |
| 21 | - | - | - | - | - | 2.635 | 0.928 | 0.579 | 1.488 | *1.933* | - | - |
| 22 | - | - | - | - | - | 2.425 | 0.900 | 0.562 | 1.477 | *1.873* | - | - |
| 23 | - | - | - | - | - | 2.253 | 0.870 | 0.541 | 1.657 | *1.841* | - | - |
| 24 | - | - | - | - | - | 2.156 | 0.876 | 0.526 | 1.874 | *1.805* | - | - |
| 25 | - | - | - | - | - | 2.102 | 0.890 | 0.511 | 1.850 | *1.768* | - | - |
| 26 | - | - | - | - | - | 2.045 | 0.855 | 0.523 | 1.870 | *1.768* | - | - |
| 27 | - | - | - | - | - | 1.989 | 0.845 | 0.742 | 1.885 | *1.686* | - | - |
| 28 | - | - | - | - | *0.010* | 1.912 | 0.846 | 0.901 | 1.965 | *1.572* | - | - |
| 29 | - | | - | - | *0.015* | 1.838 | 0.851 | 0.919 | 1.972 | *1.577* | - | - |
| 30 | - | | - | - | *0.023* | 1.781 | 0.824 | 0.949 | *1.997* | *1.567* | - | - |
| 31 | - | | - | | *0.034* | | 0.792 | 0.977 | | *1.513* | | - |
| **Mean** | - | - | - | - | 0.020 | 1.949 | 1.125 | 0.679 | 1.514 | 1.953 | 0.285 | - |
| **Max** | 0.000 | 0.000 | 0.000 | 0.000 | 0.034 | 3.305 | 1.726 | 0.977 | 1.997 | 2.303 | 1.462 | 0.000 |
| **Min** | 0.000 | 0.000 | 0.000 | 0.000 | 0.010 | 0.051 | 0.792 | 0.511 | 0.985 | 1.513 | 0.005 | 0.000 |

*Notes:*

*Estimated and modelled values are italicized.*

*Values in red denote high uncertainty based on extrapolation of the rating curve beyond 2 times the greatest measured discharge.*

# APPENDIX E HISTORICAL LAKE LEVEL COMPARISON GRAPHS

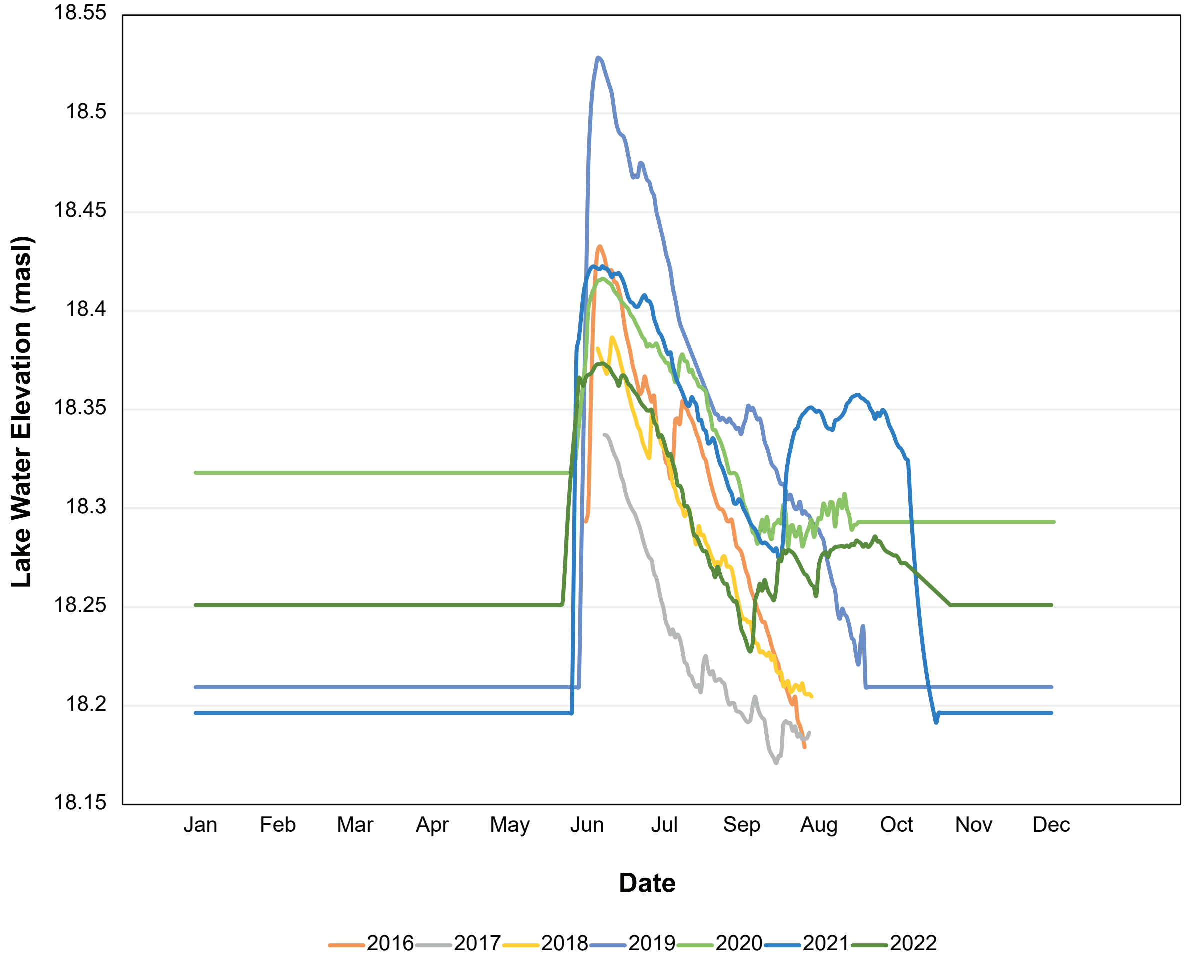



**Figure E1: Historical Mean Daily Lake Level for Monitoring Station Windy Outflow**

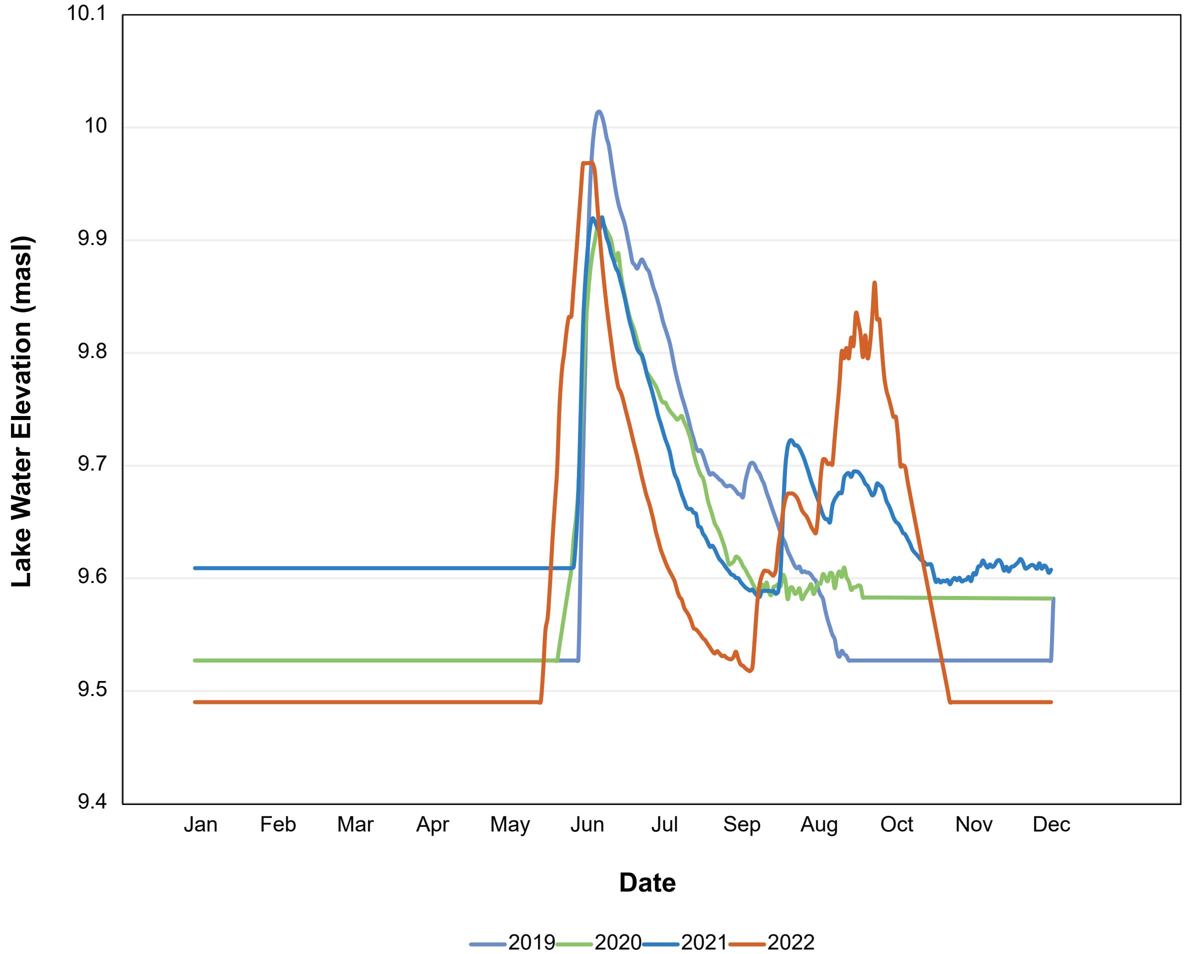



**Figure E2: Historical Mean Daily Lake Level for Monitoring Station Glenn Lake**

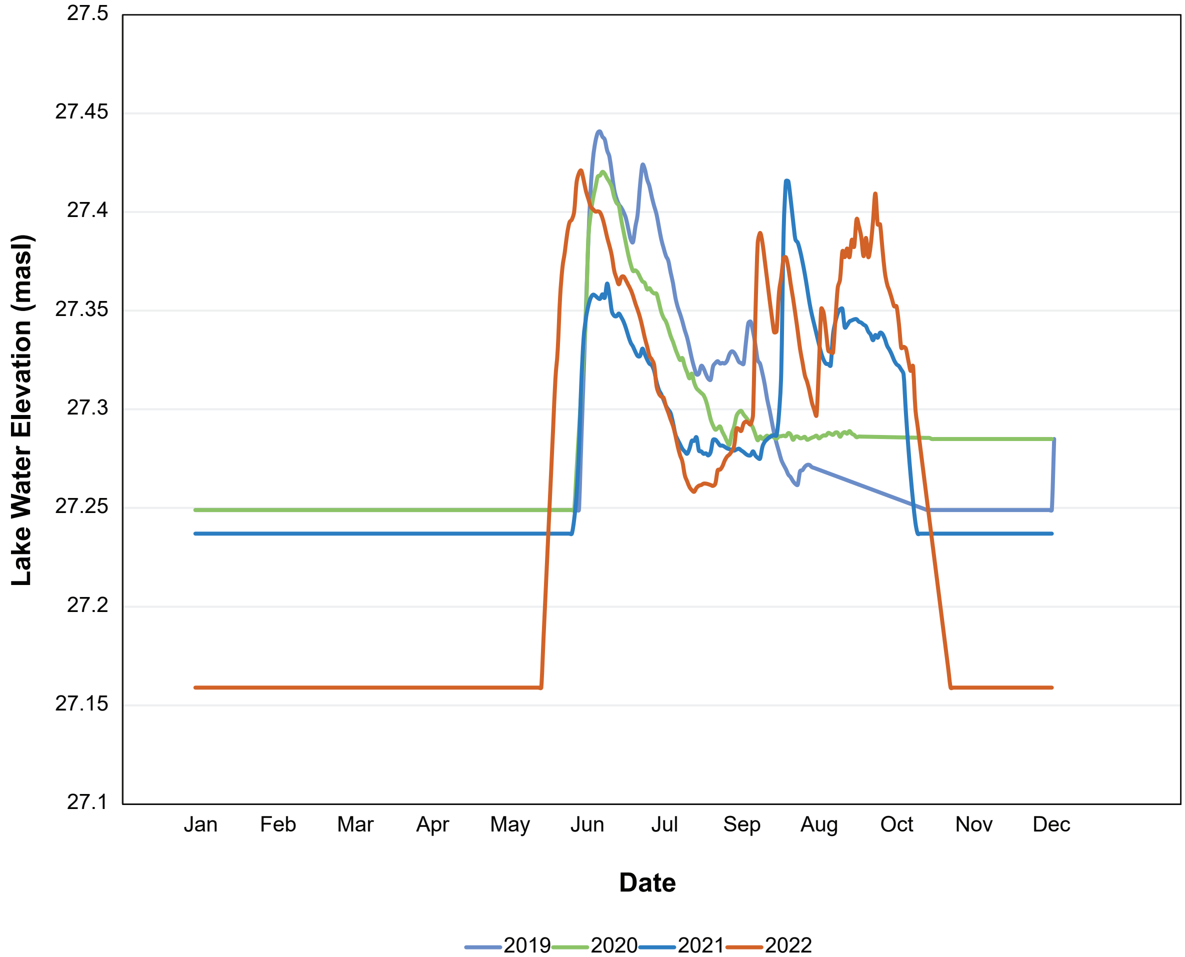



**Figure E3: Historical Mean Daily Lake Level for Monitoring Station Imniagut Lake**

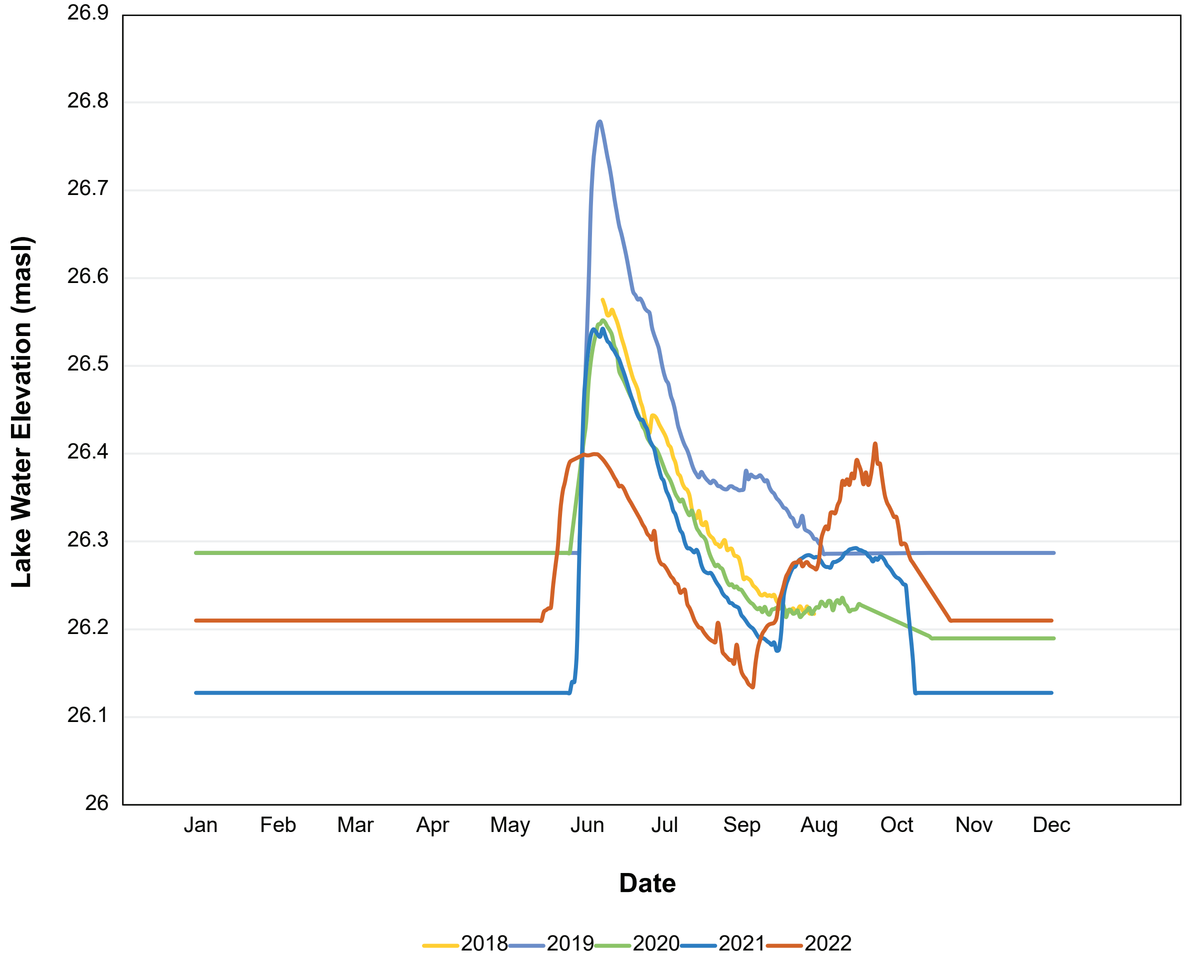



**Figure E4: Historical Mean Daily Lake Level for Monitoring Station Patch Outflow**

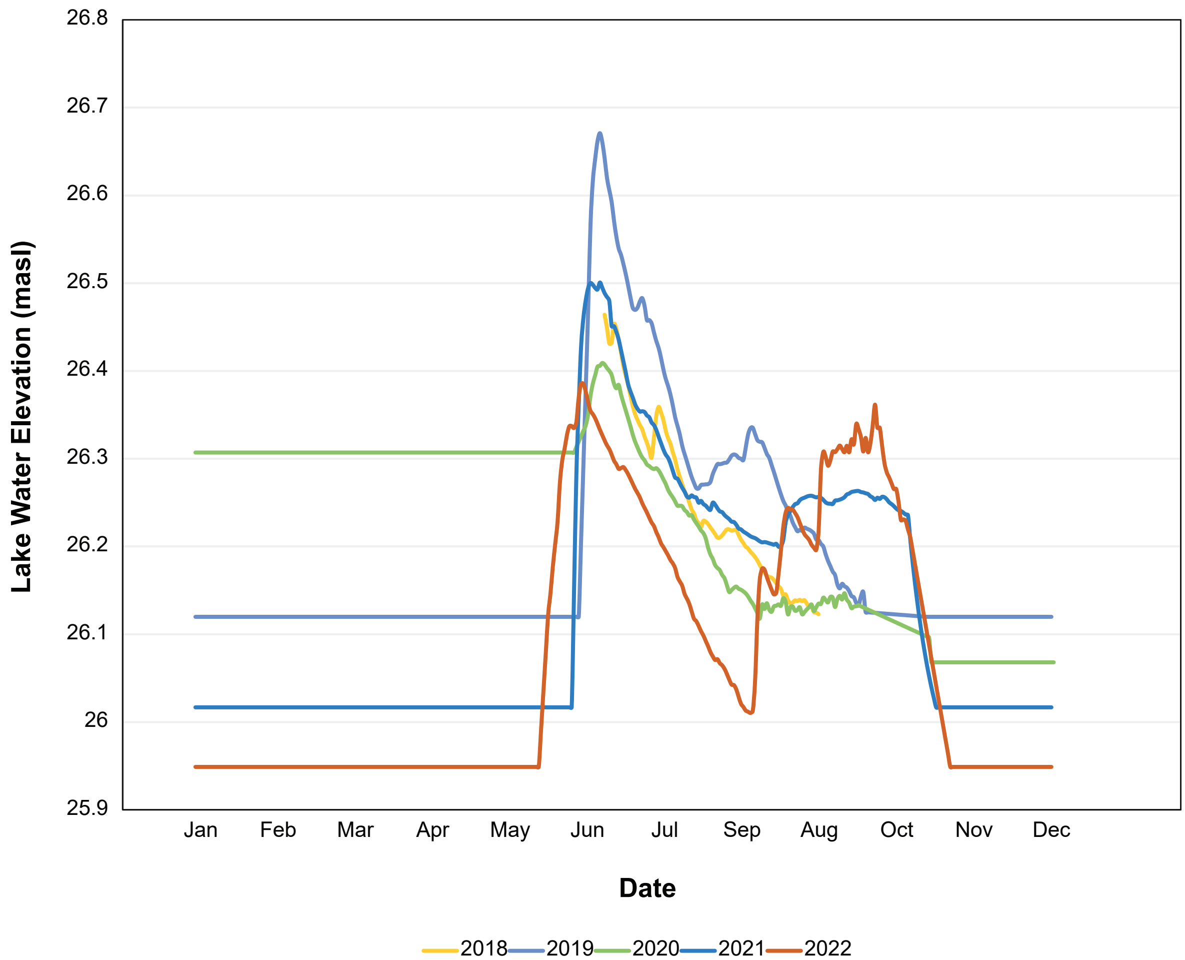



**Figure E5: Historical Mean Daily Lake Level for Monitoring Station PO Outflow**

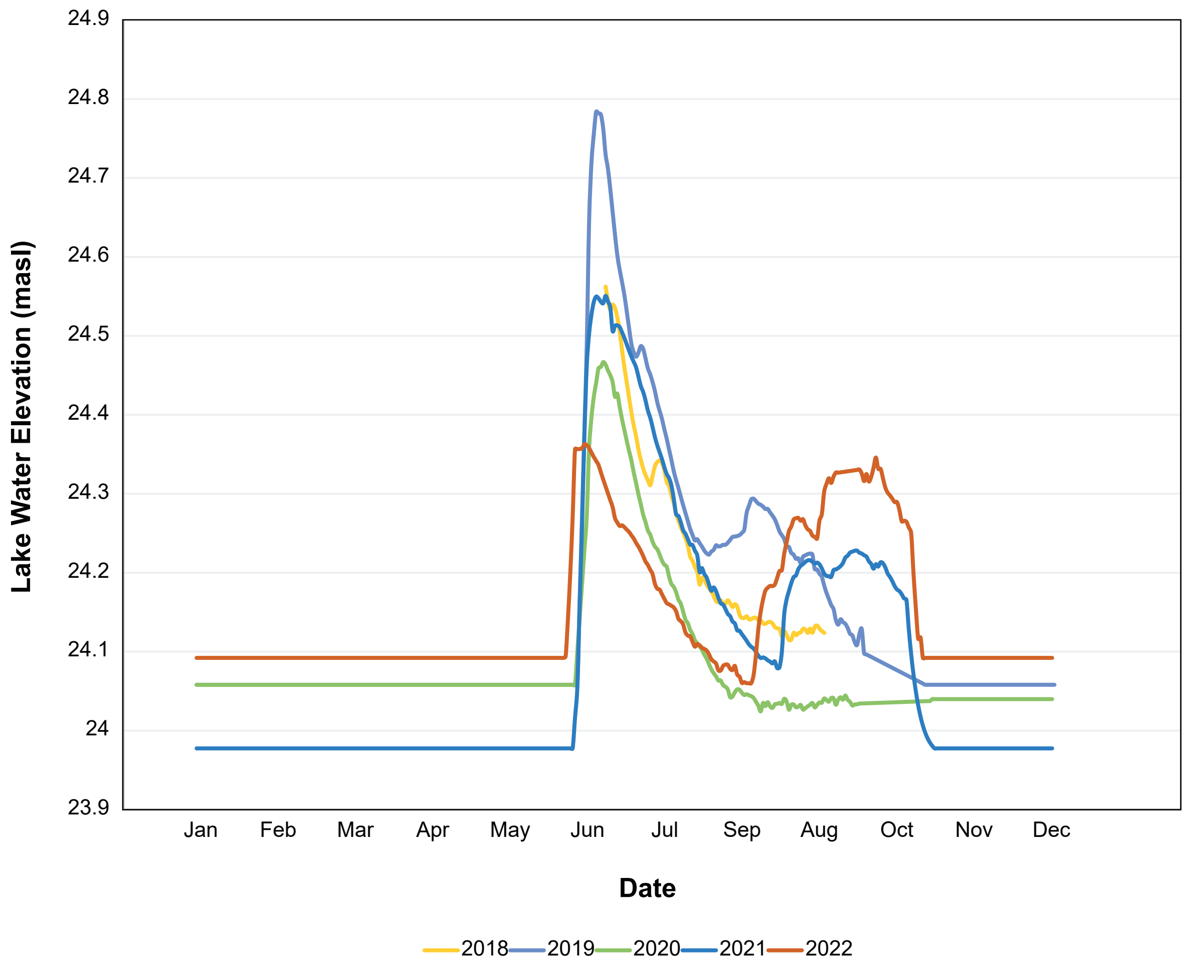



**Figure E6: Historical Mean Daily Lake Level for Monitoring Station Ogama Outflow**

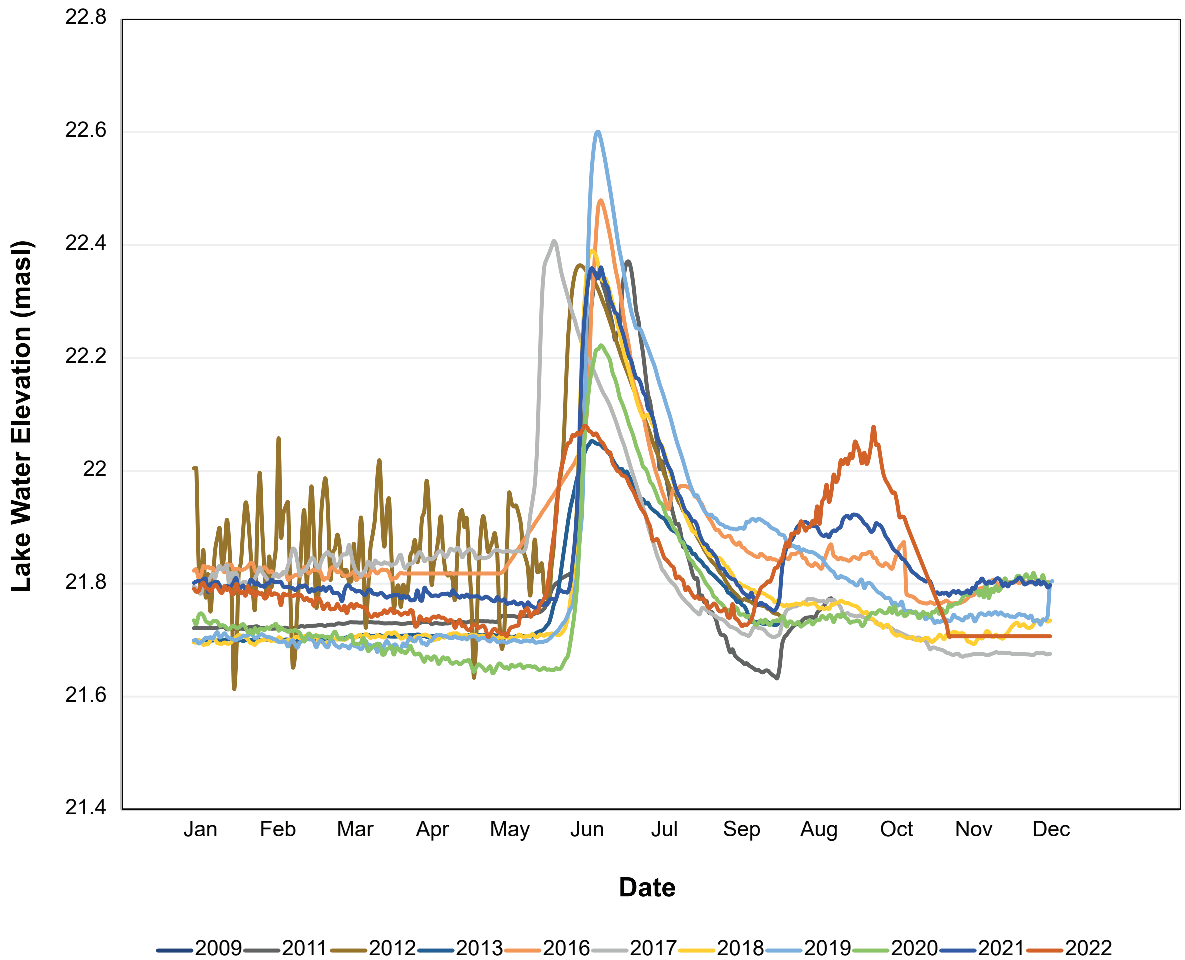



**Figure E7: Historical Mean Daily Lake Level for Monitoring Station Doris Lake**

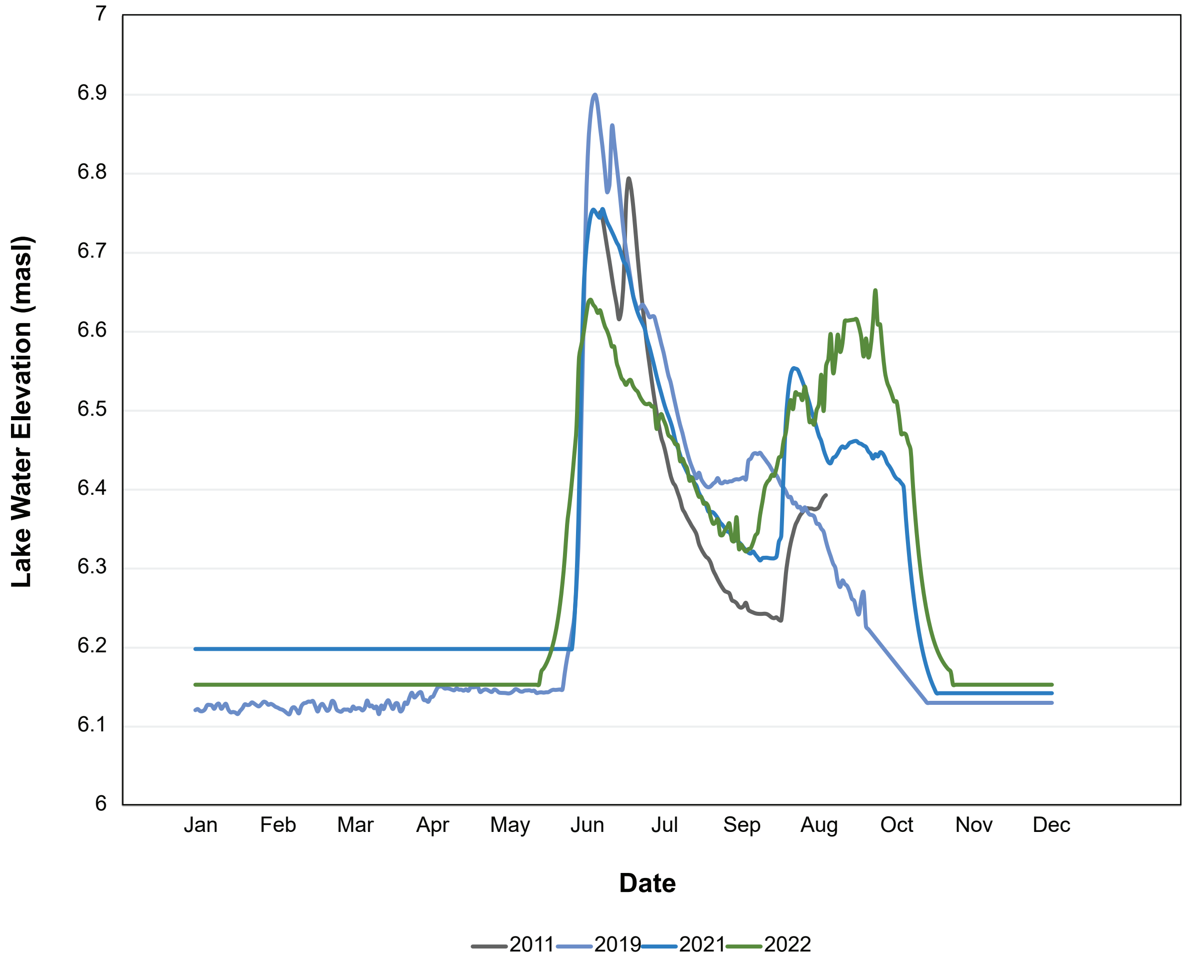



**Figure E8: Historical Mean Daily Lake Level for Monitoring Station Roberts Hydro-2**

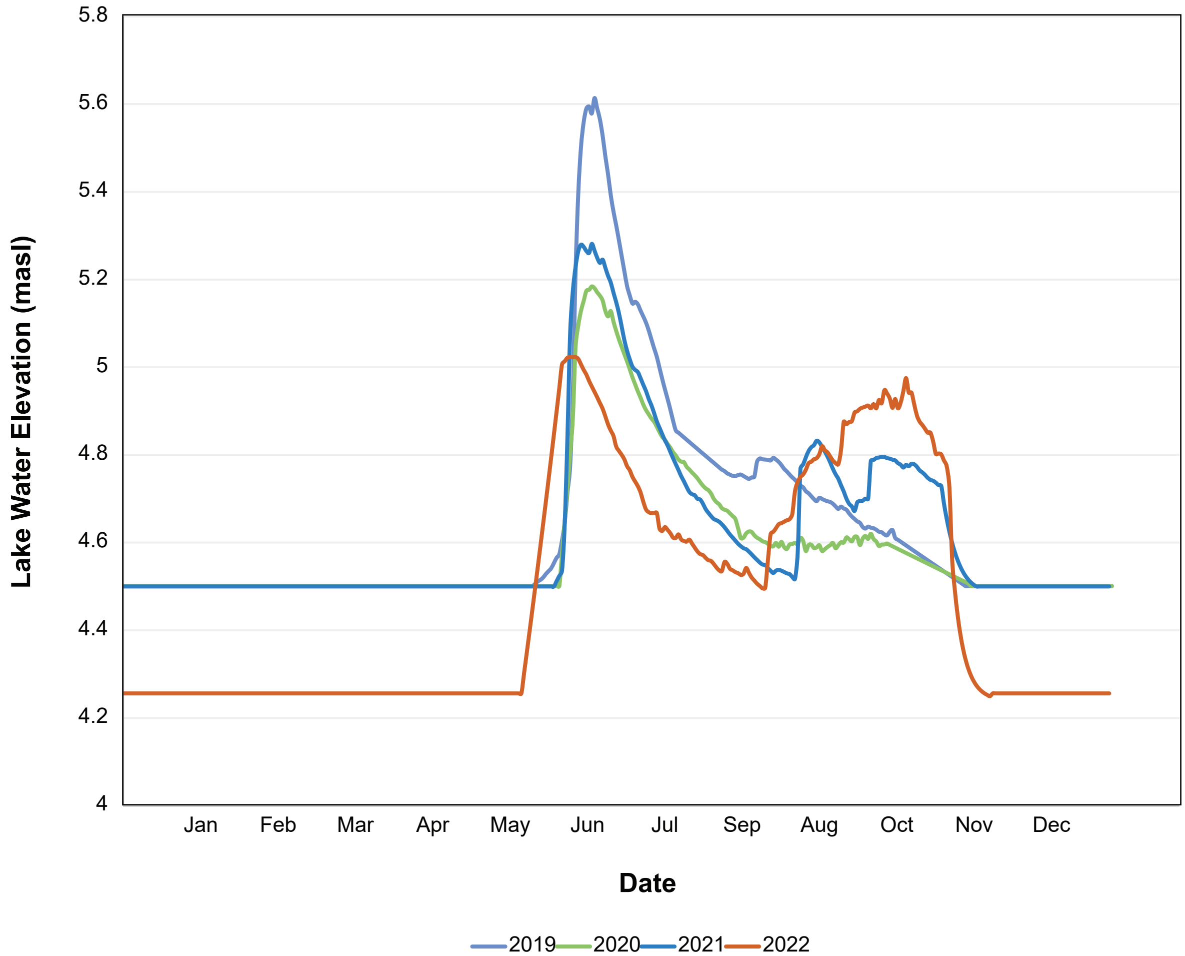



**Figure E9: Historical Mean Daily Lake Level for Monitoring Station Little Roberts Outflow**

# APPENDIX F HISTORICAL MEAN DAILY DISCHARGE COMPARISON GRAPHS

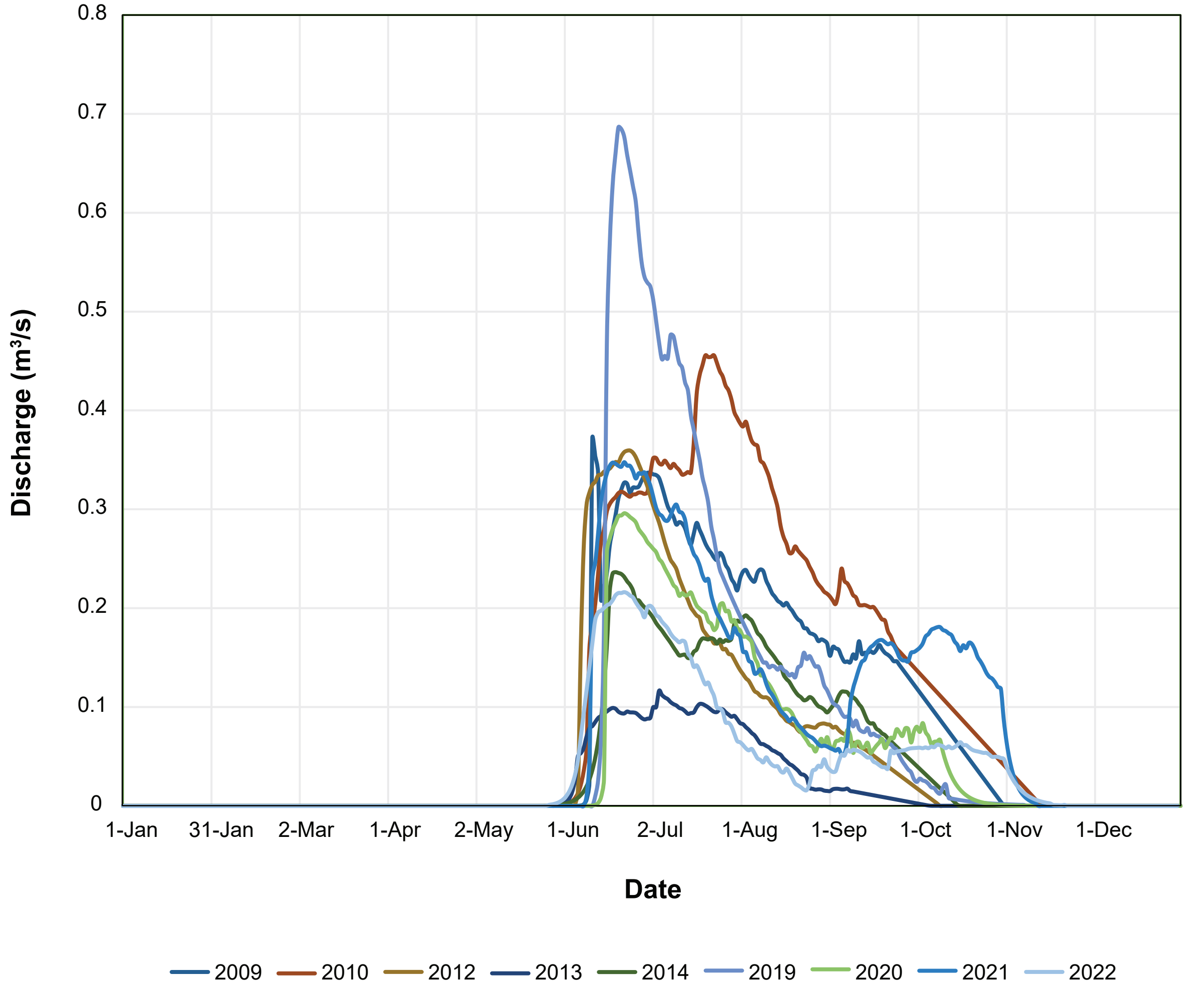
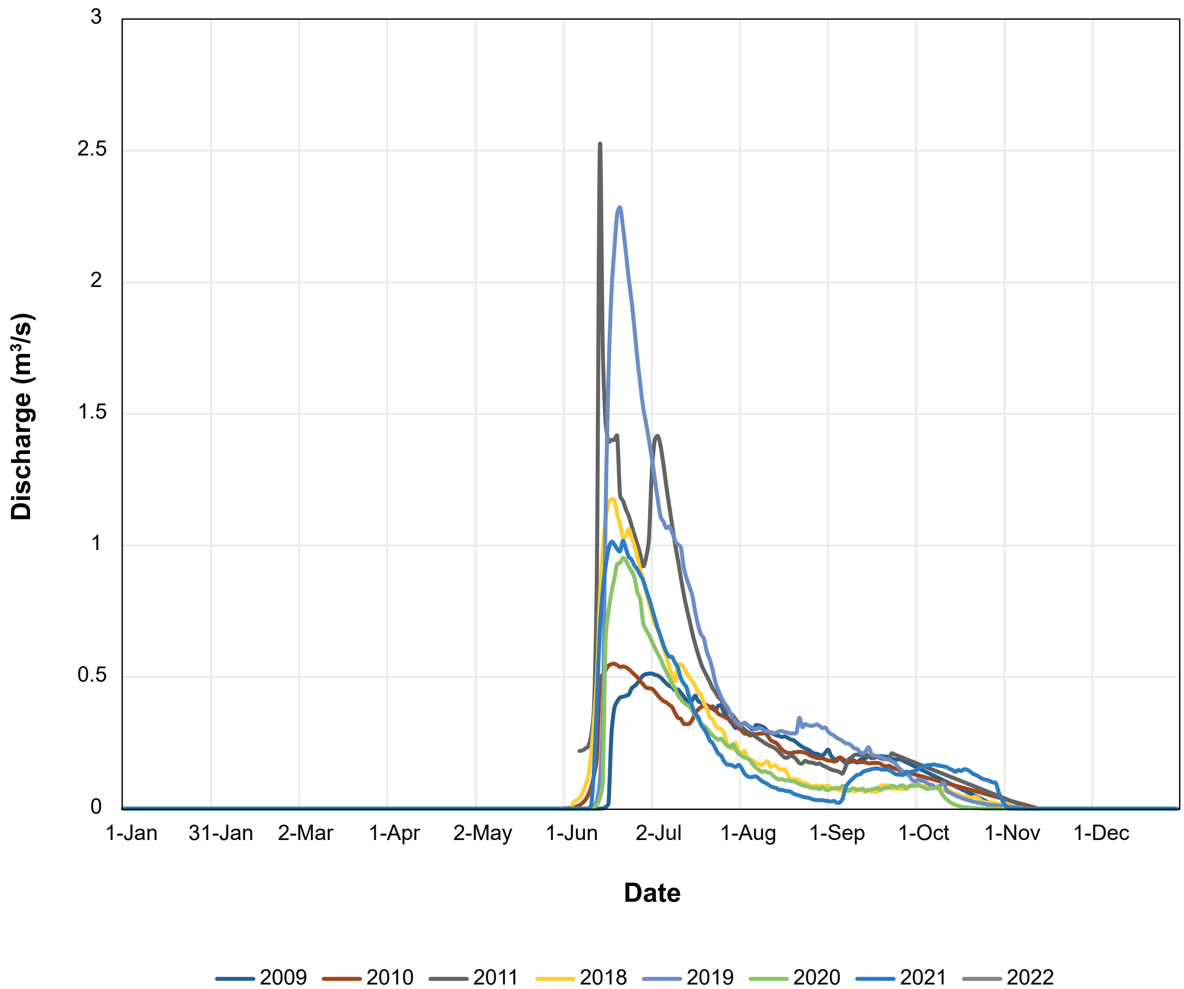



**Figure F1: Historical Mean Daily Discharge for Monitoring Station Windy Outflow**




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

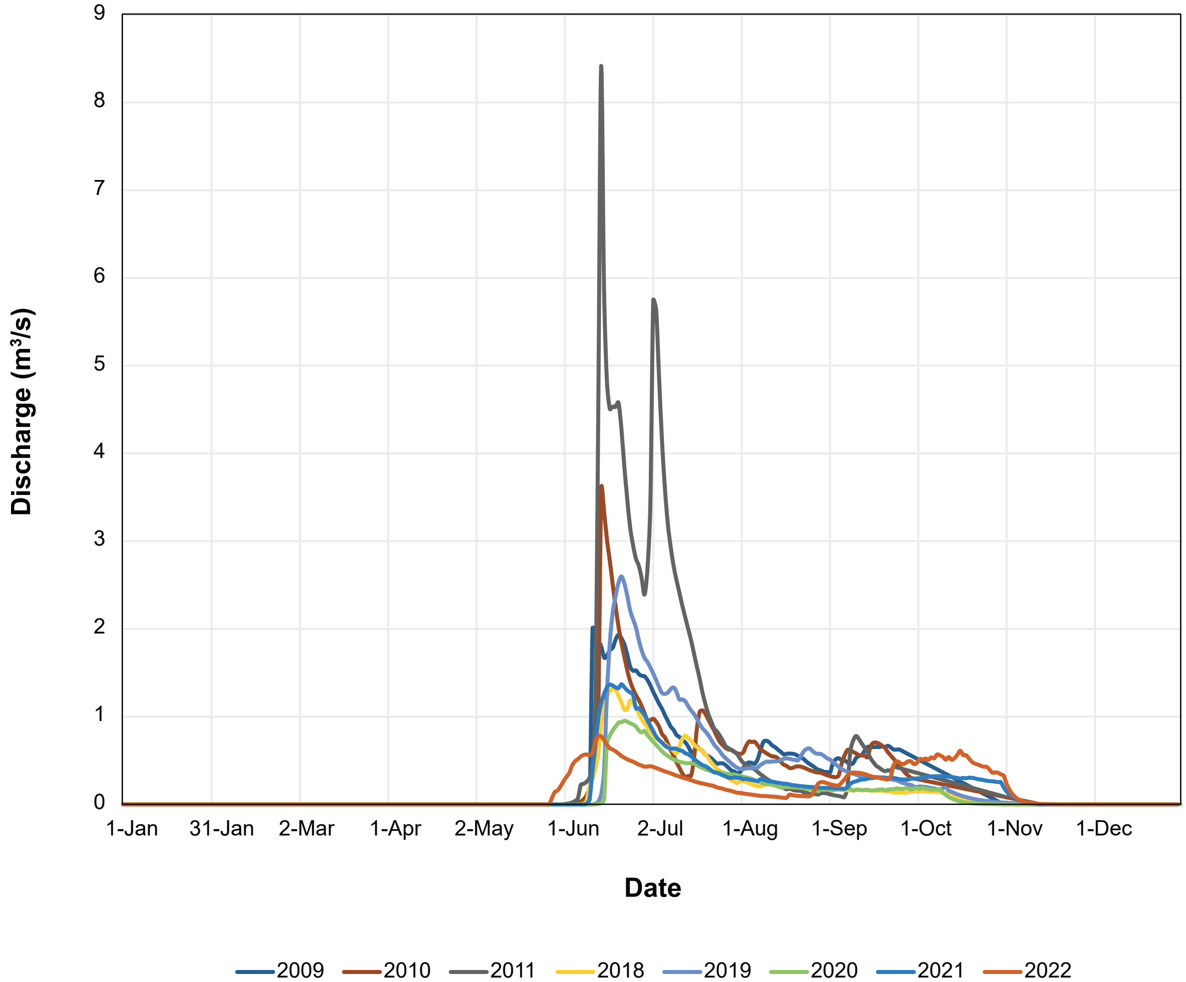



**Figure F3: Historical Mean Daily Discharge for Monitoring Station PO Outflow**

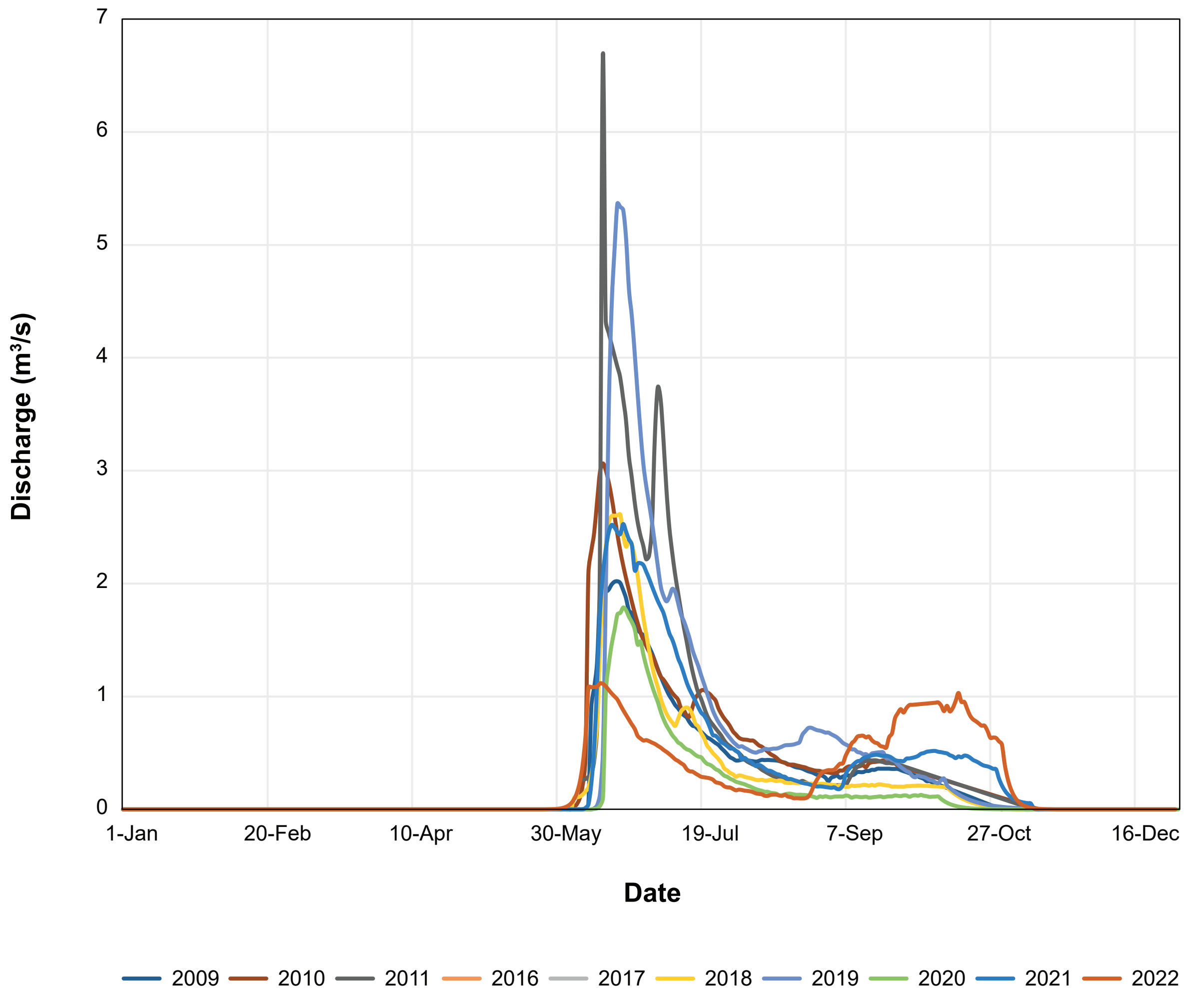



**Figure F4: Historical Mean Daily Discharge for Monitoring Station Ogama Outflow**

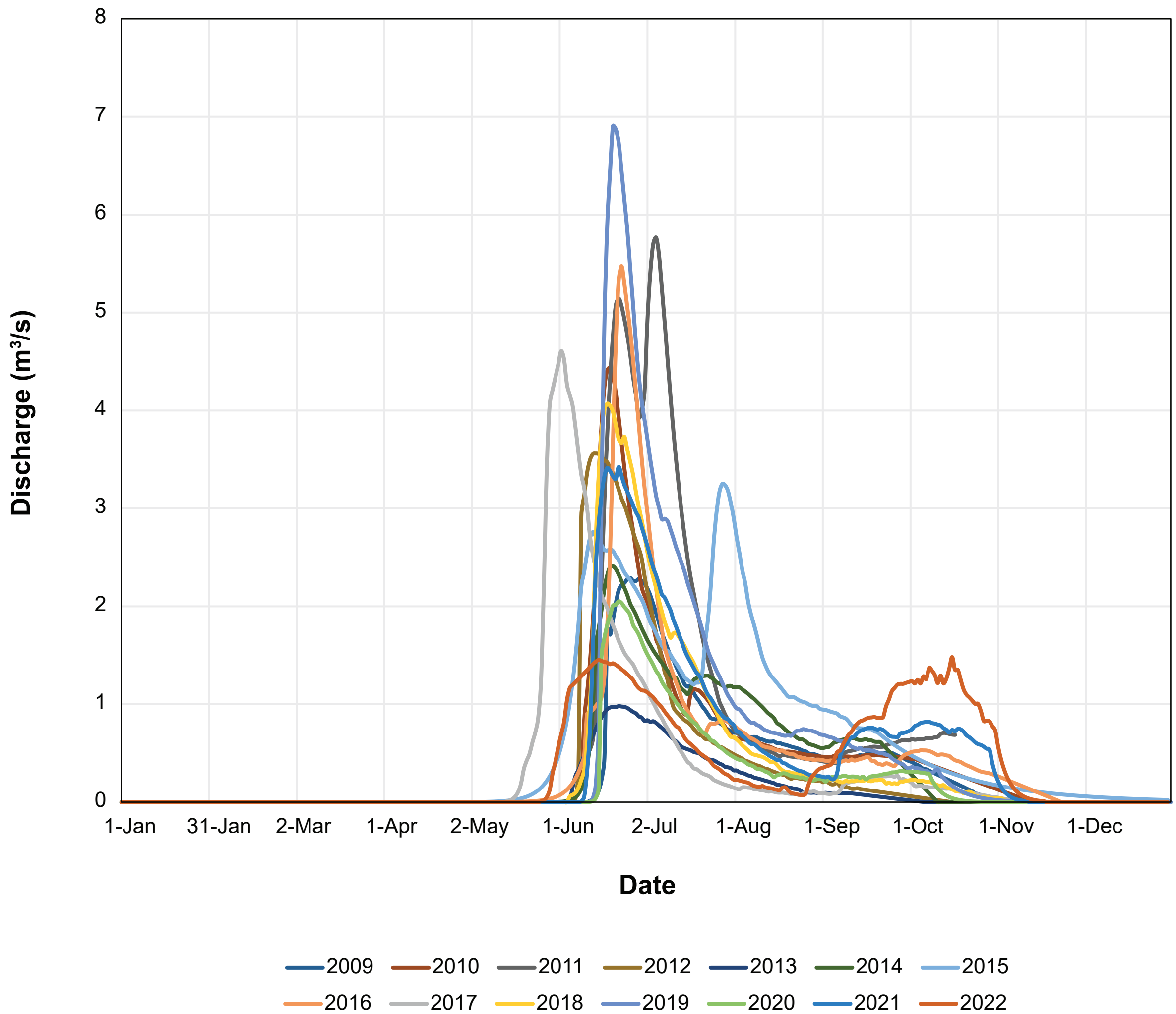



**Figure F5: Historical Mean Daily Discharge for Monitoring Station Doris Creek TL-2**

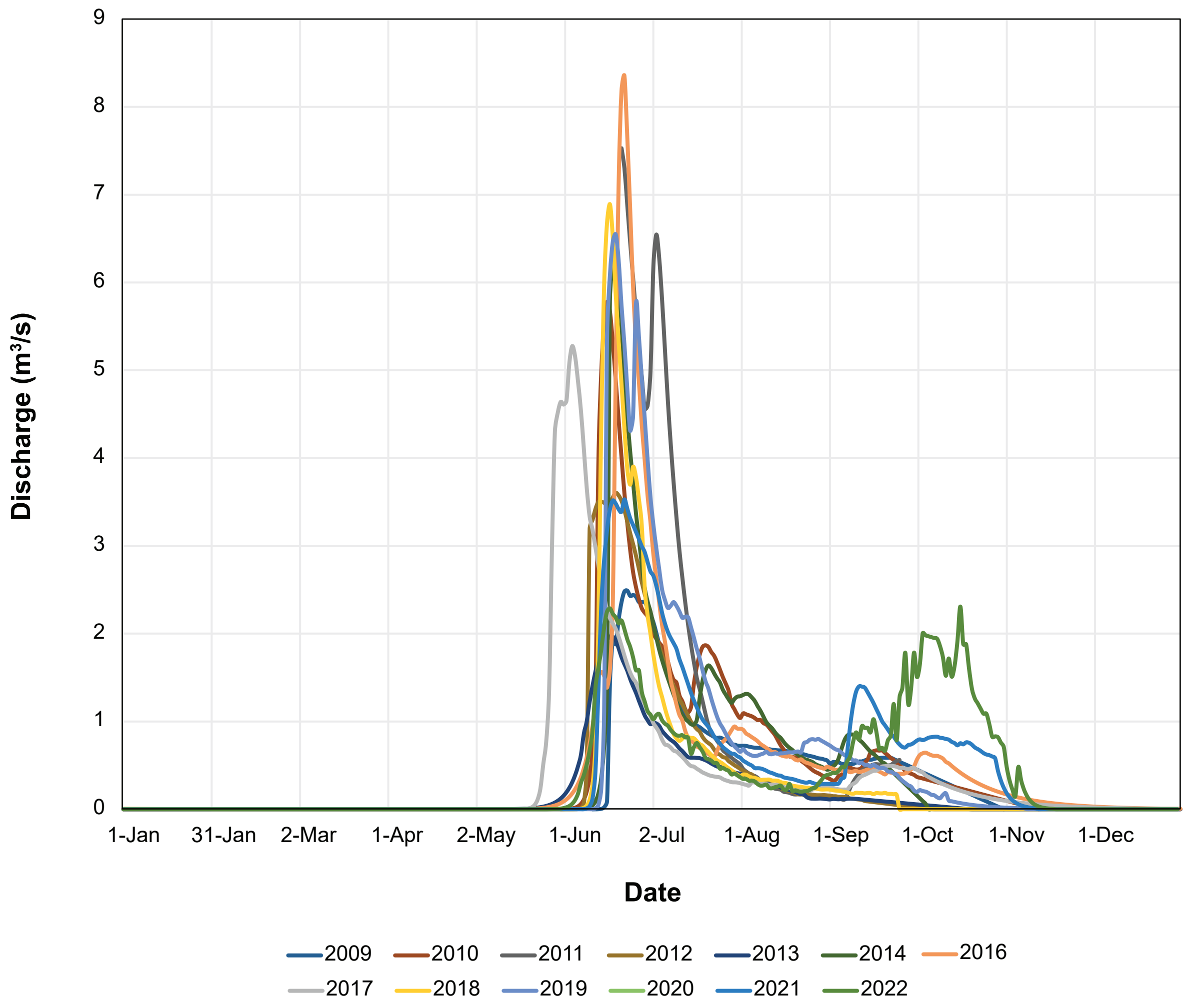



**Figure F6: Historical Mean Daily Discharge for Monitoring Station Roberts Hydro-2**

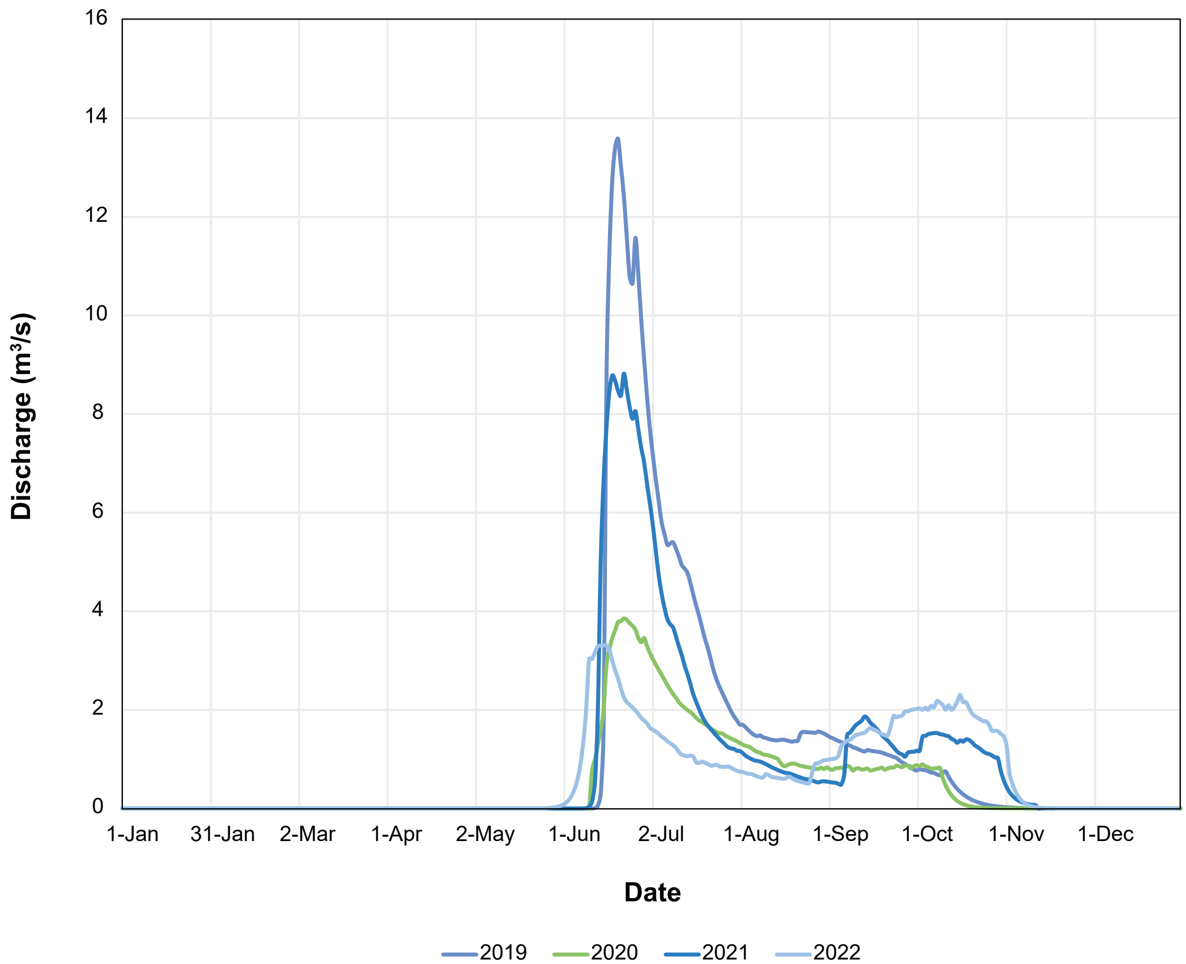



**Figure F7: Historical Mean Daily Discharge for Monitoring Station Little Roberts Outflow**

# APPENDIX C 2022 EVALUATION OF EFFECTS SUPPORTING INFORMATION

March 2023

# HOPE BAY PROJECT

2022 Aquatic Effects Monitoring Program Report

## Appendix C: 2022 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: 2022 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 data collected at the AEMP lake sites, as well as the rationale for the exclusion of certain historical data from the 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 2022 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 2022 AEMP sampling locations.

### *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 2022 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 2022 AEMP sampling locations and sampling methods.

### *C.1.3 Sediment Quality*

Table C.1-3 presents a summary of the historical sediment quality data collected at AEMP lake sites, and the rationale for the exclusion of certain historical data from the 2022 evaluation of effects. The selection of historical data to include in the sediment quality evaluation of effects was mainly based on the comparability of the depth strata sampled between historical and 2022 samples, and the proximity of historical sampling sites to the 2022 sites.

### *C.1.4 Phytoplankton Biomass*

Table C.1-4 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 2022 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 2022 AEMP sampling sites, the timing of sample collection, and comparability of sampling methods.

### *C.1.5 Benthic Invertebrates*

Table C.1-5 presents a summary of the historical benthic invertebrate data collected at AEMP lake sites, and the rationale for the exclusion of certain historical data from the 2022 evaluation of effects. The selection of historical data to include in the benthic invertebrates (benthos) evaluation of effects was mainly based on the comparability of the depth strata sampled between historical and 2022 samples, the proximity of historical sampling sites to the 2022 sites, and the similarity of sampling techniques (e.g., single grab samples vs. composite samples).

Benthos data have been collected since 1996 in the Project area. However, all of the historical data collected from 1996 to 2008 were excluded from the benthos analyses because sampling locations in the study lakes differed from locations sampled from 2009 to 2019, or because of differences in sampling depths since benthos density and assemblage can vary greatly with depth and location within the lake. The current AEMP benthos sampling depths are approximately 13 to 15 m in Doris Lake, 8 to 9 m in Patch Lake, and 10 to 11 m in Reference Lake B. Benthos data from 2009 collected in Patch and Doris lakes were similar to the current AEMP sampling locations both spatially and in terms of depth; however, 2009 benthos sampling methods differed from the methods used from 2010 to 2019. In 2009, benthos sampling consisted of collecting three discrete replicates per site with no composite sampling, while the sampling procedure that has been followed since 2010 consists of collecting three discrete samples and subsequently pooling these three subsamples to make up a composite replicate sample, and collecting a total of five composite replicates per site. To make 2009 data more comparable to data collected since 2010 (since the pooling of subsamples affects sample variability, as well as diversity components such as richness and evenness), the 2009 data were re-analyzed by manually pooling the three replicates to obtain a single composite replicate sample comparable to each of the five replicates collected during sampling efforts since 2010.

**Table C.1-1: Historical Data Selection Rationale for Temperature and Dissolved Oxygen Evaluation of Effects, Hope Bay Project, 2022**

| Lake | Years Sampled | Months Sampled | Data Included in Graphs and Analyses | Data Excluded from Graphs and Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| Doris | 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. |
| | 2003 | July, August, September | August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. |
| | 2004 | June, July, August, September | June and August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. |
| | 2005 | July, August, September | August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. |
| | 2006, 2007, 2008 | May, July, August, September | May and August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months 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. |
| | 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. Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. |
| | 2017, 2018 | April, July, August, September | April and August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. |
| | 2019 to 2022 | April, August | All | None | |
| Patch | 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 | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months 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 to 2022 | April, August | All | None | |

| Lake | Years Sampled | Months Sampled | Data Included in Graphs and Analyses | Data Excluded from Graphs and Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| Windy | 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 | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded.. Note: April data were estimated from plots of the profiles. |
| | 1998 | April | All | None | |
| | 2006 | June, July, August, September | June and August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. |
| | 2007, 2008 | May, July, August, September | May and August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. |
| | 2009, 2010, 2017 to 2020 | April, August | All | None | |
| Reference 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 | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded. Excluded data collected from April (and July) as these were collected from northeastern end of the lake. |
| | 2011 to 2018 | April, July, August, September | April and August data | July and September data | Currently, profiles for the open-water season are collected in August, so historical data collected in August were included and data from other months were excluded.. |
| | 2019 to 2022 | April, August | All | None | |

**Table C.1-2: Historical Data Selection Rationale for Water Quality Evaluation of Effects, Hope Bay Project, 2022**

| Lake | Years Sampled | Months Sampled | Data Included in Graphs and Statistical Analyses | Data Excluded from Graphs and Statistical Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| Doris | 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 | |

| Lake | Years Sampled | Months Sampled | Data Included in Graphs and Statistical Analyses | Data Excluded from Graphs and Statistical Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| | 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. |
| | 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, 2018 | April, July, August, September | All | None | |
| | 2019 to 2022 | April, August | All | None | |
| Patch | 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 to 2022 | April, August | All | None | |
| Windy | 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 to 2022 | April, August | All | None | . |
| Reference 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 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. |
| | 2011 to 2018 | April, July, August, September | All | None | |
| | 2019 to 2022 | April, August | All | None | |

### Table C.1-3: Historical Data Selection Rationale for Sediment Quality Evaluation of Effects, Hope Bay Project, 2022

| Lake | Years Sampled | Month Sampled | Data Included in Historical Graphs and Statistical Analyses | Data Excluded from Historical Graphs and Statistical Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| Doris | 1996 | 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 | July | None | All | Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake. |
| | 2009 | August | Data from deep site at northern end of lake | Data from shallow sites and sites at southern end of lake | Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake; excluded shallow sites (<5 m) as the current AEMP site is deep (>10 m). |
| | 2010 to 2016 | 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. |
| | 2017, 2019, 2022 | August | All | None | |
| Patch | 1996 | August | None | All | Excluded deep sites (>10 m) as the current AEMP site is a mid-depth site (5 to 10 m). |
| | 1997 | July | None | All | Excluded shallow sites (< 5m) as the current AEMP site is a mid-depth site (5 to 10 m). |
| | 2007 | August | None | All | Excluded deep and shallow sites as the current AEMP site is a mid-depth site (5 to 10 m); excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake. |
| | 2009 | August | Data from mid-depth site at northern end of lake | Data from shallow sites and sites at southern end of lake | Excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake; excluded shallow and deep sites as the current AEMP site is a mid-depth site (5 to 10 m). |
| | 2010 | August | None | All | Excluded shallow sites and sites at the southern end of the lake as the current AEMP site is a mid-depth site (5 to 10 m) at the northern end of the lake. |
| | 2017 to 2019, 2022 | August | All | None | |
| Reference 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; excluded shallow (< 5m) sites as the current AEMP site is a deep site (> 10 m). |
| | 2010 | August | Data from deep site | Data from shallow site | Excluded shallow (< 5m) sites as the current AEMP site is a deep site (> 10 m). |
| | 2011 to 2017, 2019, 2022 | August | All | None | |

### Table C.1-4: Historical Data Selection Rationale for Phytoplankton Biomass Evaluation of Effects, Hope Bay Project, 2022

| Lake | Years Sampled | Months Sampled | Data Included in Historical Graphs and Statistical Analyses | Data Excluded from Historical Graphs and Statistical Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| Doris | 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. |
| | 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 currently collected in the AEMP). |
| | 2006 | September | None | All | Methods not described. Assumed to be a composite sample from throughout euphotic zone. |

| Lake | Years Sampled | Months Sampled | Data Included in Historical Graphs and Statistical Analyses | Data Excluded from Historical Graphs and Statistical Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| | 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 currently collected in the AEMP). |
| | 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; currently only open-water season chlorophyll *a* data included in the evaluation of effects, so excluded historical under-ice data. |
| | 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; currently only open-water season chlorophyll *a* data included in the evaluation of effects, so excluded historical under-ice data. |
| | 2017 to 2022 | August | All | None | |
| Patch | 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. |
| | 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 currently collected in the AEMP). |
| | 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; currently, only open-water season chlorophyll *a* data included in the evaluation of effects, so excluded historical under-ice data. |
| | 2017, 2018 | April, August | August data | April data | Currently, only open-water season chlorophyll *a* data included in the evaluation of effects, so excluded historical under-ice data. |
| | 2019 | August | All | None | |
| | 2020 | August | Sample (n= 1) collected at 1m | Sample collected at deeper depth | Samples collected at bottom depth (5m) are not comparable to discrete surface sample currently collected in the AEMP. |
| | 2021 to 2022 | August | All | None | |
| Reference 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; currently only open-water season chlorophyll *a* data included in the evaluation of effects, so excluded historical under-ice data. |
| | 2011 to 2016 | April, July, August, September | July, August, September data | April data | Currently, only open-water season chlorophyll *a* data included in the evaluation of effects, so excluded historical under-ice data. |
| | 2017 | April, August | August data | April data | Currently, only open-water season chlorophyll *a* data included in the evaluation of effects, so excluded historical under-ice data. |
| | 2018 to 2022 | August | All | None | |

*Note: Phytoplankton biomass is represented as chlorophyll a.*

## Table C.1-5: Historical Data Selection Rationale for Benthic Invertebrate Evaluation of Effects, Hope Bay Project, 2022

| Lake | Years Sampled | Months Sampled | Data Included in Historical Graphs and Statistical Analyses | Data Excluded from Historical Graphs and Statistical Analyses | Rationale for Exclusion |
|---|---|---|---|---|---|
| Doris | 1996 | August | None | All | Excluded data collected from southern end of Doris Lake, as current AEMP sampling site is at northern end of the lake; unlike current AEMP sampling methods, samples consisted of single grabs rather than composite samples. |
| | 1997 | July, August | None | All | Excluded shallow sites (<5 m) and sites at the southern end of the lake as the current AEMP site is a deep site (>10 m) at the northern end of the lake; unlike current AEMP sampling methods, samples consisted of single grabs rather than composite samples. |
| | 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; unlike current AEMP sampling methods, samples consisted of single grabs rather than composite samples. |
| | 2009 | 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; although three discrete replicate samples were collected at each site in 2009, data from the three replicates were pooled to obtain a single composite sample comparable to the replicates in the current AEMP. |
| | 2010 to 2016 | 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. |
| | 2017, 2019, 2022 | August | All | None | |
| Patch | 1996 | August | None | All | Excluded deep sites (>10 m) as current AEMP site is mid-depth site (5 to 10 m); unlike current AEMP sampling methods, samples consisted of single grabs rather than composite samples. |
| | 1997 | July | None | All | Excluded shallow sites (<5 m) as current AEMP site is mid-depth site (5 to 10 m); unlike current AEMP sampling methods, samples consisted of single grabs rather than composite samples. |
| | 2007 | August | None | All | Excluded deep and shallow sites as current AEMP site is mid-depth site (5 to 10 m); excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake; unlike current AEMP sampling methods, samples consisted of single grabs rather than composite samples. |
| | 2009 | August | data collected at mid-depth site in “Patch” sampling location | data collected at shallow sites or in southern end of Patch Lake | Excluded shallow sites as current AEMP site is mid-depth site (5 to 10 m); excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake; although three discrete replicate samples were collected at each site in 2009, data from the three replicates were pooled to obtain a single composite sample comparable to the replicates in the current AEMP. |
| | 2010 | August | None | All | Excluded shallow sites as current AEMP site is mid-depth site (5 to 10 m); excluded data collected from southern end of Patch Lake, as current AEMP sampling site is at northern end of the lake. |
| | 2017 to 2019, 2022 | August | All | None | |
| Reference 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 | August | data from deep site | data from mid-depth site | Excluded data from mid-depth site (5 to 10 m) as current AEMP site is a deep site (>10 m); |
| | 2011 to 2017, 2019, 2022 | August | All | None | |

## C.2 Statistical Methods for Evaluation of Effects

The general statistical methods is described in Sections C.2.1 and C.2.2. Variations in methods specific to each monitoring component and analysis are described in Sections C.2.3 and C.2.4. Computing packages used for current analysis are outlined in C.2.5.

### *C.2.1 Lakes with Greater or Equal to 10 Continuous Years of 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 (i.e., a slope of zero), the 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 and there must be greater than three years of comparable sampling years to conduct the comparison. 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 (2022) 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 were 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 zero 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 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:

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

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

Mathematically, the regression model can be written as:

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

where:

- $E[y_i(x)]$ represents the expected mean value of the variable in lake i in year x;
- $\beta_{0i}$ represents the intercept for lake i;
- $\beta_{ki}$ 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, sediment, and benthos 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 $\varepsilon_x$ and $\varepsilon_{ix}$ 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 $\sigma_x^2$ and $\sigma_{ix}^2$, respectively.

### Assessing Model Fit and Outliers

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

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

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

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

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

### *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 $\sigma^2$.

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 $y_1, ..., y_{n1}$ and $y'_1,....,y'_{n2}$ are available from a given lake in a given year where each $y_i$ is known exactly and each $y'_i$ is censored so that $y'_i$ belongs to the interval ($a_i$, $b_i$). Given these observations, the sample average, $\bar{y}$ , was bounded such that:

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

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 $\Sigma$ 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 Less than 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 (up to and including 2018) to the mean for all after years (2019 to 2022) 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 methods 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 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 three. 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 the equation:

$$y = period \text{ + Year-R +Error-R}$$

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*;
- $\beta_0$ represents the intercept; and
- $\beta_p$ 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 $\beta_0$ is the intercept, $\beta_{sc}$ is the expected difference between reference and exposure site effects, $\beta_p$ 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 $\beta_0$ is the intercept, $\beta_{sc}$ is the expected value for site class *sc*, $\beta_p$ 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 $\alpha = 0.05$, 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 $\alpha$ = 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 Methods – 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. However, depth was not evaluated since its effect is not of primary interest. Season was included in the regression model as an interaction term with lake and time so that separate time trends were estimated for each lake-season group. The regression model for water quality data in lake *i* season *j* was as follows:

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

or mathematically:

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

where:

- $E[y_{ij}(x)]$ represents the expected mean value of the variable in lake i, season j, in year x;
- $\beta_{0ij}$ represents the intercept for lake i in season j;
- $\beta_1$ represents the mean difference between deep and surface samples;
- $\beta_{kij}$ 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 Sediment Quality

Sediment quality data were collected in August around the same depth within a lake. The regression model for sediment quality data in lake *i* was as follows:

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

or mathematically:

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

where:

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

Hypothesis testing for Doris Lake was undertaken as described in Section C.2.1.4.

### C.2.3.3 Phytoplankton Biomass

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

y = Lake + Month + 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;
- $\beta_{0i}$ represents the intercept for lake i;
- $\alpha_m$ represents the mean difference between month m and reference month m*;
- $\beta_{ki}$ 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.2.3.4 Benthic Invertebrates

#### Density

Benthos density data were collected in August and around the same depth within a lake, hence the model forms and hypothesis testing procedures followed those outlined in Section C.2.1.2 and C.2.1.4.

#### Family Richness

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

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

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

where:

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

#### Hypothesis Testing

#### Test 1: Comparison within Exposure Lake

The hypothesis of this test was:

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

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

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

#### Test 2: Comparison against Reference Lake

The hypotheses of this test was:

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

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

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.

#### Family Evenness and Bray-Curtis Index

Benthos family evenness and Bray-Curtis index data were collected in August around the same depth within a lake, hence the model forms and hypothesis testing procedures followed those outlined in Sections C.2.1.2 and C.2.1.4. However, for the regression analyses, instead of modelling the natural log of the variable value, logit transformations were employed as the data were constrained to lie between 0 and 1. The logit transformation maps data in the interval [0, 1] to the real line so that predicted values are restricted to fall in the interval [0, 1].

## C.2.4 Variations in Methods – 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. However, depth was not evaluated since its effect is not of primary interest. 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*;*
- $\beta_0$ represents the intercept*;*
- $\beta_d$ represents the expected value for depth *d*;
- $\beta_{sc}$ 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 Sediment Quality

Sediment data were collected in one season 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.2.4.3 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.2.4.4 Benthic Invertebrates*

**Benthic Invertebrate Density**

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

**Family Diversity and Bray-Curtis Index**

Benthos family diversity and Bray-Curtis index data were collected in one season at one depth, hence the model form and hypothesis testing procedure followed that outlined in section C.2.2.1 and C.2.2.2. However, instead of modelling the natural log of the variable value, logit transformations were employed as the data were constrained to lie between 0 and 1. The logit transformation maps data in the interval [0, 1] to the real line so that predicted values are restricted to fall in the interval [0, 1].

### *C.2.5 Computing*

All steps of the analysis were performed using the statistical computing package R version 4.1.1.
The following versions of packages were used for the analyses:

- dplyr (1.0.10);
- stringr (1.4.0);
- tidyr (1.2.1);
- lubridate (1.8.0);
- ggplot2 (3.4.0);
- knitr (1.39);
- readxl (1.4.0);
- here (1.0.1);
- survival (3.2.11); and
- lme4 (1.1.29).

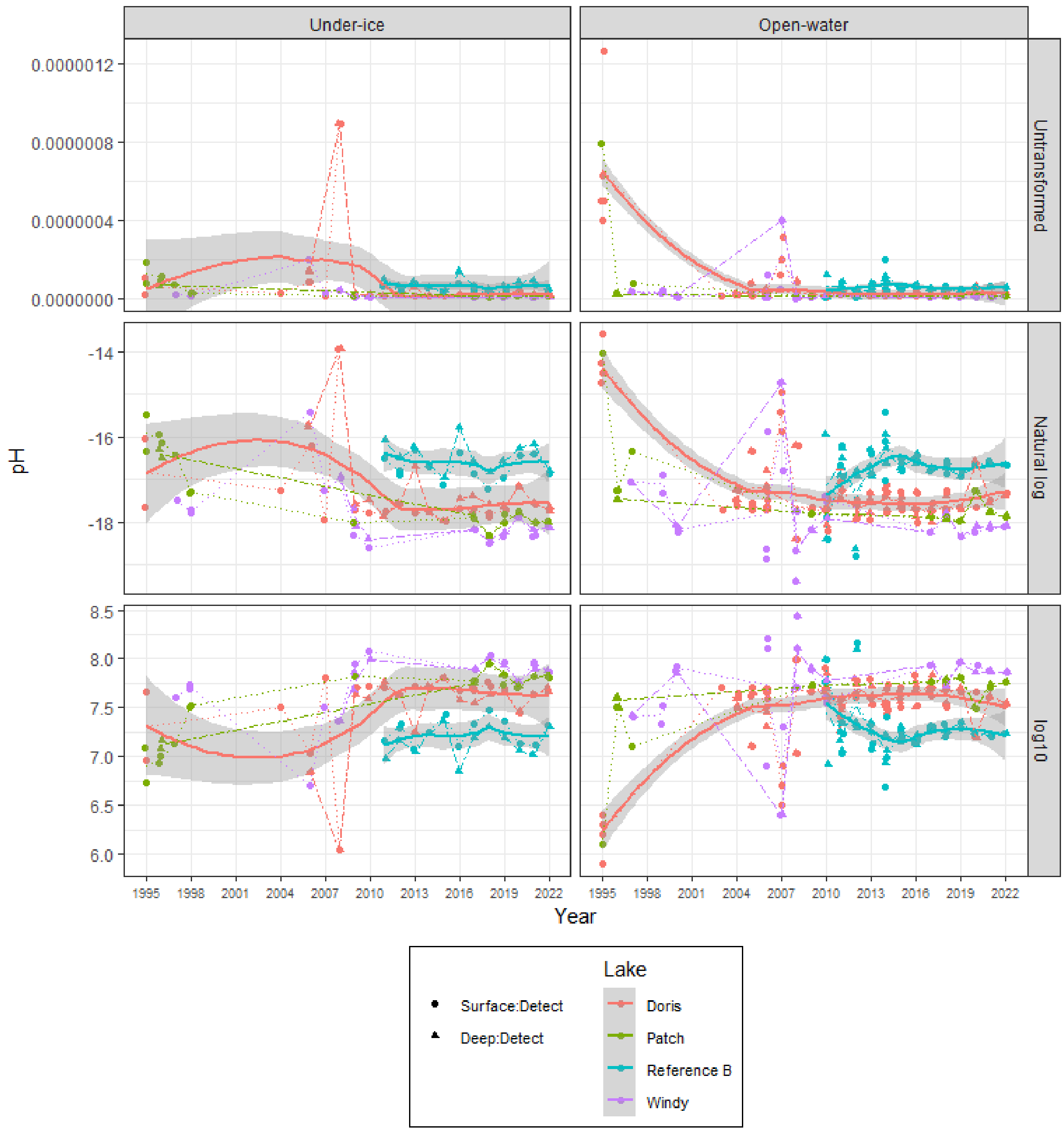
# C.3 Statistical Results for Evaluation of Effects

## *C.3.1 Water Quality*

### *C.3.1.1 pH*

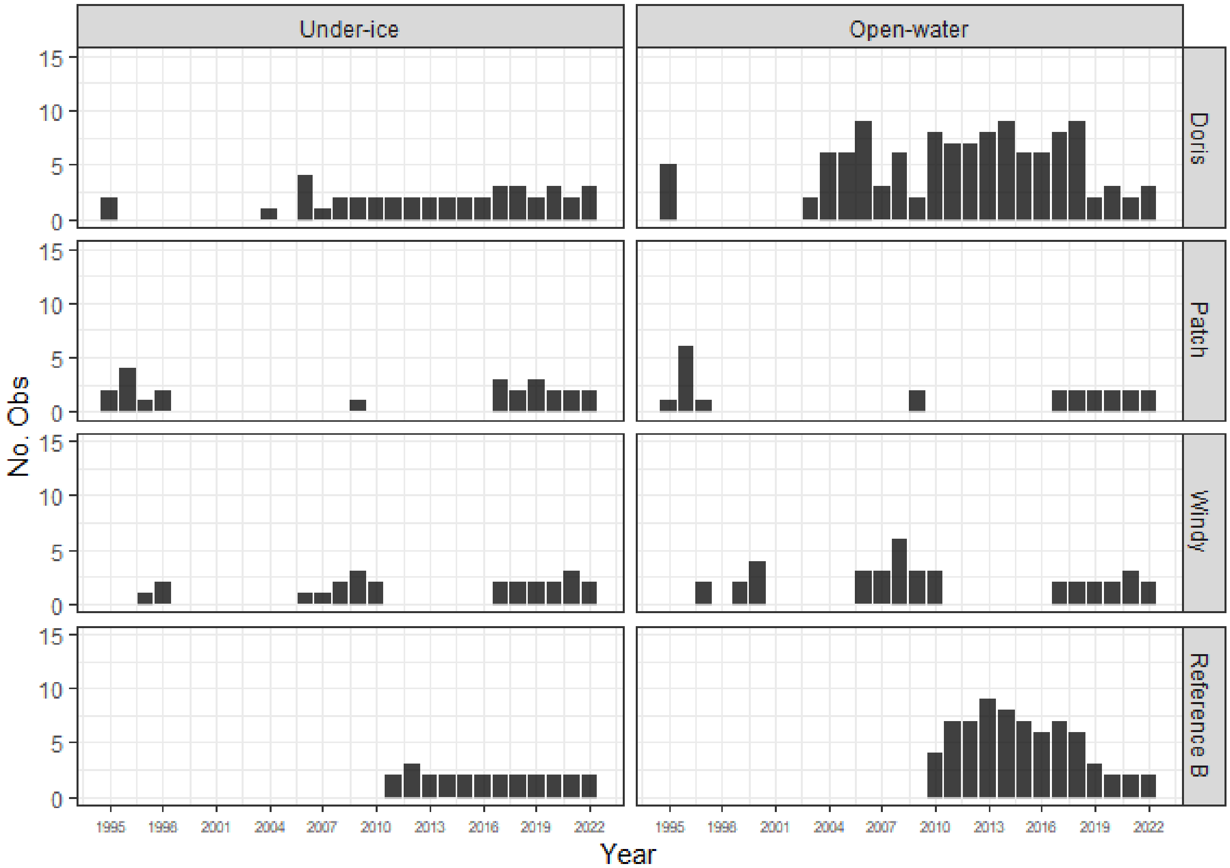
**Observed Data**

The following plots show all the observed data on the untransformed, natural log scale, and log (base 10) scale. For analysis of untransformed and natural log transformed pH, pH values were first converted to the concentration of hydrogen ions ([H+] = 10^{-pH}). For the log (base 10) transformation, raw pH values are presented, since pH = -log10[H+]. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.


Under-ice
Open-water
Untransformed
Natural log
log10
pH
Year
0.0000012
0.0000008
0.0000004
0.0000000
-14
-16
-18
8.5
8.0
7.5
7.0
6.5
6.0
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Lake
Surface:Detect
Deep:Detect
Doris
Patch
Reference B
Windy

## Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

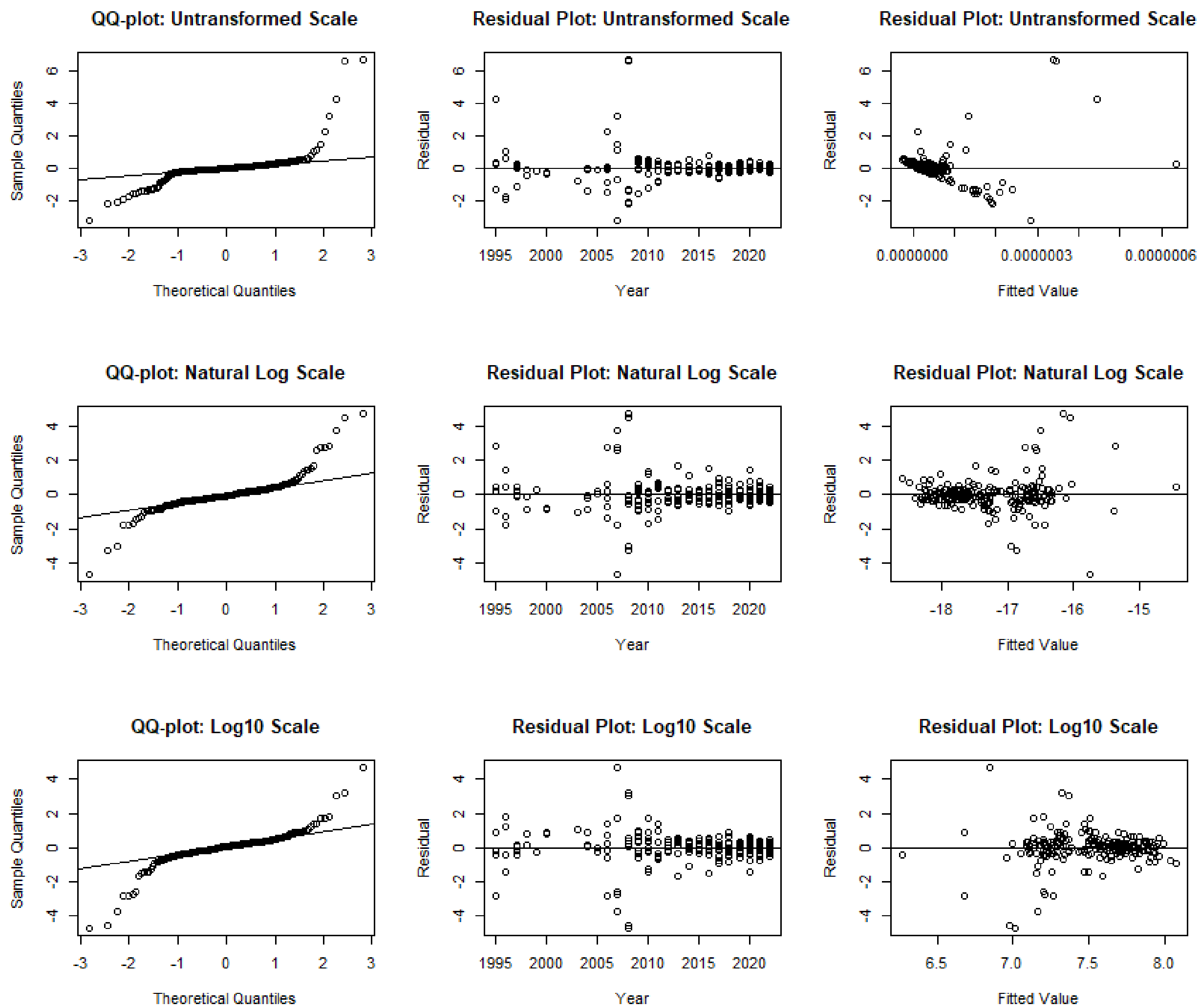
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 42 | 0 | 0 | 0 |
| Doris | Open-water | 117 | 0 | 0 | 0 |
| Patch | Under-ice | 24 | 0 | 0 | 0 |
| Patch | Open-water | 22 | 0 | 0 | 0 |
| Reference B | Under-ice | 25 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 0 | 0 | 0 |
| Windy | Under-ice | 25 | 0 | 0 | 0 |
| Windy | Open-water | 39 | 0 | 0 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

## Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 15 | Doris | 2007 | Under-ice | Surface | 0.0000000 | 0 | -3.277 |
| 18 | Doris | 2008 | Under-ice | Deep | 0.0000009 | 0 | 6.653 |
| 19 | Doris | 2008 | Under-ice | Surface | 0.0000009 | 0 | 6.729 |
| 79 | Patch | 1995 | Open-water | Surface | 0.0000008 | 0 | 4.272 |
| 177 | Windy | 2007 | Open-water | Deep | 0.0000004 | 0 | 3.207 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 15 | Doris | 2007 | Under-ice | Surface | 0.0000000 | -15.753 | -4.696 |
| 18 | Doris | 2008 | Under-ice | Deep | 0.0000009 | -16.057 | 4.523 |
| 19 | Doris | 2008 | Under-ice | Surface | 0.0000009 | -16.155 | 4.733 |
| 177 | Windy | 2007 | Open-water | Deep | 0.0000004 | -16.495 | 3.742 |
| 181 | Windy | 2008 | Open-water | Deep | 0.0000000 | -16.862 | -3.249 |
| 182 | Windy | 2008 | Open-water | Surface | 0.0000000 | -16.960 | -3.040 |

Outliers on log10 scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 15 | Doris | 2007 | Under-ice | Surface | 0.0000000 | 6.841 | 4.696 |
| 18 | Doris | 2008 | Under-ice | Deep | 0.0000009 | 6.973 | -4.523 |
| 19 | Doris | 2008 | Under-ice | Surface | 0.0000009 | 7.016 | -4.733 |
| 177 | Windy | 2007 | Open-water | Deep | 0.0000004 | 7.164 | -3.742 |
| 181 | Windy | 2008 | Open-water | Deep | 0.0000000 | 7.323 | 3.249 |
| 182 | Windy | 2008 | Open-water | Surface | 0.0000000 | 7.366 | 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 zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 18.657 | 4 | 0.00090 | sig. |
| Compare to Reference B | 3.021 | 4 | 0.55420 | not sig. |

Doris Lake appears to show significant deviation from a slope of zero. Doris Lake did not exhibit significant deviation from the trend of Reference Lake B.

#### *Open-water*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 28.196 | 4 | <0.00001 | sig. |
| Compare to Reference B | 8.897 | 4 | 0.06370 | not sig. |

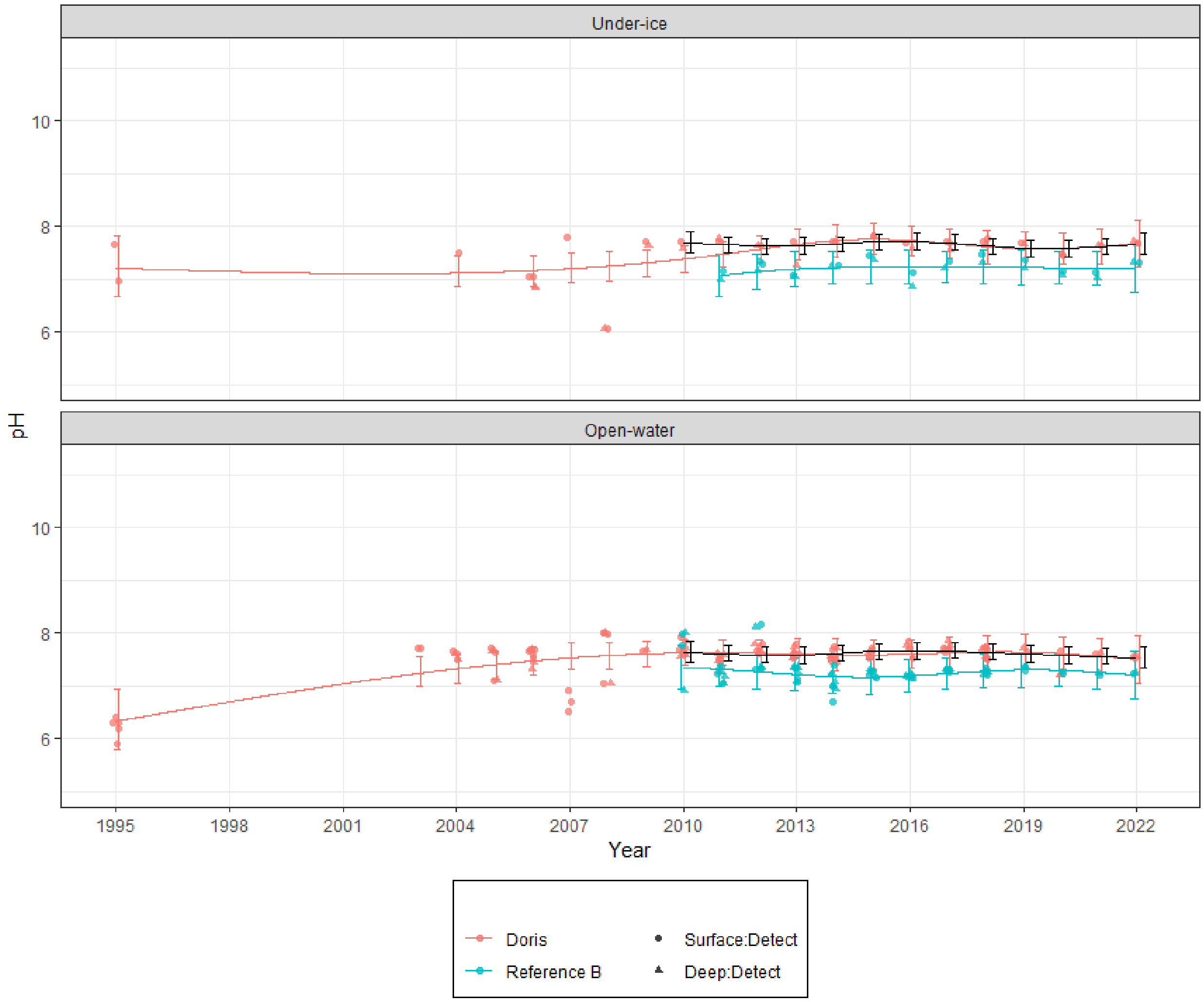
Doris Lake appears to show significant deviation from a slope of zero. Doris Lake did not exhibit significant deviation from the trend of Reference Lake B.

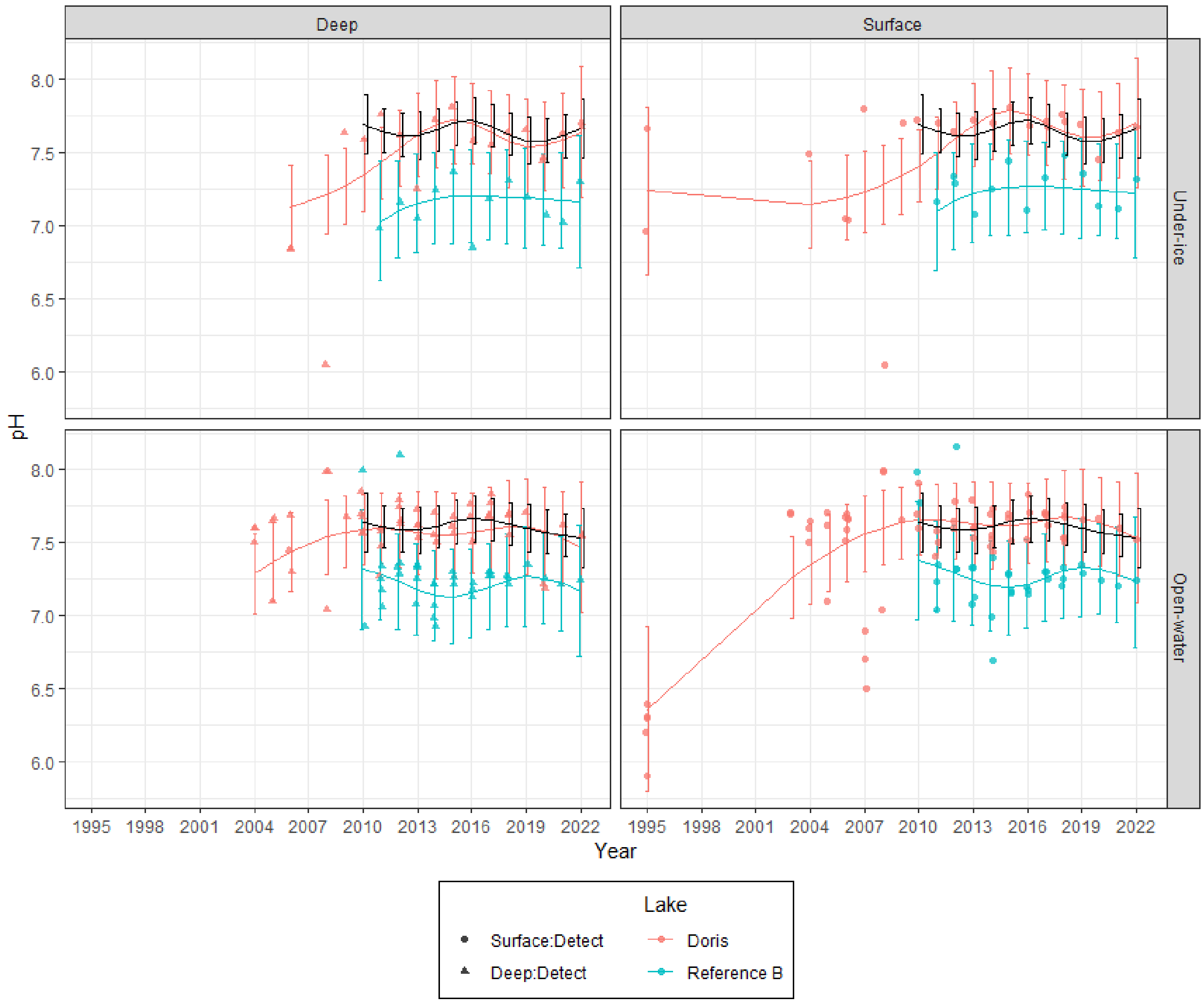
#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at

half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

As Doris Lake appears to show significant deviation from a slope of zero in at least one season, the black lines and error bars represent the model built with Doris Lake data from comparable sampling years with Reference Lake B only.






### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

#### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.335 | 0.2175 | 8.973 | 1.54 | 0.158 | not sig. |

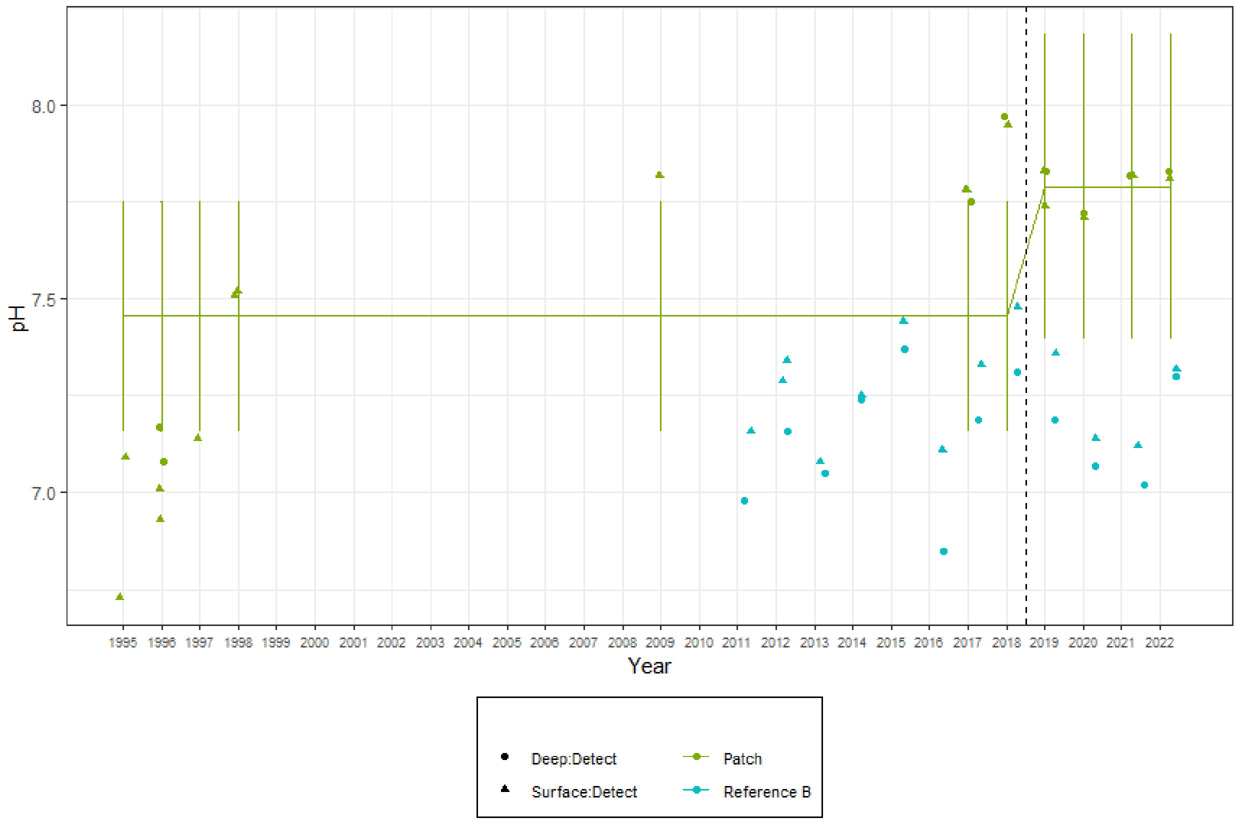
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.3605 | 0.3377 | 7.993 | 1.068 | 0.3168 | not sig. |

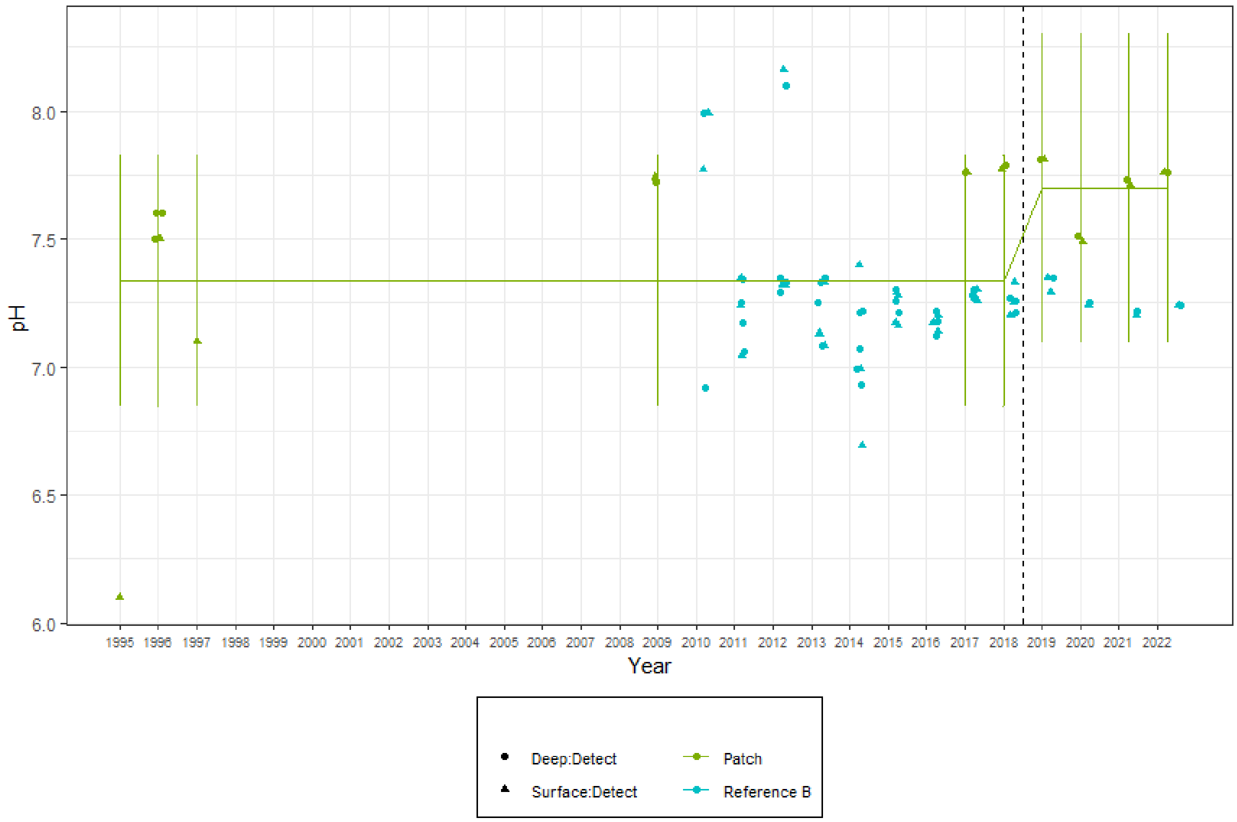
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.2577 | 0.2185 | 10.91 | 1.18 | 0.2632 | not sig. |

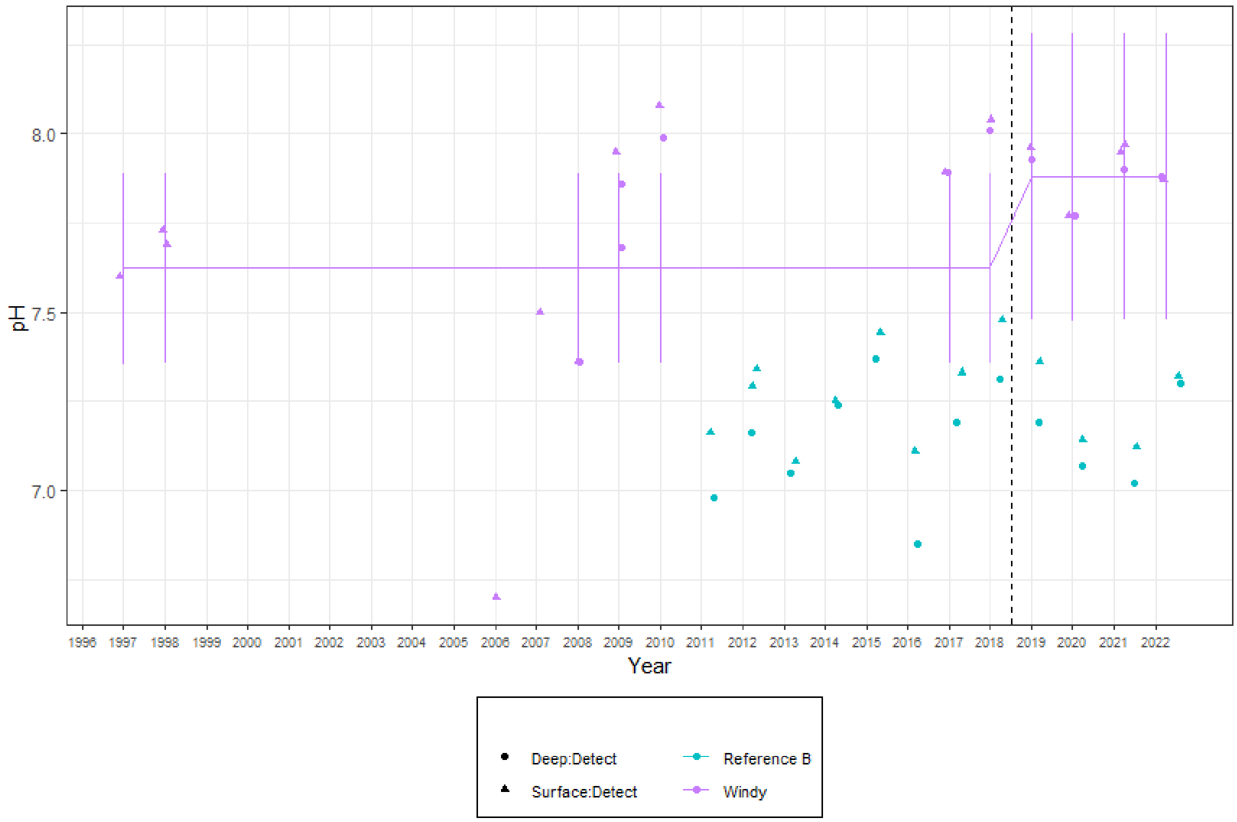
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.3207 | 0.2268 | 12 | 1.414 | 0.1827 | not sig. |

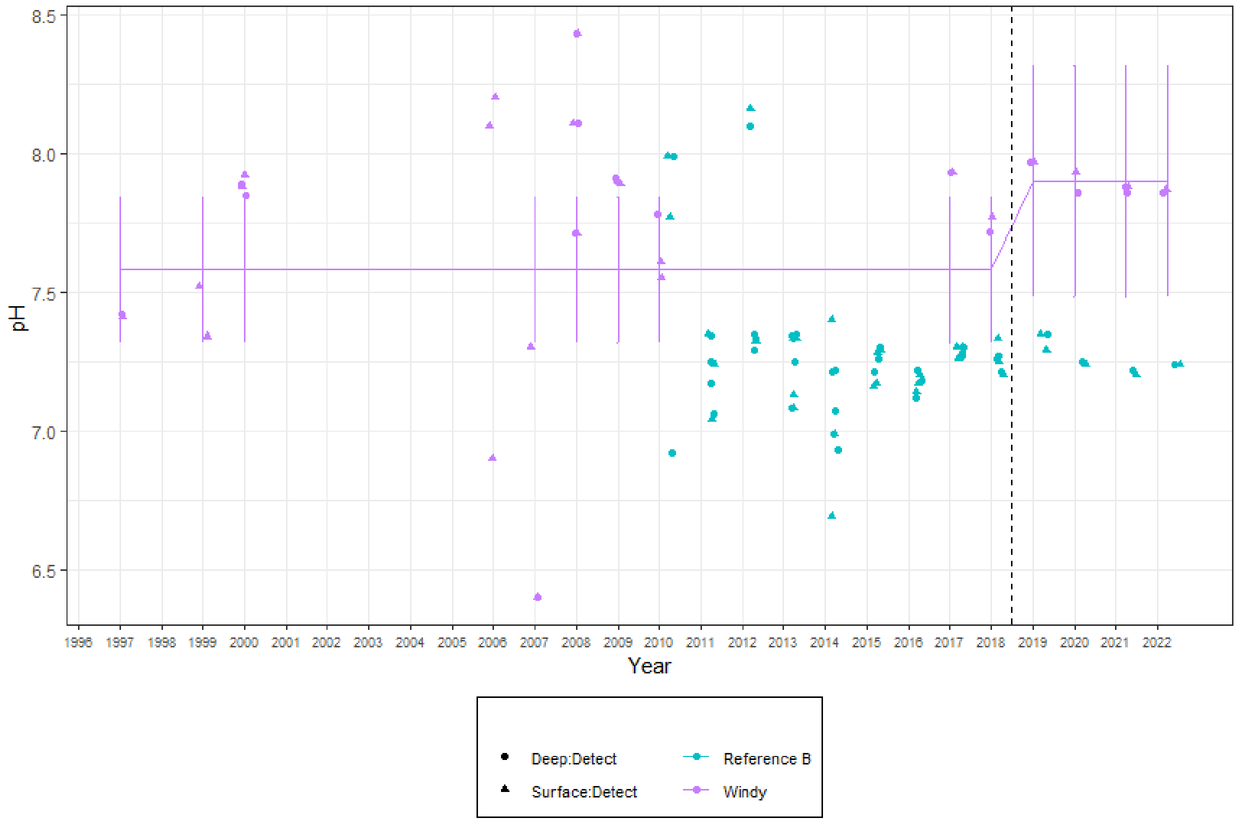
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

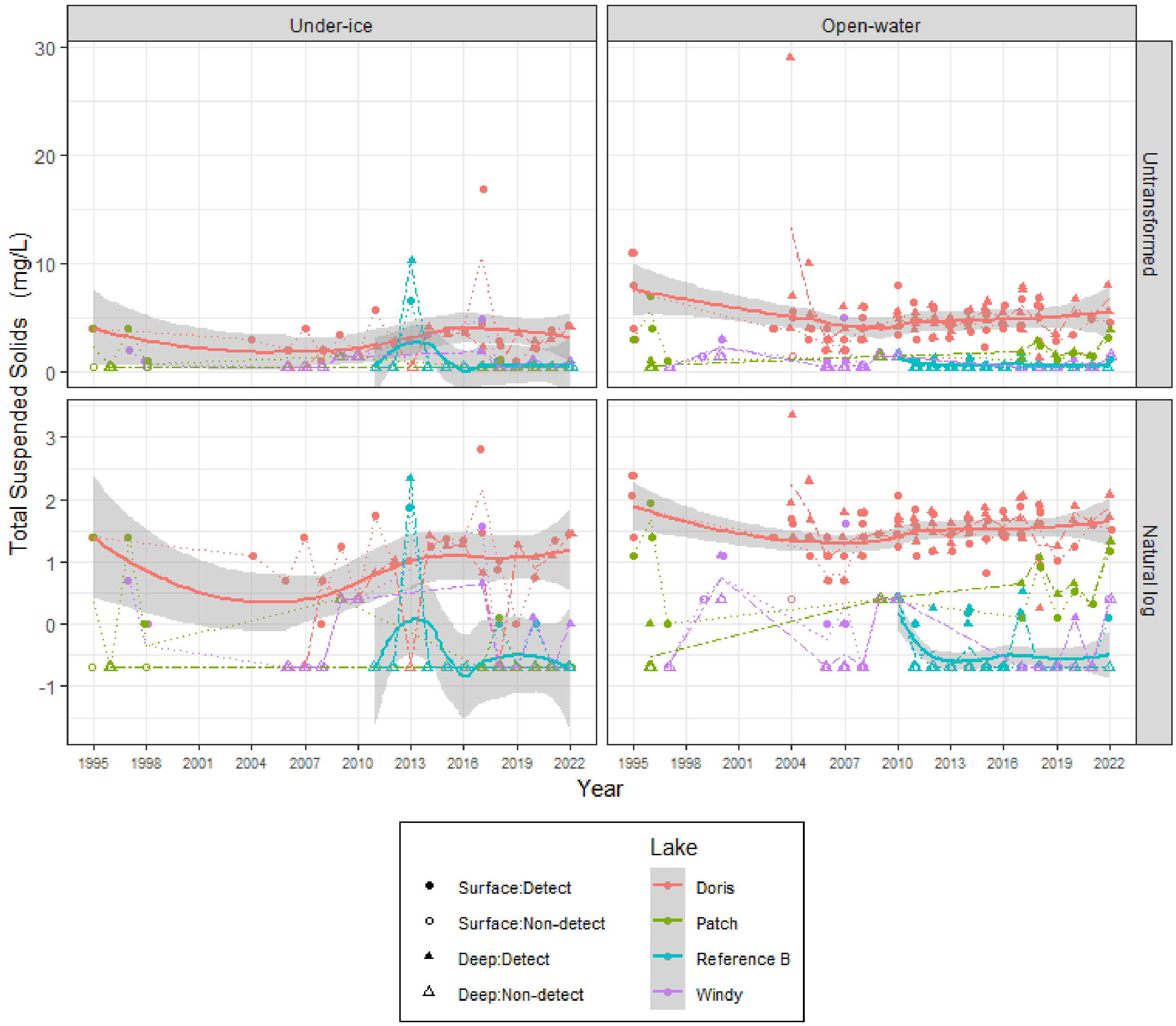
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


pH
8.5
8.0
7.5
7.0
6.5
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Year
Deep:Detect
Surface:Detect
Reference B
Windy

### *C.3.1.2 Total Suspended Solids*

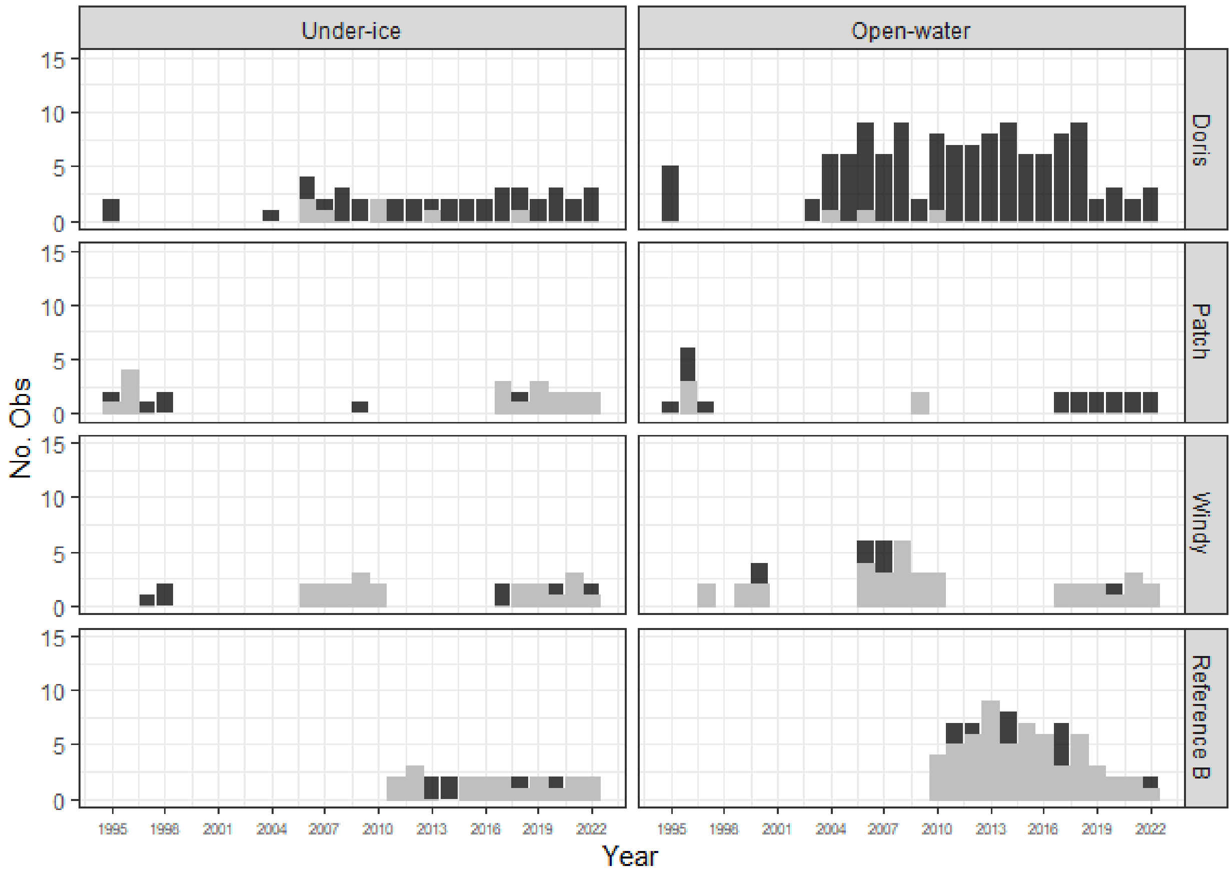
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

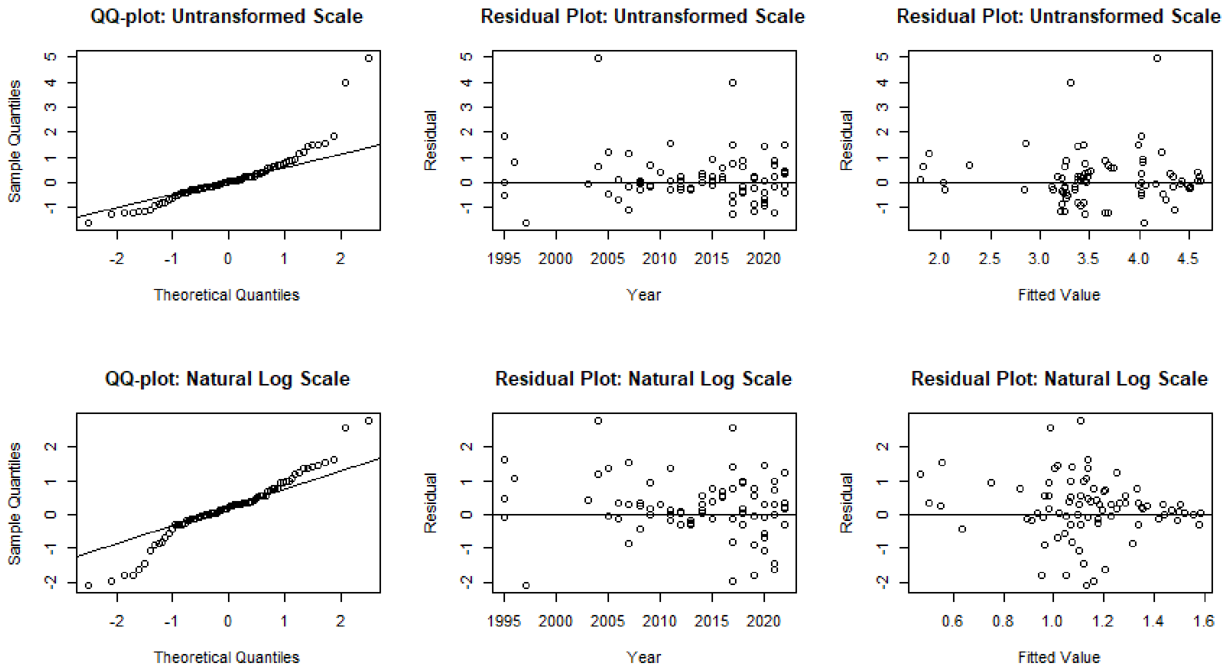
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 44 | 8 | 18 | 0 |
| Doris | Open-water | 123 | 3 | 2 | 0 |
| Patch | Under-ice | 24 | 20 | 83 | 100 |
| Patch | Open-water | 22 | 5 | 23 | 0 |
| Reference B | Under-ice | 25 | 21 | 84 | 100 |
| Reference B | Open-water | 70 | 59 | 84 | 50 |
| Windy | Under-ice | 27 | 21 | 78 | 50 |
| Windy | Open-water | 45 | 37 | 82 | 100 |

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 Lake.

### 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 |
|---|---|---|---|---|---|---|---|
| 6 | Doris | 2004 | Open-water | Deep | 13.33 | 4.170 | 4.962 |
| 55 | Doris | 2017 | Under-ice | Surface | 10.60 | 3.302 | 3.952 |

Outliers on natural log scale:

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 10.7 | 3 | 0.01350 | sig. |

Doris Lake appears to show significant deviation from a slope of zero.

Comparison to Reference Lake B could not be completed.

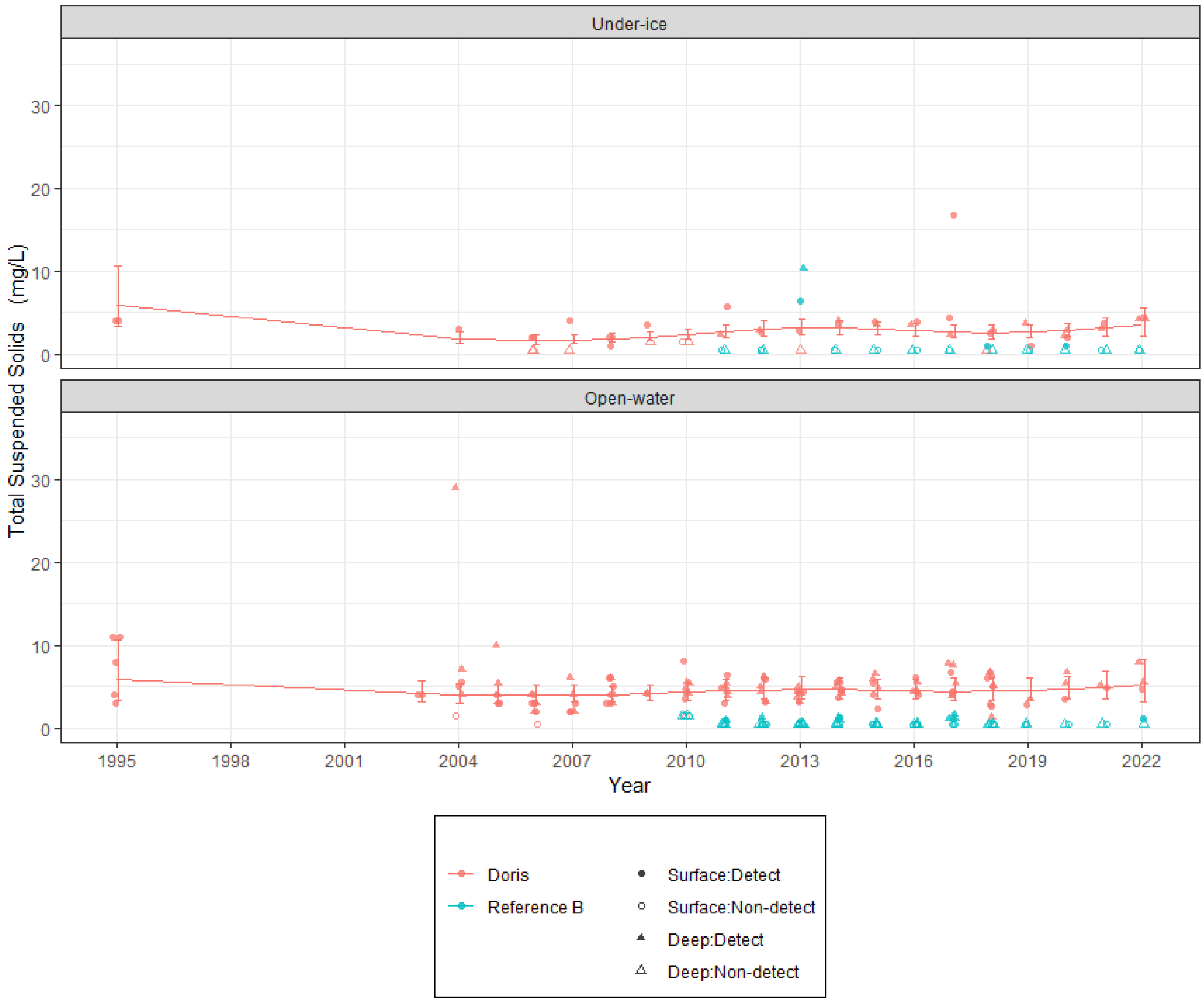
#### *Open-water*

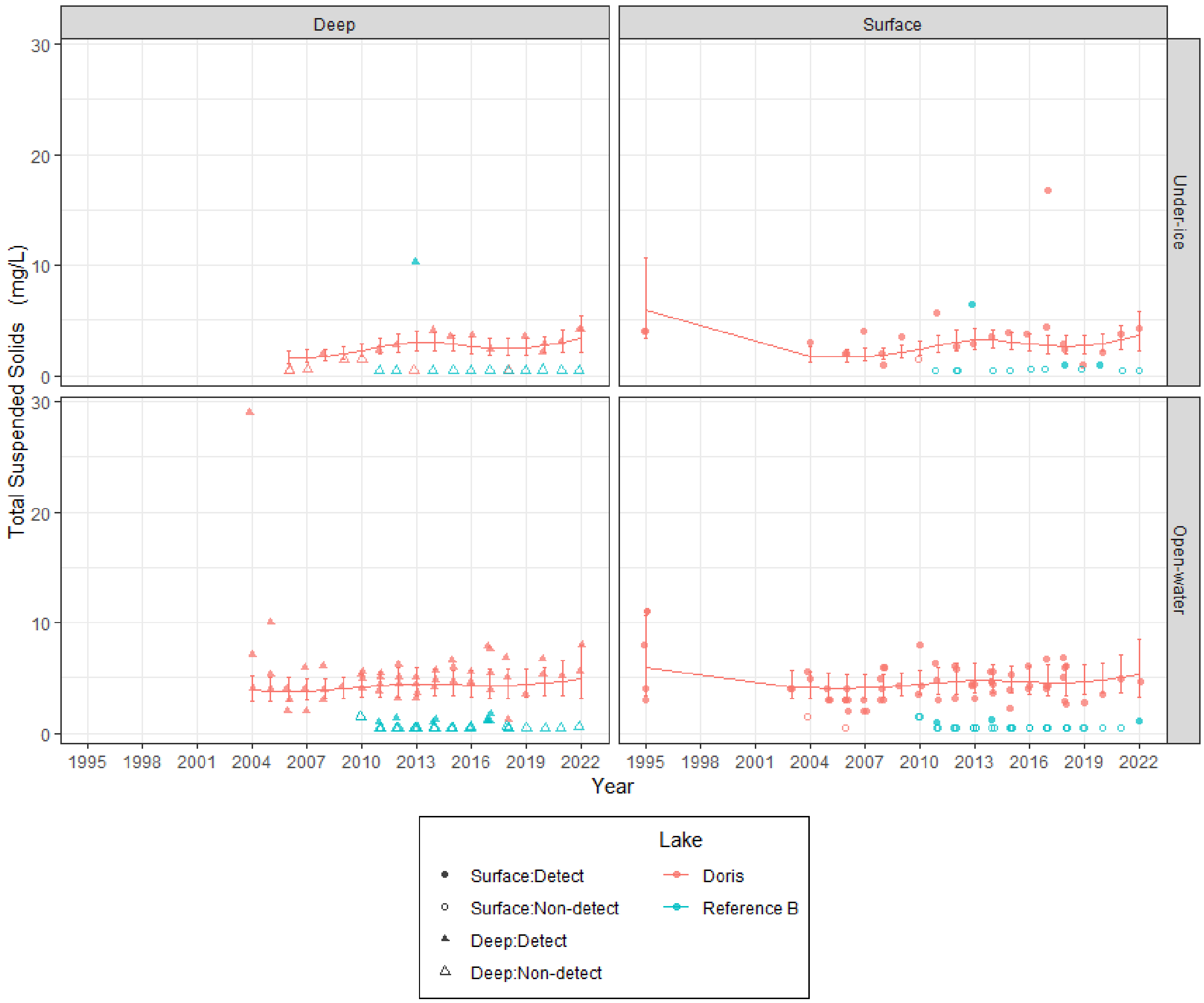
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 1.109 | 3 | 0.77490 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were 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 | 0.0359 | 0.2714 | 15 | 0.1322 | 0.8966 | not sig. |

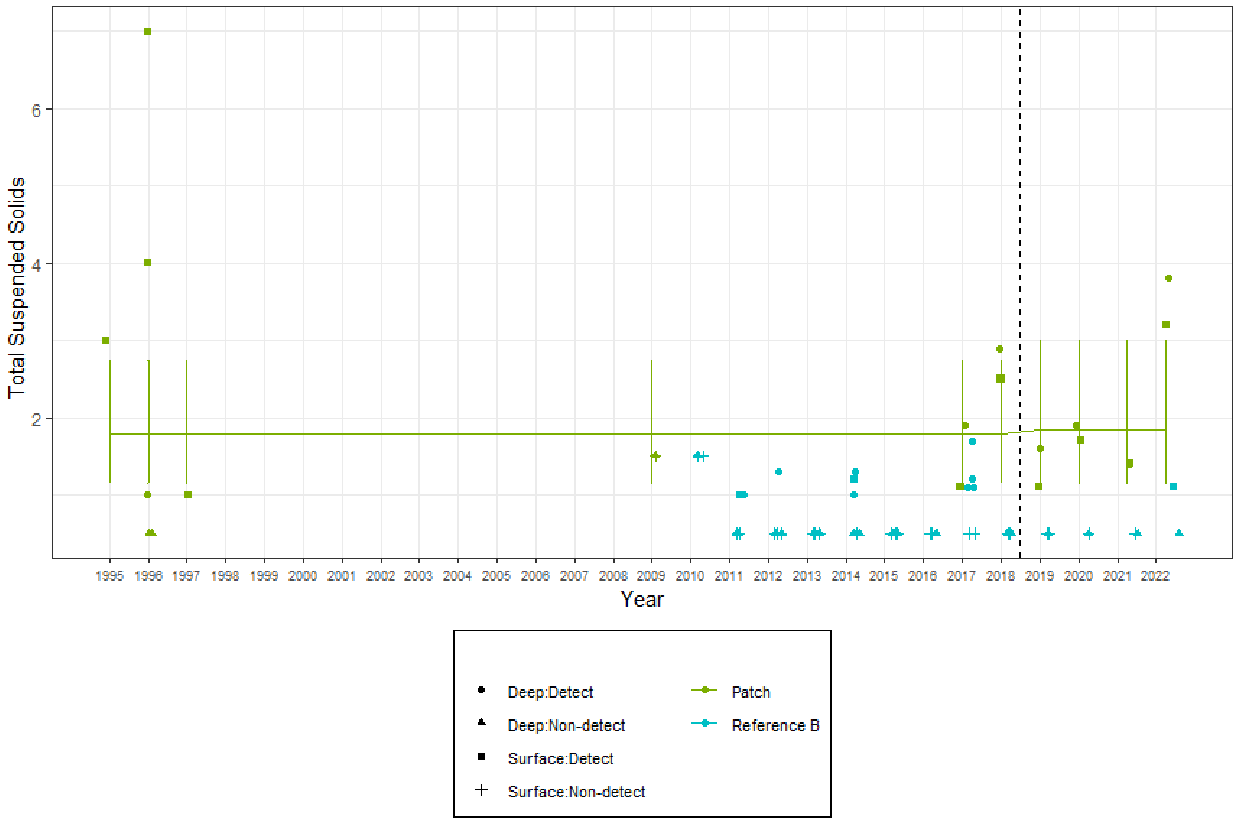
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




## Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

### *Under-ice*

Analysis not performed.

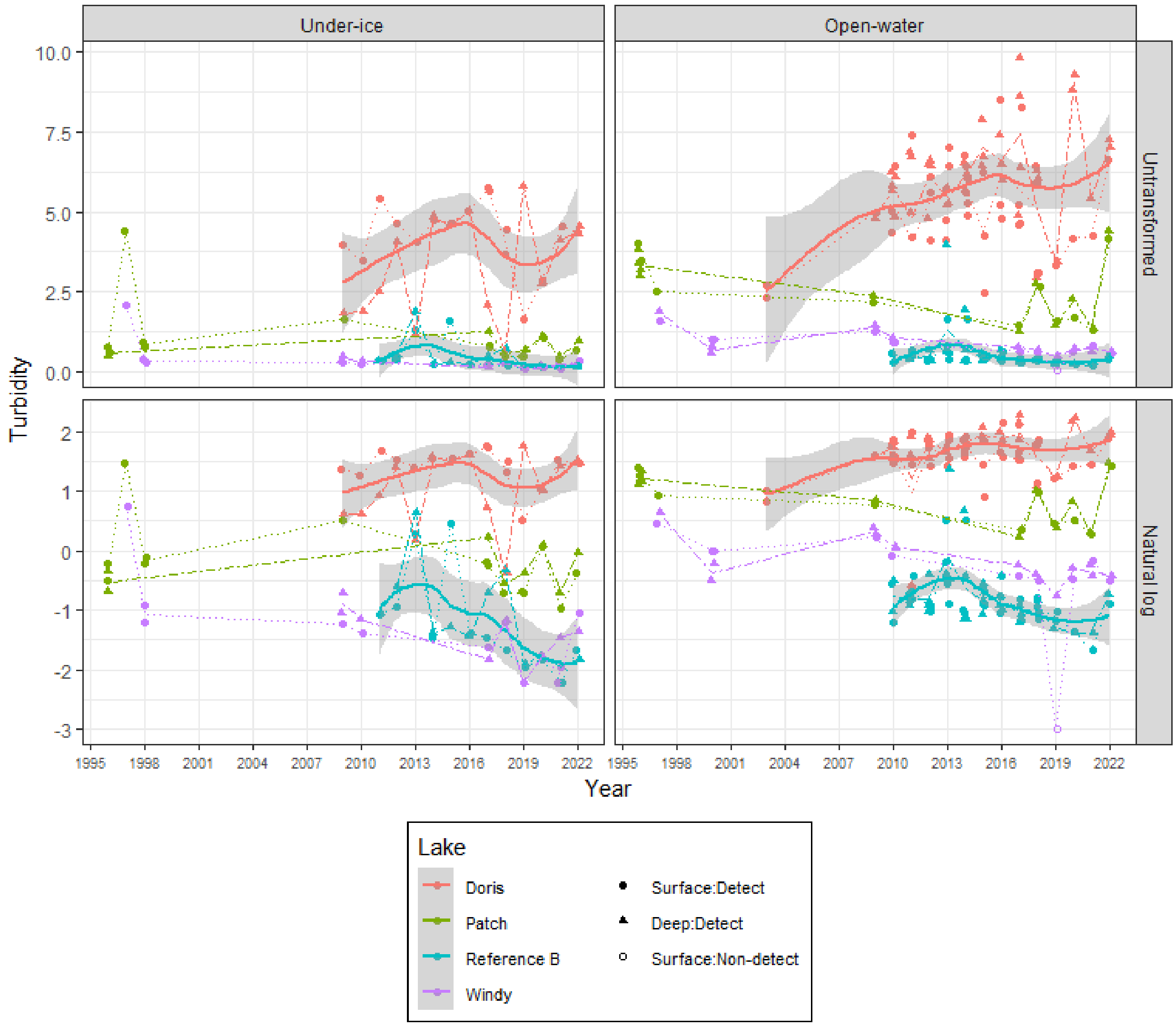
### *Open-water*

Analysis not performed.

### *C.3.1.3 Turbidity*

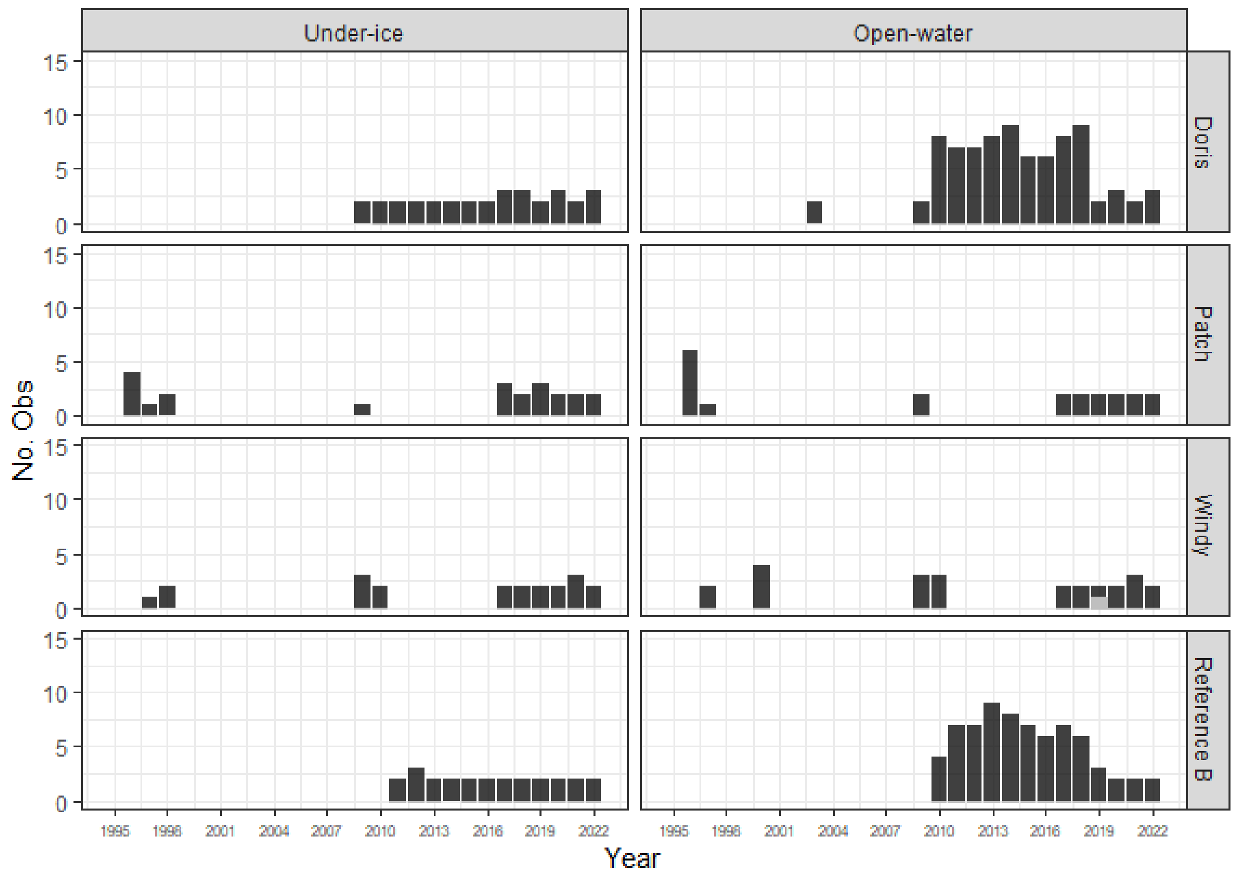
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

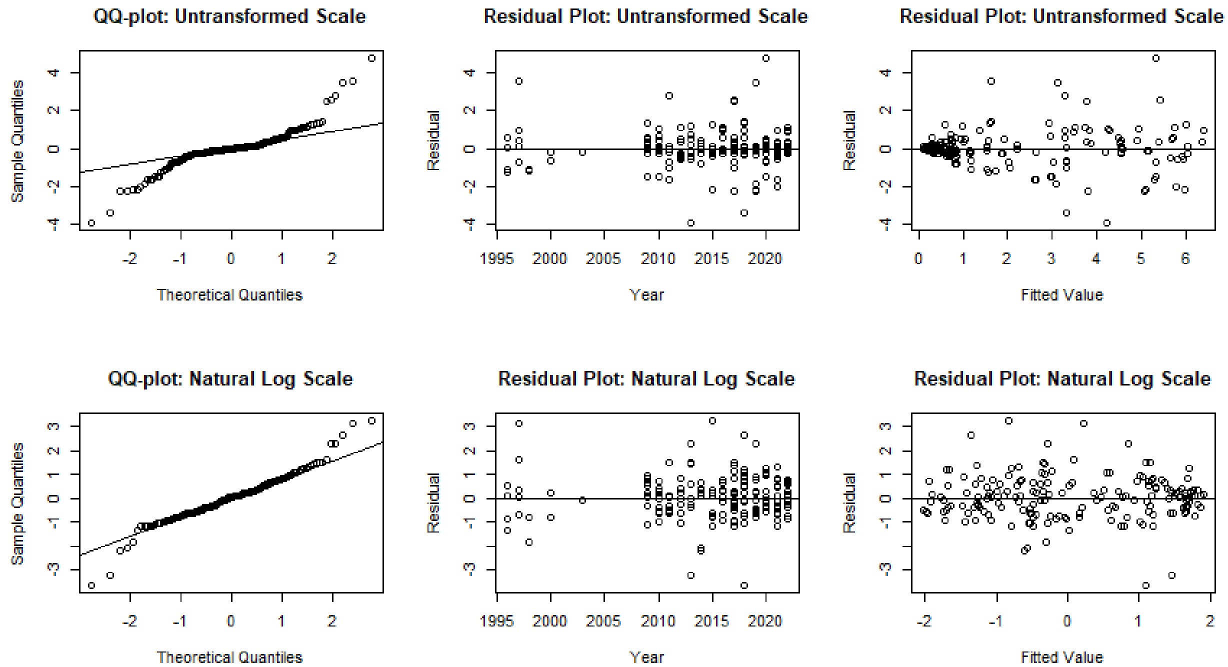
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 32 | 0 | 0 | 0 |
| Doris | Open-water | 82 | 0 | 0 | 0 |
| Patch | Under-ice | 22 | 0 | 0 | 0 |
| Patch | Open-water | 21 | 0 | 0 | 0 |
| Reference B | Under-ice | 25 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 0 | 0 | 0 |
| Windy | Under-ice | 21 | 0 | 0 | 0 |
| Windy | Open-water | 25 | 1 | 4 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 38 | Doris | 2013 | Under-ice | Deep | 1.18 | 4.220 | -3.924 |
| 58 | Doris | 2018 | Under-ice | Deep | 0.69 | 3.327 | -3.404 |
| 62 | Doris | 2019 | Under-ice | Deep | 5.82 | 3.121 | 3.484 |
| 68 | Doris | 2020 | Open-water | Deep | 9.03 | 5.344 | 4.758 |
| 84 | Patch | 1997 | Under-ice | Surface | 4.40 | 1.631 | 3.575 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 38 | Doris | 2013 | Under-ice | Deep | 1.18 | 1.453 | -3.204 |
| 58 | Doris | 2018 | Under-ice | Deep | 0.69 | 1.098 | -3.656 |
| 84 | Patch | 1997 | Under-ice | Surface | 4.40 | 0.219 | 3.143 |
| 133 | Reference B | 2015 | Under-ice | Surface | 1.59 | -0.836 | 3.235 |

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

### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 7.971 | 4 | 0.09270 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

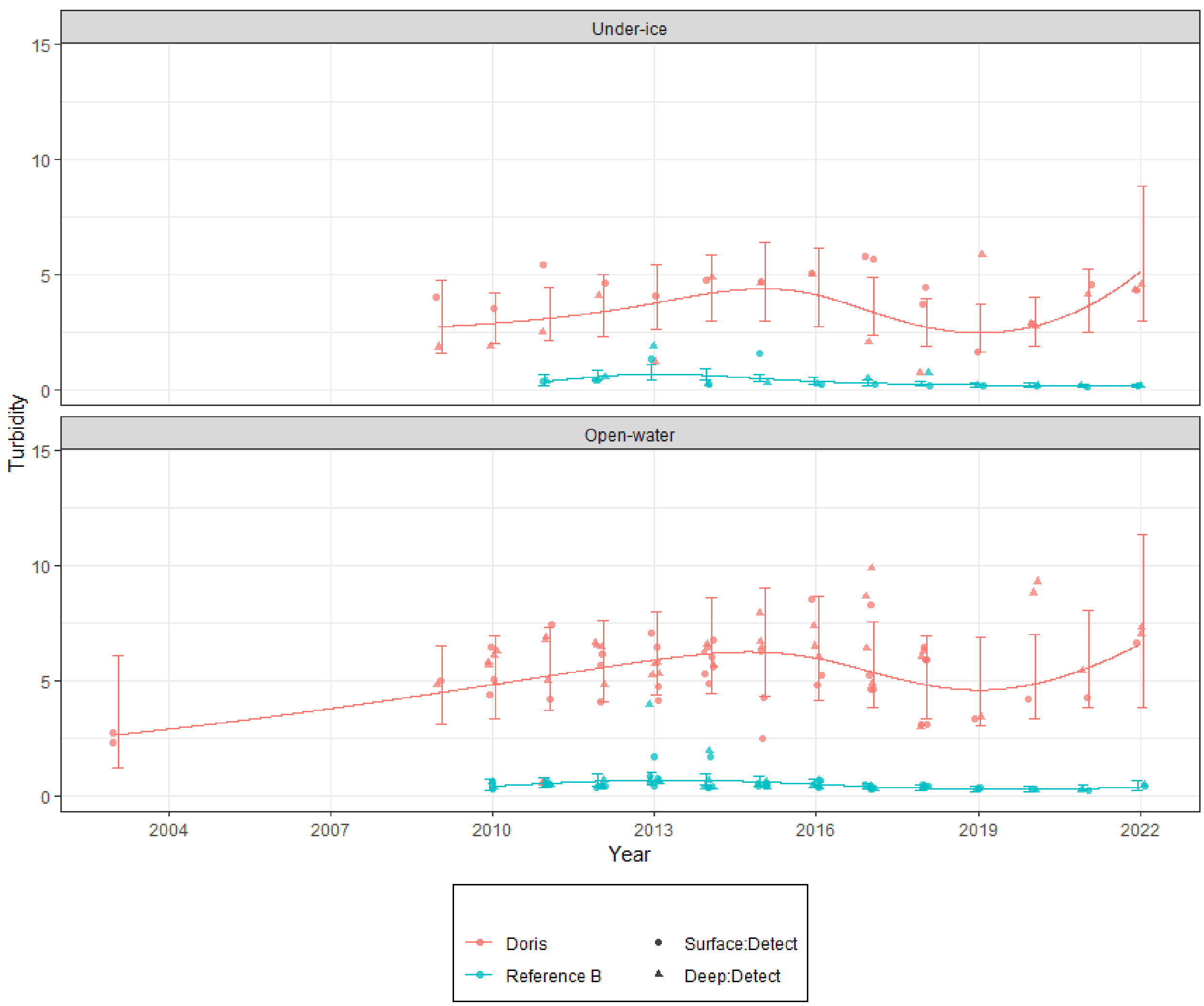
### *Open-water*

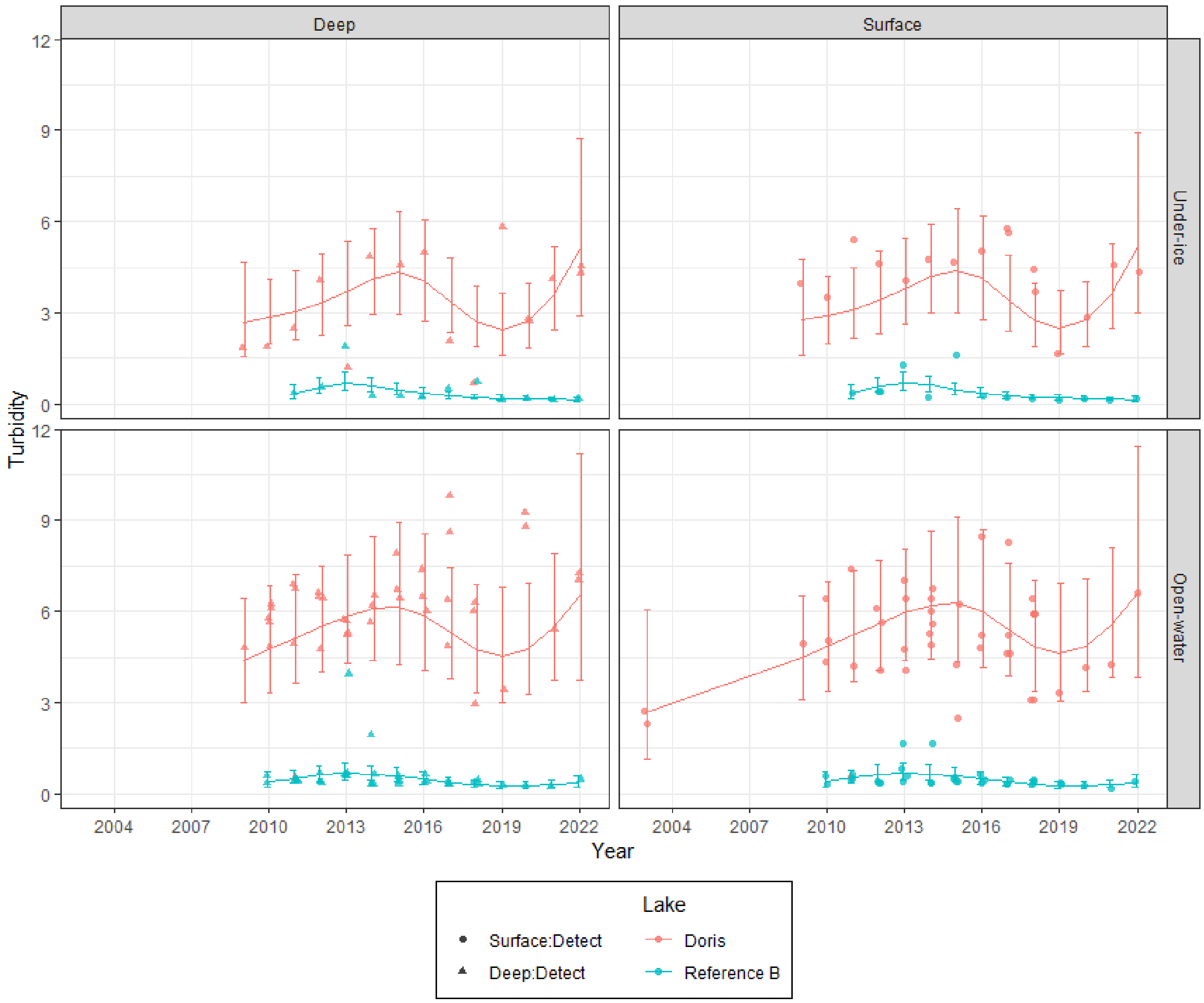
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 5.785 | 4 | 0.21580 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.5422 | 0.4379 | 7.846 | -1.238 | 0.2514 | not sig. |

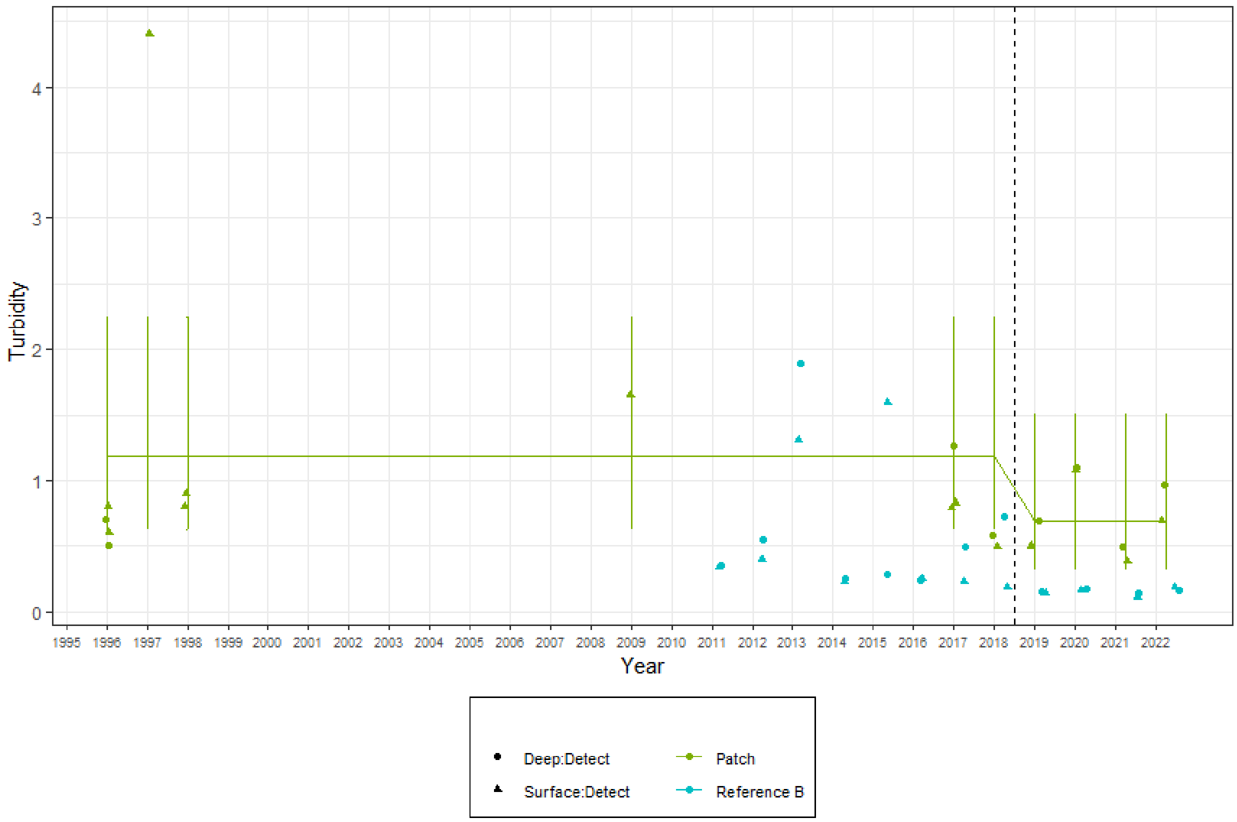
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.1523 | 0.2921 | 7.034 | -0.5214 | 0.6181 | not sig. |

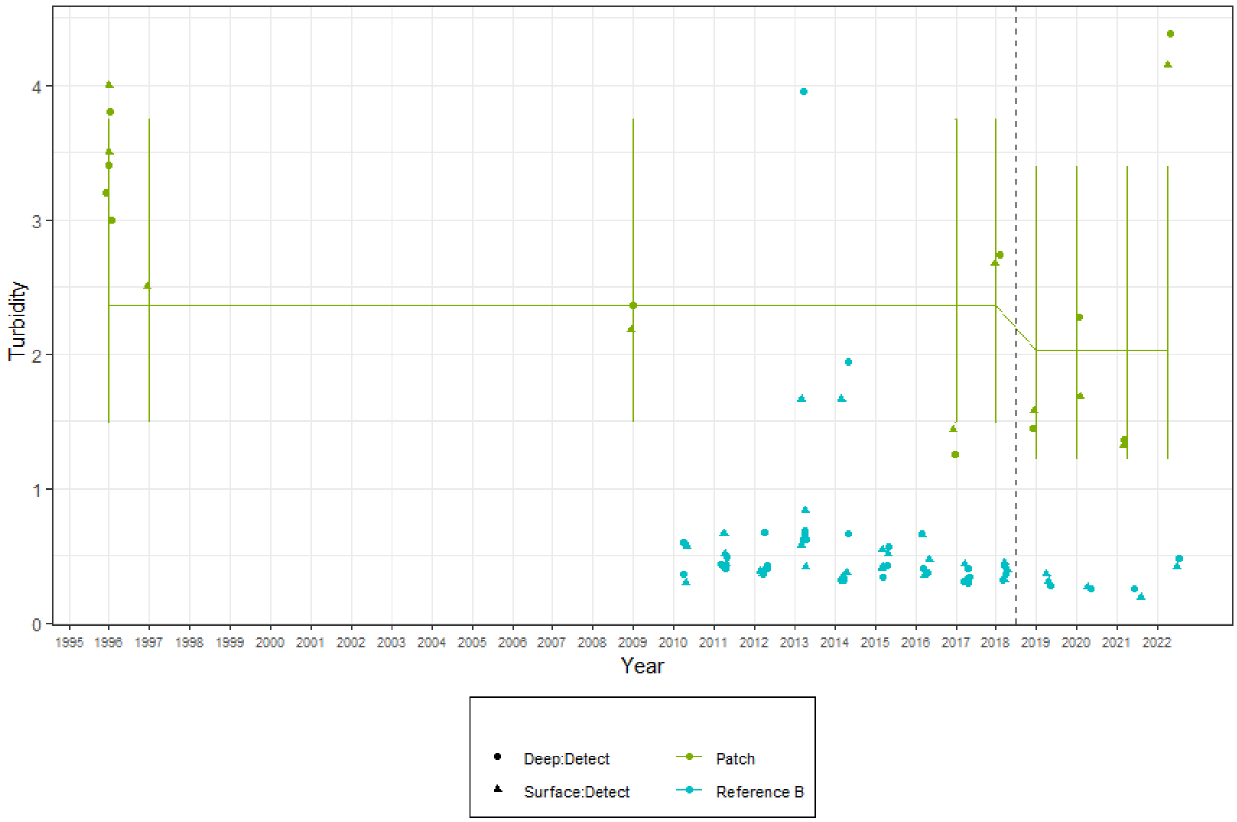
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




## Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.8166 | 0.4609 | 7.562 | -1.772 | 0.1165 | not sig. |

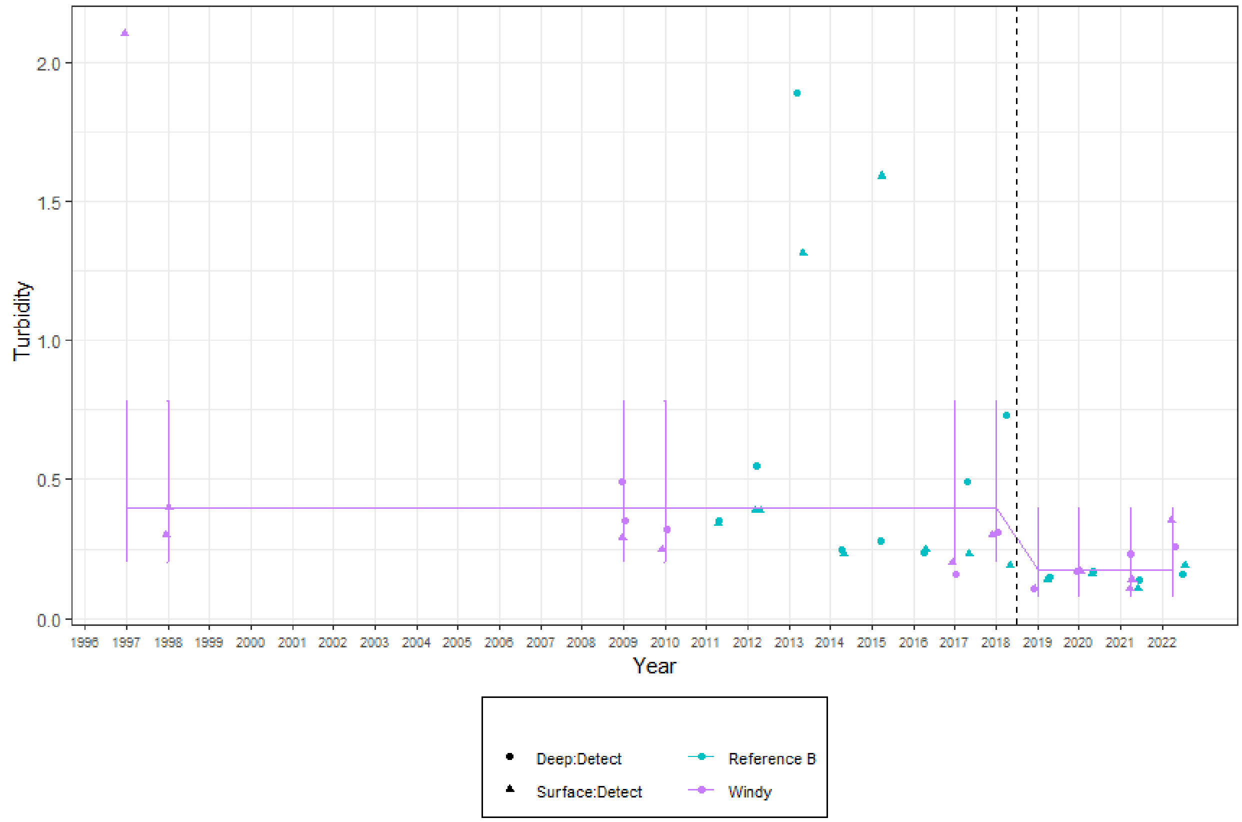
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.7246 | 0.3571 | 8 | -2.03 | 0.0769 | not sig. |

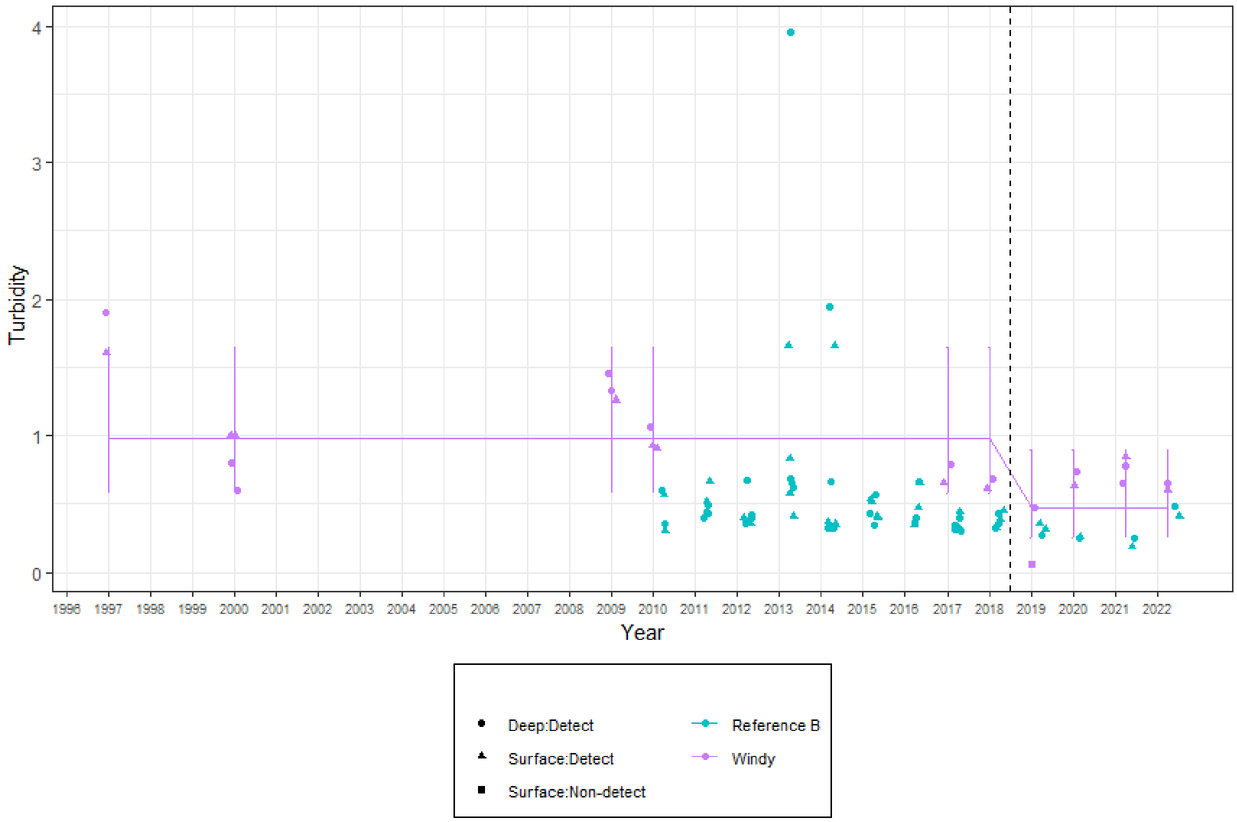
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

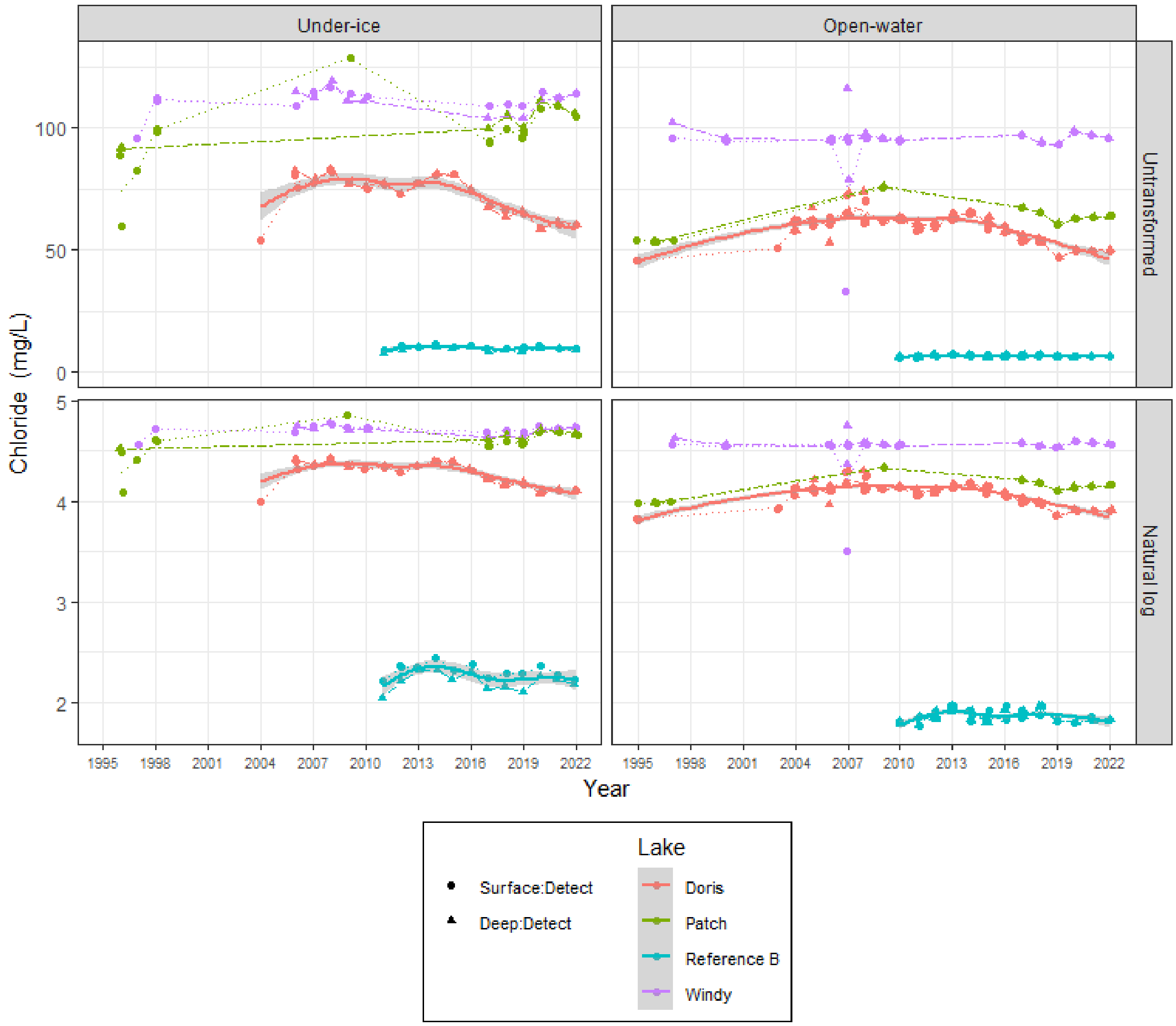
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Turbidity
4
3
2
1
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Year
Deep:Detect
Surface:Detect
Surface:Non-detect
Reference B
Windy

### *C.3.1.4 Chloride*

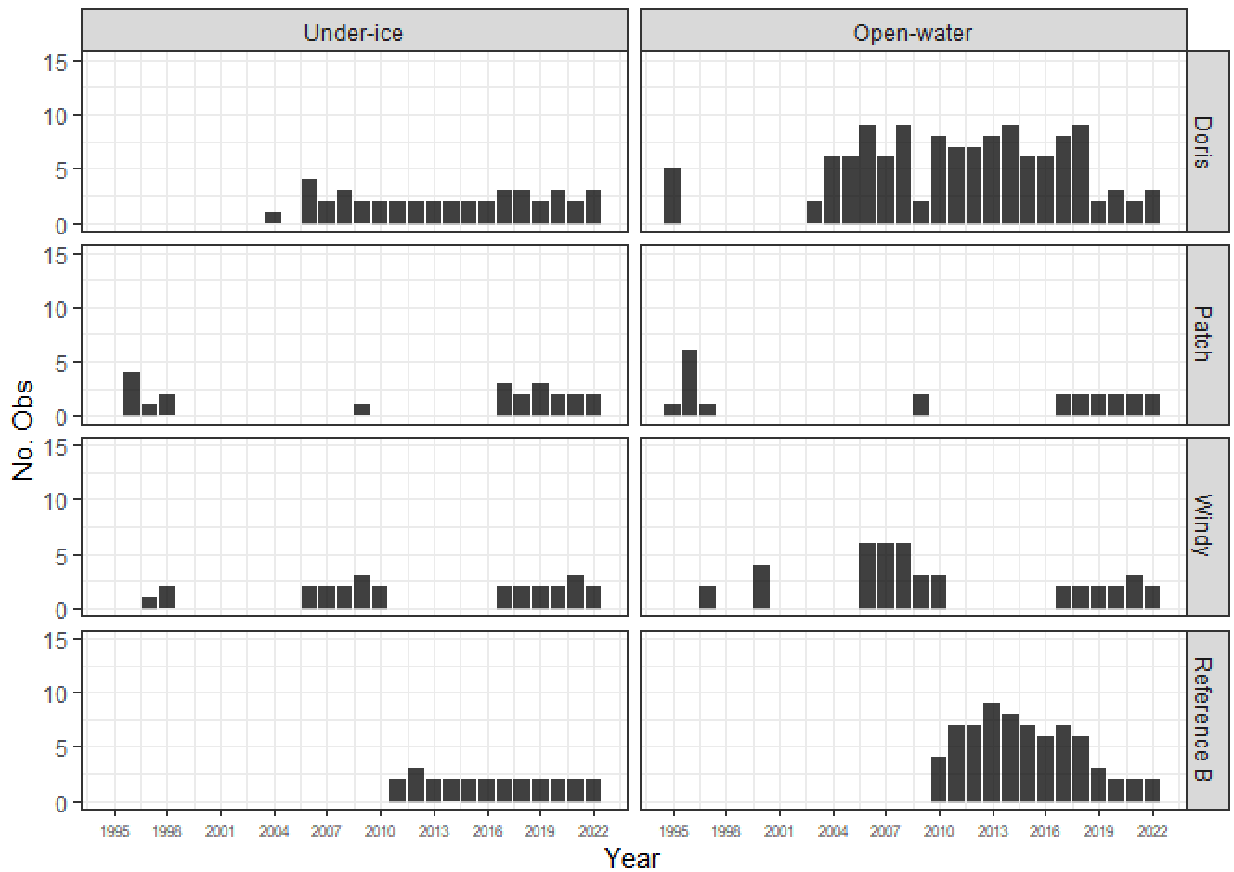
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

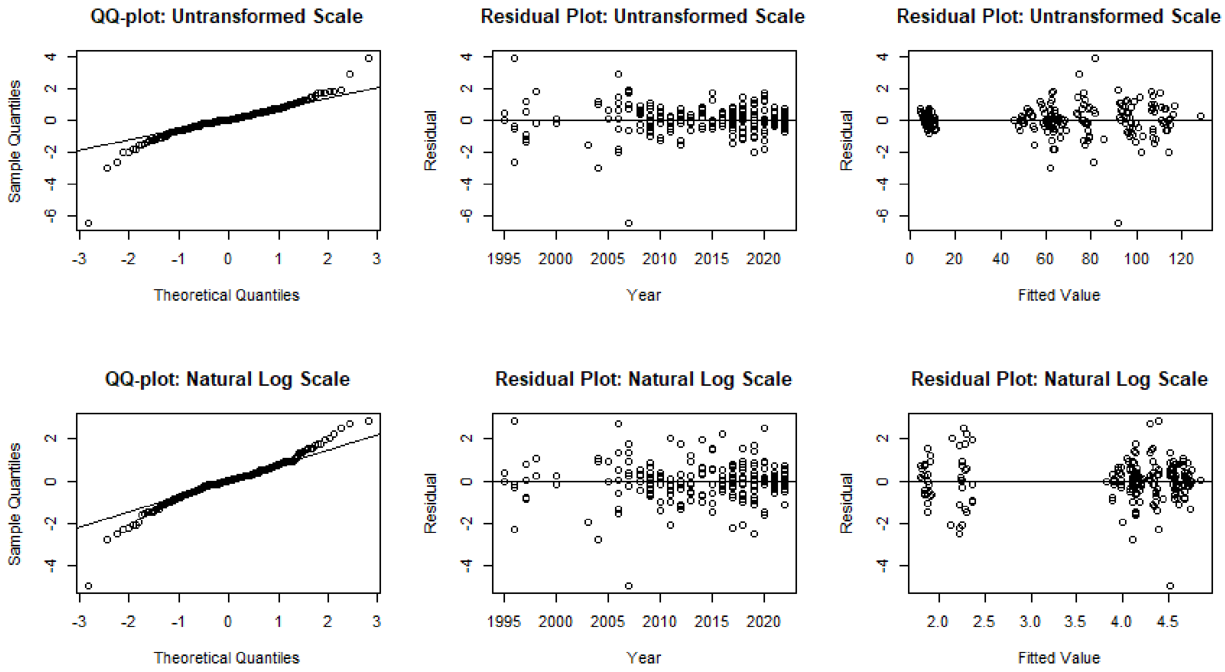
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 42 | 0 | 0 | 0 |
| Doris | Open-water | 123 | 0 | 0 | 0 |
| Patch | Under-ice | 22 | 0 | 0 | 0 |
| Patch | Open-water | 22 | 0 | 0 | 0 |
| Reference B | Under-ice | 25 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 0 | 0 | 0 |
| Windy | Under-ice | 27 | 0 | 0 | 0 |
| Windy | Open-water | 43 | 0 | 0 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 5 | Doris | 2004 | Under-ice | Surface | 54.00 | 61.93 | -3.022 |
| 80 | Patch | 1996 | Under-ice | Deep | 91.65 | 81.51 | 3.864 |
| 178 | Windy | 2007 | Open-water | Surface | 74.57 | 91.59 | -6.484 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 178 | Windy | 2007 | Open-water | Surface | 74.57 | 4.523 | -4.979 |

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

### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 92.69 | 4 | <0.00001 | sig. |
| Compare to Reference B | 83.92 | 4 | <0.00001 | sig. |

Doris Lake appears to show significant deviation from a slope of zero. Doris Lake appears to show significant deviation from the trend of Reference Lake B.

### *Open-water*

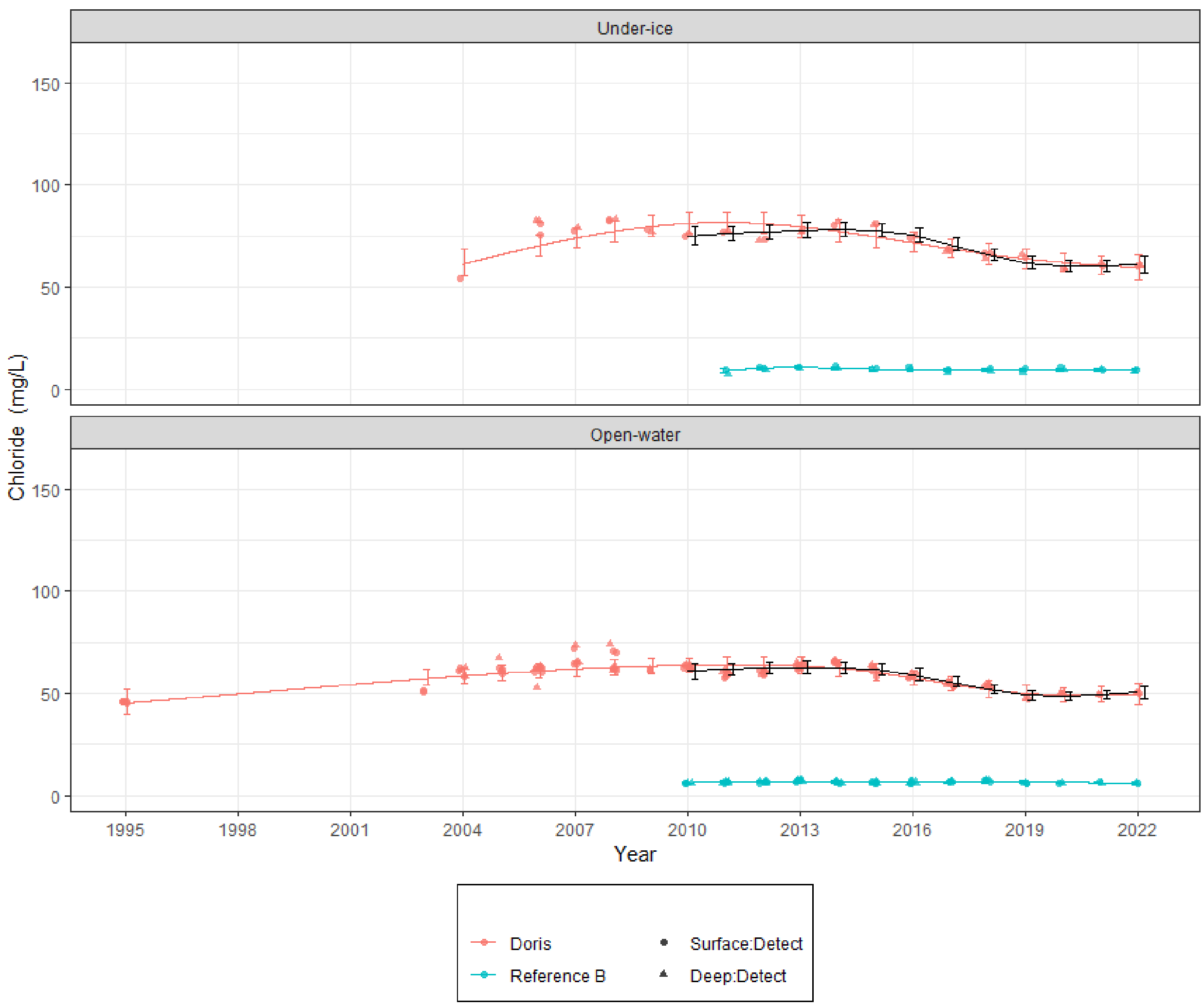
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 93.05 | 4 | <0.00001 | sig. |
| Compare to Reference B | 65.20 | 4 | <0.00001 | sig. |

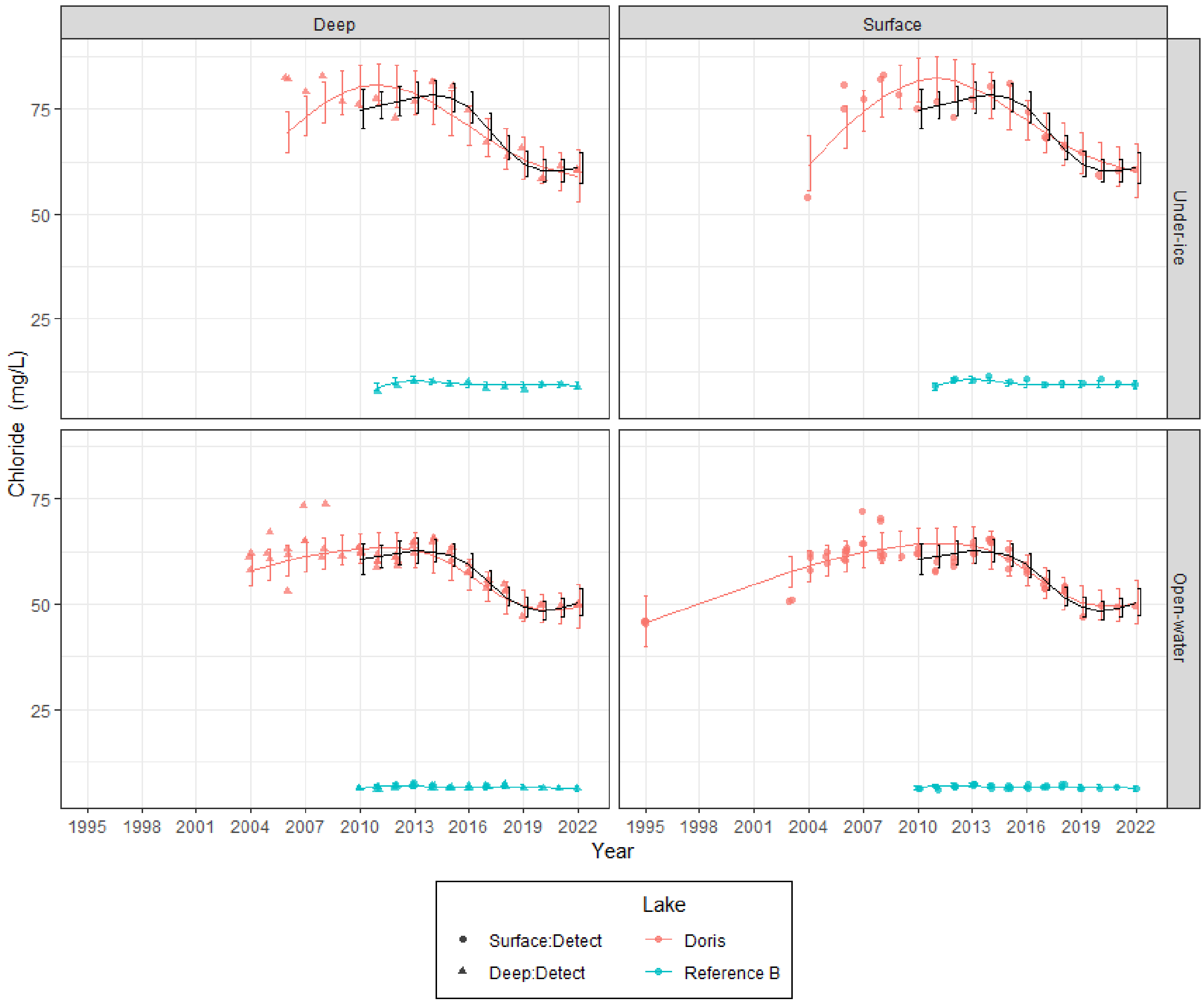
Doris Lake appears to show significant deviation from a slope of zero. Doris Lake appears to show significant deviation from the trend of Reference Lake B.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

As Doris Lake appears to show significant deviation from a slope of zero in at least one season, the black lines and error bars represent the model built with Doris Lake data from comparable sampling years with Reference Lake B only.






### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

#### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0671 | 0.0865 | 7.418 | 0.7752 | 0.4622 | not sig. |

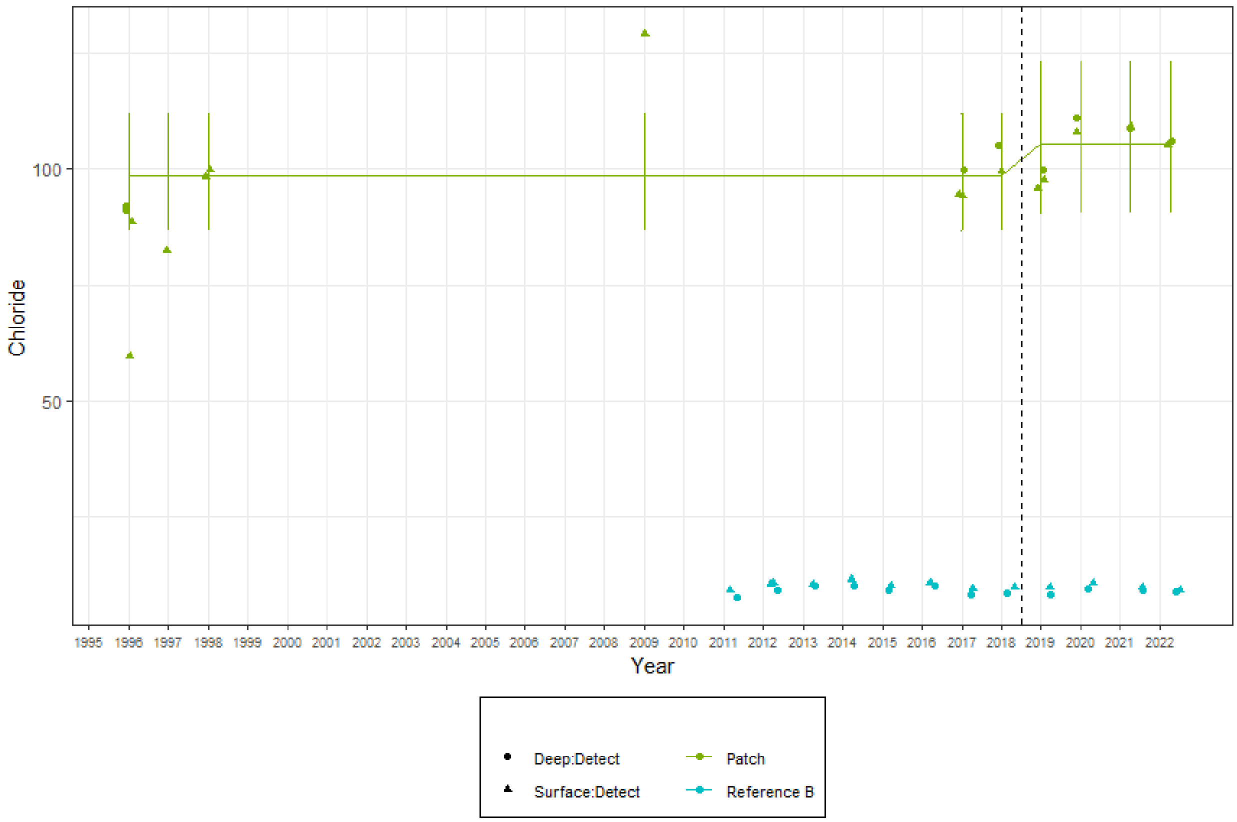
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0252 | 0.0759 | 7.999 | 0.3312 | 0.749 | not sig. |

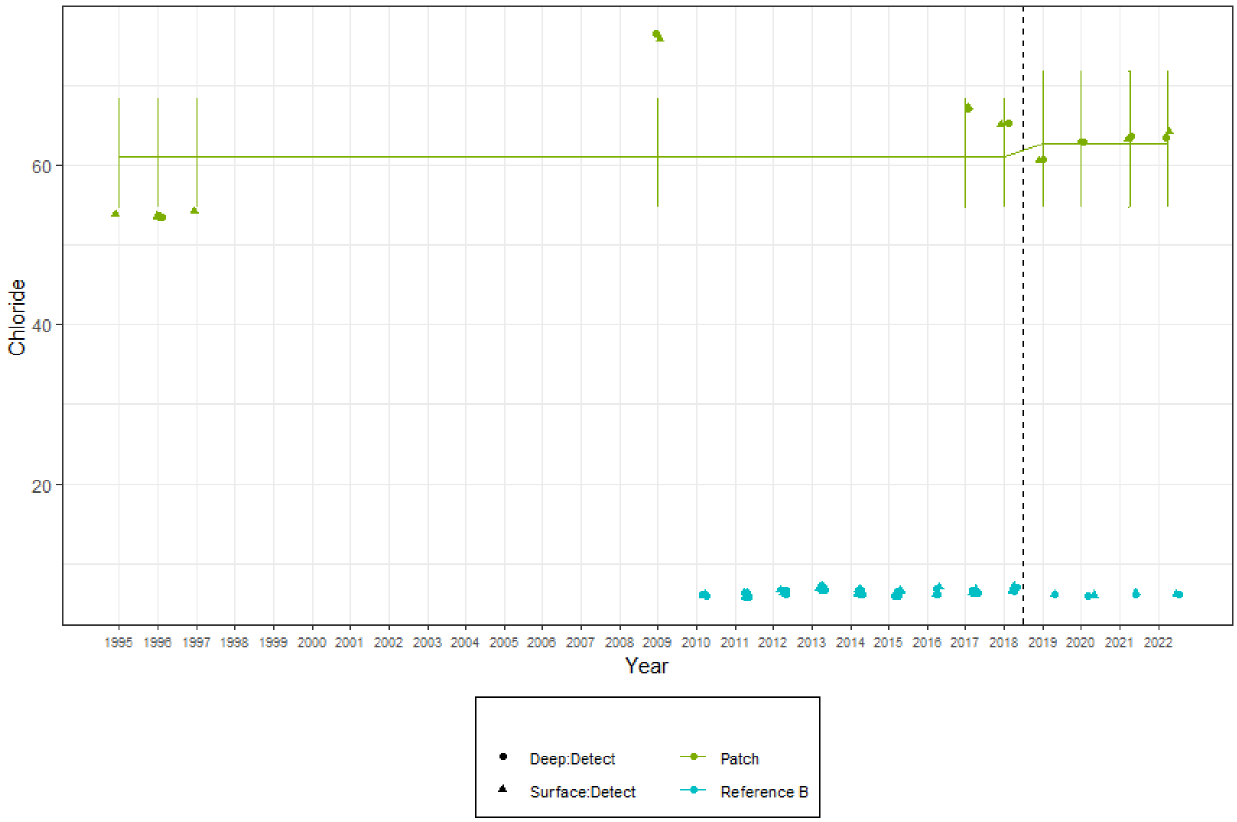
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




## Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0143 | 0.0309 | 9.781 | 0.4628 | 0.6536 | not sig. |

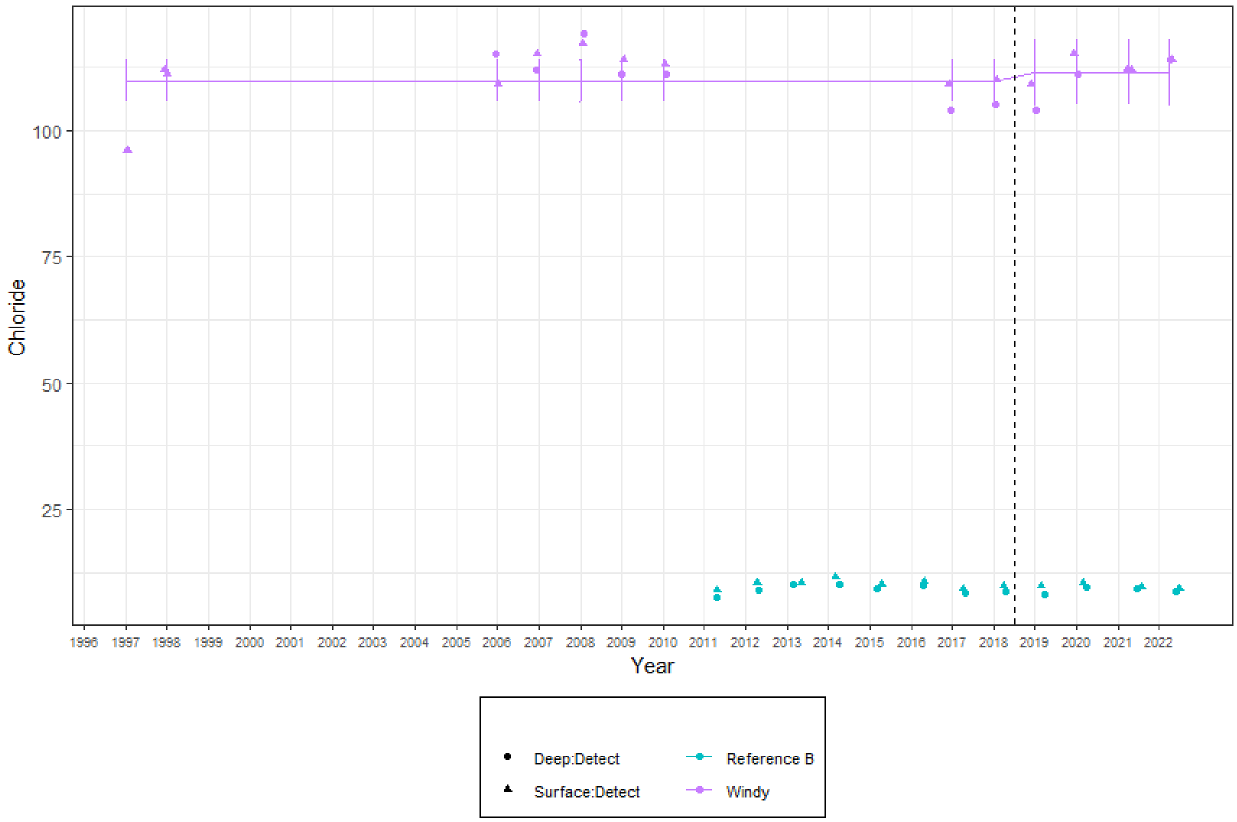
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0149 | 0.0233 | 11 | 0.6398 | 0.5354 | not sig. |

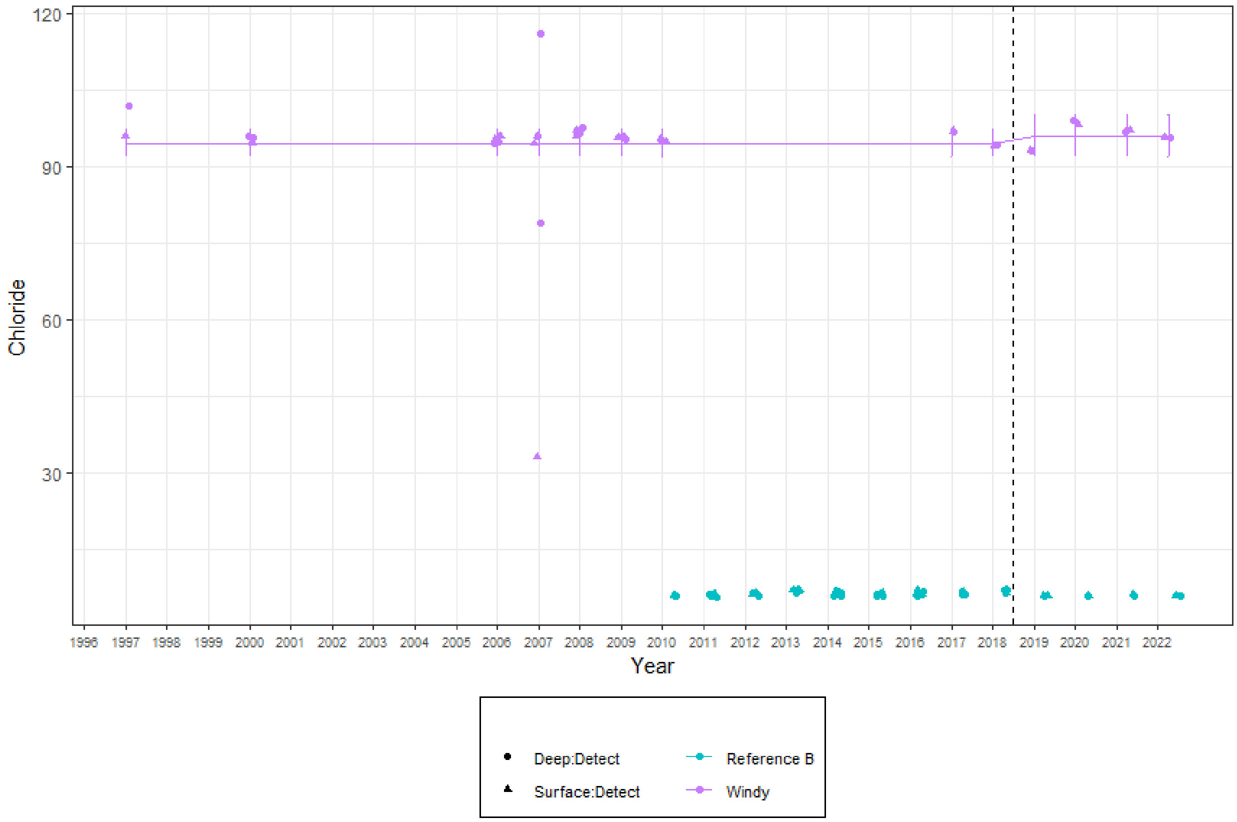
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.


Chloride
120
90
60
30
1996
1997
1998
1999
2000
2001
2002
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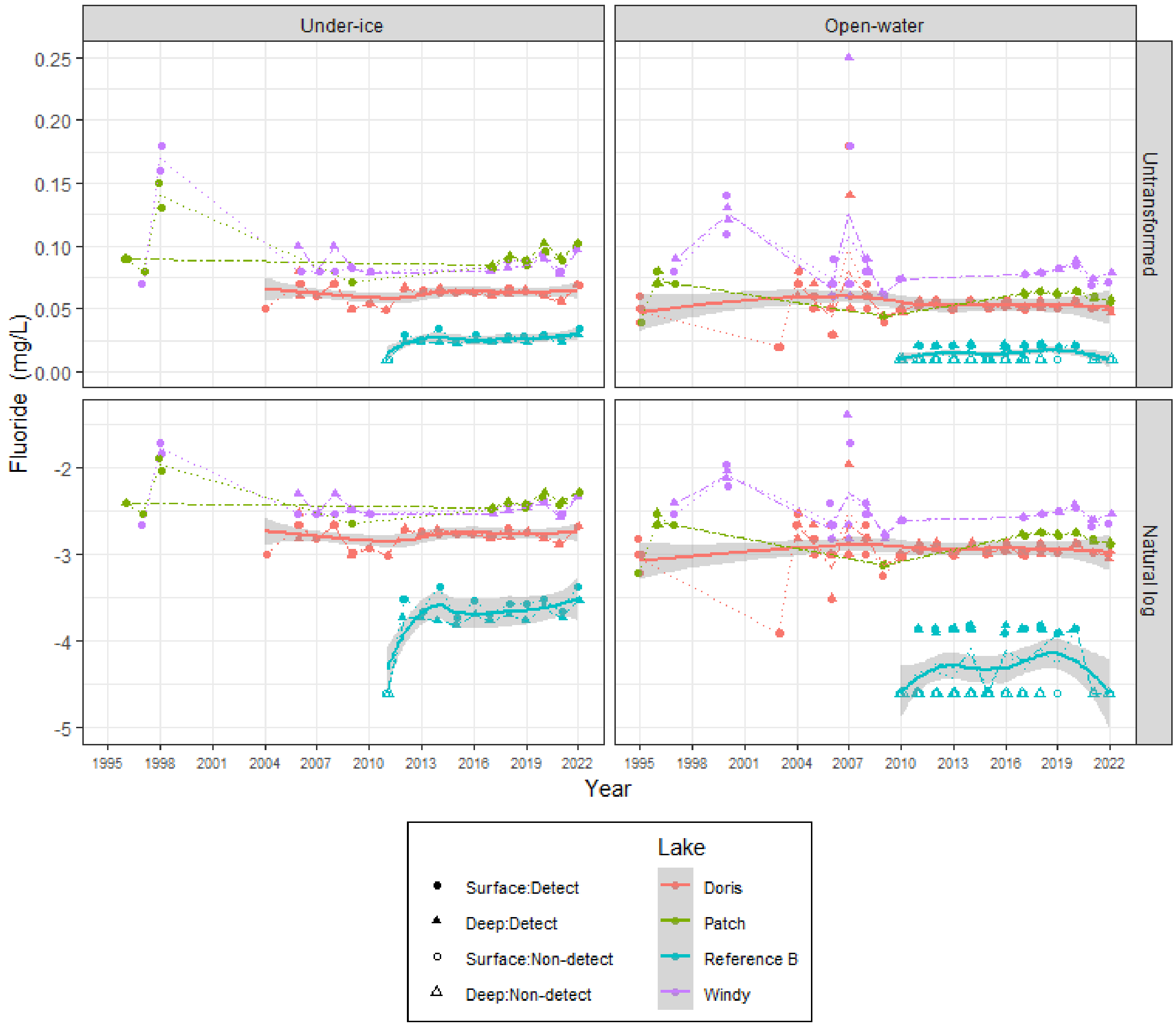
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Deep:Detect
Surface:Detect
Reference B
Windy

### *C.3.1.5 Fluoride*

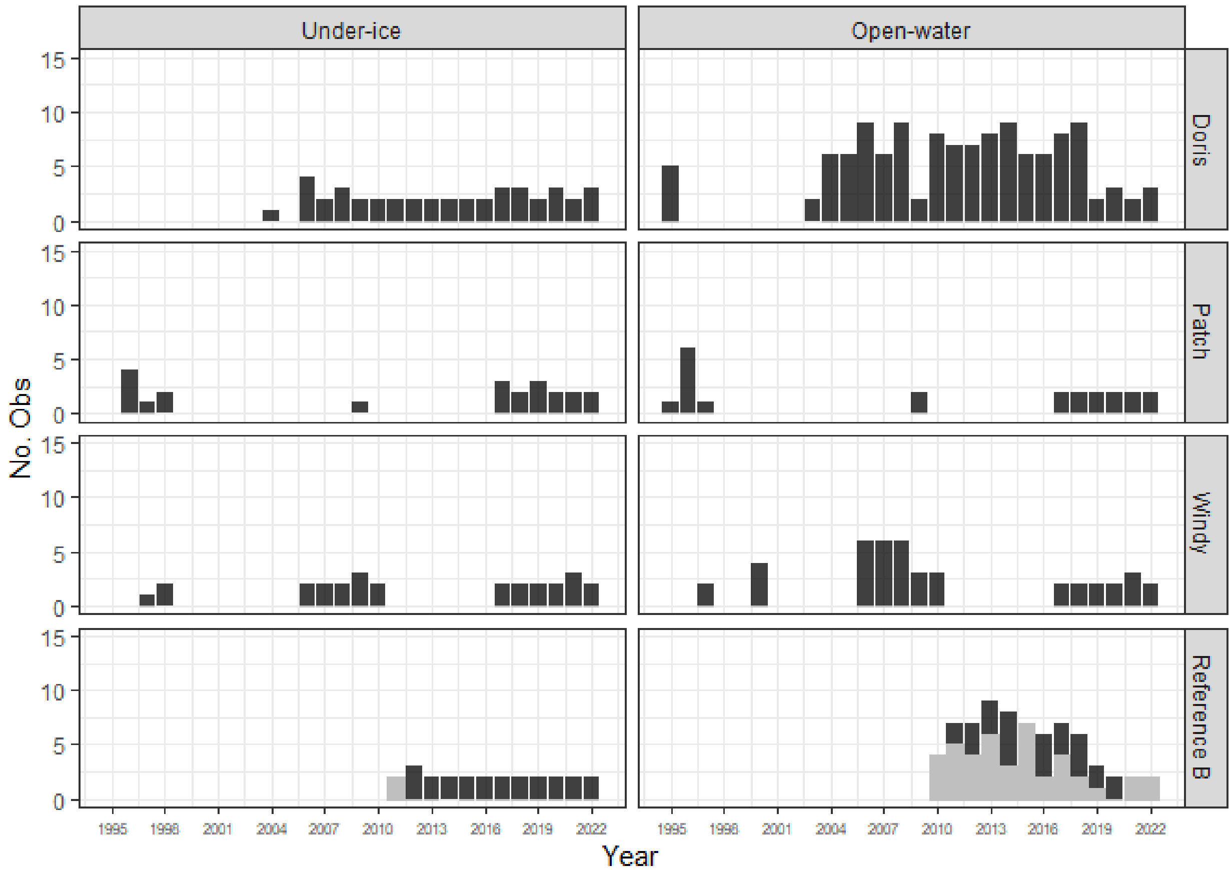
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

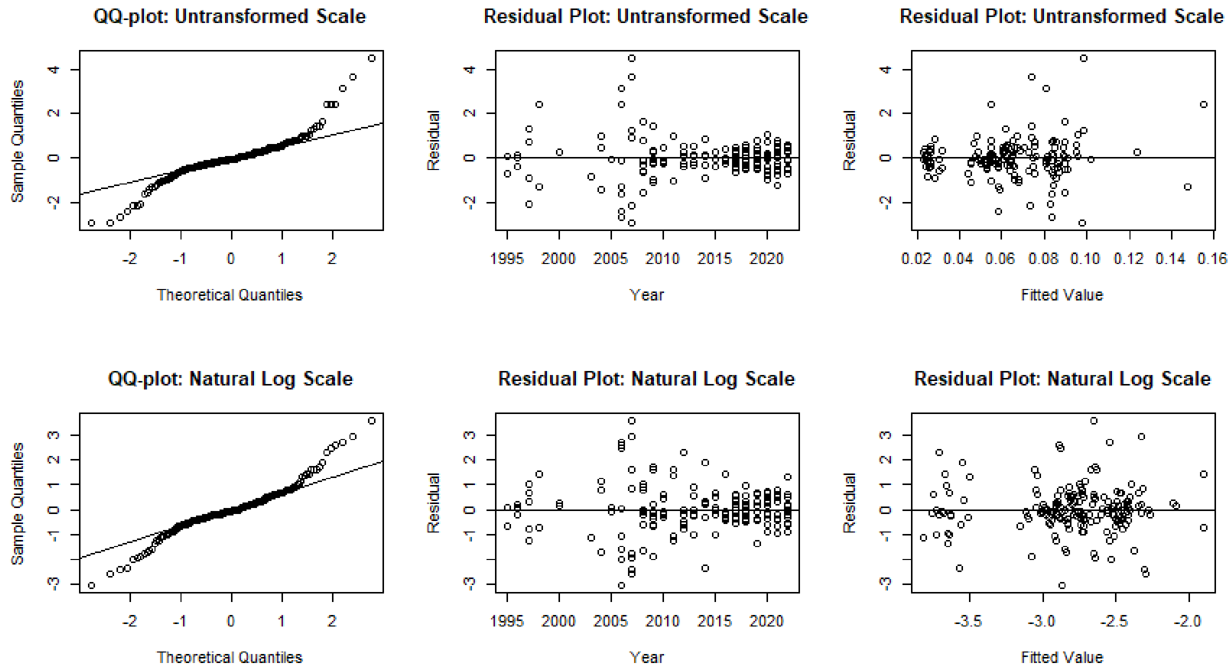
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs | # < DL | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 42 | 0 | 0 | 0 |
| Doris | Open-water | 123 | 0 | 0 | 0 |
| Patch | Under-ice | 22 | 0 | 0 | 0 |
| Patch | Open-water | 22 | 0 | 0 | 0 |
| Reference B | Under-ice | 25 | 2 | 8 | 0 |
| Reference B | Open-water | 70 | 42 | 60 | 100 |
| Windy | Under-ice | 27 | 0 | 0 | 0 |
| Windy | Open-water | 43 | 0 | 0 | 0 |

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.

### 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 |
|---|---|---|---|---|---|---|---|
| 17 | Doris | 2007 | Open-water | Surface | 0.0967 | 0.074 | 3.623 |
| 145 | Windy | 2006 | Under-ice | Deep | 0.1000 | 0.081 | 3.119 |
| 151 | Windy | 2007 | Open-water | Deep | 0.1267 | 0.099 | 4.495 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 12 | Doris | 2006 | Open-water | Deep | 0.0433 | -2.865 | -3.052 |
| 17 | Doris | 2007 | Open-water | Surface | 0.0967 | -2.656 | 3.561 |

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 5.901 | 4 | 0.20670 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

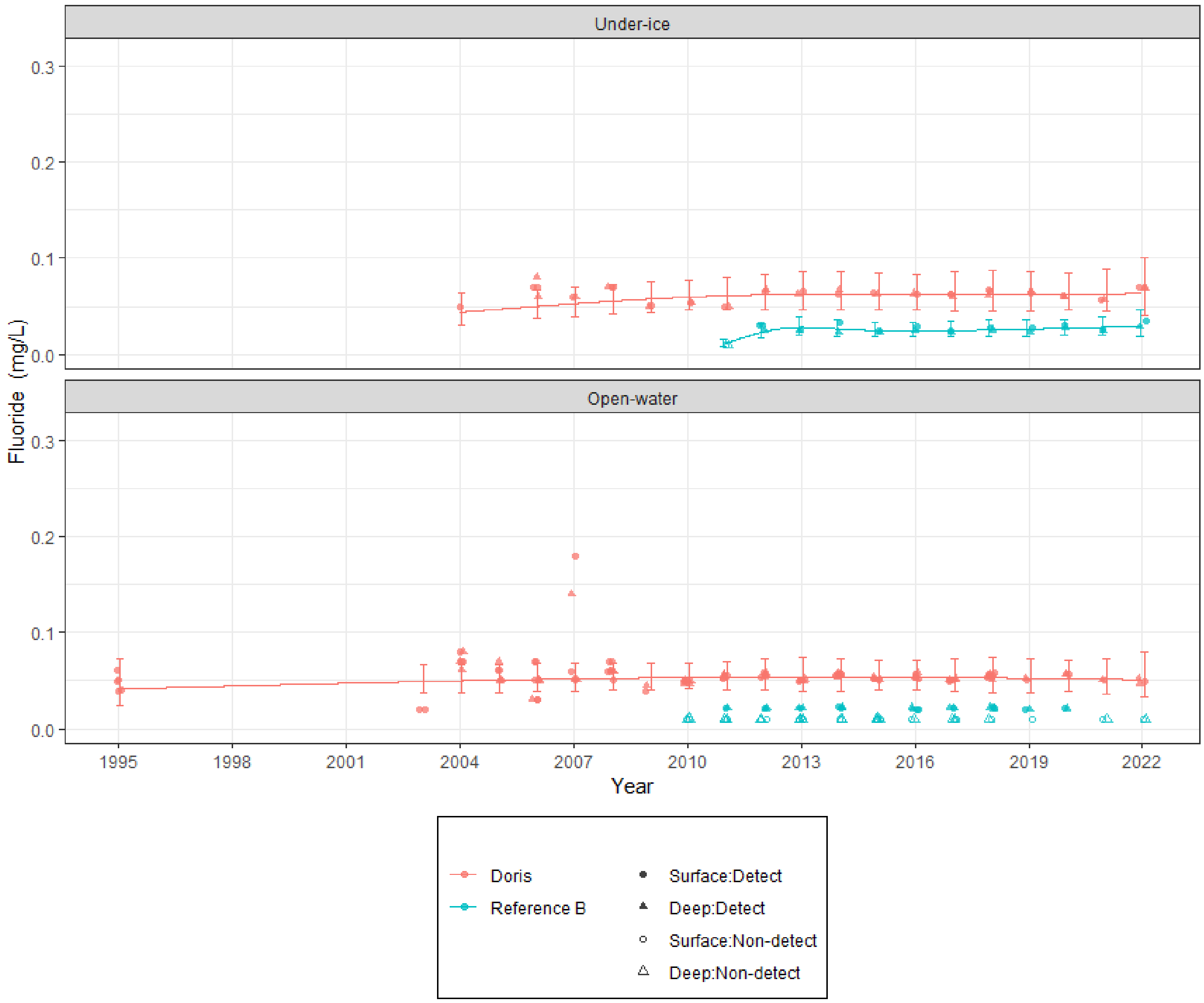
### *Open-water*

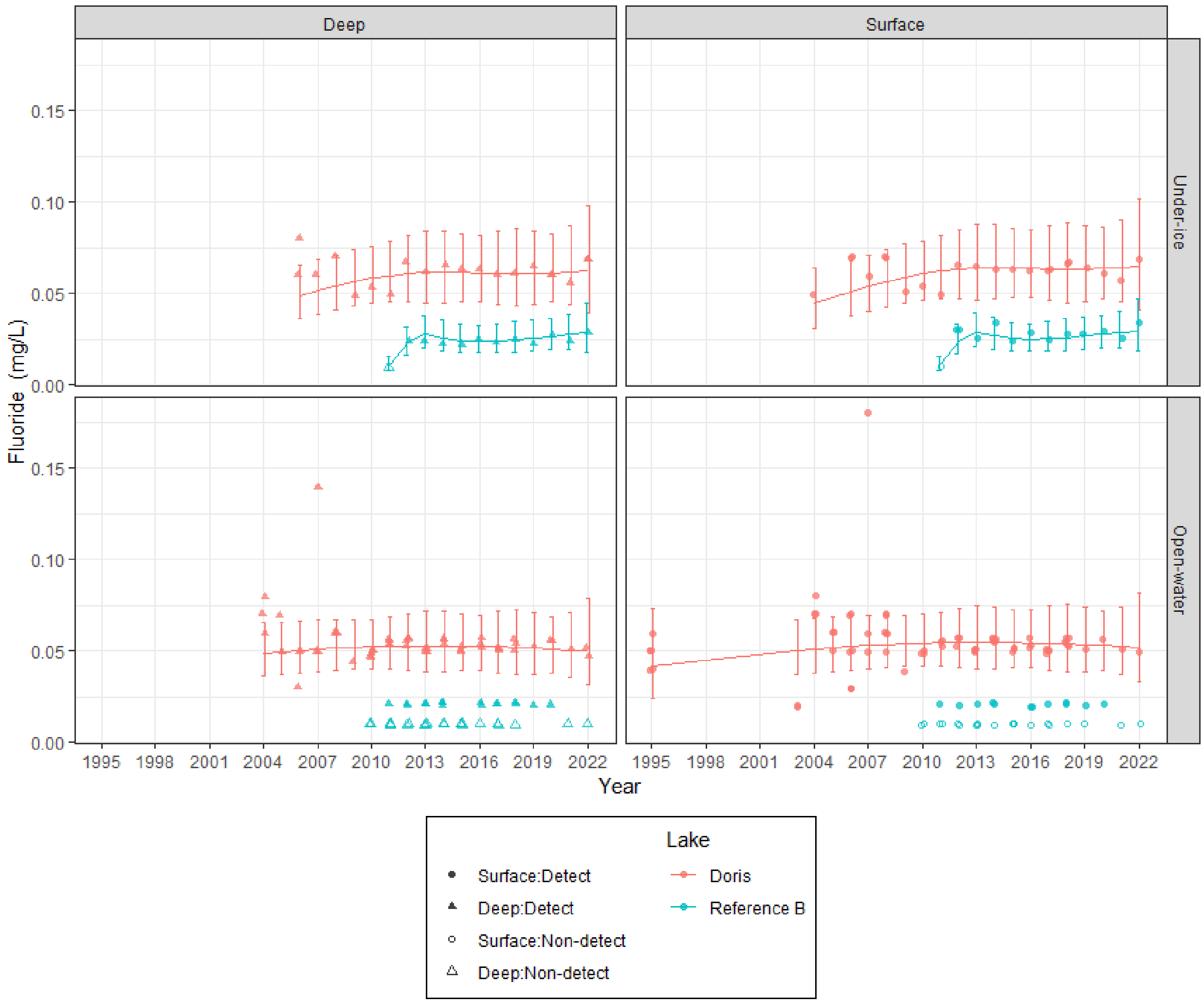
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 1.234 | 4 | 0.87250 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

#### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0352 | 0.1224 | 7.969 | 0.2874 | 0.7812 | not sig. |

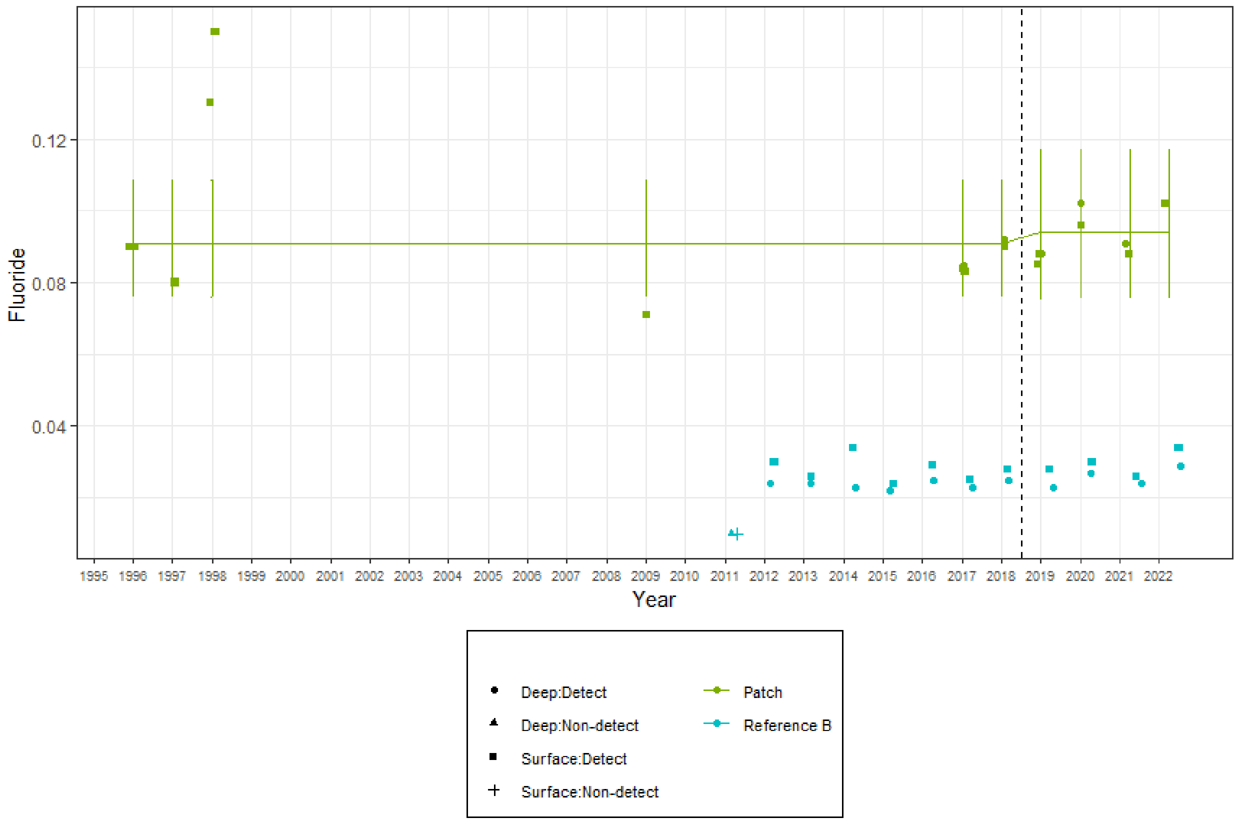
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0508 | 0.1311 | 7.98 | 0.3874 | 0.7086 | not sig. |

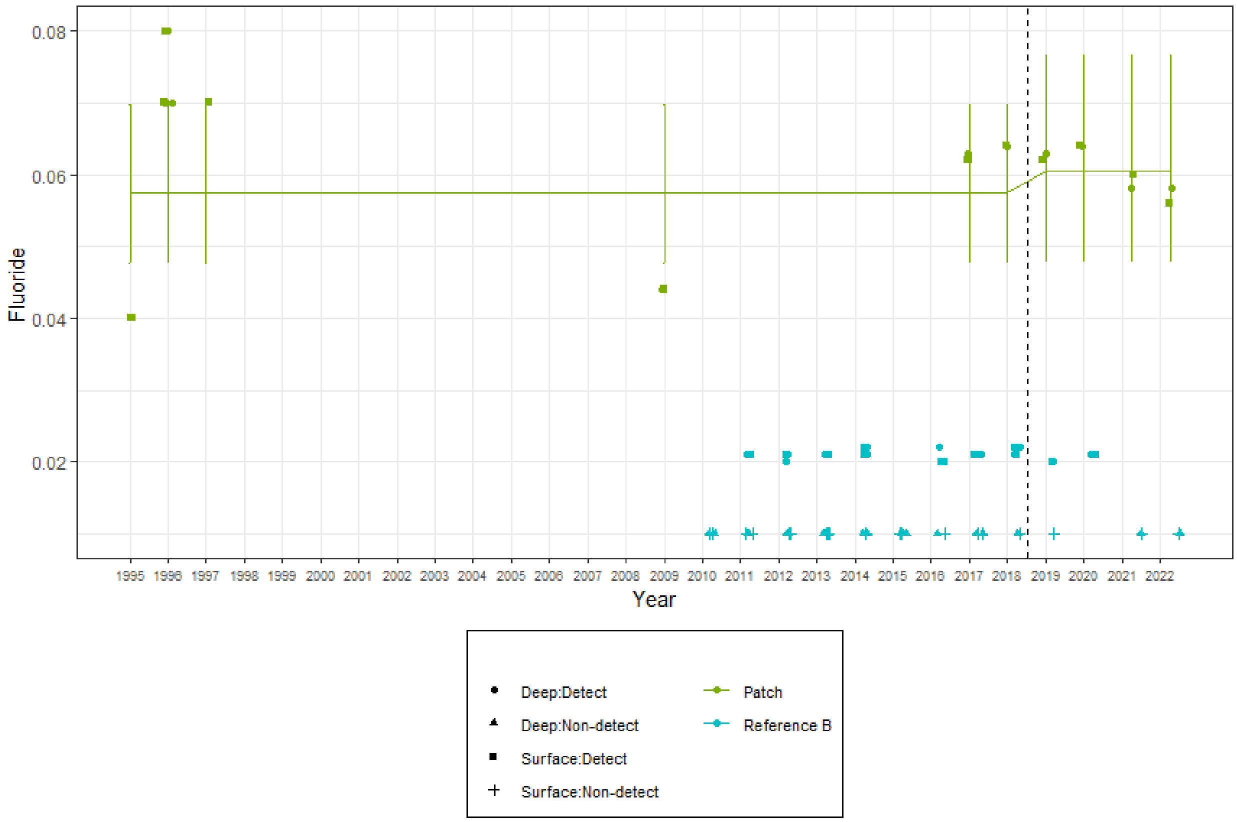
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0026 | 0.1279 | 9.793 | -0.02 | 0.9845 | not sig. |

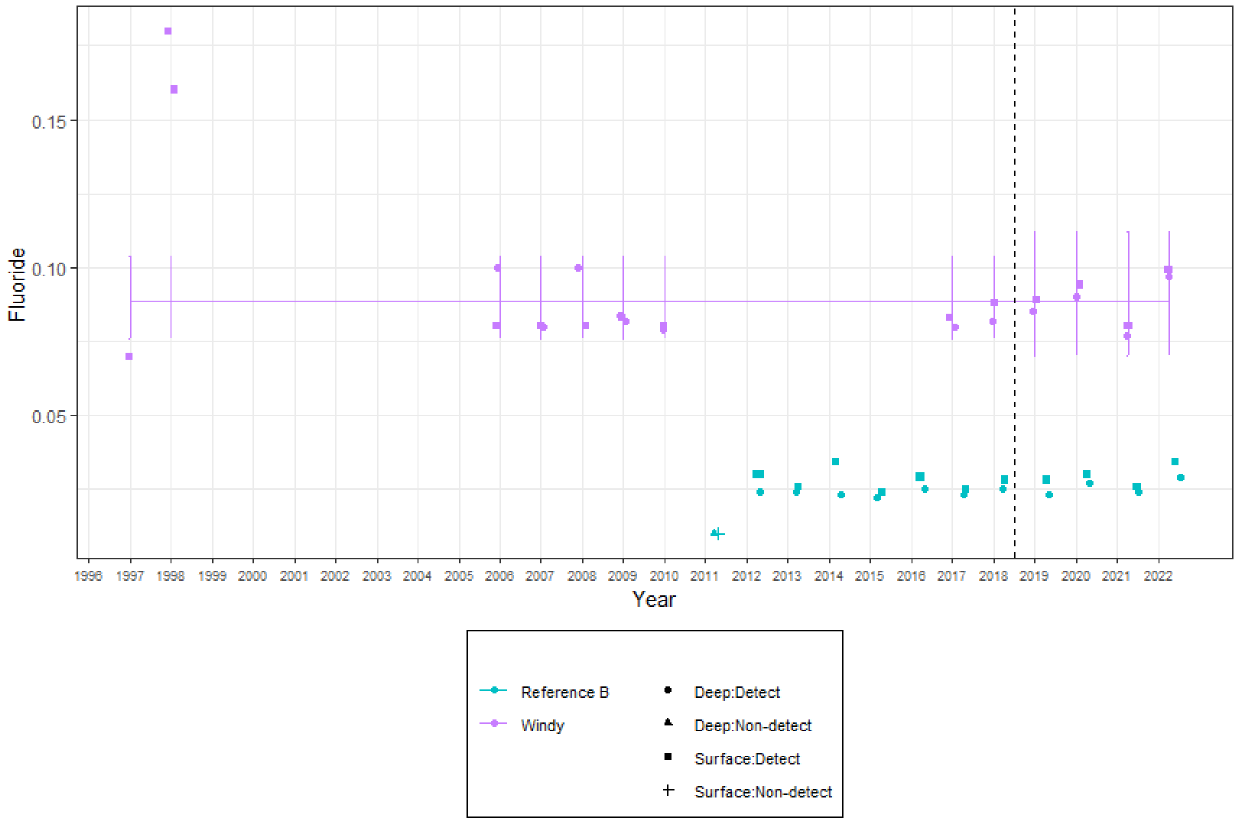
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0669 | 0.1204 | 11 | -0.5559 | 0.5894 | not sig. |

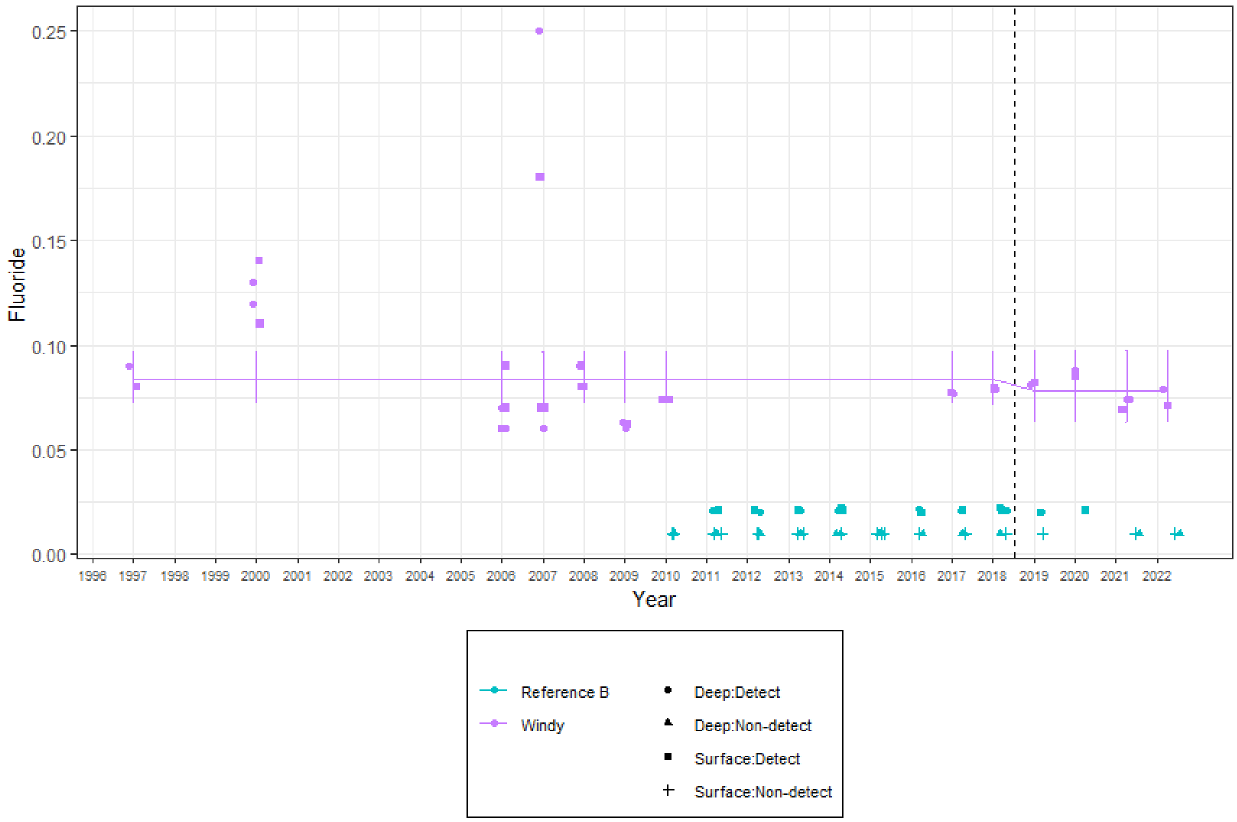
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.


Fluoride
0.25
0.20
0.15
0.10
0.05
0.00
1996
1997
1998
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2000
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2002
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2004
2005
2006
2007
2008
2009
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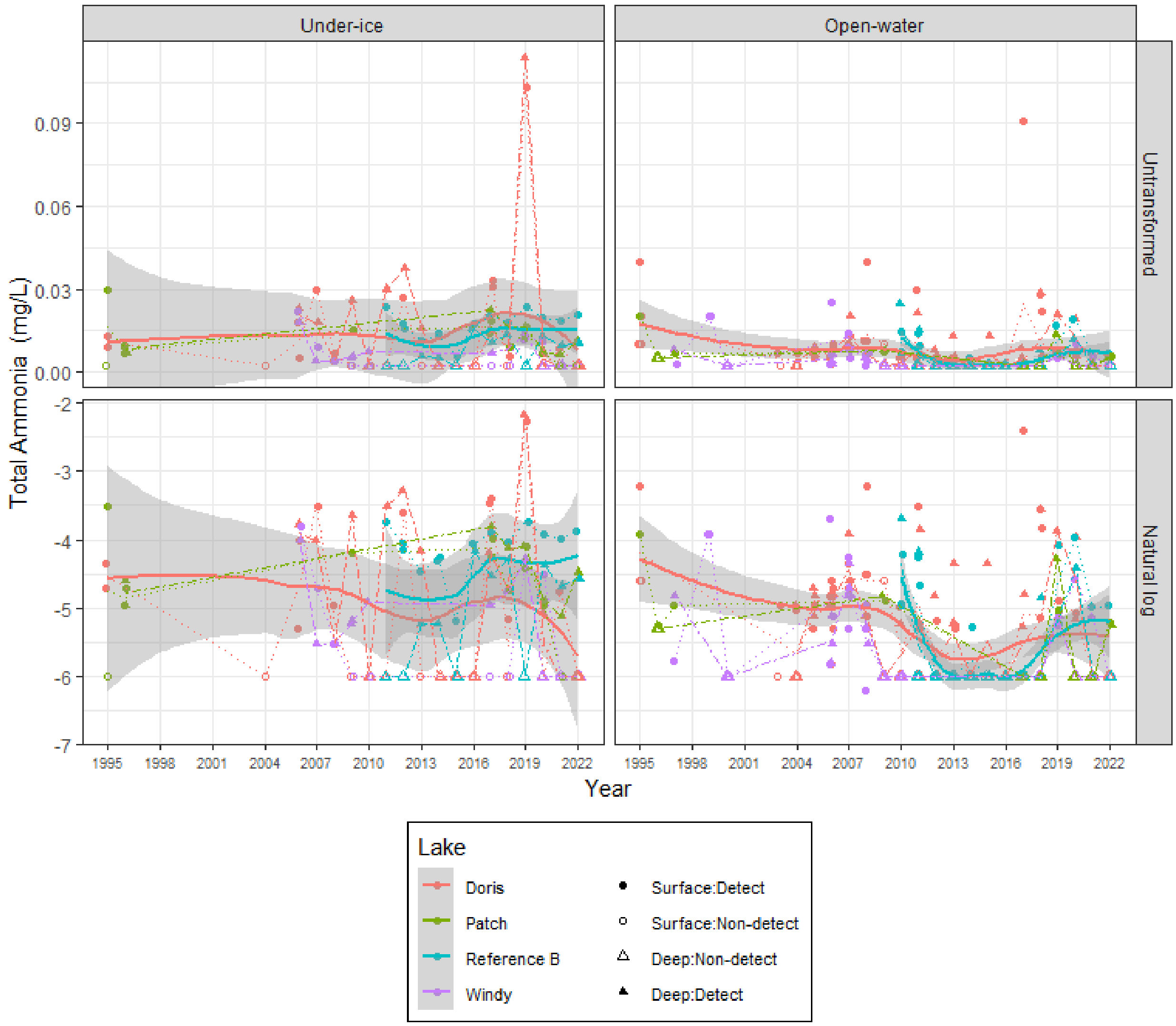
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

## *C.3.1.6 Total Ammonia*

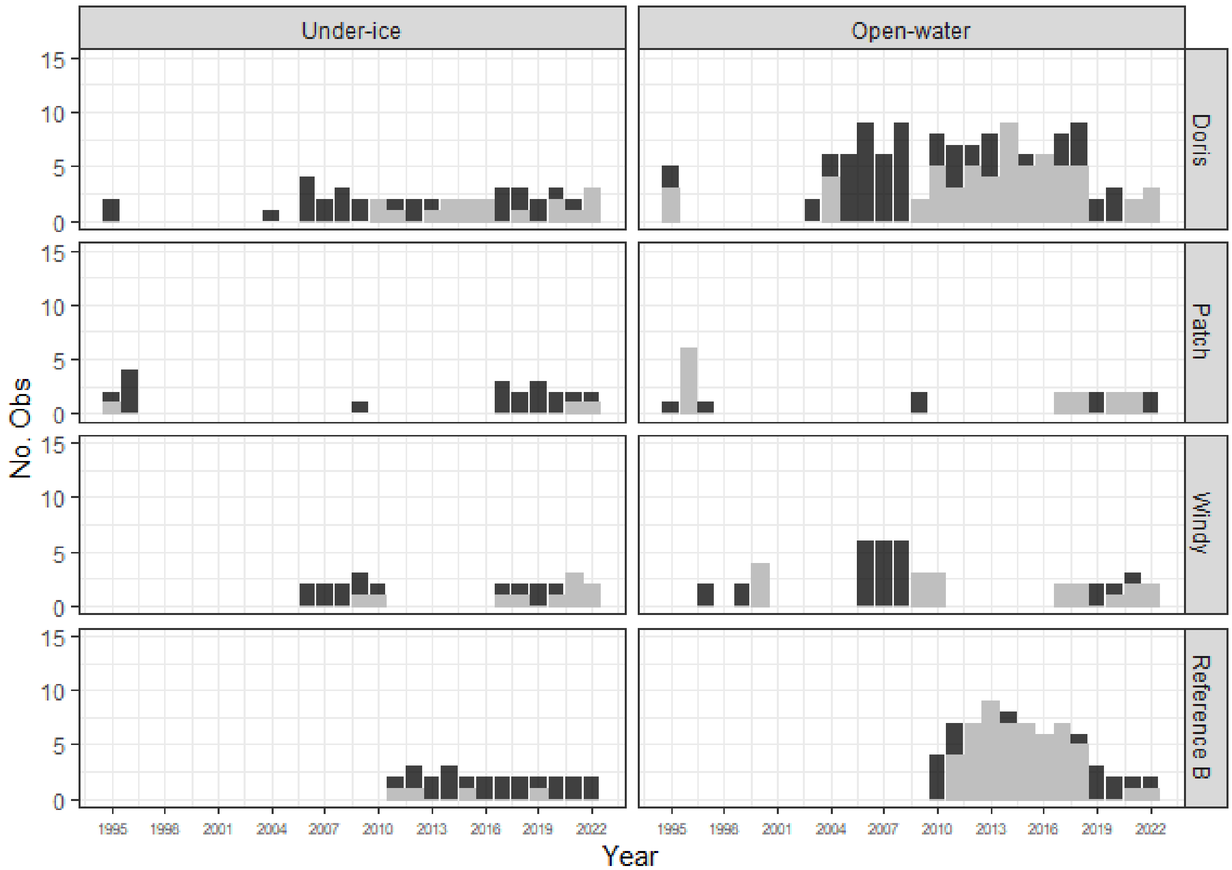
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

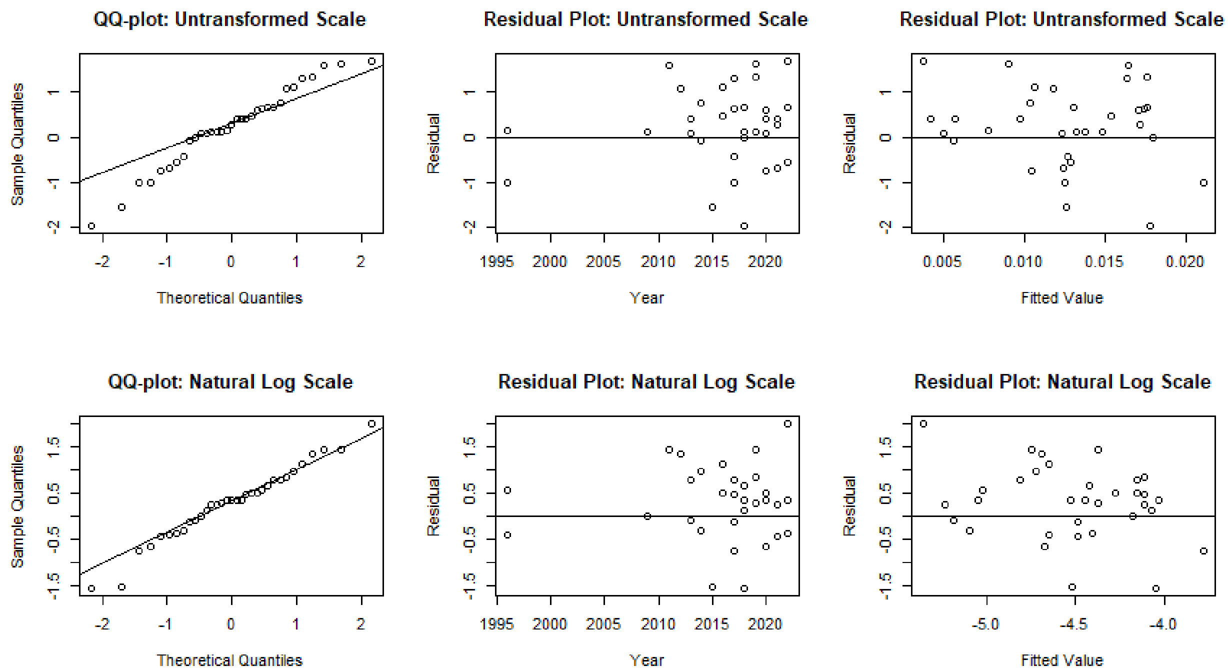
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 44 | 19 | 43 | 100 |
| Doris | Open-water | 123 | 62 | 50 | 100 |
| Patch | Under-ice | 21 | 3 | 14 | 50 |
| Patch | Open-water | 22 | 14 | 64 | 0 |
| Reference B | Under-ice | 26 | 4 | 15 | 0 |
| Reference B | Open-water | 70 | 54 | 77 | 50 |
| Windy | Under-ice | 24 | 10 | 42 | 100 |
| Windy | Open-water | 45 | 19 | 42 | 100 |

More than 50% of data under detection limit in Doris under-ice, 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, Doris open-water, Patch under-ice, 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 Lake.

### 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:

Outliers on natural log scale:

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

### Doris Lake

#### *Under-ice*

All data from Doris under-ice removed from the analysis. No analysis performed.

#### *Open-water*

All data from Doris Lake open-water removed from the analysis. No analysis performed.

### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0065 | 0.0032 | 7.138 | -2.034 | 0.0806 | not sig. |

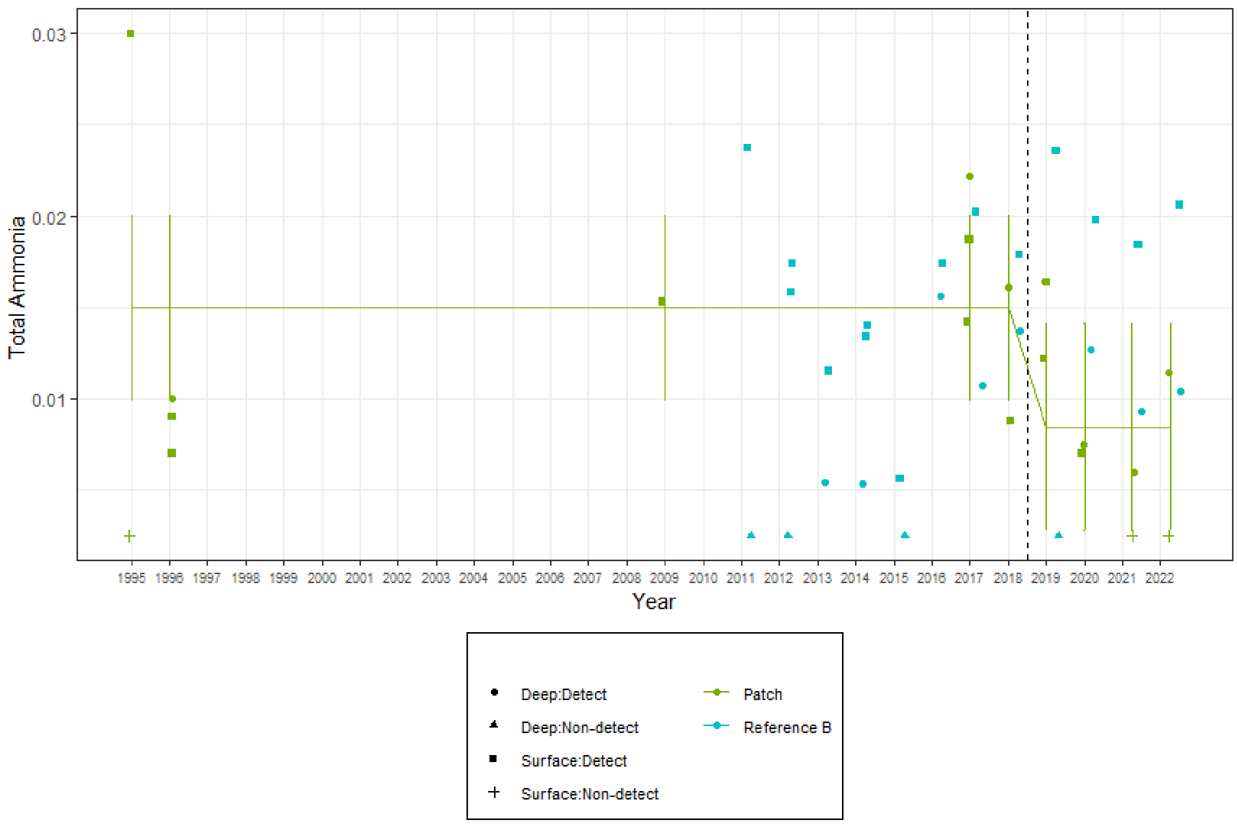
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

Analysis not performed.

### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

*Under-ice*

Analysis not performed.

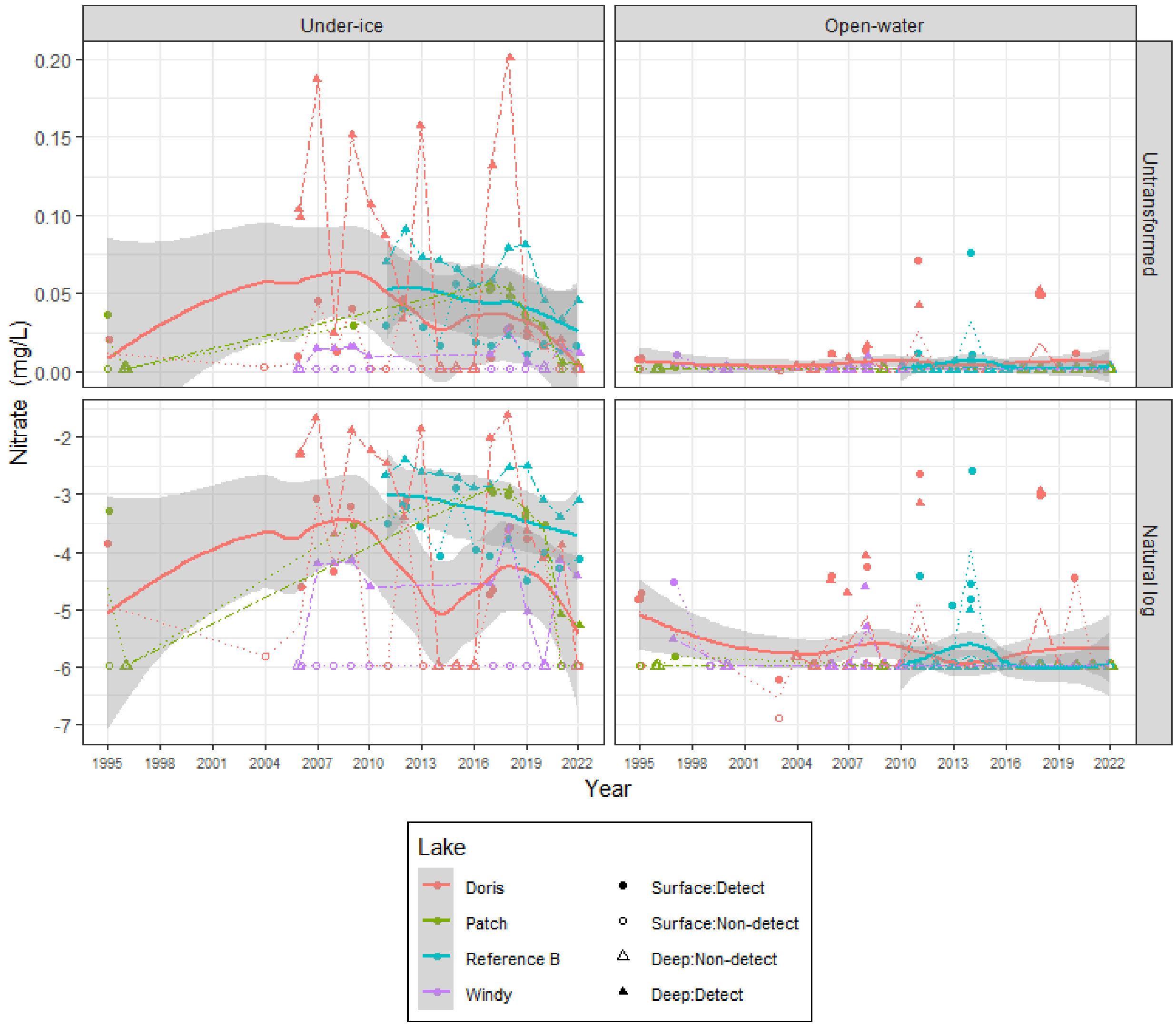
*Open-water*

Analysis not performed.

## *C.3.1.7 Nitrate*

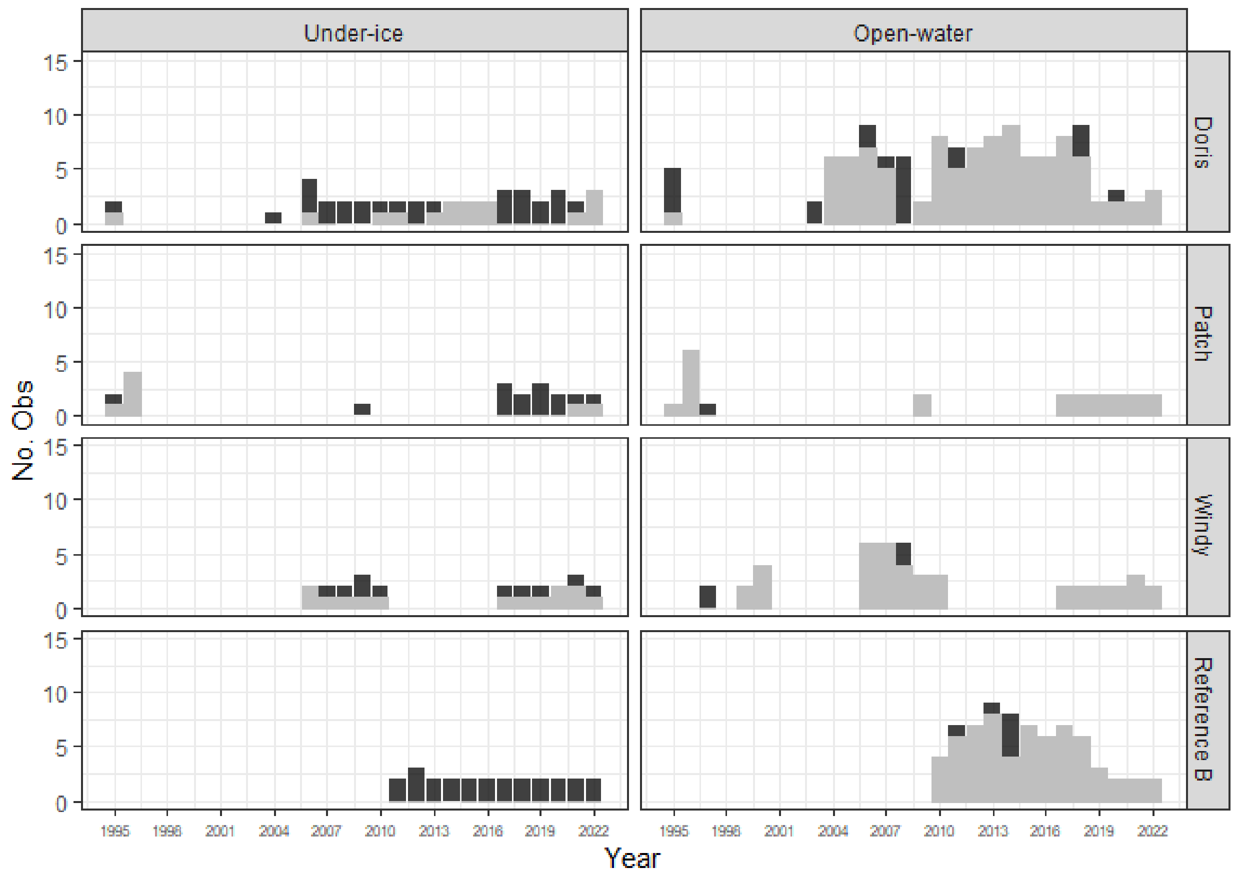
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

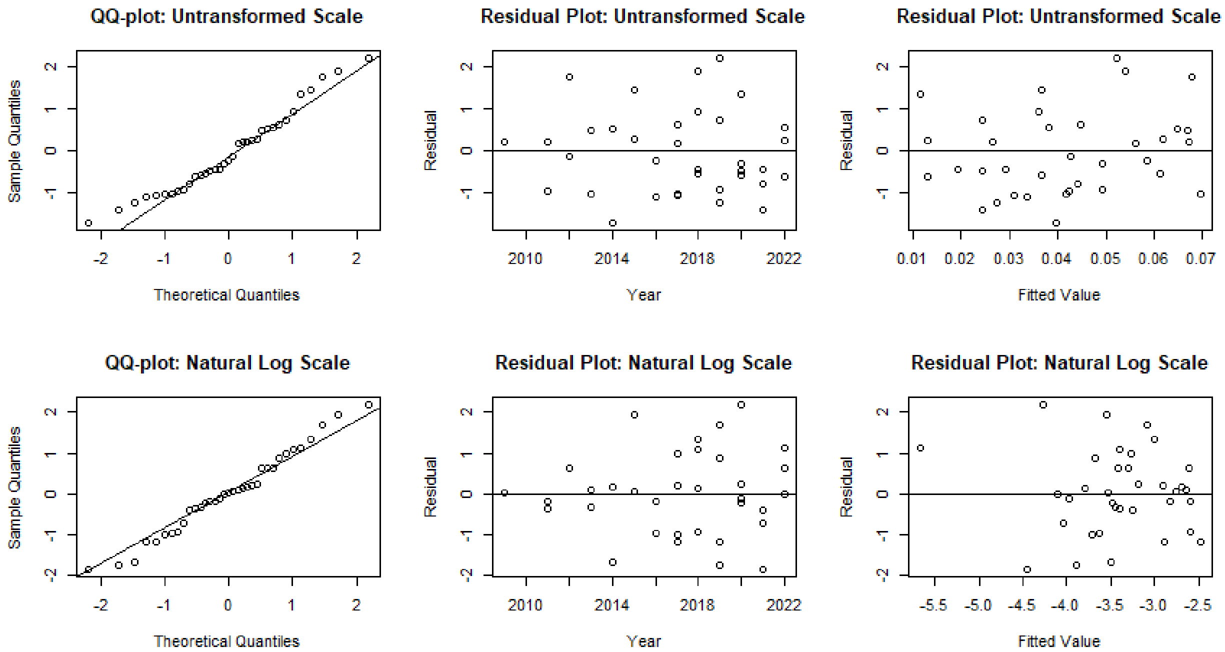
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 16 | 37 | 100 |
| Doris | Open-water | 120 | 103 | 86 | 100 |
| Patch | Under-ice | 21 | 7 | 33 | 50 |
| Patch | Open-water | 22 | 21 | 95 | 100 |
| Reference B | Under-ice | 25 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 64 | 91 | 100 |
| Windy | Under-ice | 24 | 14 | 58 | 50 |
| Windy | Open-water | 45 | 41 | 91 | 100 |

More than 50% of data under detection limit in Doris under-ice, 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 Lake.

### 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:

Outliers on natural log scale:

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

### Doris Lake

#### *Under-ice*

All data from Doris under-ice removed from the analysis. No analysis performed.

#### *Open-water*

All data from Doris Lake open-water removed from the analysis. No analysis performed.

### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

#### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0138 | 0.0132 | 7.007 | -1.046 | 0.3304 | not sig. |

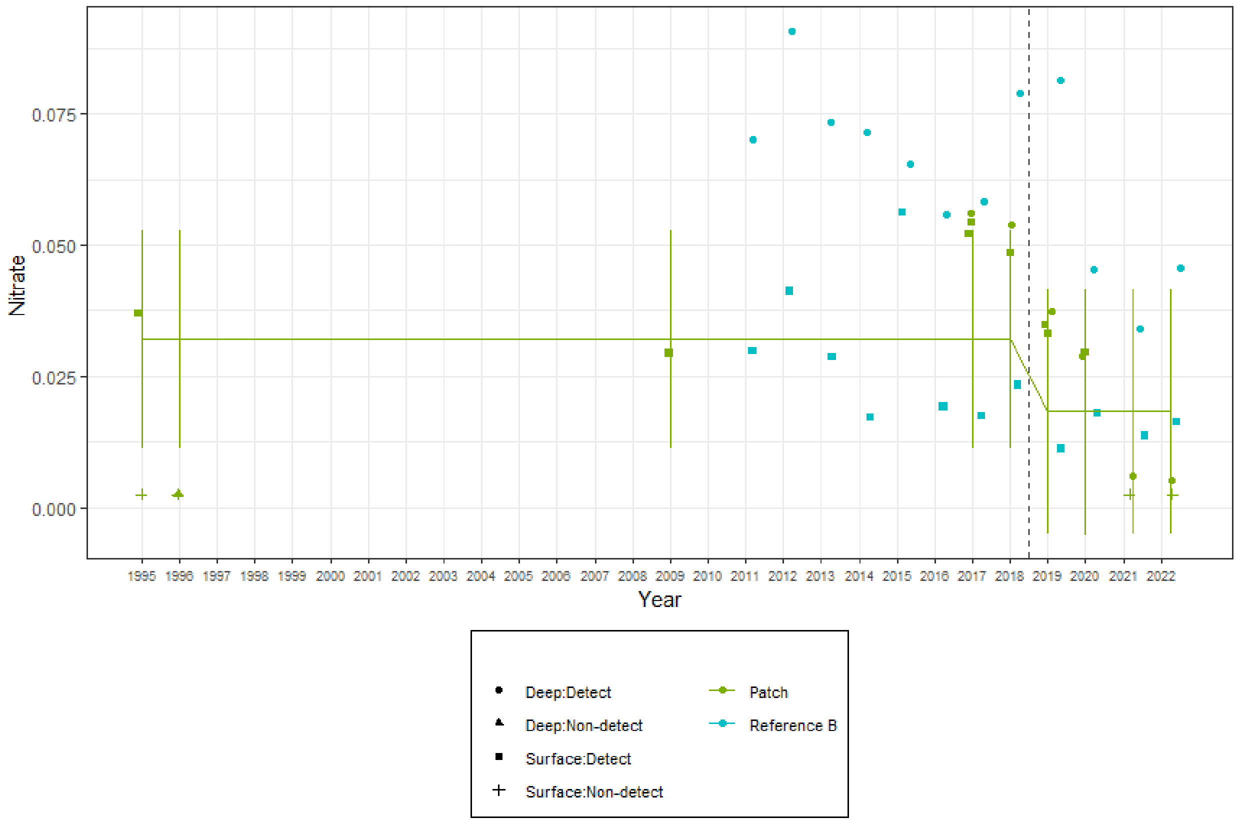
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water Before-vs-After Analysis*

Analysis not performed.

### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

*Under-ice*

Analysis not performed.

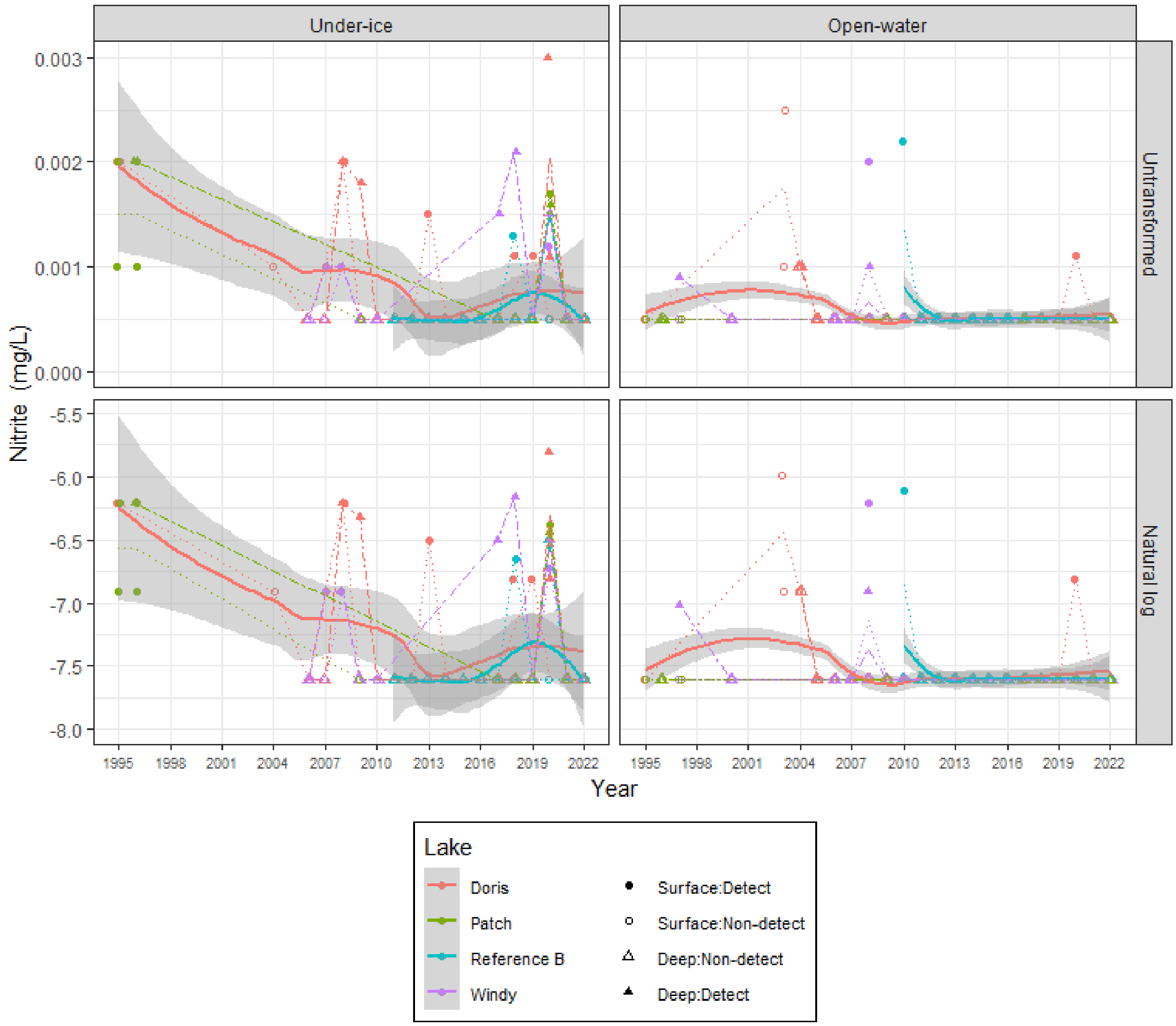
*Open-water*

Analysis not performed.

## *C.3.1.8 Nitrite*

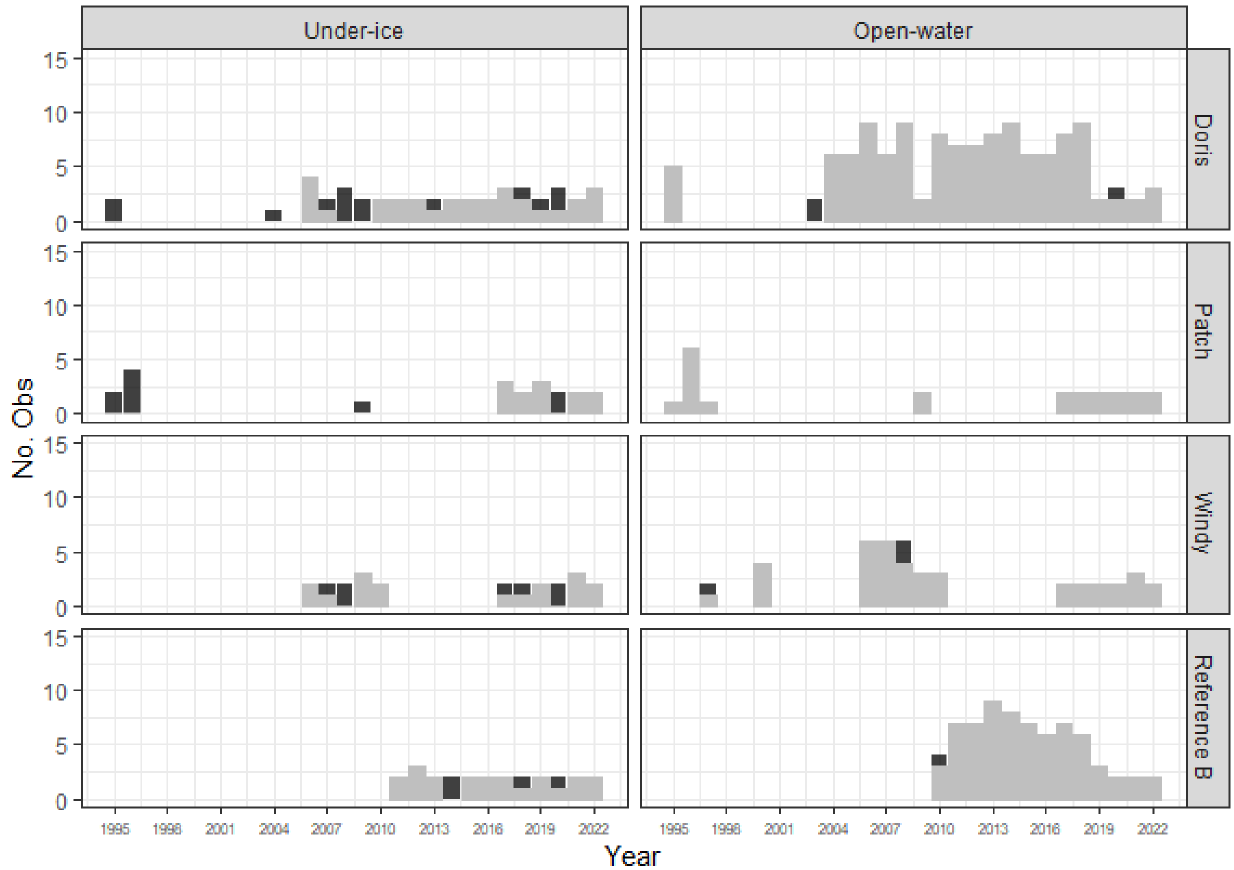
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

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

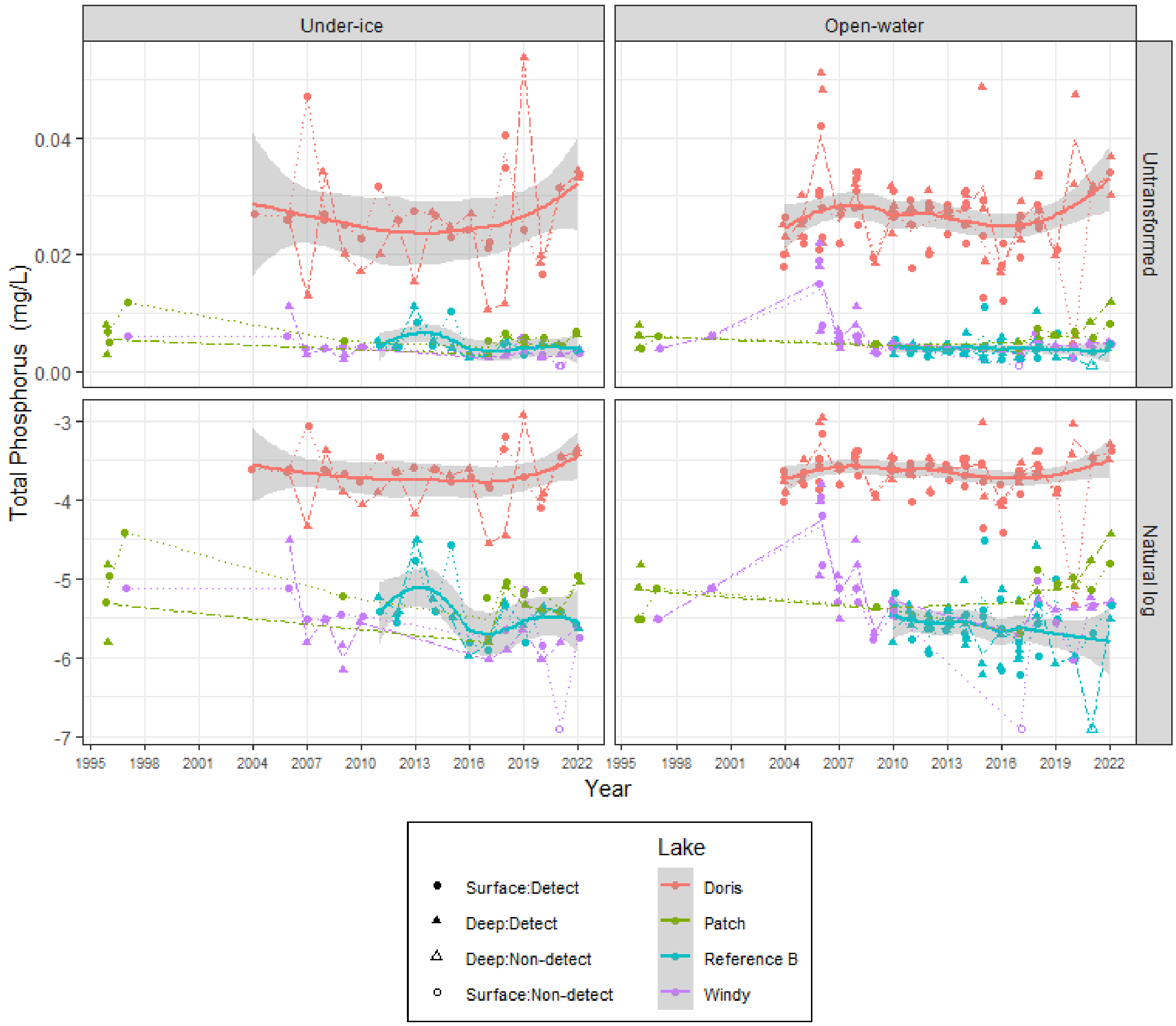
| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 44 | 32 | 73 | 100 |
| Doris | Open-water | 123 | 122 | 99 | 100 |
| Patch | Under-ice | 21 | 13 | 62 | 100 |
| Patch | Open-water | 22 | 22 | 100 | 100 |
| Reference B | Under-ice | 25 | 23 | 92 | 100 |
| Reference B | Open-water | 70 | 69 | 99 | 100 |
| Windy | Under-ice | 24 | 17 | 71 | 100 |
| Windy | Open-water | 43 | 40 | 93 | 100 |

All data from Doris, Patch and Windy in 2022 were censored. All data removed from the analysis and no statistical analyses were performed.

## *C.3.1.9 Total Phosphorus*

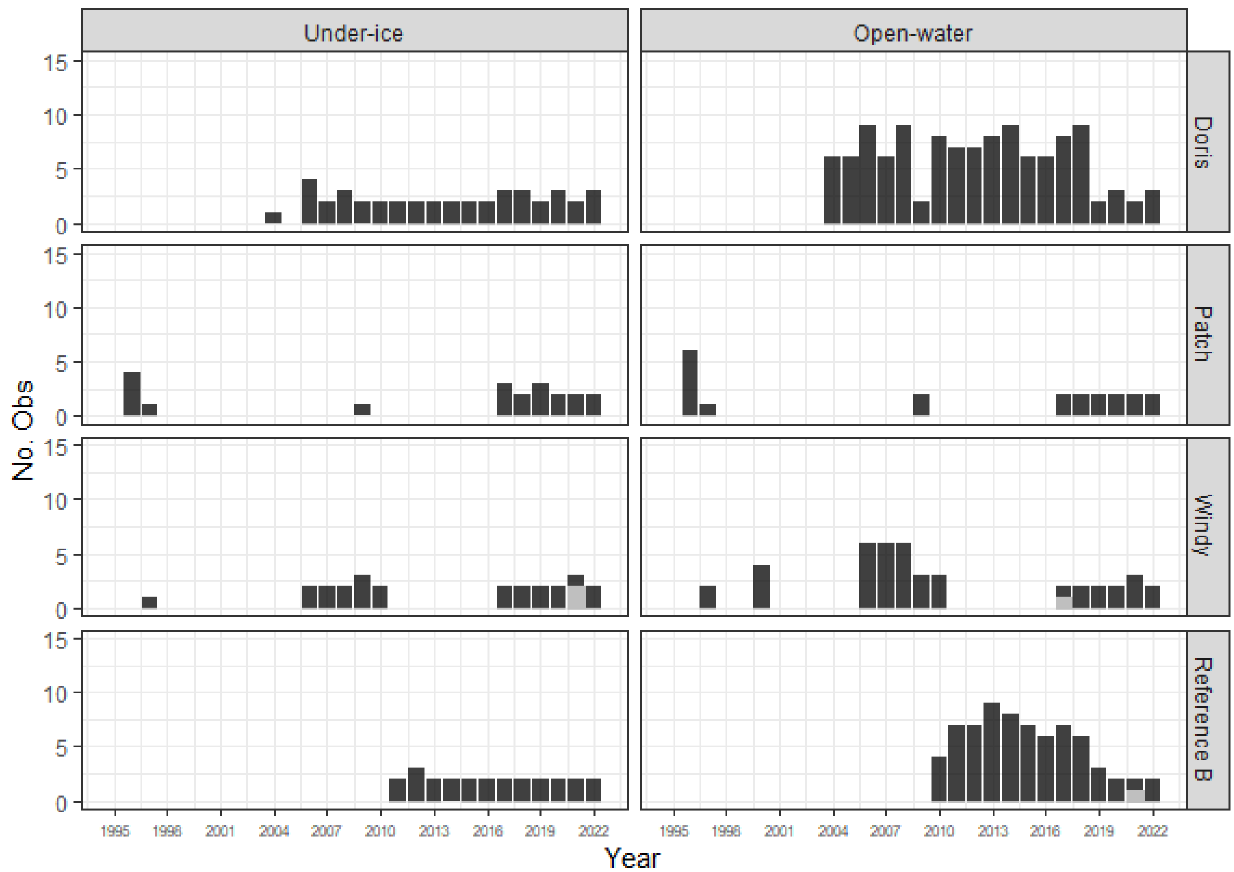
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

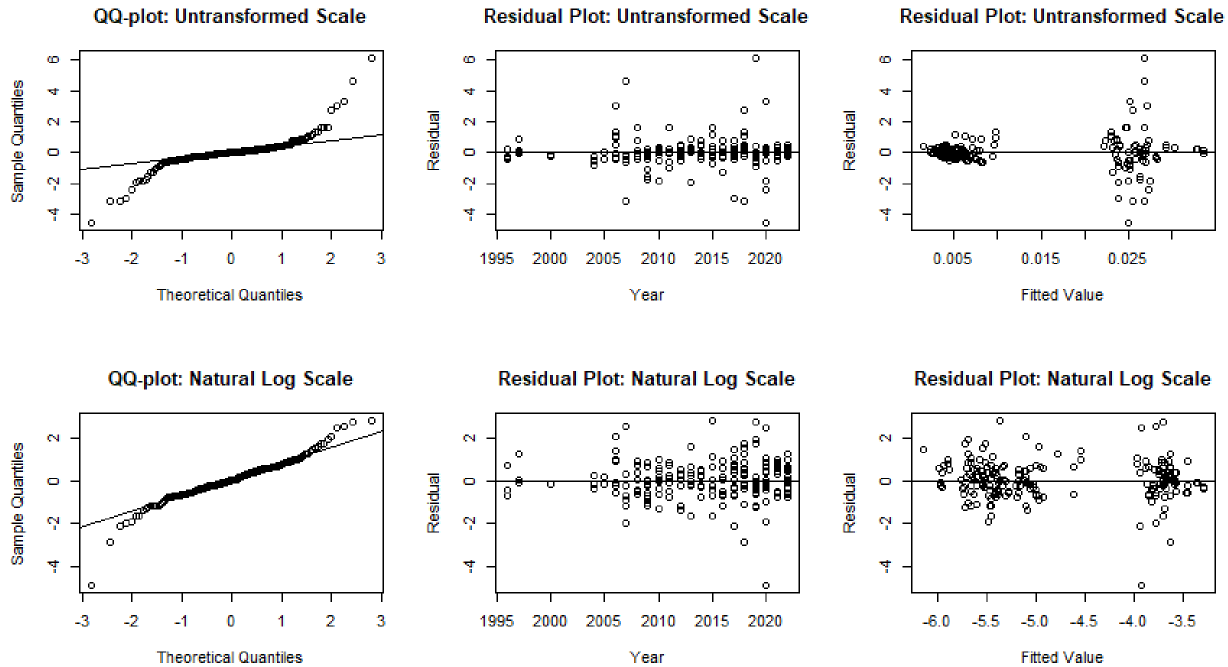
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 42 | 0 | 0 | 0 |
| Doris | Open-water | 116 | 0 | 0 | 0 |
| Patch | Under-ice | 20 | 0 | 0 | 0 |
| Patch | Open-water | 21 | 0 | 0 | 0 |
| Reference B | Under-ice | 25 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 1 | 1 | 0 |
| Windy | Under-ice | 25 | 2 | 8 | 0 |
| Windy | Open-water | 43 | 1 | 2 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 14 | Doris | 2007 | Under-ice | Deep | 0.0130 | 0.027 | -3.137 |
| 15 | Doris | 2007 | Under-ice | Surface | 0.0470 | 0.027 | 4.595 |
| 54 | Doris | 2017 | Under-ice | Deep | 0.0105 | 0.024 | -3.007 |
| 58 | Doris | 2018 | Under-ice | Deep | 0.0116 | 0.026 | -3.161 |
| 62 | Doris | 2019 | Under-ice | Deep | 0.0537 | 0.027 | 6.117 |
| 68 | Doris | 2020 | Open-water | Deep | 0.0397 | 0.025 | 3.302 |
| 69 | Doris | 2020 | Open-water | Surface | 0.0048 | 0.025 | -4.595 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 69 | Doris | 2020 | Open-water | Surface | 0.0048 | -3.931 | -4.882 |

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

### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 3.761 | 4 | 0.43940 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

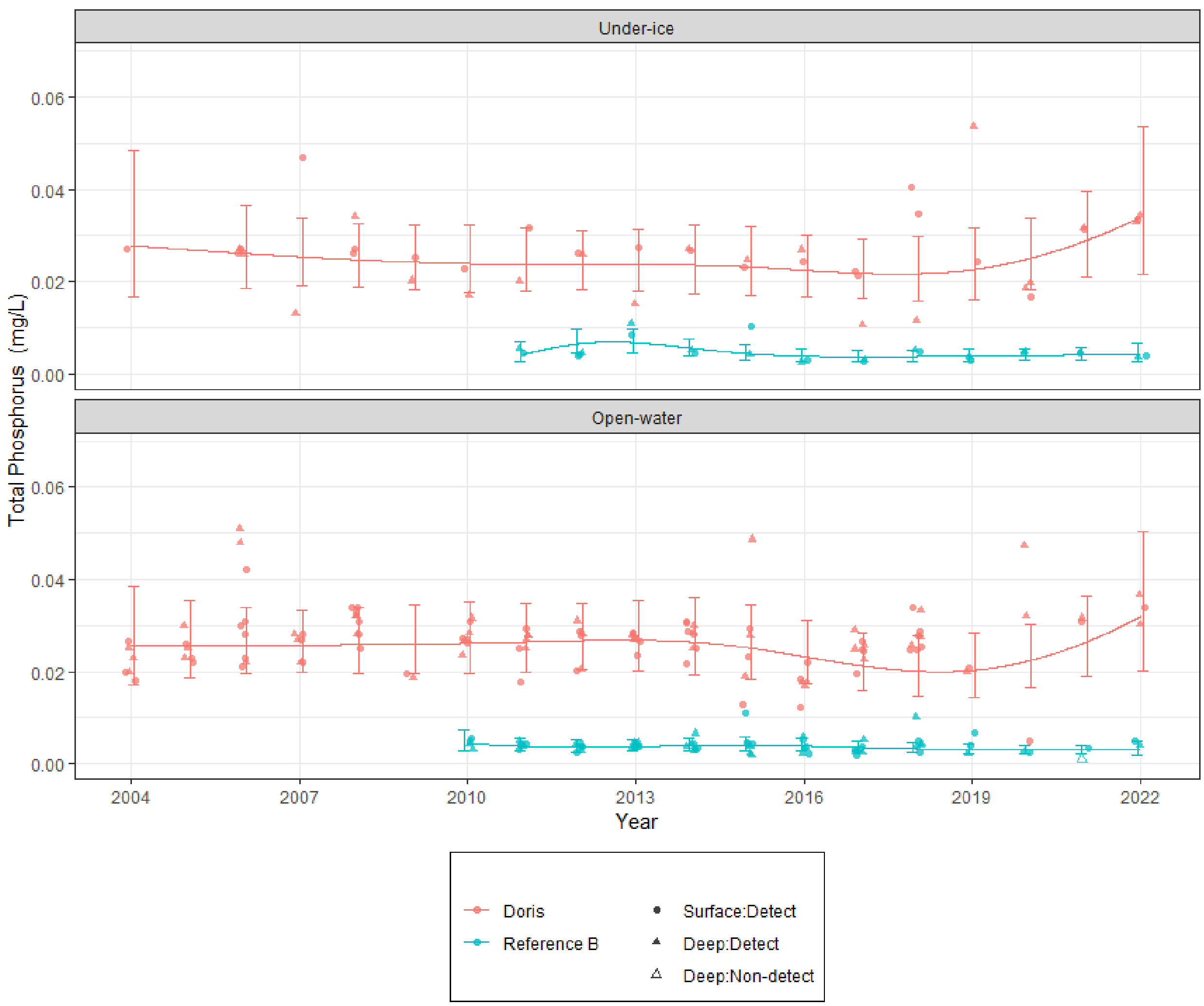
### *Open-water*

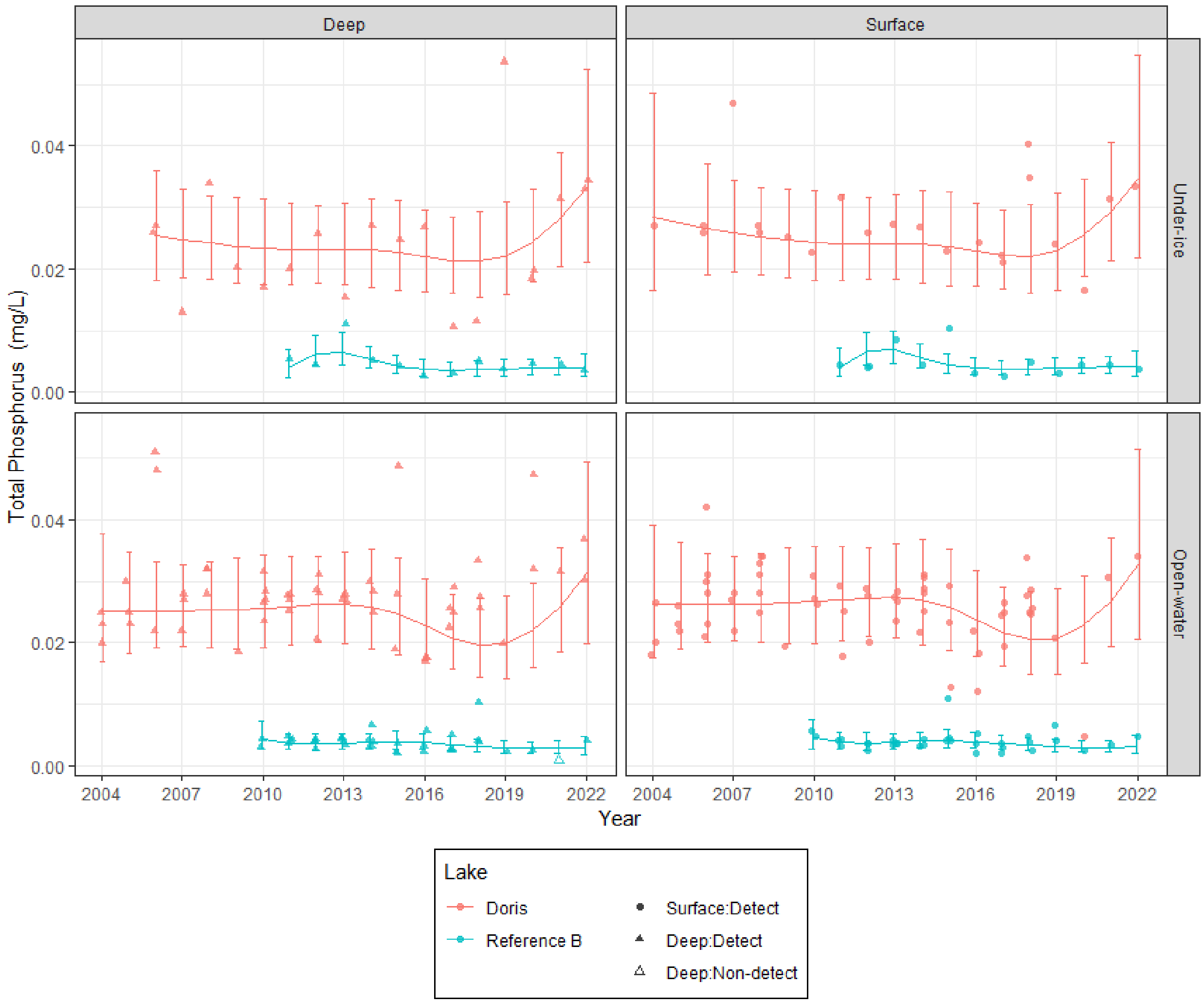
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 4.242 | 4 | 0.37430 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

#### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.1106 | 0.2223 | 6.836 | -0.4977 | 0.6343 | not sig. |

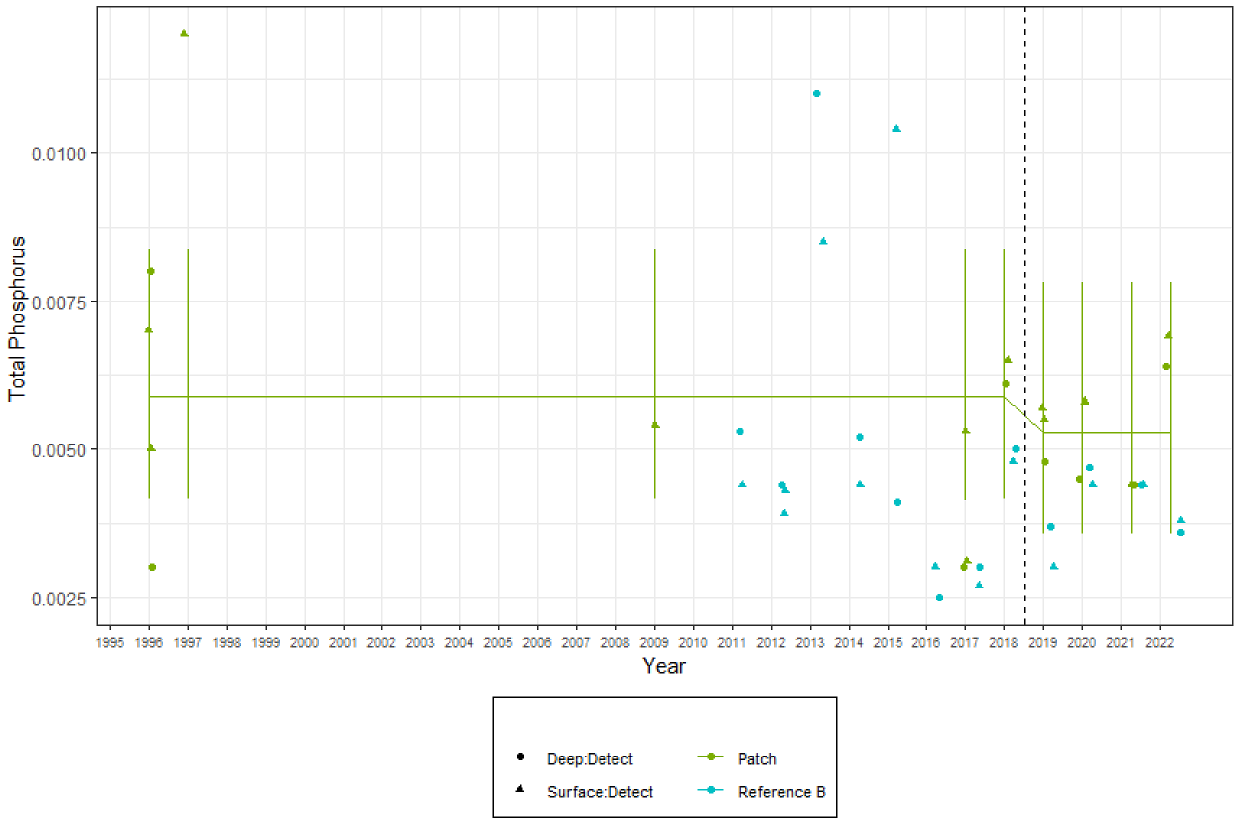
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.3384 | 0.1389 | 6.849 | 2.436 | 0.0458 | sig. |

Conclusion:

The change in concentrations at Patch Lake from before to after was significantly different.

*BACI Analysis*

Results of the ANOVA test on the fixed effects of the model:

| | Sum Sq. | Mean Sq. | NumDF | DenDF | F value | p |
|---|---|---|---|---|---|---|
| class | 2.0274 | 2.0274 | 1 | 15 | 16.9711 | <0.001 |
| period | 0.0018 | 0.0018 | 1 | 4 | 0.0147 | 0.909 |
| Depth.Zone | 0.0343 | 0.0343 | 1 | 15 | 0.2875 | 0.6 |
| class:period | 0.4894 | 0.4894 | 1 | 15 | 4.0965 | 0.0612 |

Estimated marginal means for site class by period:

| Class | Period | LSmean | SE | DF | LowerCL | UpperCL |
|---|---|---|---|---|---|---|
| Monitored | after | -4.928 | 0.1649 | 7.322 | -5.315 | -4.542 |
| Reference | after | -5.848 | 0.1649 | 7.322 | -6.234 | -5.461 |
| Monitored | before | -5.261 | 0.2332 | 7.322 | -5.807 | -4.714 |
| Reference | before | -5.574 | 0.2332 | 7.322 | -6.121 | -5.028 |

Results are given on the natural log scale.

Summary of BACI contrasts for relative difference between changes from the before to after in Patch and Reference Lake B, with 95% confidence intervals:

| Patch vs: | Estimate | Lower C.I. | Upper C.I. | Significance |
|---|---|---|---|---|
| Reference Sites | 0.6058 | -0.0322 | 1.244 | not sig. |

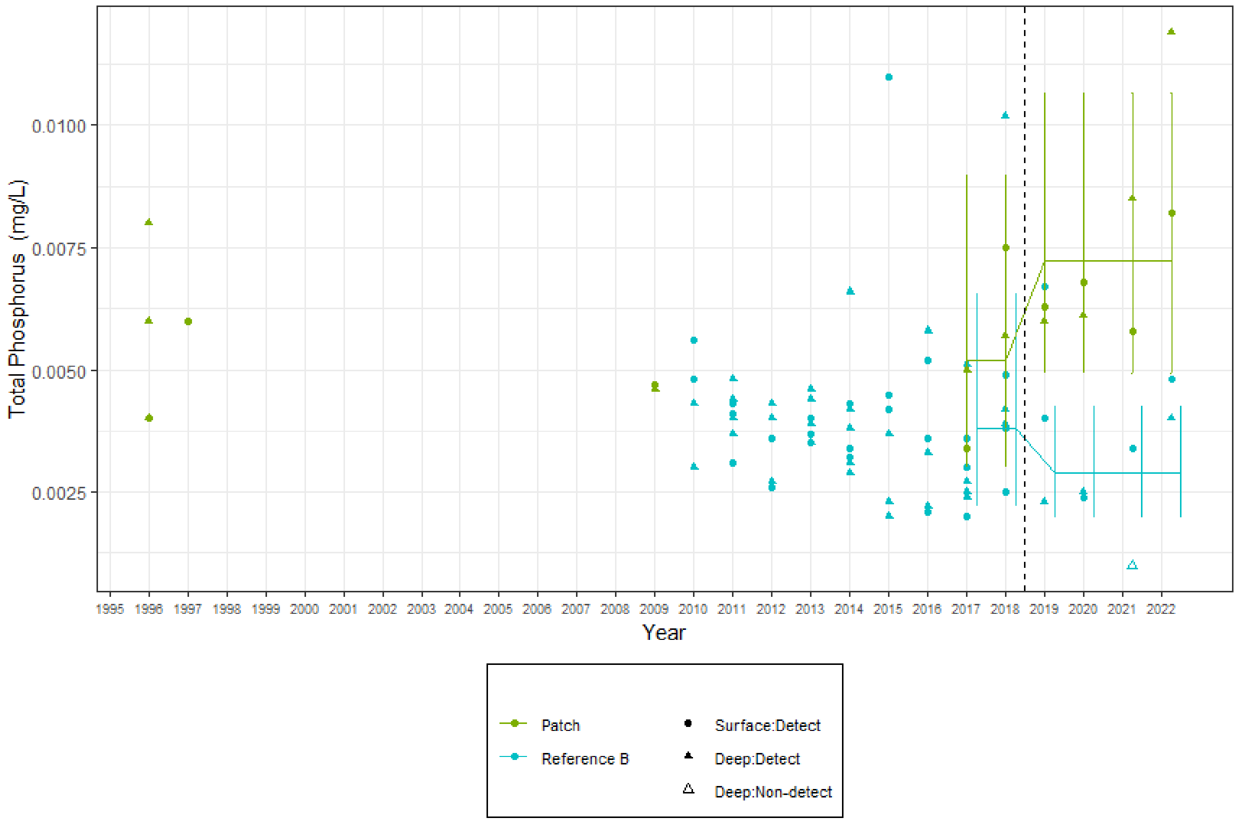
A BACI contrast is identified as significant if the confidence interval does not include 0.

Conclusion:

The change in Total Phosphorus concentrations at the Patch site from before to after was not significantly ($p$ = 0.061) different from the change at Reference Lake B, according to the test on the BACI term (*class:period*).

### *Observed Data and Fitted Values for Comparable Sampling Years*

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 and hollow symbols 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 monitored and reference sites.




## Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.3229 | 0.2287 | 9.761 | -1.412 | 0.1891 | not sig. |

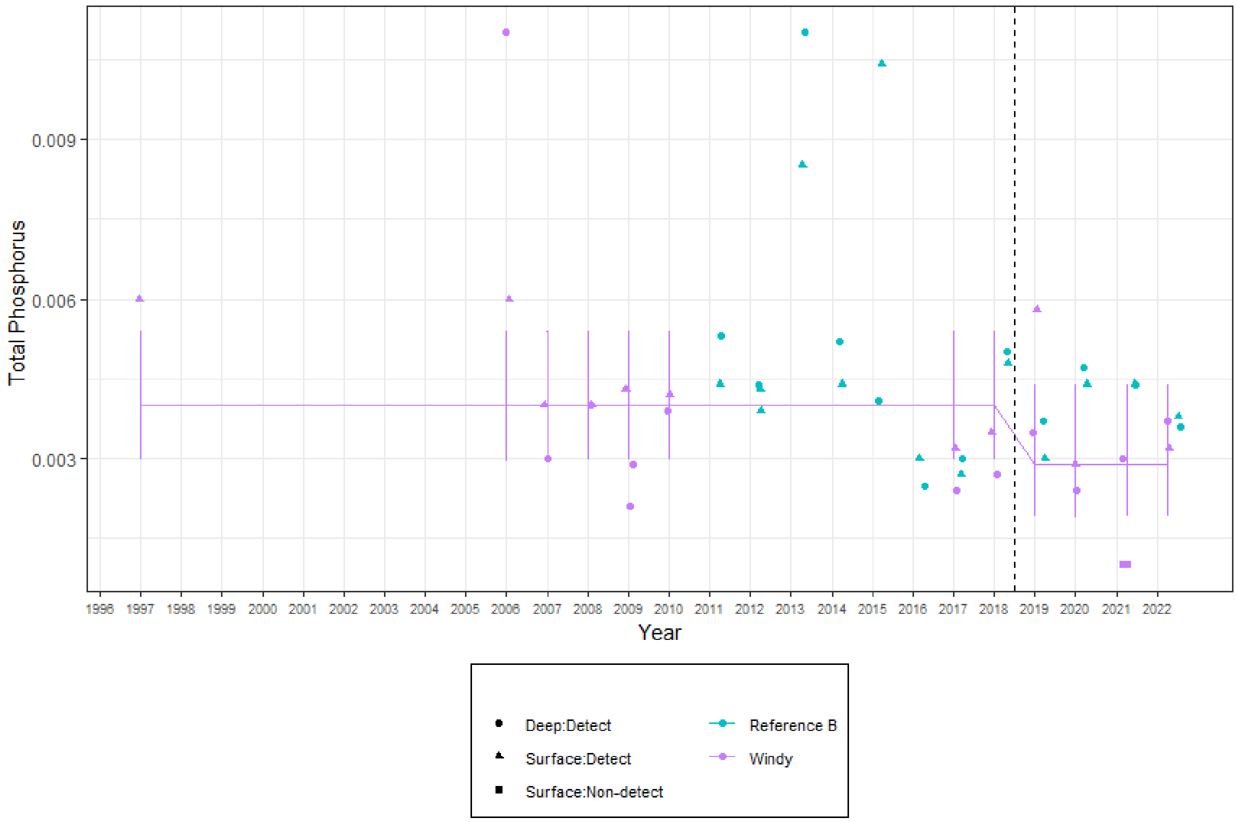
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.1678 | 0.2985 | 11 | -0.562 | 0.5854 | not sig. |

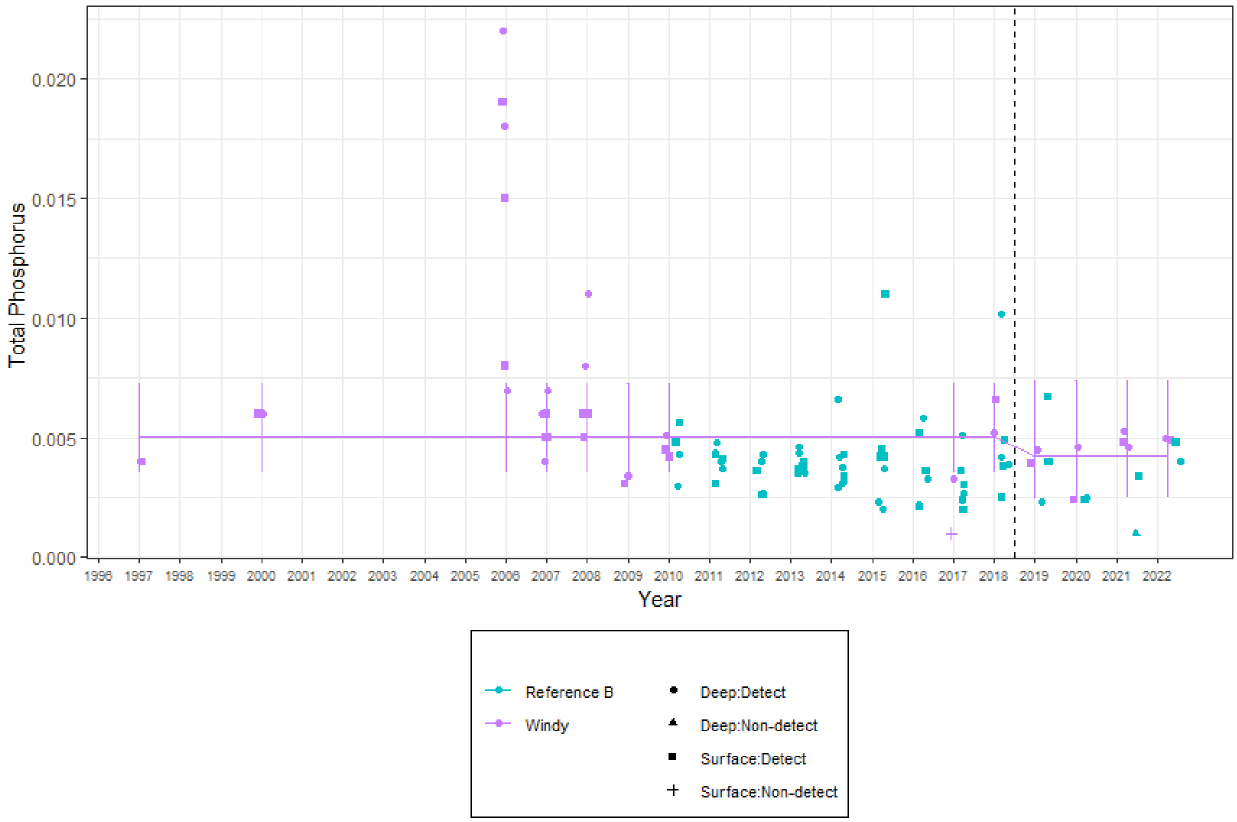
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

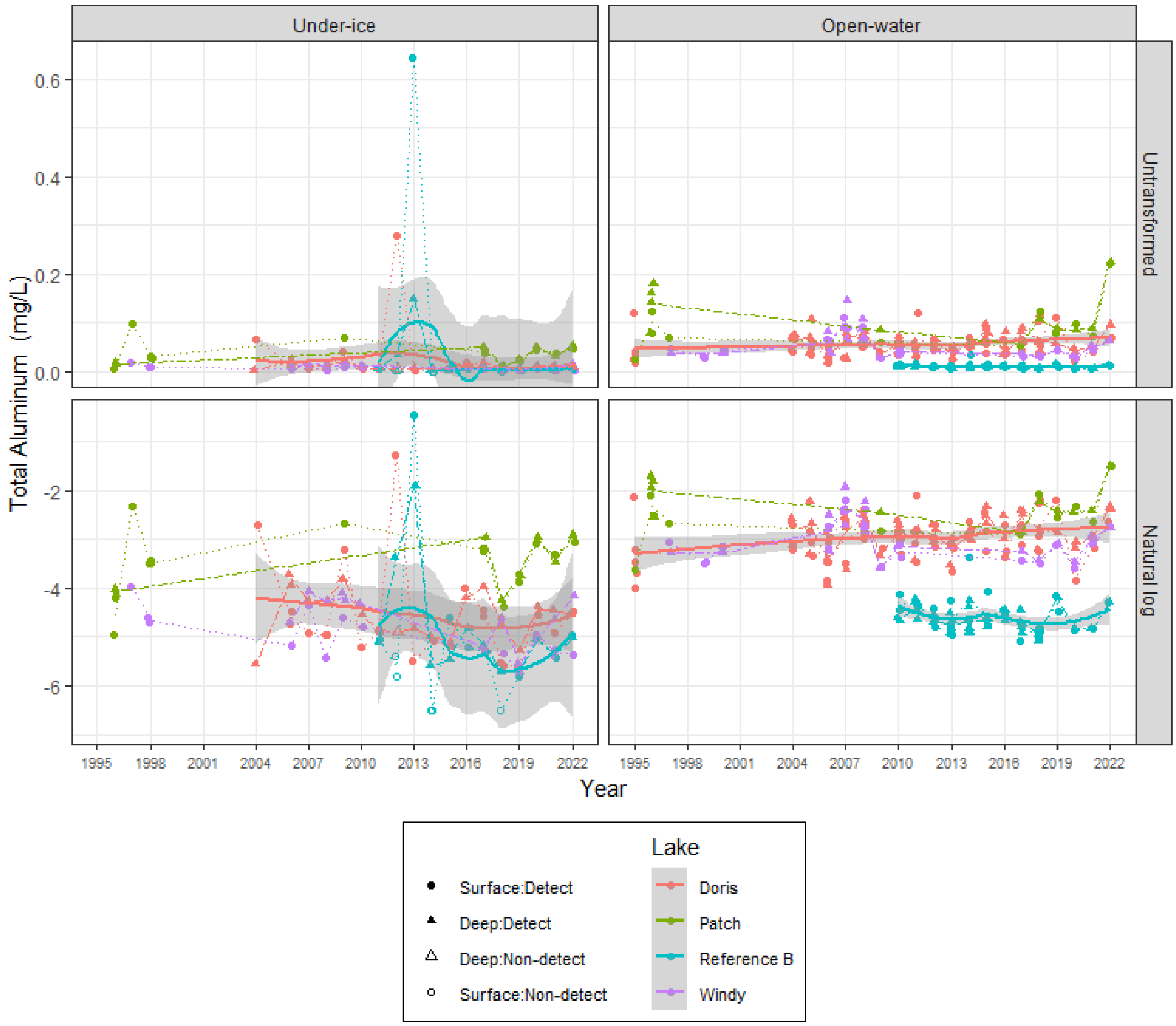
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Total Phosphorus
0.000
0.005
0.010
0.015
0.020
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

### *C.3.1.10 Total Aluminum*

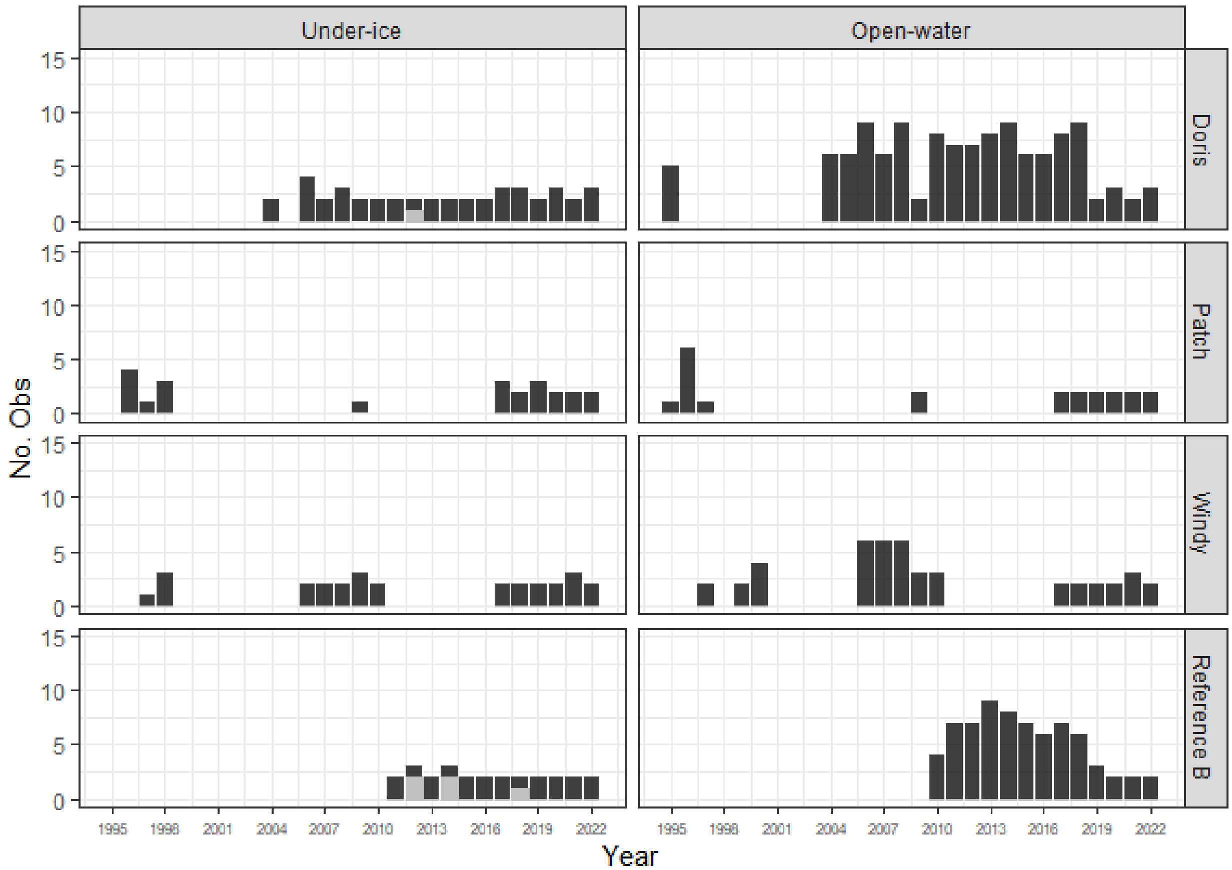
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

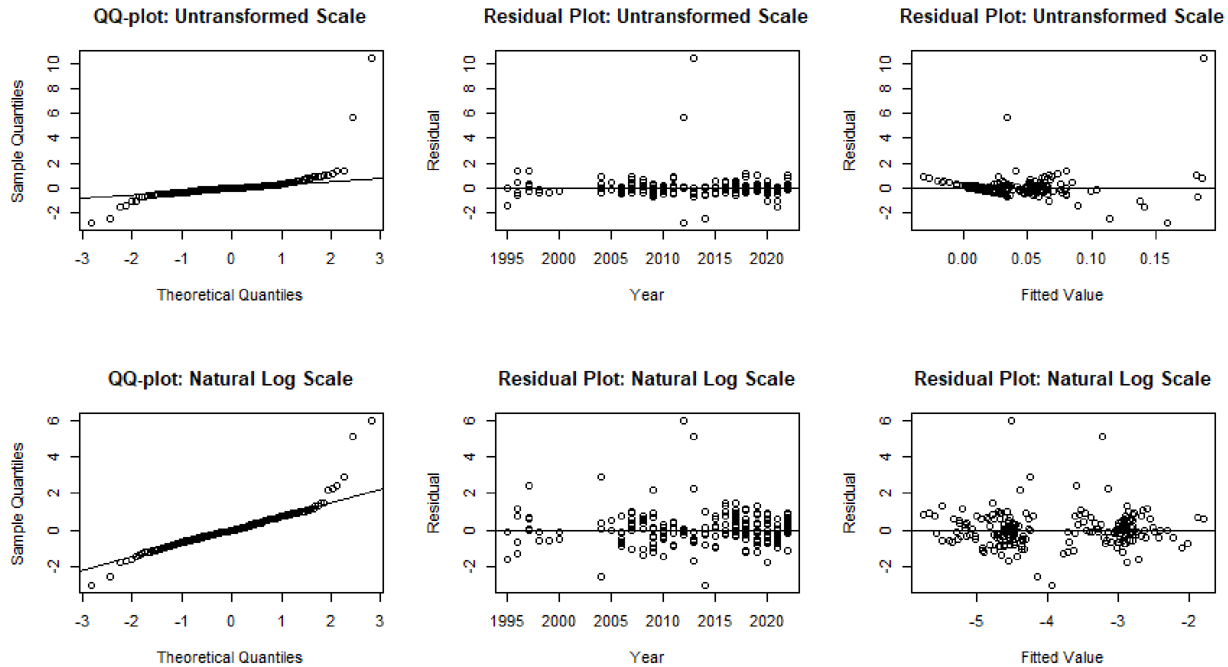
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 1 | 2 | 0 |
| Doris | Open-water | 121 | 0 | 0 | 0 |
| Patch | Under-ice | 23 | 0 | 0 | 0 |
| Patch | Open-water | 22 | 0 | 0 | 0 |
| Reference B | Under-ice | 26 | 5 | 19 | 0 |
| Reference B | Open-water | 70 | 0 | 0 | 0 |
| Windy | Under-ice | 28 | 0 | 0 | 0 |
| Windy | Open-water | 45 | 0 | 0 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 35 | Doris | 2012 | Under-ice | Surface | 0.280 | 0.033 | 5.646 |
| 125 | Reference B | 2013 | Under-ice | Surface | 0.644 | 0.187 | 10.449 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 35 | Doris | 2012 | Under-ice | Surface | 0.2800 | -4.509 | 5.970 |
| 125 | Reference B | 2013 | Under-ice | Surface | 0.6440 | -3.227 | 5.141 |
| 128 | Reference B | 2014 | Under-ice | Deep | 0.0037 | -3.938 | -3.066 |

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 3.516 | 3 | 0.31870 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

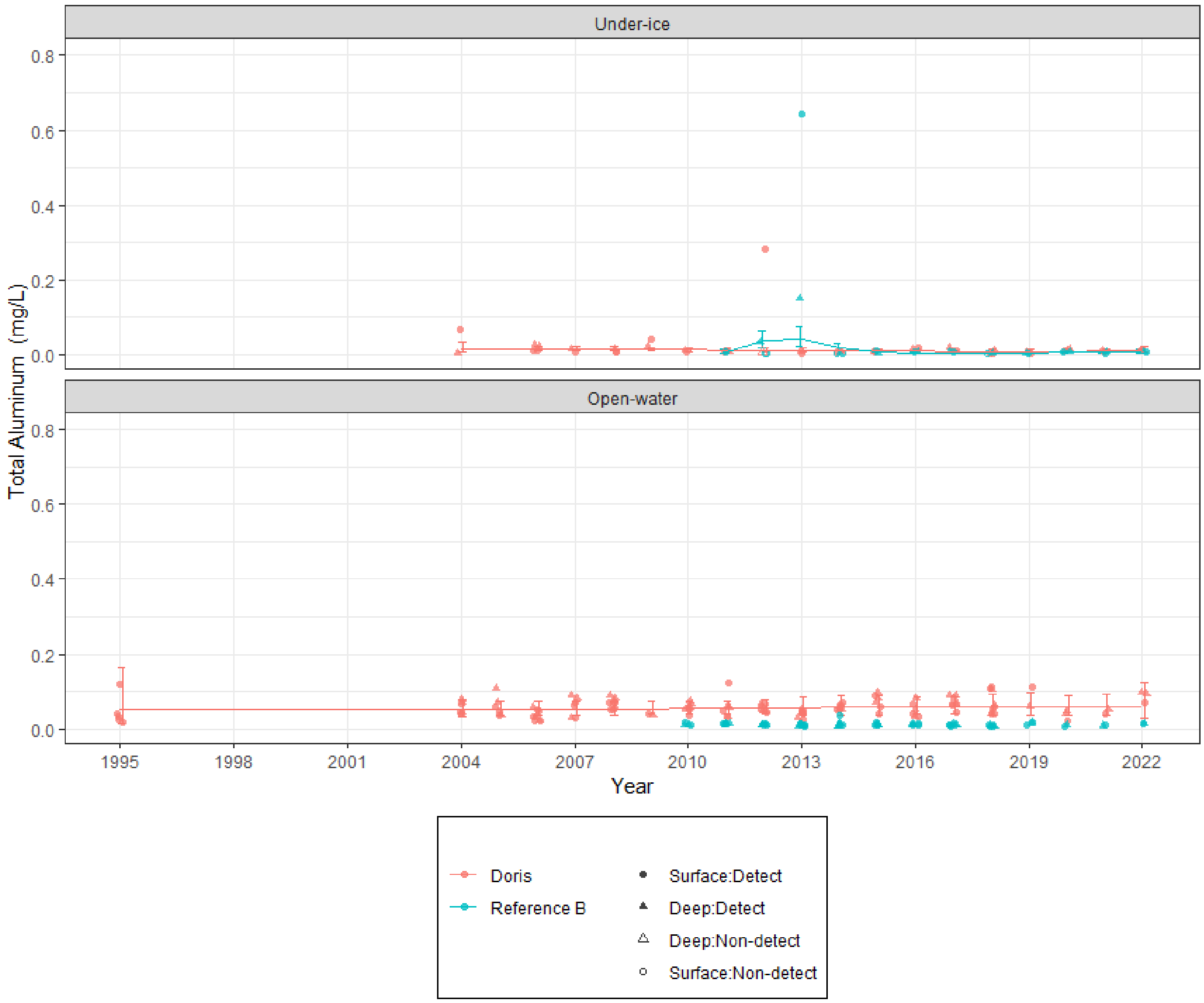
### *Open-water*

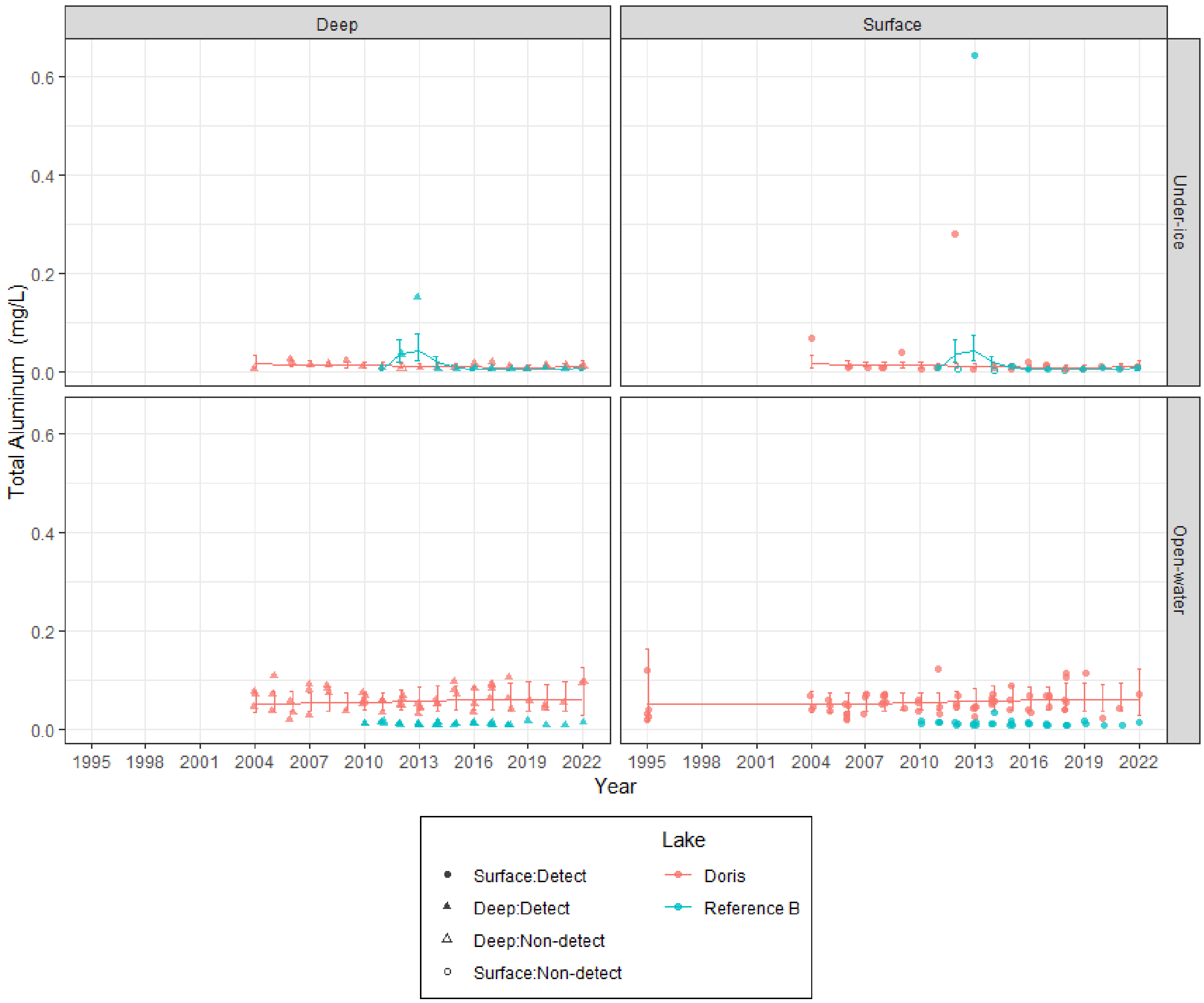
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 0.281 | 3 | 0.96360 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.046 | 0.4622 | 7.938 | 0.0996 | 0.9231 | not sig. |

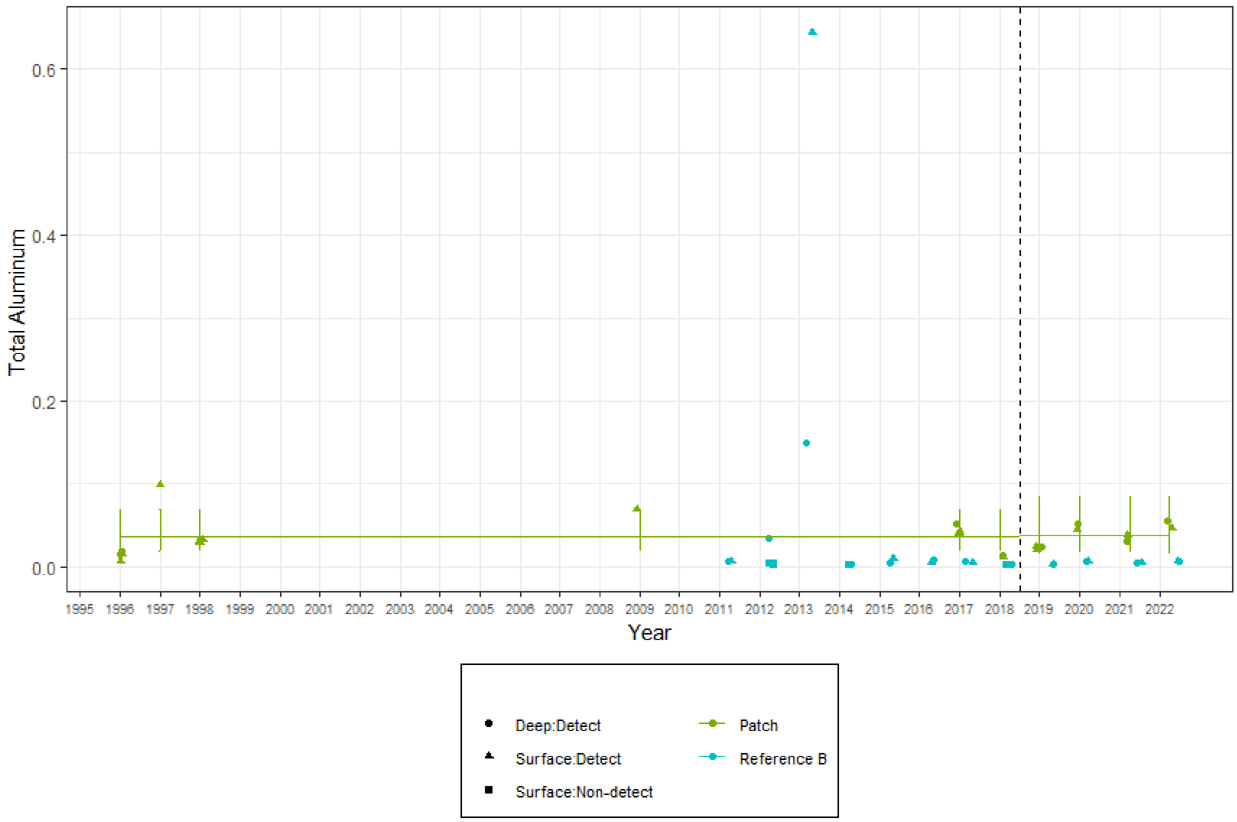
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.4332 | 0.3288 | 7.852 | 1.317 | 0.2248 | not sig. |

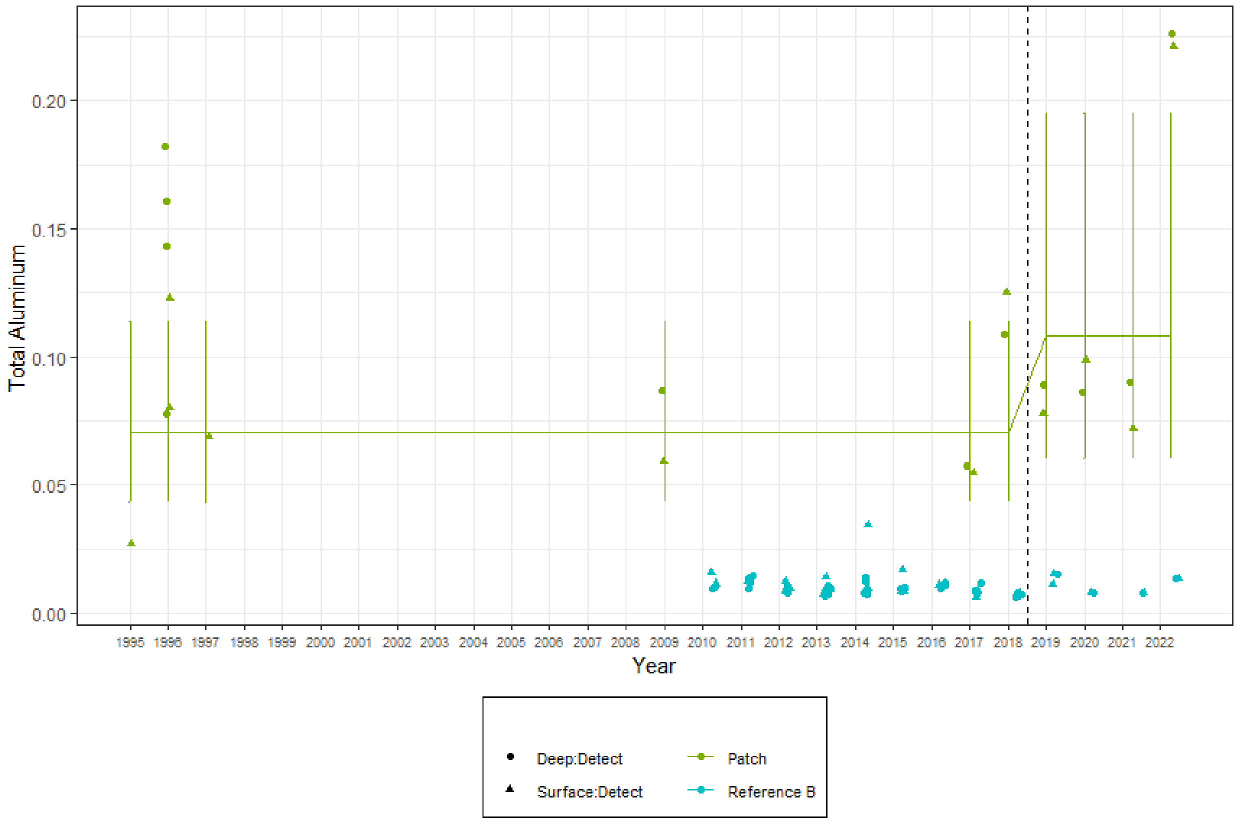
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.4773 | 0.2525 | 9.698 | -1.89 | 0.0889 | not sig. |

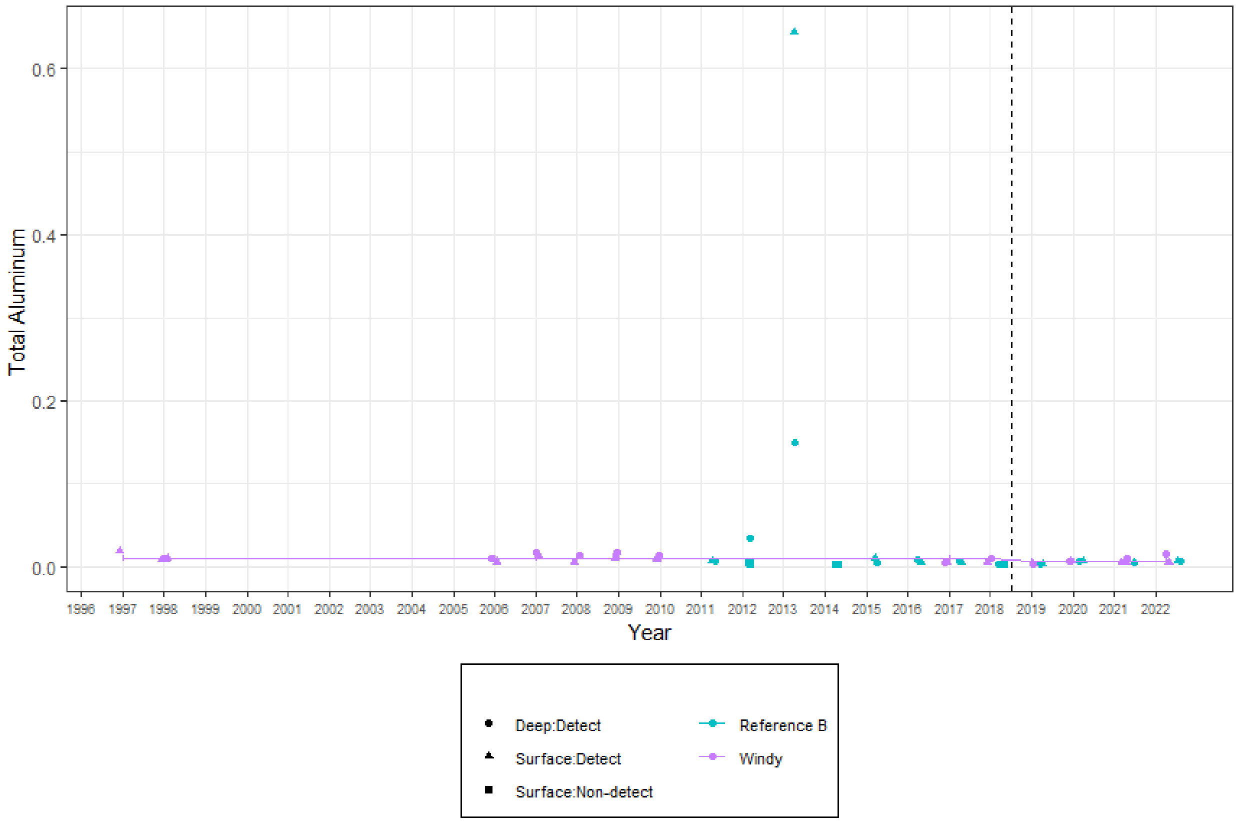
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0139 | 0.2337 | 11.98 | 0.0595 | 0.9535 | not sig. |

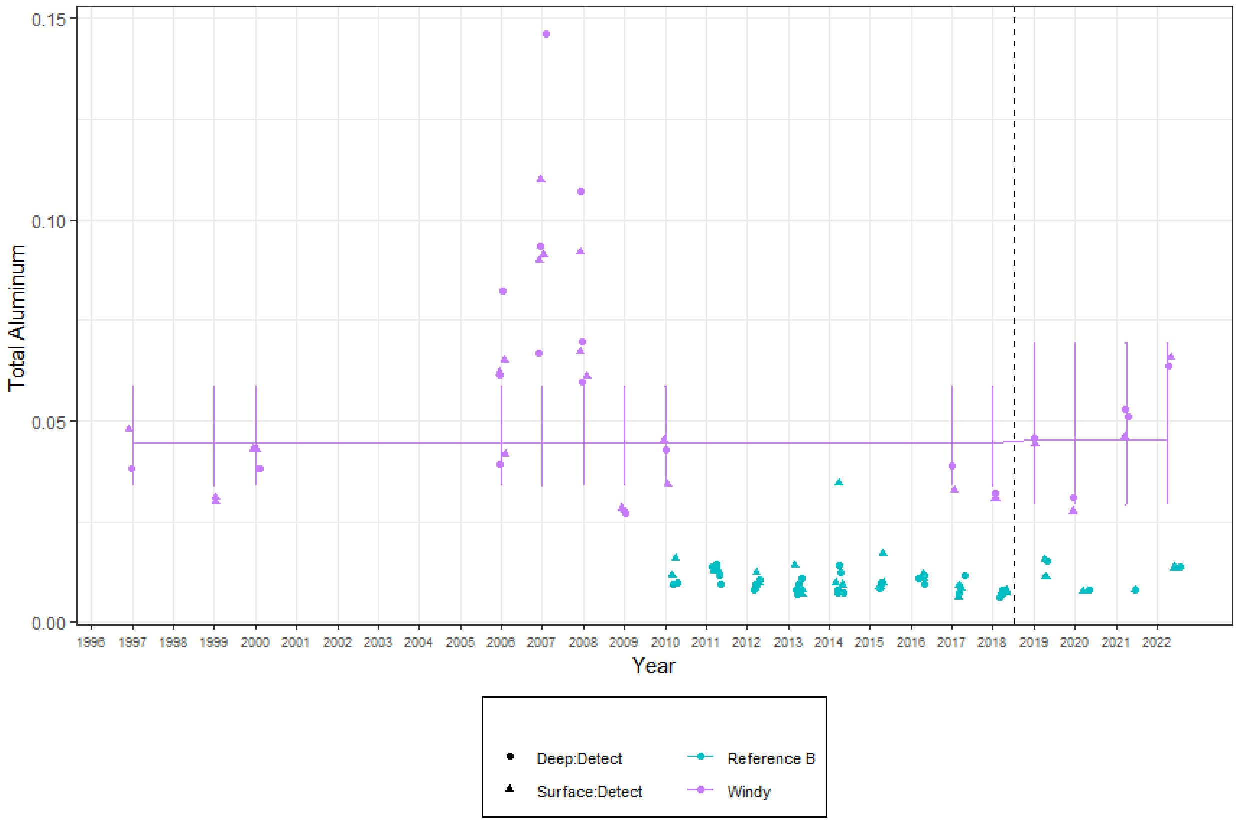
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

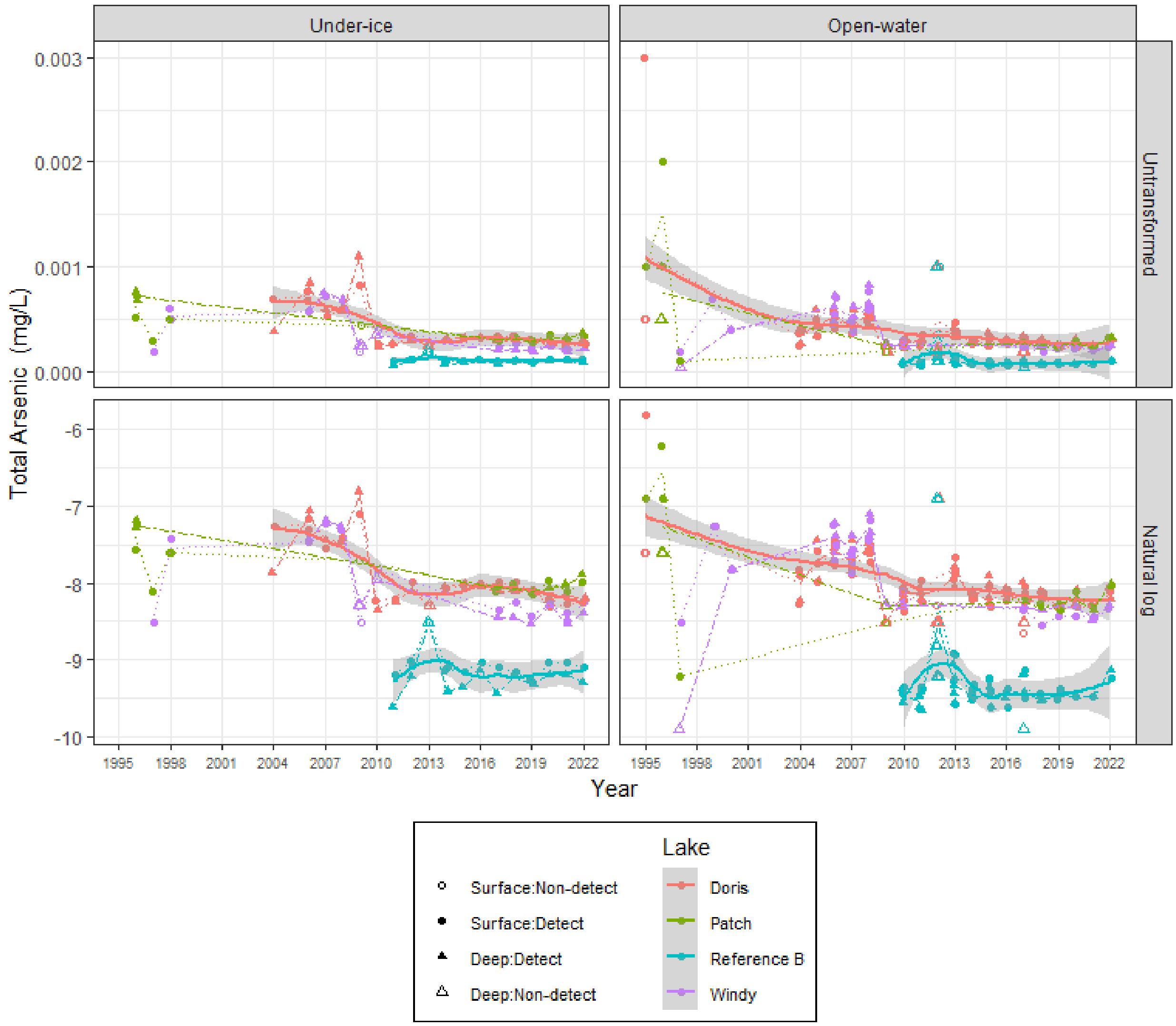
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Total Aluminum
0.15
0.10
0.05
0.00
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Deep:Detect
Surface:Detect
Reference B
Windy

## *C.3.1.11 Total Arsenic*

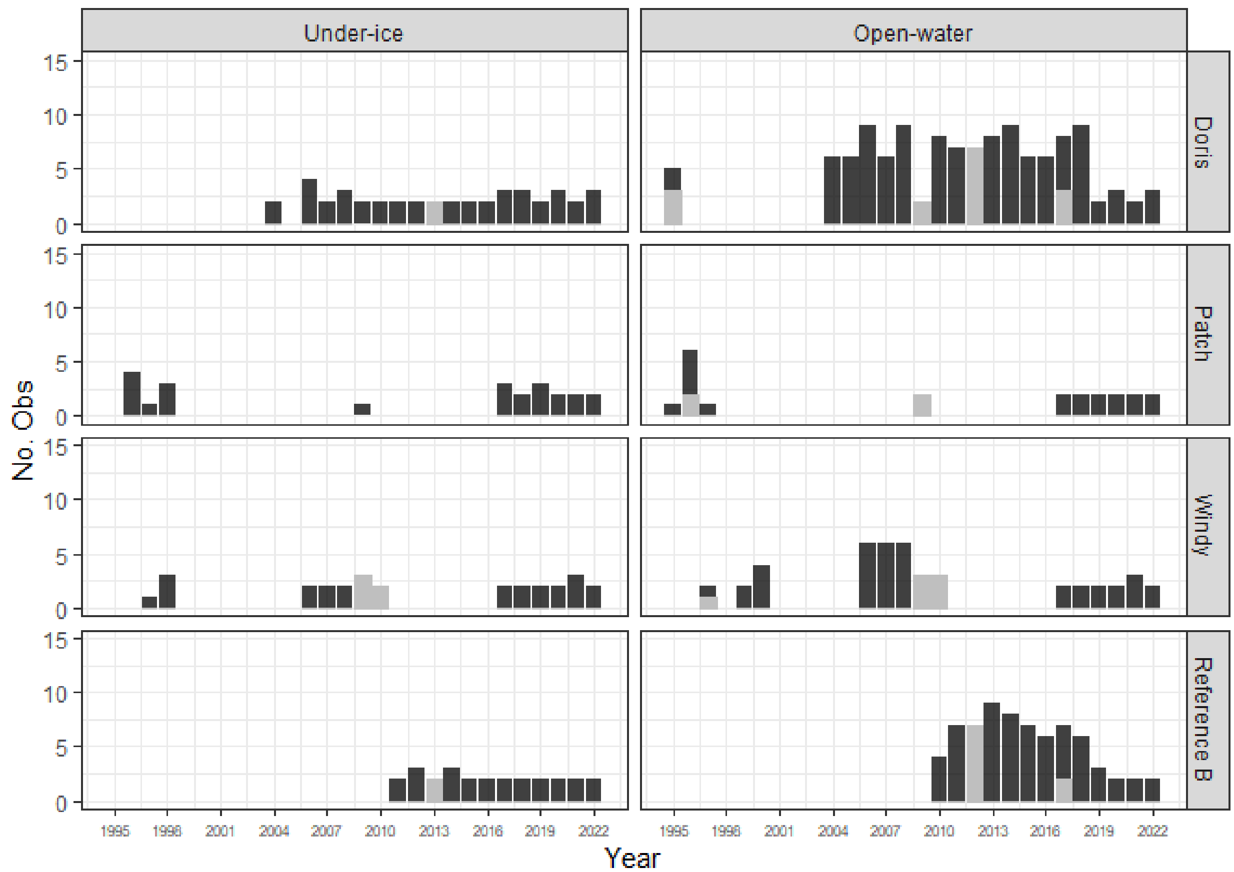
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

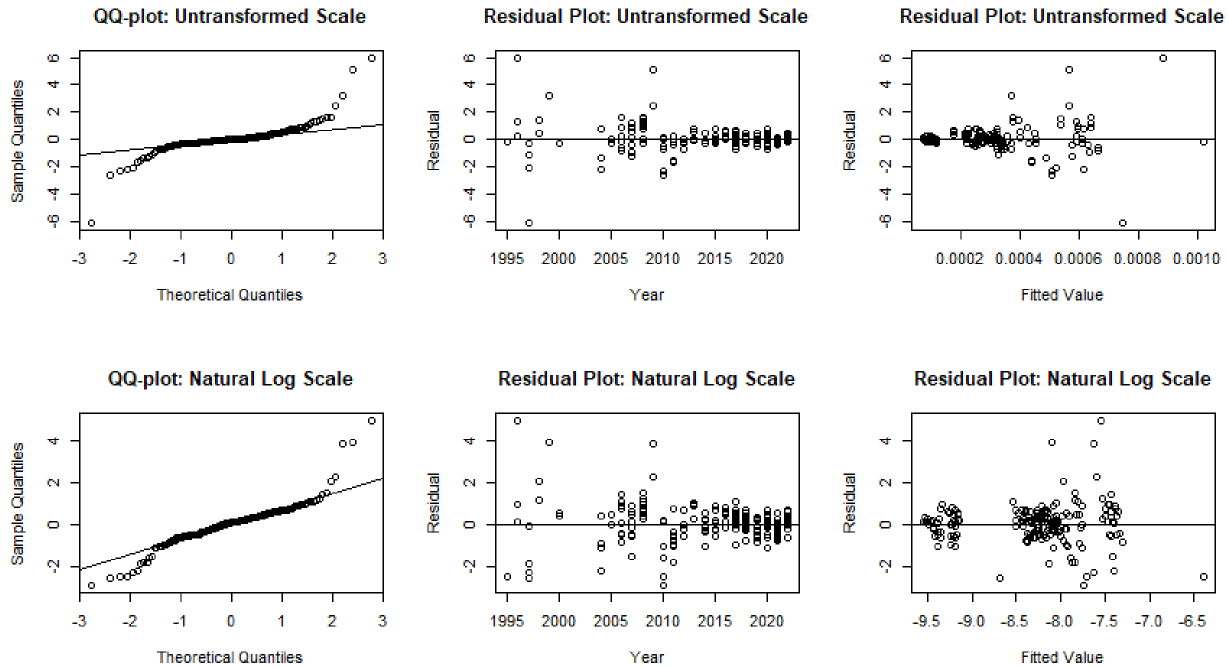
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 2 | 5 | 0 |
| Doris | Open-water | 121 | 15 | 12 | 0 |
| Patch | Under-ice | 23 | 1 | 4 | 0 |
| Patch | Open-water | 22 | 4 | 18 | 0 |
| Reference B | Under-ice | 26 | 2 | 8 | 0 |
| Reference B | Open-water | 70 | 9 | 13 | 0 |
| Windy | Under-ice | 28 | 5 | 18 | 0 |
| Windy | Open-water | 45 | 7 | 16 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression. 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 Lake.

### 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 |
|---|---|---|---|---|---|---|---|
| 22 | Doris | 2009 | Under-ice | Deep | 0.0011 | 0.001 | 5.133 |
| 83 | Patch | 1996 | Open-water | Surface | 0.0015 | 0.001 | 5.951 |
| 85 | Patch | 1997 | Open-water | Surface | 0.0001 | 0.001 | -6.180 |
| 168 | Windy | 1999 | Open-water | Surface | 0.0007 | 0.000 | 3.159 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 22 | Doris | 2009 | Under-ice | Deep | 0.0011 | -7.627 | 3.899 |
| 83 | Patch | 1996 | Open-water | Surface | 0.0015 | -7.546 | 5.000 |
| 168 | Windy | 1999 | Open-water | Surface | 0.0007 | -8.093 | 3.966 |

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

### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 80.76 | 3 | <0.00001 | sig. |
| Compare to Reference B | 11.48 | 3 | 0.00940 | sig. |

Doris Lake appears to show significant deviation from a slope of zero. Doris Lake appears to show significant deviation from the trend of Reference Lake B.

*Open-water*

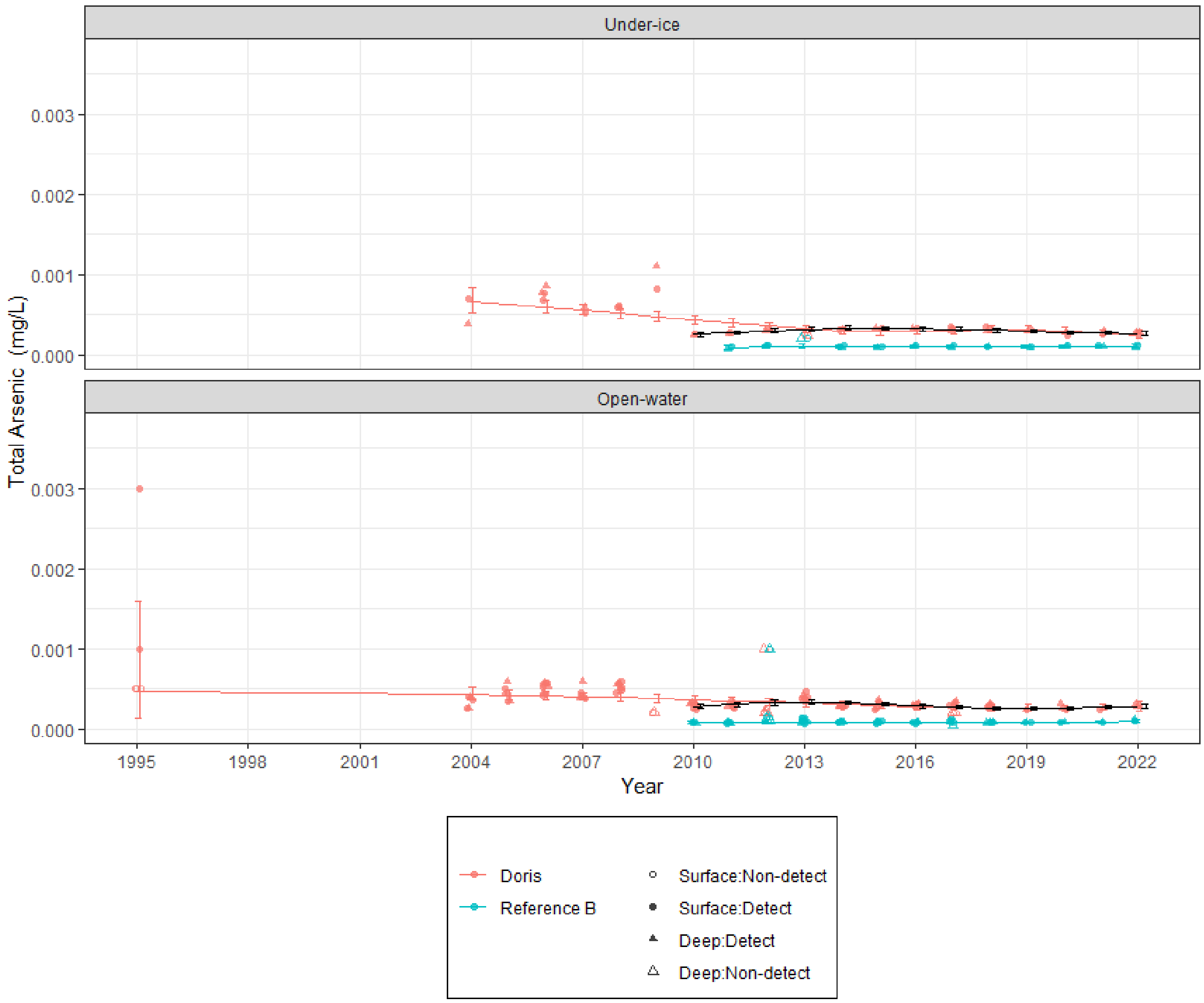
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 32.929 | 3 | <0.00001 | sig. |
| Compare to Reference B | 8.785 | 3 | 0.03230 | sig. |

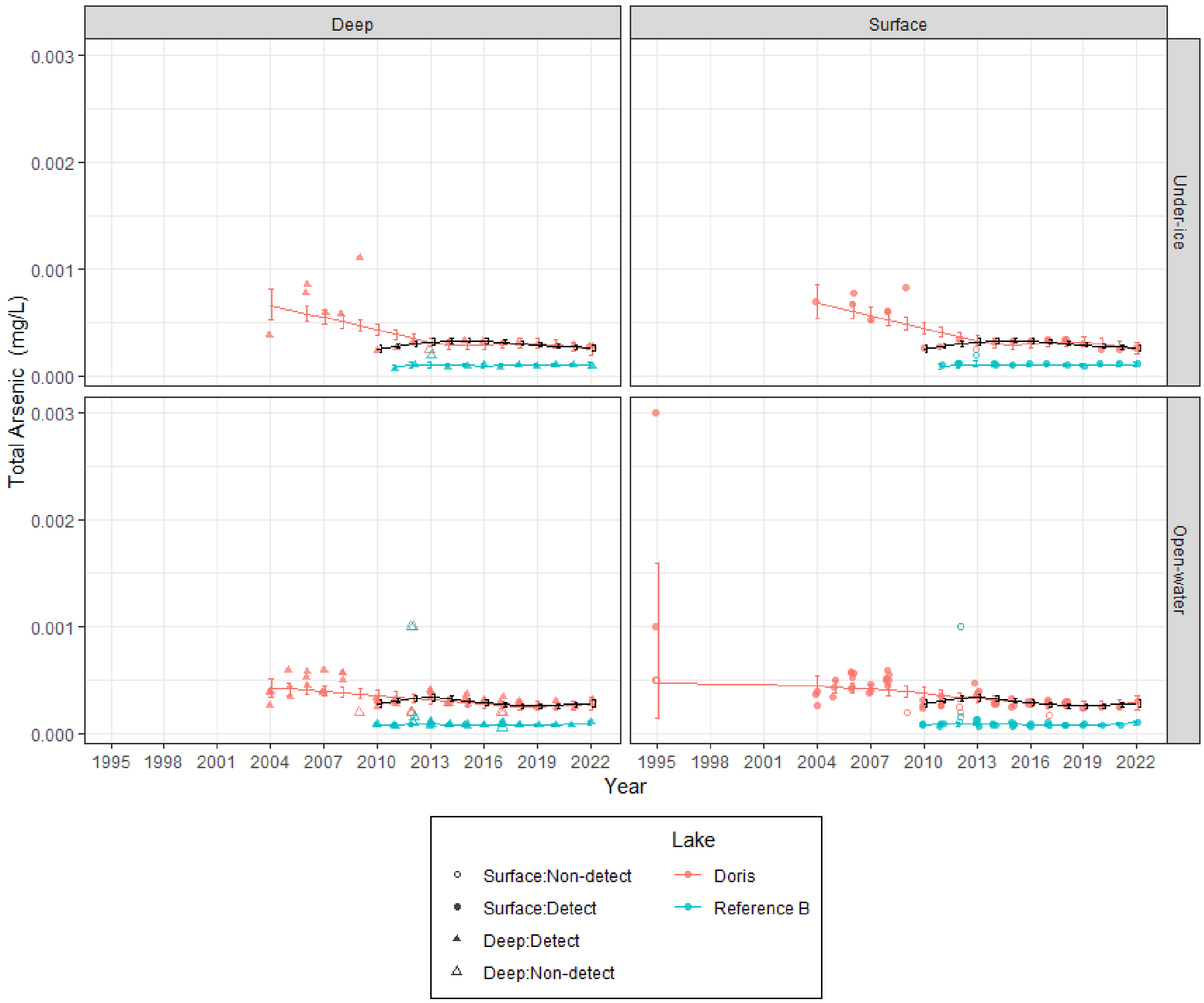
Doris Lake appears to show significant deviation from a slope of zero. Doris Lake appears to show significant deviation from the trend of Reference Lake B.

*Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

As Doris Lake appears to show significant deviation from a slope of zero in at least one season, the black lines and error bars represent the model built with Doris Lake data from comparable sampling years with Reference Lake B only.


Under-ice
Open-water
Total Arsenic (mg/L)
0.000
0.001
0.002
0.003
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
Year
Doris
Reference B
Surface:Non-detect
Surface:Detect
Deep:Detect
Deep:Non-detect




### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

#### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.2396 | 0.1667 | 8.007 | -1.437 | 0.1886 | not sig. |

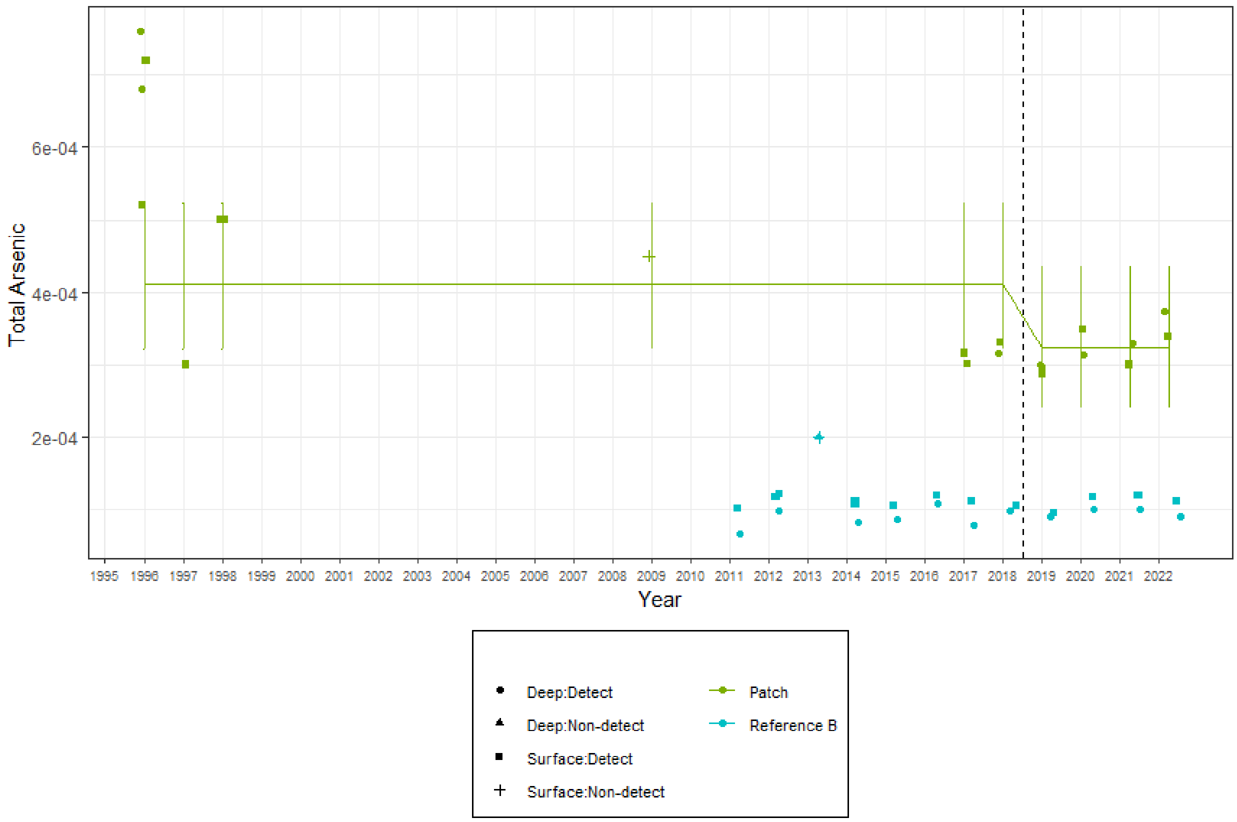
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.212 | 0.4701 | 7.757 | -0.4509 | 0.6644 | not sig. |

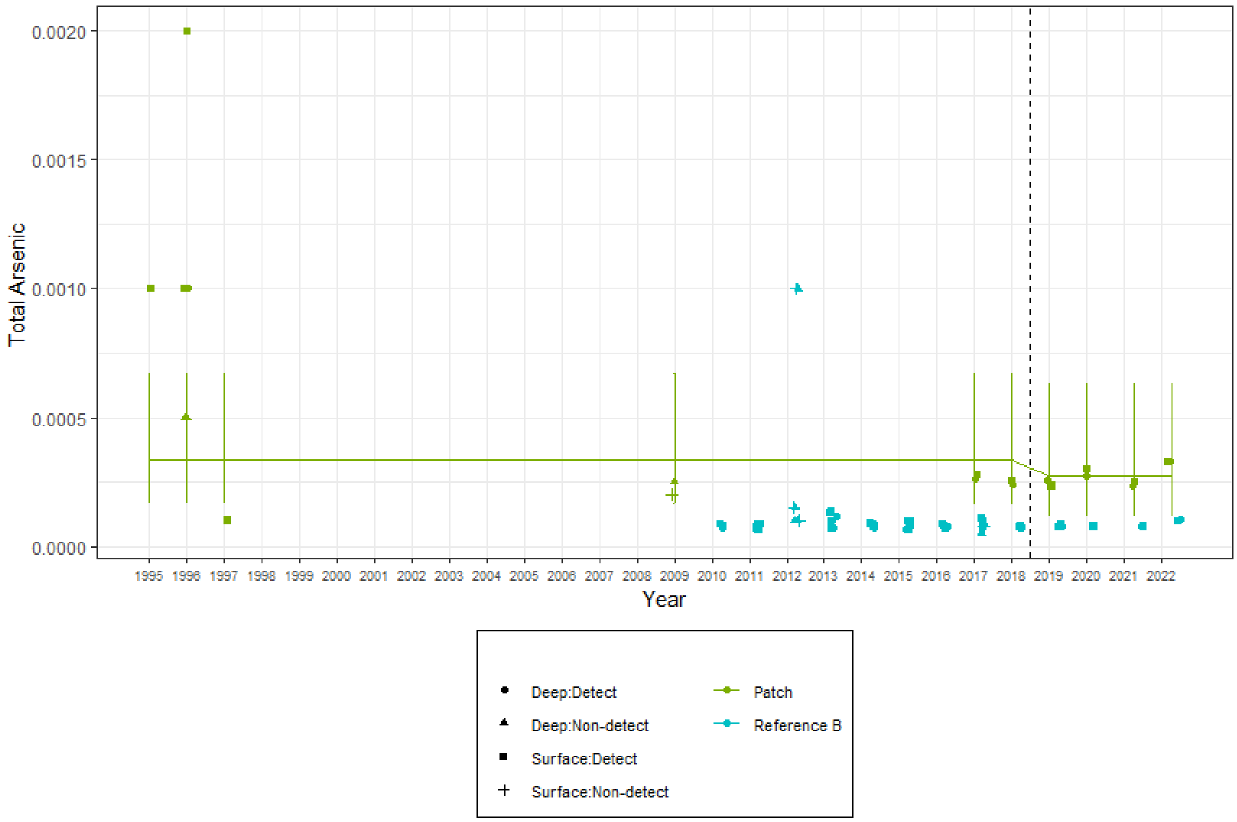
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.4983 | 0.2767 | 10.95 | -1.801 | 0.0993 | not sig. |

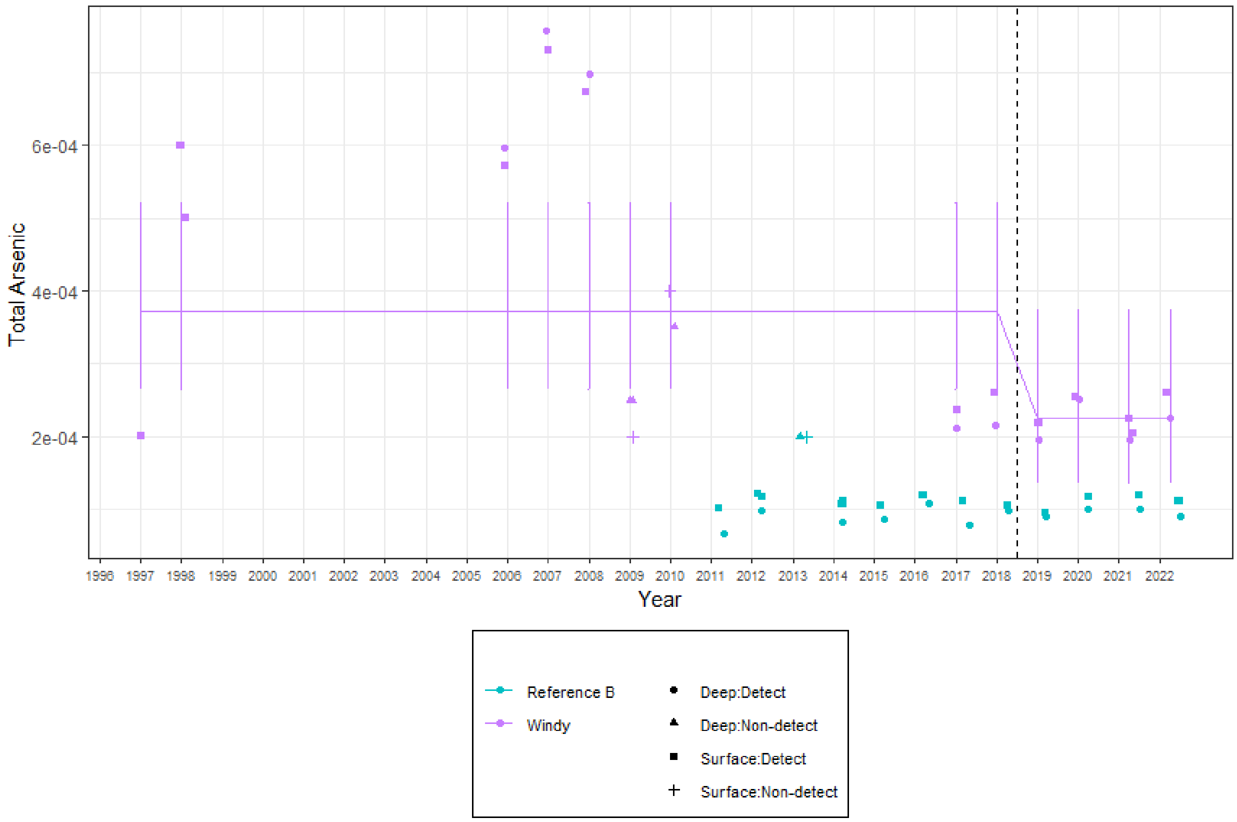
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.3657 | 0.3118 | 11.66 | -1.173 | 0.2643 | not sig. |

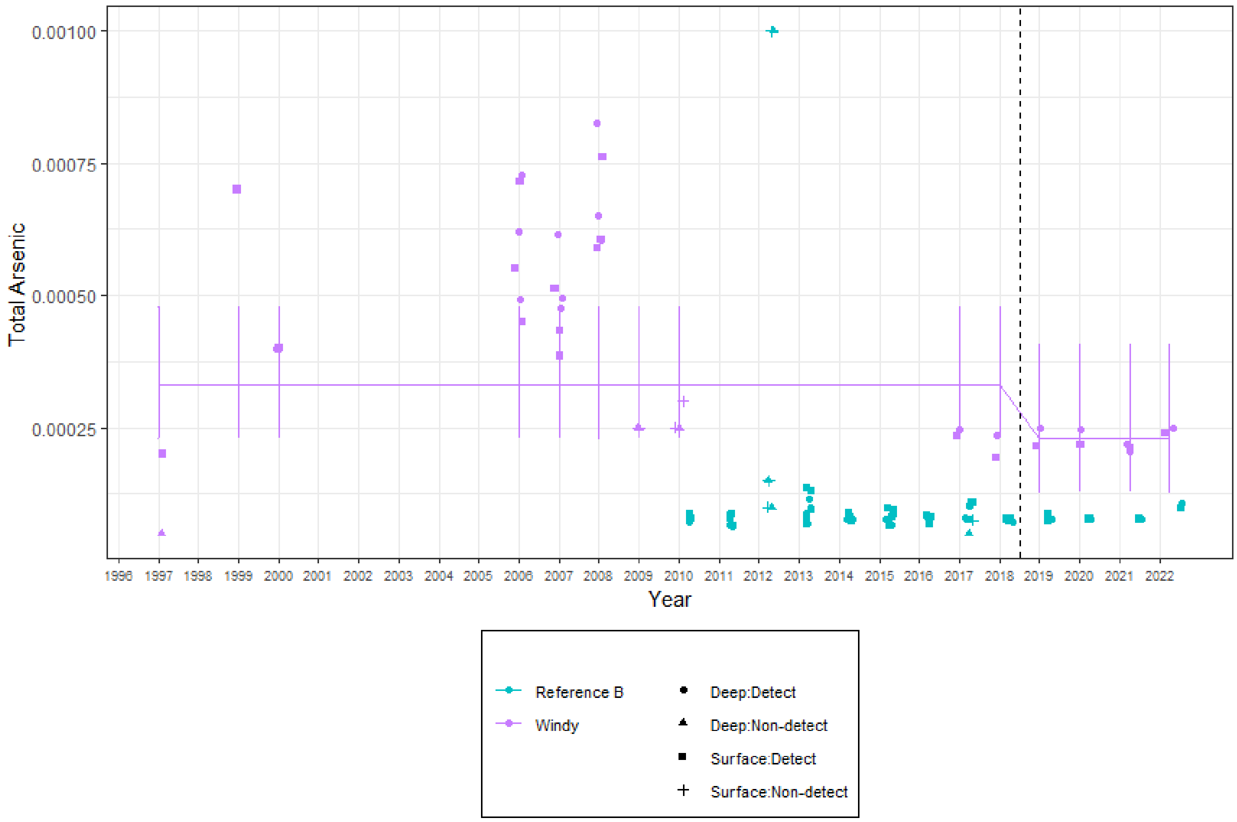
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

### *Observed Data and Fitted Values*

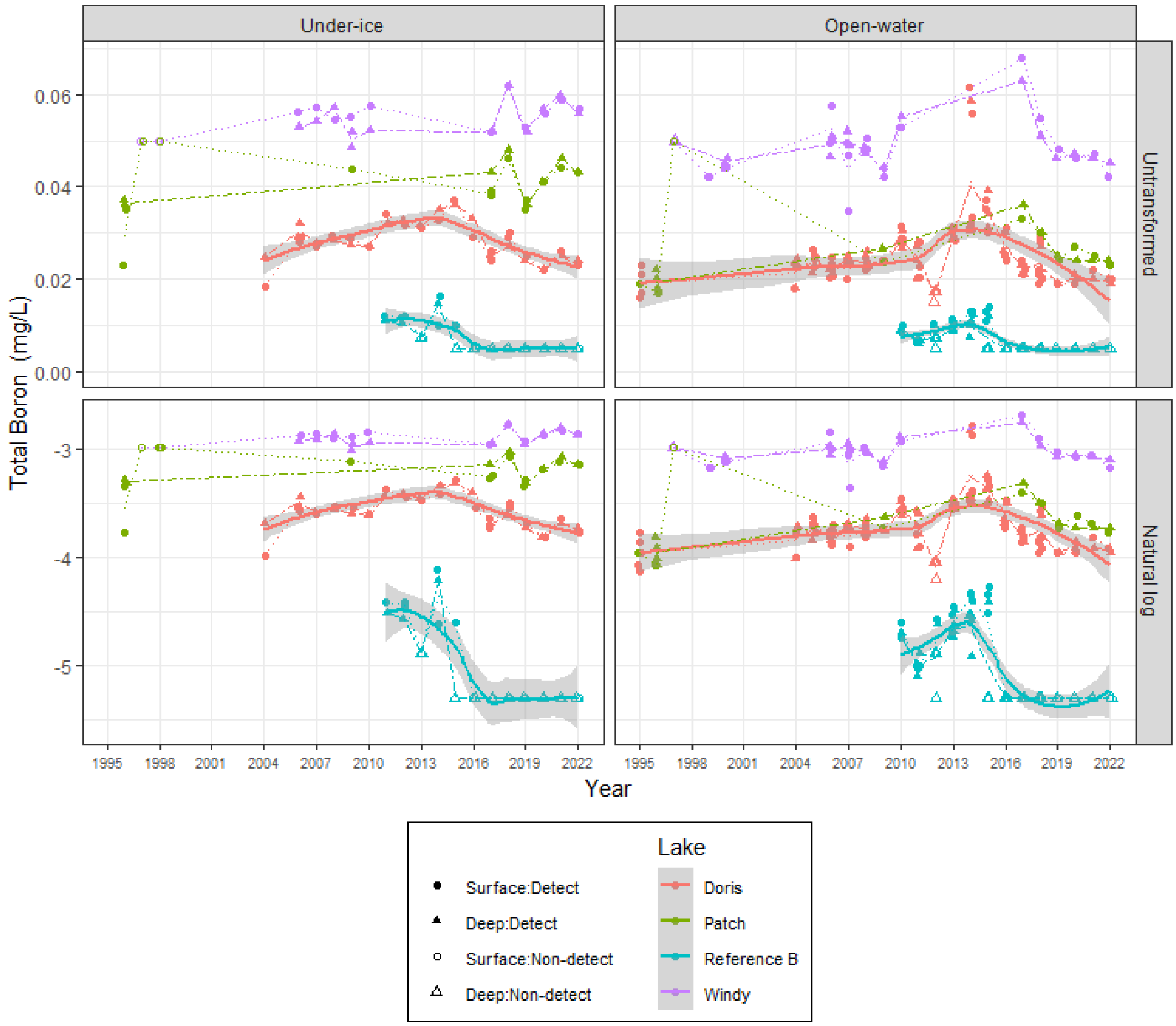
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Total Arsenic
0.00100
0.00075
0.00050
0.00025
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

### *C.3.1.12 Total Boron*

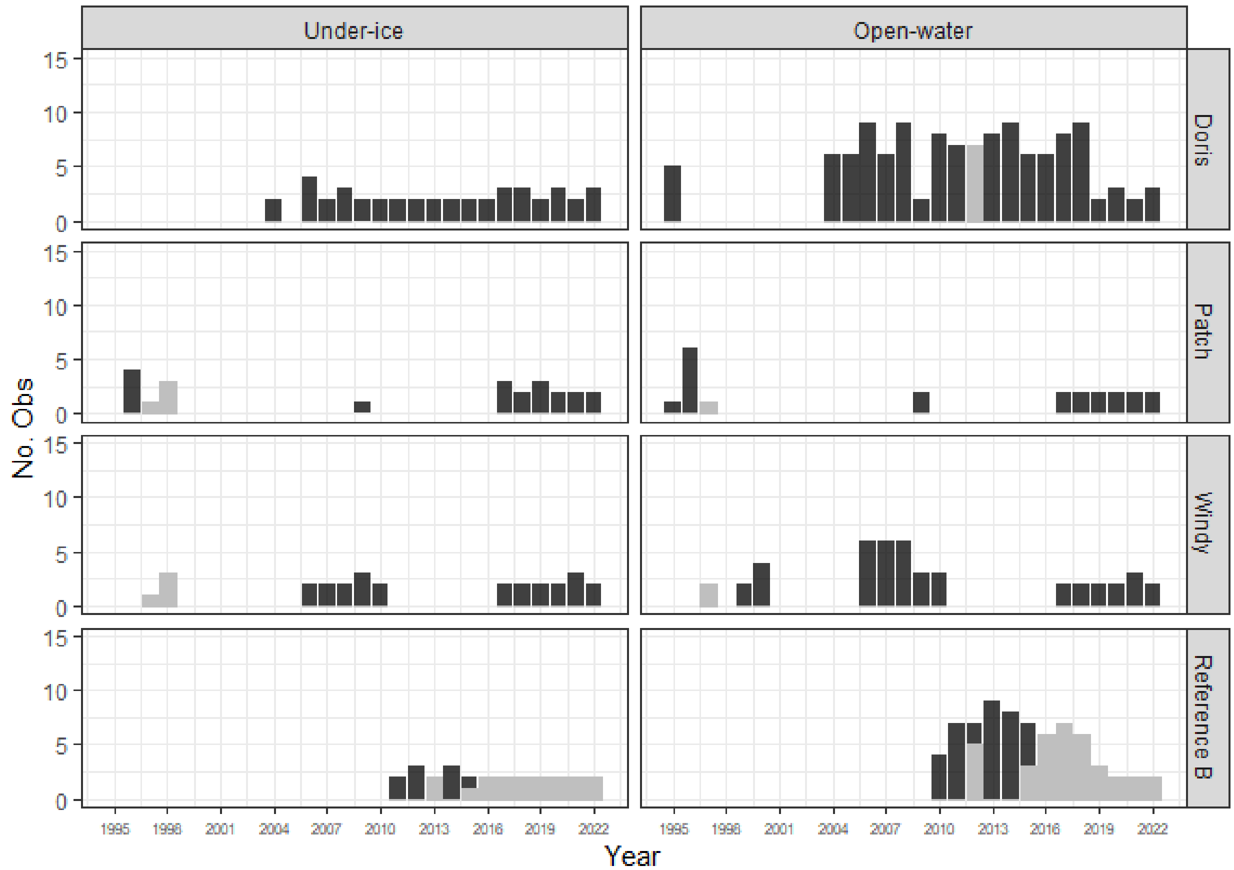
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

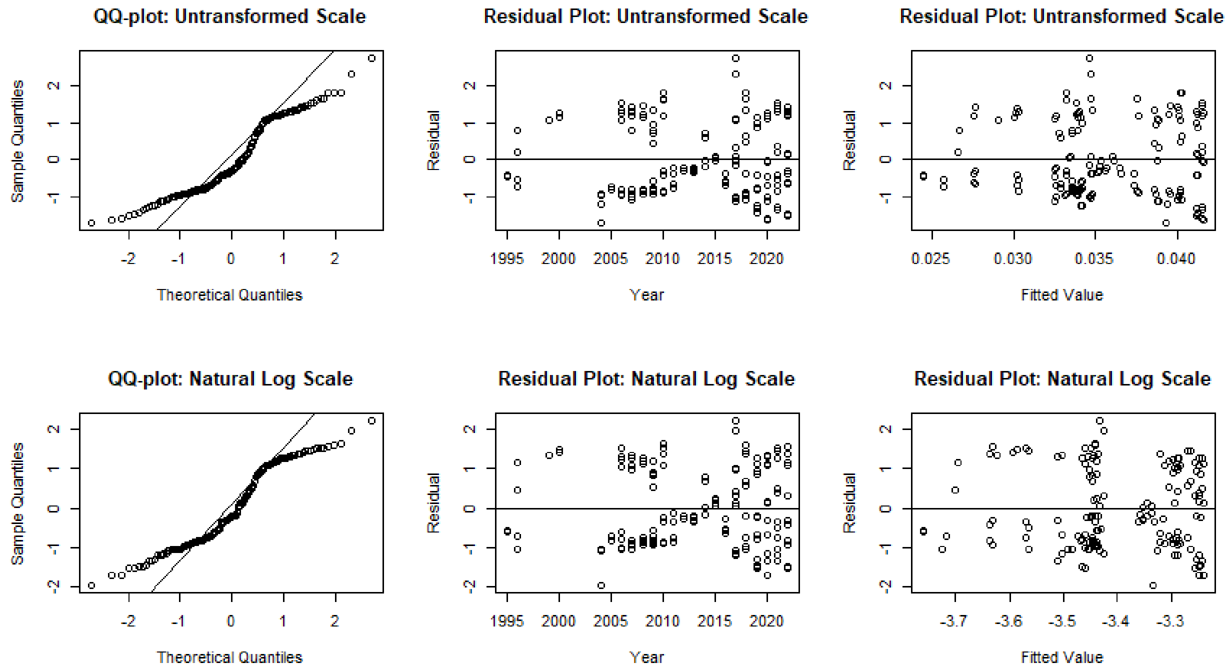
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 0 | 0 | 0 |
| Doris | Open-water | 121 | 7 | 6 | 0 |
| Patch | Under-ice | 23 | 4 | 17 | 0 |
| Patch | Open-water | 22 | 1 | 5 | 0 |
| Reference B | Under-ice | 26 | 17 | 65 | 100 |
| Reference B | Open-water | 70 | 36 | 51 | 100 |
| Windy | Under-ice | 28 | 4 | 14 | 0 |
| Windy | Open-water | 45 | 2 | 4 | 0 |

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.

### 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:

Outliers on natural log scale:

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 41.53 | 3 | <0.00001 | sig. |

Doris Lake appears to show significant deviation from a slope of zero.

#### *Open-water*

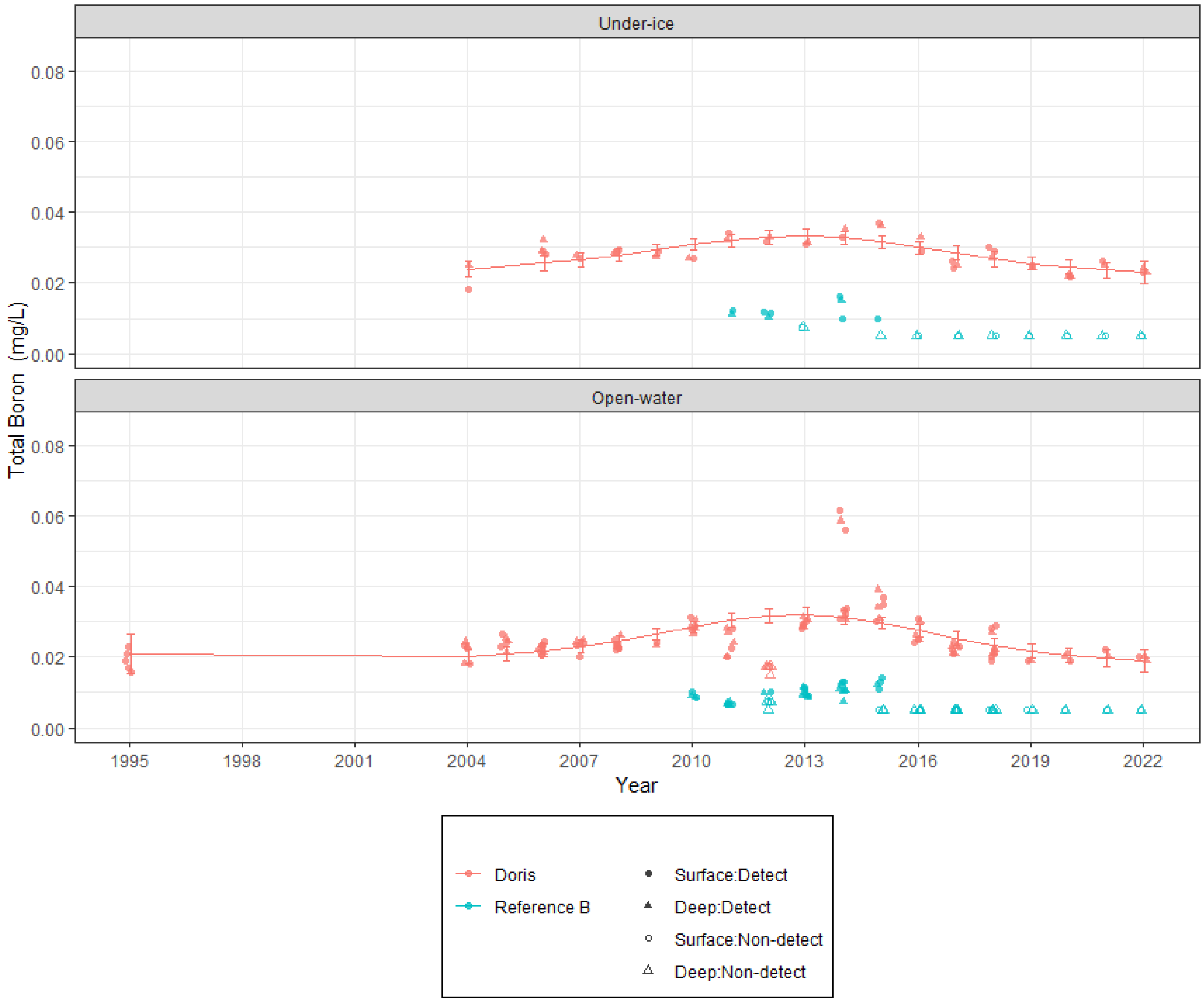
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 49.83 | 3 | <0.00001 | sig. |

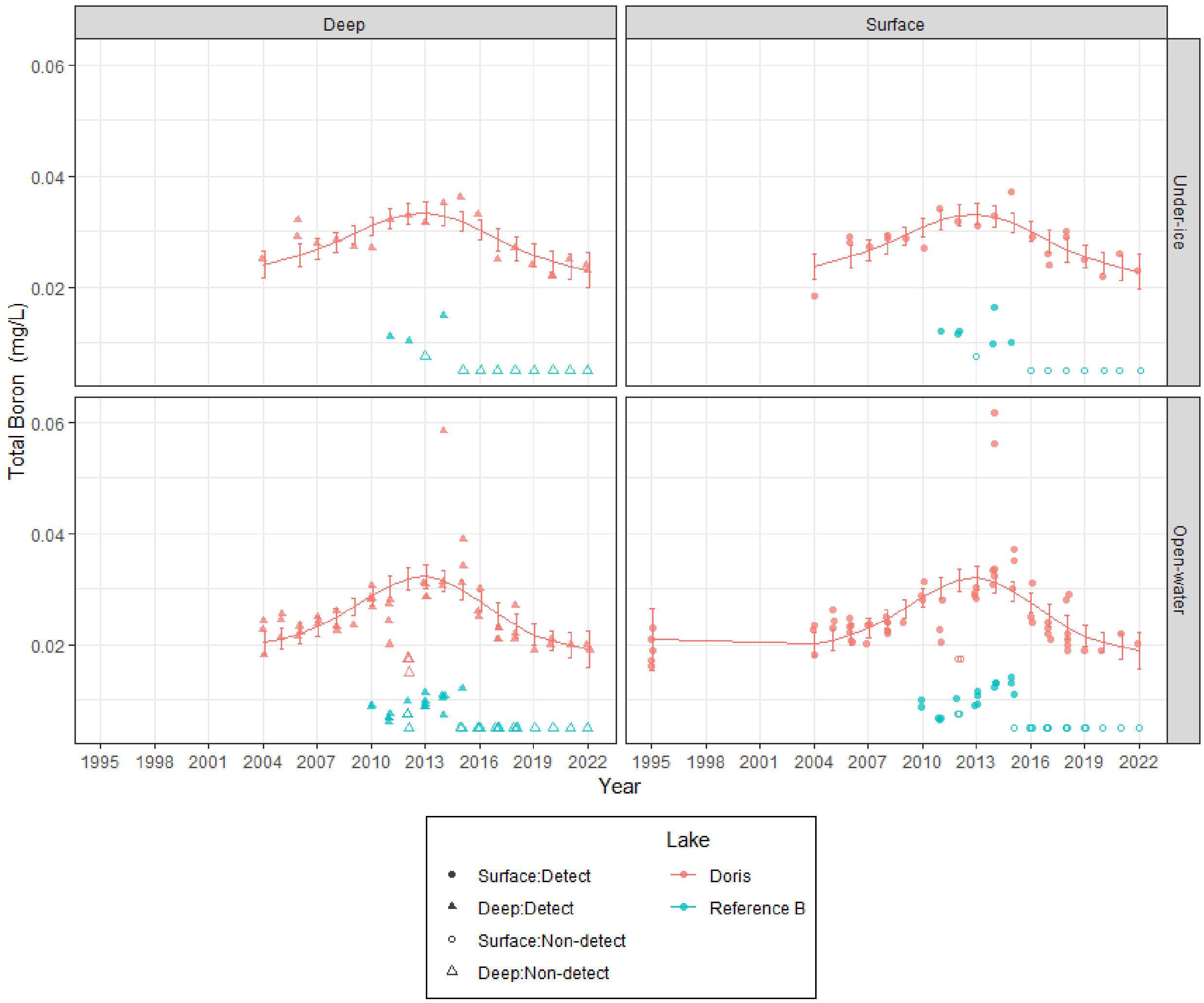
Doris Lake appears to show significant deviation from a slope of zero.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at

half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0032 | 0.0039 | 7.915 | -0.8281 | 0.4319 | not sig. |

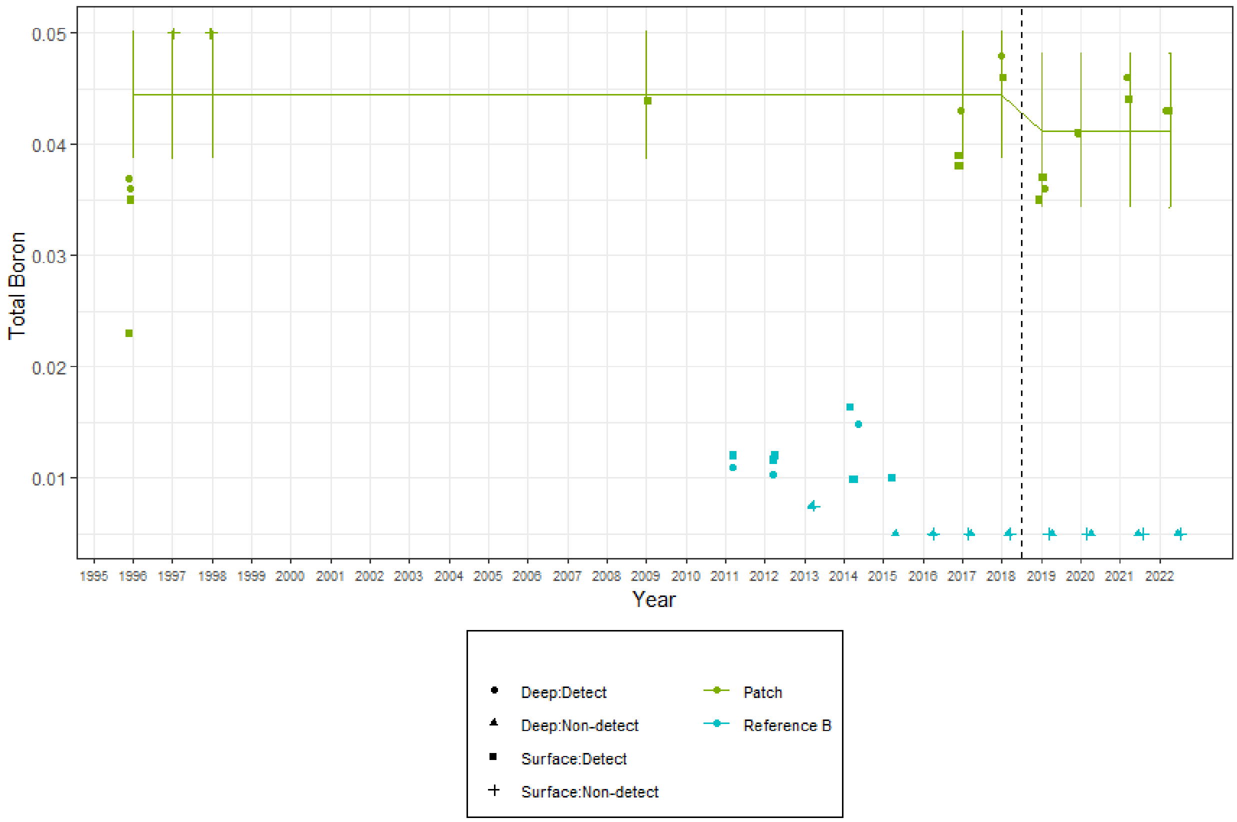
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0051 | 0.0061 | 7.885 | -0.8389 | 0.4262 | not sig. |

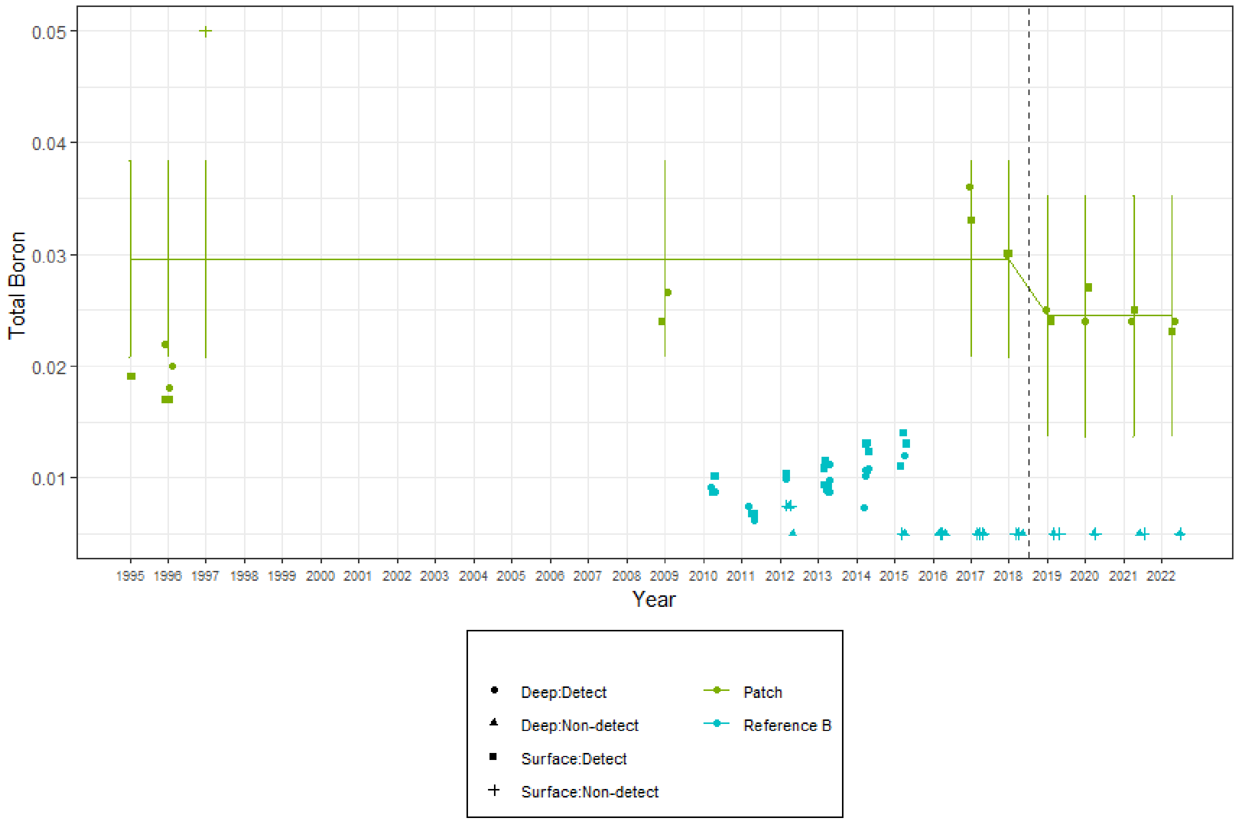
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0021 | 0.0021 | 10.31 | 0.9688 | 0.3548 | not sig. |

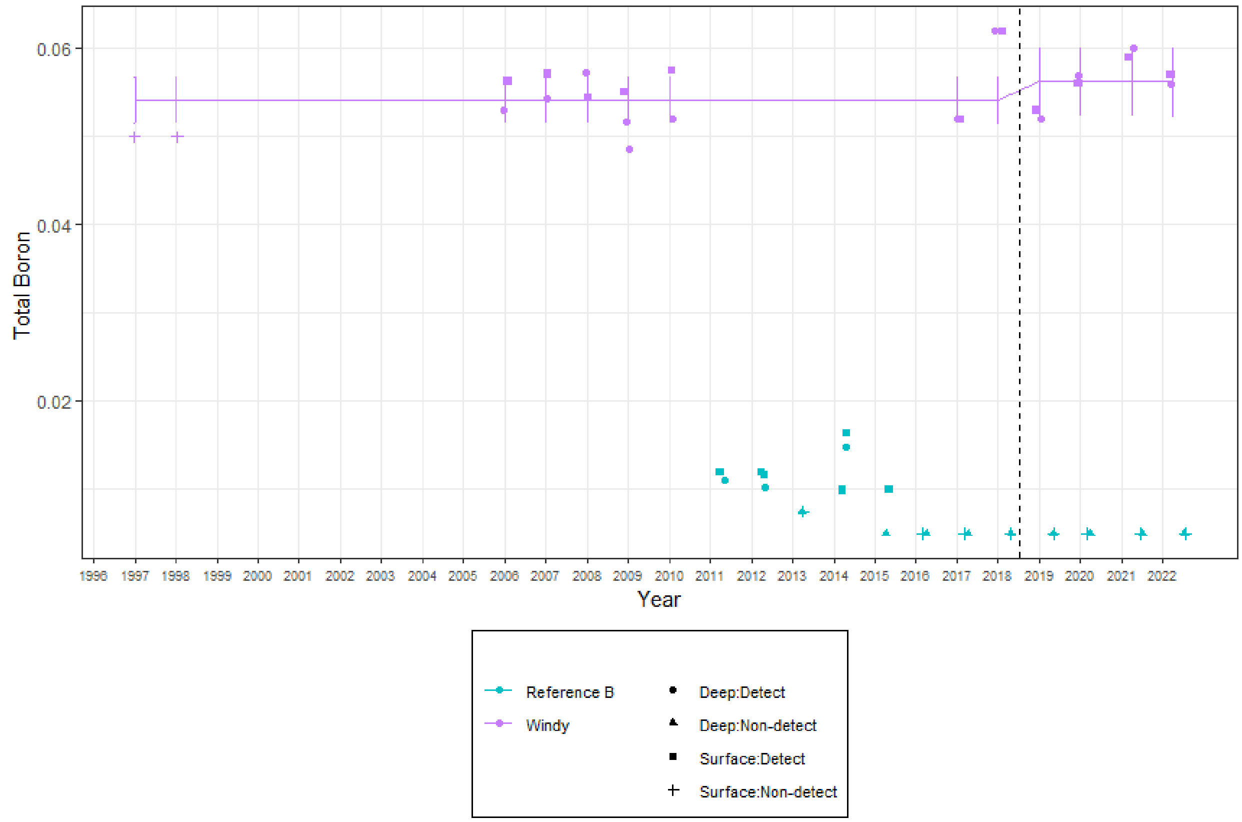
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.004 | 0.0035 | 11.83 | -1.123 | 0.2839 | not sig. |

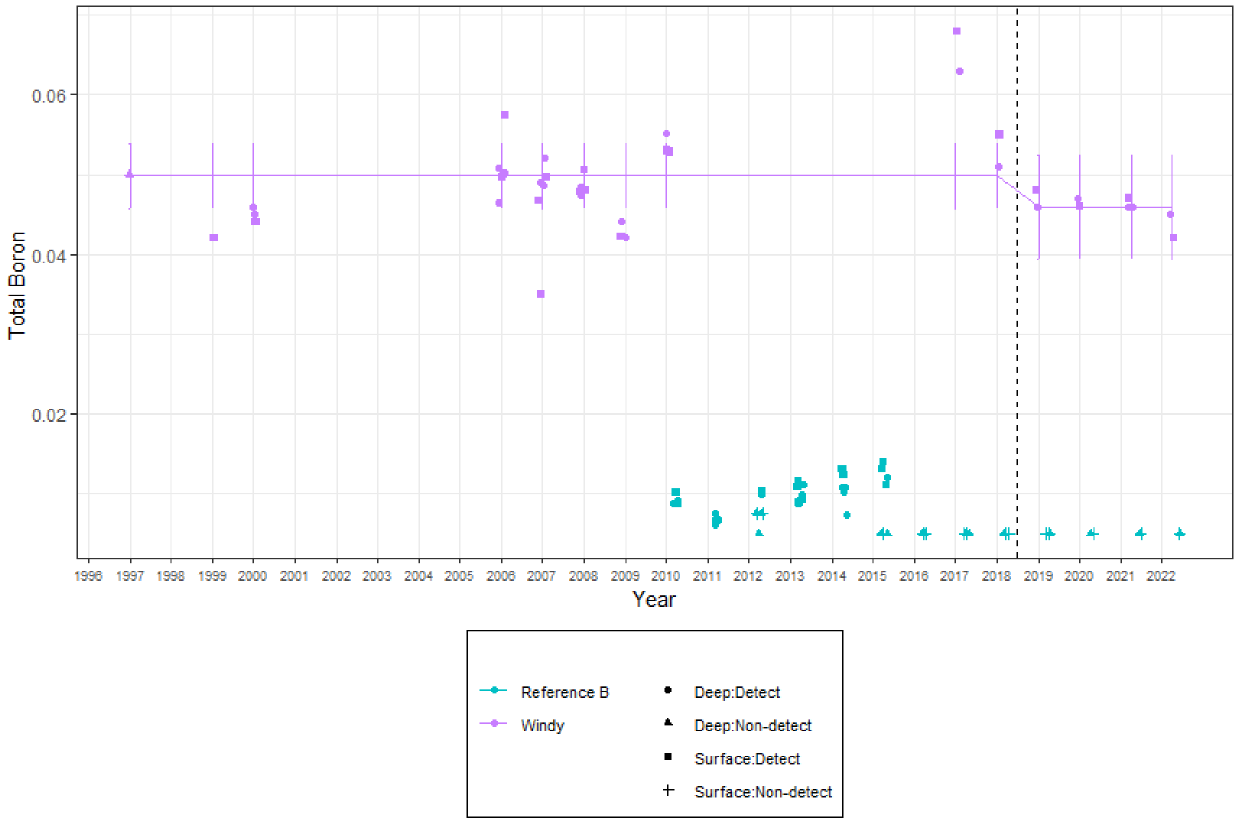
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

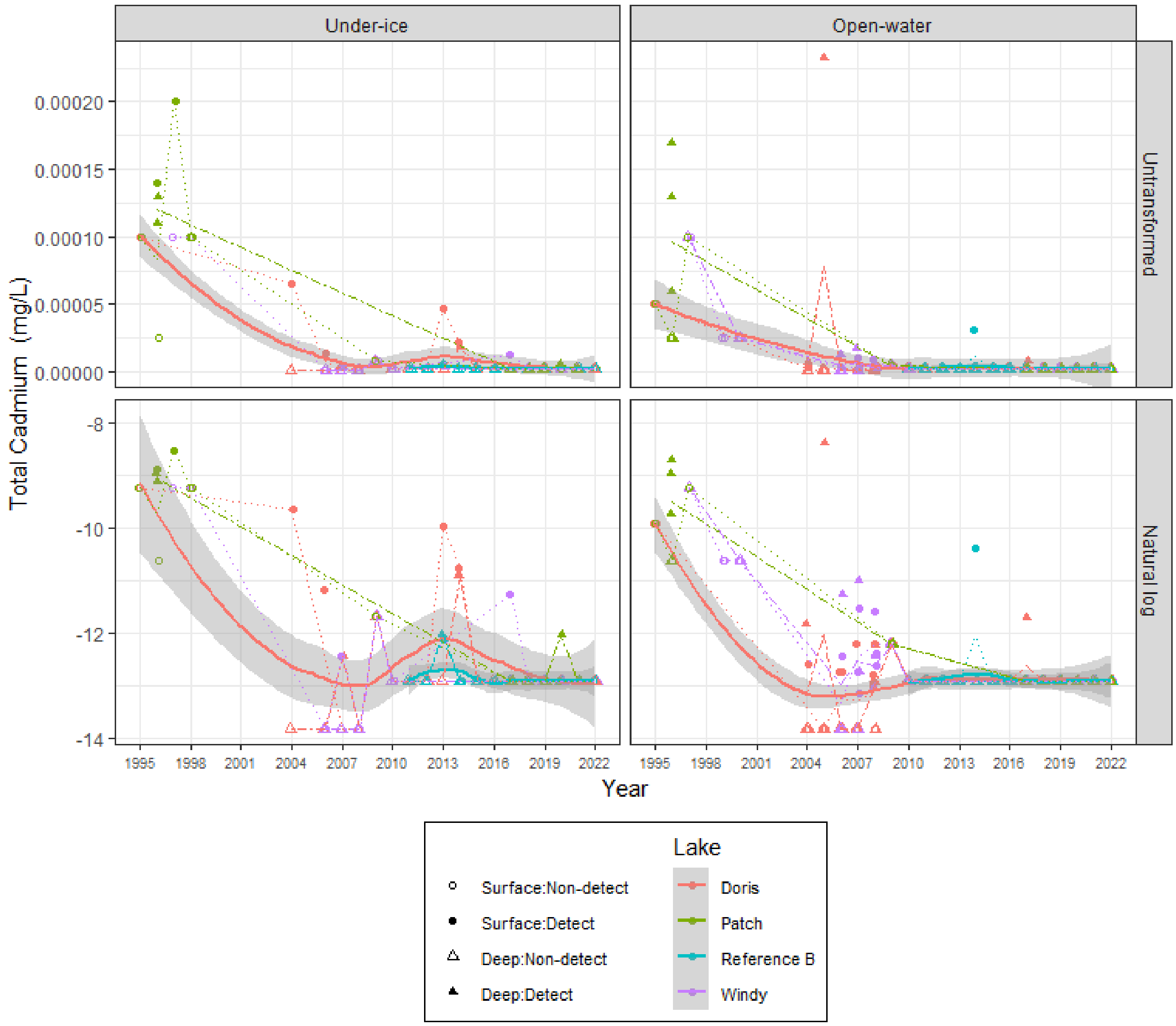
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


0.06
0.04
0.02
Total Boron
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

### *C.3.1.13 Total Cadmium*

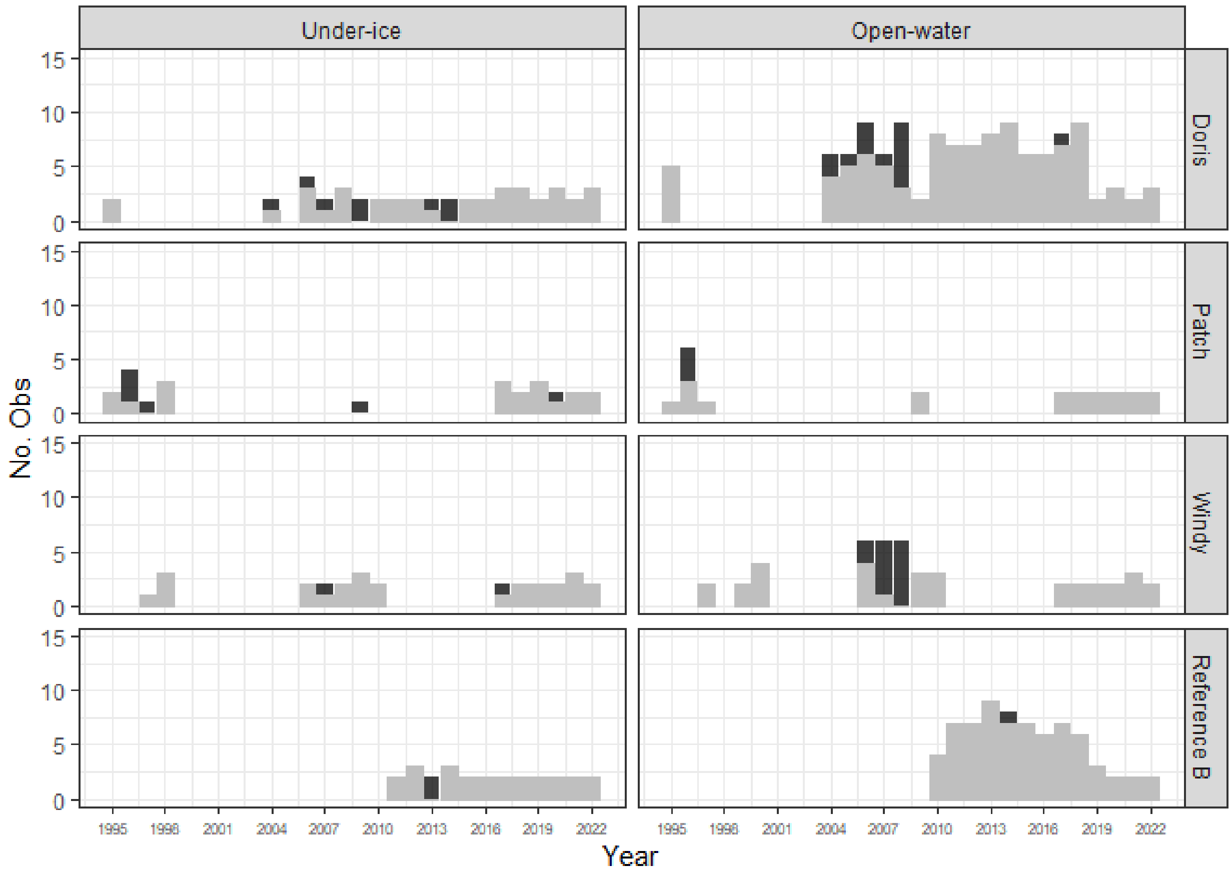
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

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

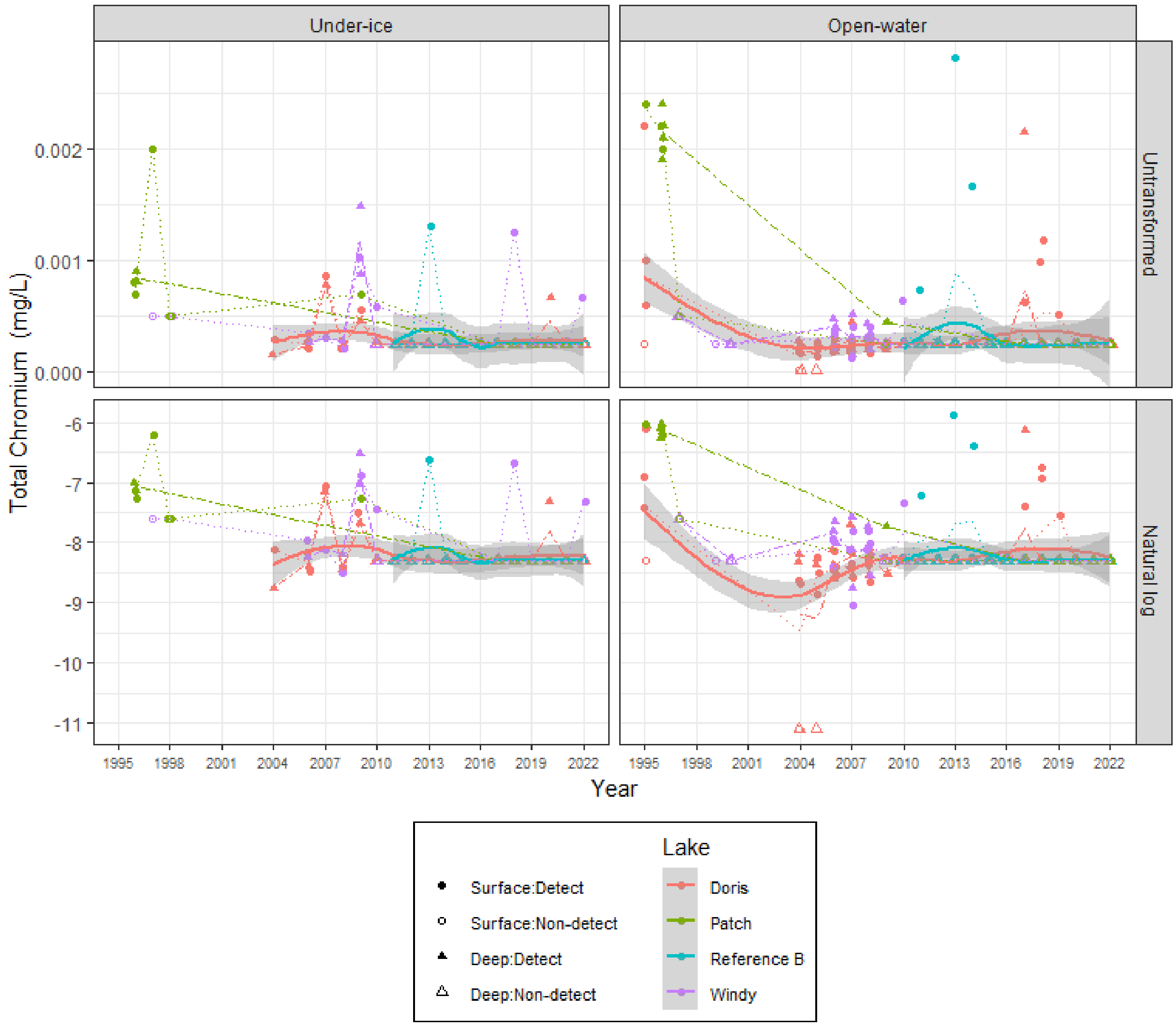
| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 45 | 39 | 87 | 100 |
| Doris | Open-water | 121 | 107 | 88 | 100 |
| Patch | Under-ice | 25 | 20 | 80 | 100 |
| Patch | Open-water | 22 | 19 | 86 | 100 |
| Reference B | Under-ice | 26 | 24 | 92 | 100 |
| Reference B | Open-water | 70 | 69 | 99 | 100 |
| Windy | Under-ice | 28 | 26 | 93 | 100 |
| Windy | Open-water | 45 | 32 | 71 | 100 |

All data from Doris, Patch and Windy were censored. All data removed from the analysis and no statistical analyses were performed.

### *C.3.1.14 Total Chromium*

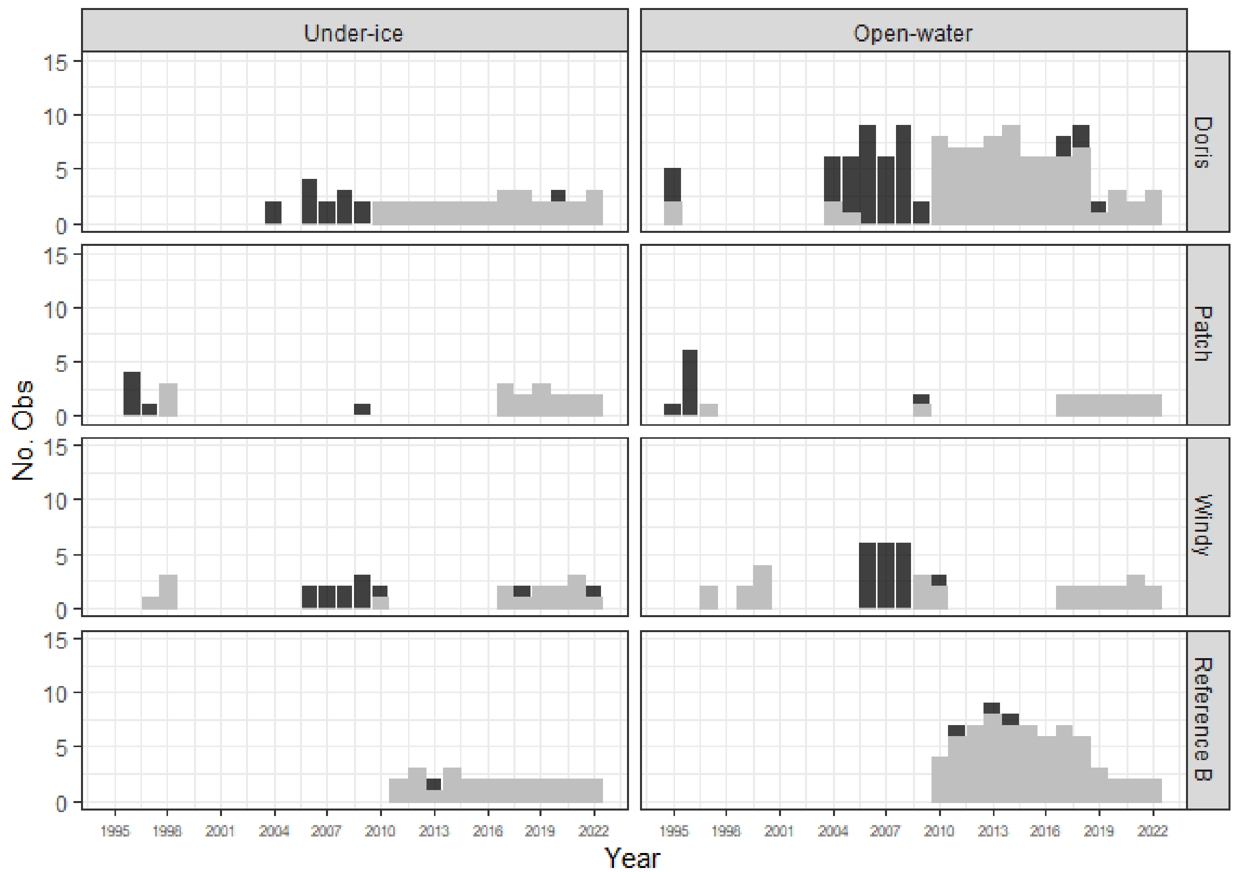
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

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

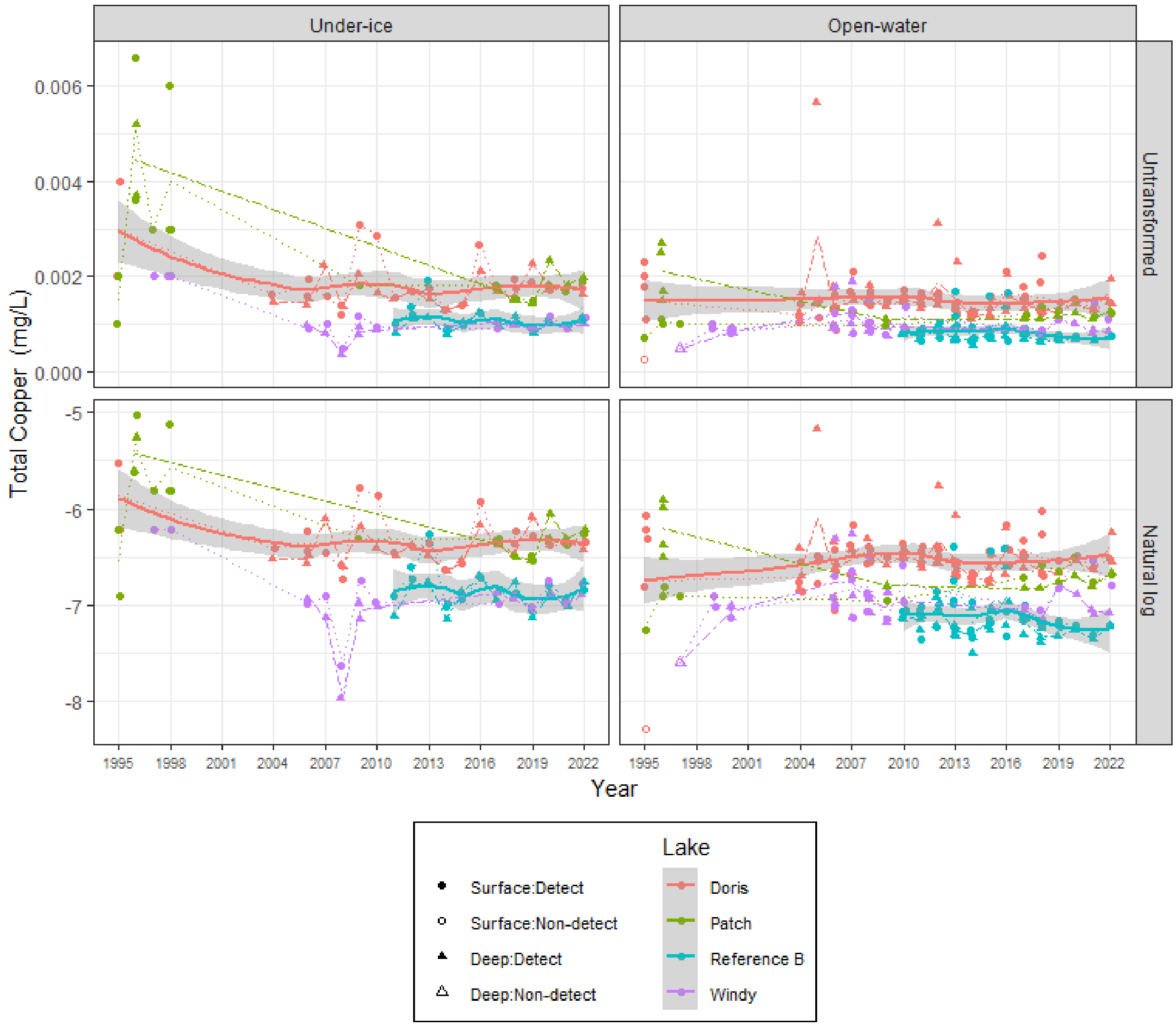
| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 29 | 67 | 100 |
| Doris | Open-water | 121 | 78 | 64 | 100 |
| Patch | Under-ice | 23 | 17 | 74 | 100 |
| Patch | Open-water | 22 | 14 | 64 | 100 |
| Reference B | Under-ice | 26 | 25 | 96 | 100 |
| Reference B | Open-water | 70 | 67 | 96 | 100 |
| Windy | Under-ice | 28 | 16 | 57 | 50 |
| Windy | Open-water | 45 | 26 | 58 | 100 |

All data from Doris, Patch and Windy were censored. All data removed from the analysis and no statistical analyses were performed.

### *C.3.1.15 Total Copper*

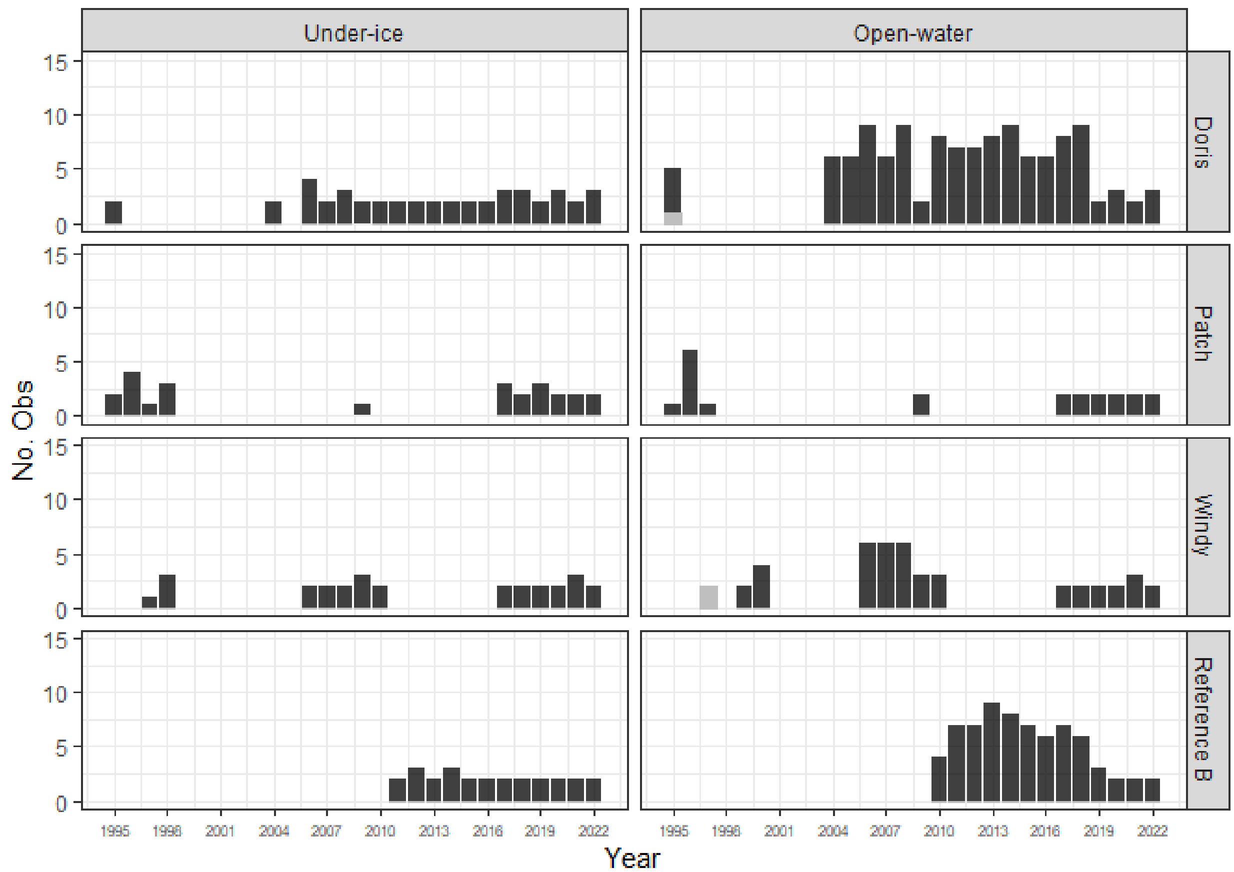
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

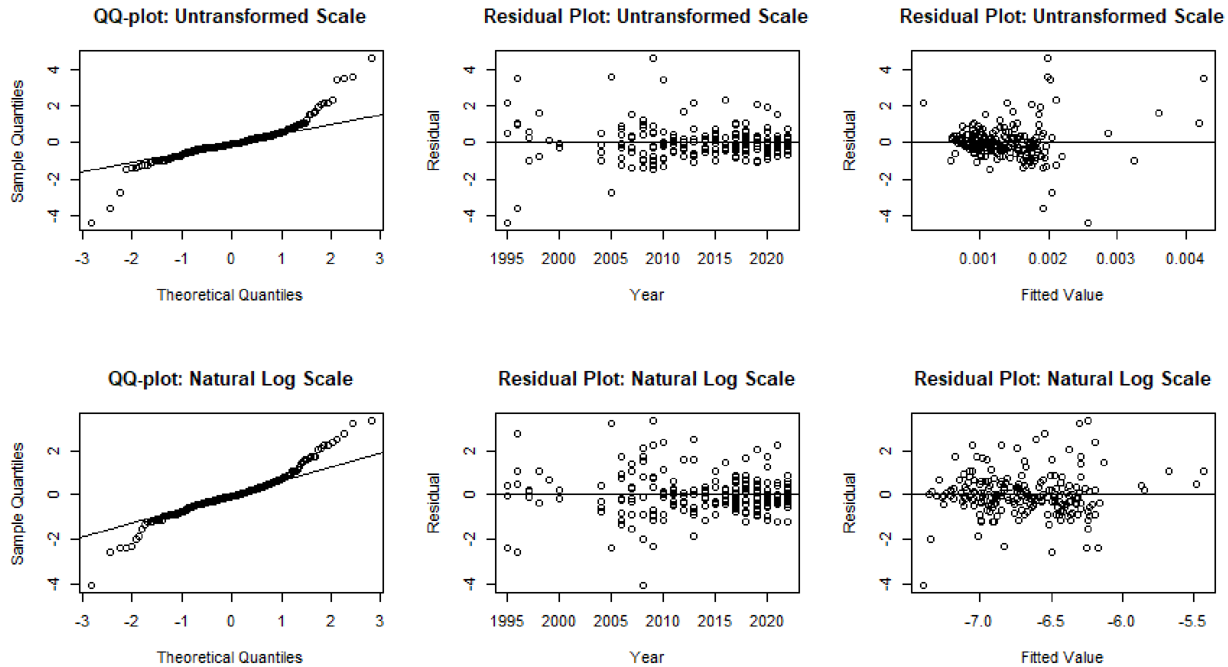
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 45 | 0 | 0 | 0 |
| Doris | Open-water | 121 | 1 | 1 | 0 |
| Patch | Under-ice | 25 | 0 | 0 | 0 |
| Patch | Open-water | 22 | 0 | 0 | 0 |
| Reference B | Under-ice | 26 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 0 | 0 | 0 |
| Windy | Under-ice | 28 | 0 | 0 | 0 |
| Windy | Open-water | 45 | 2 | 4 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 8 | Doris | 2005 | Open-water | Deep | 0.0029 | 0.002 | 3.575 |
| 23 | Doris | 2009 | Under-ice | Surface | 0.0031 | 0.002 | 4.612 |
| 27 | Doris | 2010 | Under-ice | Surface | 0.0029 | 0.002 | 3.447 |
| 78 | Patch | 1995 | Under-ice | Surface | 0.0015 | 0.003 | -4.419 |
| 81 | Patch | 1996 | Under-ice | Surface | 0.0051 | 0.004 | 3.492 |
| 83 | Patch | 1996 | Open-water | Surface | 0.0011 | 0.002 | -3.594 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 8 | Doris | 2005 | Open-water | Deep | 0.0029 | -6.302 | 3.186 |
| 23 | Doris | 2009 | Under-ice | Surface | 0.0031 | -6.244 | 3.338 |
| 179 | Windy | 2008 | Under-ice | Deep | 0.0003 | -7.398 | -4.106 |

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

### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 9.155 | 4 | 0.05730 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

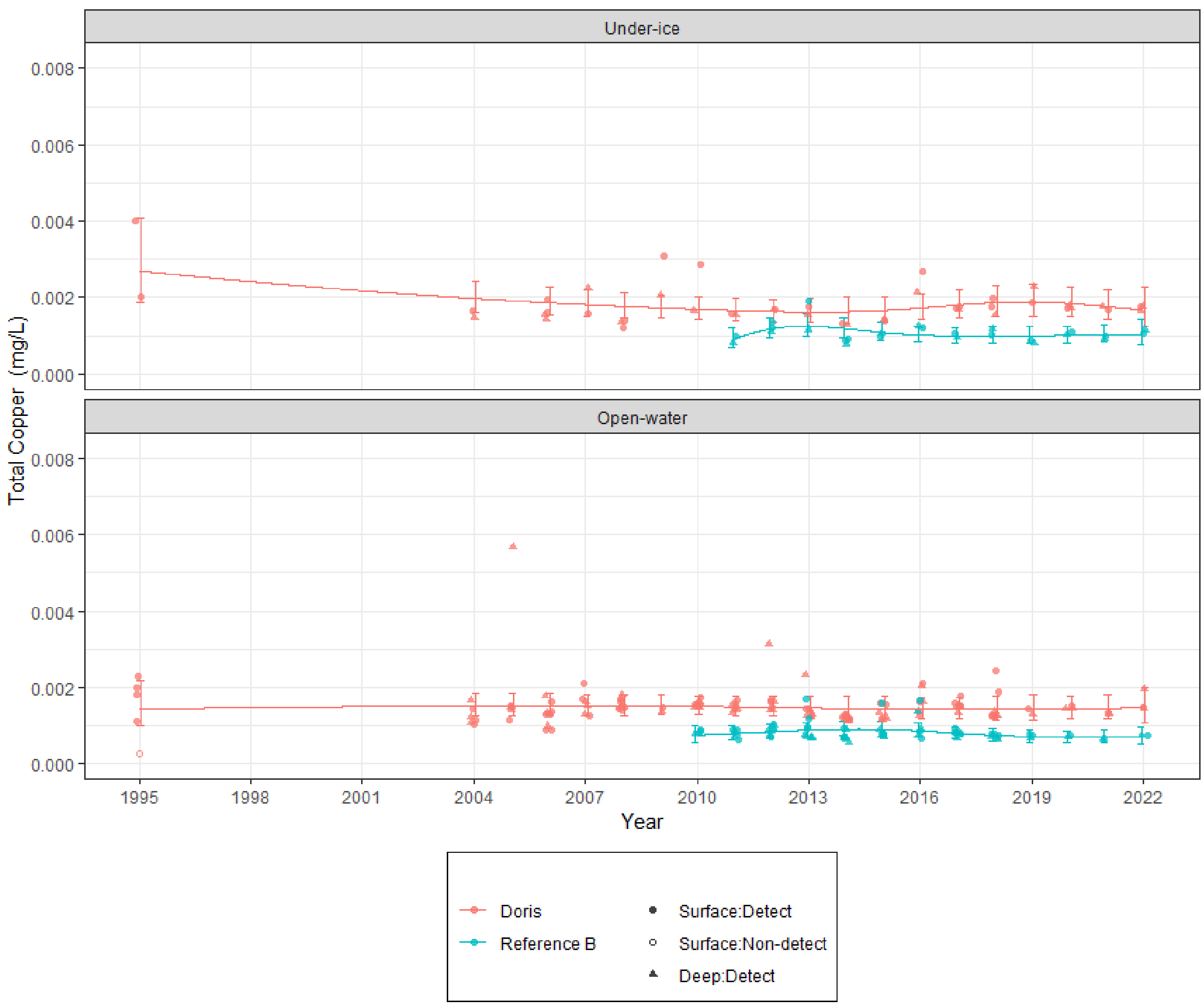
### *Open-water*

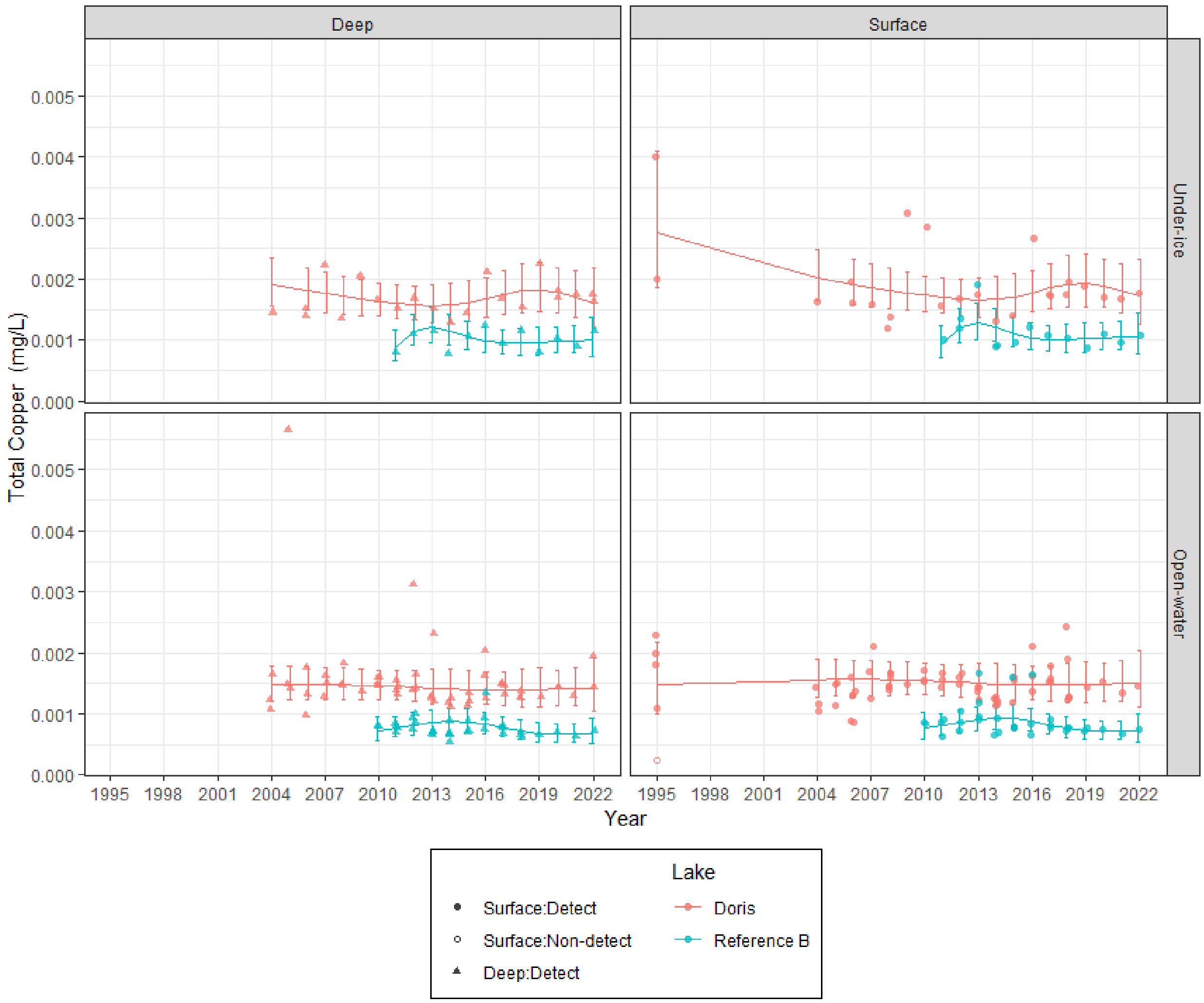
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 0.528 | 4 | 0.97070 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.2847 | 0.2517 | 8.962 | -1.131 | 0.2875 | not sig. |

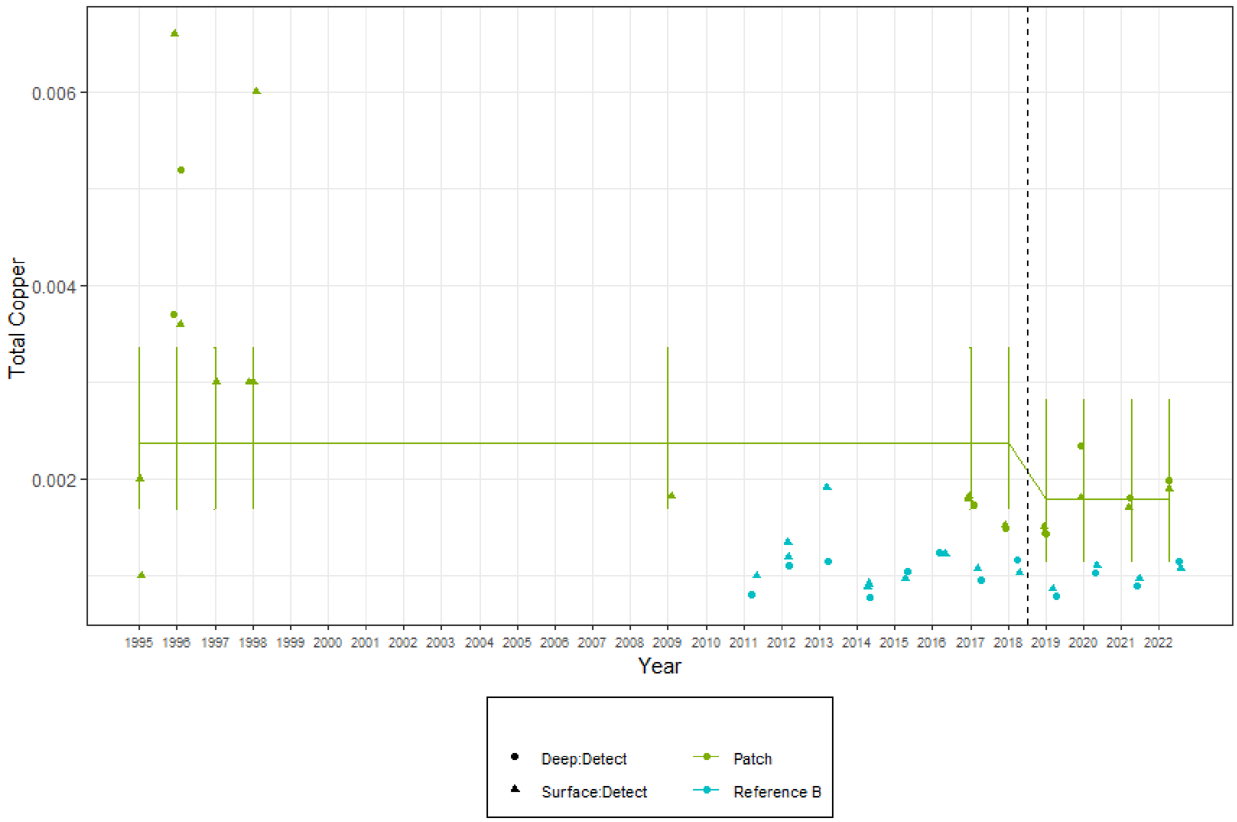
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0902 | 0.1056 | 15 | 0.854 | 0.4066 | not sig. |

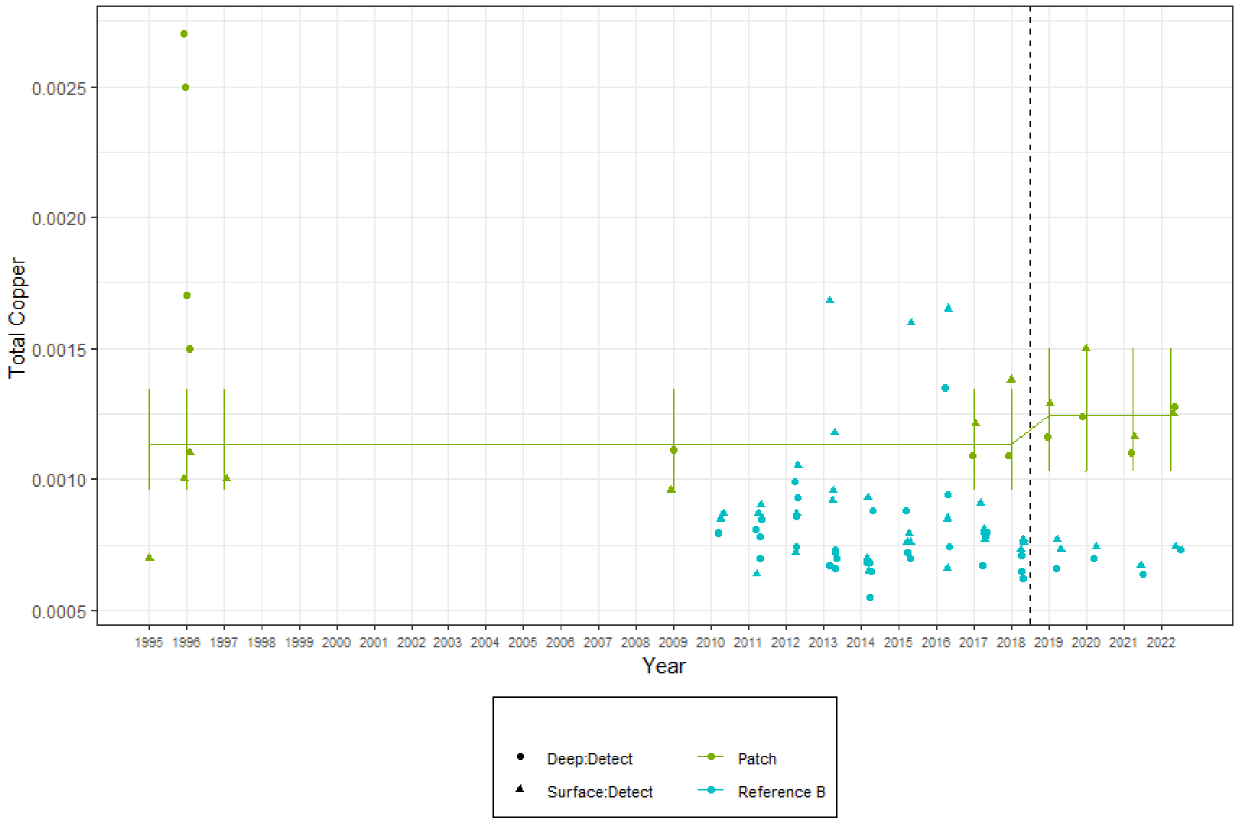
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




## Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0157 | 0.2311 | 10.62 | -0.0679 | 0.9471 | not sig. |

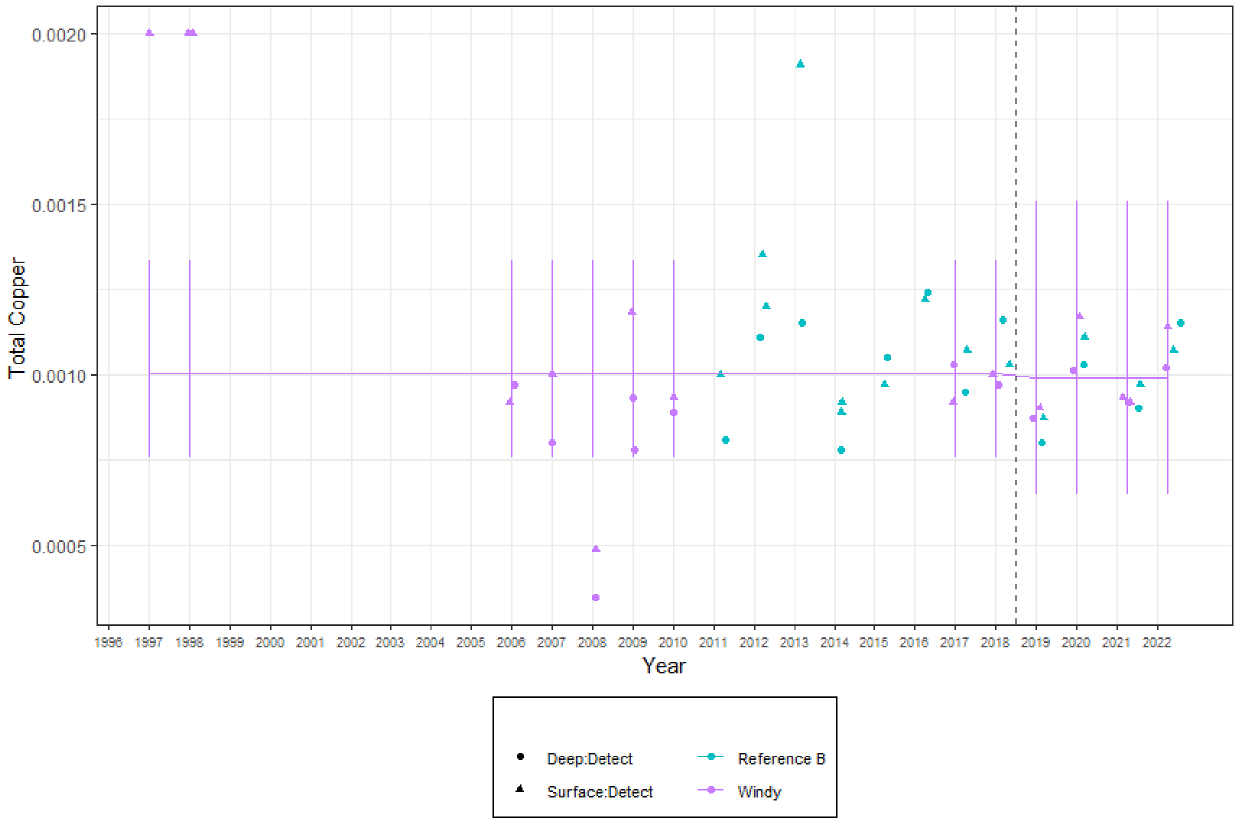
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.2061 | 0.128 | 12.08 | 1.611 | 0.133 | not sig. |

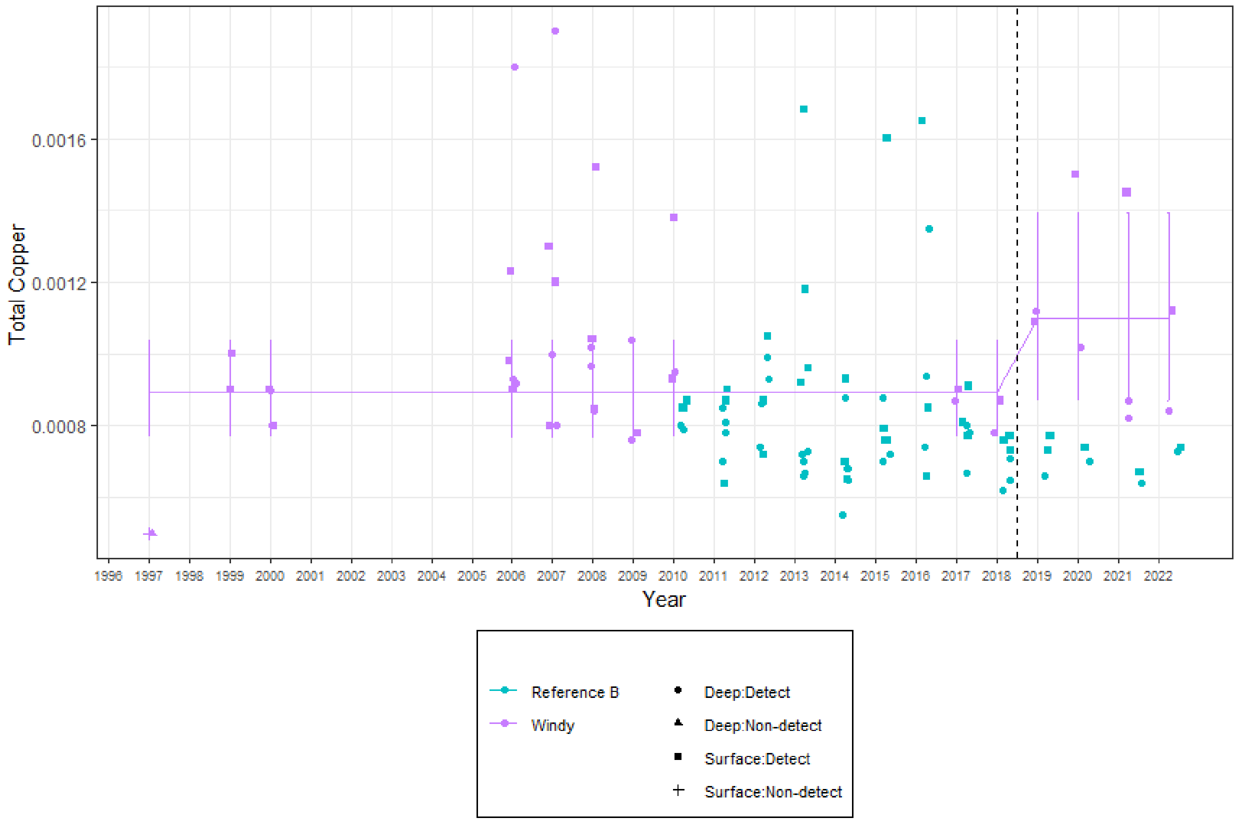
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

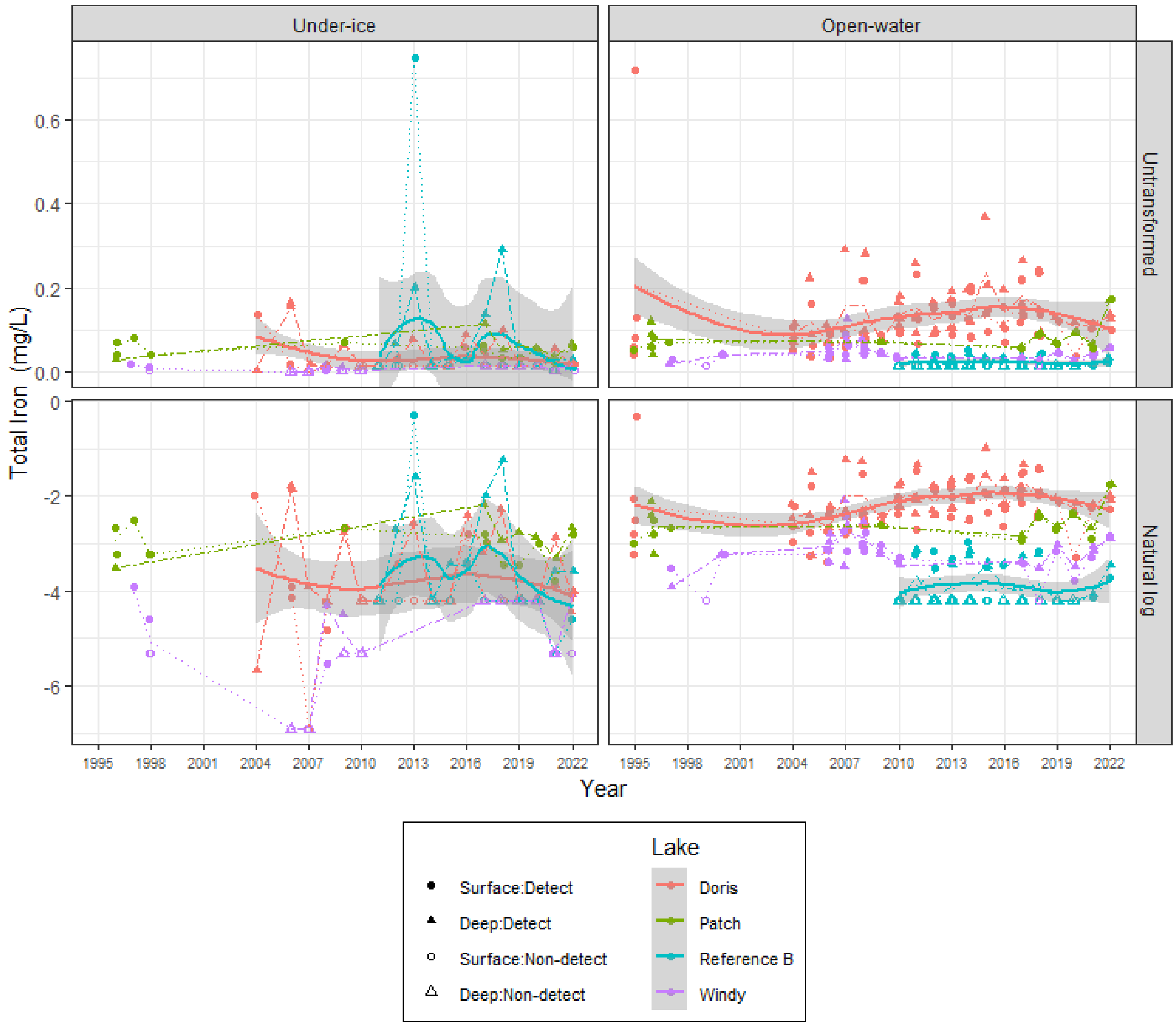
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Total Copper
0.0016
0.0012
0.0008
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

## *C.3.1.16 Total Iron*

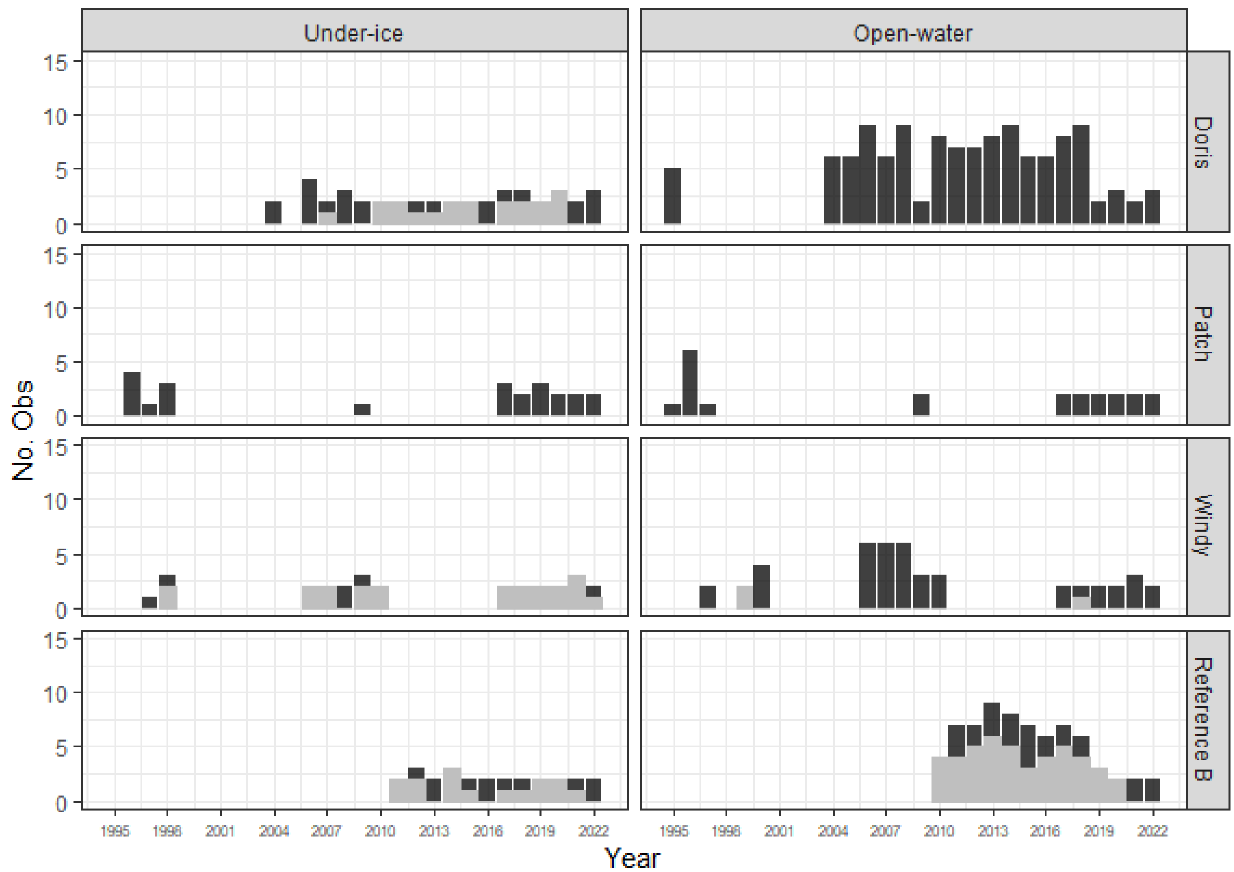
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

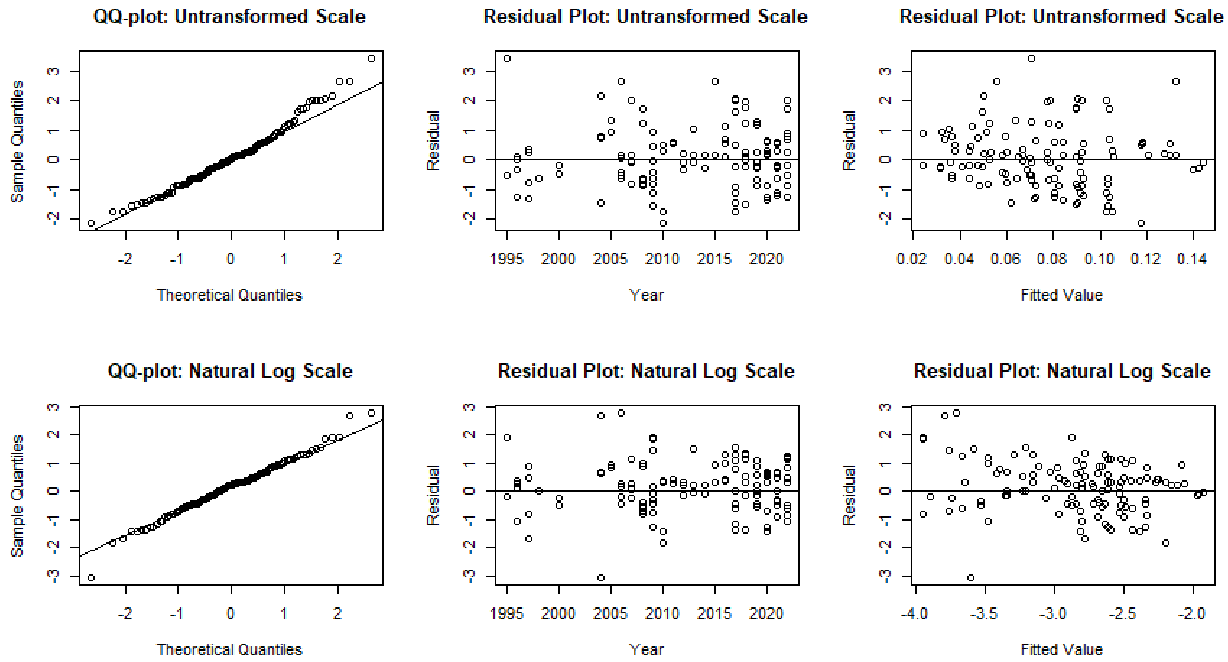
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 20 | 47 | 0 |
| Doris | Open-water | 121 | 0 | 0 | 0 |
| Patch | Under-ice | 23 | 0 | 0 | 0 |
| Patch | Open-water | 22 | 0 | 0 | 0 |
| Reference B | Under-ice | 26 | 15 | 58 | 0 |
| Reference B | Open-water | 70 | 45 | 64 | 0 |
| Windy | Under-ice | 28 | 22 | 79 | 50 |
| Windy | Open-water | 45 | 3 | 7 | 0 |

More than 50% of data under detection limit in 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 exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris Lake.

### 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 |
|---|---|---|---|---|---|---|---|
| 2 | Doris | 1995 | Open-water | Surface | 0.206 | 0.071 | 3.422 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 4 | Doris | 2004 | Under-ice | Deep | 0.0034 | -3.601 | -3.076 |

The natural log transformed model 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 zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 13.16 | 3 | 0.00430 | sig. |

Doris Lake appears to show significant deviation from a slope of zero.

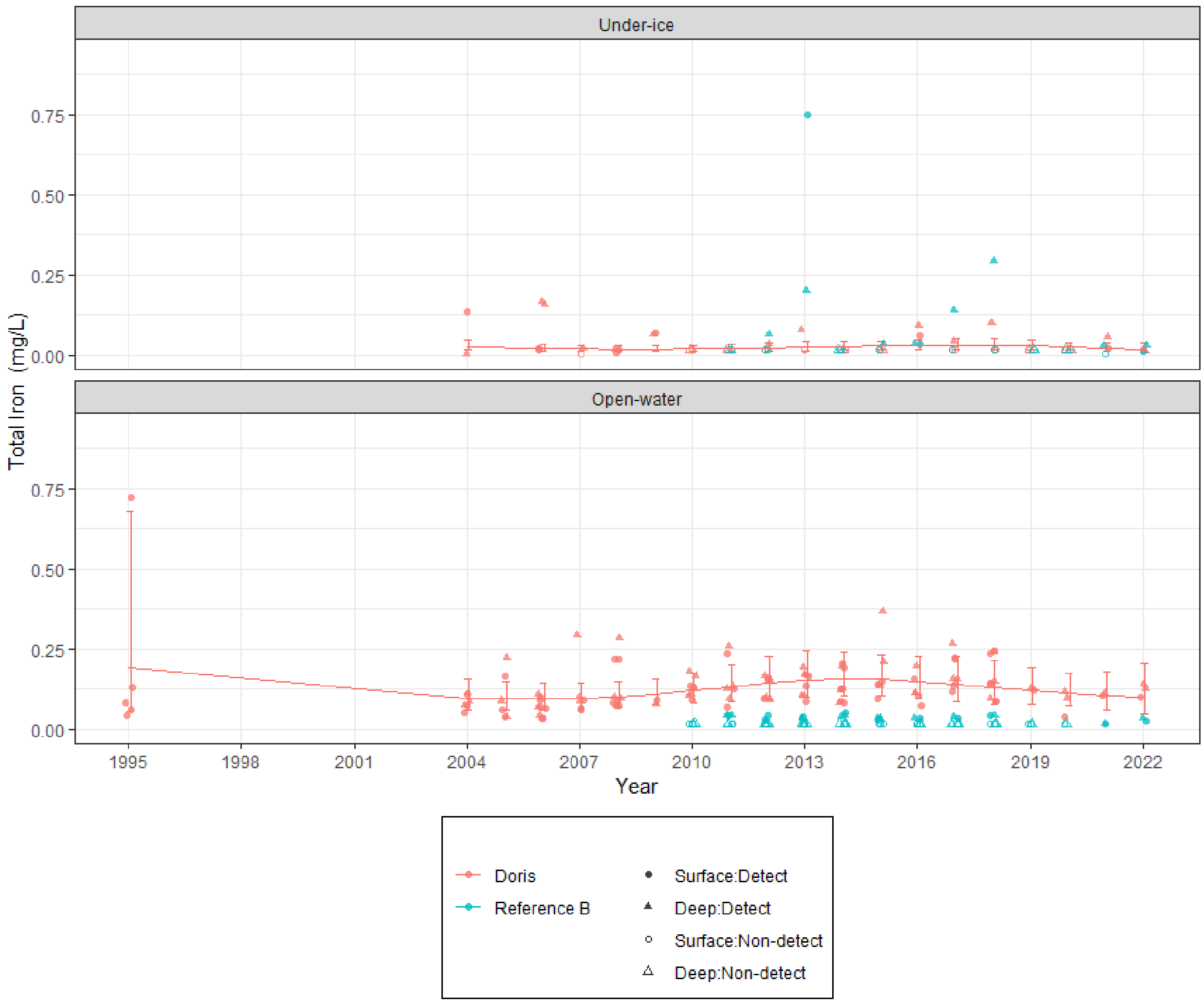
#### *Open-water*

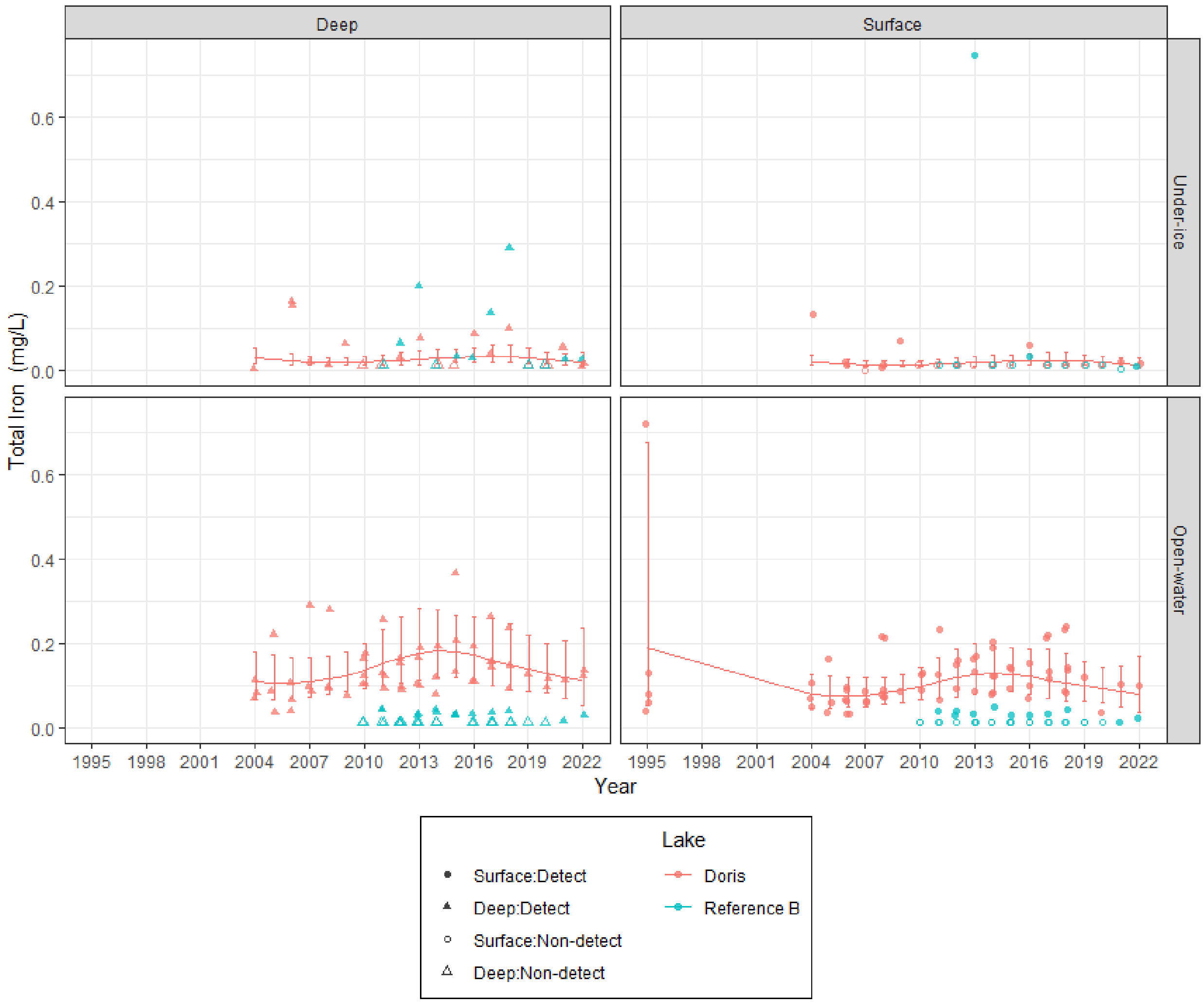
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 3.338 | 3 | 0.34240 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.2296 | 0.2348 | 7.785 | -0.9779 | 0.3575 | not sig. |

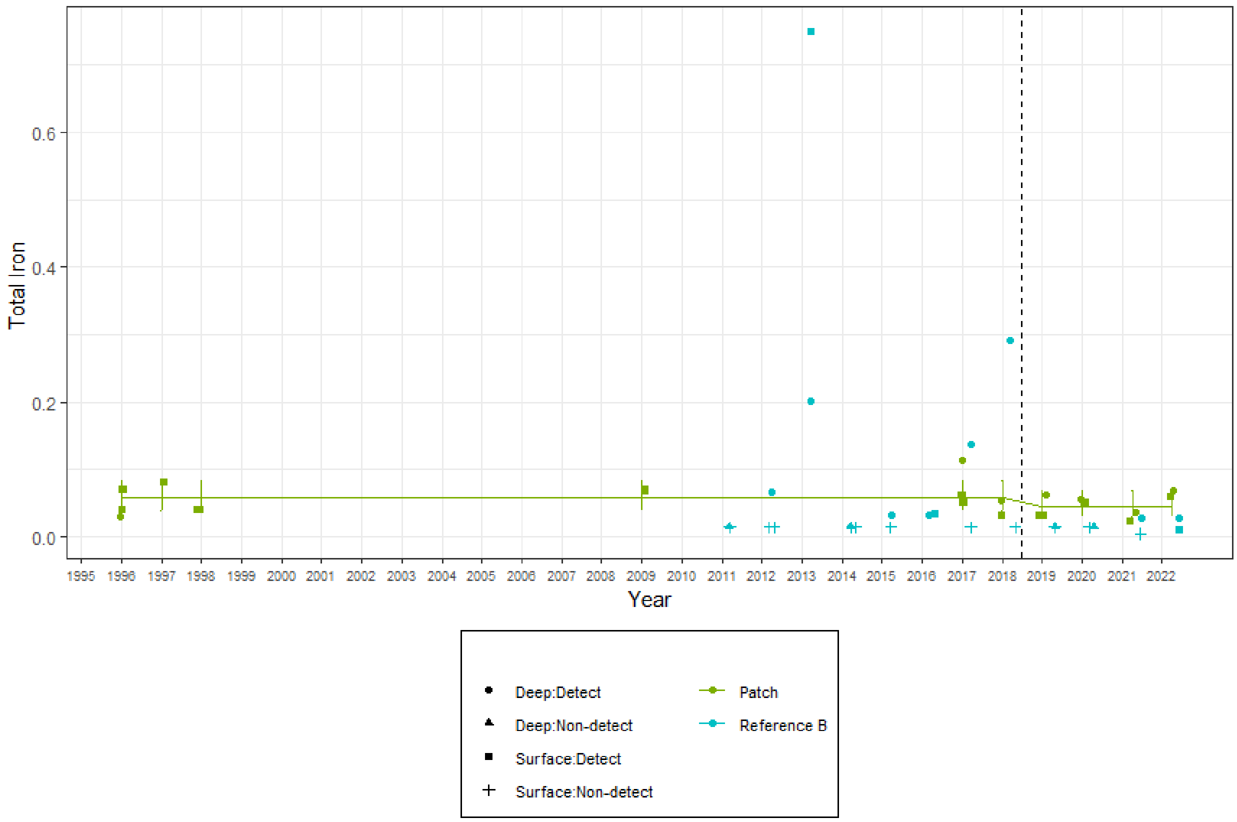
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.2875 | 0.2108 | 8.017 | 1.364 | 0.2096 | not sig. |

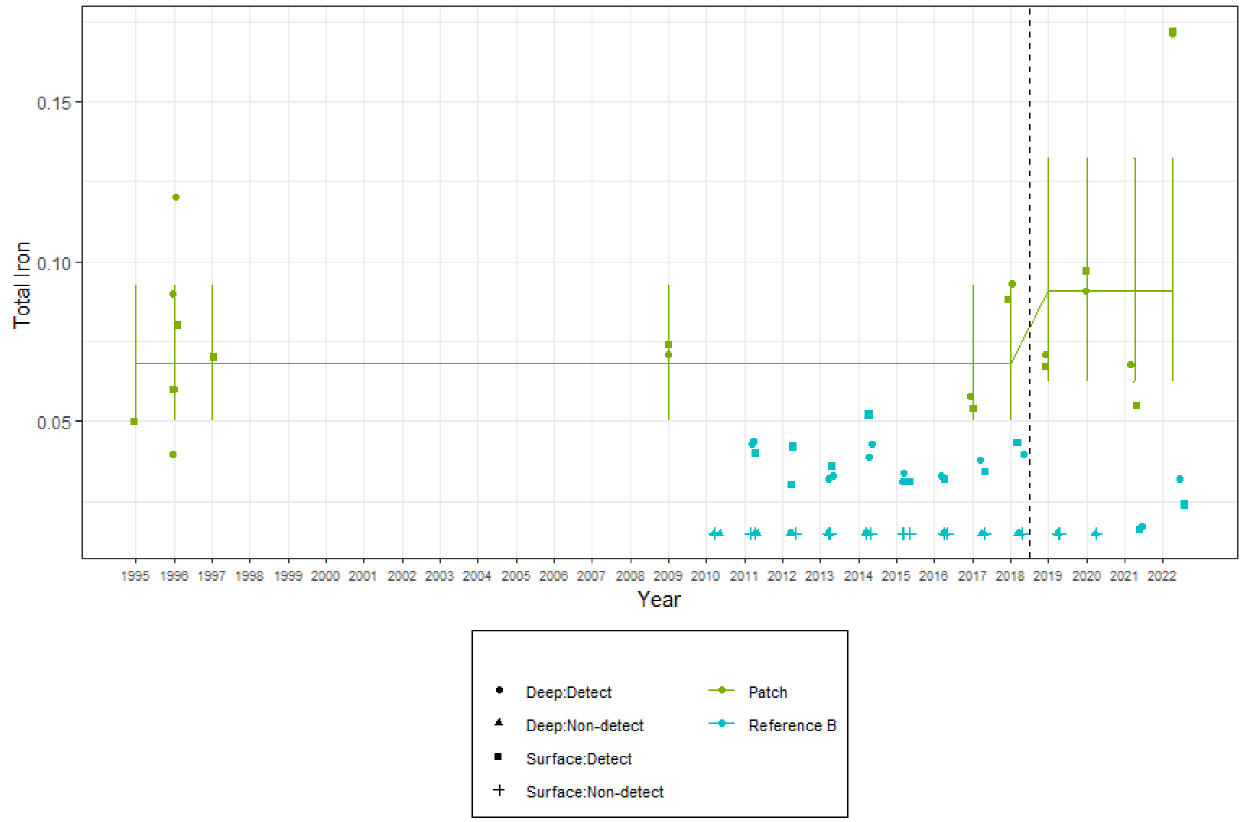
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

Analysis not performed.

#### *Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.1473 | 0.2438 | 11.39 | 0.6042 | 0.5575 | not sig. |

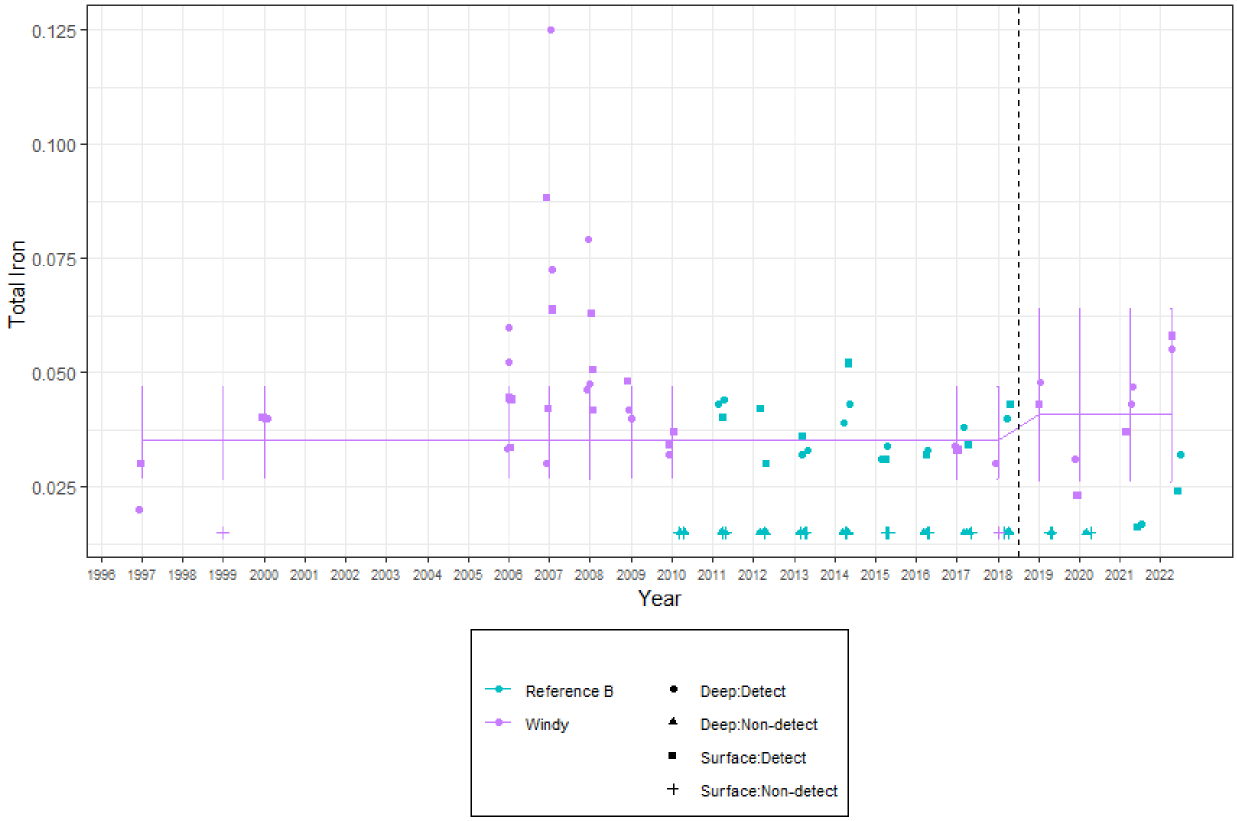
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

#### *Observed Data and Fitted Values*

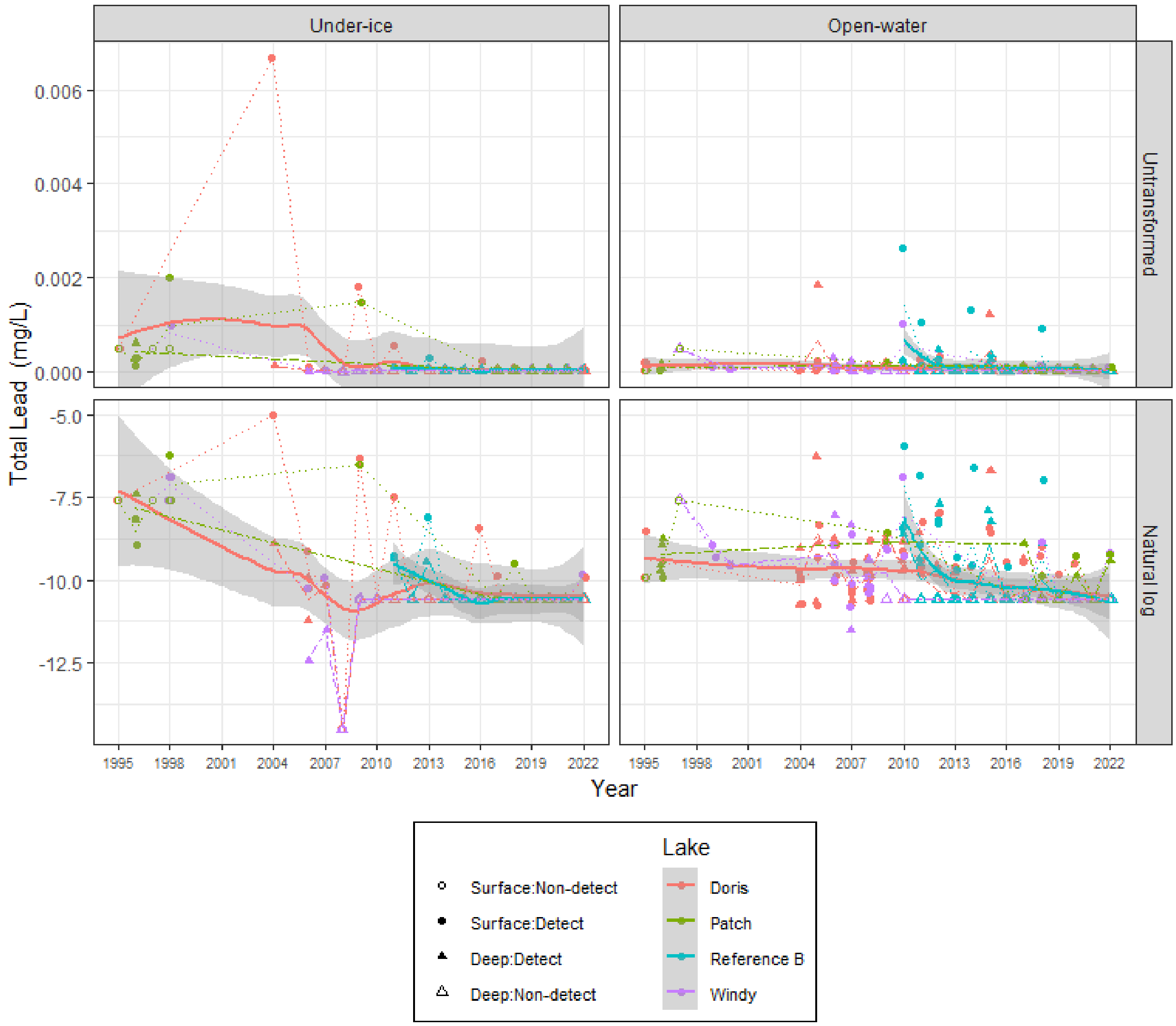
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.



### *C.3.1.17 Total Lead*

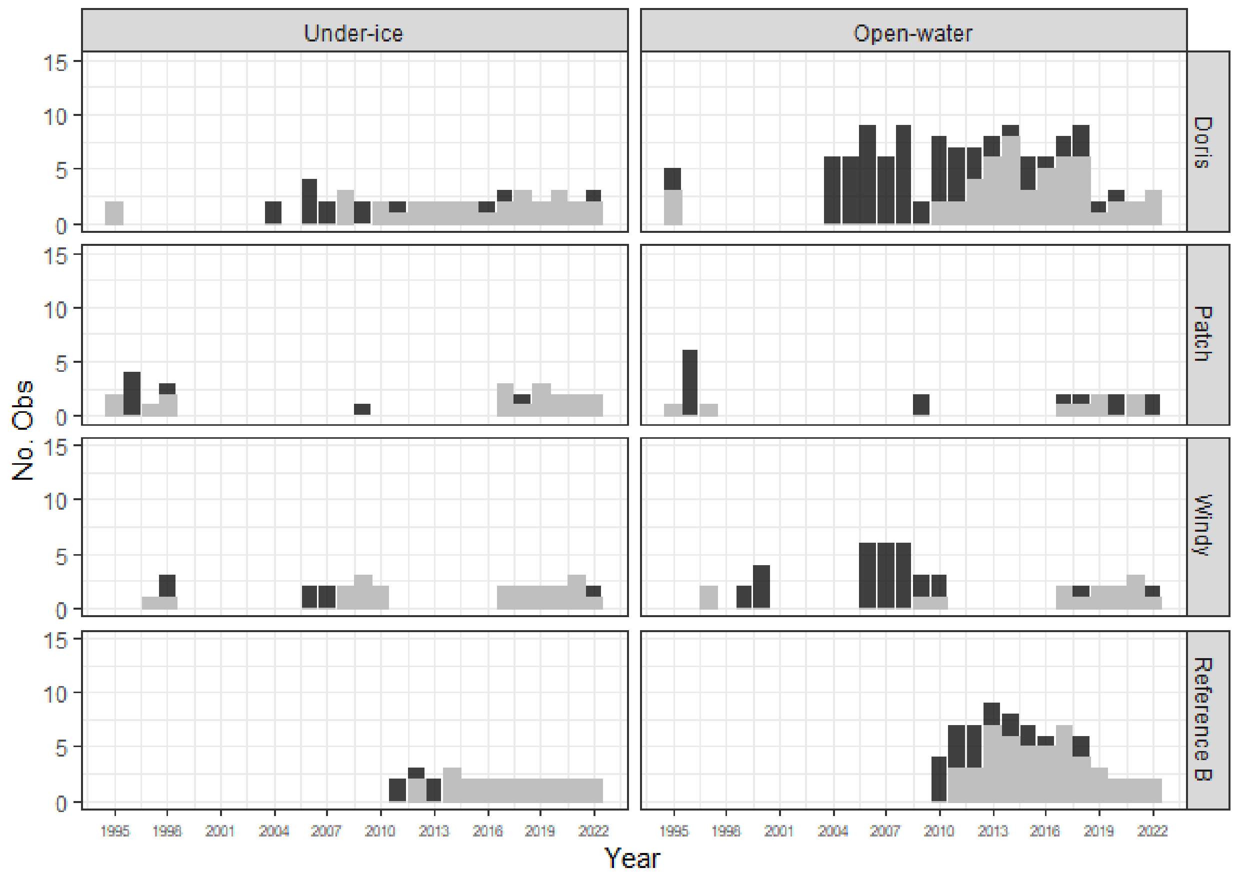
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

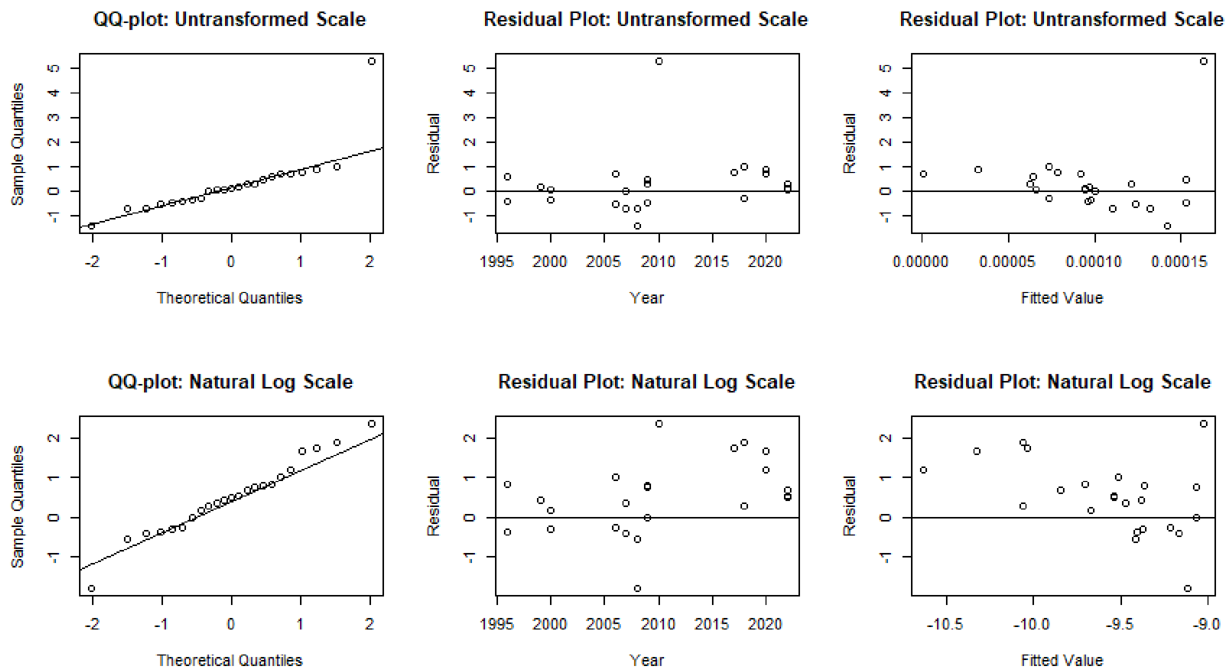
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 45 | 32 | 71 | 67 |
| Doris | Open-water | 121 | 53 | 44 | 100 |
| Patch | Under-ice | 25 | 18 | 72 | 100 |
| Patch | Open-water | 22 | 8 | 36 | 0 |
| Reference B | Under-ice | 26 | 21 | 81 | 100 |
| Reference B | Open-water | 70 | 49 | 70 | 100 |
| Windy | Under-ice | 28 | 21 | 75 | 50 |
| Windy | Open-water | 45 | 15 | 33 | 50 |

More than 50% of data under detection limit in Doris under-ice, Doris open-water, 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 Lake.

### 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 |
|---|---|---|---|---|---|---|---|
| 33 | Windy | 2010 | Open-water | Surface | 0.0006 | 0 | 5.273 |

Outliers on natural log scale:

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

### Doris Lake

#### *Under-ice*

All data from Doris under-ice removed from the analysis. No analysis performed.

#### *Open-water*

All data from Doris Lake open-water removed from the analysis. No analysis performed.

### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were 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 | -0.7111 | 0.5246 | 6.809 | -1.355 | 0.2185 | not sig. |

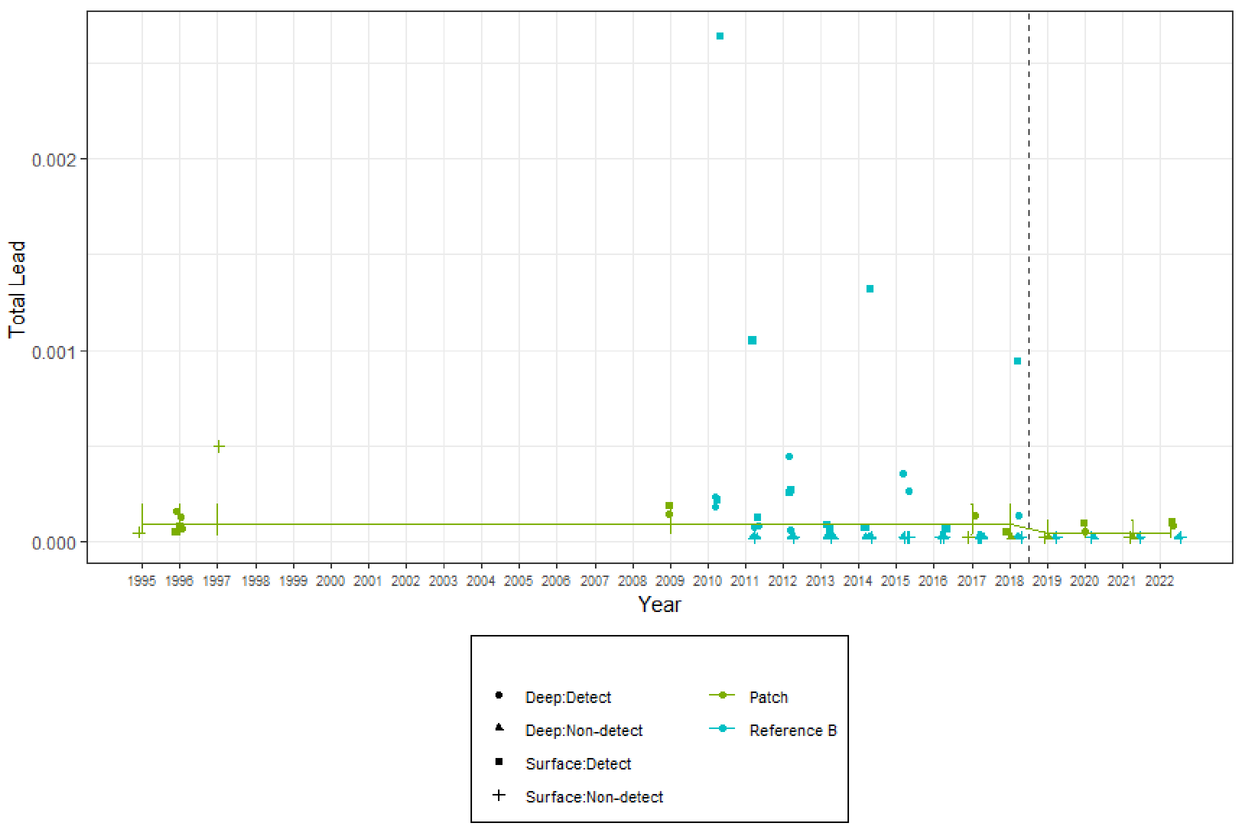
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




## Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

### *Under-ice*

Analysis not performed.

### *Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -1.057 | 0.4185 | 12.04 | -2.526 | 0.0266 | sig. |

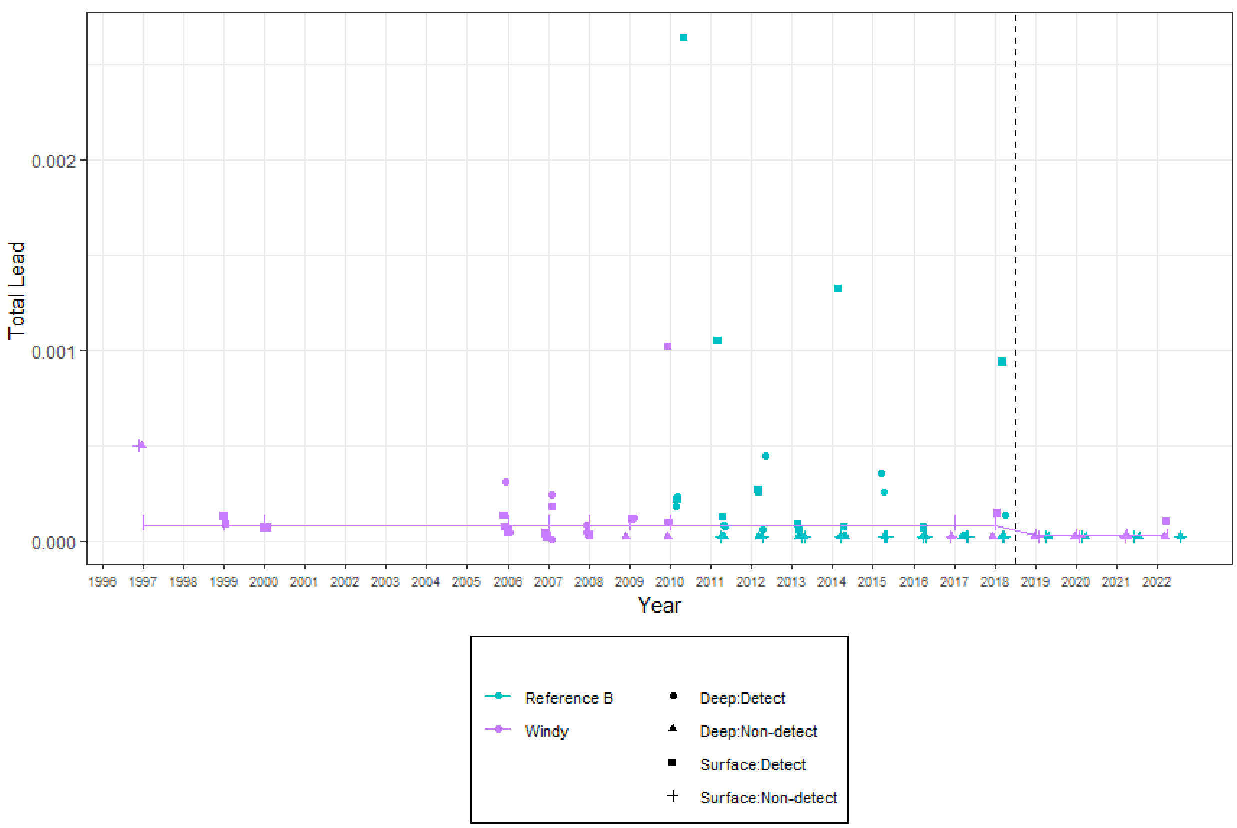
Conclusion:

The change in concentrations at Windy Lake from before to after was significantly different.

BACI analysis not performed.

### *Observed Data and Fitted Values*

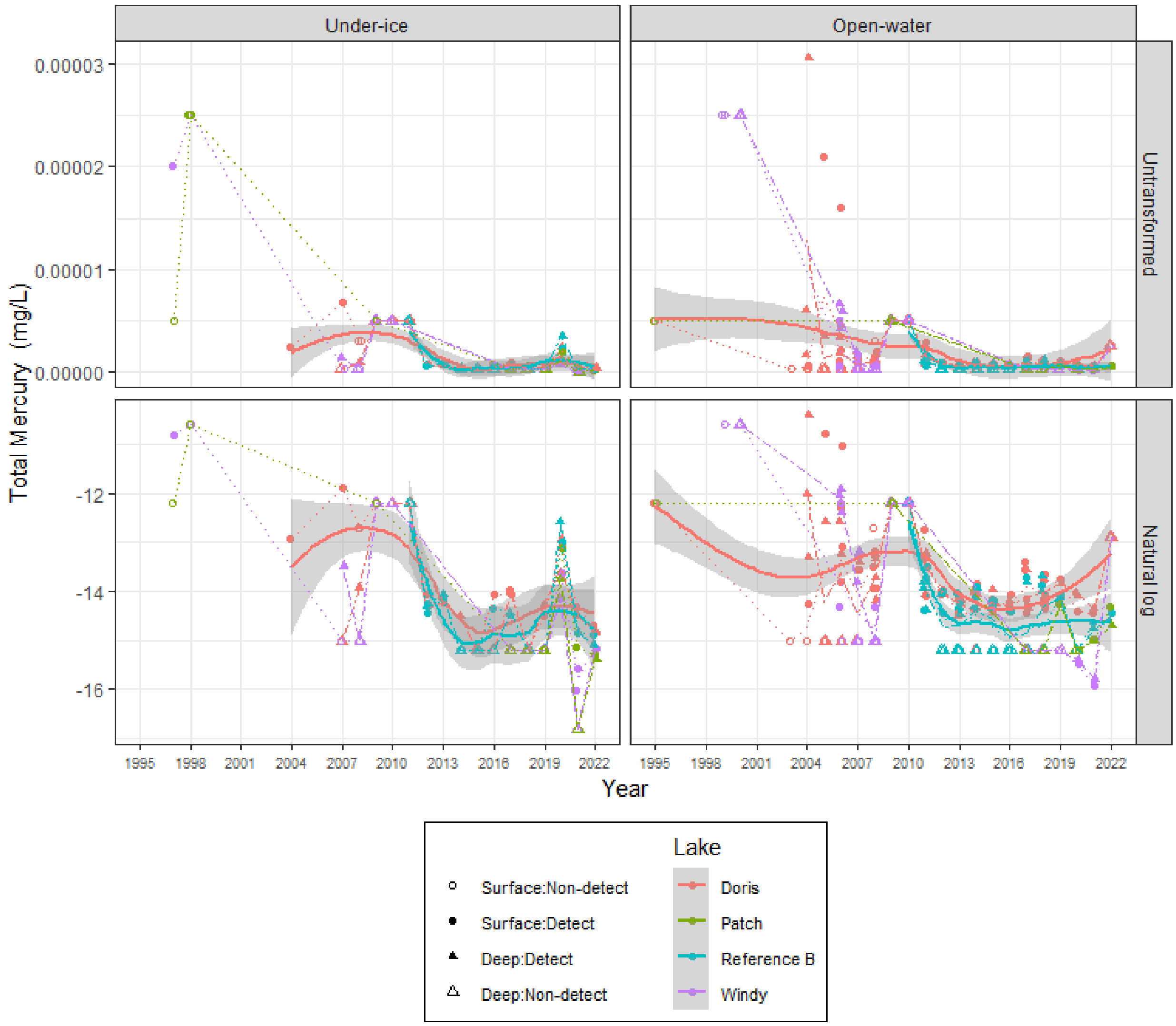
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.



### *C.3.1.18 Total Mercury*

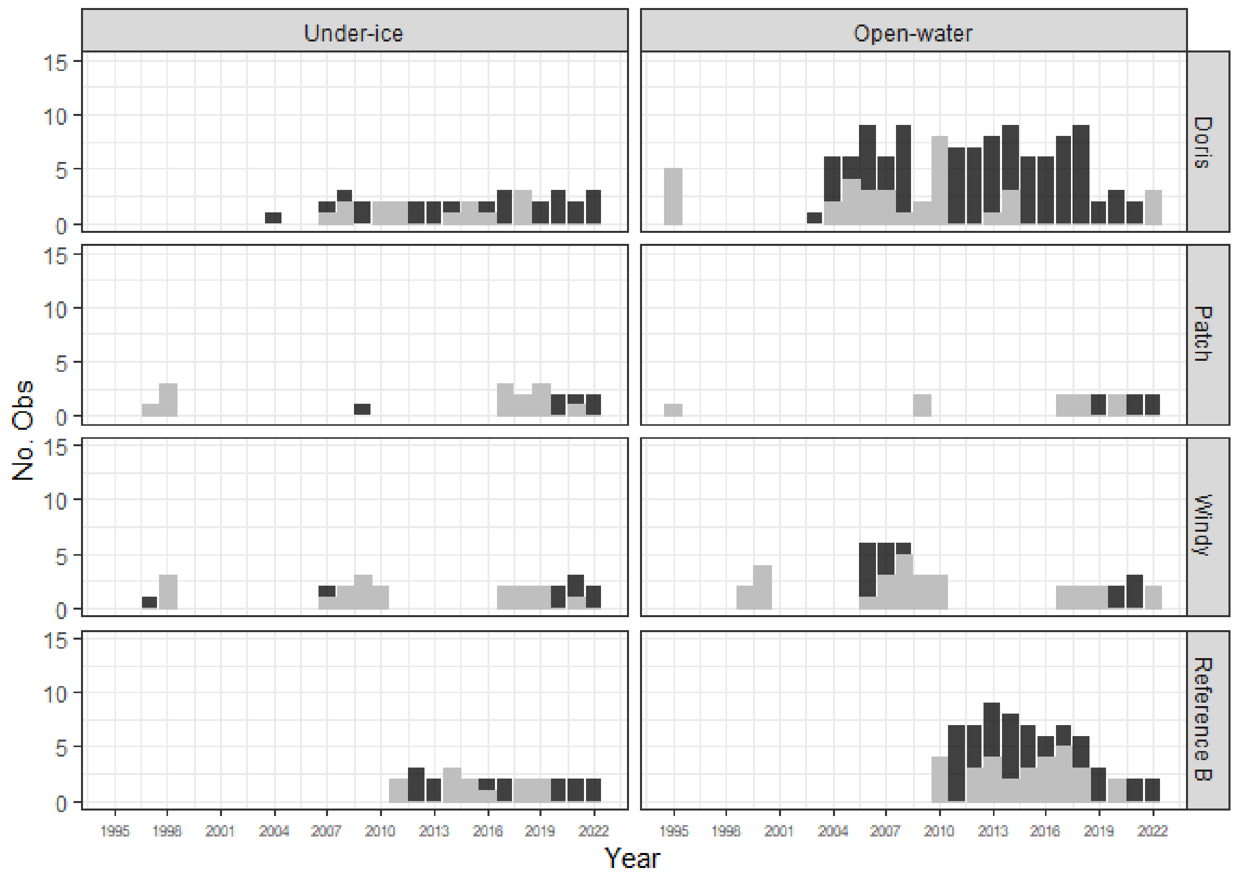
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

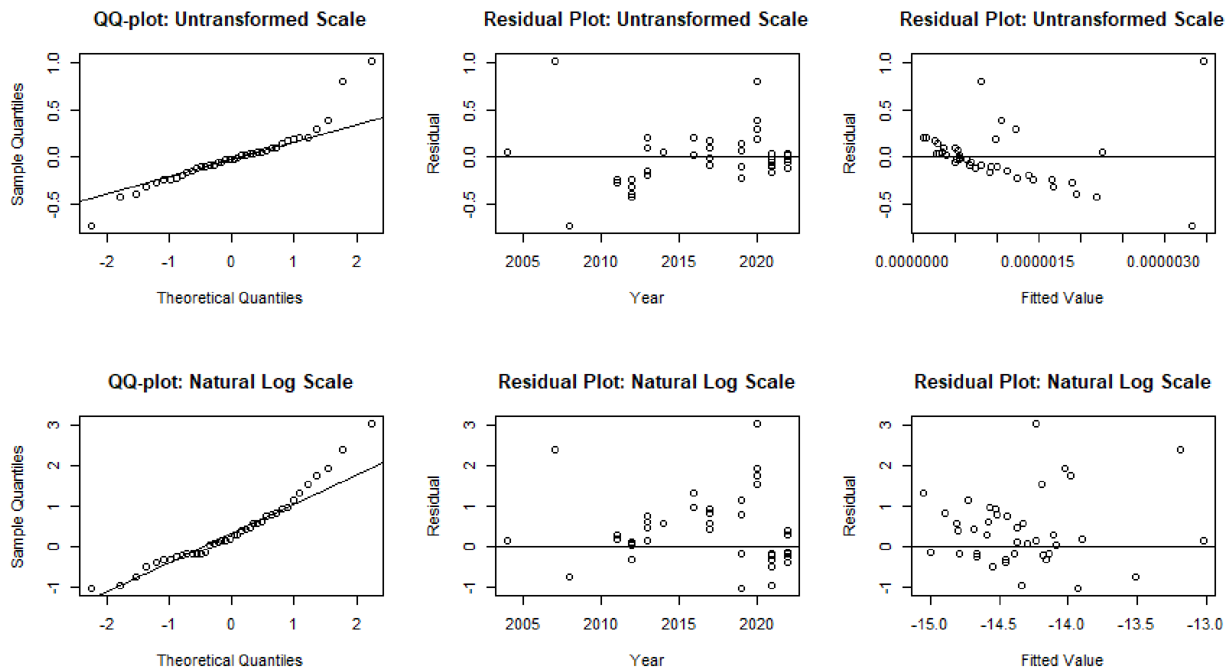
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 38 | 16 | 42 | 0 |
| Doris | Open-water | 122 | 36 | 30 | 100 |
| Patch | Under-ice | 19 | 14 | 74 | 0 |
| Patch | Open-water | 15 | 9 | 60 | 0 |
| Reference B | Under-ice | 26 | 12 | 46 | 0 |
| Reference B | Open-water | 70 | 30 | 43 | 0 |
| Windy | Under-ice | 26 | 18 | 69 | 0 |
| Windy | Open-water | 43 | 29 | 67 | 100 |

More than 50% of data under detection limit in Doris open-water, Patch under-ice, Patch open-water, Windy under-ice, and Windy open-water. Data from those site-season groupings will be removed from the analysis. Doris under-ice, Doris open-water, Reference B under-ice, and Reference B open-water exhibited more than 10% of data under detection limit. The analysis proceeds with tobit regression for Doris Lake. Reference Lake B exhibited close to 50% under detection limit in the open-water season. Inclusion of Reference Lake B lead to unstable results, hence Reference Lake B was removed from the analysis. The analysis proceeds with tobit regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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:

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 76 | Reference B | 2020 | Under-ice | Deep | 0 | -14.23 | 3.021 |

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 9.166 | 3 | 0.02720 | sig. |
| Compare to Reference B | 0.111 | 3 | 0.99050 | not sig. |

Doris Lake appears to show significant deviation from a slope of zero. Doris Lake did not exhibit significant deviation from the trend of Reference Lake B.

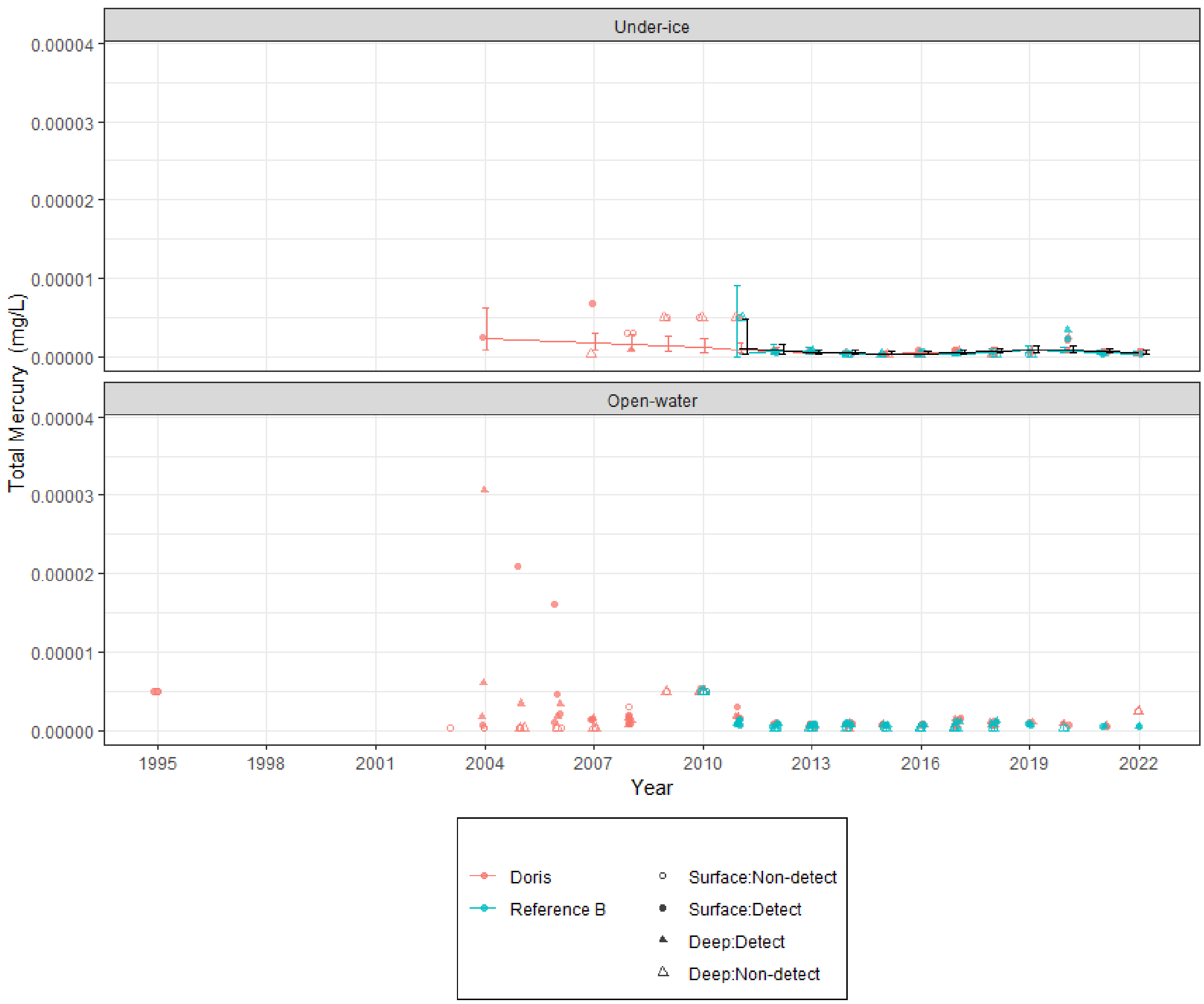
*Open-water*

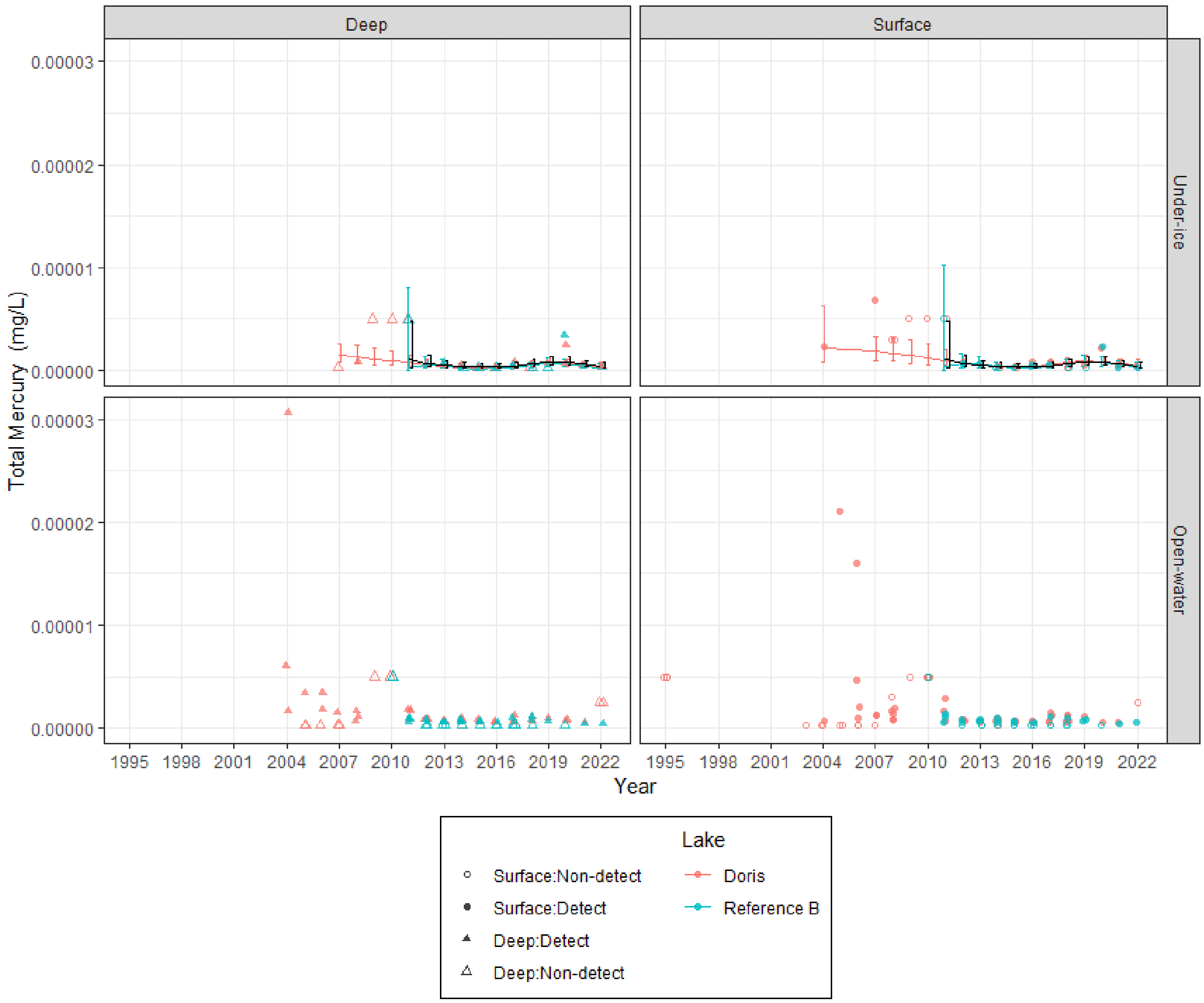
All data from Doris Lake open-water removed from the analysis. No analysis performed.

*Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

As Doris Lake appears to show significant deviation from a slope of zero in at least one season, the black lines and error bars represent the model built with Doris Lake data from comparable sampling years with Reference Lake B only.






### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were 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 in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

*Under-ice*

Analysis not performed.

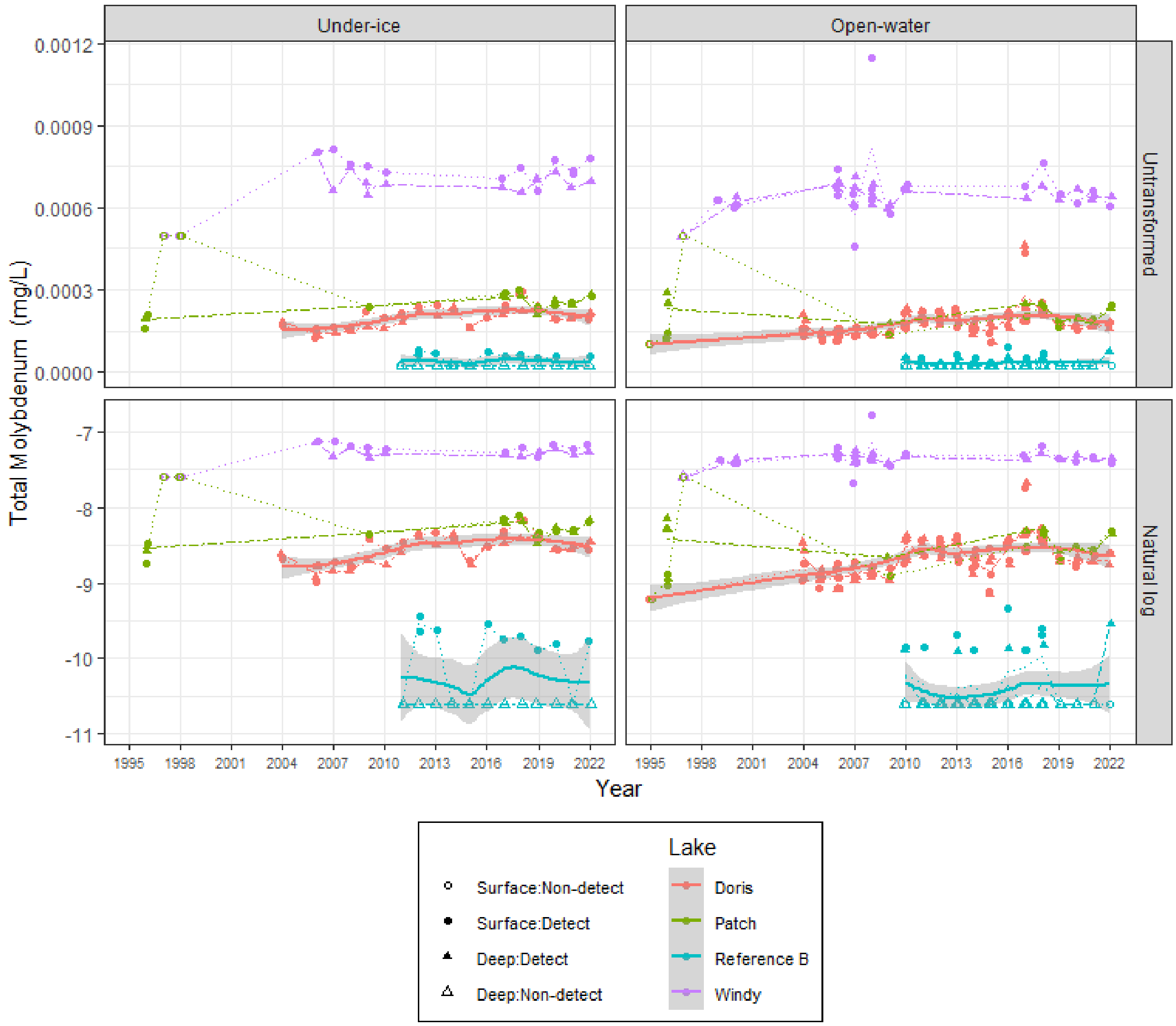
*Open-water*

Analysis not performed.

## *C.3.1.19 Total Molybdenum*

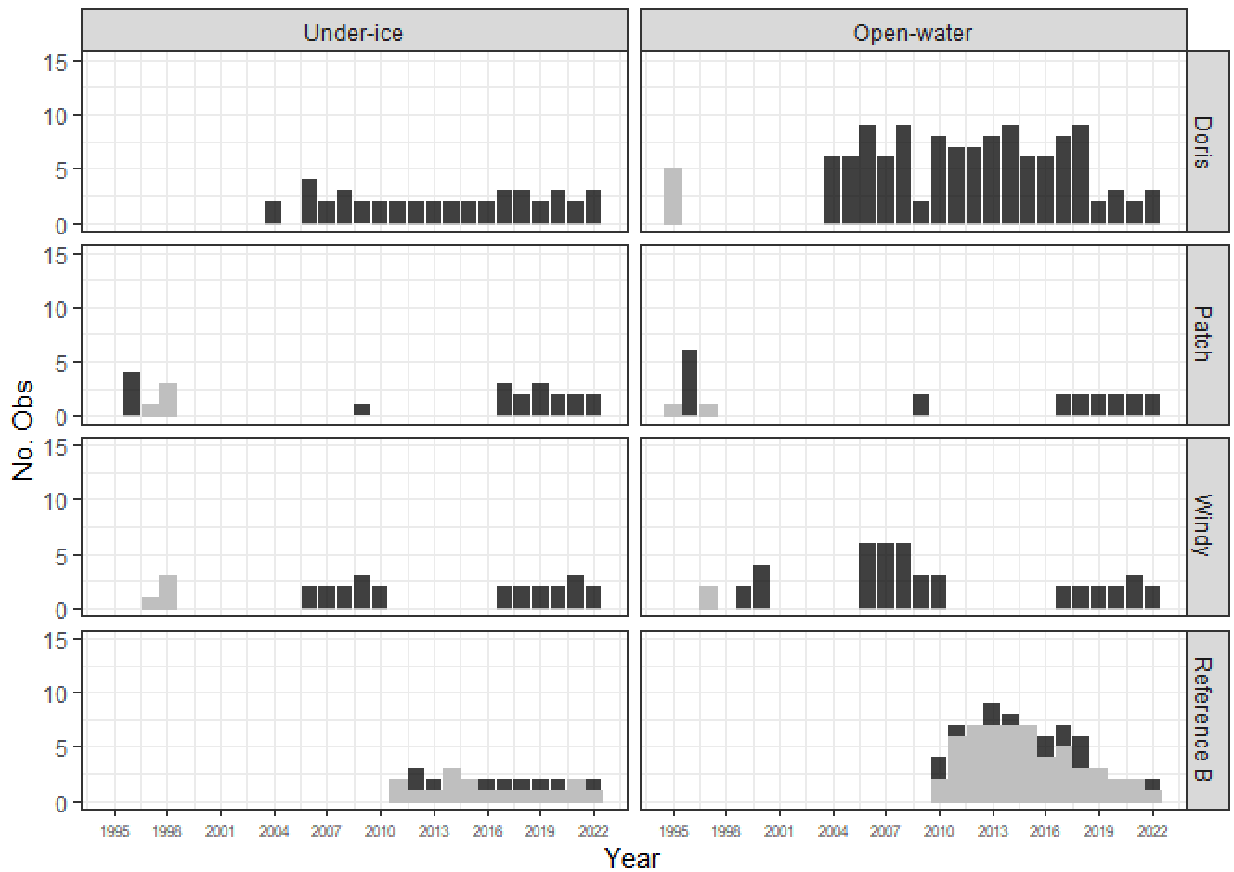
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

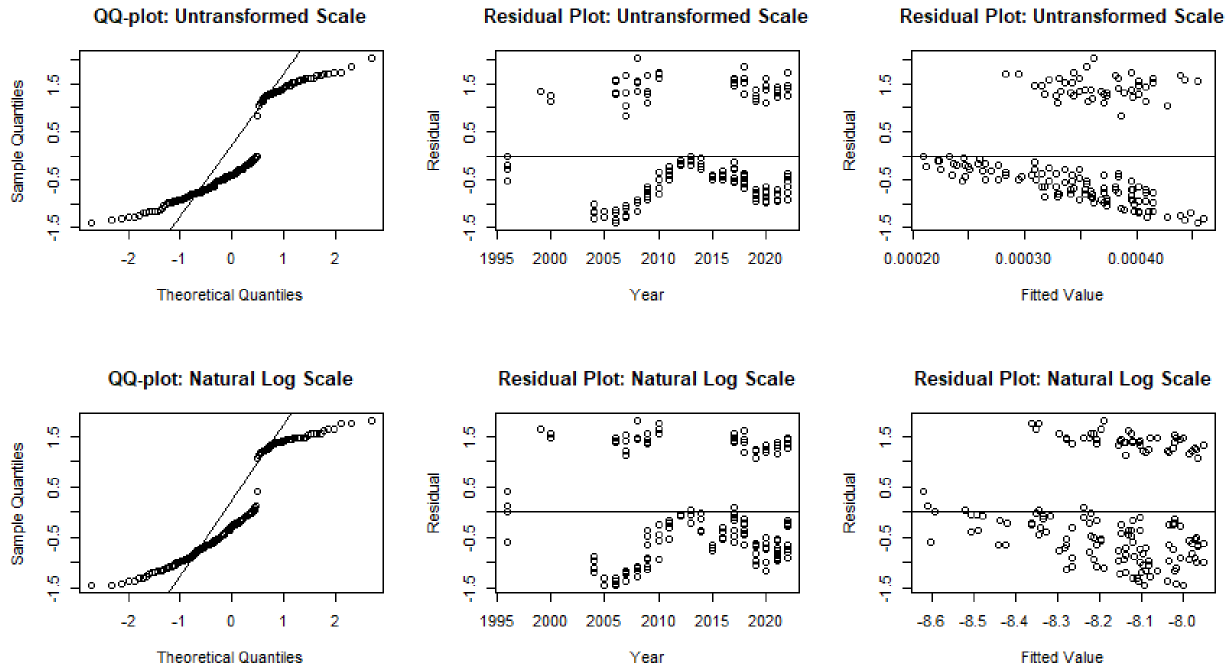
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 0 | 0 | 0 |
| Doris | Open-water | 121 | 5 | 4 | 0 |
| Patch | Under-ice | 23 | 4 | 17 | 0 |
| Patch | Open-water | 22 | 2 | 9 | 0 |
| Reference B | Under-ice | 26 | 17 | 65 | 50 |
| Reference B | Open-water | 70 | 56 | 80 | 50 |
| Windy | Under-ice | 28 | 4 | 14 | 0 |
| Windy | Open-water | 45 | 2 | 4 | 0 |

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.

### 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:

Outliers on natural log scale:

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 25.24 | 3 | <0.00001 | sig. |

Doris Lake appears to show significant deviation from a slope of zero.

#### *Open-water*

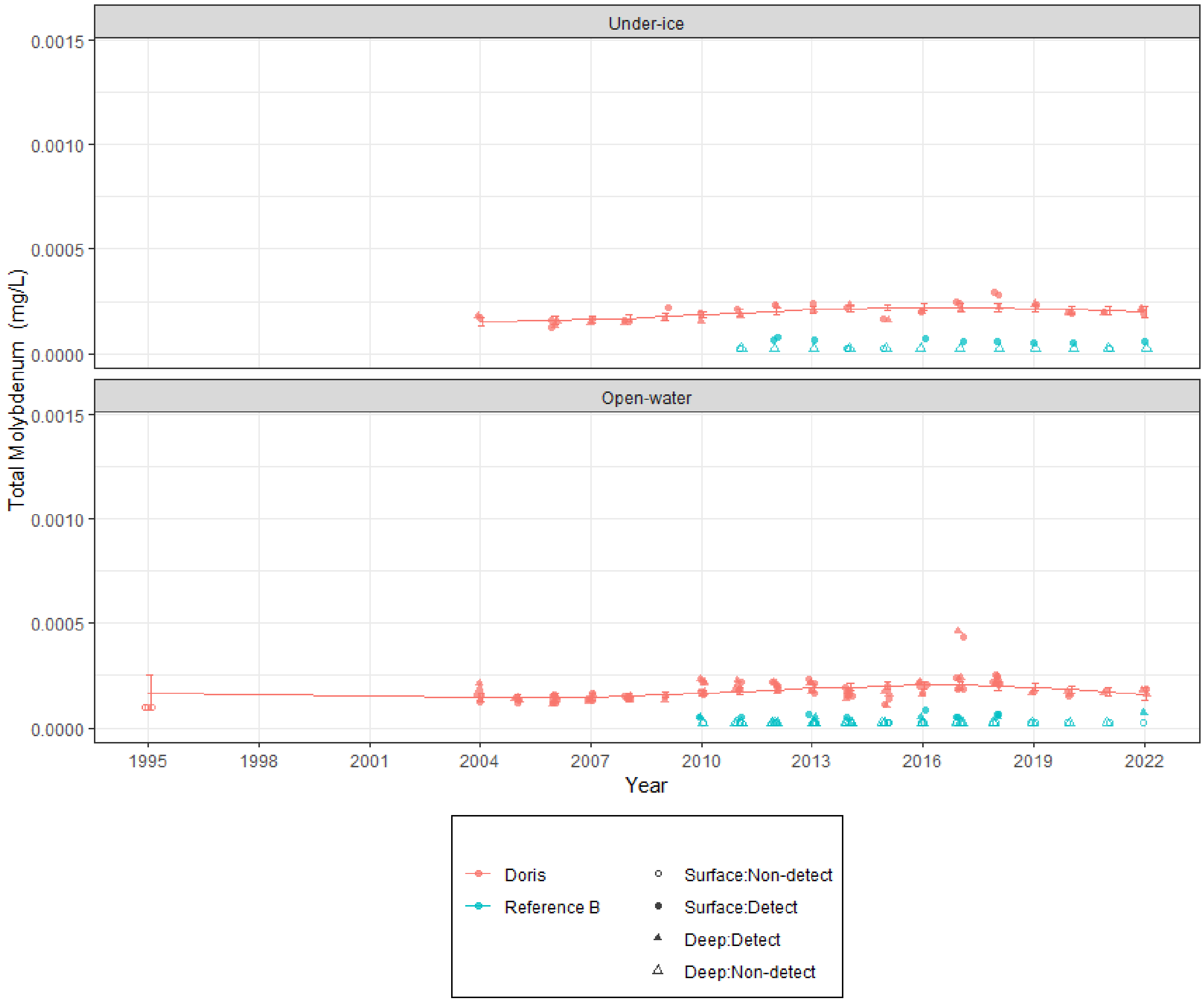
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 24.01 | 3 | <0.00001 | sig. |

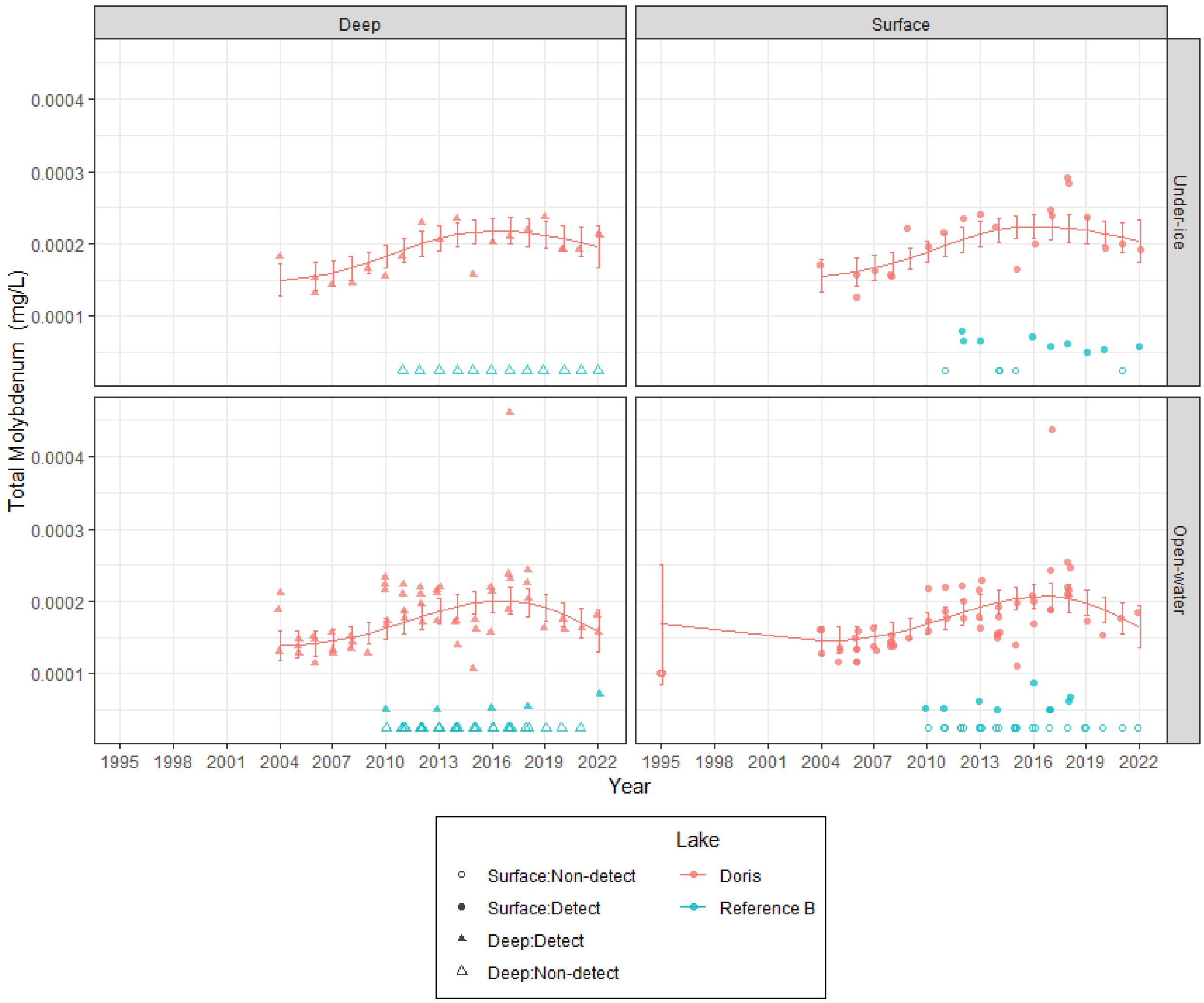
Doris Lake appears to show significant deviation from a slope of zero.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at

half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were 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 | 179.8 | -1.176 | 0.2411 | not sig. |

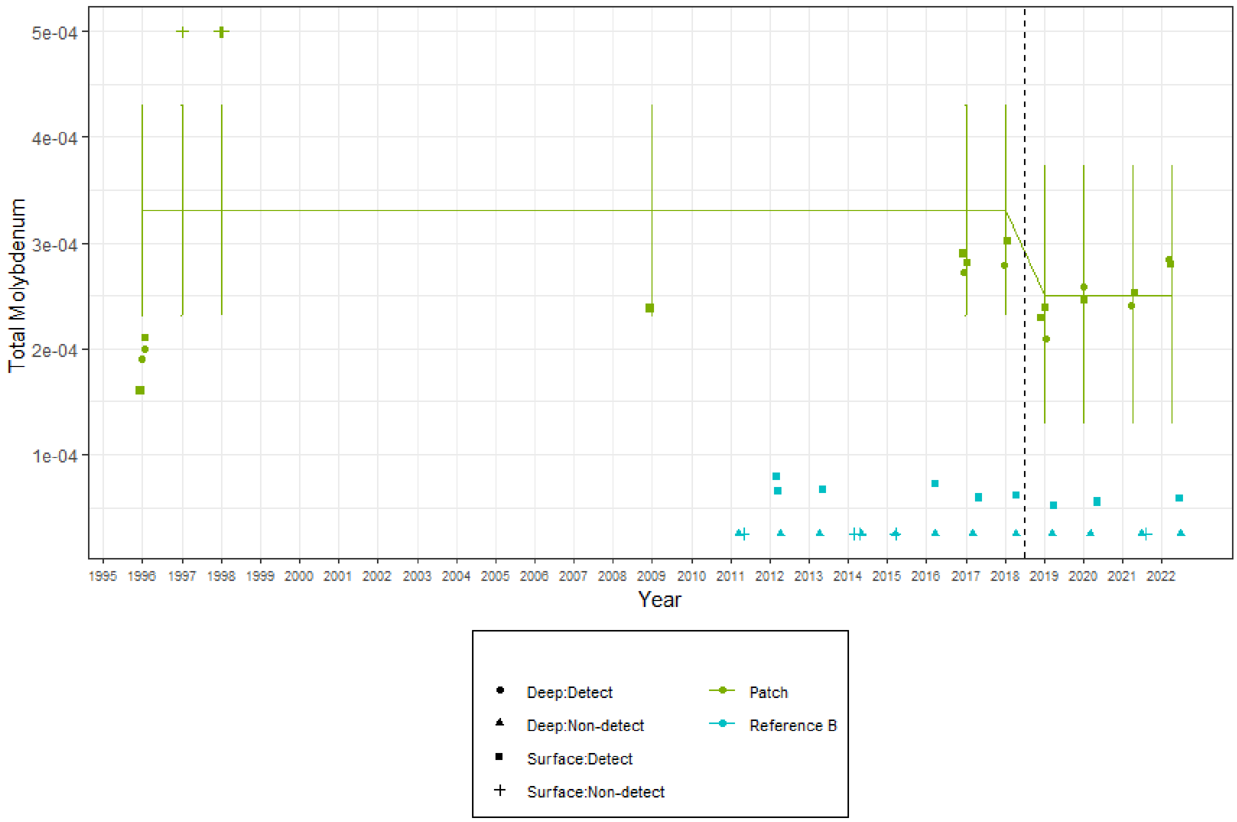
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0 | 1e-04 | 7.655 | -0.5068 | 0.6265 | not sig. |

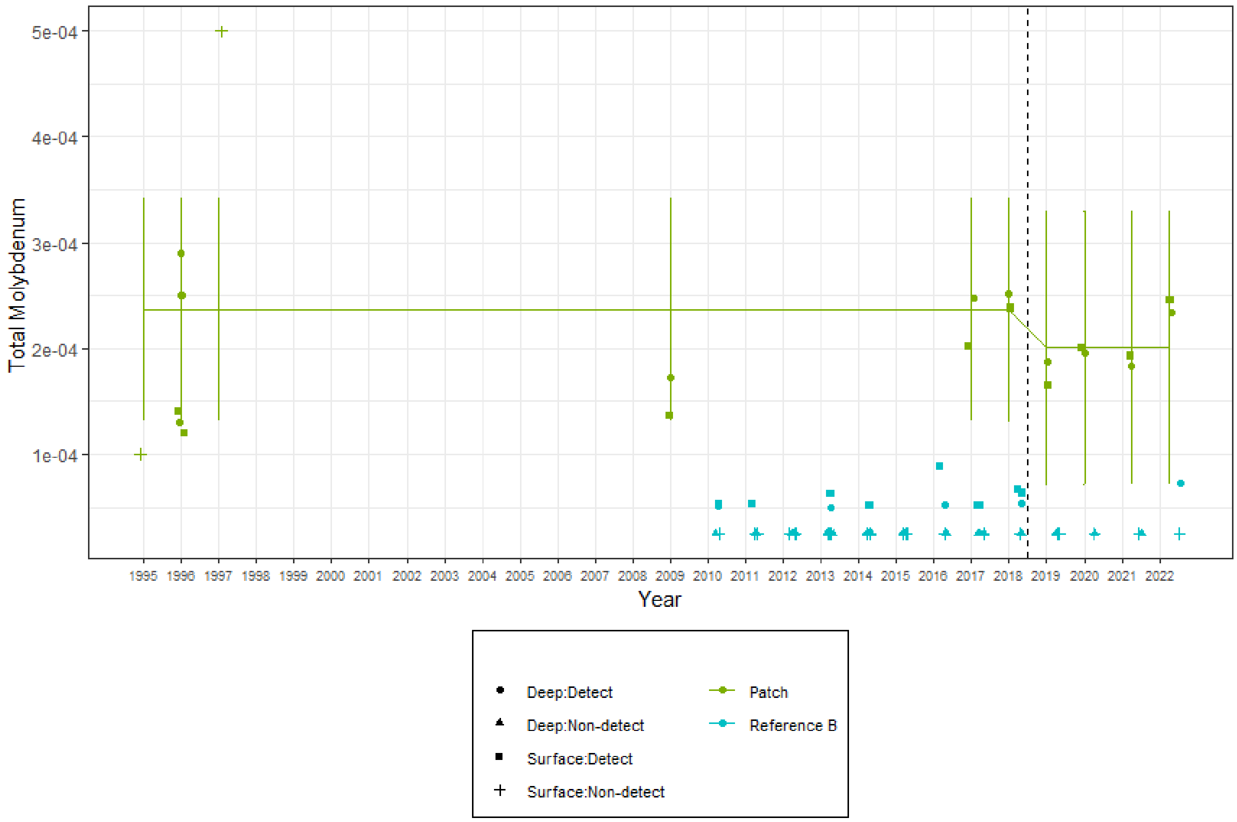
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0 | 1e-04 | 9.653 | 0.7376 | 0.4783 | not sig. |

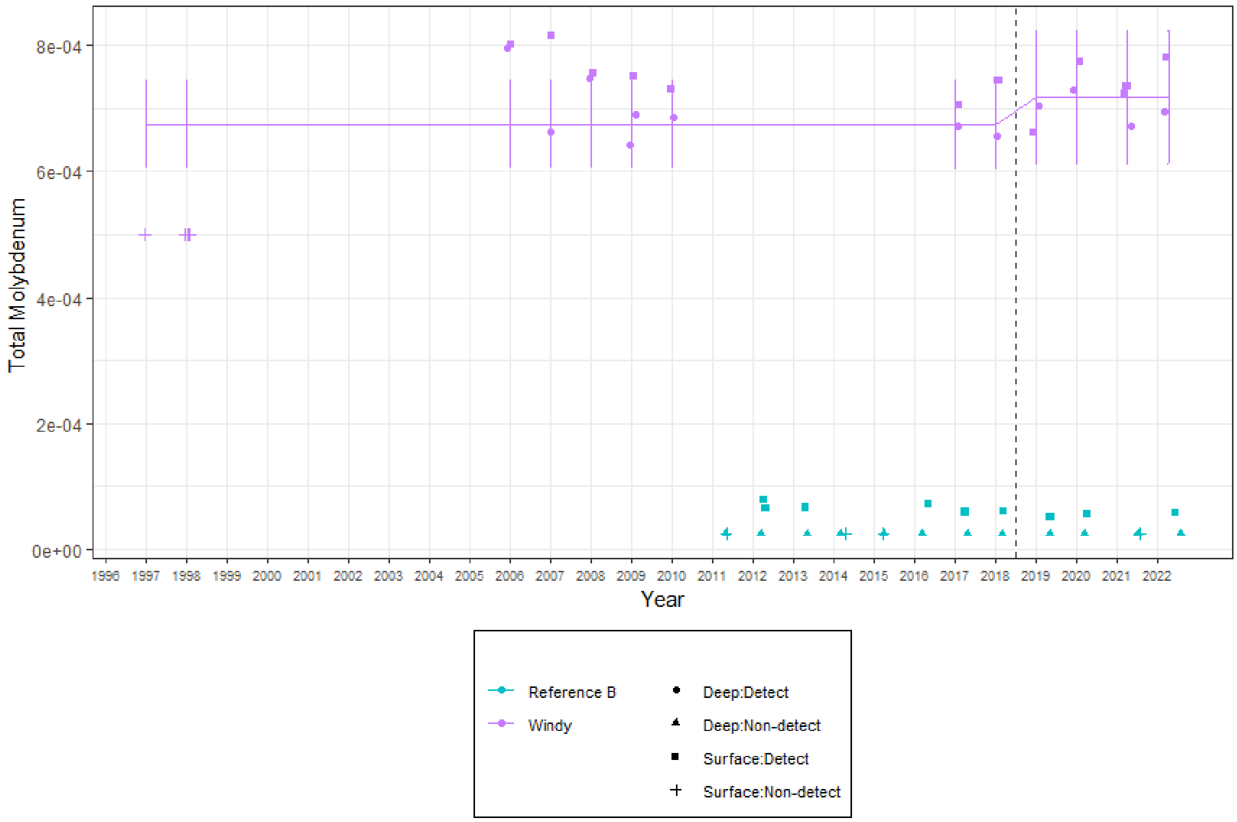
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0 | 0 | 12.05 | -0.1216 | 0.9052 | not sig. |

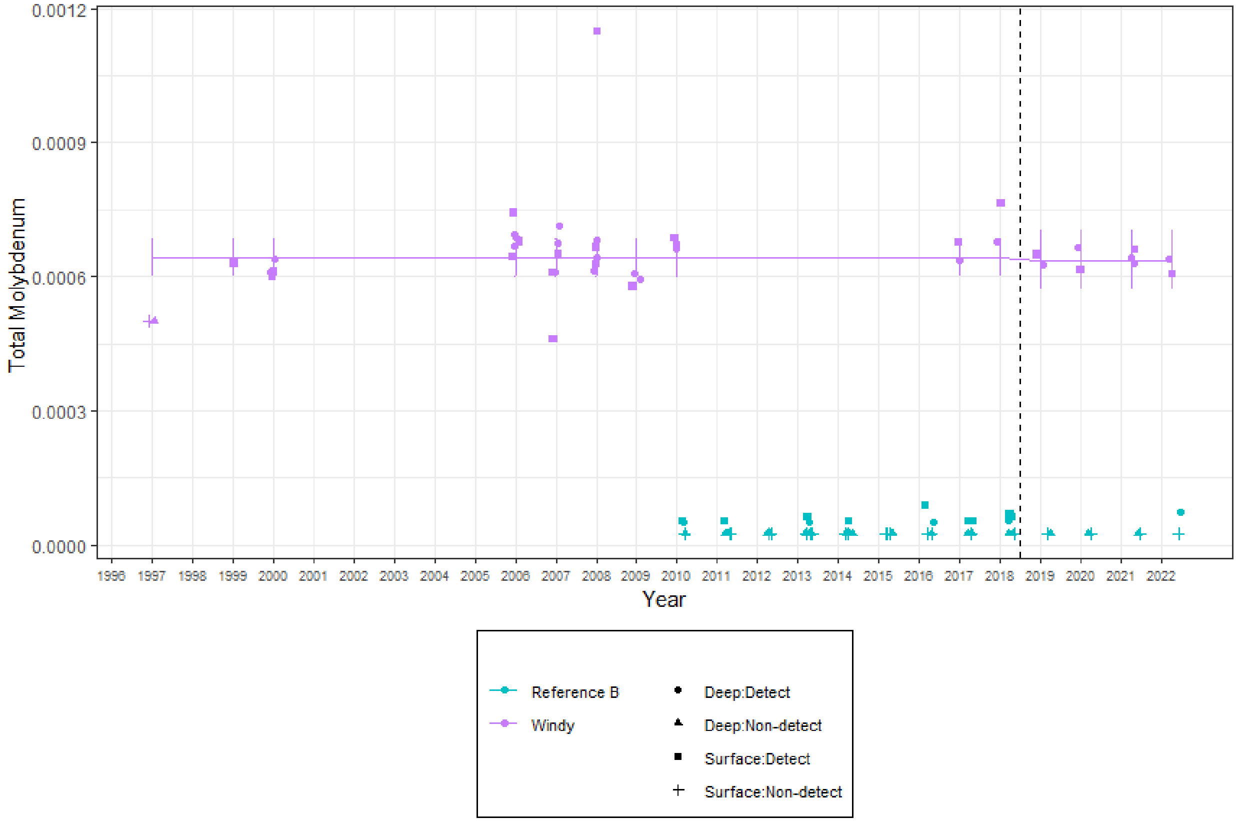
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

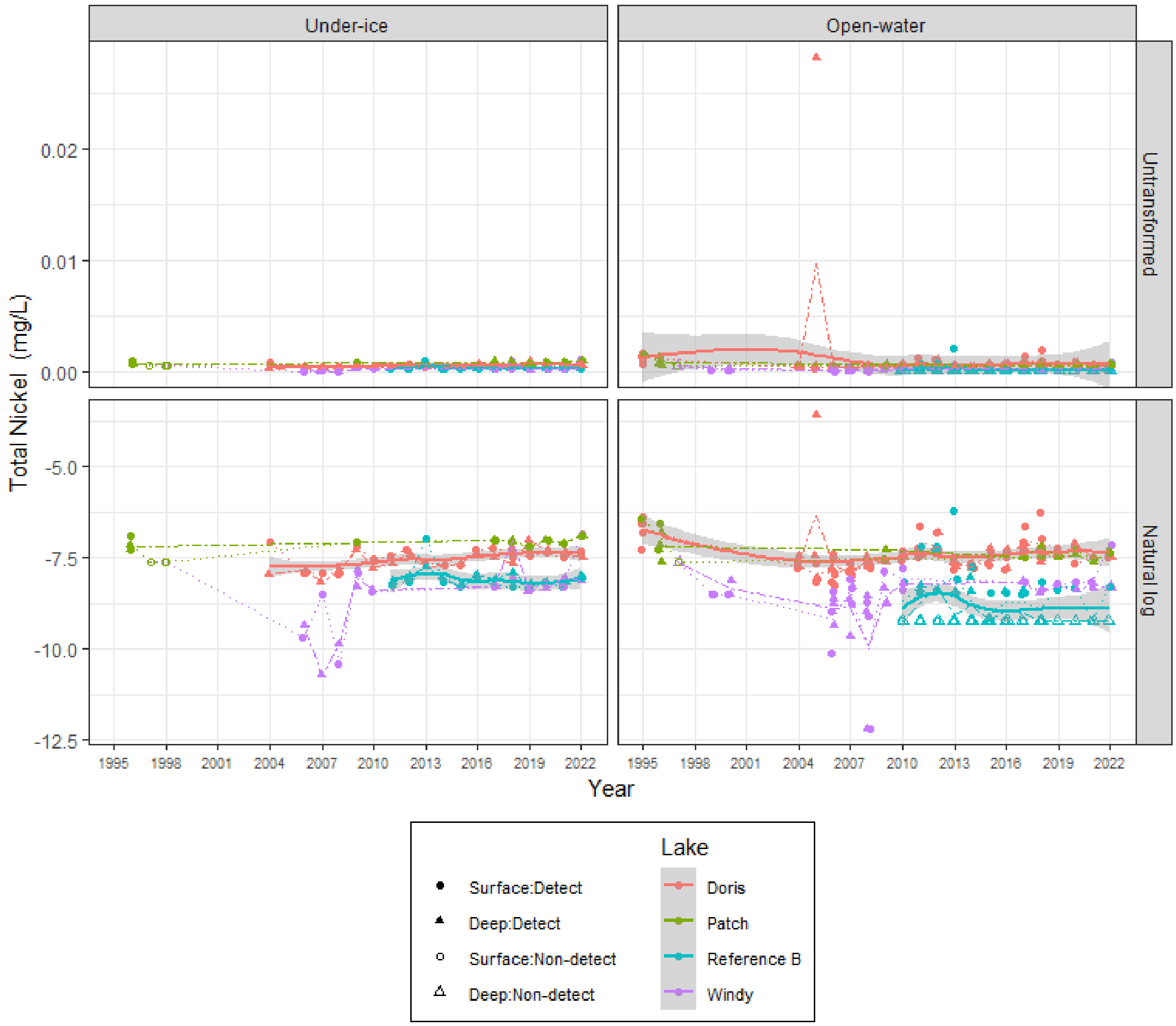
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Total Molybdenum
Year
0.0000
0.0003
0.0006
0.0009
0.0012
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

## *C.3.1.20 Total Nickel*

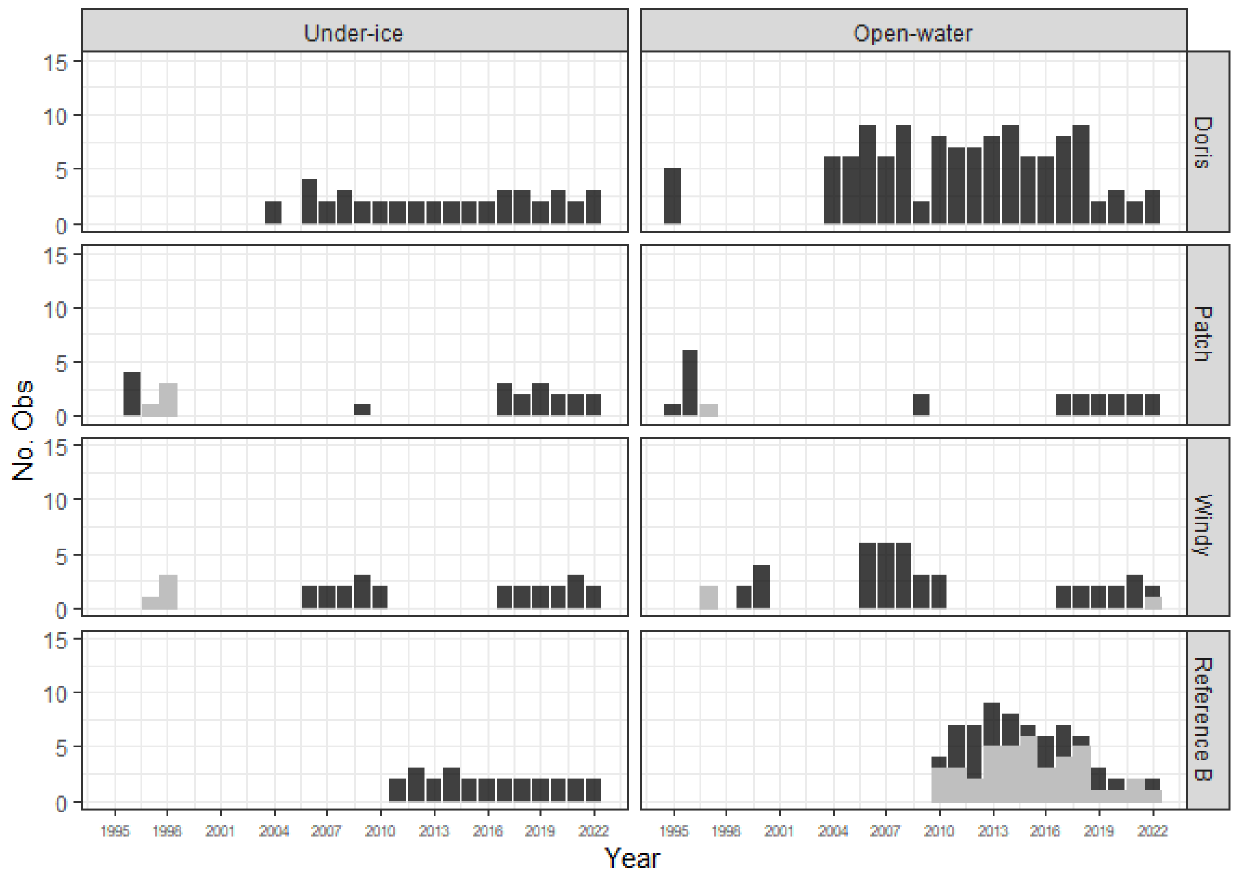
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

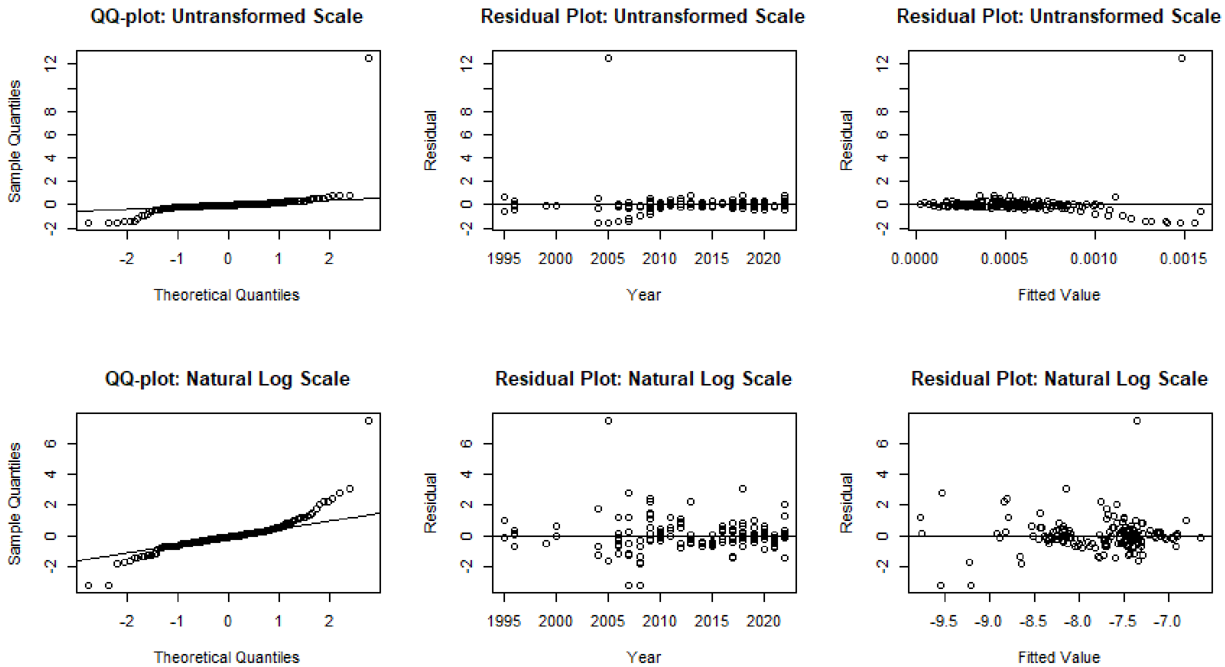
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 0 | 0 | 0 |
| Doris | Open-water | 121 | 0 | 0 | 0 |
| Patch | Under-ice | 23 | 4 | 17 | 0 |
| Patch | Open-water | 22 | 1 | 5 | 0 |
| Reference B | Under-ice | 26 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 41 | 59 | 50 |
| Windy | Under-ice | 28 | 4 | 14 | 0 |
| Windy | Open-water | 45 | 3 | 7 | 50 |

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.

### 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 |
|---|---|---|---|---|---|---|---|
| 8 | Doris | 2005 | Open-water | Deep | 0.0097 | 0.001 | 12.54 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 8 | Doris | 2005 | Open-water | Deep | 0.0097 | -7.361 | 7.469 |
| 149 | Windy | 2007 | Under-ice | Deep | 0.0000 | -9.546 | -3.227 |
| 154 | Windy | 2008 | Under-ice | Surface | 0.0000 | -9.214 | -3.239 |
| 169 | Windy | 2018 | Under-ice | Deep | 0.0009 | -8.148 | 3.106 |

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

### Doris Lake

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 0.183 | 3 | 0.98030 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

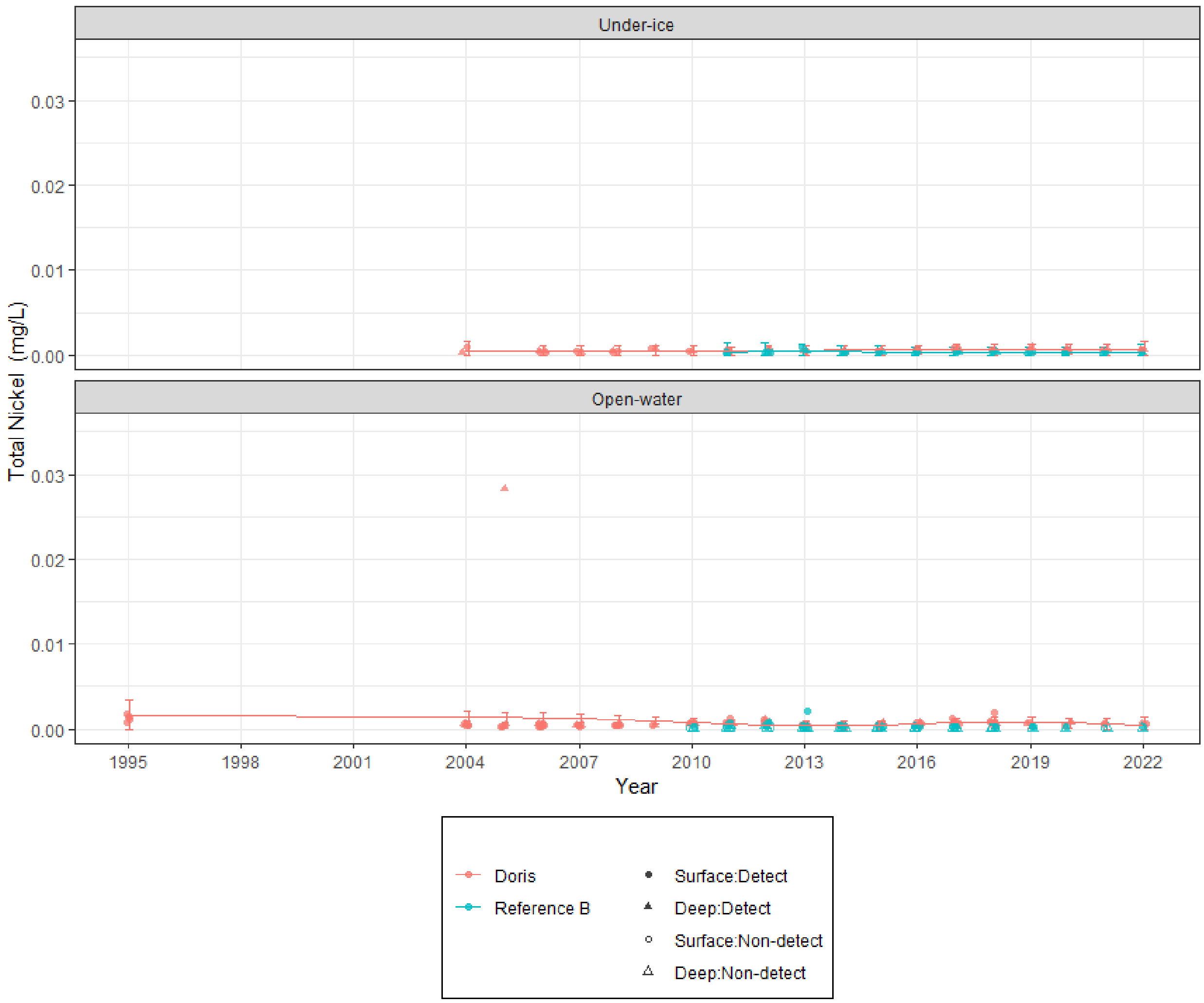
### *Open-water*

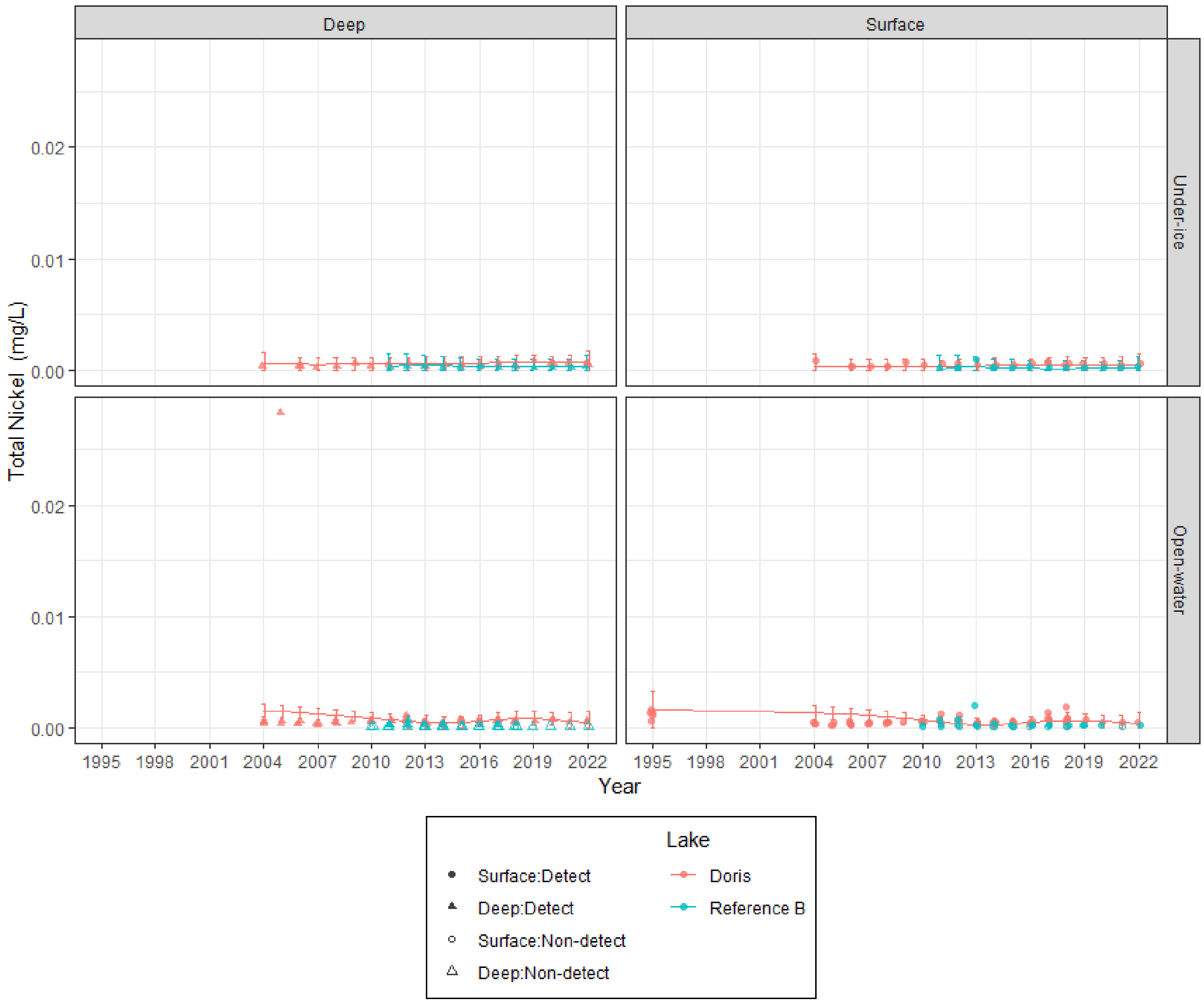
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 5.117 | 3 | 0.16340 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were 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 | 7.841 | 1.189 | 0.269 | not sig. |

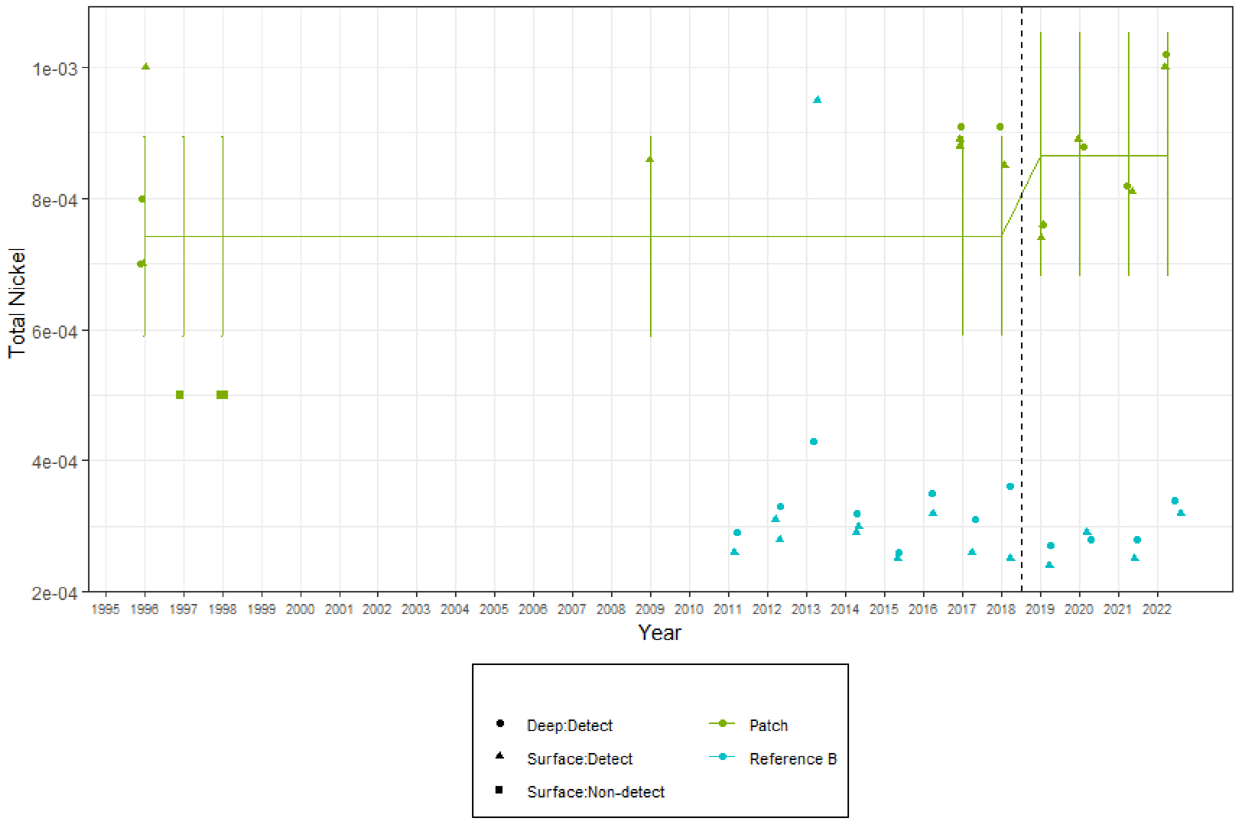
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -2e-04 | 2e-04 | 7.412 | -0.9952 | 0.351 | not sig. |

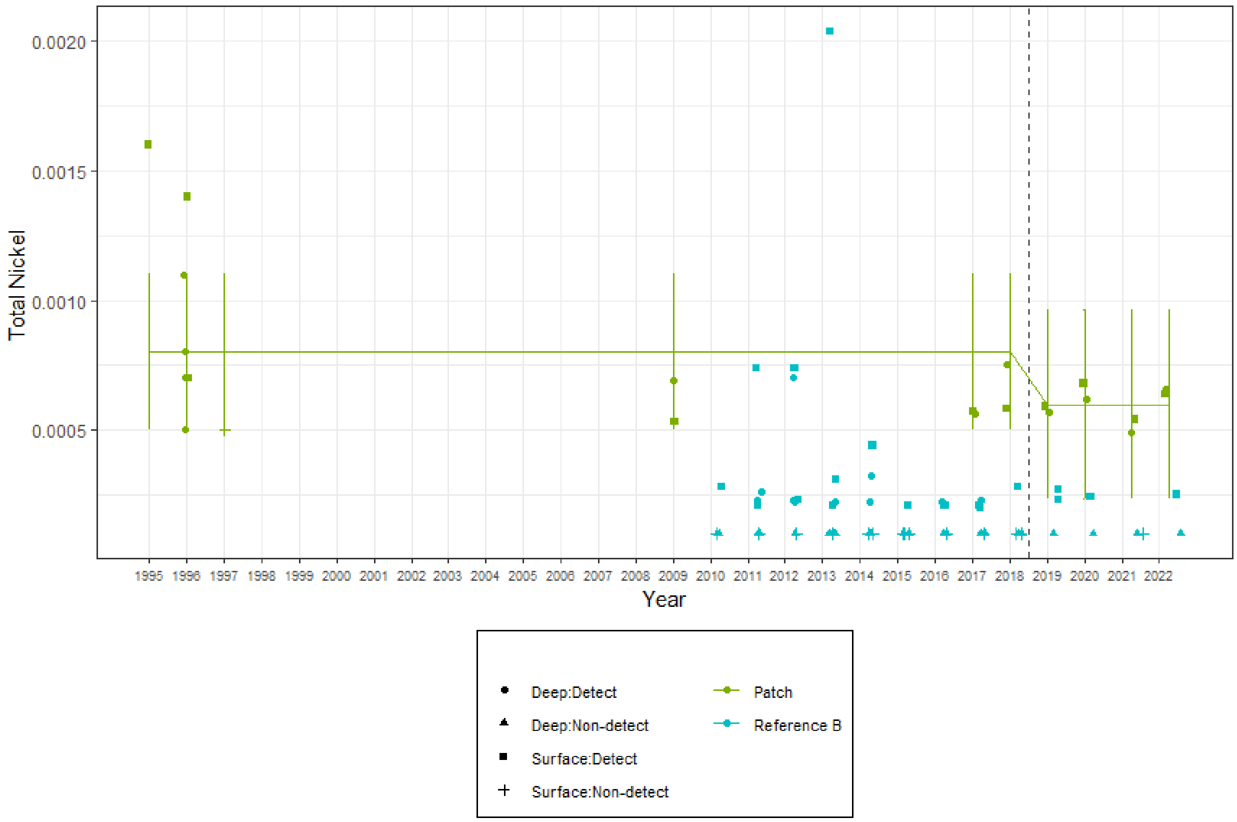
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 1e-04 | 1e-04 | 10.41 | 0.7722 | 0.4571 | not sig. |

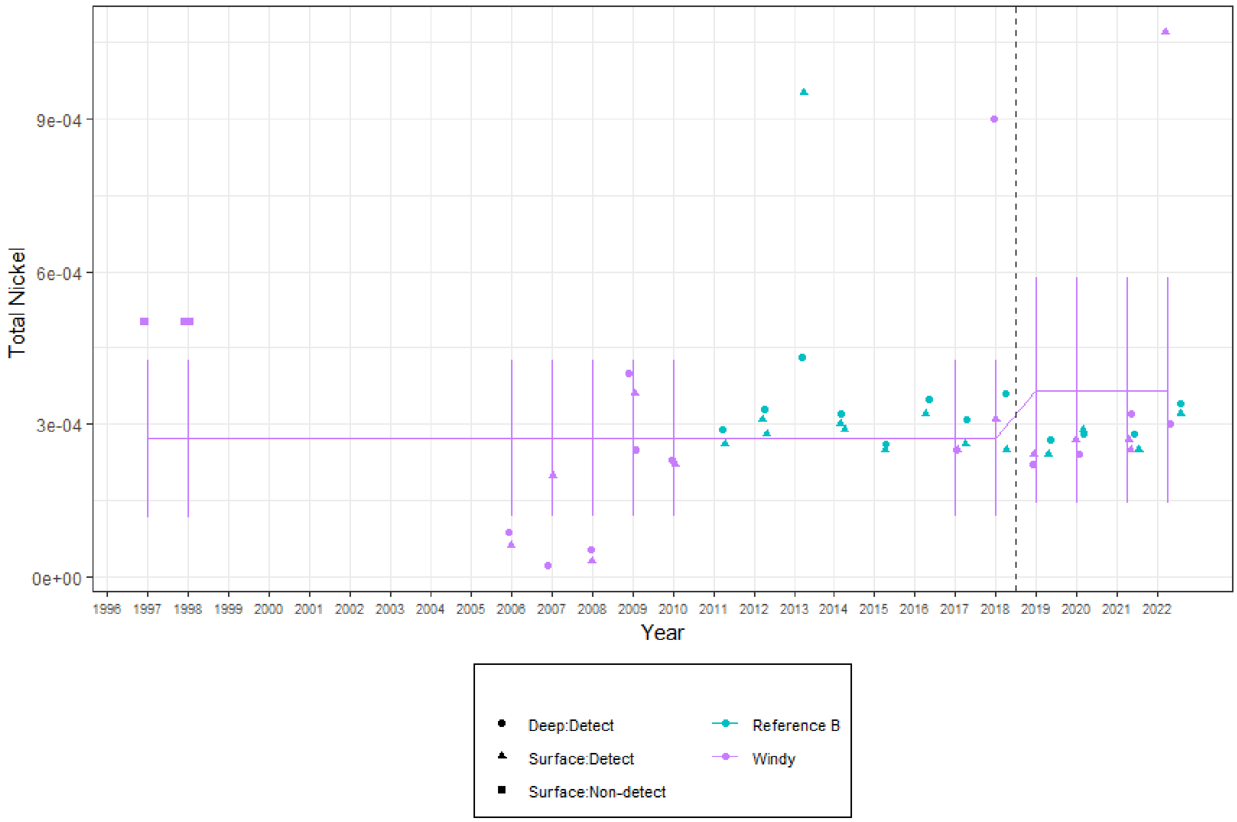
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 1e-04 | 1e-04 | 11.93 | 1.2 | 0.2534 | not sig. |

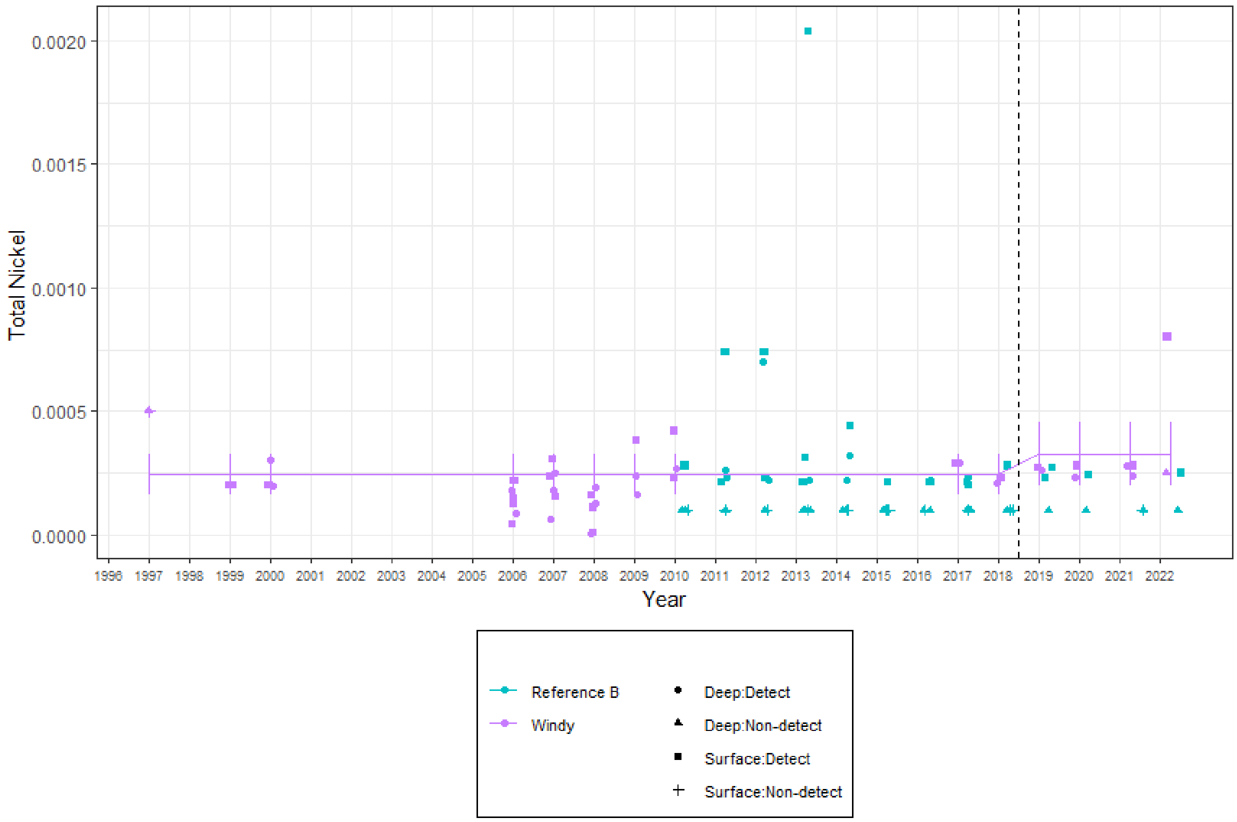
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

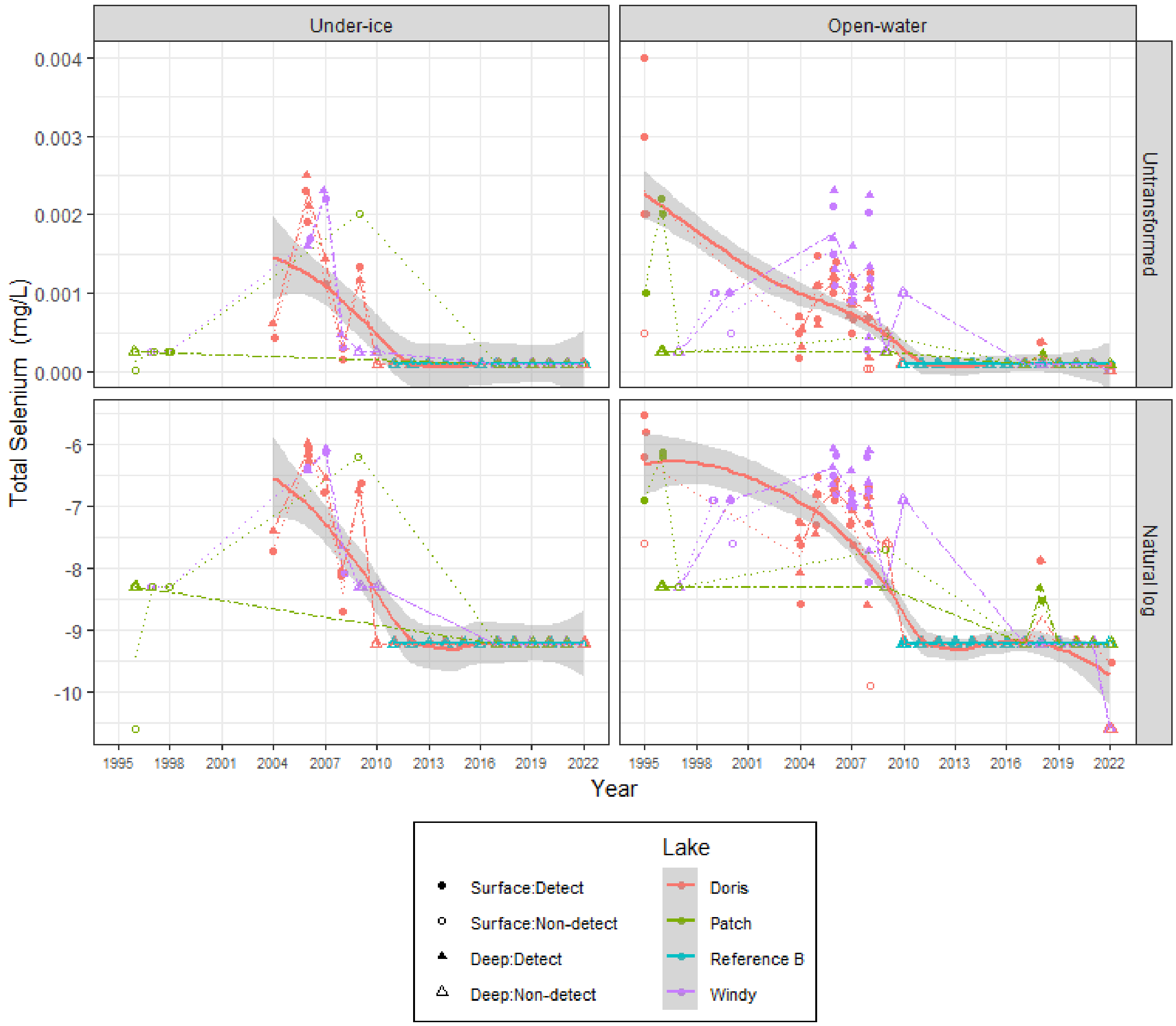
Depth was accounted for in the model but not evaluated since its effect is not of primary interest. Below are plots of the observed and fitted data. The symbols represent the observed data values and hollow symbols at half the detection limit. Solid lines represent the fitted means. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Total Nickel
0.0020
0.0015
0.0010
0.0005
0.0000
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

## *C.3.1.21 Total Selenium*

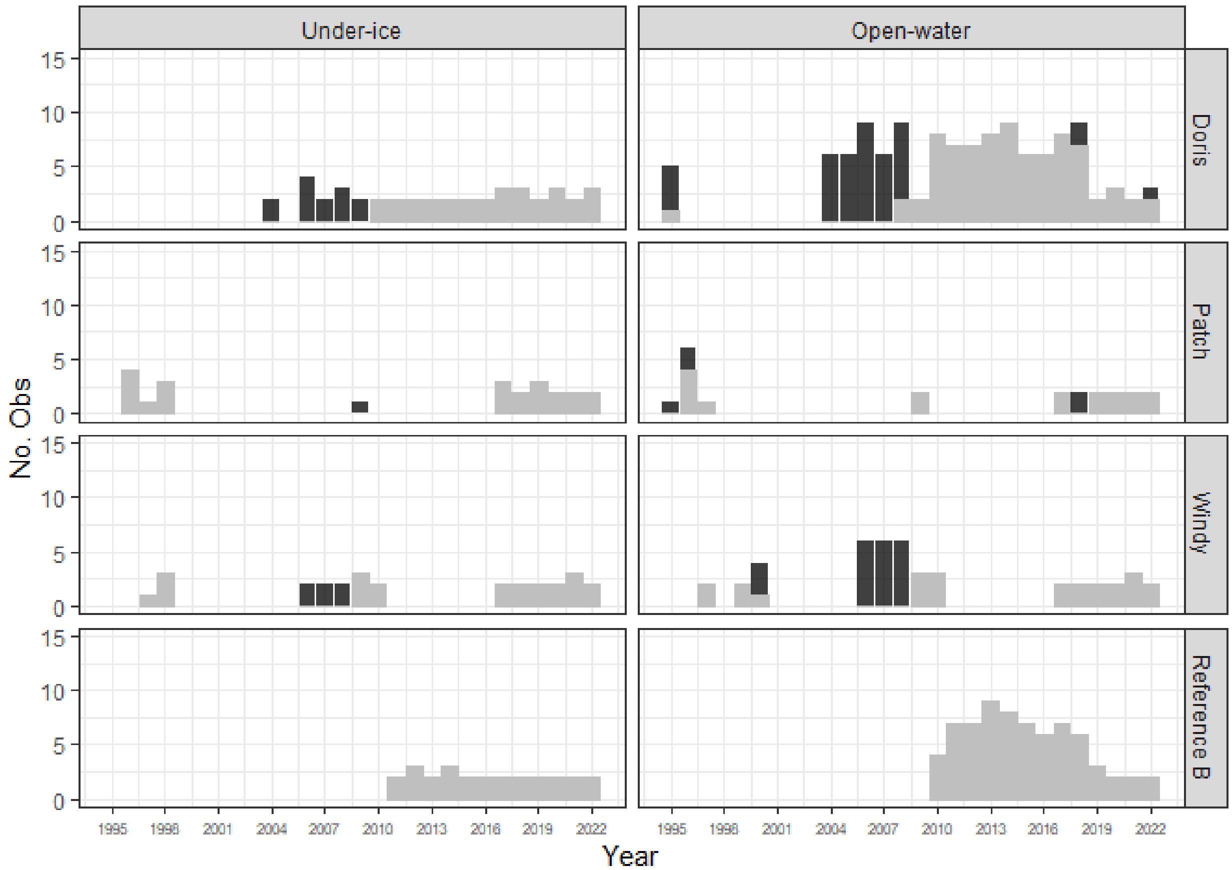
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

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

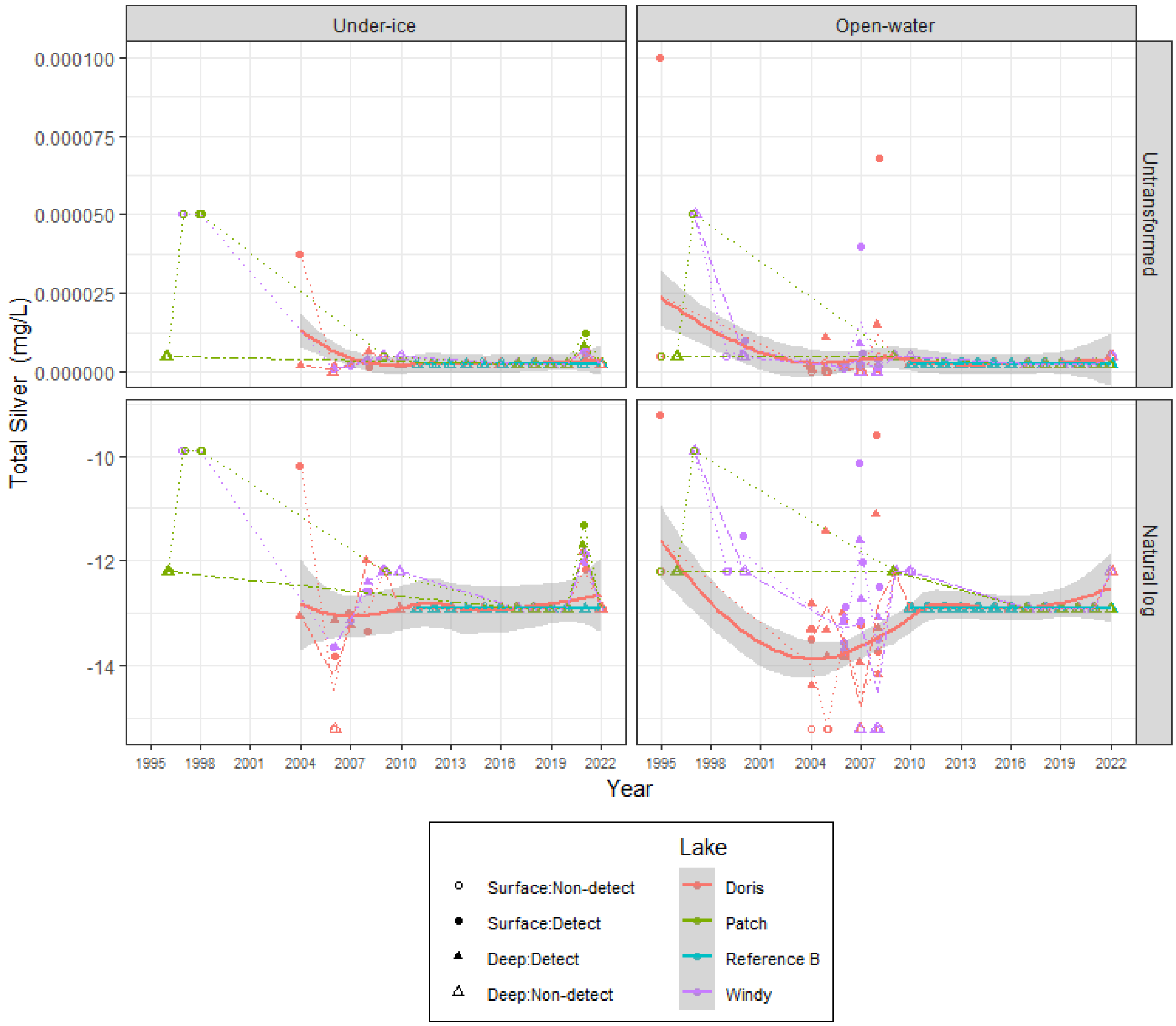
| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 30 | 70 | 100 |
| Doris | Open-water | 121 | 80 | 66 | 67 |
| Patch | Under-ice | 23 | 23 | 100 | 100 |
| Patch | Open-water | 22 | 17 | 77 | 100 |
| Reference B | Under-ice | 26 | 26 | 100 | 100 |
| Reference B | Open-water | 70 | 70 | 100 | 100 |
| Windy | Under-ice | 28 | 22 | 79 | 100 |
| Windy | Open-water | 45 | 24 | 53 | 100 |

All data from Doris, Patch and Windy were censored. All data removed from the analysis and no statistical analyses were performed.

### *C.3.1.22 Total Silver*

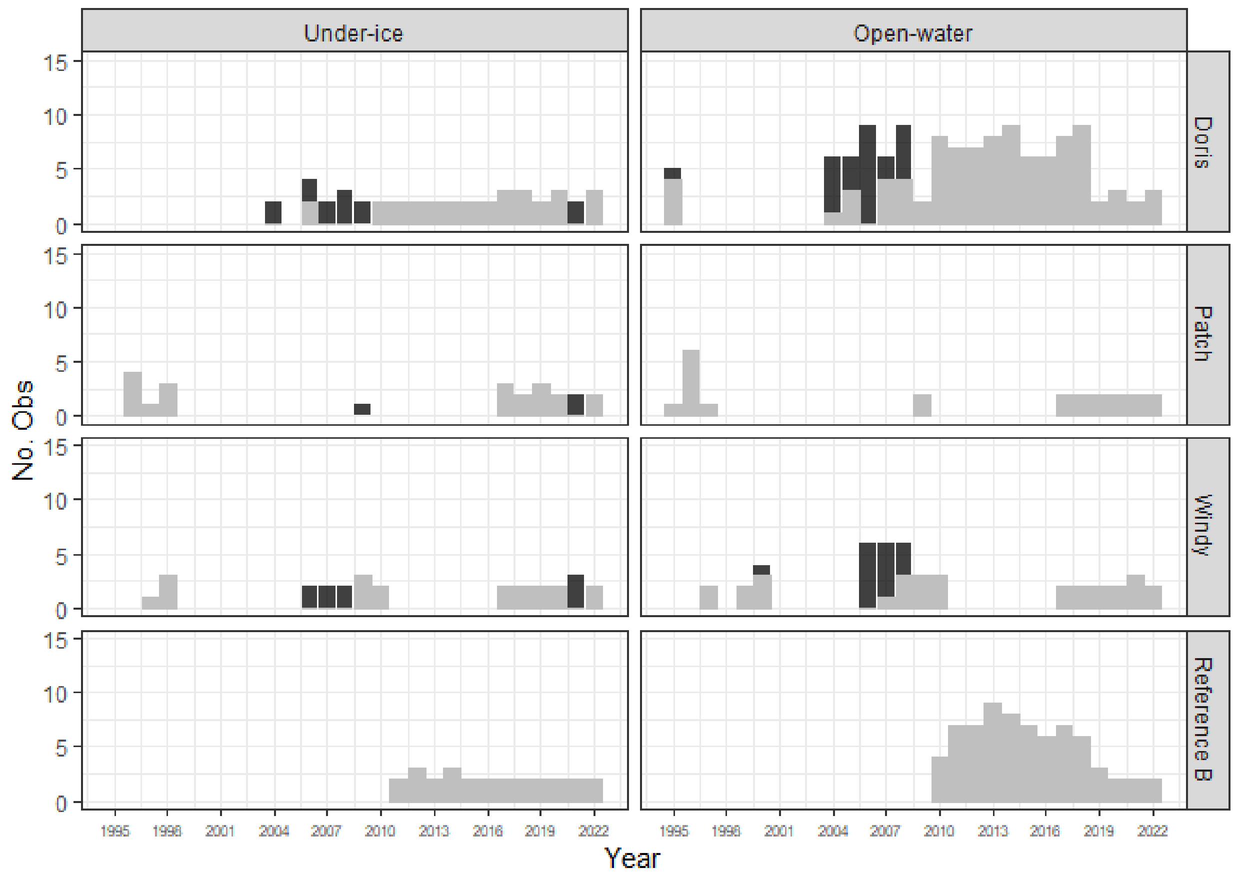
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

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

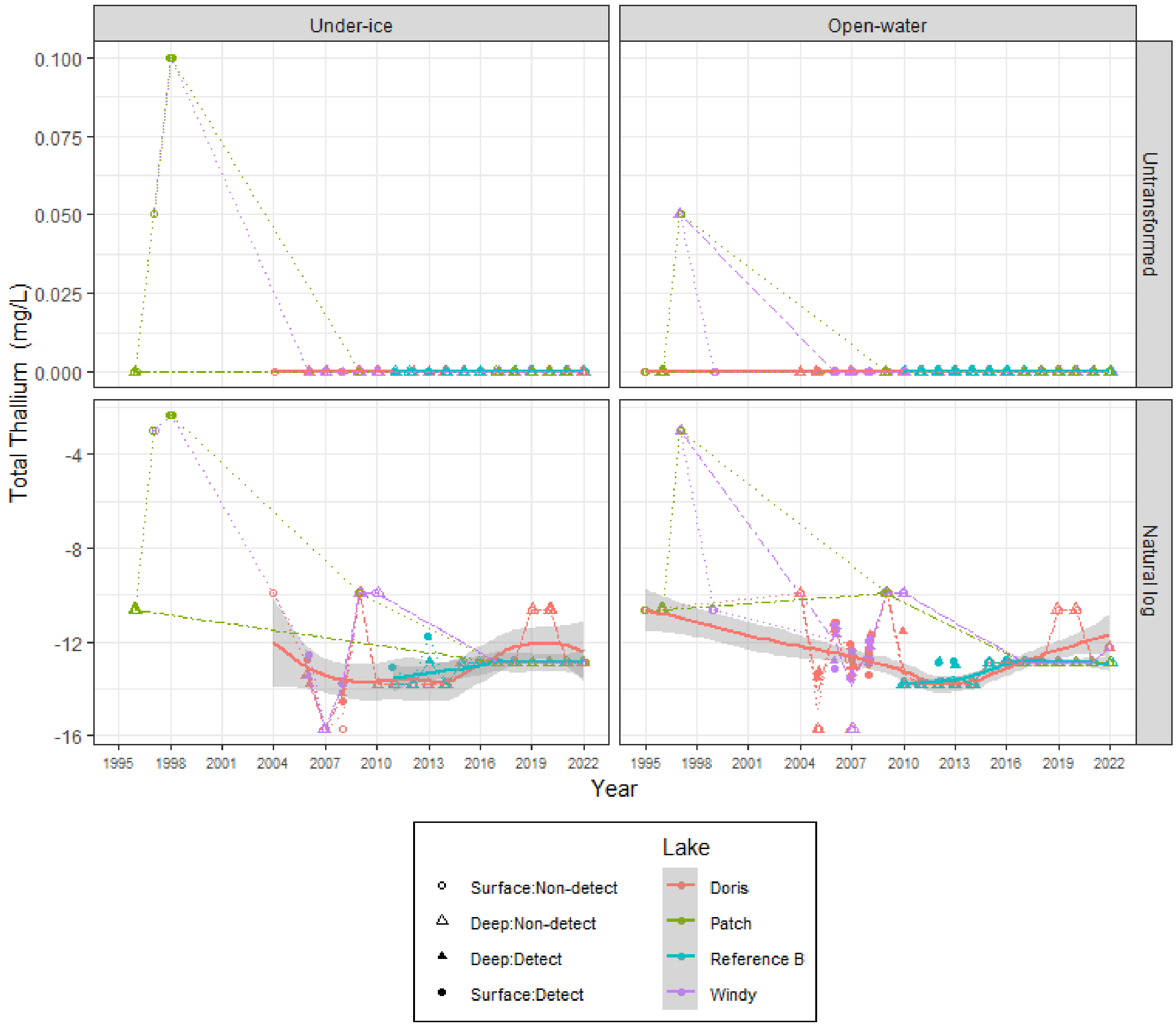
| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 32 | 74 | 100 |
| Doris | Open-water | 121 | 96 | 79 | 100 |
| Patch | Under-ice | 23 | 21 | 91 | 100 |
| Patch | Open-water | 22 | 22 | 100 | 100 |
| Reference B | Under-ice | 26 | 26 | 100 | 100 |
| Reference B | Open-water | 70 | 70 | 100 | 100 |
| Windy | Under-ice | 28 | 19 | 68 | 100 |
| Windy | Open-water | 45 | 30 | 67 | 100 |

All data from Doris, Patch and Windy were censored. All data removed from the analysis and no statistical analyses were performed.

### *C.3.1.23 Total Thallium*

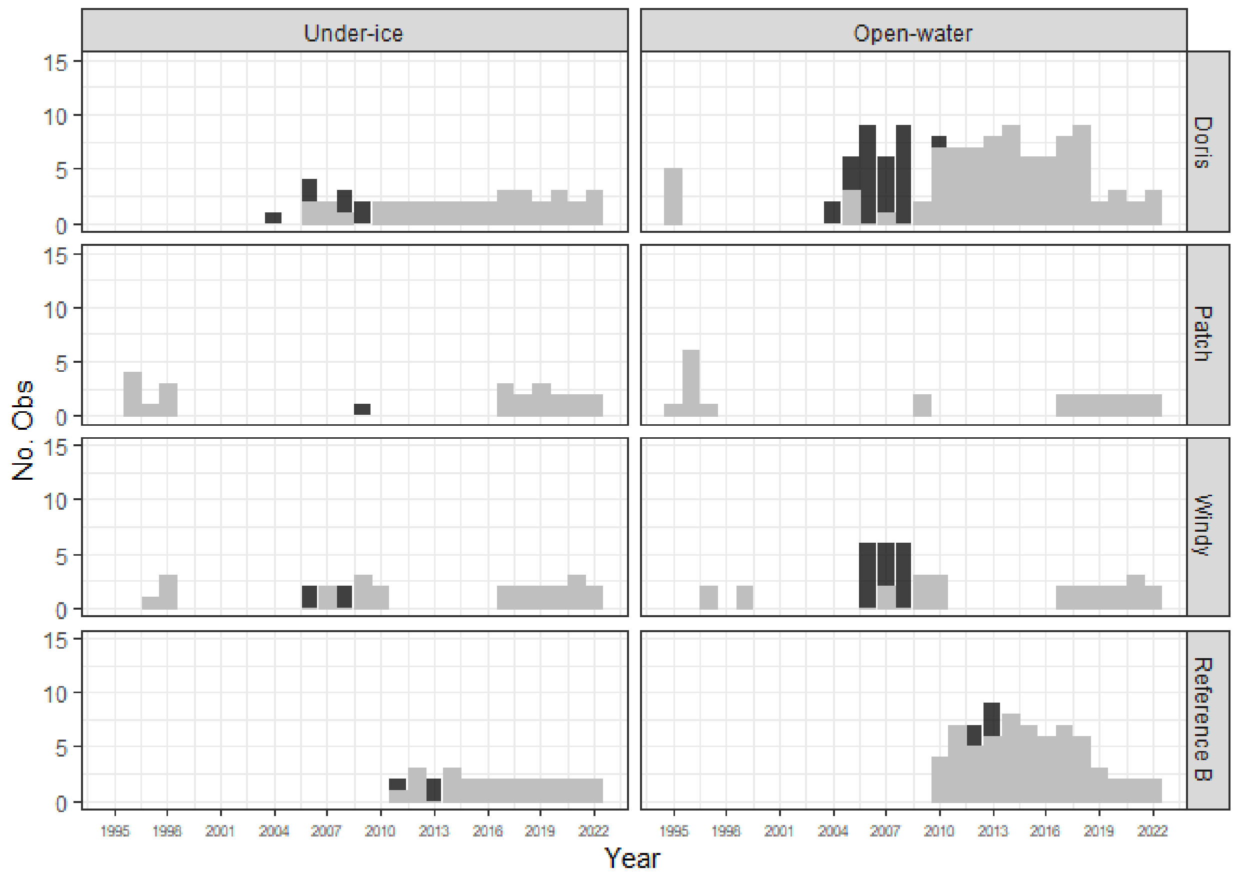
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

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

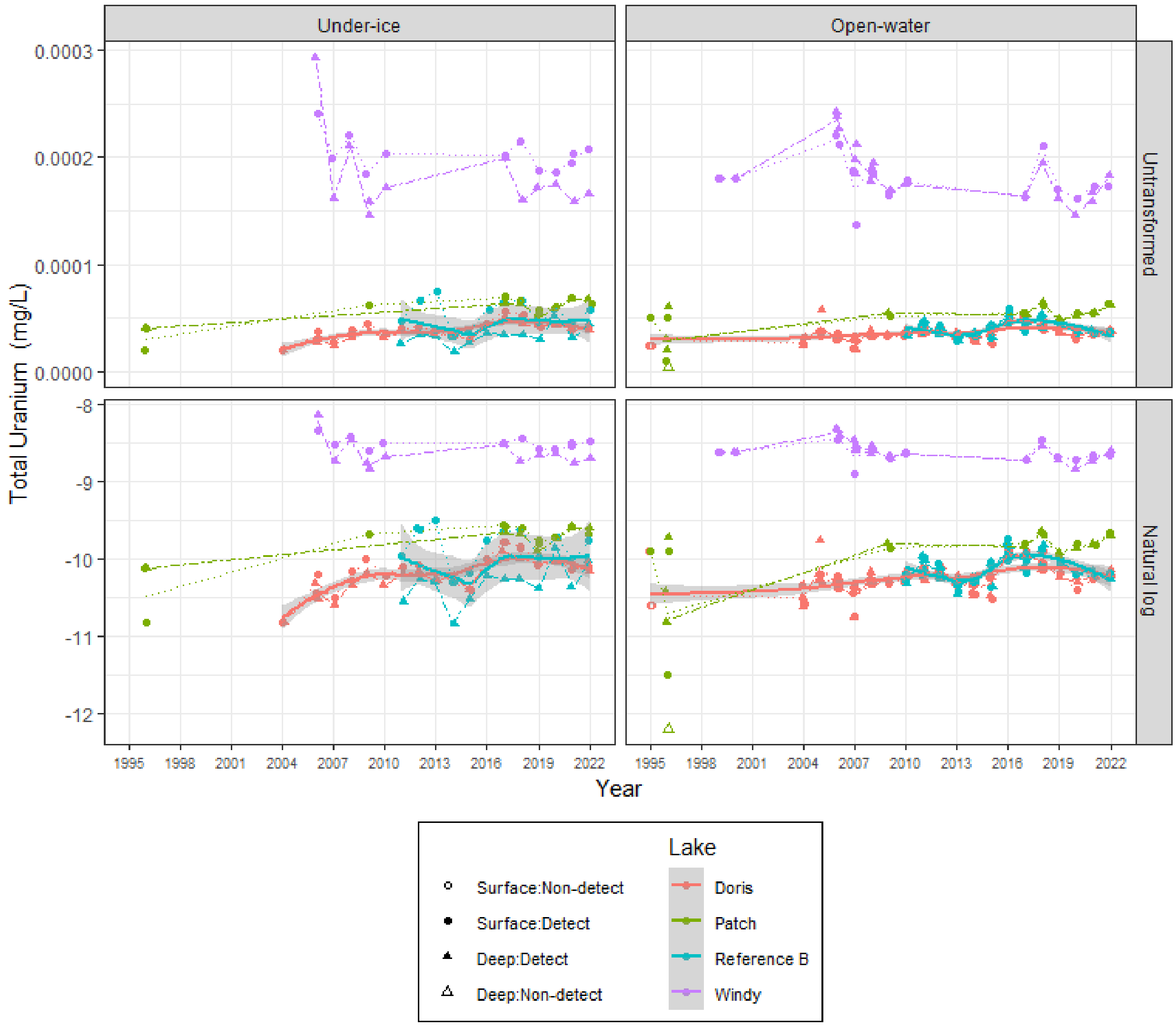
| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 42 | 38 | 90 | 100 |
| Doris | Open-water | 117 | 90 | 77 | 100 |
| Patch | Under-ice | 23 | 23 | 100 | 100 |
| Patch | Open-water | 22 | 22 | 100 | 100 |
| Reference B | Under-ice | 26 | 23 | 88 | 100 |
| Reference B | Open-water | 70 | 65 | 93 | 100 |
| Windy | Under-ice | 28 | 24 | 86 | 100 |
| Windy | Open-water | 41 | 25 | 61 | 100 |

All data from Doris, Patch and Windy were censored. All data removed from the analysis and no statistical analyses were performed.

## *C.3.1.24 Total Uranium*

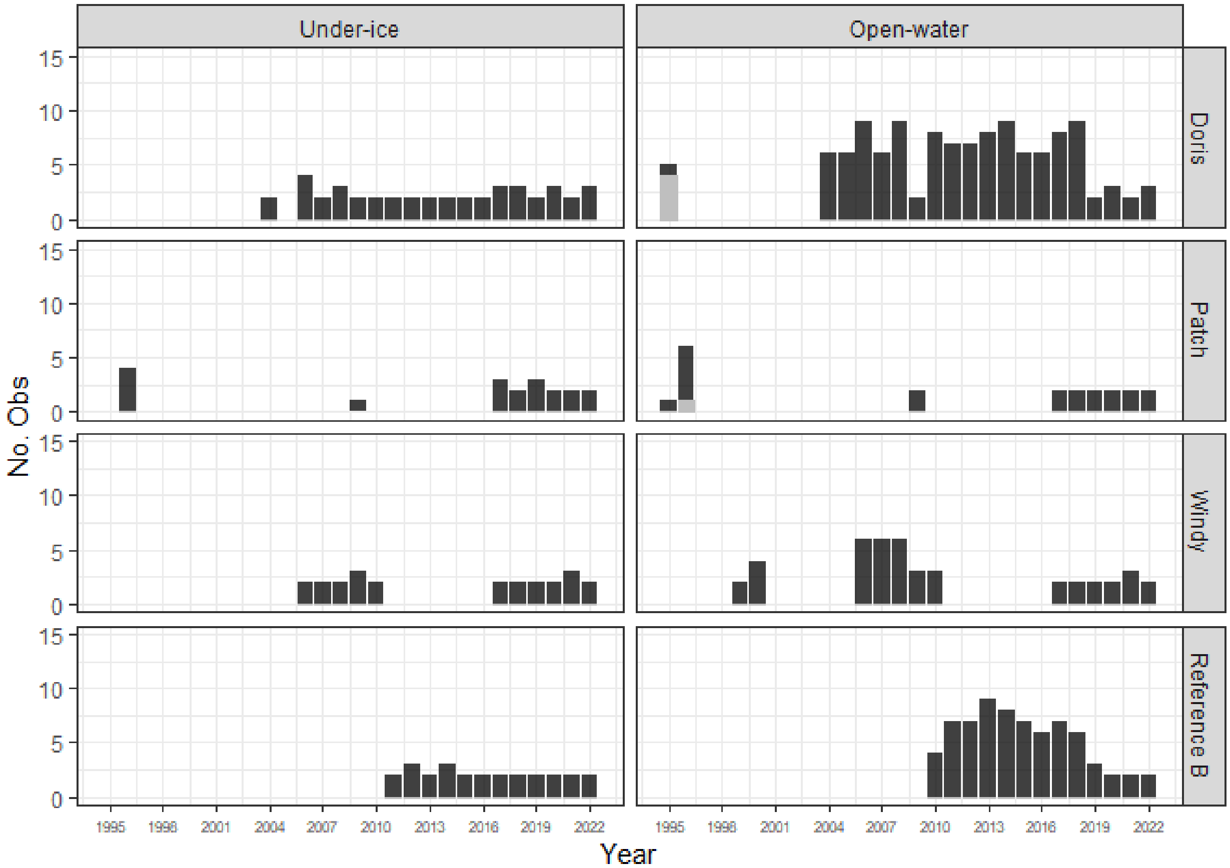
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

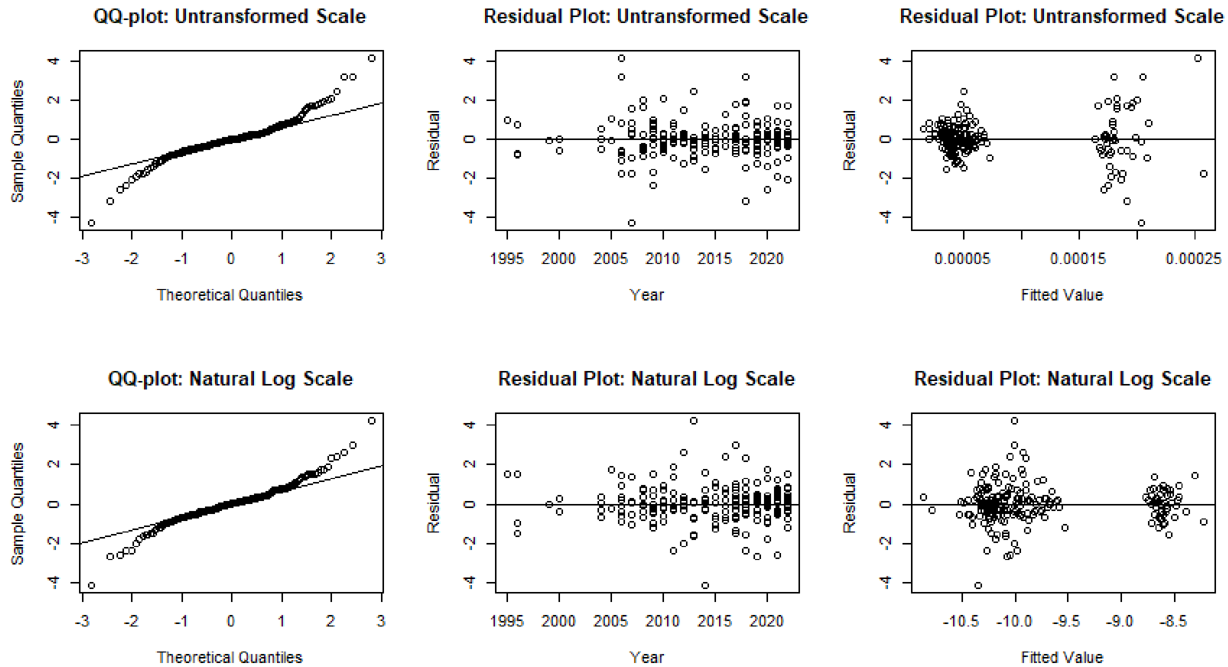
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 43 | 0 | 0 | 0 |
| Doris | Open-water | 121 | 4 | 3 | 0 |
| Patch | Under-ice | 19 | 0 | 0 | 0 |
| Patch | Open-water | 21 | 1 | 5 | 0 |
| Reference B | Under-ice | 26 | 0 | 0 | 0 |
| Reference B | Open-water | 70 | 0 | 0 | 0 |
| Windy | Under-ice | 24 | 0 | 0 | 0 |
| Windy | Open-water | 43 | 0 | 0 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 171 | Windy | 2006 | Under-ice | Deep | 0.0003 | 0 | 4.131 |
| 173 | Windy | 2006 | Open-water | Deep | 0.0002 | 0 | 3.143 |
| 175 | Windy | 2007 | Under-ice | Deep | 0.0002 | 0 | -4.291 |
| 195 | Windy | 2018 | Under-ice | Deep | 0.0002 | 0 | -3.194 |
| 198 | Windy | 2018 | Open-water | Surface | 0.0002 | 0 | 3.140 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 125 | Reference B | 2013 | Under-ice | Surface | 0.0001 | -10.01 | 4.207 |
| 128 | Reference B | 2014 | Under-ice | Deep | 0.0000 | -10.35 | -4.150 |

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

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 37.584 | 4 | <0.00001 | sig. |
| Compare to Reference B | 3.272 | 4 | 0.51340 | not sig. |

Doris Lake appears to show significant deviation from a slope of zero. Doris Lake did not exhibit significant deviation from the trend of Reference Lake B.

### *Open-water*

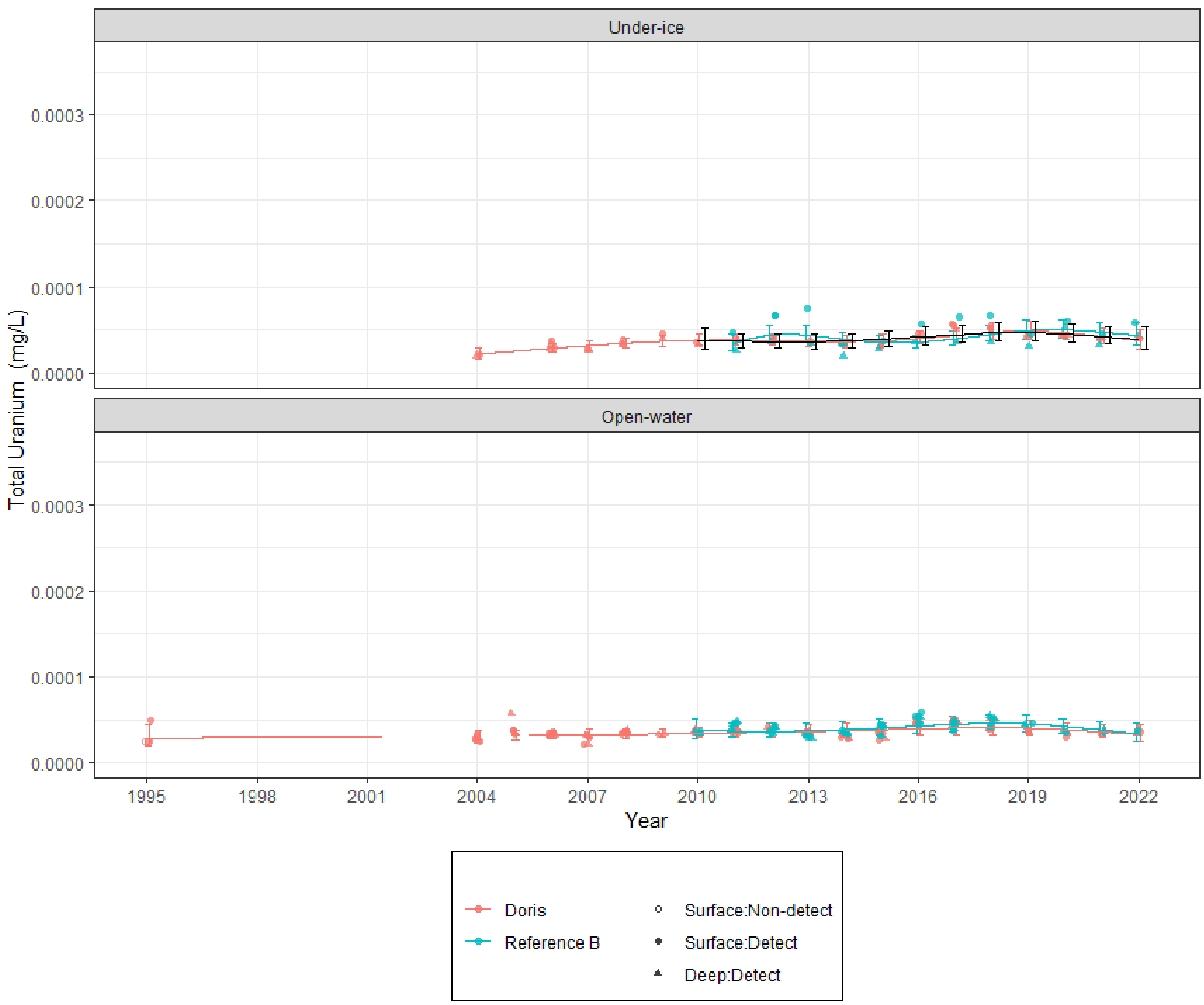
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 8.87 | 4 | 0.06440 | not sig. |

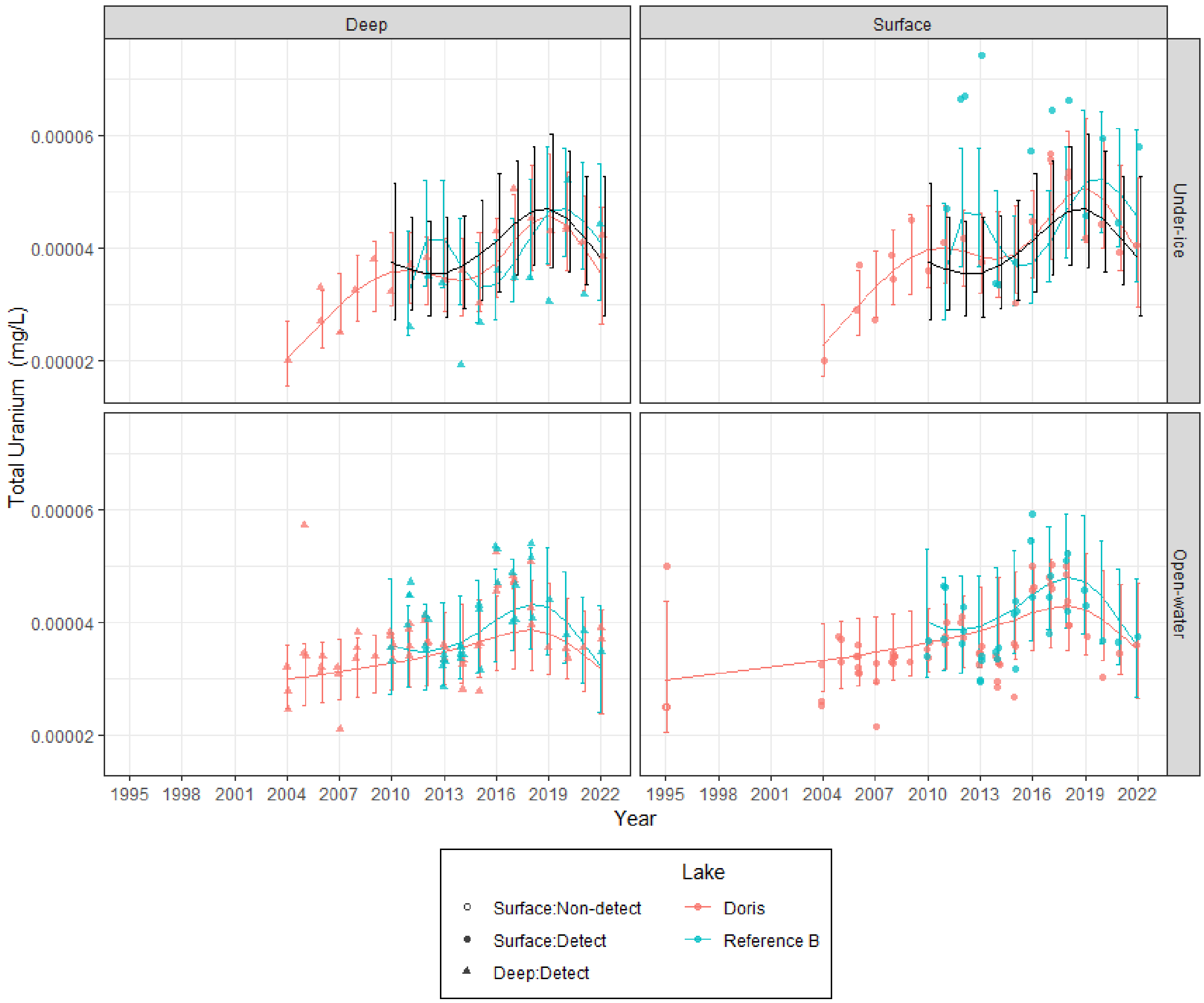
Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.

As Doris Lake appears to show significant deviation from a slope of zero in at least one season, the black lines and error bars represent the model built with Doris Lake data from comparable sampling years with Reference Lake B only.






### Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

*Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.1076 | 0.1676 | 6.08 | 0.6422 | 0.5442 | not sig. |

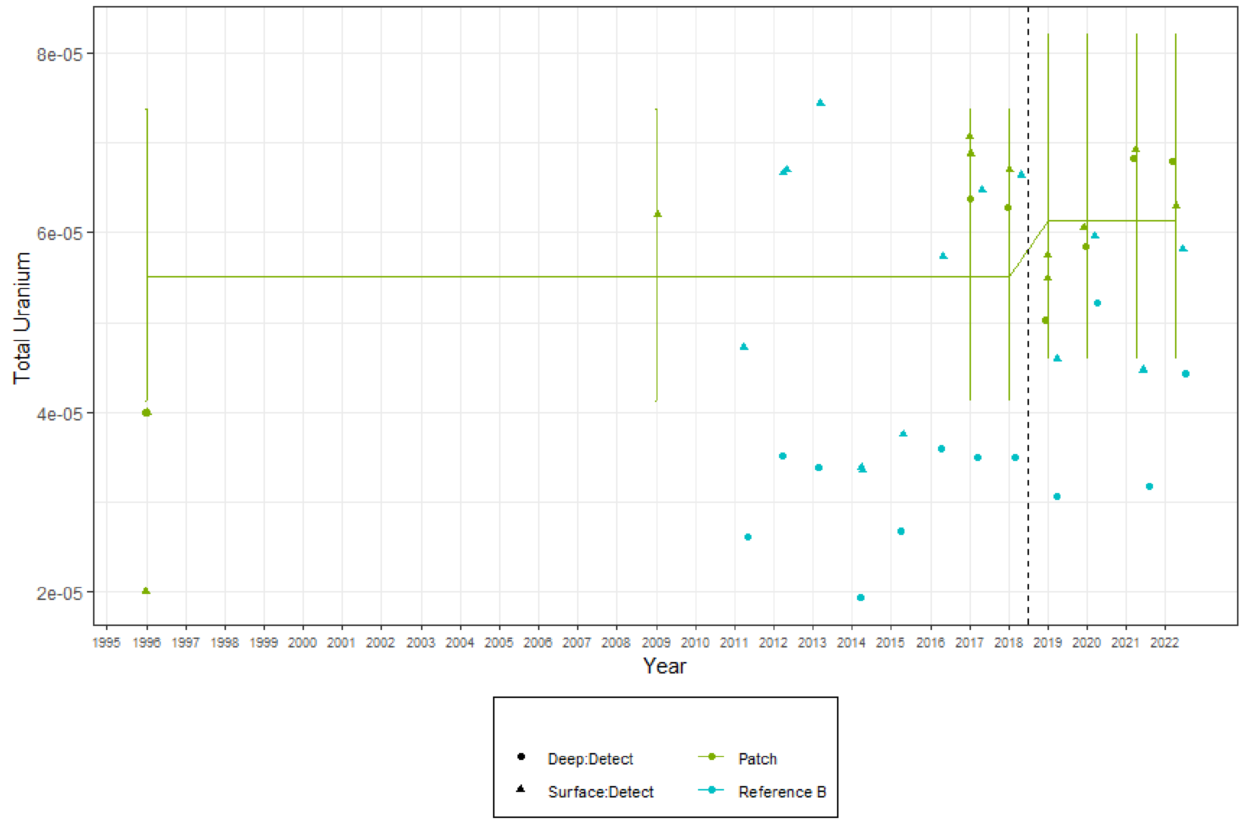
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.1125 | 0.1567 | 7.012 | 0.718 | 0.496 | not sig. |

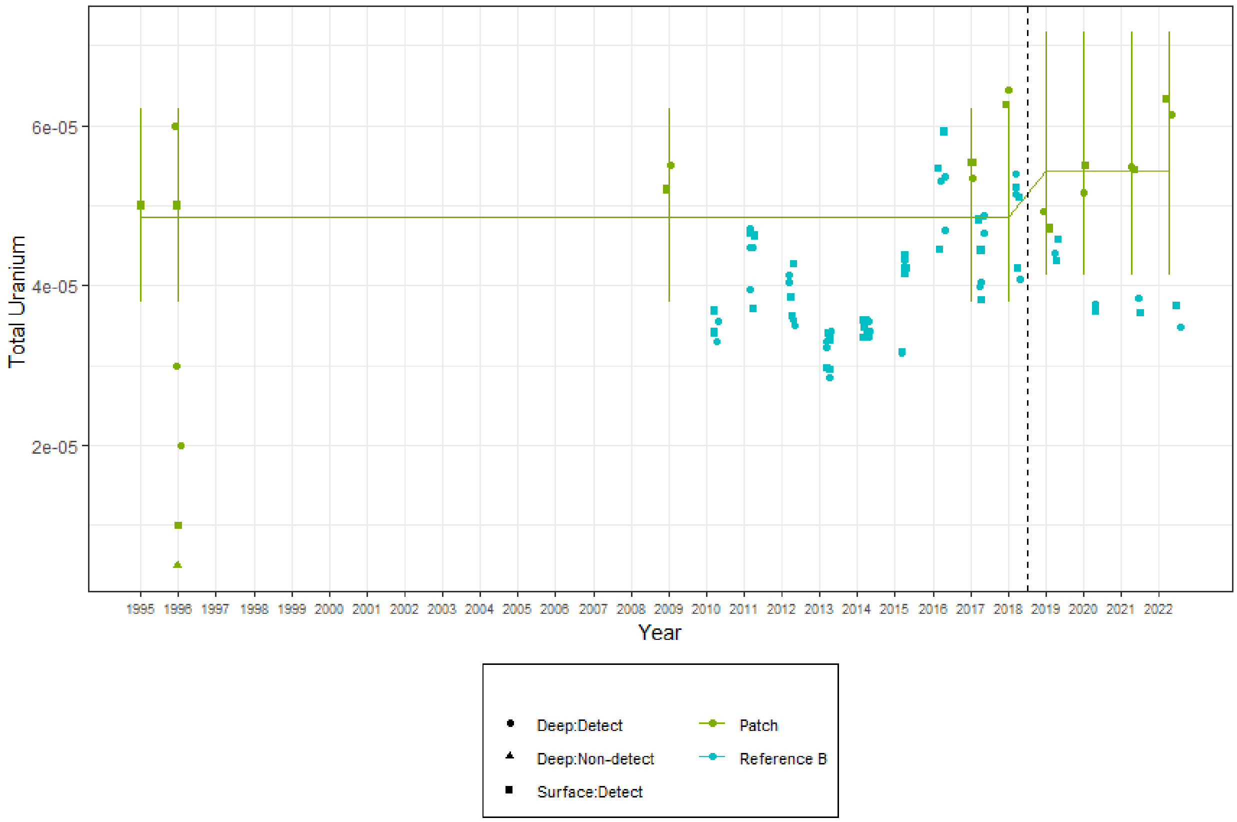
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0901 | 0.0783 | 9 | -1.151 | 0.2795 | not sig. |

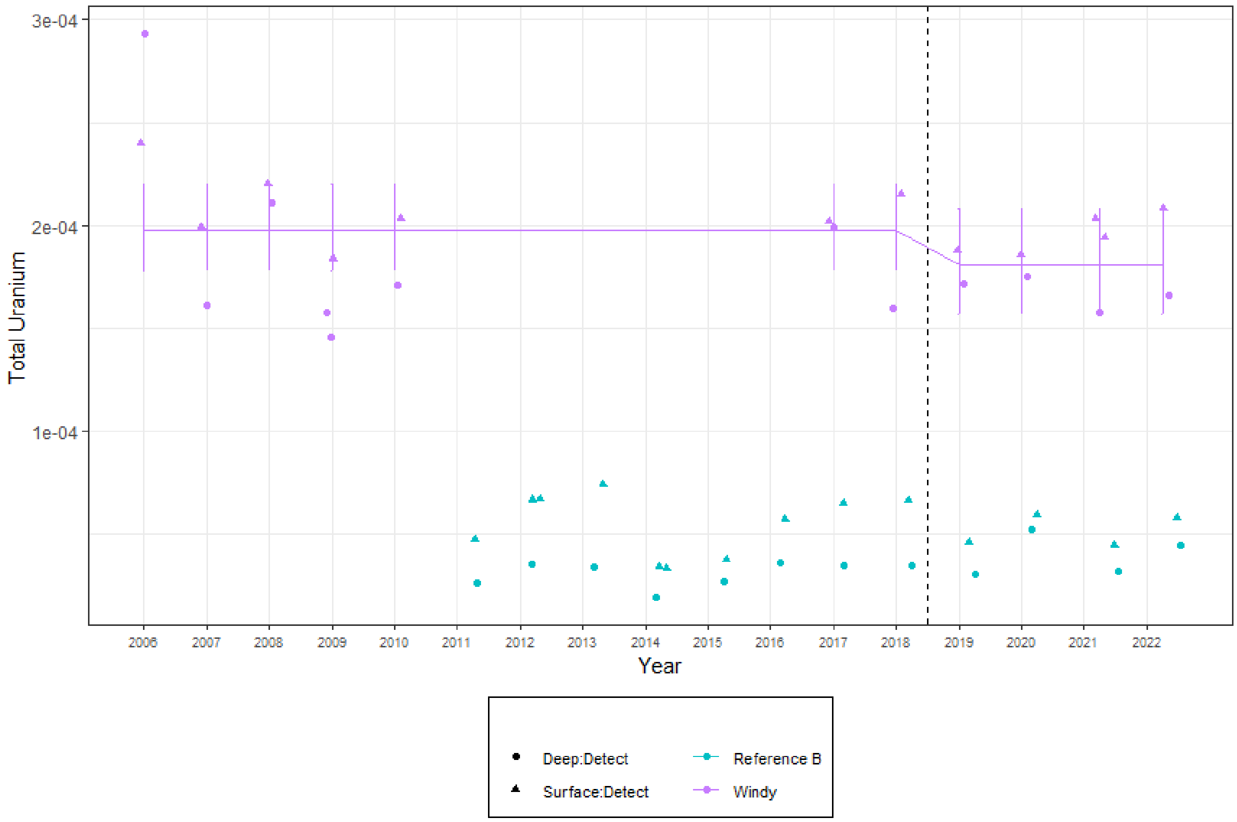
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




*Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.1034 | 0.0547 | 11.06 | -1.891 | 0.0851 | not sig. |

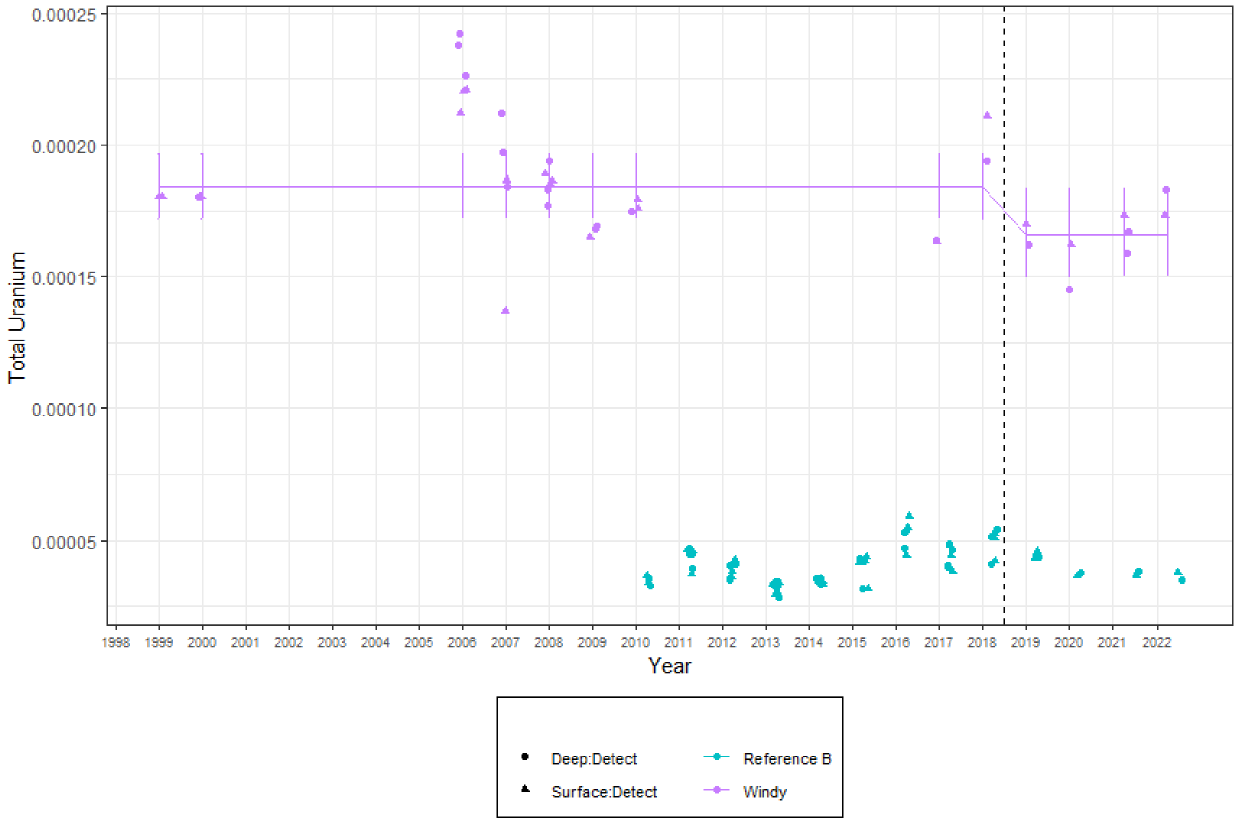
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.


0.00025
0.00020
0.00015
0.00010
0.00005
Total Uranium
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
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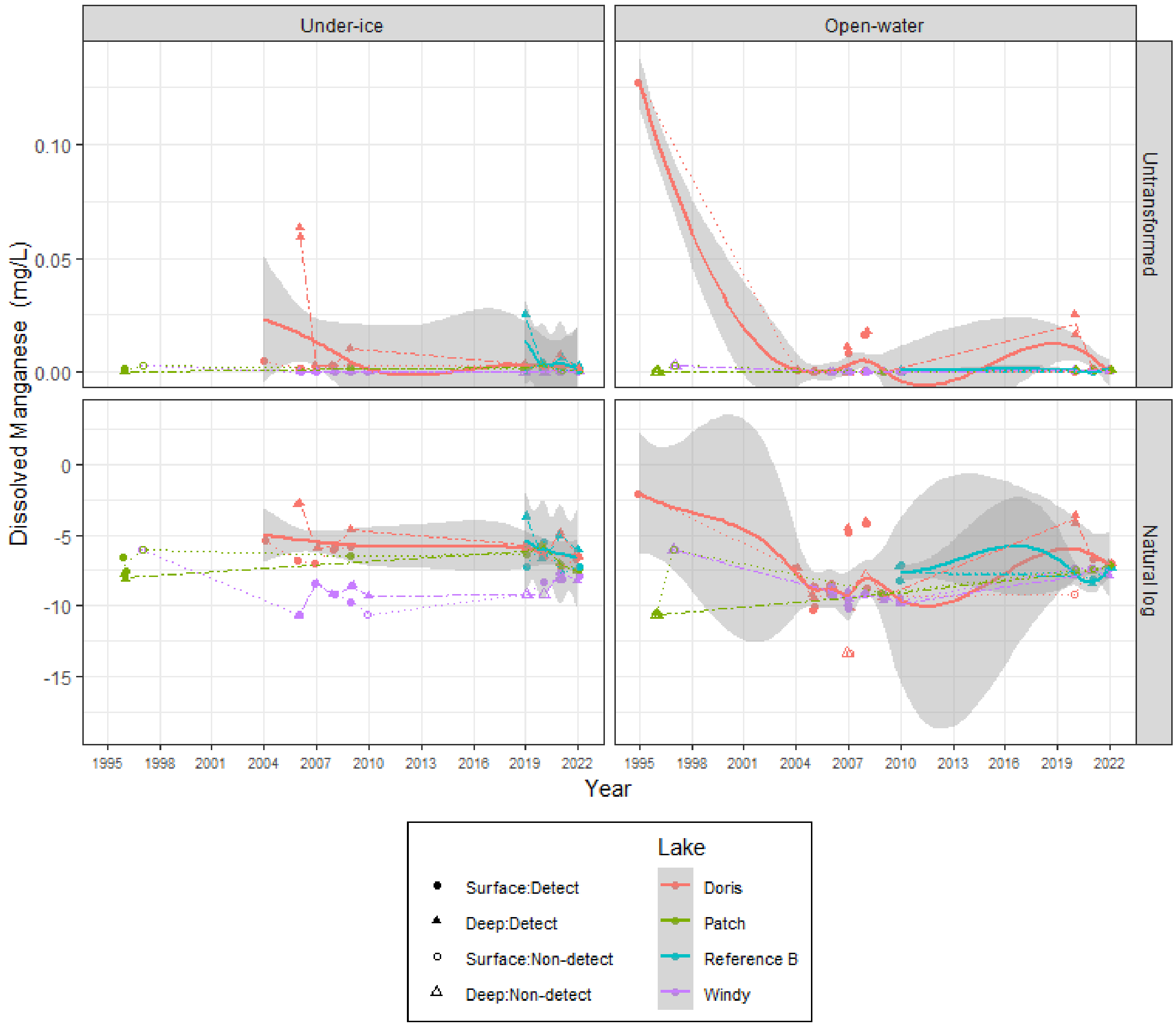
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Deep:Detect
Surface:Detect
Reference B
Windy

### *C.3.1.25 Dissolved Manganese*

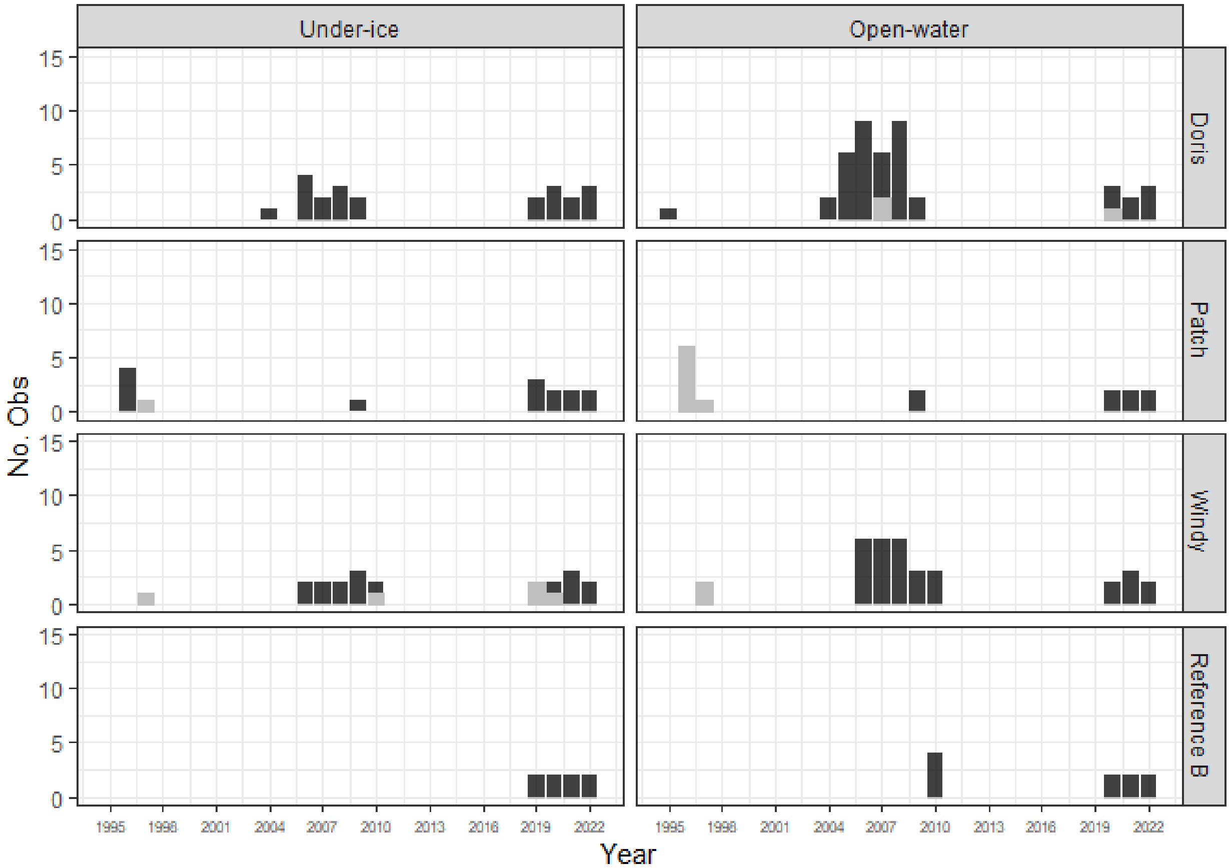
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

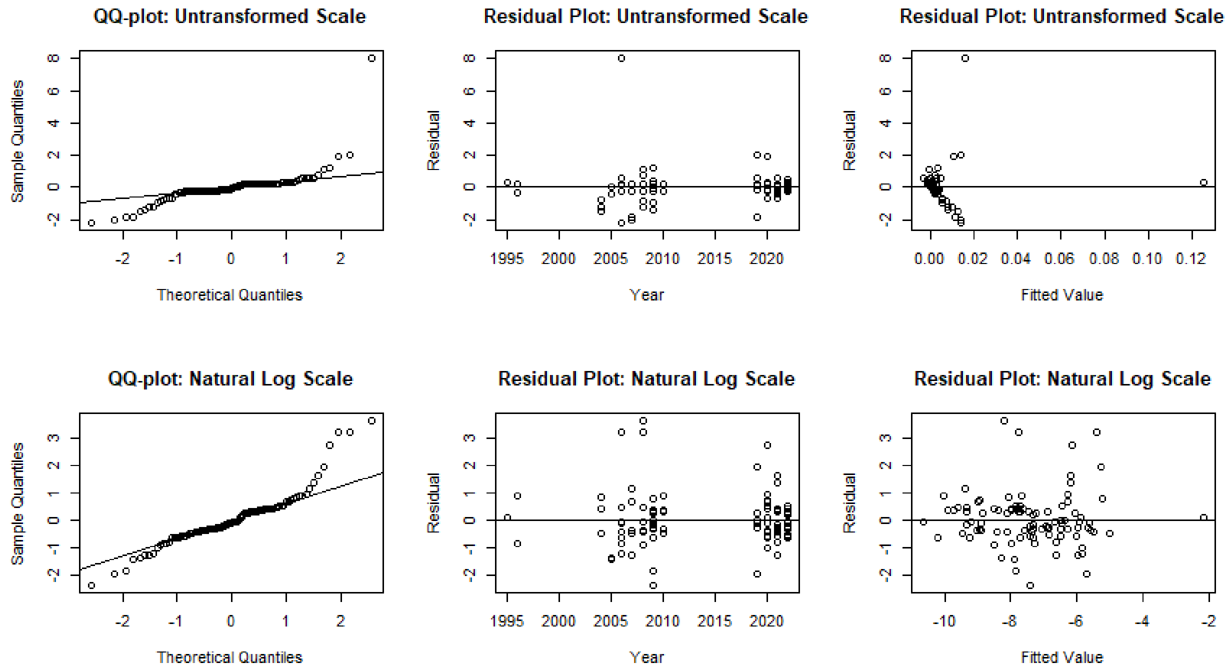
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 22 | 0 | 0 | 0 |
| Doris | Open-water | 43 | 3 | 7 | 0 |
| Patch | Under-ice | 15 | 1 | 7 | 0 |
| Patch | Open-water | 15 | 7 | 47 | 0 |
| Reference B | Under-ice | 8 | 0 | 0 | 0 |
| Reference B | Open-water | 10 | 0 | 0 | 0 |
| Windy | Under-ice | 21 | 5 | 24 | 0 |
| Windy | Open-water | 33 | 2 | 6 | 0 |

None of the sites exhibited greater than 50% of data less than the detection limit. The analysis proceeds with linear mixed model regression.

### Initial Model Fit

A model was fit both on the untransformed and natural log scale to assess the need for transformations. Outliers were identified from the 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 |
|---|---|---|---|---|---|---|---|
| 10 | Doris | 2006 | Under-ice | Deep | 0.0611 | 0.016 | 8.022 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 10 | Doris | 2006 | Under-ice | Deep | 0.0611 | -5.422 | 3.226 |
| 20 | Doris | 2008 | Open-water | Deep | 0.0059 | -7.777 | 3.248 |
| 21 | Doris | 2008 | Open-water | Surface | 0.0054 | -8.184 | 3.650 |

The natural log-transformed data better meets the residual assumptions. Analysis proceeds with natural log-transformed data. 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 zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

#### *Under-ice*

| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 2.702 | 3 | 0.43990 | not sig. |

Doris Lake did not exhibit significant deviation from a slope of zero.

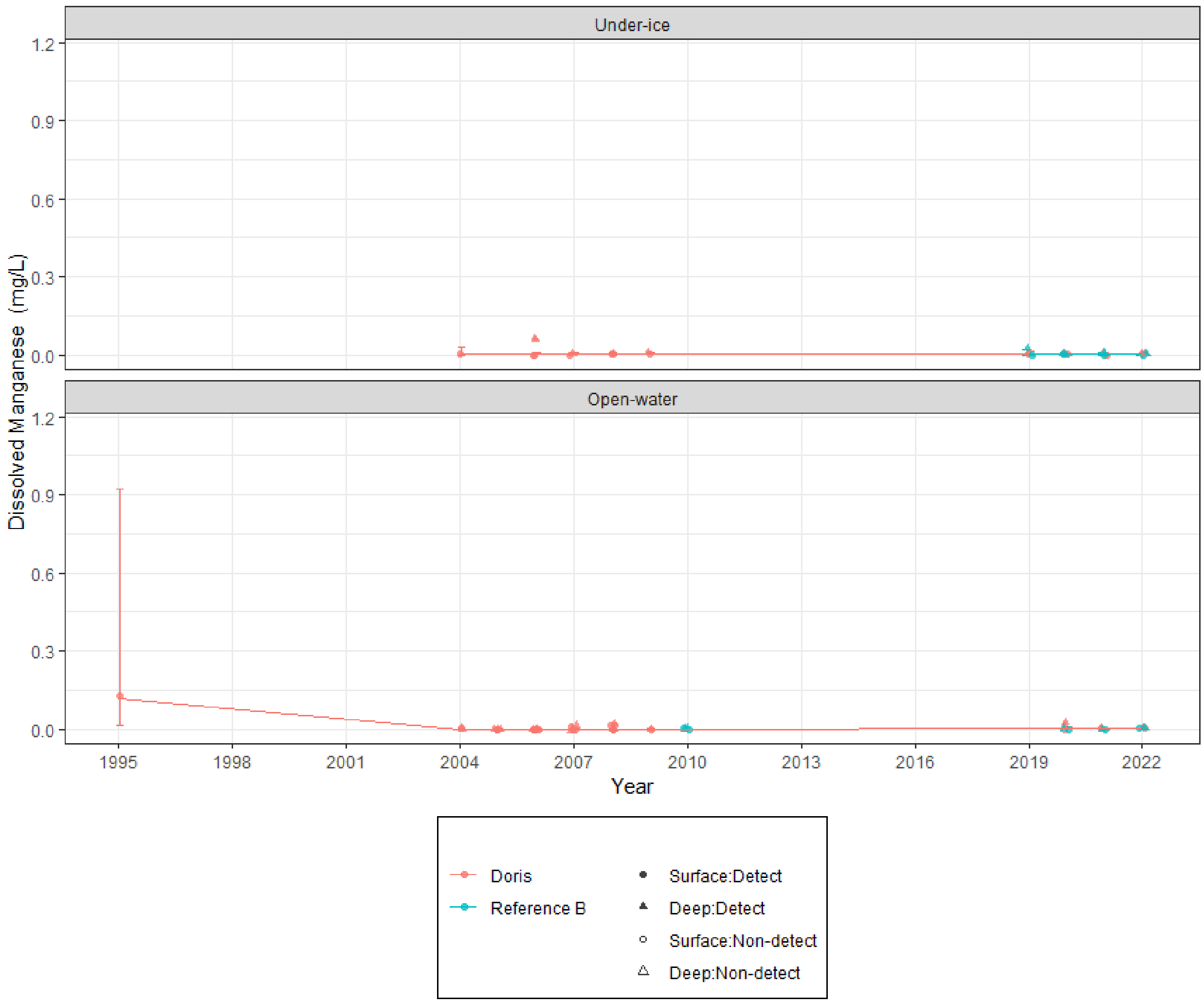
### *Open-water*

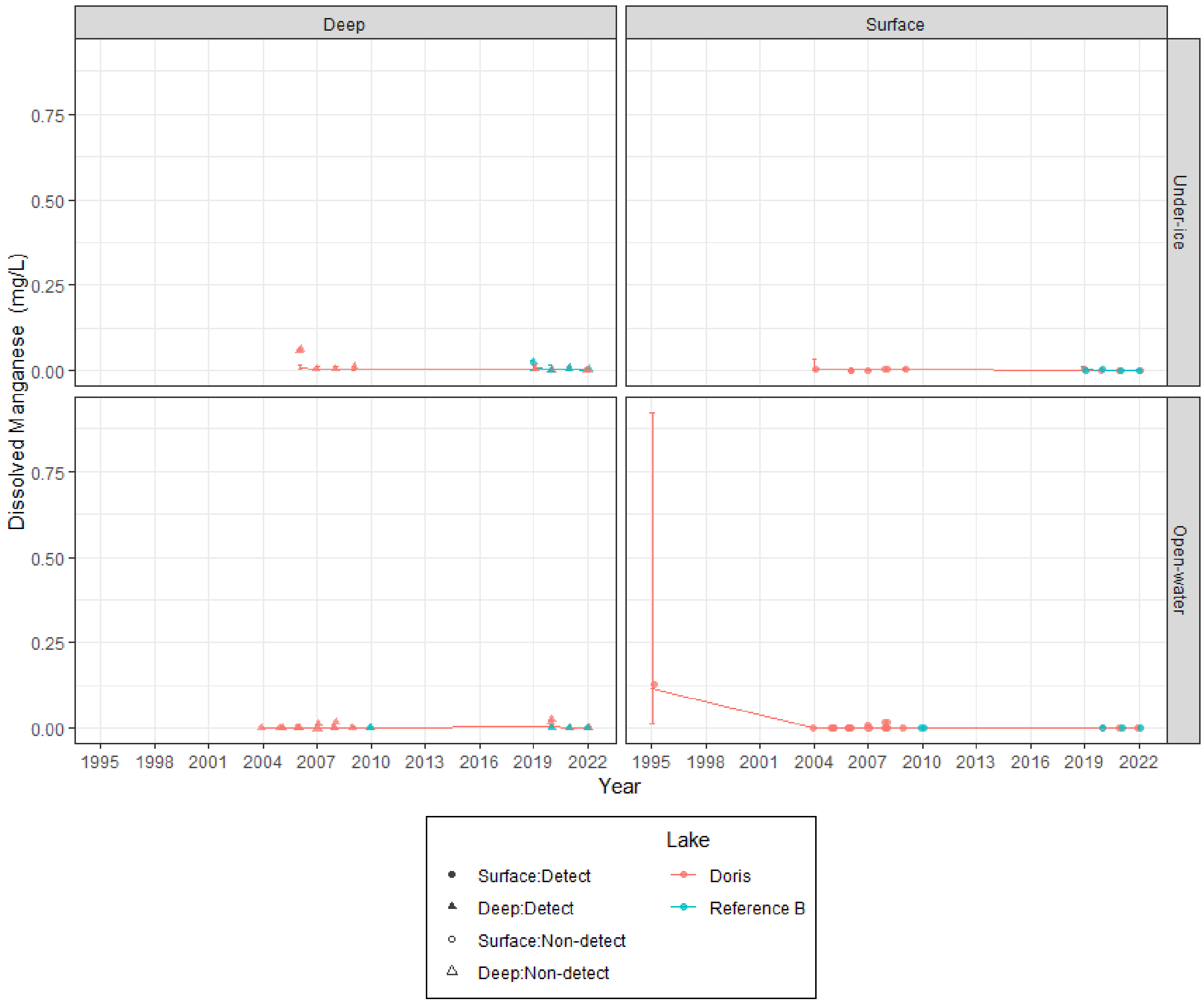
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 31.28 | 3 | <0.00001 | sig. |

Doris Lake appears to show significant deviation from a slope of zero. Doris Lake was not statistically compared to Reference Lake B due to only 3 years of continuous comparable data.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The first plots are averaged over depth, where the second plots are separated by depth to visually assess the differences between surface and deep samples. The symbols represent the observed data values and hollow symbols are values presented at half the detection limit. Solid lines represent the fitted curves. Error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.






## Patch Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Patch Lake. Models were fit separately for each season.

### *Under-ice Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.1049 | 0.5795 | 5.31 | 0.181 | 0.8631 | not sig. |

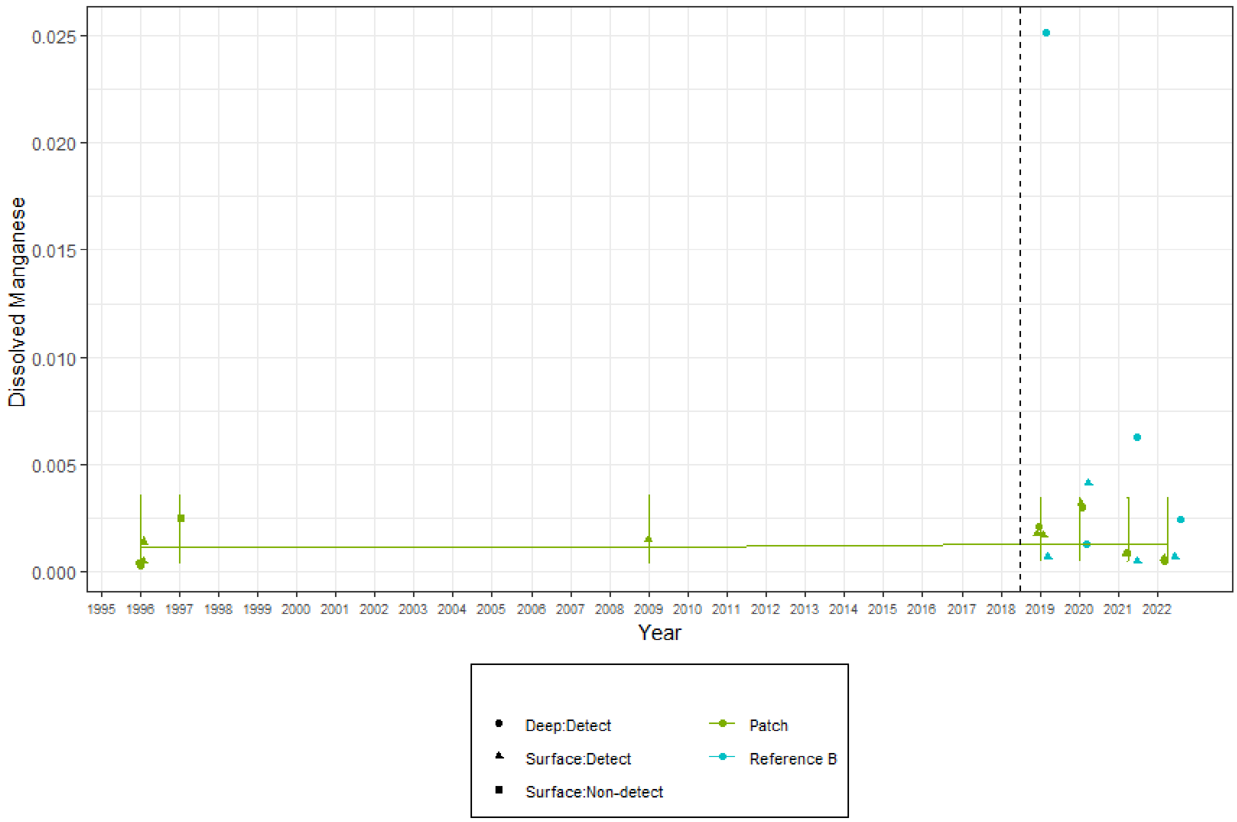
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 1.191 | 1.347 | 3.994 | 0.8842 | 0.4266 | not sig. |

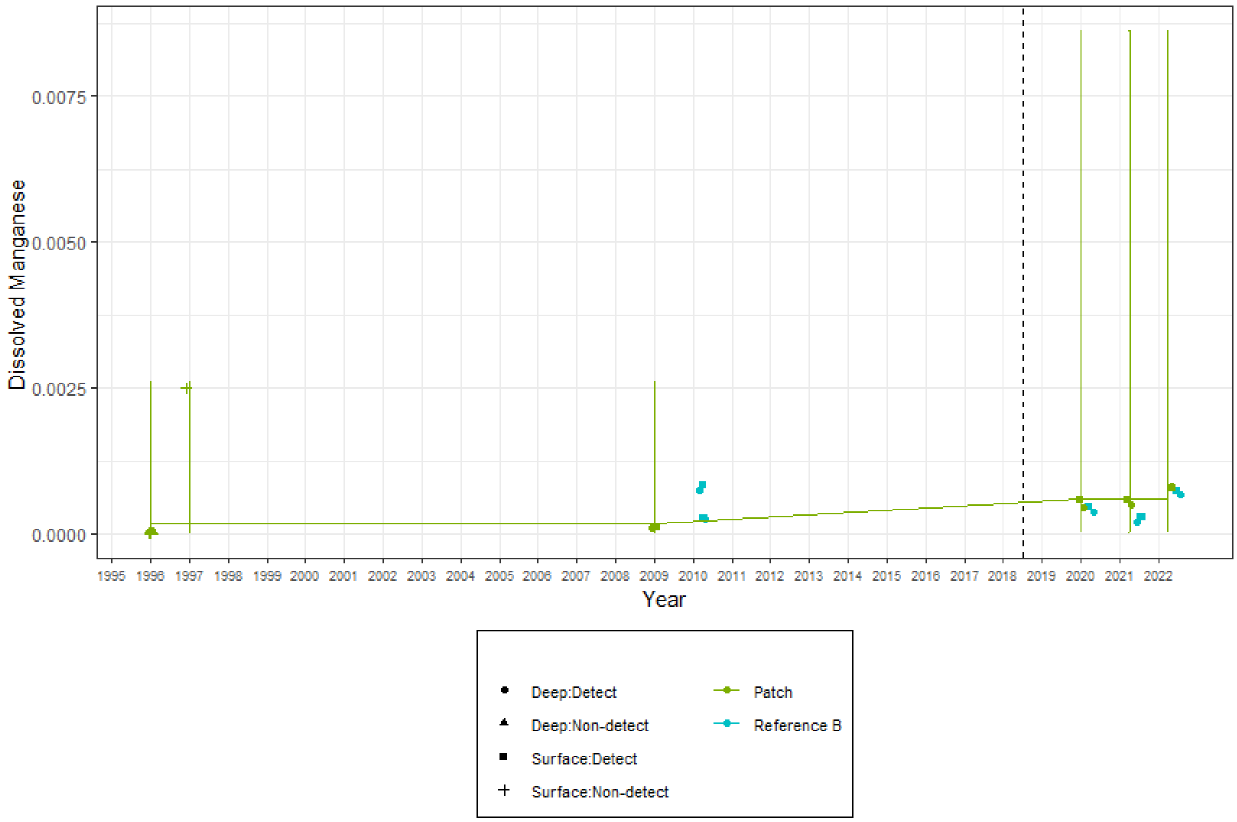
Conclusion:

The change in concentrations at Patch Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### Windy Lake

Before-after analyses were first performed to compare the change in concentrations in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years between Reference Lake B and Windy. Models were fit separately for each season.

#### *Under-ice*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.4413 | 0.846 | 7.324 | 0.5216 | 0.6173 | not sig. |

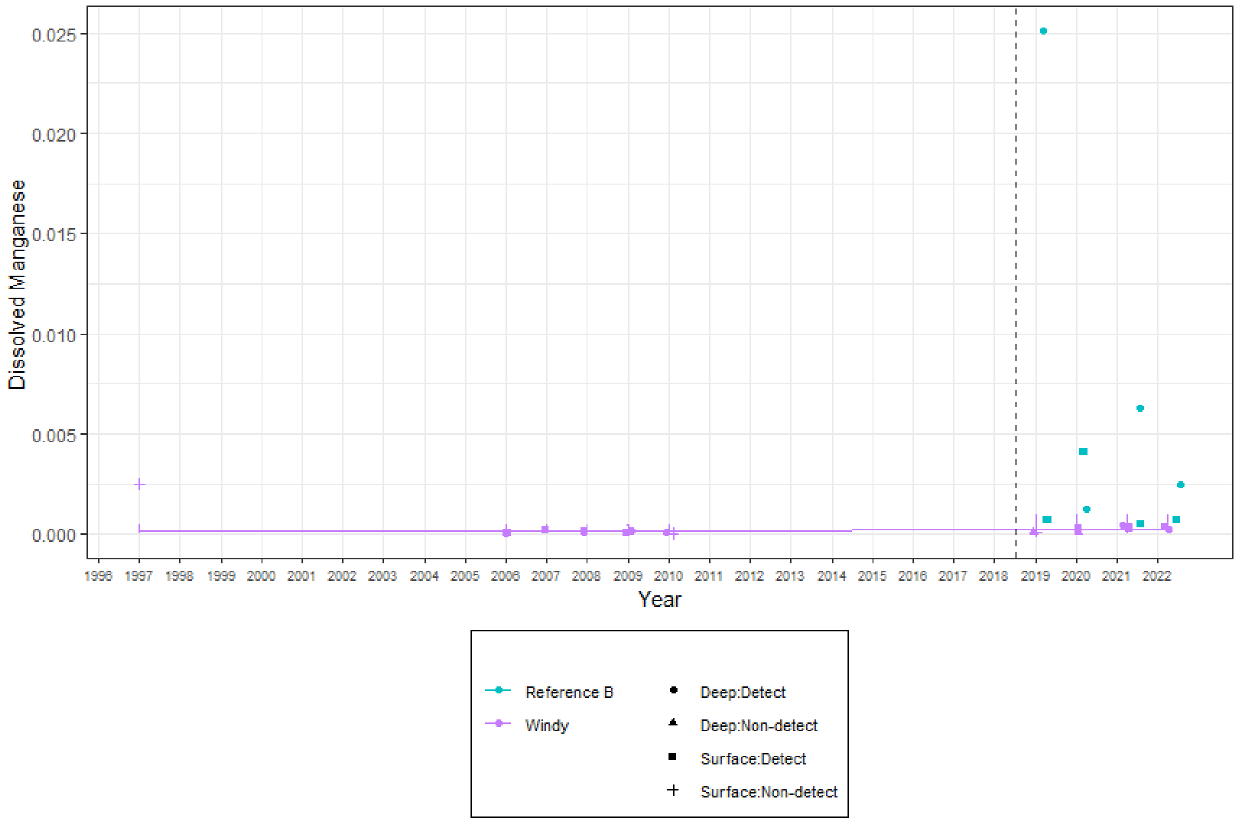
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.




### *Open-water*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 1.26 | 0.8459 | 7 | 1.49 | 0.1799 | not sig. |

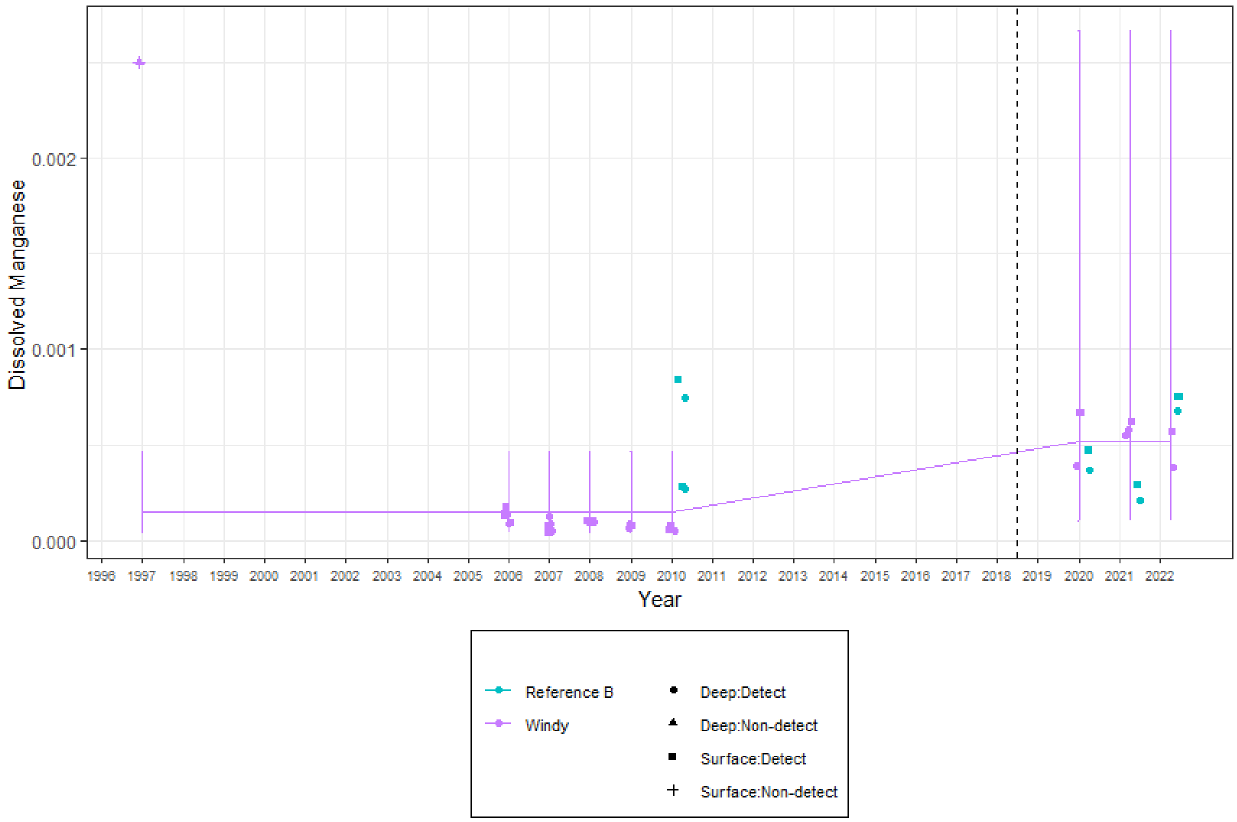
Conclusion:

The change in concentrations at Windy Lake from before to after was not significantly different.

BACI analysis not 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. The symbols represent the observed data values and hollow symbols 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 monitored site.


Dissolved Manganese
0.000
0.001
0.002
Year
1996
1997
1998
1999
2000
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2002
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2004
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2006
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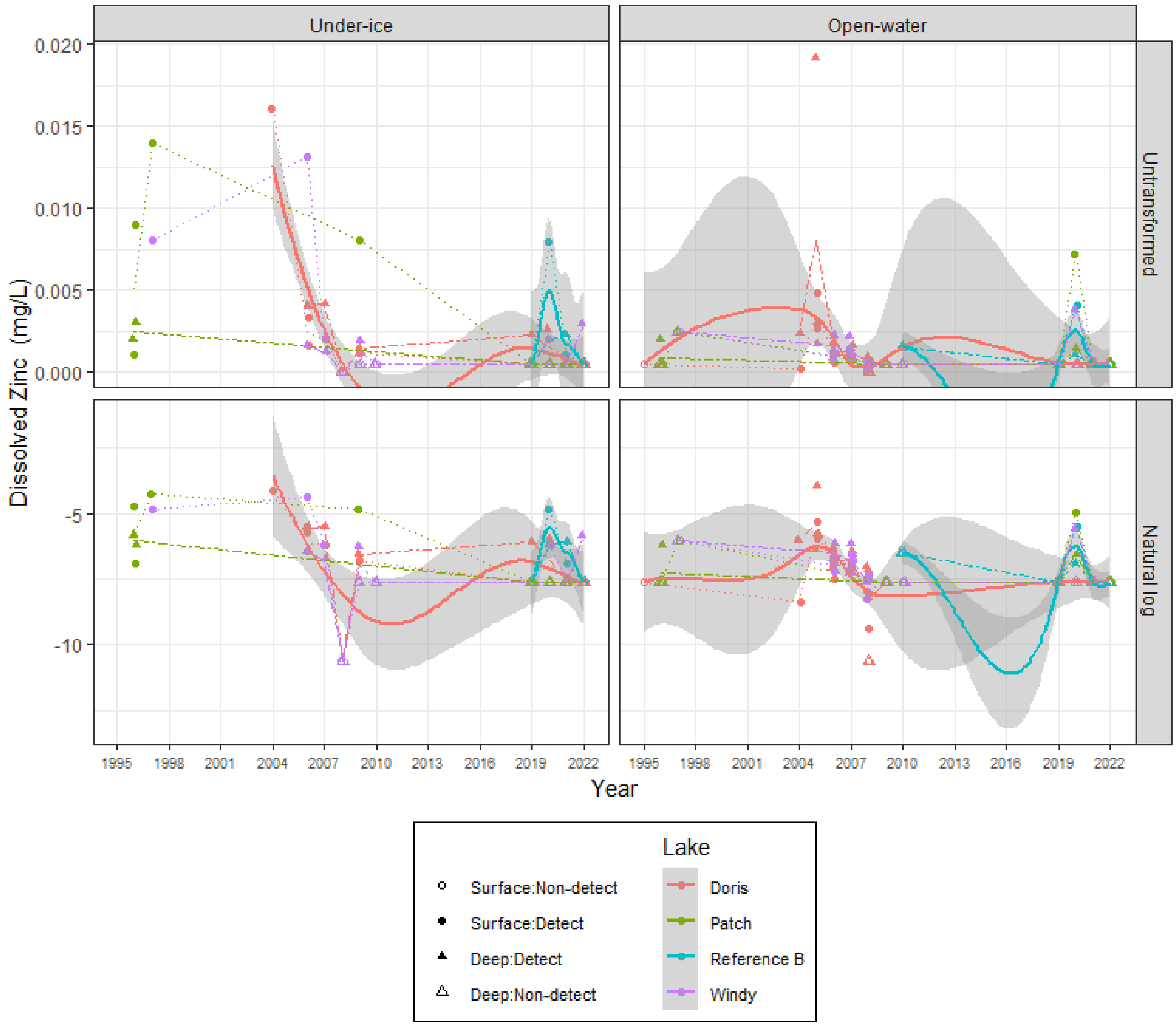
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Reference B
Windy
Deep:Detect
Deep:Non-detect
Surface:Detect
Surface:Non-detect

### *C.3.1.26 Dissolved Zinc*

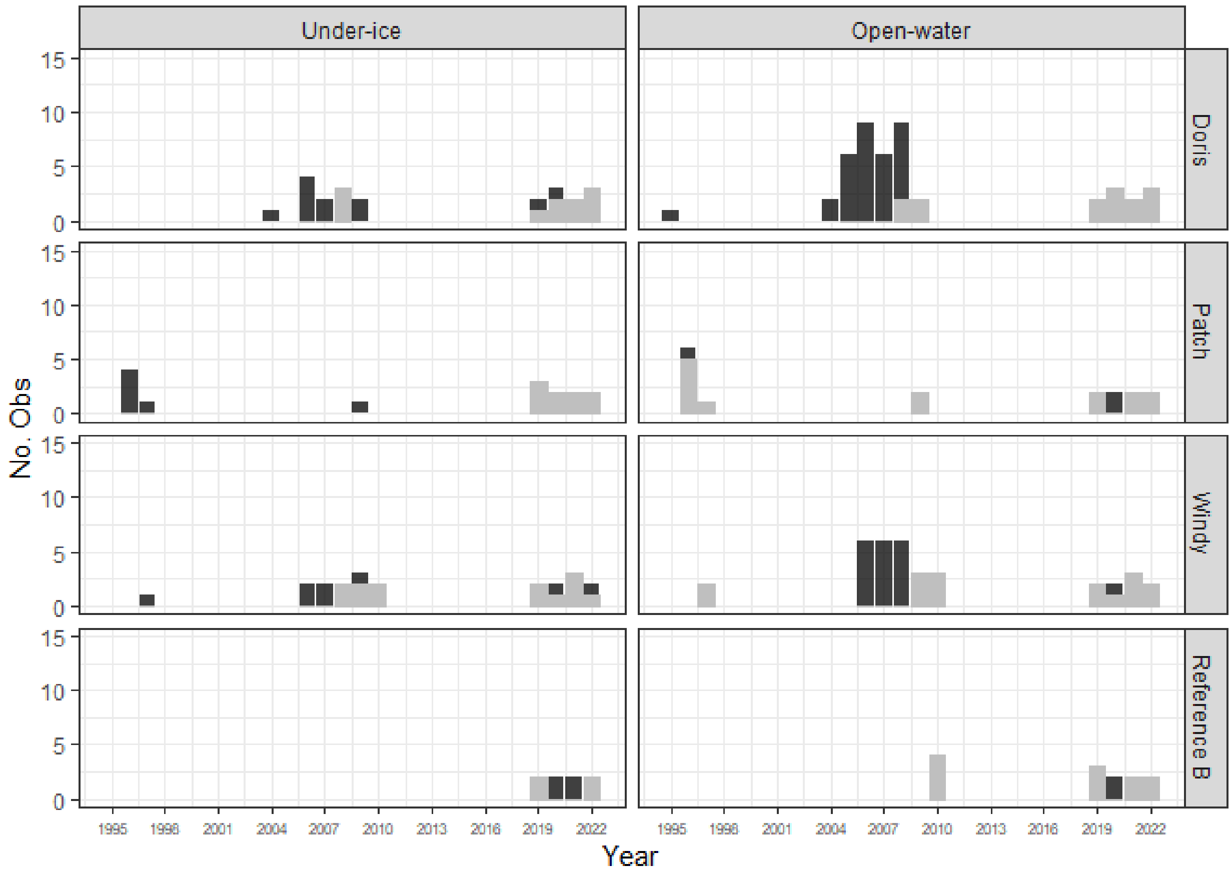
**Observed Data**

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. Samples collected at different depths are shown by symbols and lines. The lines dashed lines connect 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 (gray shading) are shown to provide a representation of trends in the data.




**Censored Values and Sample Sizes**

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). 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., 2022) were censored.

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

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Under-ice | 22 | 11 | 50 | 100 |
| Doris | Open-water | 45 | 15 | 33 | 100 |
| Patch | Under-ice | 15 | 9 | 60 | 100 |
| Patch | Open-water | 17 | 14 | 82 | 100 |
| Reference B | Under-ice | 8 | 4 | 50 | 100 |
| Reference B | Open-water | 13 | 11 | 85 | 100 |
| Windy | Under-ice | 21 | 13 | 62 | 50 |
| Windy | Open-water | 35 | 16 | 46 | 100 |

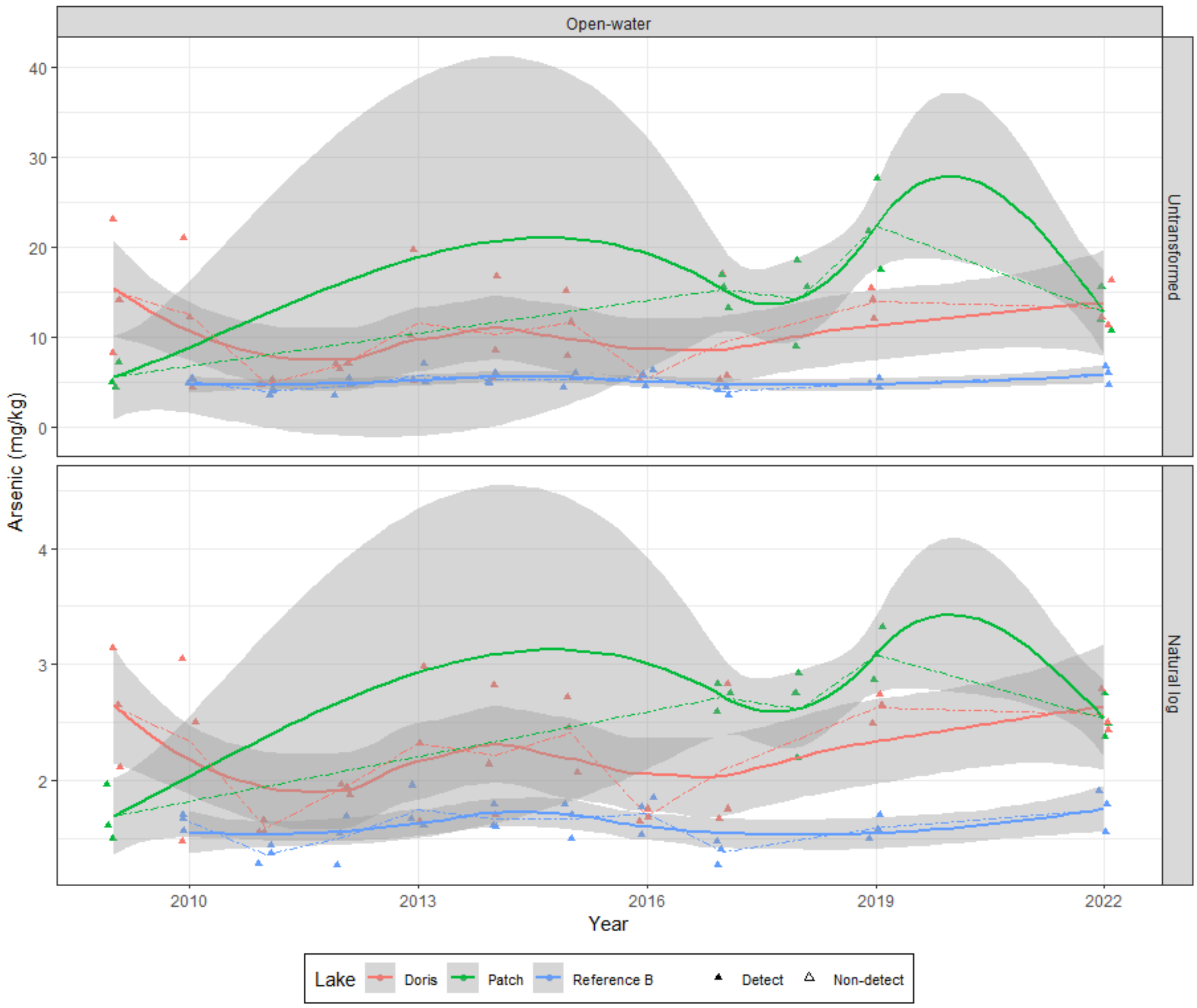
All data from Doris, Patch and Windy were censored. All data removed from the analysis and no statistical analyses were performed.

## C.3.2 Sediment Quality

### C.3.2.1 Arsenic

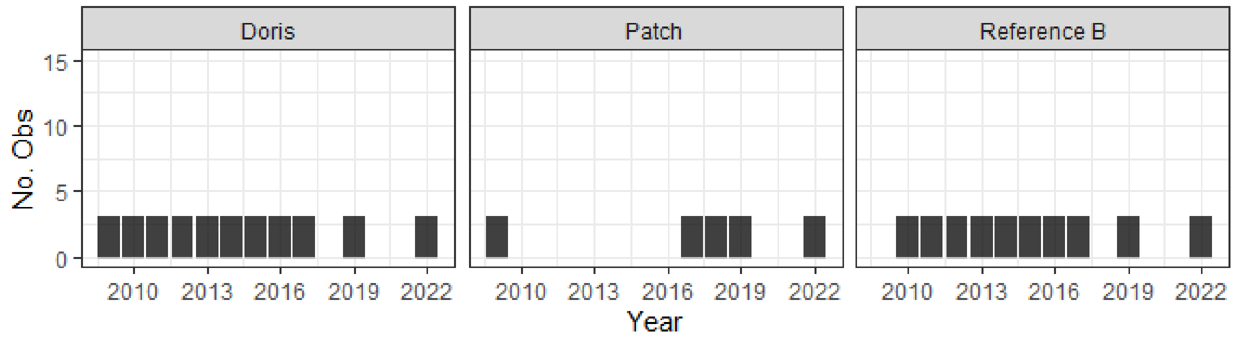
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Symbols represent observations and the dashed lines connect the annual means. Observations are slightly jittered along the x-axis for legibility. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). Observations at or below the 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., 2022) were censored.

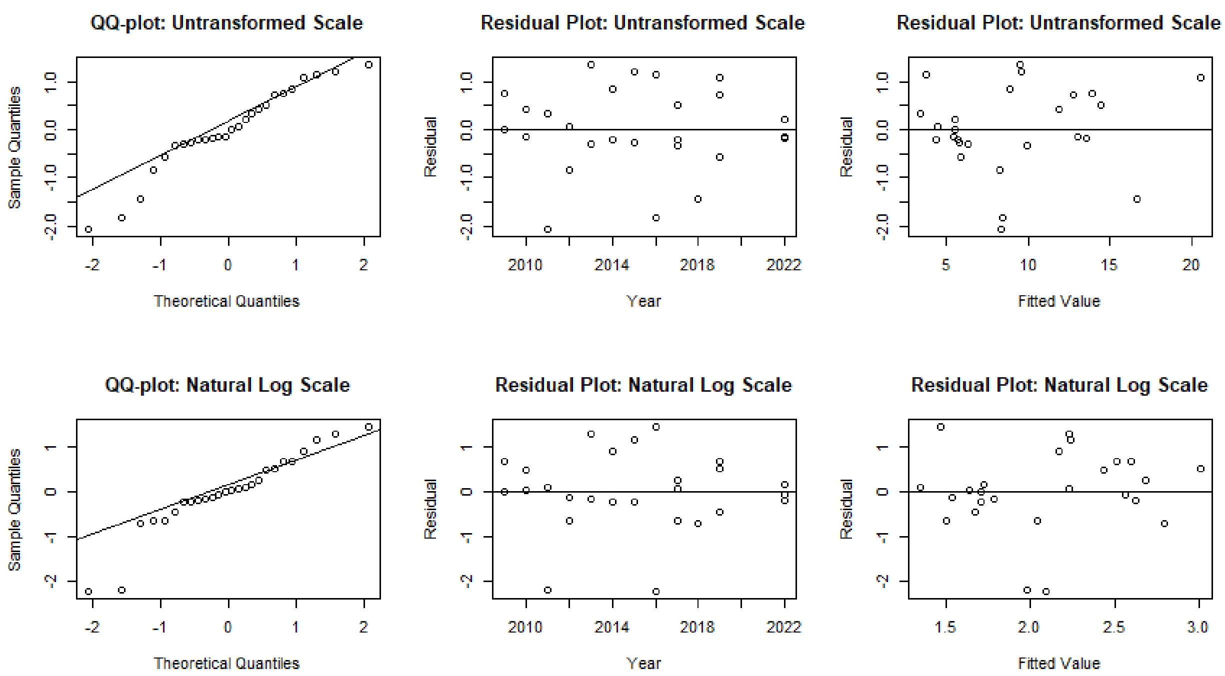
The sample sizes and median values per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 33 | 0 | 0 | 0 |
| Patch | Open-water | 15 | 0 | 0 | 0 |
| Reference B | Open-water | 30 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers on untransformed scale:

None

Outliers on natural log scale:

None

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

### Doris

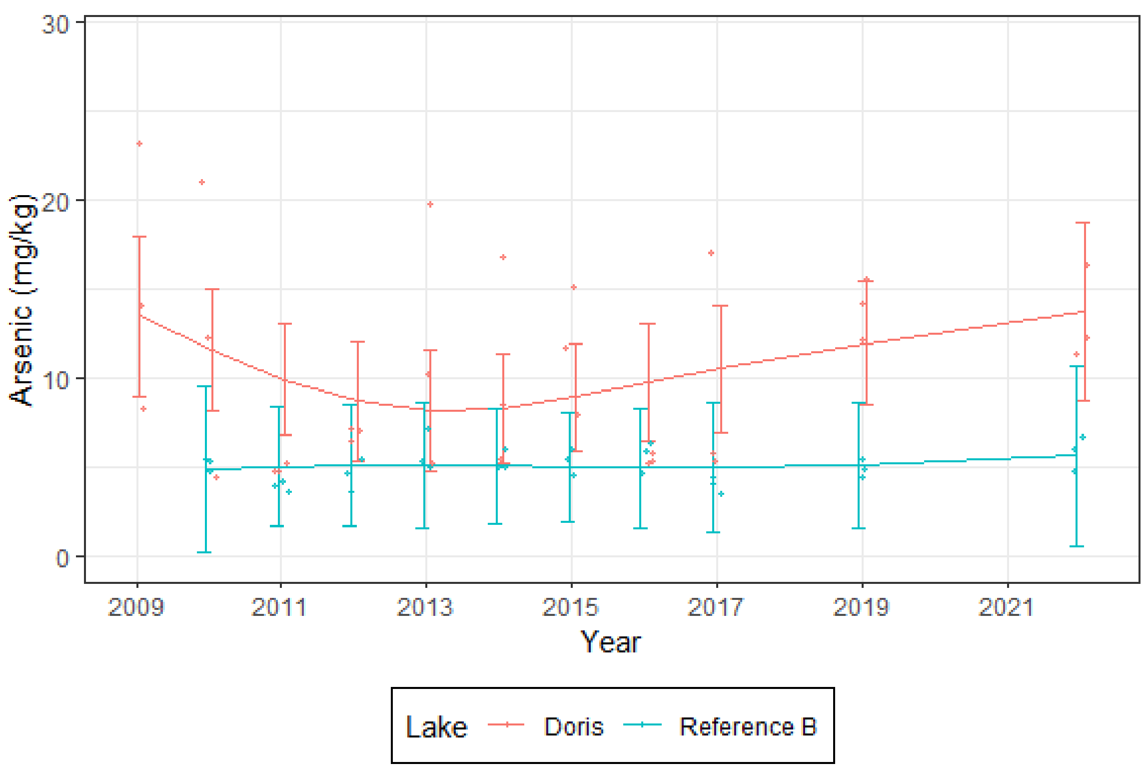
The trend of Doris Lake was compared to a slope of zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

| Analysis | Chi.sq | DF | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 10.010 | 3 | 0.0185 | sig. |
| Compare to Reference B | 4.534 | 3 | 0.2093 | not sig. |

Doris Lake appears to show significant deviation from slope of zero. However, Doris Lake did not exhibit significant deviation from the trend of Reference Lake B.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data, solid lines represent the fitted curves, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



### Patch

A before-after analysis was first performed to compare the change in concentrations in the before and after period for the exposure lake. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years relative to Reference Lake B and Patch Lake.

#### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 2.284 | 2.392 | 6.924 | 0.955 | 0.3717 | not sig. |

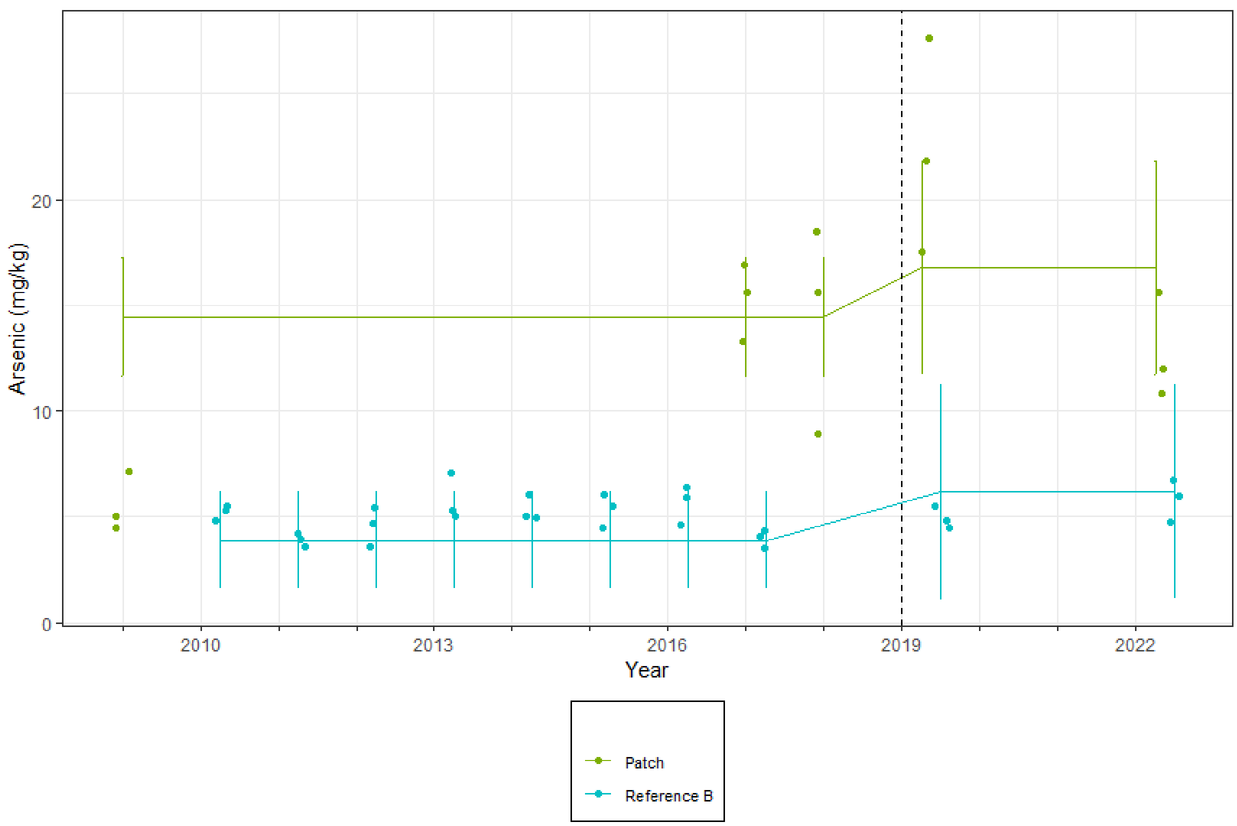
Conclusion:

The change in concentrations from before to after was not significantly different.

BACI analysis not performed.

#### *Observed Data and Fitted Values*

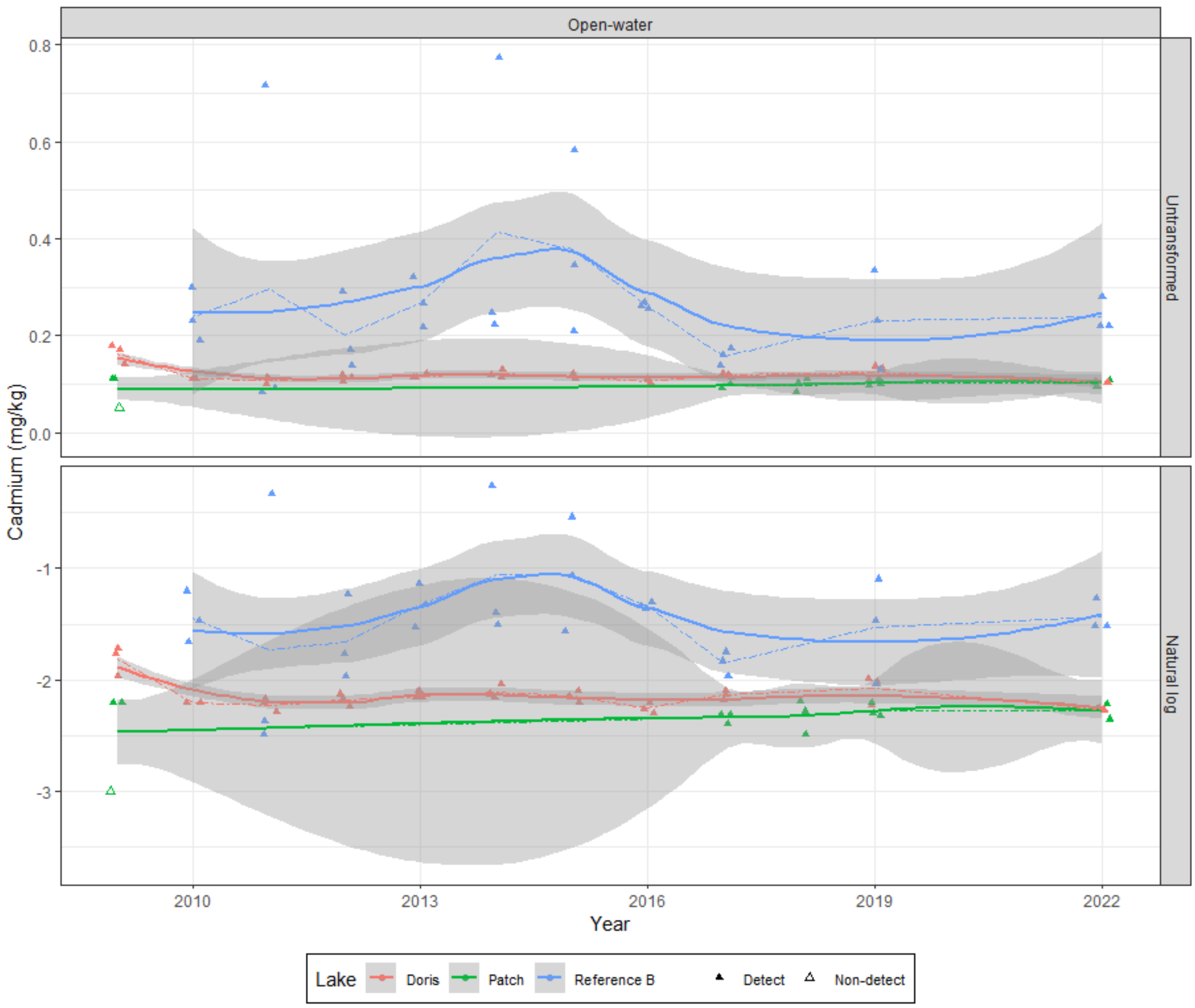
Points represent the observed data values, hollow symbols represent data less than the detection limit and presented at half the detection limit. Solid lines represent the fitted means, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.



### *C.3.2.2 Cadmium*

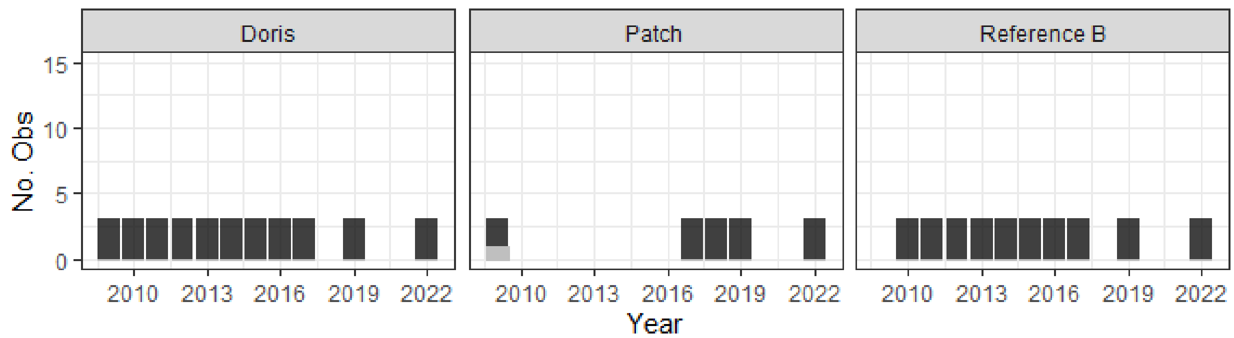
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Symbols represent observations and the dashed lines connect the annual means. Observations are slightly jittered along the x-axis for legibility. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). Observations at or below the 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., 2022) were censored.

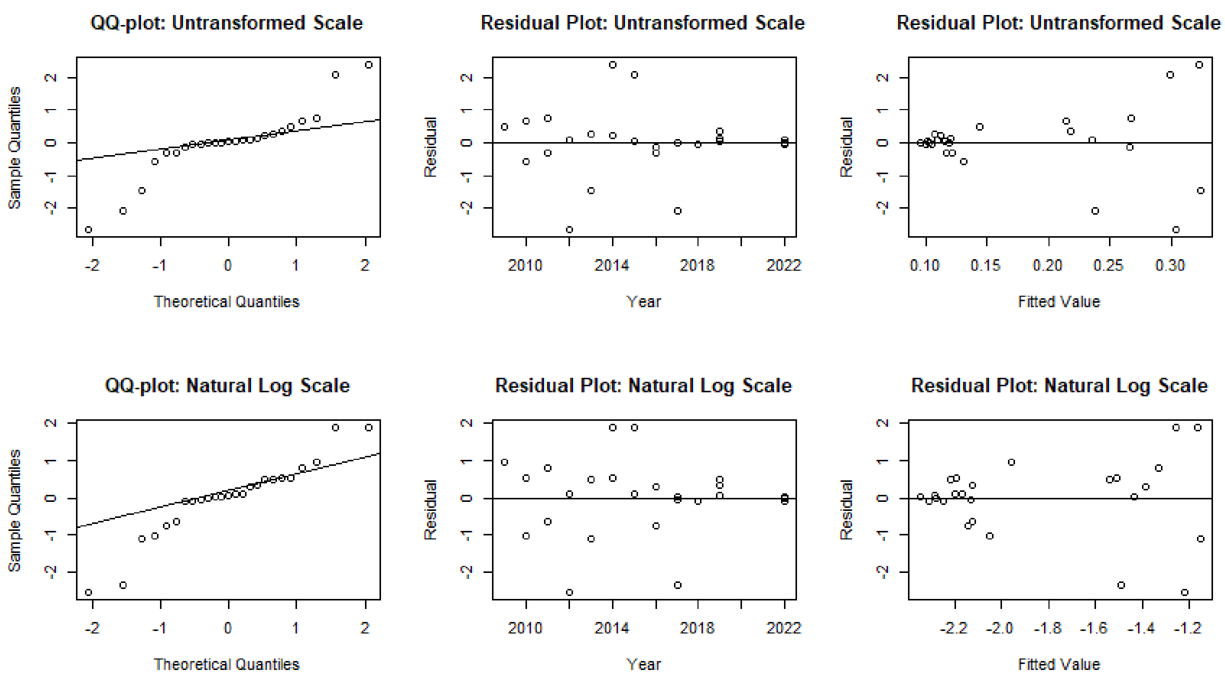
The sample sizes and median values per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 33 | 0 | 0 | 0 |
| Patch | Open-water | 15 | 1 | 6.67 | 0 |
| Reference B | Open-water | 30 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers on untransformed scale:

None

Outliers on natural log scale:

None

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

### Doris

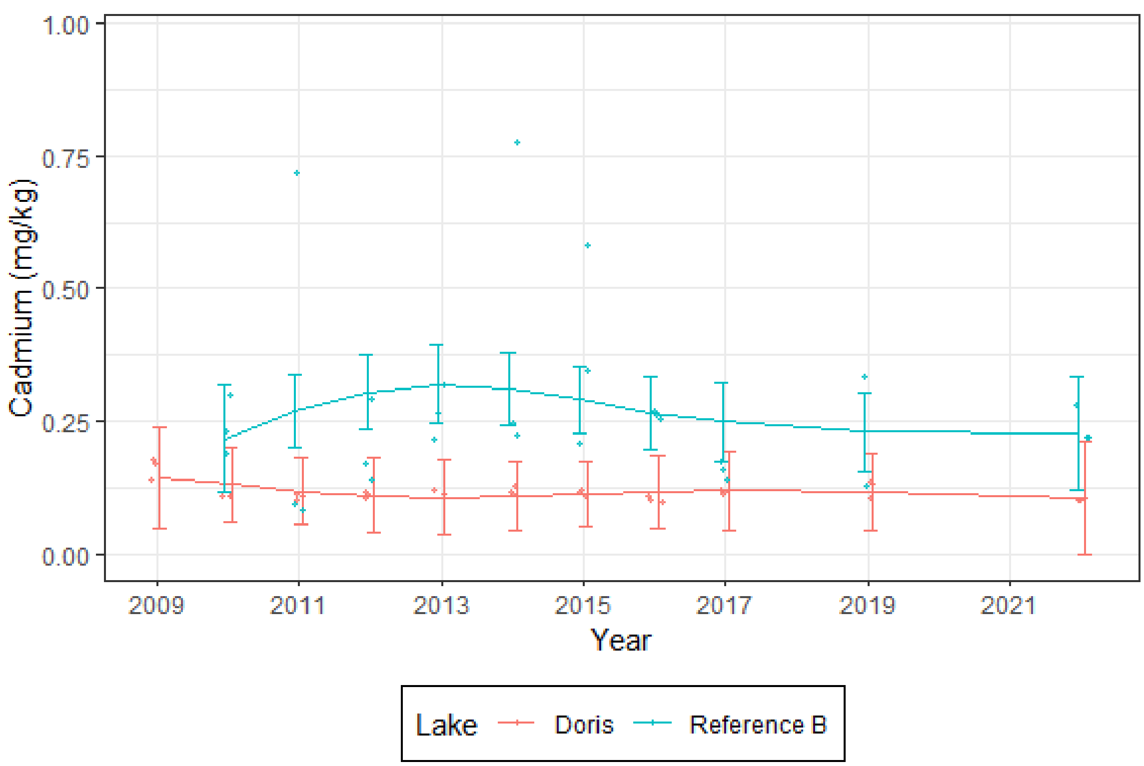
The trend of Doris Lake was compared to a slope of zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

| Analysis | Chi.sq | DF | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 0.61 | 3 | 0.8941 | not sig. |

Doris Lake did not exhibit significant deviation from slope of zero. Comparison to Reference Lake B not performed.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data, solid lines represent the fitted curves, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



## Patch

A before-after analysis was first performed to compare the change in concentrations in the before and after period for the exposure lake. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years relative to Reference Lake B and Patch Lake.

### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0207 | 0.0458 | 42 | -0.452 | 0.6536 | not sig. |

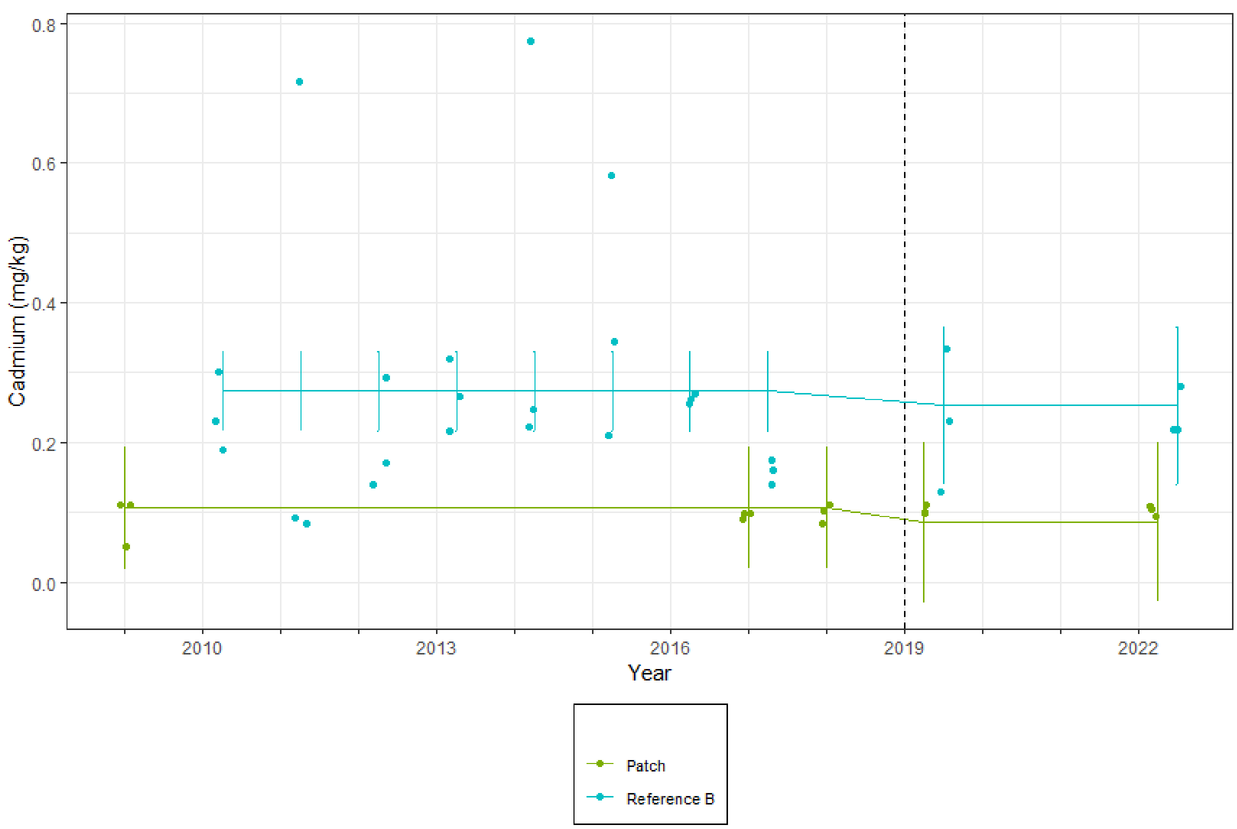
Conclusion:

The change in concentrations from before to after was not significantly different.

BACI analysis not performed.

### *Observed Data and Fitted Values*

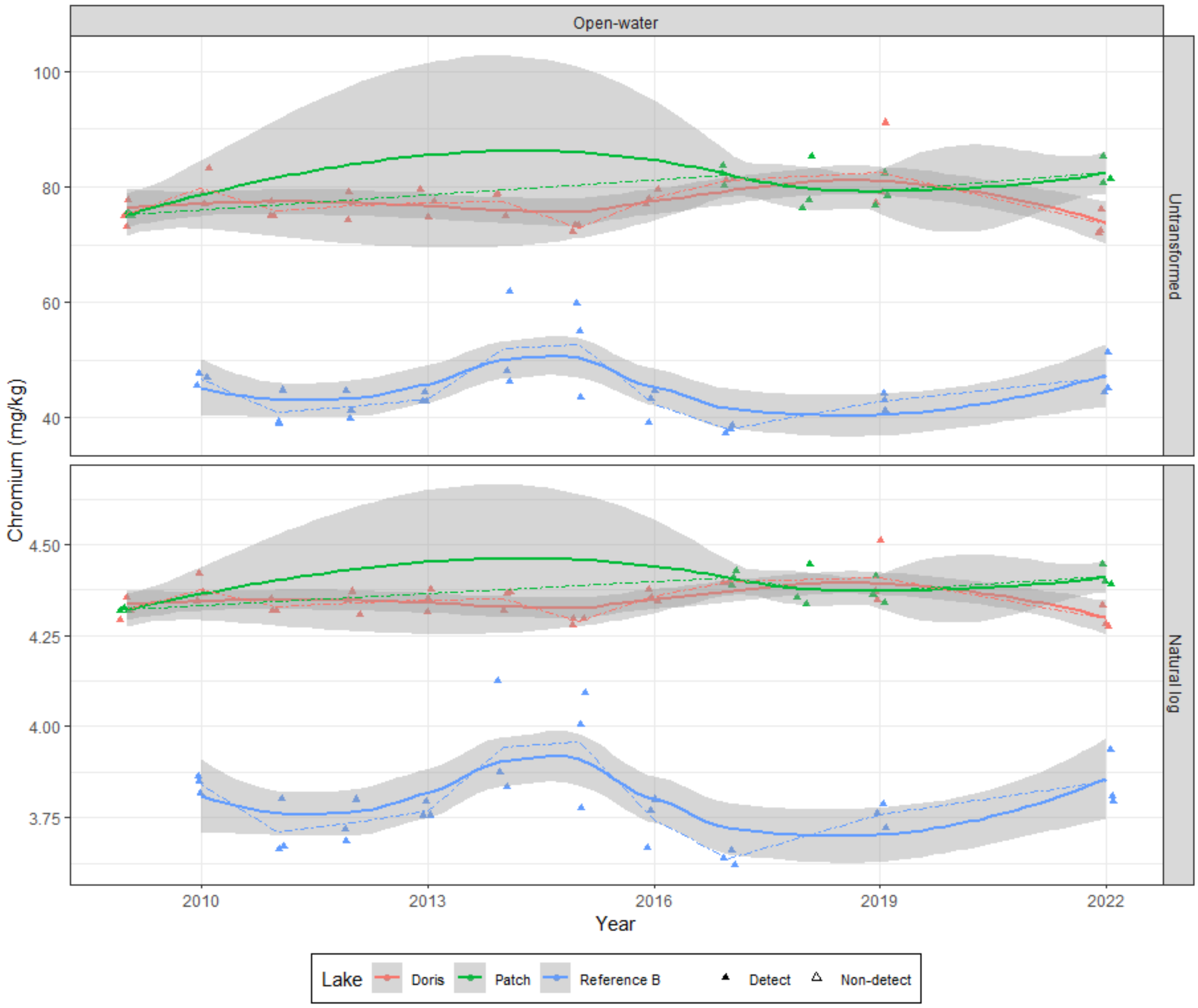
Points represent the observed data values, hollow symbols represent data less than the detection limit and presented at half the detection limit. Solid lines represent the fitted means, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.



### *C.3.2.3 Chromium*

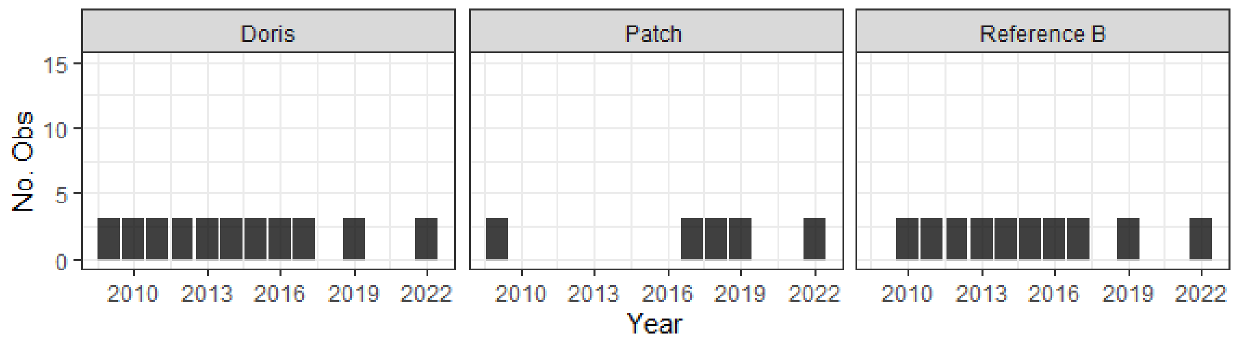
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Symbols represent observations and the dashed lines connect the annual means. Observations are slightly jittered along the x-axis for legibility. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). Observations at or below the 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., 2022) were censored.

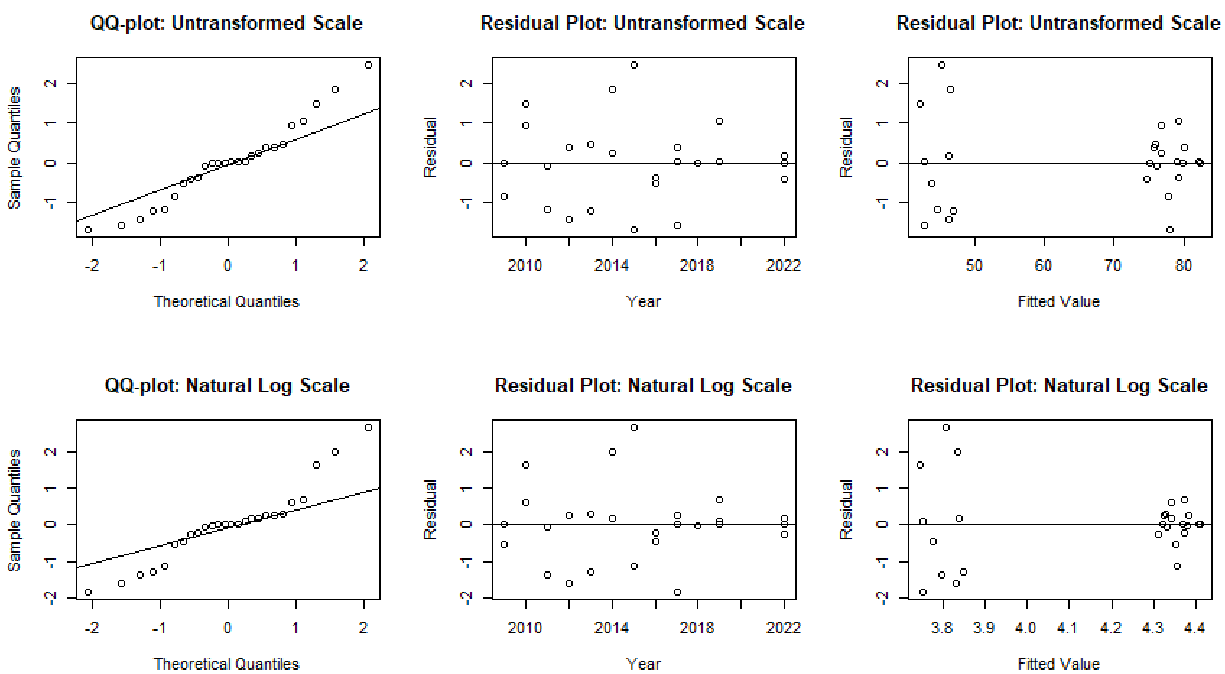
The sample sizes and median values per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 33 | 0 | 0 | 0 |
| Patch | Open-water | 15 | 0 | 0 | 0 |
| Reference B | Open-water | 30 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers on untransformed scale:

None

Outliers on natural log scale:

None

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

### Doris

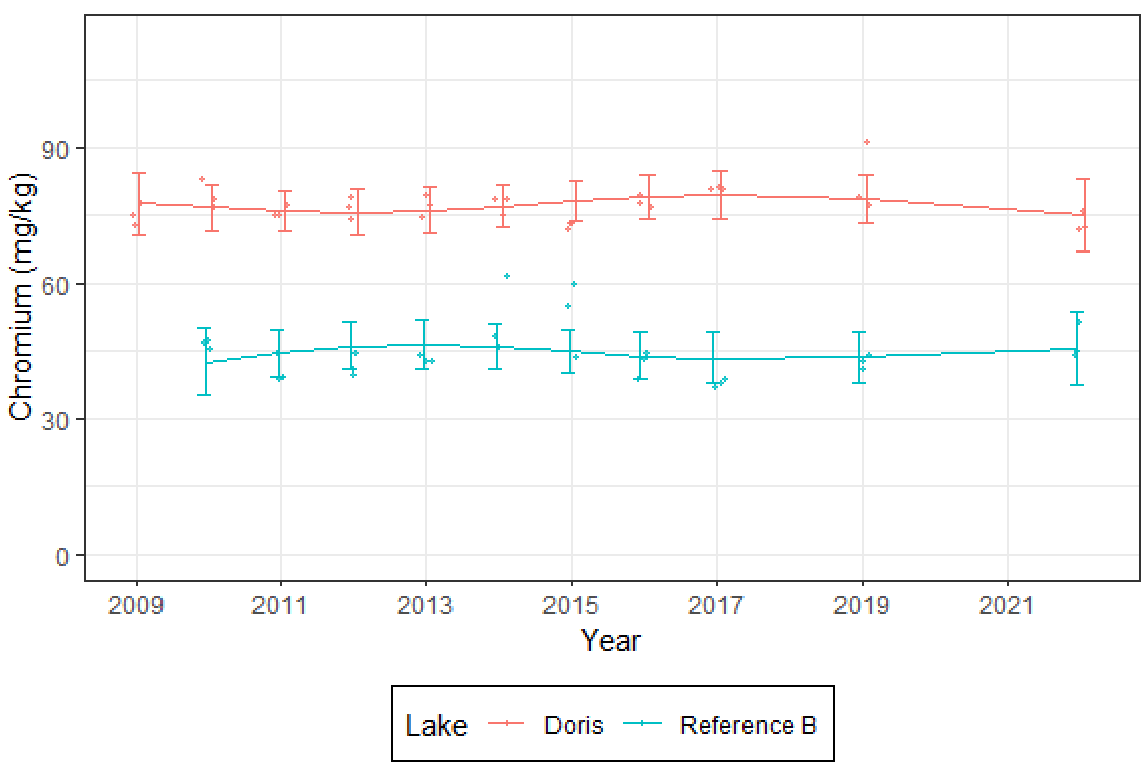
The trend of Doris Lake was compared to a slope of zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

| Analysis | Chi.sq | DF | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 1.831 | 3 | 0.6082 | not sig. |

Doris Lake did not exhibit significant deviation from slope of zero. Comparison to Reference Lake B not performed.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data, solid lines represent the fitted curves, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



### Patch

A before-after analysis was first performed to compare the change in concentrations in the before and after period for the exposure lake. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years relative to Reference Lake B and Patch Lake.

*Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0.0934 | 3.444 | 7.34 | 0.0271 | 0.9791 | not sig. |

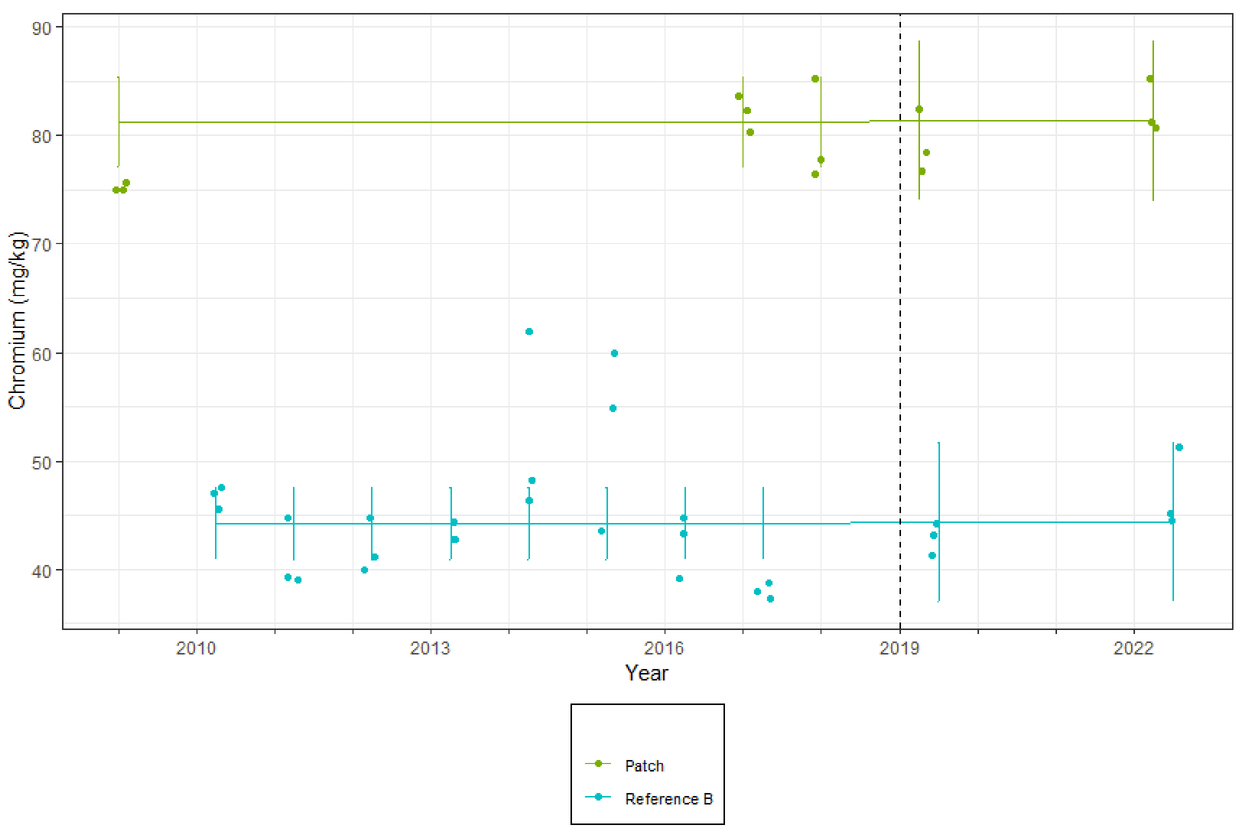
Conclusion:

The change in concentrations from before to after was not significantly different.

BACI analysis not performed.

*Observed Data and Fitted Values*

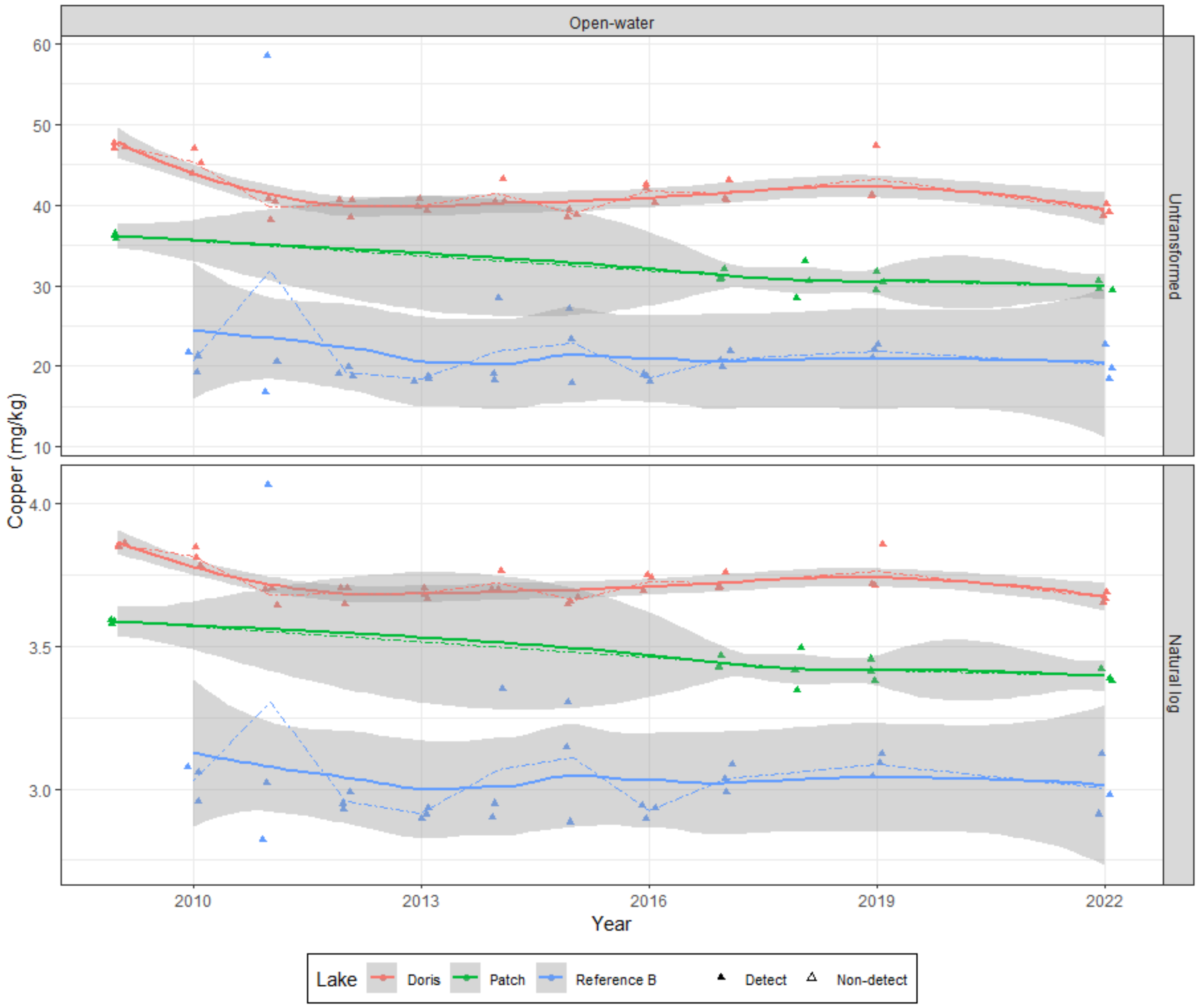
Points represent the observed data values, hollow symbols represent data less than the detection limit and presented at half the detection limit. Solid lines represent the fitted means, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.



### *C.3.2.4 Copper*

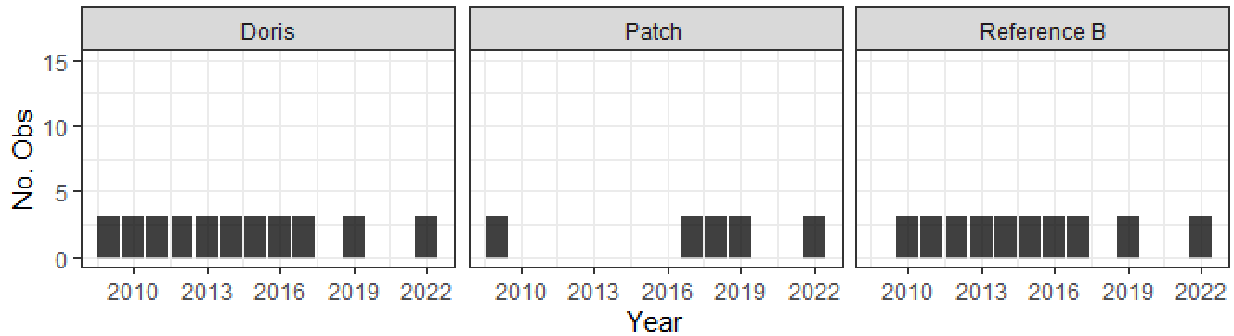
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Symbols represent observations and the dashed lines connect the annual means. Observations are slightly jittered along the x-axis for legibility. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). Observations at or below the 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., 2022) were censored.

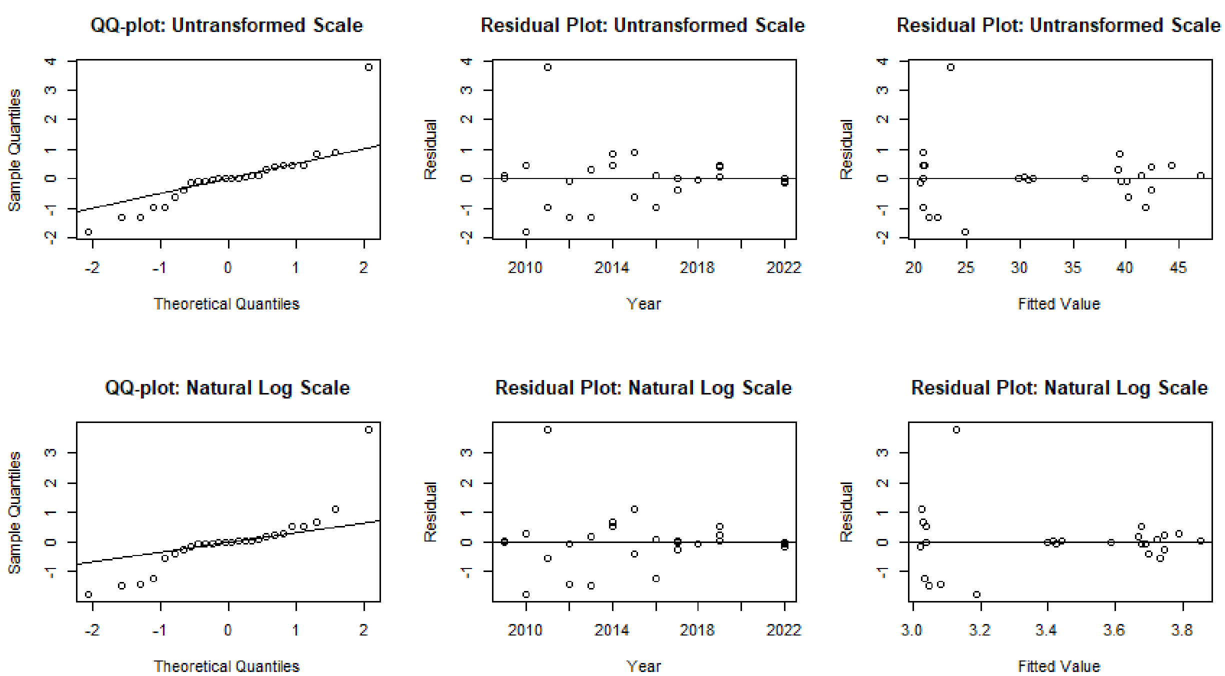
The sample sizes and median values per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 33 | 0 | 0 | 0 |
| Patch | Open-water | 15 | 0 | 0 | 0 |
| Reference B | Open-water | 30 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers on untransformed scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 18 | Reference B | 2011 | Open-water | Deep | 31.93 | 23.43 | 3.782 |

Outliers on natural log scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 18 | Reference B | 2011 | Open-water | Deep | 31.93 | 3.13 | 3.772 |

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

### Doris

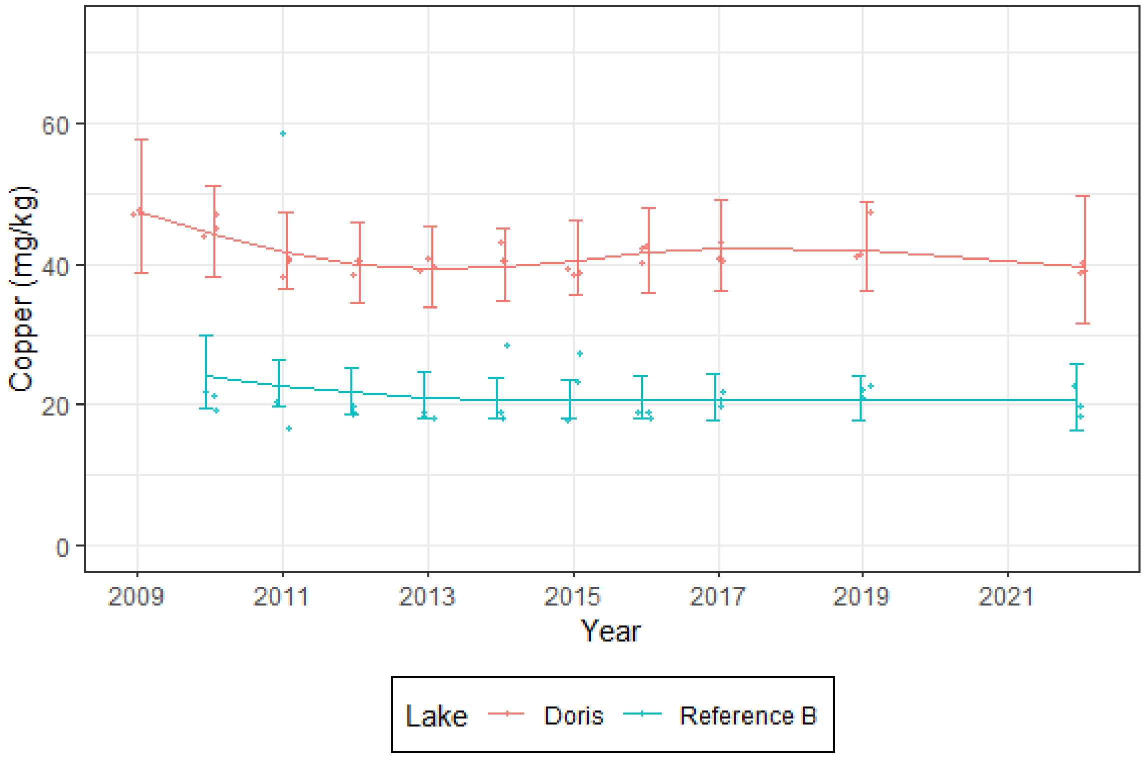
The trend of Doris Lake was compared to a slope of zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

| Analysis | Chi.sq | DF | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 3.178 | 3 | 0.365 | not sig. |

Doris Lake did not exhibit significant deviation from slope of zero. Comparison to Reference Lake B not performed.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data, solid lines represent the fitted curves, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.




### Patch

A before-after analysis was first performed to compare the change in concentrations in the before and after period for the exposure lake. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years relative to Reference Lake B and Patch Lake.

#### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.0315 | 0.0669 | 42 | -0.4713 | 0.6399 | not sig. |

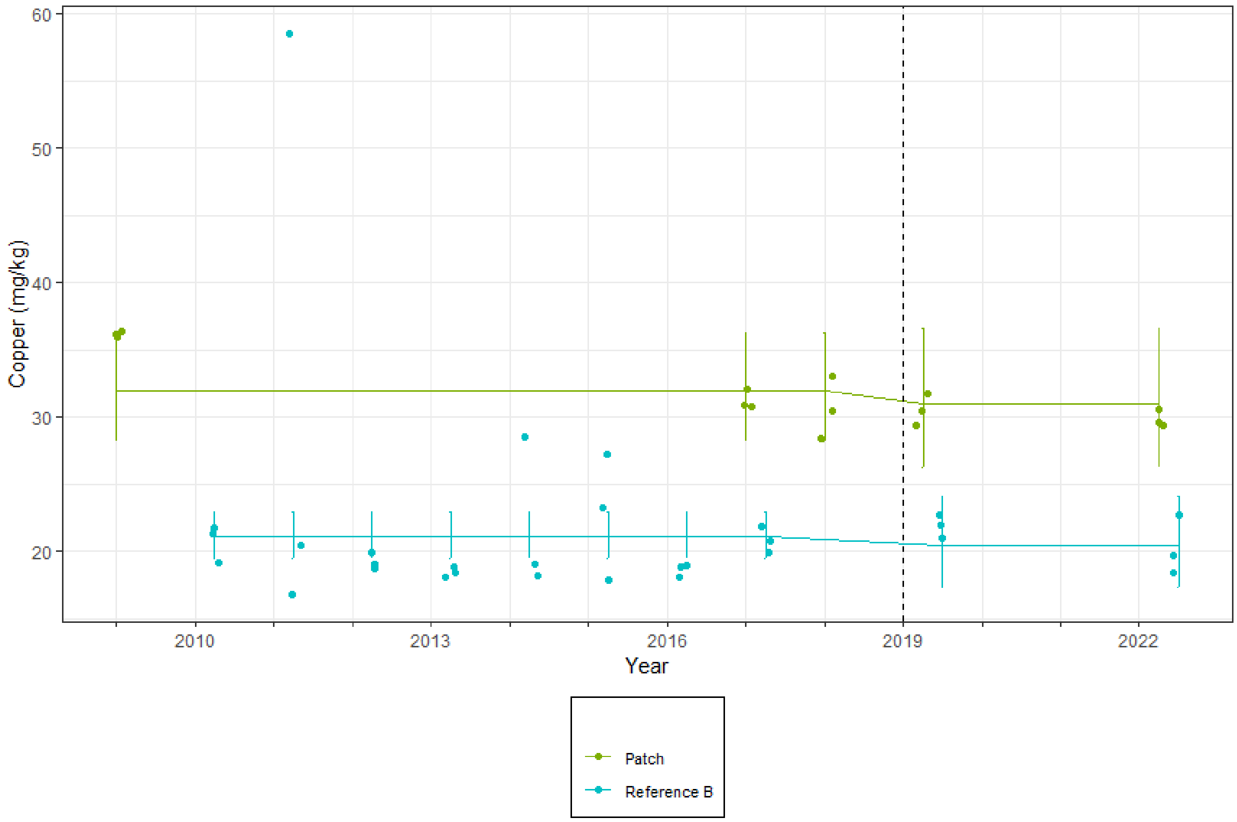
Conclusion:

The change in concentrations from before to after was not significantly different.

BACI analysis not performed.

#### *Observed Data and Fitted Values*

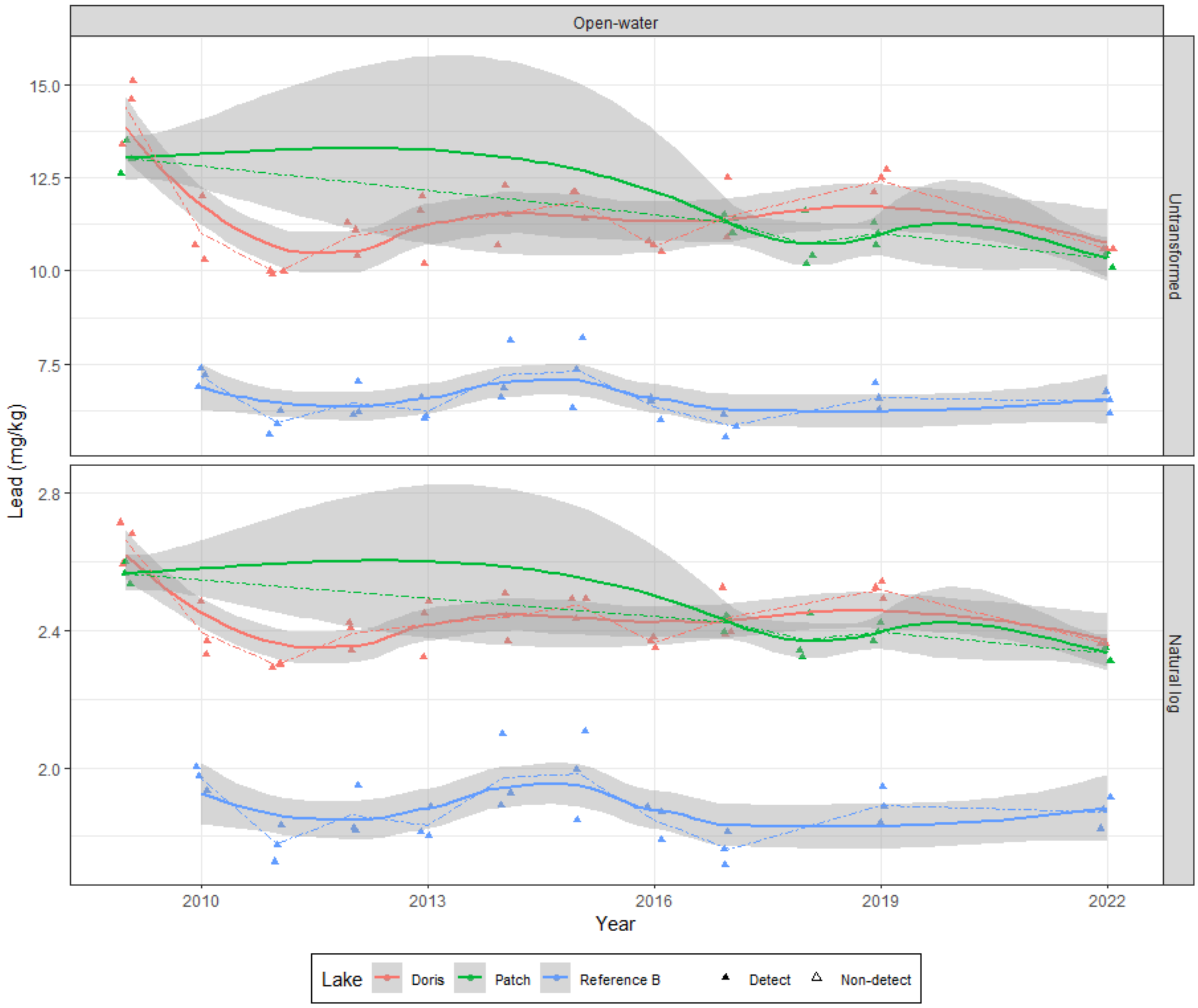
Points represent the observed data values, hollow symbols represent data less than the detection limit and presented at half the detection limit. Solid lines represent the fitted means, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.


Copper (mg/kg)
60
50
40
30
20
2010
2013
2016
2019
2022
Year
Patch
Reference B

## C.3.2.5 Lead

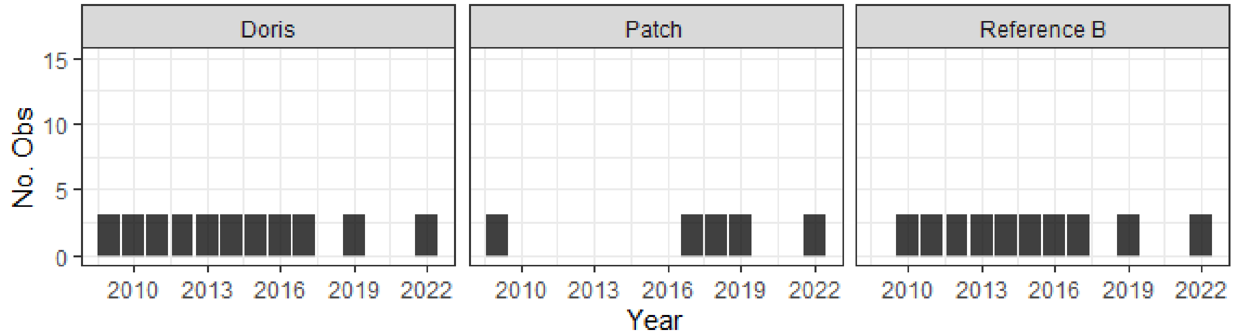
### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Symbols represent observations and the dashed lines connect the annual means. Observations are slightly jittered along the x-axis for legibility. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). Observations at or below the 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., 2022) were censored.

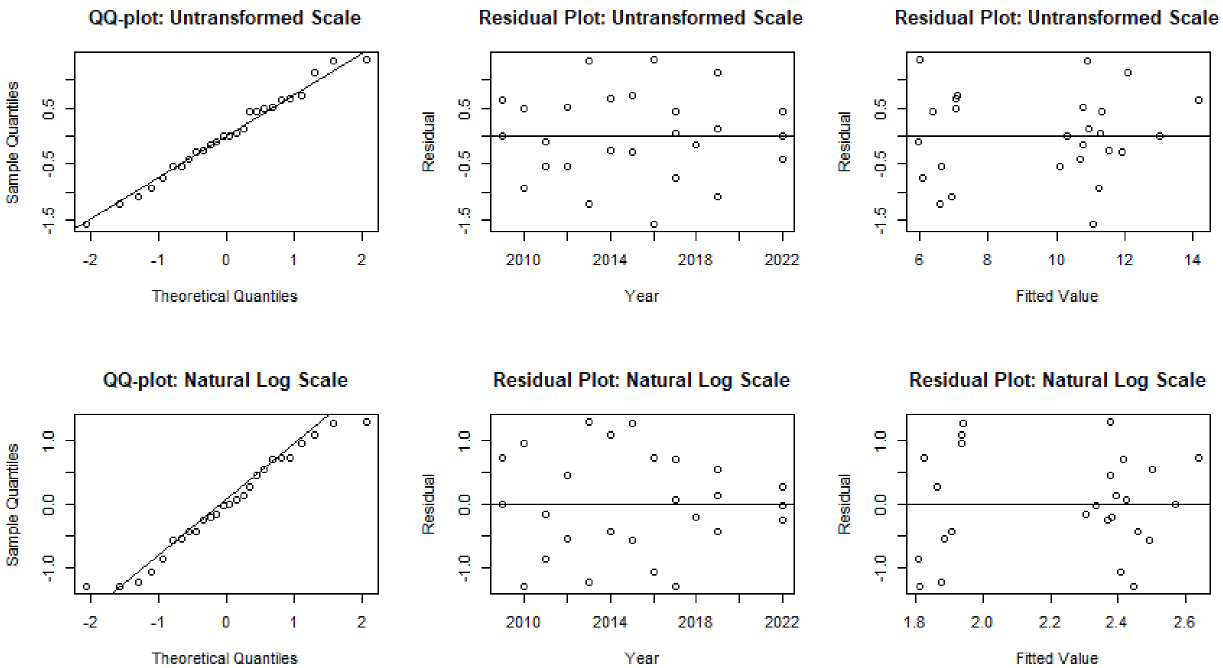
The sample sizes and median values per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 33 | 0 | 0 | 0 |
| Patch | Open-water | 15 | 0 | 0 | 0 |
| Reference B | Open-water | 30 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers on untransformed scale:

None

Outliers on natural log scale:

None

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

### Doris

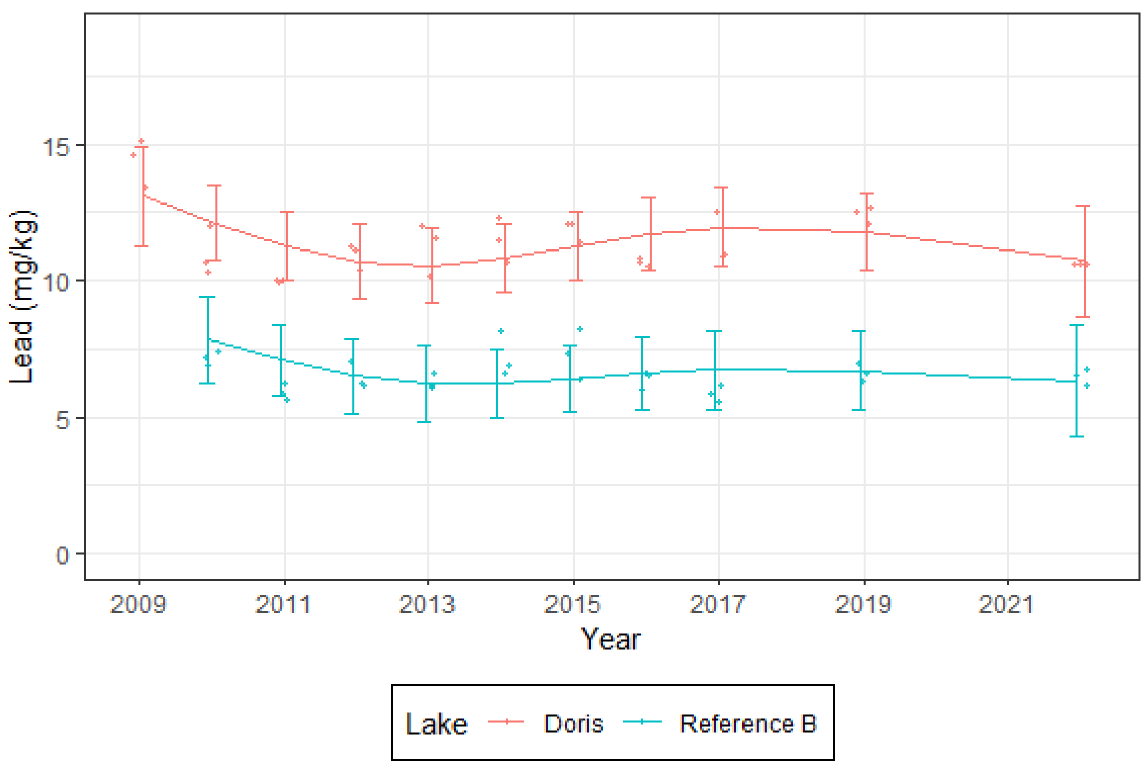
The trend of Doris Lake was compared to a slope of zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

| Analysis | Chi.sq | DF | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 9.873 | 3 | 0.0197 | sig. |
| Compare to Reference B | 6.487 | 3 | 0.0902 | not sig. |

Doris Lake appears to show significant deviation from slope of zero. However, Doris Lake did not exhibit significant deviation from the trend of Reference Lake B.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data, solid lines represent the fitted curves, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



## Patch

A before-after analysis was first performed to compare the change in concentrations in the before and after period for the exposure lake. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years relative to Reference Lake B and Patch Lake.

### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.4437 | 0.5492 | 8.629 | -0.8079 | 0.4409 | not sig. |

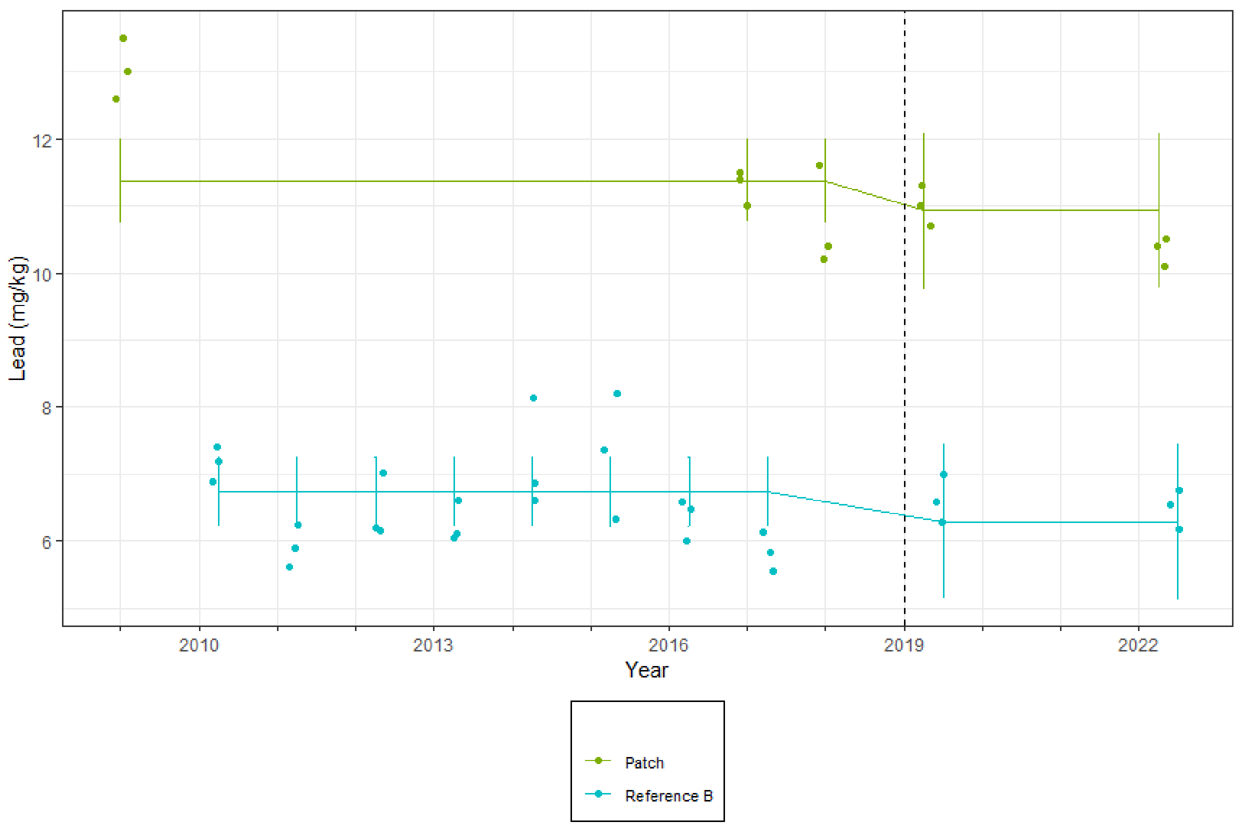
Conclusion:

The change in concentrations from before to after was not significantly different.

BACI analysis not performed.

### *Observed Data and Fitted Values*

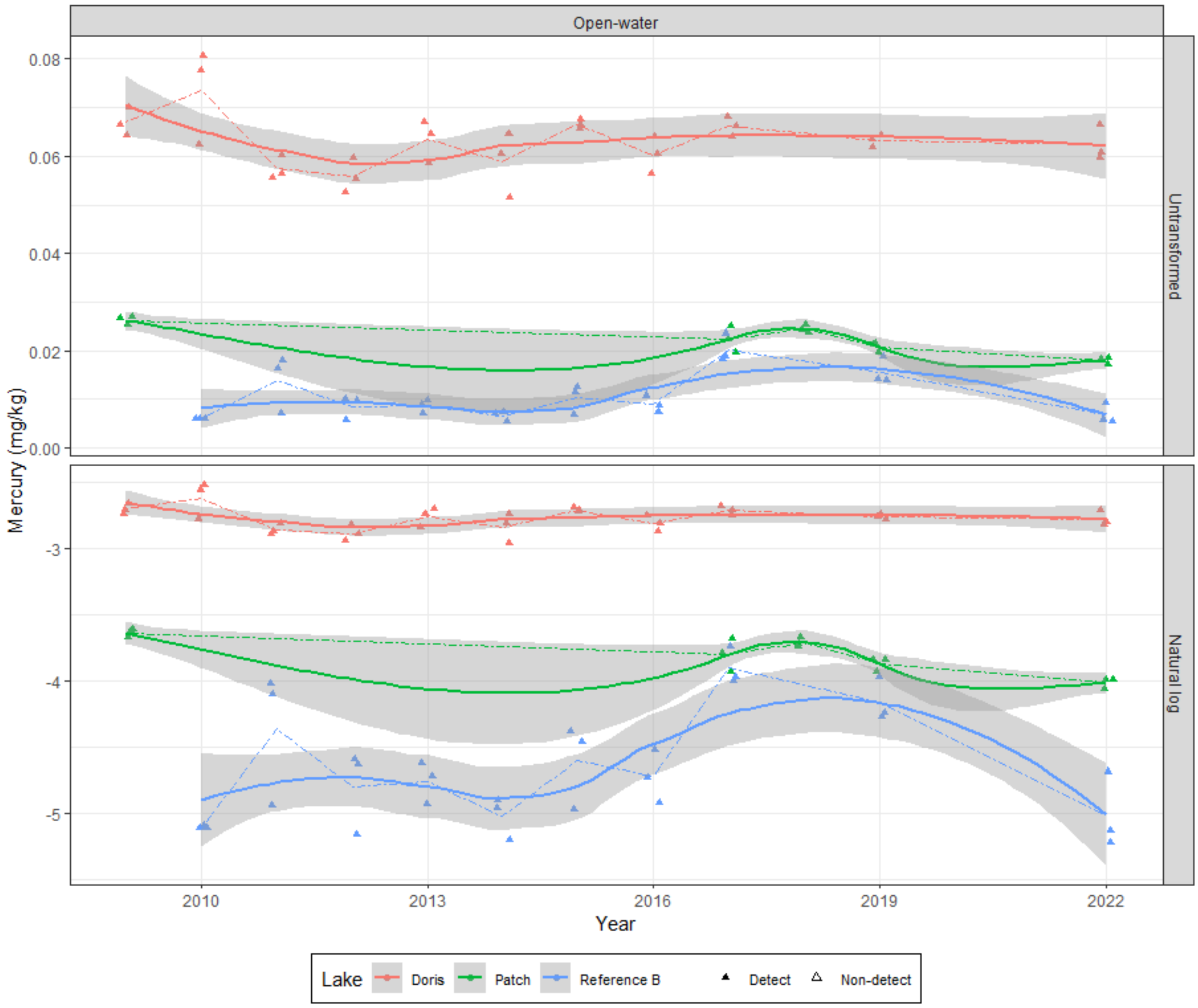
Points represent the observed data values, hollow symbols represent data less than the detection limit and presented at half the detection limit. Solid lines represent the fitted means, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.



### *C.3.2.6 Mercury*

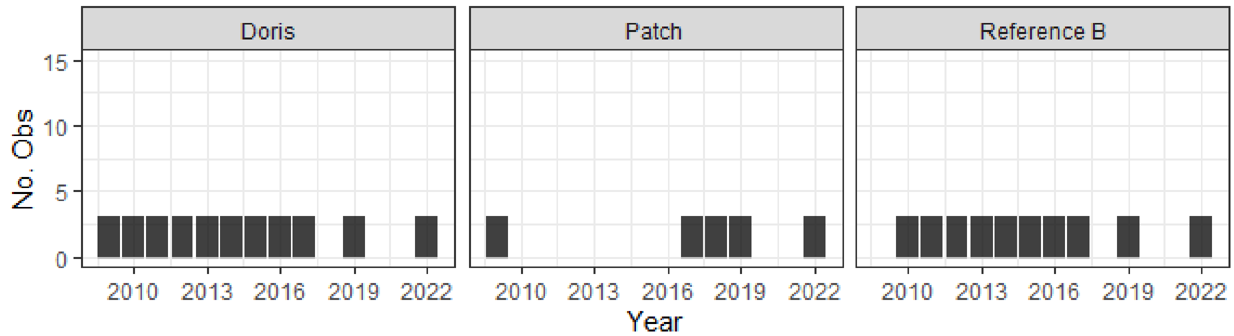
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Symbols represent observations and the dashed lines connect the annual means. Observations are slightly jittered along the x-axis for legibility. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). Observations at or below the 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., 2022) were censored.

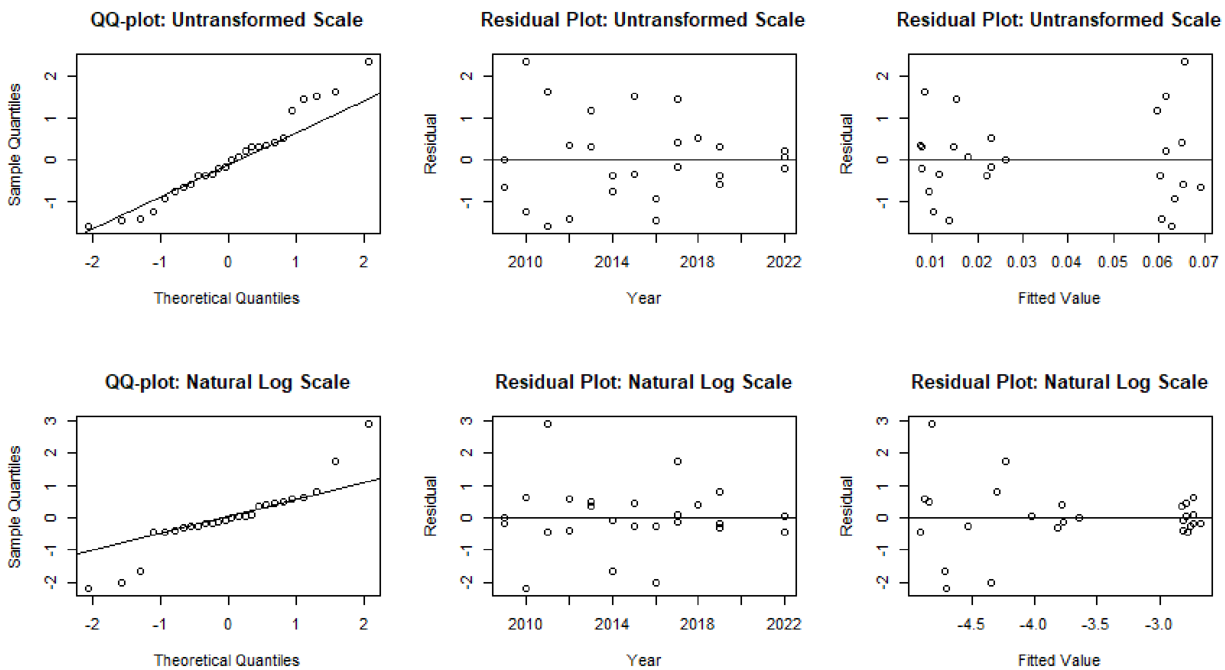
The sample sizes and median values per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 33 | 0 | 0 | 0 |
| Patch | Open-water | 15 | 0 | 0 | 0 |
| Reference B | Open-water | 30 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers on untransformed scale:

None

Outliers on natural log scale:

None

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

### Doris

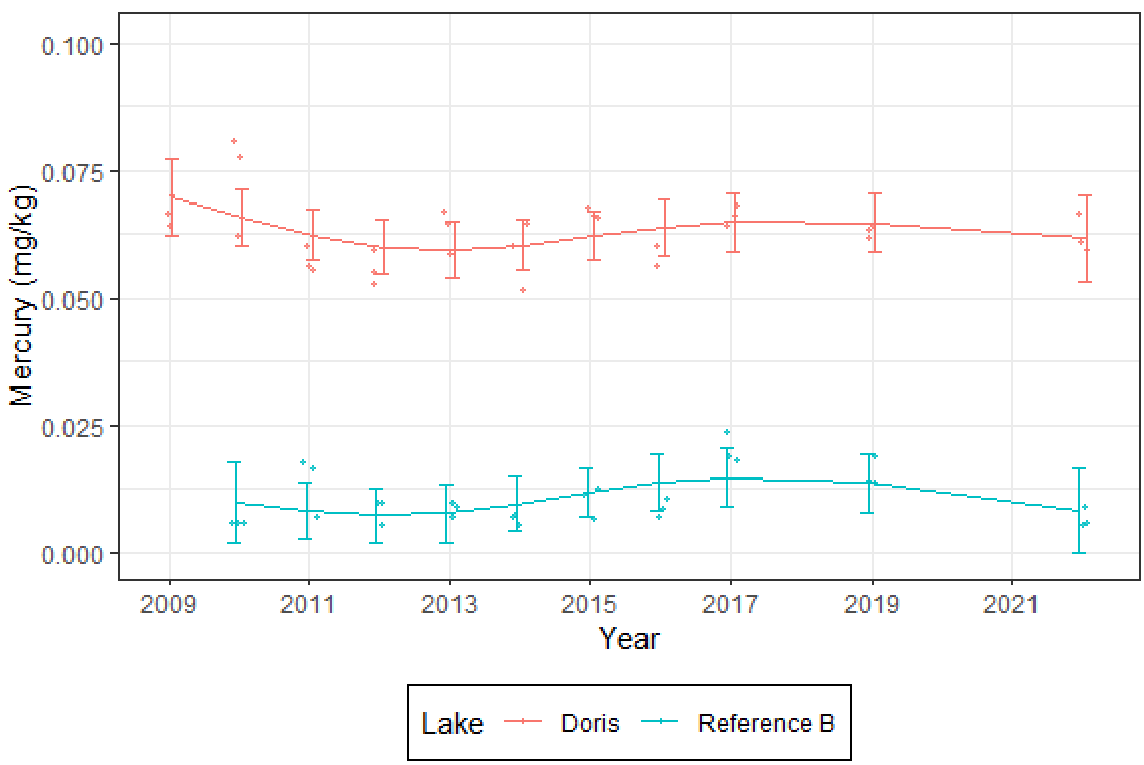
The trend of Doris Lake was compared to a slope of zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

| Analysis | Chi.sq | DF | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 6.698 | 3 | 0.0822 | not sig. |

Doris Lake did not exhibit significant deviation from slope of zero. Comparison to Reference Lake B not performed.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data, solid lines represent the fitted curves, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



## Patch

A before-after analysis was first performed to compare the change in concentrations in the before and after period for the exposure lake. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years relative to Reference Lake B and Patch Lake.

### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 0 | 0.0037 | 8.098 | -0.0055 | 0.9957 | not sig. |

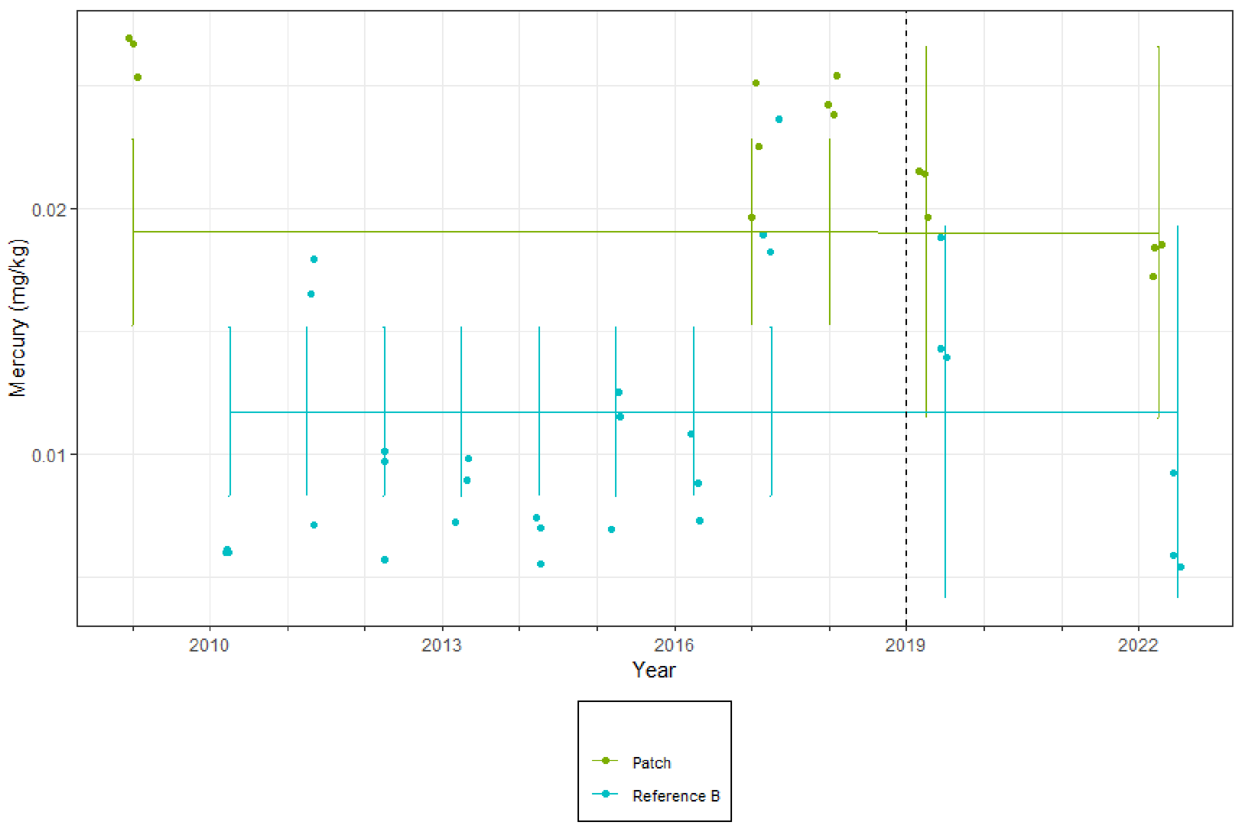
Conclusion:

The change in concentrations from before to after was not significantly different.

BACI analysis not performed.

### *Observed Data and Fitted Values*

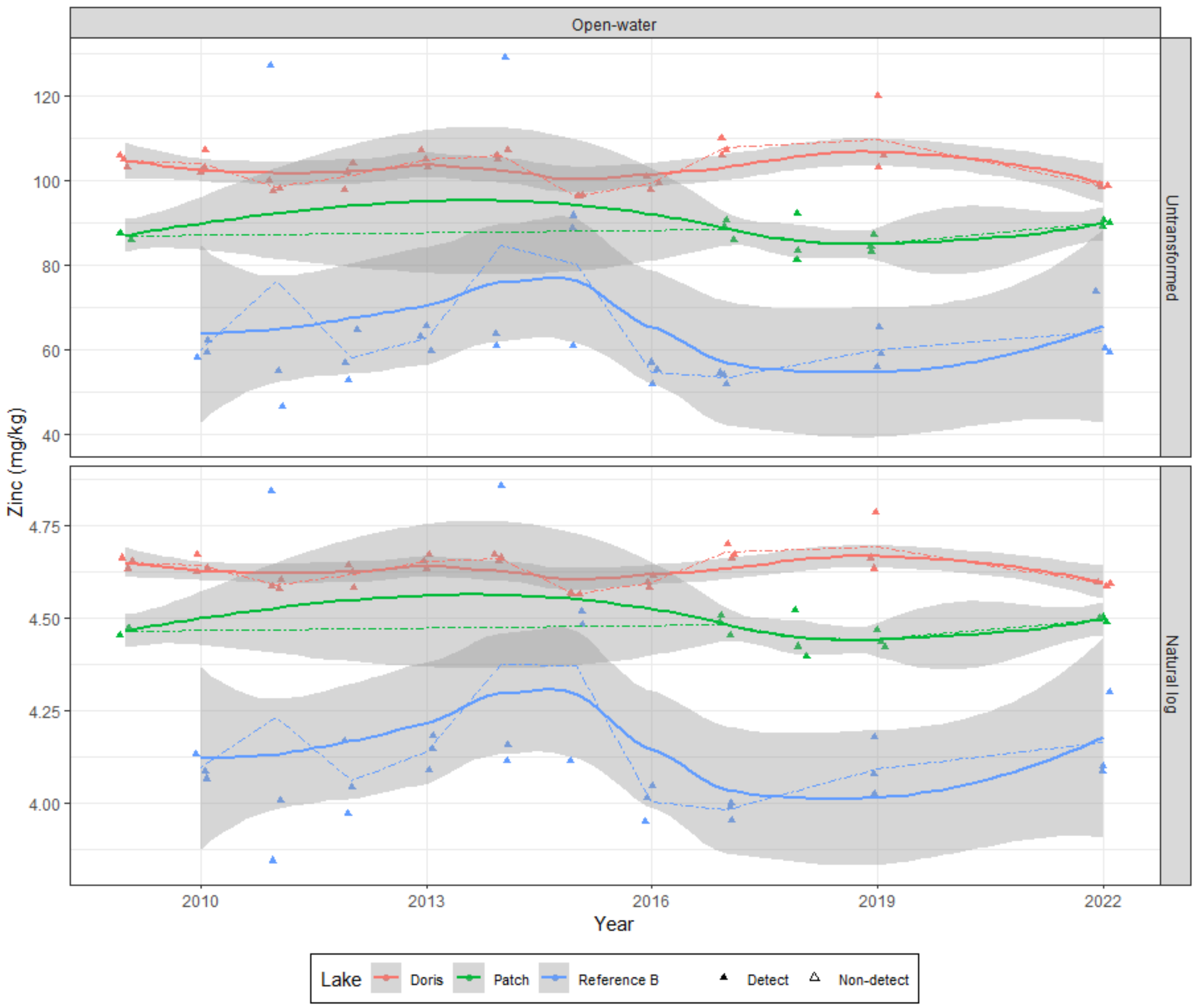
Points represent the observed data values, hollow symbols represent data less than the detection limit and presented at half the detection limit. Solid lines represent the fitted means, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.



### *C.3.2.7 Zinc*

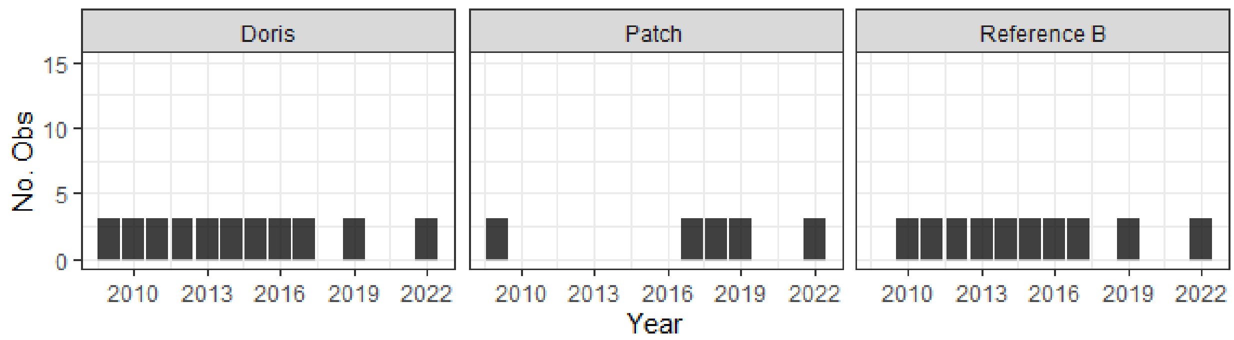
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Symbols represent observations and the dashed lines connect the annual means. Observations are slightly jittered along the x-axis for legibility. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake that were less than the detection limit (light gray) or greater than the detection limit (dark gray). Observations at or below the 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., 2022) were censored.

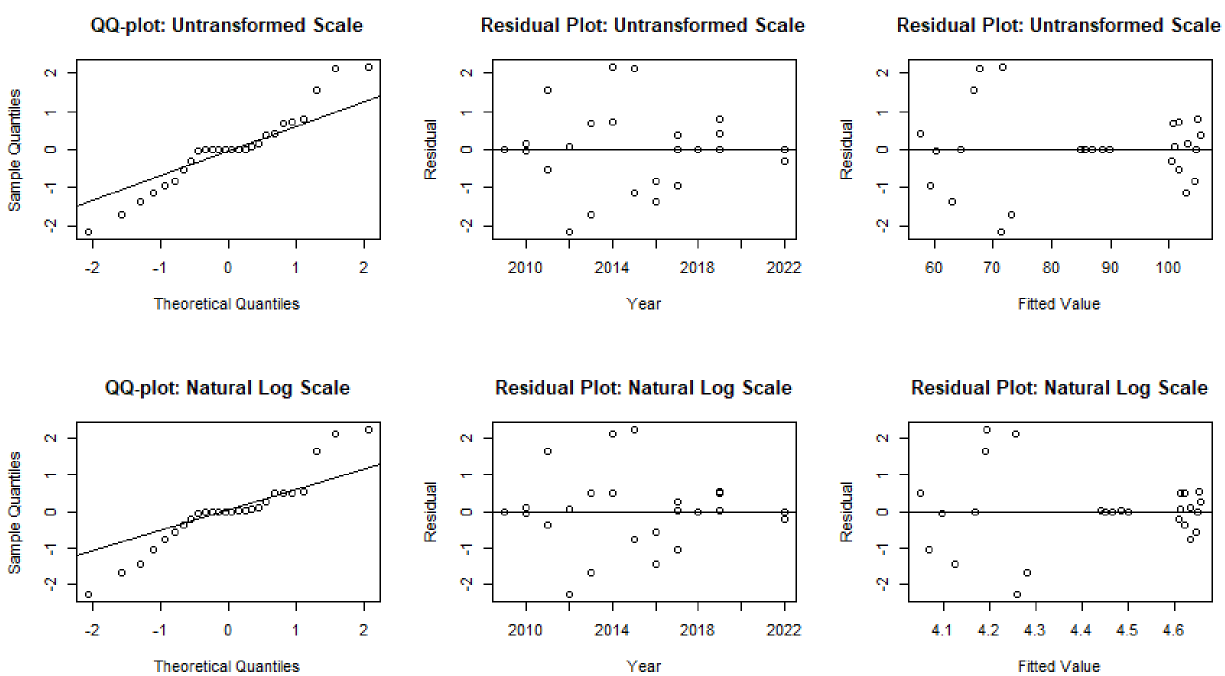
The sample sizes and median values per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 33 | 0 | 0 | 0 |
| Patch | Open-water | 15 | 0 | 0 | 0 |
| Reference B | Open-water | 30 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers on untransformed scale:

None

Outliers on natural log scale:

None

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

### Doris

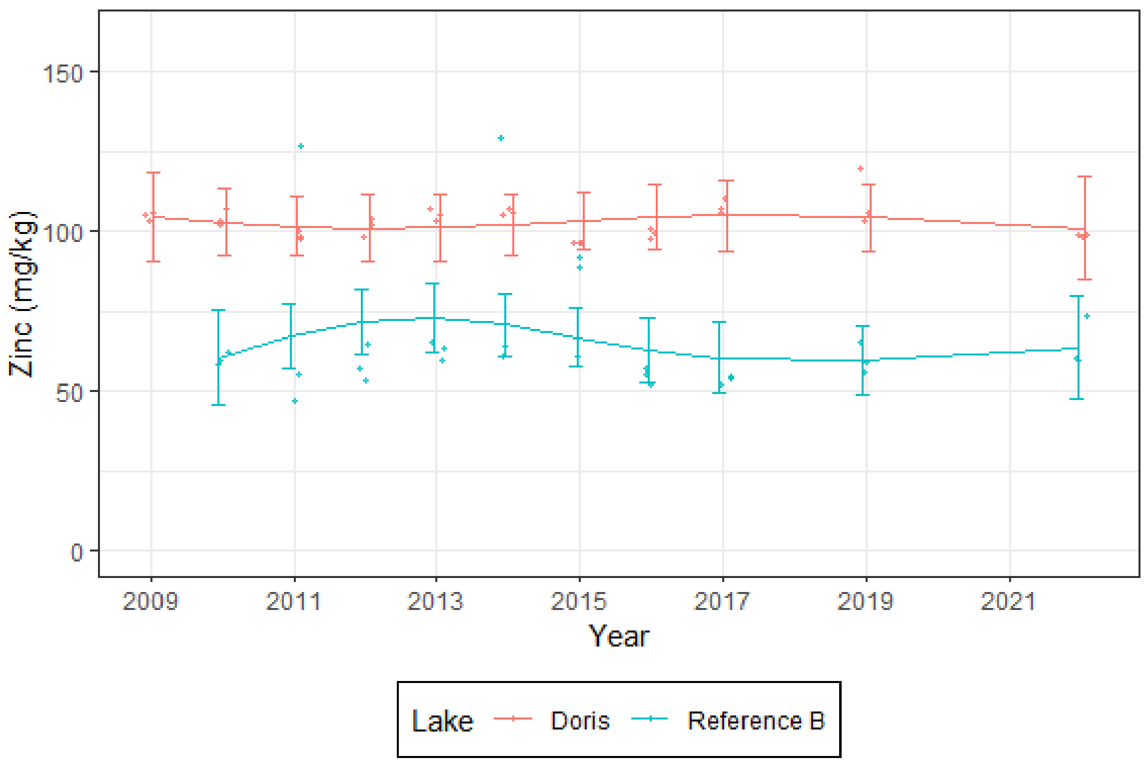
The trend of Doris Lake was compared to a slope of zero. If there is a significant trend, then the trend of Doris Lake is compared to the trend in Reference Lake B. This contrast does not test for differences in intercepts between lakes.

| Analysis | Chi.sq | DF | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 0.482 | 3 | 0.9228 | not sig. |

Doris Lake did not exhibit significant deviation from slope of zero. Comparison to Reference Lake B not performed.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data, solid lines represent the fitted curves, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations.



### Patch

A before-after analysis was first performed to compare the change in concentrations in the before and after period for the exposure lake. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in concentrations before and after baseline years relative to Reference Lake B and Patch Lake.

#### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -2.377 | 6.19 | 3.906 | -0.384 | 0.7209 | not sig. |

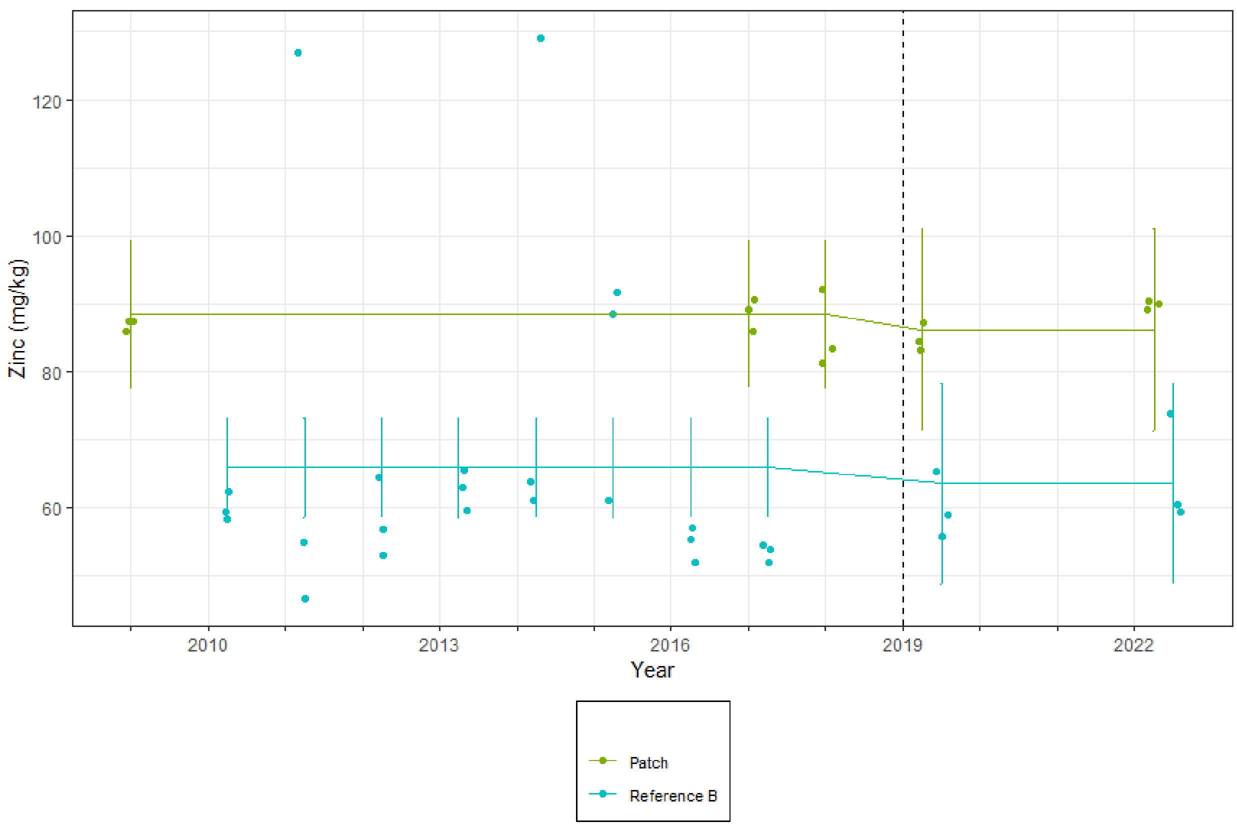
Conclusion:

The change in concentrations from before to after was not significantly different.

BACI analysis not performed.

#### *Observed Data and Fitted Values*

Points represent the observed data values, hollow symbols represent data less than the detection limit and presented at half the detection limit. Solid lines represent the fitted means, and error bars indicate the upper and lower 95% confidence intervals of the modelled concentrations in the before and after periods for the monitored site.

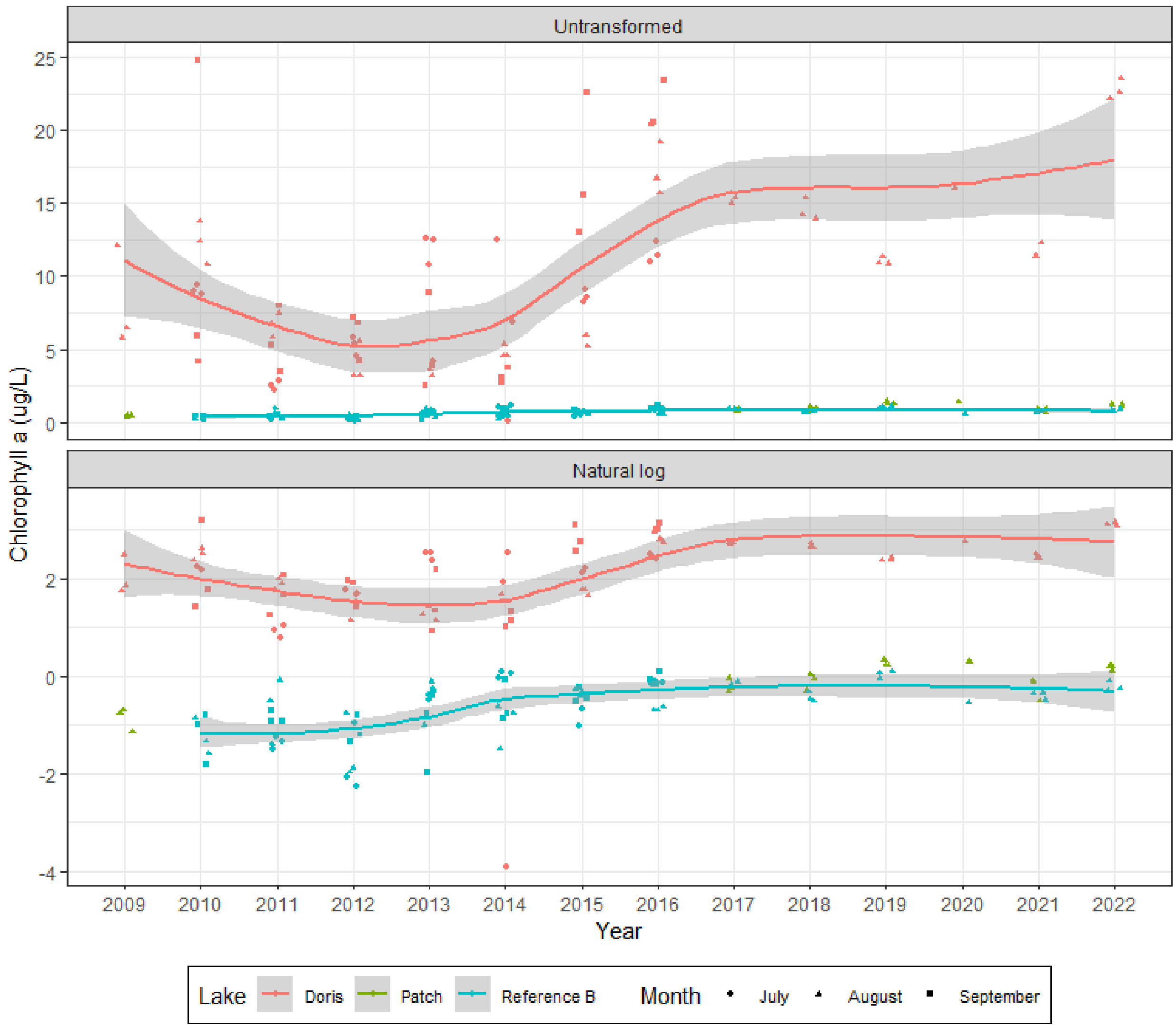


## C.3.3 Phytoplankton

### C.3.3.1 Phytoplankton Biomass

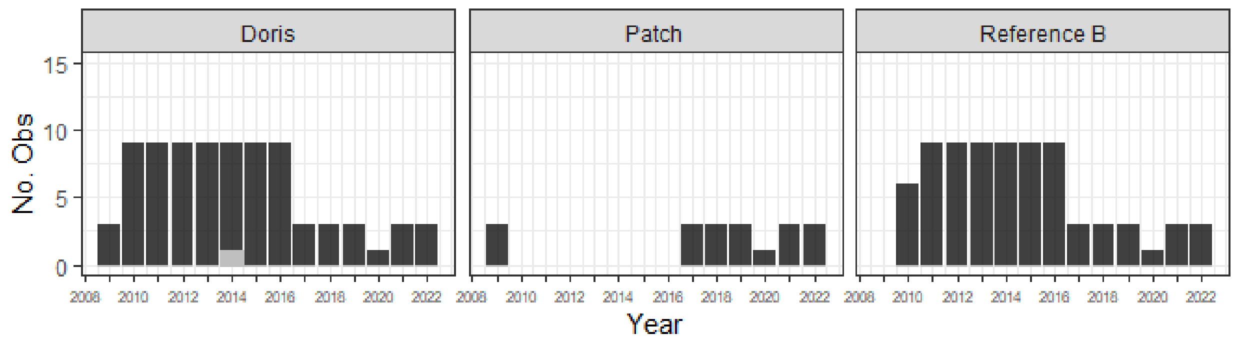
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. The dashed lines drawn through the scatter plots connect 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 (gray shading) are shown to provide a clearer representation of 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 (gray) or greater than the detection limit (dark gray). Observations at or 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., 2022) were censored.

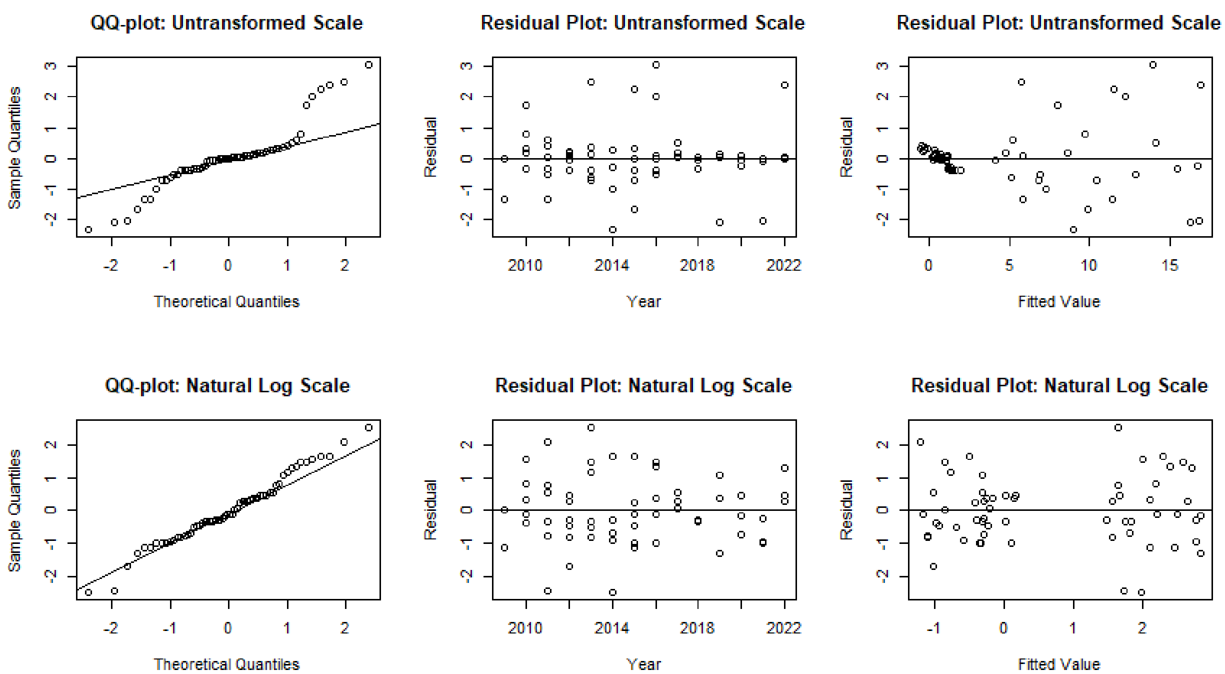
The sample sizes and median values per lake are summarized in the table below.

| Lake | Season | # Obs (total) | # < DL (total) | % < DL (total) | % < DL (2022) |
|---|---|---|---|---|---|
| Doris | Open-water | 82 | 1 | 1 | 0 |
| Patch | Open-water | 19 | 0 | 0 | 0 |
| Reference B | Open-water | 76 | 0 | 0 | 0 |

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

### Initial Model Fit

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



Outliers 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 |
|---|---|---|---|---|---|---|---|
| 22 | Doris | 2016 | Open-water | Deep | 21.46667 | 13.913 | 3.056 |

Outliers on natural log scale:

None

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

### Doris

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

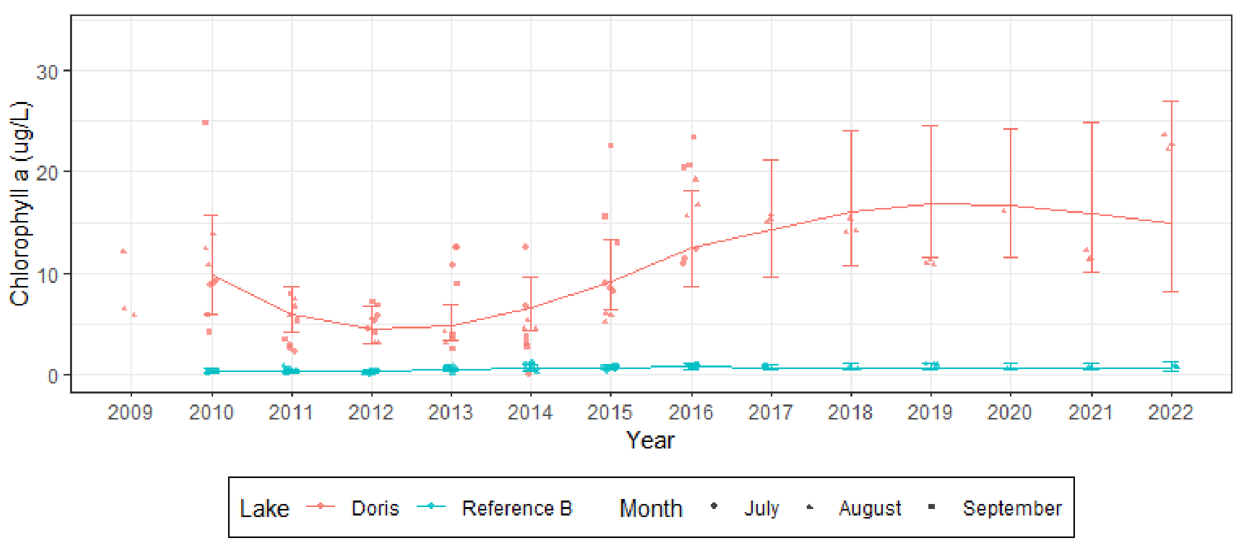
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 45.866 | 4 | <0.00001 | sig. |
| Compare to Reference B | 12.140 | 4 | 0.01630 | sig. |

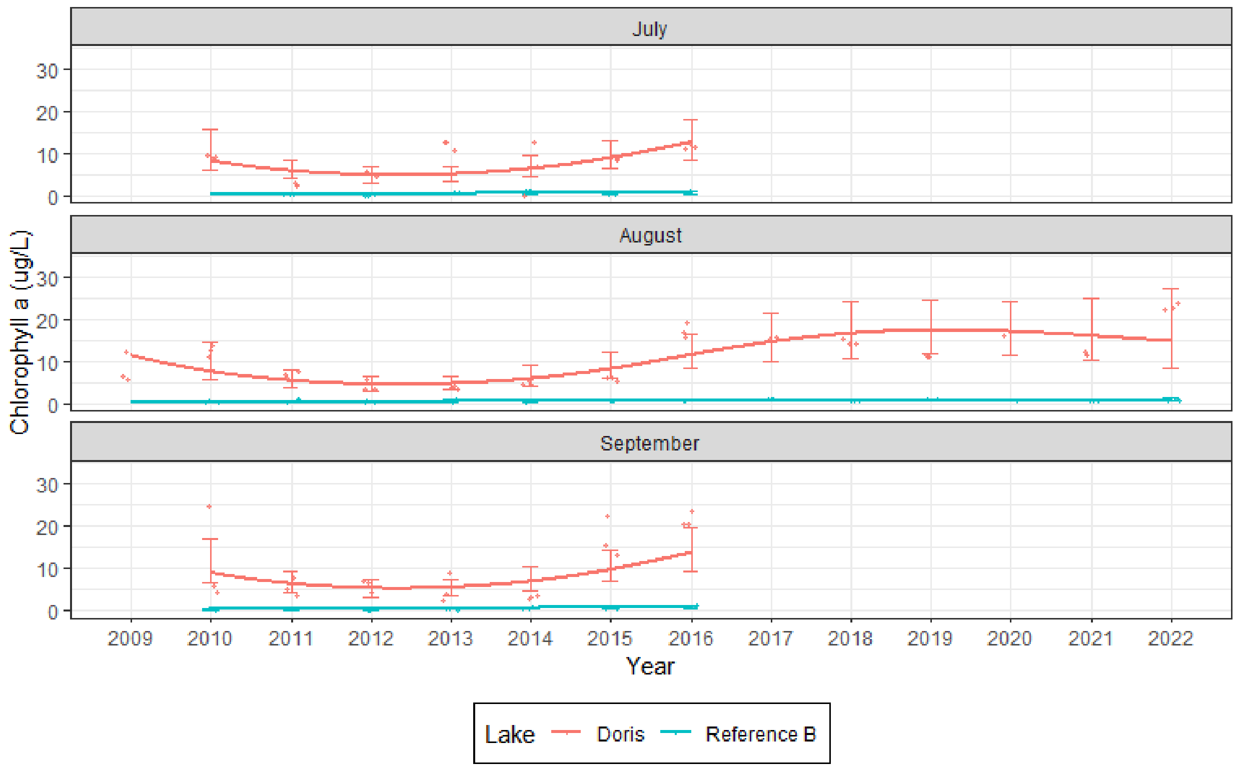
Conclusions:

Doris Lake appears to show significant deviation from a slope of zero. Doris Lake appears to show sigificant deviation from the trend of Reference Lake B.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. Symbols represent the observed data values. Observations under detection limit are shown by hollow symbols and plotted at half the detection limit. Solid lines represent the fitted curves and the error bars indicate the upper and lower 95% confidence intervals. The sampling month was accounted for in the model but not evaluated since its effect is not of primary interest, the data is presented further by month to confirm any variation in trends in the historical data.






### Patch

Before-after analyses were first performed to compare the change in values in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modeling was applied to compare the change in values before and after baseline years between Reference B and Patch lakes.

| Coefficient | Estimate | Std. Error | t value | p | Significance |
|---|---|---|---|---|---|
| periodafter | 0.0889 | 0.3636 | 0.2444 | 0.8166 | not sig. |

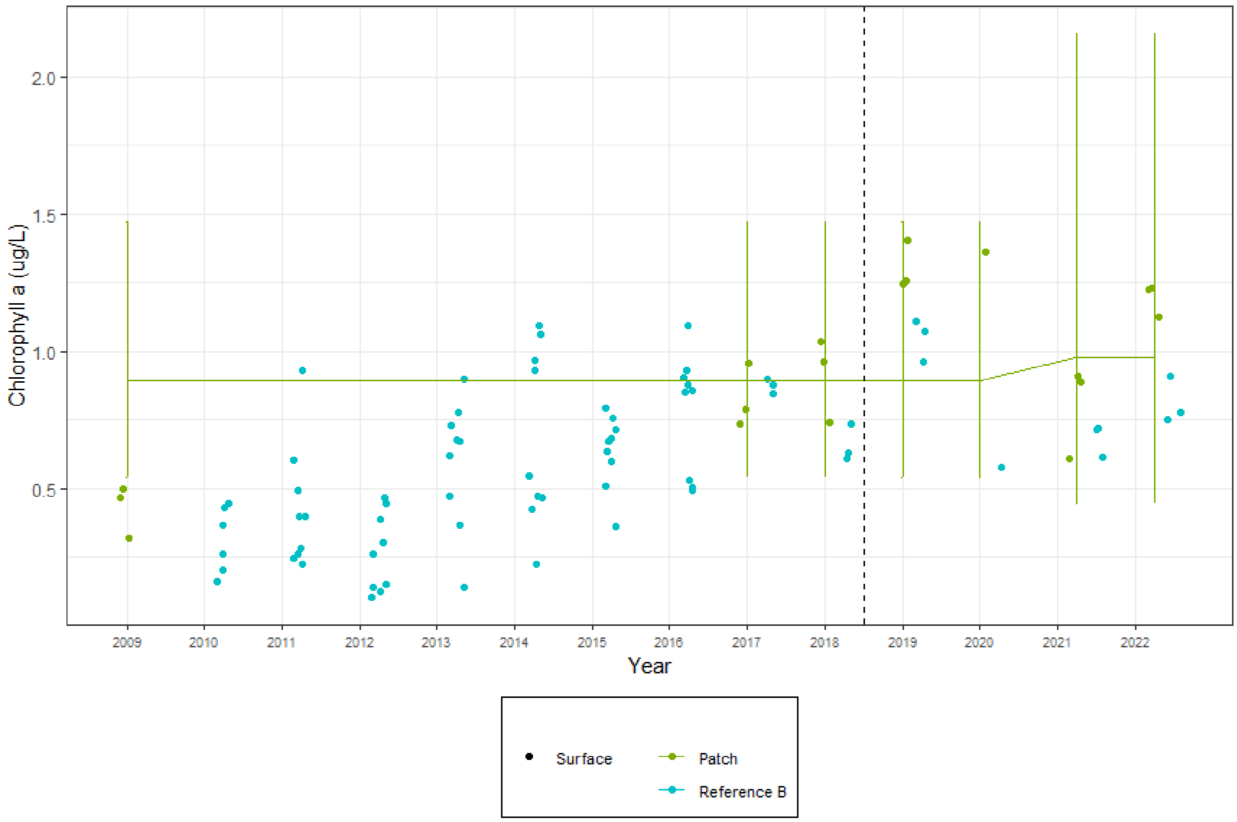
Conclusion:

The change at Patch Lake from before to after was not significantly 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 and error bars indicate the upper and lower 95% confidence intervals.

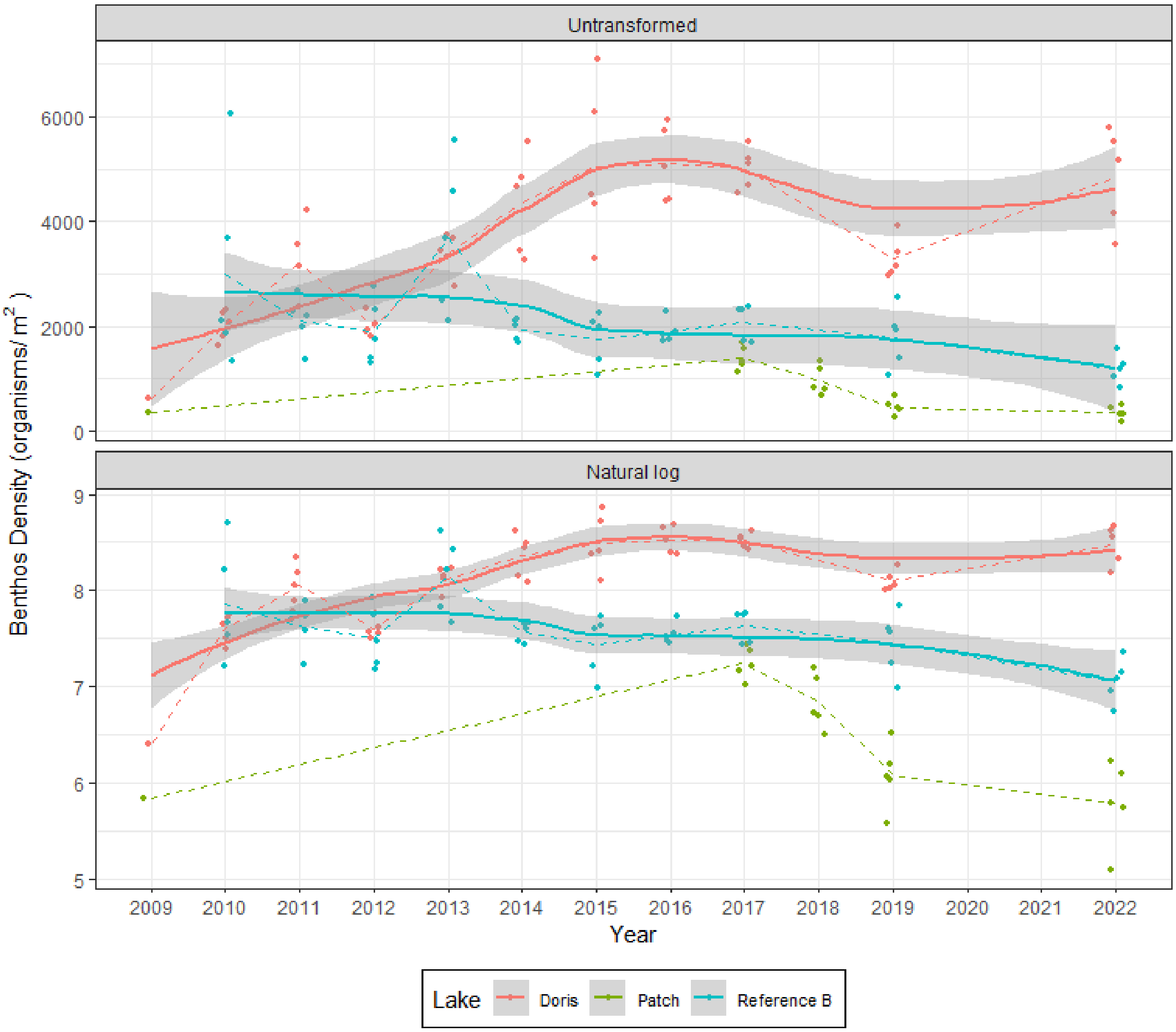



## C.3.4 Benthic Invertebrates

### C.3.4.1 Density

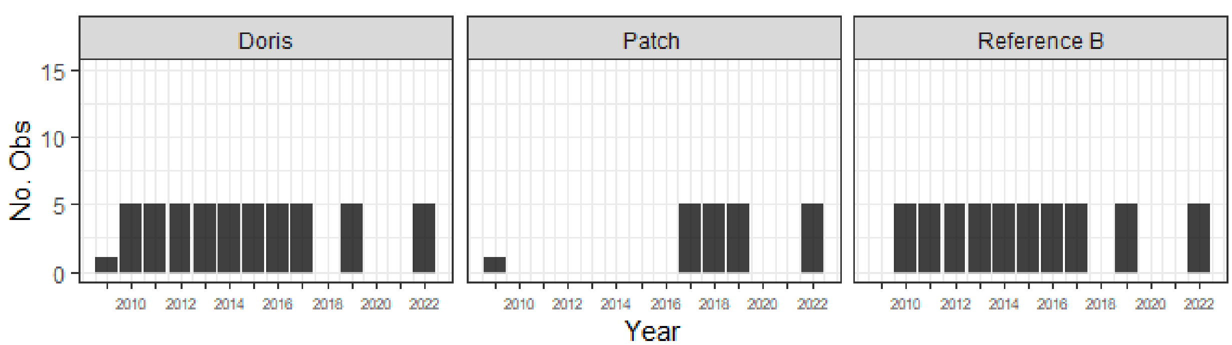
#### Observed Data

The following plots show all the observed data on the untransformed and natural log scale. Observations are slightly jittered along the x-axis for legibility. The dashed lines drawn through the scatter plots connect the annual means. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake. Due to the nature of benthos density data, there are no censored data.



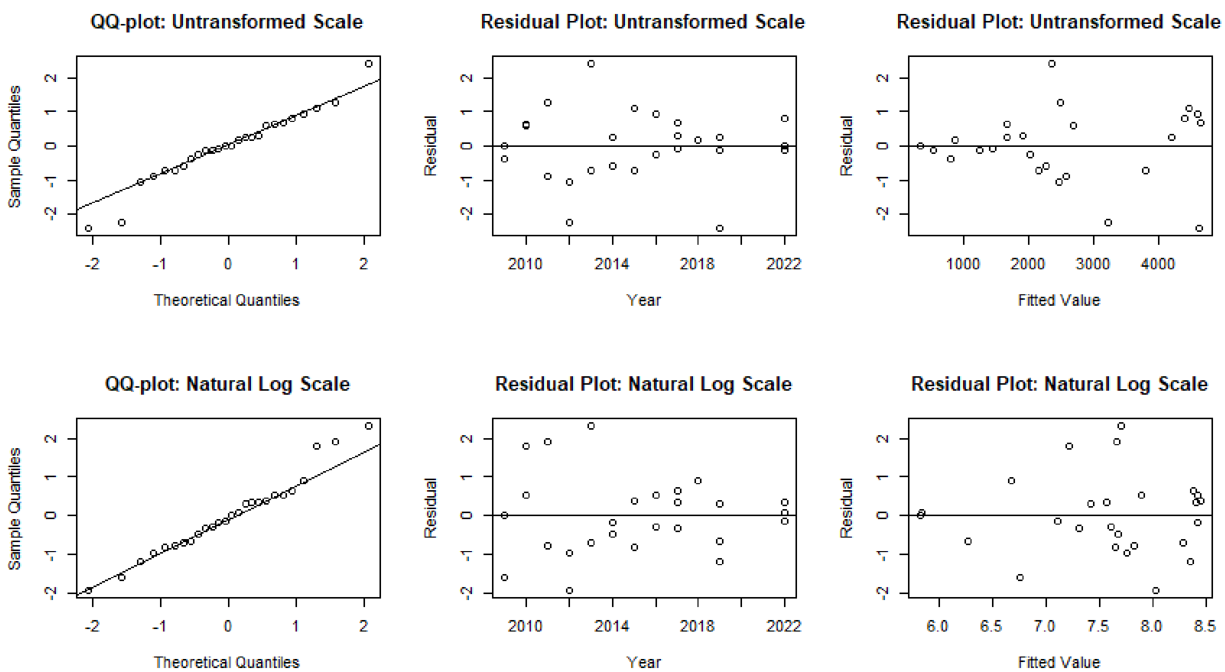
The sample sizes per lake are summarized in the table below.

| Lake | Season | # Obs (total) |
|---|---|---|
| Doris | Open-water | 51 |
| Patch | Open-water | 21 |
| Reference B | Open-water | 50 |

The analysis proceeds with linear mixed model regression.

### Initial Model Fit

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




Outliers on untransformed scale:

None

Outliers on natural log scale:

None

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

### Doris

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

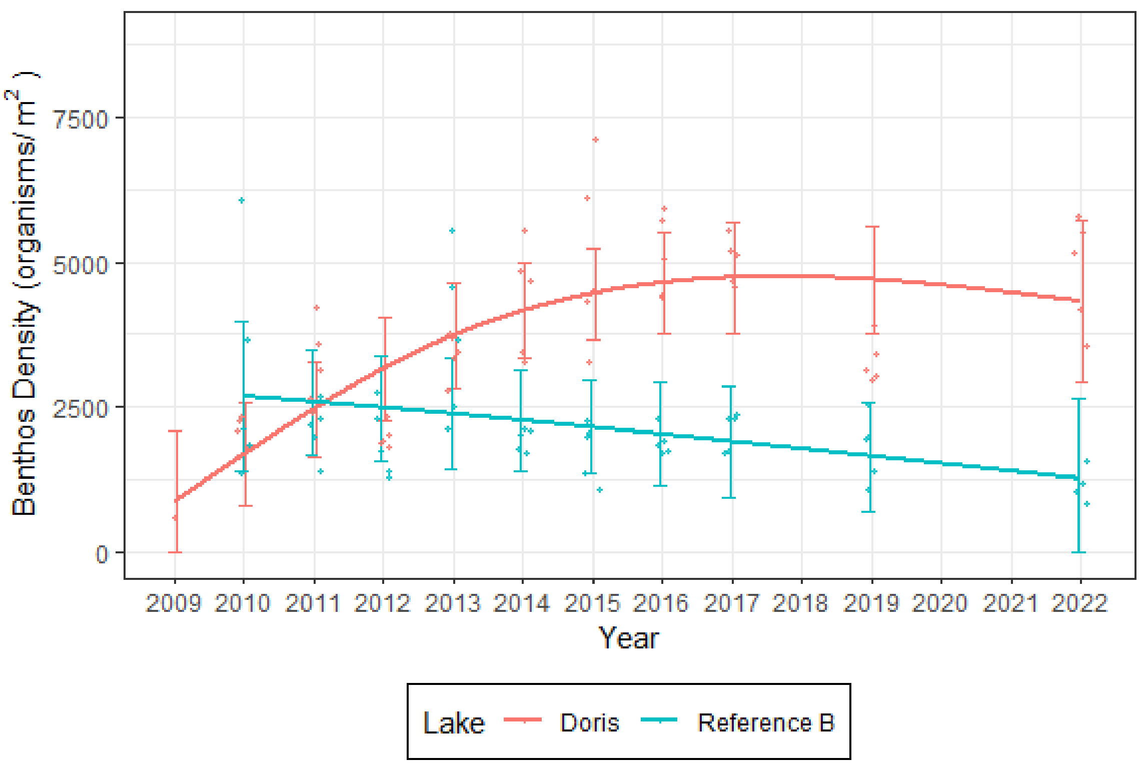
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 47.760 | 3 | <0.05 | sig. |
| Compare to Reference B | 28.334 | 3 | <0.05 | sig. |

Conclusions:

Doris Lake appears to show sigificant deviation from a slope of zero. Doris Lake appears to show sigificant deviation from the trend of Reference B Lake.

*Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data. Solid lines represent the fitted curves and the error bars indicate the upper and lower 95% confidence intervals of the modelled densities.




### Patch

Before-after analyses were first performed to compare the change in densities in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in densities before and after baseline years between Reference B Lake and Patch Lake.

### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -536.5 | 373.4 | 2.526 | -1.437 | 0.2622 | not sig. |

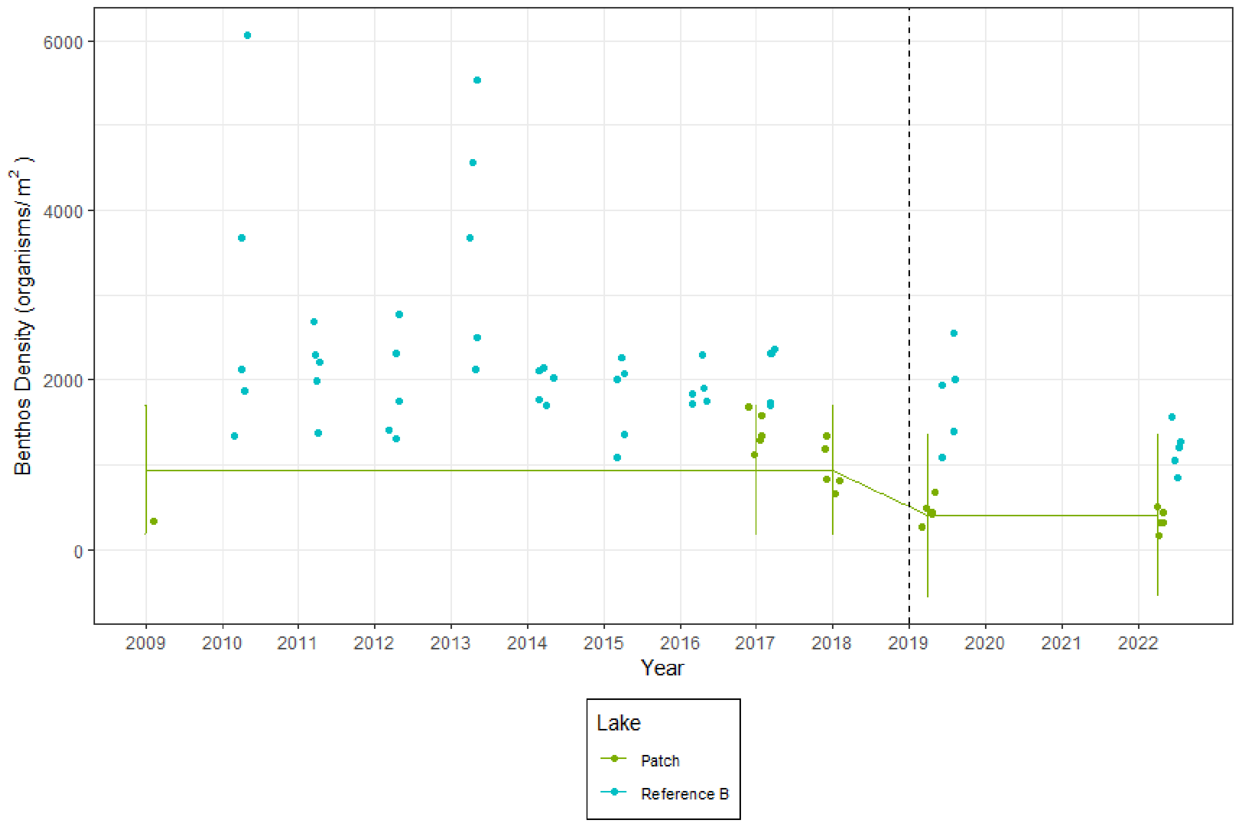
Conclusion:

The change at the Patch Lake from *before* to *after* was not significantly different.

BACI analysis not performed.

### *Observed Data and Fitted Values*

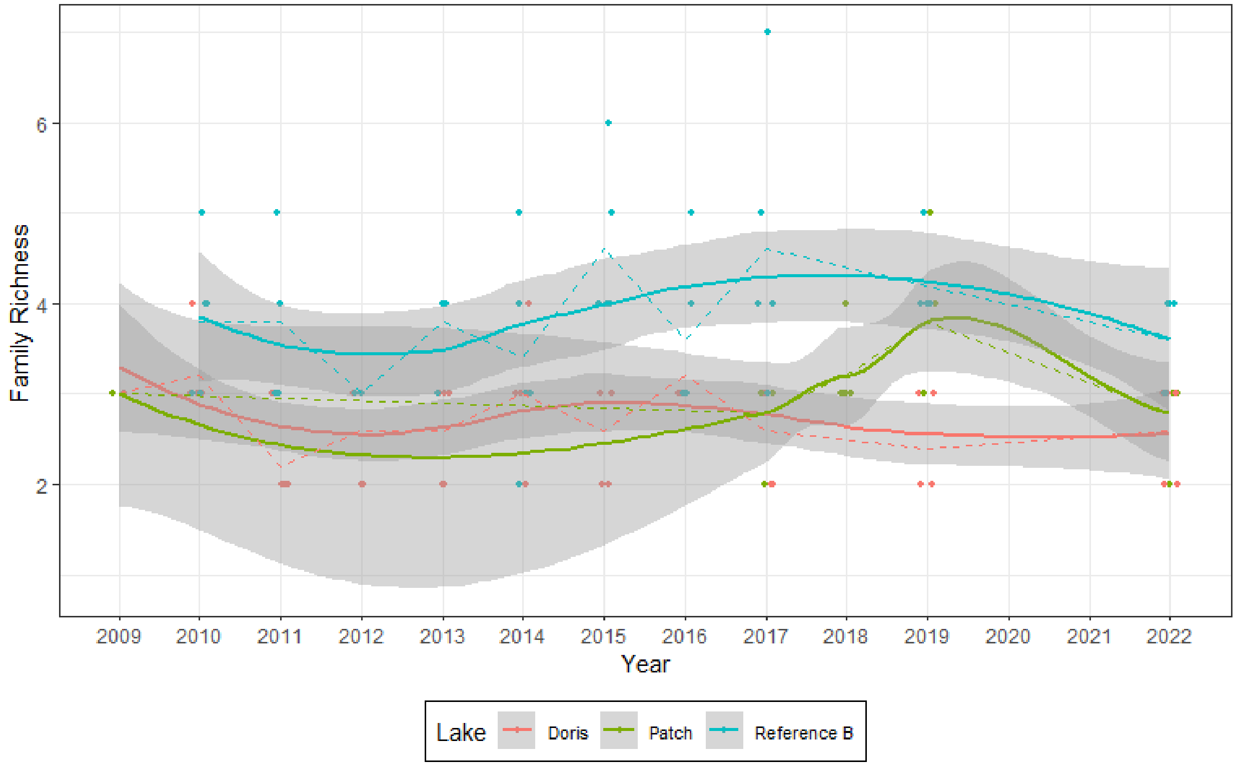
Below are plots of the observed and fitted data. The symbols represent the observed data values. Solid lines represent the fitted means and error bars indicate the upper and lower 95% confidence intervals.



### *C.3.4.2 Family Richness*

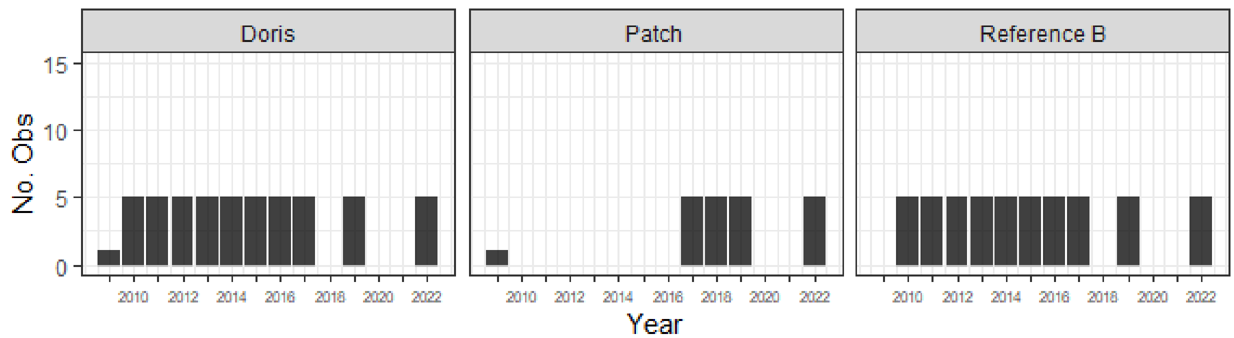
#### Observed Data

The following plots show all the observed data. Observations are slightly jittered along the x-axis for legibility. The dashed lines drawn through the scatter plots connect the annual means. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake. Due to the nature of benthos family richness data, there are no censored data.



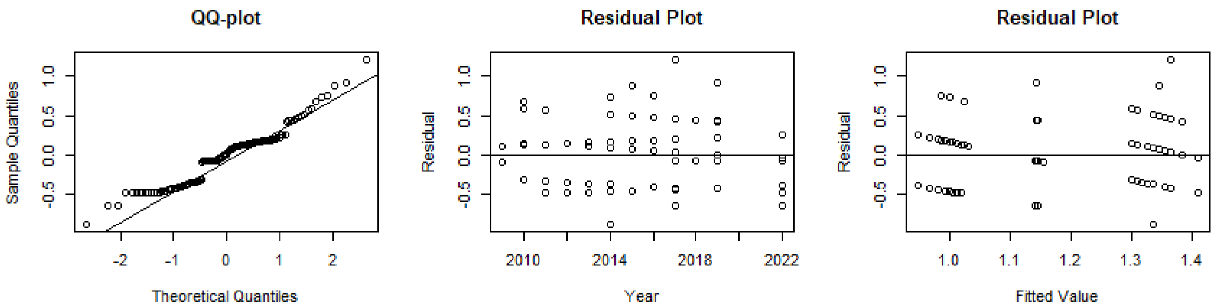
The sample sizes per lake and season are summarized in the table below.

| Lake | Season | # Obs (total) |
|---|---|---|
| Doris | Open-water | 51 |
| Patch | Open-water | 21 |
| Reference B | Open-water | 50 |

The analysis proceeds with linear mixed model regression.

### Initial Model Fit

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:

None

### Doris

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

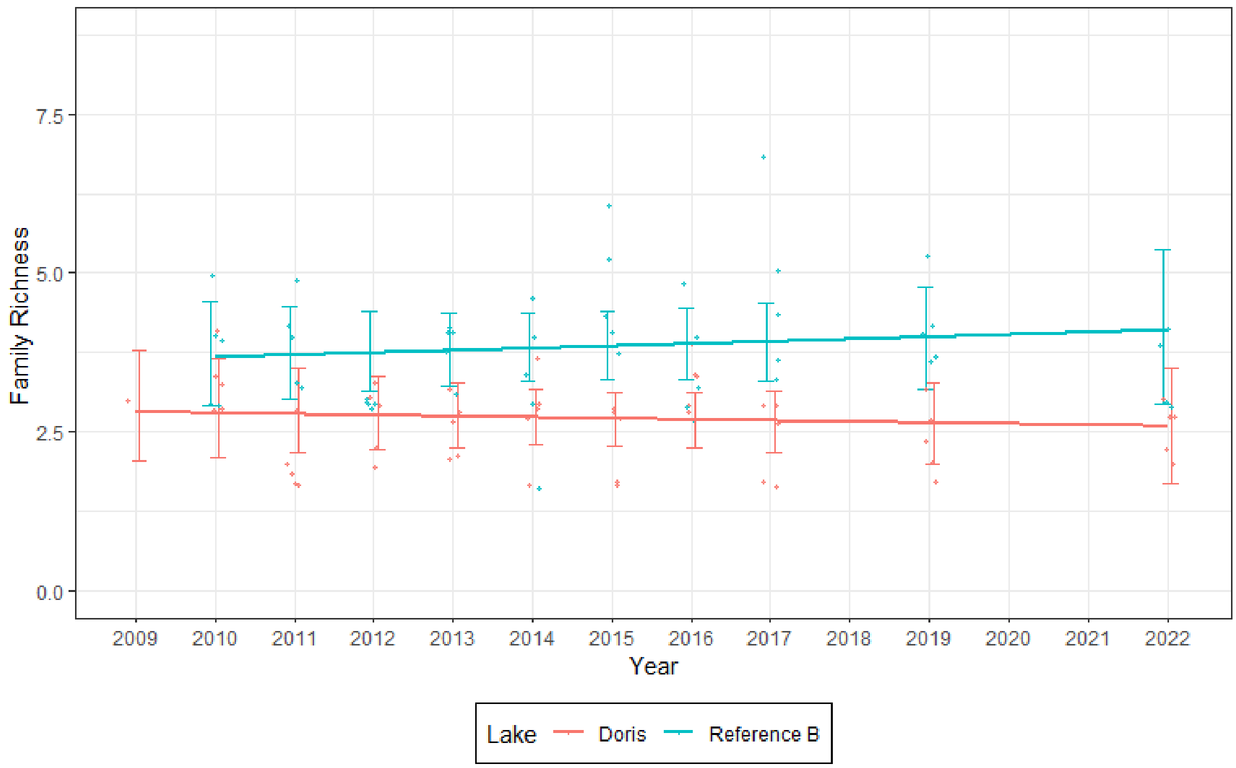
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 0.071 | 1 | 0.7901 | not sig. |

Conclusions:

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

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data. Solid lines represent the fitted curves and the error bars indicate the upper and lower 95% confidence intervals.




### Patch

Before-after analyses were first performed to compare the change in values in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modeling was applied to compare the change in values before and after baseline years between Reference B Lake and Patch Lake.

#### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | z value | p | Significance |
|---|---|---|---|---|---|
| periodafter | 0.0953 | 0.2462 | 0.3872 | 0.6986 | not sig. |

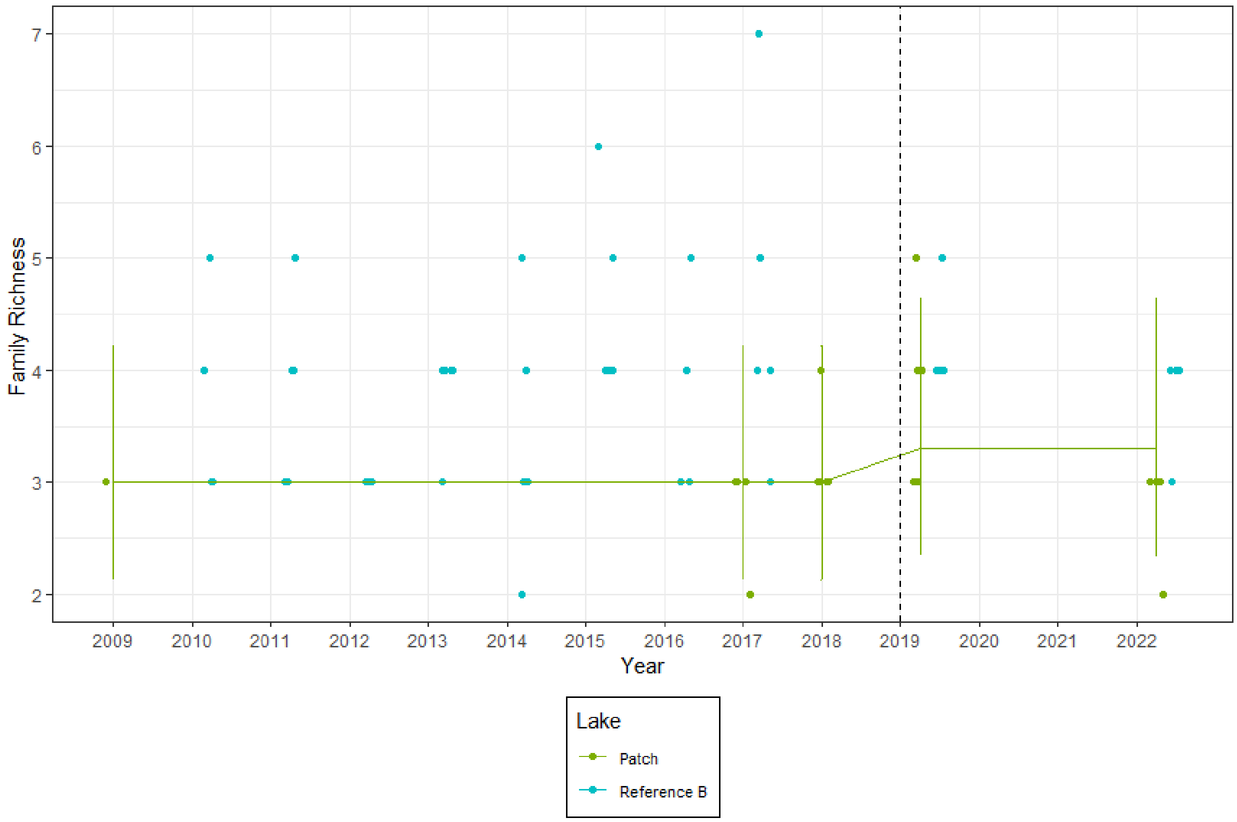
Conclusion:

The change at the Patch Lake from before to after was not significantly different.

BACI analysis not performed.

#### *Observed Data and Fitted Values*

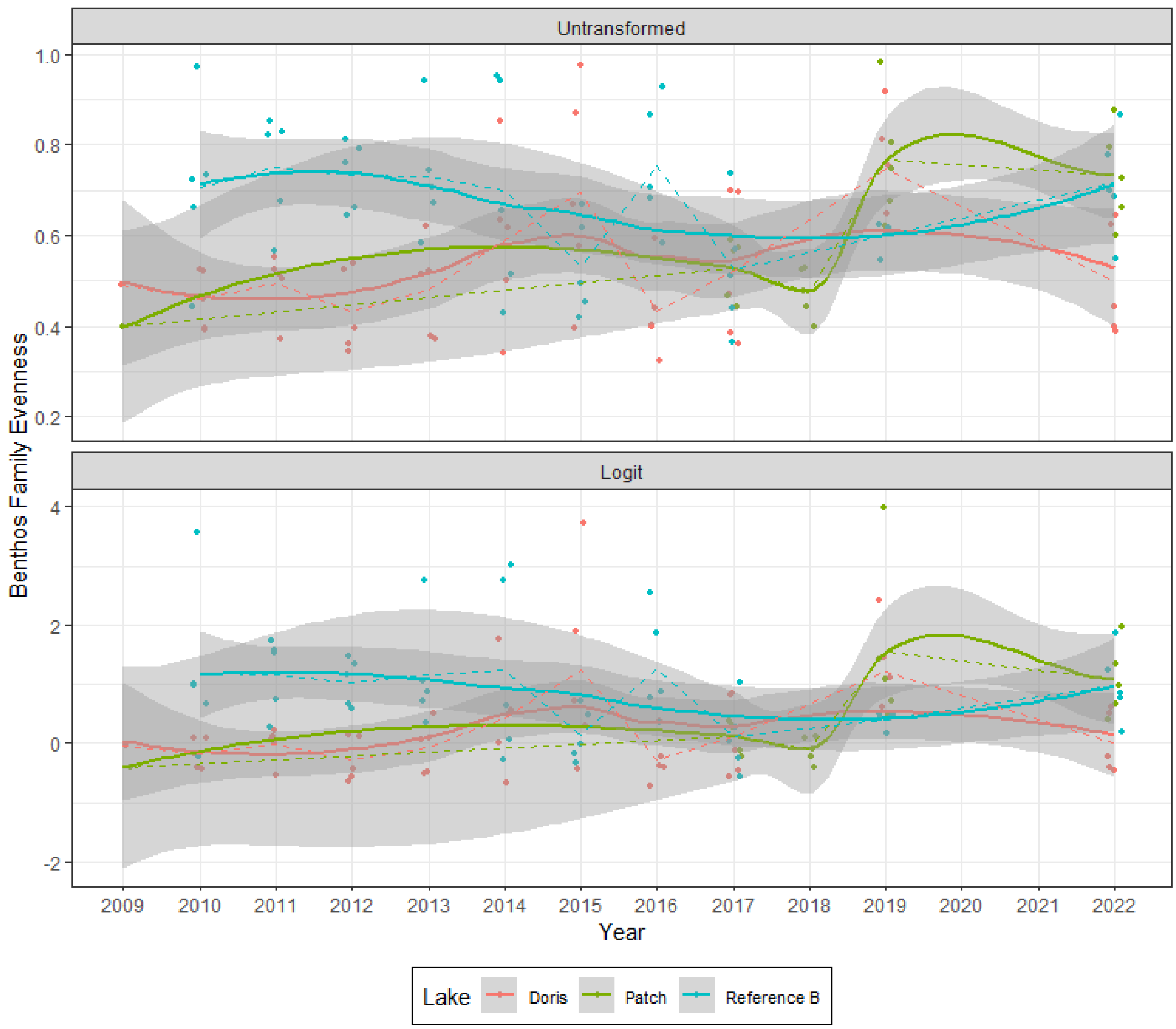
Below are plots of the observed and fitted data. The symbols represent the observed data values. Solid lines represent the fitted means and error bars indicate the upper and lower 95% confidence intervals.


Family Richness
7
6
5
4
3
2
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Lake
Patch
Reference B

### *C.3.4.3 Benthic Invertebrate Family Evenness*

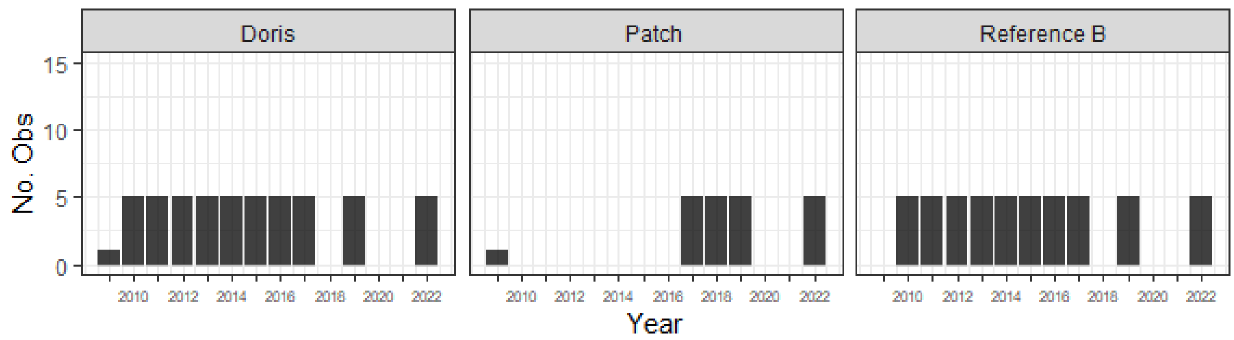
#### Observed Data

The following plots show all the observed data on the untransformed and logit scale. Observations are slightly jittered along the x-axis for legibility. The dashed lines drawn through the scatter plots connect the annual means. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




#### Censored Values and Sample Sizes

The following plots indicate the number of observations for each year from each lake. Due to the nature of benthos family richness data, there are no censored data.



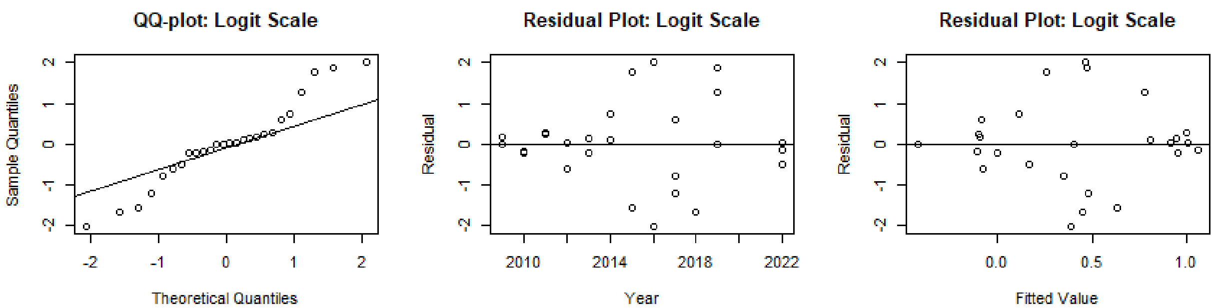

The sample sizes per lake are summarized in the table below.

| Lake | Season | # Obs (total) |
|---|---|---|
| Doris | Open-water | 51 |
| Patch | Open-water | 21 |
| Reference B | Open-water | 50 |

The analysis proceeds with linear mixed model regression.

### Initial Model Fit

The logit transformation was selected since the observed data lies in the interval [0, 1].




Outliers on logit scale:

None

Analysis proceeds with logit transformed data.

### Doris

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

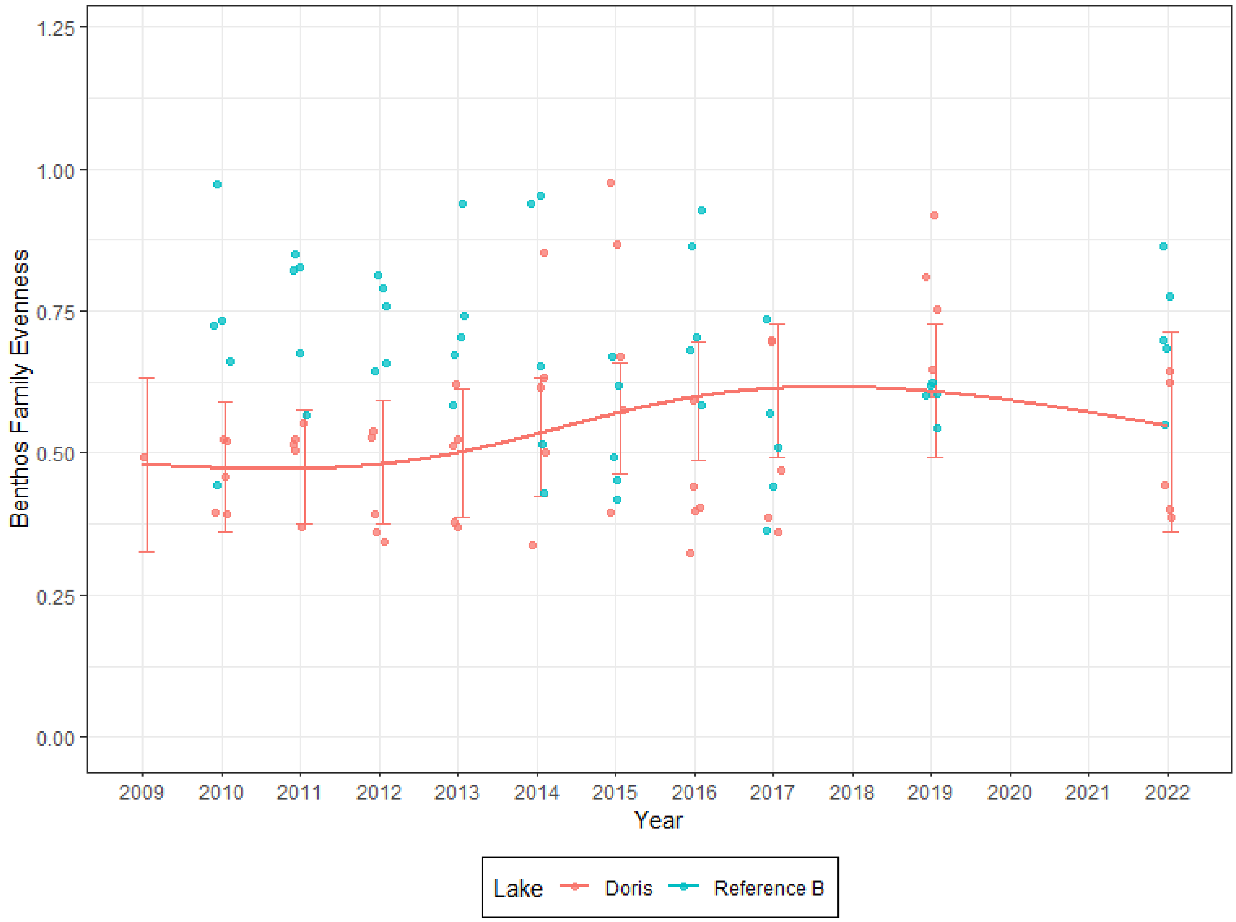
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 4.941 | 3 | 0.1762 | not sig. |

Conclusions:

Doris Lake did not exhibit significant deviation from a slope of zero.

### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data. Solid lines represent the fitted curves and the error bars indicate the upper and lower 95% confidence intervals of the modelled data.




## Patch

Before-after analyses were first performed to compare the change in values in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modelling was applied to compare the change in values before and after baseline years between Reference B Lake and Patch Lake.

### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | 1.34 | 0.3293 | 19 | 4.069 | 0.0007 | sig. |

Conclusion:

The change at the Patch Lake from *before* to *after* was significantly different.

### *BACI Analysis*

Results of the ANOVA test on the fixed effects of the model:

| | Sum Sq. | Mean Sq. | NumDF | DenDF | F value | p |
|---|---|---|---|---|---|---|
| class | 0.330 | 0.330 | 1 | 61.738 | 0.4377 | 0.5110 |
| period | 3.791 | 3.791 | 1 | 4.556 | 5.0278 | 0.0802 |
| class:period | 7.360 | 7.360 | 1 | 61.738 | 9.7610 | 0.0027 |

Estimated marginal means for site class by period:

| Class | Period | LSmean | SE | DF | LowerCL | UpperCL |
|---|---|---|---|---|---|---|
| Monitored | after | 1.3084 | 0.2746 | 12.90 | 0.7147 | 1.9021 |
| Reference | after | 0.6940 | 0.2746 | 12.90 | 0.1003 | 1.2877 |
| Monitored | before | -0.0315 | 0.2817 | 14.88 | -0.6323 | 0.5693 |
| Reference | before | 0.9131 | 0.1389 | 12.90 | 0.6127 | 1.2134 |

- Results are given on the natural log scale.

Summary of BACI contrasts for relative difference between changes from the *before* to *after* in Patch and Reference B Lakes, with 95% confidence intervals:

| Patch vs: | Estimate | Lower C.I. | Upper C.I. | Significance |
|---|---|---|---|---|
| Reference Sites | 1.559 | 0.5614 | 2.557 | sig. |

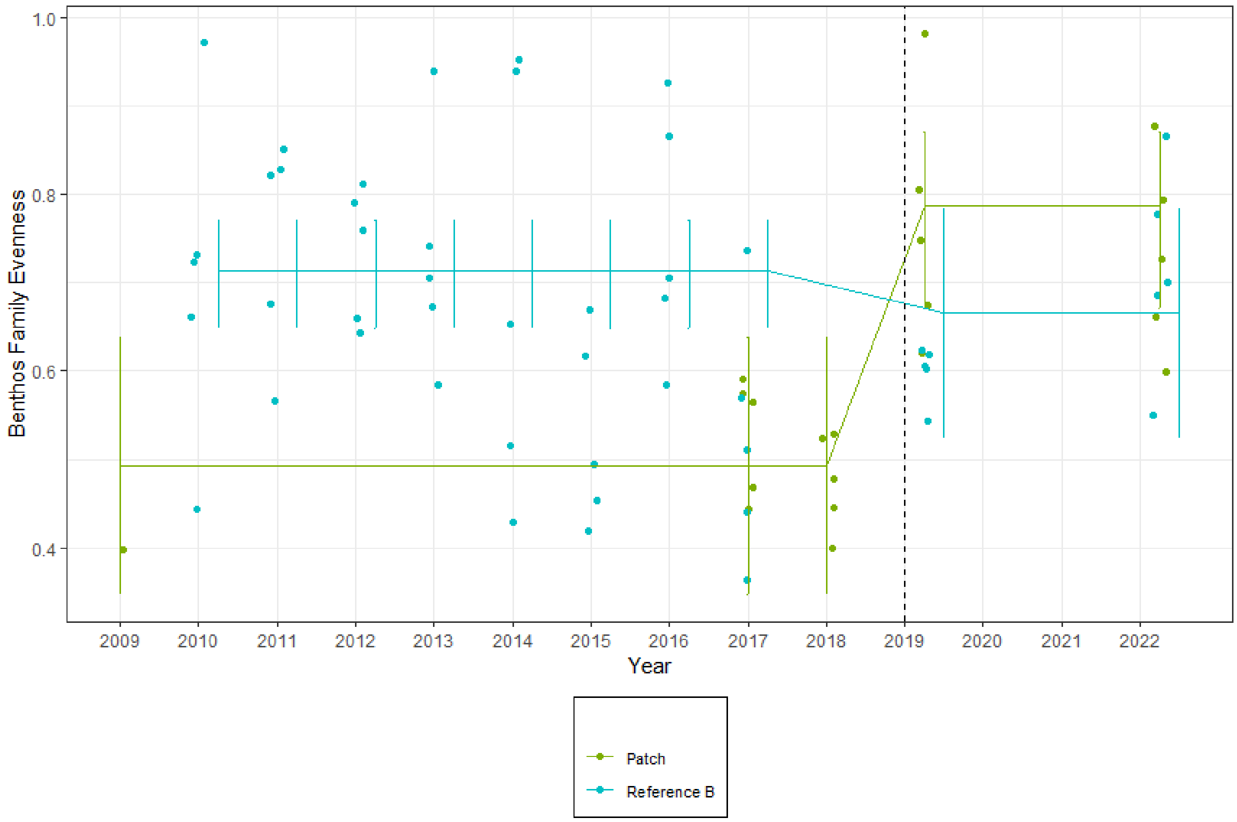
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

The change at the Patch Lake from *before* to *after* was significantly different from the change at Reference B Lake, according to the test on the BACI term (*class:period*).

### *Observed Data and Fitted Values*

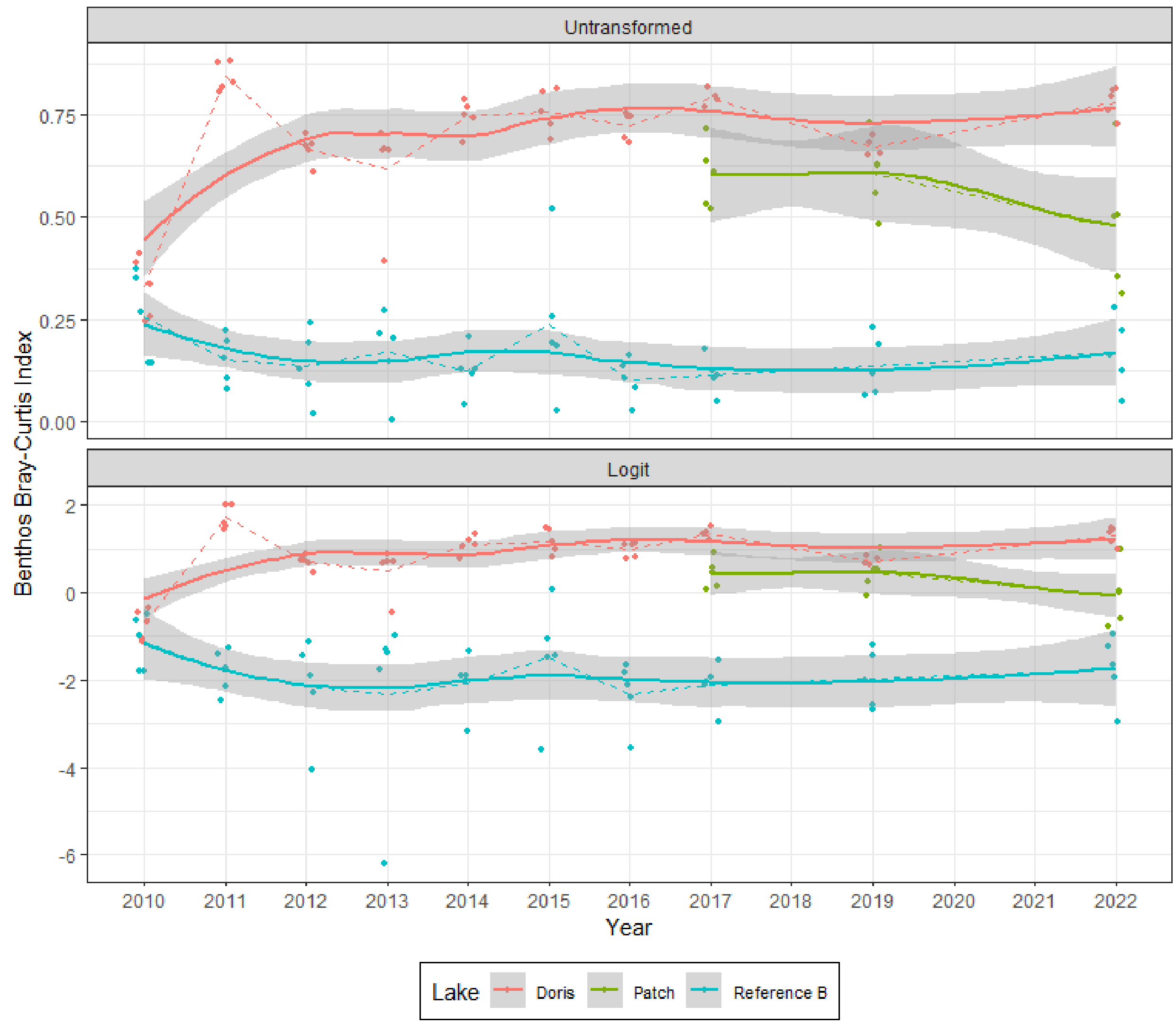
Below are plots of the observed and fitted data. The symbols represent the observed data values. Solid lines represent the fitted means and error bars indicate the upper and lower 95% confidence intervals.




### C.3.4.4 Bray-Curtis Index

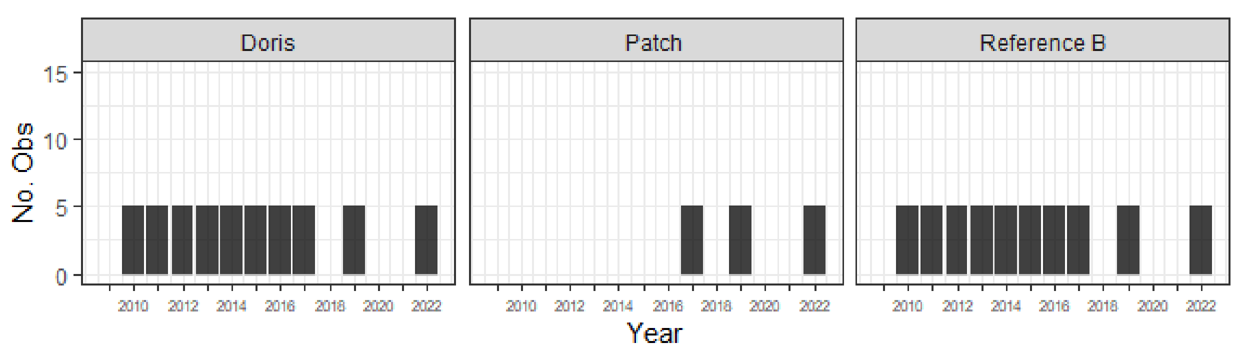
#### Observed Data

The following plots show all the observed data on the untransformed and logit scale. Observations are slightly jittered along the x-axis for legibility. The dashed lines drawn through the scatter plots connect the annual means. LOESS smoothing curves and corresponding 95% confidence intervals (gray shading) are shown to provide a representation of trends in the data.




## Censored Values and Sample Sizes

The following plots indicate the number of measurements taken in each year from each lake. Due to the nature of benthos Bray-Curtis Index, there are no censored data.



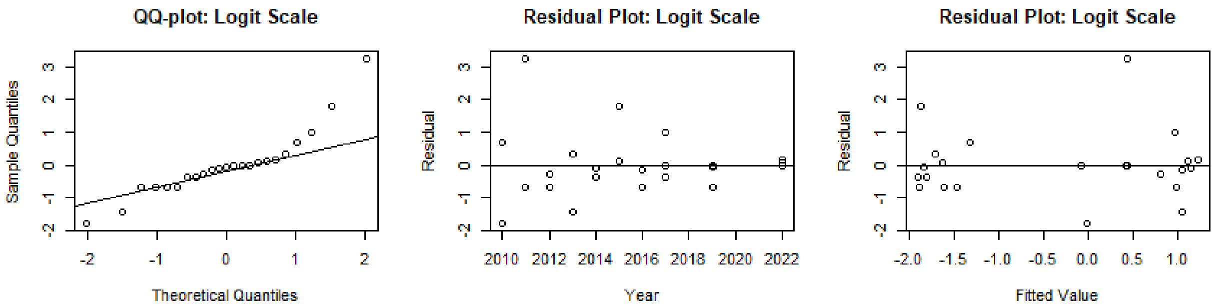
The sample sizes per lake are summarized in the table below.

| Lake | Season | # Obs (total) |
|---|---|---|
| Doris | Open-water | 50 |
| Patch | Open-water | 15 |
| Reference B | Open-water | 50 |

The analysis proceeds with linear mixed model regression.

### Initial Model Fit

The logit transformation was selected since the observed data lies in the interval [0, 1].




Outliers on logit scale:

| | Lake | Year | Season | Depth.Zone | Impute | Fitted | Std. Residual |
|---|---|---|---|---|---|---|---|
| 3 | Doris North | 2011 | Open-water | Deep | 0.8441955 | 0.432089 | 3.260495 |

Analysis proceeds with logit transformed data. However, there was an outlier retained in the analysis. Results should be interpreted with caution and along with graphical results.

### Doris

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

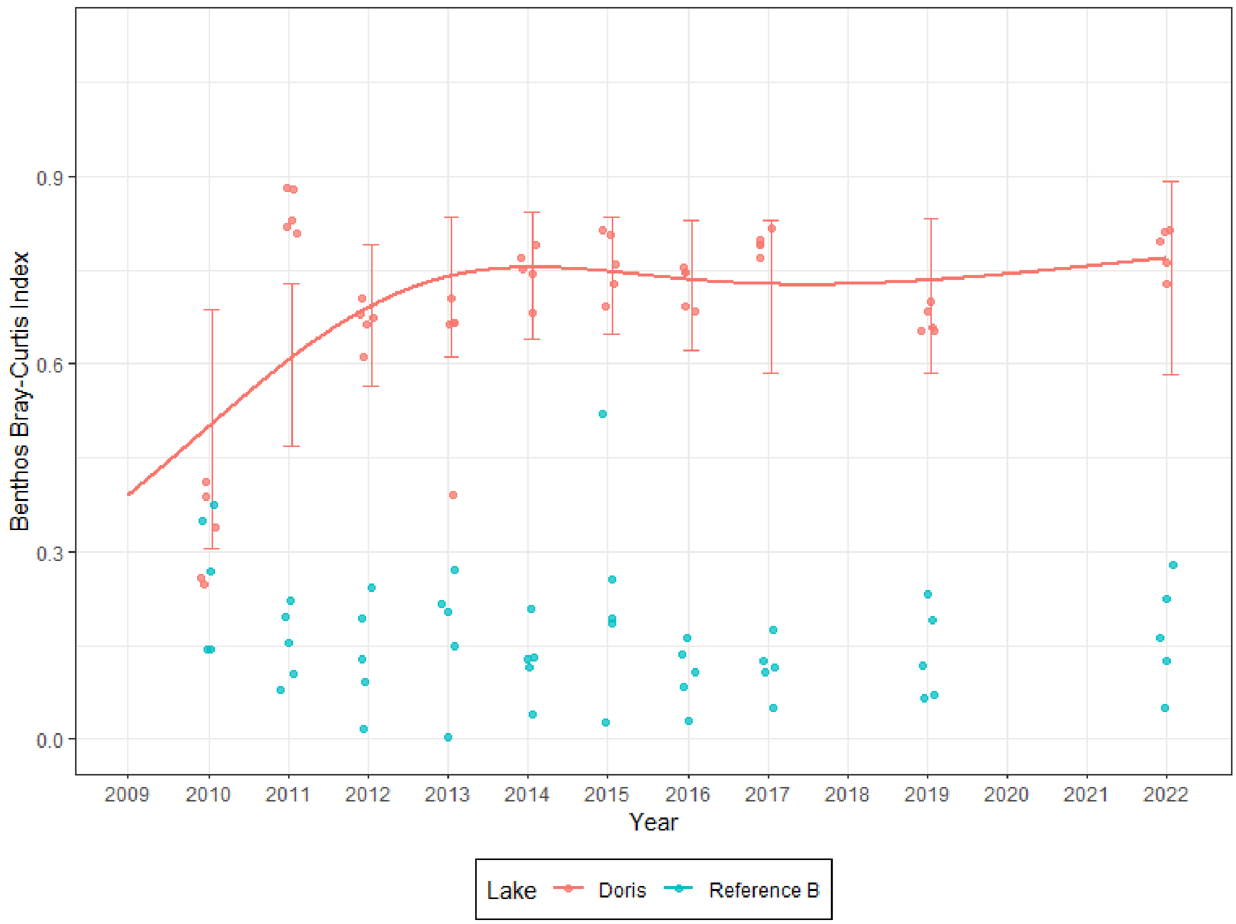
| Analysis | Chi.sq | df | p | Significance |
|---|---|---|---|---|
| Compare to slope zero | 7.31 | 3 | 0.0626 | not sig. |

Conclusions:

Doris Lake did not exhibit significant deviation from a slope of zero.

#### *Observed Data and Fitted Values*

Below are plots of the observed and fitted data. The symbols represent the observed data. Solid lines represent the fitted curves and the error bars indicate the upper and lower 95% confidence intervals of the modelled data.




### Patch

Before-after analyses were first performed to compare the change in values in the before and after period in the monitored site. If a change has been detected then before-after-control-impact linear modeling was applied to compare the change in values before and after baseline years between Reference Lake B and Patch Lake.

#### *Before-vs-After Analysis*

| Coefficient | Estimate | Std. Error | df | t value | p | Significance |
|---|---|---|---|---|---|---|
| periodafter | -0.2415 | 0.453 | 1 | -0.533 | 0.6883 | not sig. |

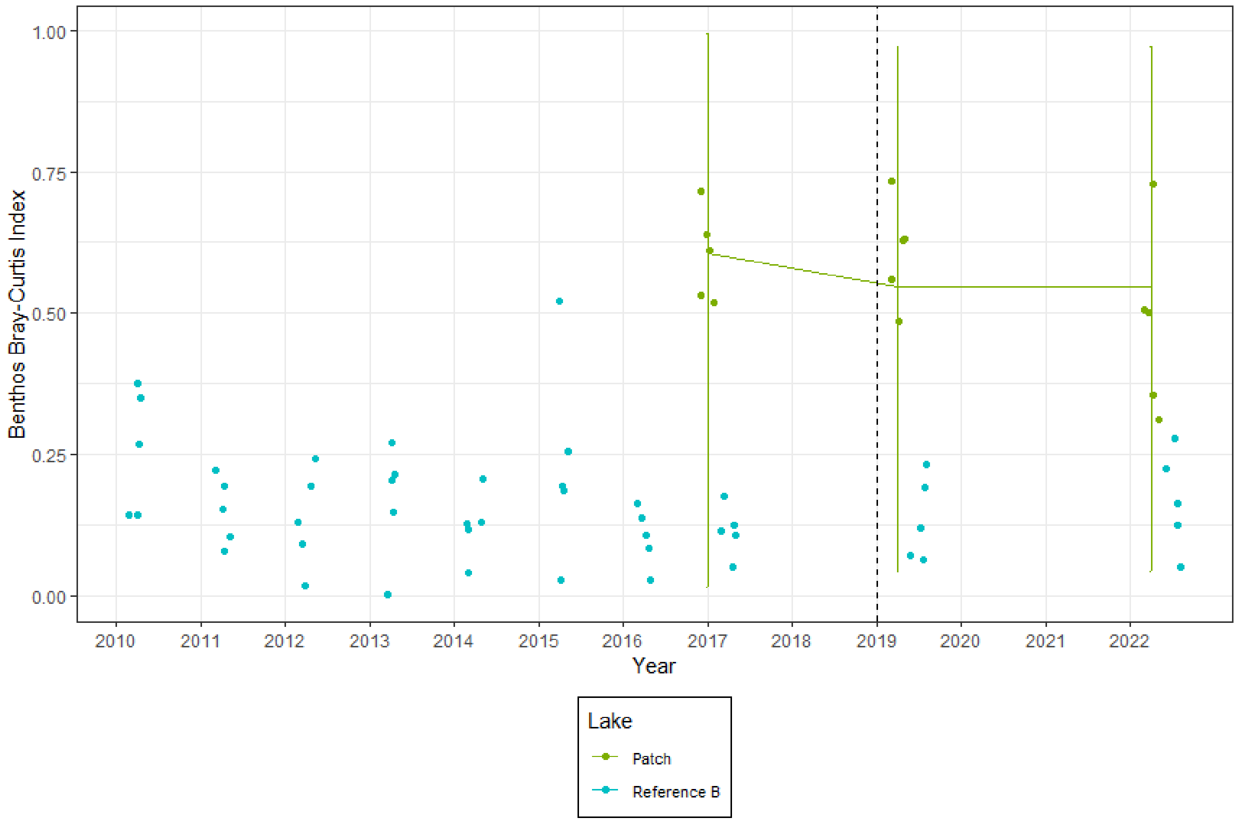
Conclusion:

The change in benthos Bray-Curtis Index at the Patch Lake from *before* to *after* was not significantly 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 and error bars indicate the upper and lower 95% confidence intervals.


Benthos Bray-Curtis Index
1.00
0.75
0.50
0.25
0.00
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Lake
Patch
Reference B